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All India Coordinated Wheat and Barley Improvement Project

PROGRESS REPORT
2014-15

Vol.III

CROP PROTECTION

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Every effort has been made to avoid errors or misprints, etc. However, any printer's devils or omissions that might have crept in inadvertently may please be excused.

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CONTENTS

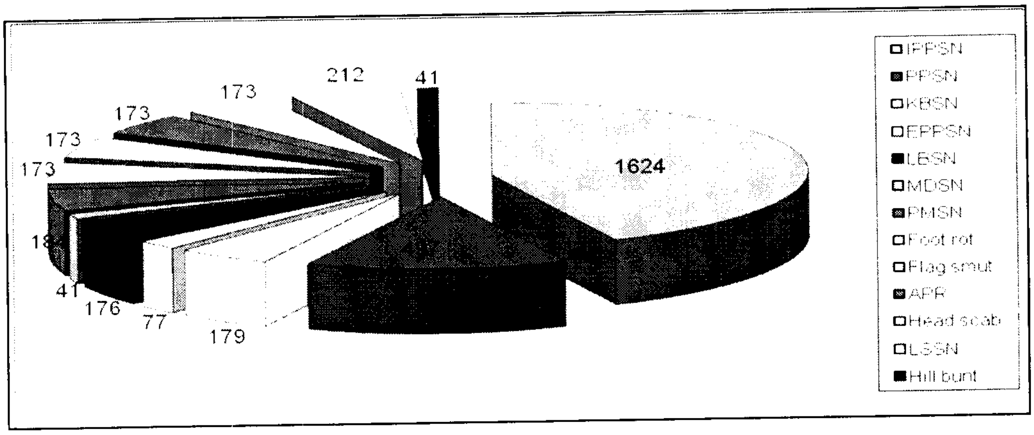
SUMMARY

The major thrust areas of Crop Protection are: crop health monitoring (pre and post harvest), distribution of rust pathotypes, host resistance, rust resistance genes postulation and pest management (host resistance, tillage options, chemical control and IPM modules). The highlights of the programme are given hereunder:

HOST RESISTANCE

For providing support to the wheat breeding programme, evaluation of disease/pest screening nurseries was undertaken at various hot spot locations under natural and artificially inoculated conditions. The major nurseries were: IPPSN, PPSN, EPPSN, MDSN, MPSN, and disease/pest specific nurseries.

The Initial Plant Pathological Nursery (IPPSN), with 1624 entries and Plant Pathological Screening Nursery (PPSN) with 497 genotypes including checks, are the main nurseries which are the major components of the Decision Support System in promotion of entries from one stage to the other, and finally the identification of genotypes for release. The other nurseries that are evaluated at hot spot multilocations are, LBSN, KBSN, LSSN, PMSN, nurseries for diseases of limited importance (FHB, Foot rot, hill bunt, flag smut), EPPSN, MDSN, MPSN and the evaluation against nematodes and insect pests. AVT entries were also evaluated at specific locations for Race Specific Adult Plant Resistance (APR) to three rusts (brown, black and yellow). Slow rusting lines for different rusts were identified by calculating the Area Under Disease Progress Curve (AUDPC) at Karnal (stripe rust) and Mahabaleshwar (leaf & stem rusts) centres. Constitiution of plant pathological nurseries during 2014-15 has been shown below:



Constitution of different plant pathological nurseries during 2014-15

Rust resistance materials in AVT IInd and Ist Year (2014-15) with ACI upto 10.0 are given below:

Stem, Leaf and Stripe Rusts

AVT IInd Year

HD 4728 (d), HD 4730, HI 8498 (d) (C), HI 8737 (D)(I) (C), HS 507 (C), MPO 1215 (d) (C), PBW 723, PDW 233 (C), TL 2942 (C) and TL 2969 (C).

AVT Ist Year

DBW 181, DDW 31, HI 8759 (d), HI 8765 (d), HPBW 02, HPBW 08, HPBW 09, HPW 394, HPW 422, HS 580, HS 596, HS 597, HS 599, HUW 695, HUW 712, K 1312, K 1314, MACS 3949, MACS 3970 (d), MACS 3972 (d), MACS 4024, PBW 709, PBW 718, TL 3001, TL 3002, TL 3003, TL 3004, TL 3005, UAS 453 (d), UAS 455 (d), VL 3002, VL 3007, VL 3008, WB 1 and WB 5.

Stem and Stripe Rusts

AVT IInd Year

UAS 428 (d) (C)

AVT Ist Year

DBW 184, HI 1604, HPBW 07, HPW 421, HS 601, PBW 707 and VL 1006.

Stem and leaf rusts

AVT IInd Year

DBW 14 (C), DBW 88 (C), DPW 621-50 (C), GW 322 (C), HD 2864 (C), HD 2888 (C), HD 2967 (C), HD 3043 (C), HD 3059 (C), (HD 2932 + *Lr* 19/*Sr*25), HI 1544 (C), HI 1563 (C), HD 4730 (d), HPW 251 (C), HPW 349 (C), HS 490 (C), HS 542 (C), HW 1098(C), MACS 6222 (C), MP 3336 (C), PBW 644 (C), Raj 4083 (C), VL 829 (C), VL 892 (C), VL 907 (C), WH 1021 (C), WH 1080 (C) and WH 1105 (C).

Leaf and stripe rusts

AVT IInd Year

PDW 314 (C) and UAS 446 (d) (I) (C)

AVT Ist Year

DDW 32, HD 3165, HS 583, HS 600 and PBW 721.

Seedling resistance in wheat genotypes

To identify rust resistant lines of wheat and characterize rust resistance genes, 173 lines of AVT I and II were evaluated at seedling stage using an array of pathotypes of black (*Puccinia graminis tritici*), brown (*P. triticina*) and yellow rust (*P. striiformis*) having different avirulence/virulence structures. None of the lines was resistant to all the rusts. Three lines of AVT II and one line of AVT I exhibited resistance to the two rusts. In addition to all the lines having *Sr*31 were resistant to black rust of wheat, whereas lines possessing *Lr*24, some with *Lr*26 were resistant to brown rust and few lines with *Yr*9 showed resistance to yellow rust of wheat. Details of the wheat rust resistant lines are given below:

AVT 2nd Year

Resistant to black and brown rusts: HI 1563 (C) and PBW 723.

Resistant to black and yellow rusts: HD 3043 (C)

Resistant to yellow rust only: HD 3059 (C) and MACS 3927(d).

Resistant to black rust only: HD 2932 (C), HI 1544 (C), TL 2942 (C) and TL 2969 (C).

Resistant to brown rust only: HD 2684 (C), HD 4728 (d), HD 4730 (d), MACS 6222 (C), NIAW 2030 and UAS 446 (d) (C).

AVT I year

Resistant to black and brown rusts: HPBW 09

Resistant to yellow rust only: DBW 182, DDW 32, HD 3171, HPBW 07, HS 596, HUW 688, HUW 695, MACS 3972, PBW 709, UP 2883 and VL 3002.

Resistant to brown rust only: DBW 147, HPBW 08, MACS 3949, MACS 4024, TL 302, TL 303 and WB 5.

Based on rigorous screening of multiple diseases screening nursery at multilocations, following genotypes have been identified for multiple disease resistance:

Resistant to all rusts +Leaf Blight (LB) + Karnal Bunt (KB) + Flag Smut (FS): HI 8738 (d)
Resistant to all three rusts +LB + PM: PBW 660
Resistant to all three rusts + FS: HI 8724 (d), HI 8725 (d) and HI 8728 (d)
Resistant to all three rusts: HPW 381, UP 2871 and WH 1098.
Resistant to stem and leaf rust + KB + FS: HI 8739 (d), HI 8742 (d), HS 578 and NIDW 699 (d).
Resistant to stem and leaf rust + LB + PM: HW 1900, HW 4042, HW 5237 and MACS 5031.
Resistant to stem and leaf rust + PM + FS: DDK 1044 (dic.), DDK 1045 (dic.)
Resistant to stem and leaf rust + LB: KRL 348, VL 3001, GW 432, HUW 668, HW 4013, UP 2872 and WH 1137.
Resistant to stem and leaf rust: RAJ 4250, HI 1588 Q, HW 1099, HW 5235, JAUW 598, RAJ 4324, UP 2843, UP 2847
Resistant to leaf and yellow rust + LB + KB + FS: NIDW 706 (d)
Resistant to leaf and yellow rust + LB + PM + FS: HW 5224
Resistant to stem and yellow rust + LB: HD 3121

Utilization of resistance sources through NGSN

A total of 15 entries known for confirmed sources of multiple disease and insect pests resistance were contributed in the NGSN, 2014-15. They were planted at 23 breeding centres across different agro climatic zones of country for their utilization in breeding programme against various biotic stresses. All 15 entries were utilized in the range of 8.7 – 52.2% by most of the breeding centres. The most utilized entries at many centres were HI 1579, HD 3098, PBW 658, Raj 4270, HS 526 and HS 557. The Kanpur centre, utilized 12 entries in their breeding programme followed by Powarkheda.

Preparedness to combat Ug99

Indian wheat advance lines (200) were evaluated at Kenya and Ethiopia for resistance against Ug99, as a part of our strategy to meet the threat in case this pt. is able to enter India.

Rust resistance genes in AVT material

To know the genetic diversity in Advance Varietal Trial material, rust resistance genes were characterized using host- pathogen interaction data and applying gene matching technique. Mostly rust resistance genes were inferred in those wheat lines where differential response to rust pathotypes were observed, however, morphological markers, genetic linkage and characteristic infection types were also used to reach at a conclusion.

***Yr* genes:** Five rust resistance genes (*Yr*2, A, 9, 18 and 27) to yellow rust of wheat were characterized in 47 lines of AVT II. Among these *Yr*2 was inferred in more than 70 % lines followed by *Yr*9 gene which was characterized in about 30% lines. Other resistance genes were postulated in few lines only. In AVT I lines, three *Yr* genes (*Yr*2, A and 9) were observed in 67 lines. *Yr*2 was postulated in 40 lines followed by *Yr*9 in 19 lines and *Yr*A in 7 lines only.

***Sr* genes:** In AVT II, 10 *Sr* genes (*Sr*2, 5, 8a, 9b, 9e, 11, 13, 24, 25 and 31) were postulated in 65 lines. *Sr*2 based on characteristic mottling was observed in 56 lines followed by *Sr*11 in 23 lines and *Sr*31 based on its linkage to *Lr*26/*Yr*9 in 13 lines. The resistance of most of the durums was based on *Sr*7b, 9e and *Sr*11. Other *Sr* genes were inferred only in few lines. In AVT I, 14 *Sr* genes (*Sr*2, 5, 7b, 8a, 9b, 9e, 11, 12, 13, 15, 24, 25, 30 and 31) were postulated in 99 lines. *Sr*2, known adult plant resistance gene to stem rust was observed in 63 lines followed by *Sr*11 in 37, *Sr*7b in 34 and *Sr*31 in 19 lines. *Sr*9e was characterized in 7, *Sr*13 in 6 lines whereas remaining eight *Sr* genes were postulated in few lines only.

***Lr* genes:** In AVT II, nine *Lr* genes (*Lr*1,10,13,14a,19,23,24,26,34) in 60 lines where differential host pathogen interactions were observed. Like AVT I, *Lr*13 was postulated in 22 lines followed by *Lr*23 in 21, *Lr*26 in 13 and *Lr*10 in 11 lines. *Lr*1, *Lr*34 and *Lr*24 were found to confer brown rust resistance in 8, 6 and 4 lines, respectively. In addition *Lr*14a and *Lr*19 were characterized in one line each. In AVT I, nine *Lr* genes viz. *Lr*1, 2a, 10, 13, 19, 20, 23, 24 and 26 were characterized in 87 lines. Among these *Lr*13 was most common and was observed in 48 lines. This gene is known widely for conferring resistance to brown rust at high temperatures. *Lr*23 was characterized in 30 lines followed by *Lr*10 in 23, *Lr*26 in 19 and *Lr*1 in 16 lines. Other resistance genes namely *Lr*2a, *Lr*19 and *Lr*24 were observed in 3, 1 and 1 lines, respectively. These had been further decrease in the proportion of *Lr*26 in AVT I accessions in comparison to the previous years.

SURVEY AND SURVEILLANCE

Pre- Harvest Crop Health Monitoring

Crop health was rigorously monitored during the crop season as well during the off season in the high hills of Himachal Pradesh (Lahaul, Spiti, Kullu), Nilgiri hills (Tamil Nadu) and J & K (Ladakh). Advisory for stripe rust management was issued during December-March regularly. Information on wheat crop health was disseminated through the "*Wheat Crop Health Newsletter*", Vol. 20. Mehtaensis Vol. 35, No. 1 and 2 was issued in January and July, respectively. This crop year was marked with the sporadic appearance of yellow (stripe) rust in some pockets of Northern India. Though the yellow rust was observed in early January 2015, however, due to the resistance in cultivated varieties as well as pro active steps for the management, it could be managed well. In Karnataka, leaf rust was observed in Lokur area of Dharwad on January 2, 2015 in Local bread wheat variety (parrot green colour ear head). In Maharashtra, leaf rust was observed on January 28, 2015 in village Kenjal (Satara), on var. Lok-1. Except for the yellow rust in NHZ and NWPZ, the overall crop health status was satisfactory in the country.

Stripe Rust

Punjab: On 24-12-2014, yellow rust was reported in one field in the village Daroli Upper near Anandpur Sahib on unrecommended wheat variety Berbet. In 2nd week of January, one foci of infection of yellow rust was observed in villages of Chhidauri (on var. DBW-17) and Kharod (on var. HD-2967) in SBS Nagar and in Mohan Mazra (on var. HD 2967) in Ropar. Yellow rust was observed in village Dakal, Ropar in variety HD 2967 on 29.1.2015. On February 18, 2015, yellow rust was noticed at farmers fields in villages Pasredi Jatta Chamkaur Sahib, Morinda and Ropar. On 19.2.2015, there was incidence of yellow rust in few villages on the route but from Langroya to Saroa, almost all the fields were infected with yellow rust but severity was very low (upto 10S) except for the village Diyall where one field (var. HD 2967) around one acre was severely infected with yellow rust (60S). Yellow rust was observed in TRAP plot nurseries (TPN) sown at KVK Lngroya and KVK Ropar.

Haryana: On January 16, 2015, stripe rust was observed (10 MS-S) in one field in Yamunanagar area. In Munda khera village, Chhachhurali, stripe rust was severe (40-60S) in 10m x 7 m area in the early sown crop (var. Barbat). The late sown crop is having few plants infected with yellow rust. In another field of Mr. Joneykumar, Pahadipur village, Sadhaura, Super 172 was found infected with stripe rust (trace-

10MS). On 28th January, 2015, yellow rust was observed on variety HD 2851 at one farmers field in village Mahua Kheri, Babbain (Kurukshetra). On 31.1.2015, yellow rust was noticed on the field of Sh. Sunder, village Chhapra, Ambala. On February 9, 2015, yellow rust (10S) was recorded in variety HD 2967 at Jaloda, Yamunanagar. On 12th February, 2015, yellow rust was observed only at Bharwabgarh, Budhia (5S) and in farmers fields of Fatehgarh (20 - 40S) villages. In 2nd week of February, yellow rust was noticed in village Ding on HD 2851 in Sirsa district in traces. On February 19, 2015, yellow rust was reported n the village Shargarh (Karnal).

Himachal Pradesh: In last week of January, yellow rust was recorded with minor incidence and severity less than 10S on PBW 550 at Nagrota Suria Dam area (Nagrota Surian block) and HD 2967 at Lunj Kahlian (Kangra block) and Bhanth (Fatehpur block). However, the disease was observed in severe form touching severity 60S on varietal mixture (Raj 3765 main) in a large patch (Focus) at Bhanth-Sthana (Fatehpur block). Wheat Disease Monitoring Nursery/ Trap Plot Nursery of wheat planted at SAREC Kangra was free from rust in the last week of January. During 2nd week of February, yellow rust was noticed in Barotiwala (Paonta) on wheat variety HD 2967 at 3-4 locations in traces. Yellow rust was also recorded in traces on local variety in village Shivpur. High severity of yellow rust up to 60S was recorded on HD 2967 and HD 2380 in village Bharapur on February 16, 2015. Similarly, high severity of yellow rust up to 40S noticed in village Kolar at three locations. Yellow rust in Trap and SAARC nurseries was recorded at Dhaulakuan on February 10, 2015 on wheat varieties, WL-711 (10S), HD-2329 (5S), Agra local (10S), Lal Bhadur (10S), Kharchia mutant (10S), HP 1633 (5S), WH 147 (10S), Anna Purna (5S), HD 2189 (10S), Pak 81 (5S) and susceptible check (30S). Yellow rust in traces was reported from same places of district Bilaspur, Hamirpur, Kangra, Mandi, Sirmour and Una during 1st week of February. During 2nd week of February, yellow rust was observed in traces in Bilaspur (villages, Nanawan and Bhatoli), in Mandi (villages, Mehar, Surahi, Tandu), in Una (villages, Adarsh Nagar, Amb, Athwan, Krishna Nagar, Busal, Dehar, Badoh, Jalgran) and in Sirmour (villages, Dhaun, Bhangani, Nagal, Phoolpur, Shivpur, Subhkhera, Surajpur).

Jammu & Kashmir: On 8th January, 2015, the presence of any yellow rust was observed in SAARC and TPN nursery (Village- Saharan) on Agra Local. On 25th January, 2015, stripe rust was observed on PBW-175 with some pustules with 5S severity at Lalyal Camp (Jammu) at the field of Yash Paul Sharma. On 26th January, 2015, the field of Taj Ram (Chak Gogal) of wheat variety HD 2967was found infected with yellow rust in 2-3 patches with 20MS severity. On one field of Bal Dev Singh (Nagari, Kathua), many foci of stripe rust with severity of 10-20MS were observed. One field in Arnia of unknown wheat varieties was also infected with stripe rust (0.05 ha) with 10-20S severity. Stripe rust was also observed on wheat varieties HD-2967 and RSP-561 with 10-20MS severity in 4-5 patches (1 meter) in experimental field of Chatha, SKUAST -Jammu on 20th January. On February 10, 2015, field patches of yellow rust were noticed in Jammu and Samba district in Jammu region. These patched were of 2 - 10 m^2 with the severity of 10-60S.

Uttarakhand: On 16 Feb 2015, yellow rust was observed in traces atne of the farmer's field at village Chunpuri (Gadarpur) in patches showing severity of 70S in PBW 343 in one hectare area.

WHEAT DISEASE MONITORING NURSERY (WDMN)

Over the years wheat disease monitoring nursery (earlier trap plot nursery) is working as a logistic and effective tool for monitoring the occurrence of rusts, blights, powdery mildew and other wheat diseases across different wheat growing zones of India. Additionally, it has helped in knowing the seasonal progress of these diseases over different wheat growing zones. Wheat and barley rust samples collected from WDMN gives an overview of area wise distribution and load of rust pathotypes. The effectiveness of different wheat lines or resistance genes has been assessed through the WDMNs. The 47th wheat disease monitoring nursery was planted at 43 locations covering all the major wheat growing areas in the country, especially those situated near the bordering areas to the neighboring countries. There were 20/21 (High Altitude Zone and North Hills Zone) entries in the nursery during 2014-15. Of these, first 15 entries were common to all zones, rest of the five/six (northern hills and high altitude zone) entries were zone specific varieties. Keeping into account the changed varietal situation along with pathogen dynamics, some changes were made in the composition of WDMN entries for some of the zones.

SAARC Wheat Disease Monitoring Nursery

Under the umbrella of Regional Station, ICAR-IIWBR, Shimla and CIMMYT, Nepal, SAARC wheat disease monitoring nursery is being conducted in SAARC countries with the objectives similar to the wheat disease monitoring nursery (WDMN) in India. During 2014-15, SAARC wheat disease monitoring nursery was planted at 27 locations across the six SAARC countries. Information on wheat diseases in SAARC Wheat Disease Monitoring Nursery has been received from all the locations in India, Bangladesh and Bhutan.

Wheat disease situation in India

Rusts

SAARC nursery was planted at 12 locations of NHZ and NWPZ, Faizabad, Pusa and Wellington. Yellow rust was observed at all the SAARC nursery locations in India except at Pusa, Faizabad and Wellington. Yellow rust was first observed at Udhaywalla (10.01.15) followed by Pantnagar (30.01.15), Kathua (02.02.15), Dhaulakuan (13.02.15), Almora (4th week of February, 2015) and Jaipur (28.02.15). All the entries of SAARC nursery were infected at Dhaulakuan, where 19 entries of the SAARC nursery were showing more than 40S yellow rust severity. At Delhi only 6 entries *viz.*, Annapurna (5S), PBW 343 (10S), HD 2687 (5S), HP 1633 (TR), Kohsar (20S) and susceptible check (50S) were showing yellow rust infection. During last year crop season, there was no yellow rust on SAARC nursery at Jaipur however during 2014-15, all the entries except PBW 660 were infected with it. PBW 343 was showing more than 40S severity of yellow rust at 7 locations.

Brown rust was observed at all the SAARC nursery locations except at Dhaulakuan, Rajauri, Dera Baba Nanak and Jaipur. First report of brown rust was from Pusa (20.02.15) followed by Faizabad (24.02.15), Pantnagar (05.03.15), Delhi (09.03.15), Udhaywalla (19.03.15) and Kathua (21.03.15). At Abohar and Ludhiana, only susceptible check was showing brown rust infection with 40S and 10S severity, respectively. Only three entries *viz.*, PBW 343 (TR), Kohsar (TR) and susceptible check (10S) were infected with brown rust at Pusa. Similarly at Faizabad, Annapurna (30S), PBW 343 (20S) and Check (80S) were the only entries showing brown rust infection. All the entries except Raj 3765 and Bakhtawar 94 were the only brown rust free entries at Wellington. At Pantnagar, six SAARC nursery entries *viz.*, HD 2204 (TR), HD 2687 (TR), Rawal 87 (5S), Kohsar (15S), Bakhtawar 94 (TR) and susceptible check (10S) were infected with brown rust. Black rust was observed only at Wellington, where the all the entries of SAARC nursery were infected with black rust. Black rust severity at Wellington was ranging from 10S in PBW 343 and Inquilab 91 to 80S in HP 1633.

Blights

Leaf blight of wheat was observed only at seven locations of SAARC nursery. All the entries at Delhi, Dhaulakuan, Dera Baba Nanak, Abohar, Ludhiana, Gurdaspur, Jaipur and Pantnagar were free from leaf blight. All the entries were showing blight infection at the locations where blight was observed except at Wellington, where only 10 entries *viz.*, Annapurna-1, WL 1562, HD 2204, PBW 343, RAJ 3765, Pak 81, Faisalabad 83, Rawal 87, Gourab and susceptible Check were free from blight infection. There was severe leaf blight infection on all the entries of SAARC nursery at Faizabad and Pusa.

Powdery Mildew

Powdery mildew has been reported only from two locations i. e. Almora and Udhaywalla. It was first reported at Almora (06.02.15) and then at Udhaywalla on 11.02.15. All the entries were infected with powdery mildew at both the locations. Ten entries had more than 6 severity of powdery mildew at Udhaywalla, whereas 19 entries were showing less than 5 severity at Almora.

Loose Smut

Loose smut was not reported from any of the location of SAARC nursery in India.

Disease situation in Bhutan

SAARC wheat disease monitoring nursery was planted only at one location in Bhutan. Yellow rust and leaf blight were reported from the nursery planted in Bhutan. HP 1633 was the only entry with 60S yellow rust severity. Leaf blight was observed only on six entries viz., Annapurna-1, WL1563, Pak 81, Faisalabad 85, Kohsar and Gourab.

Disease situation in Bangladesh

SAARC wheat disease monitoring nursery was planted at five locations in Bangladesh i.e. Jamalpur, Jessore, Joydebpur, Rajshahi and Dinajpur. Only leaf blight disease of wheat was observed at all five locations. Brown rust was observed only at Jamalpur and Dinajpur. At Jamalpur, seven entries *viz.*, Annapurna-1 (20R), HD 2687 (10R), HP 1633, (10R), PBW 373 (10R), Pak 81 (10R), Chakwal 86 (10R) and check (20MS) were infected with brown rust whereas at Dinajpur, all the entries except HP 1633, Raj 3765 and Gourab were showing brown rust infection, though the severity was very low. Leaf blight was very severe at all the locations.

PATHOTYPE DISTRIBUTION OF WHEAT RUSTS

Incidence of wheat rusts in India

All the wheat rusts were observed in India during 2014-15. This year was marked by the low incidence of wheat rusts. Black rust (*Puccinia graminis tritici*) was restricted to peninsular India whereas brown rust (*P. triticina*) of wheat was widely distributed with low incidence. Yellow rust (*P. striiformis*) was restricted to northern India in some pockets in endemic form. Yellow rust was reported almost one month late to the previous years and remained below the threshold level because of the joint efforts of ICAR, SAUs and state department of agriculture. During the year, 1262 samples of three rusts of wheat and barley were received from ten states of India and neighboring countries Bangladesh, Bhutan and Nepal.

Sample analysis and pathotype distribution of wheat and barley rusts

So far 793 samples of three rusts of wheat and yellow rust of barley have been analyzed from India and neighboring countries.

Yellow rust of wheat (*P. striiformis*)

Ten pathotypes of wheat yellow rust were identified in 335 samples from seven states of India, Nepal and Bhutan. Population of yellow rust of wheat was avirulent to *Yr*5, *Yr*10, *Yr*13, *Yr*14, *Yr*15, *Yr*26, *Yr*Sp and *Yr*Sk. Owing to the cool and humid weather, increase in the area under non PBW343 varieties especially HD 2967, the population of pathotype 46S119, which is virulent to *Yr*9 and *Yr*A has increased in proportion and was observed in more than 72 % of the samples analyzed so far. Pathotype 78S84 which used to be a predominant pathotype prior to 2010 was identified in 3% of the samples only. Except for the pathotypes T, CI, P and 7S0 which were identified in one sample each, four new pathotypes were recorded in remaining samples. These new pathotypes have more virulence than the existing pathotypes and appear to be mutation in existing pathotypes on Suwon x Omar and Riebesel 47/51. These new pathotypes have been designated as 110S119, 238S119, 46S117 and 110S84. Among these pathotype 110S119 was most common and was identified in about 12% samples. Further studies on these pathotypes are being conducted.

New pathotypes: Five new pathotypes of *Pucciina striiformis* have been identified and confirmed during the year. These have been designated as 46S117, 110S119, 238S119, 110S247 and 110S84. Among these pathotype 110S119 was most common and was identified in about 12% samples. Most of the yellow rust pathotypes are progressive mutations in the existing pathotypes and are more aggressive. *Yr*11, *Yr*12 and most probably *Yr*24, which used to be resistant to yellow rust in India, have been rendered susceptible. Among the 9 lines of AVTI, which were resistant to yellow rust, seven have become susceptible to one or more of the new pathotypes.

Black rust of wheat (*P. graminis tritici*)

Virulence on *Sr*31 (Ug99 type of pathotype) was not identified anywhere in India, Bangladesh, Bhutan and Nepal. Population of black rust of wheat was avirulent to *Sr* 26, *Sr* 27, Sr 31, *Sr* 32, *Sr* 35, *Sr*39, *Sr* 40, *Sr* 43, *Sr*Tt3 and *Sr* Tmp. Seventy two samples were analyzed from six states of India. Among the eight pathotypes identified in black rust samples, pathotype 11 was observed in more than 50% of the samples followed by 40A and 21-1. Remaining pathotypes were identified in few samples only. Characteristic feature of this analysis was the predominance of pathotype 11 instead of pathotype 40A which used to be the predominant during the previous years.

Brown rust of wheat (*P. triticina*)

Twenty five pathotypes were identified in 379 samples received from 9 states of India and three neighboring countries. There was a shift in virulence pattern with pathotype 77-9 becoming more frequent in Tamil Nadu, Karnataka, Maharashtra, Madhya Pradesh and Punjab. Three predominant pathotypes i.e. 77-9 (38%), 77-5(32%) and 104-2 (14%) comprised of 85% of the flora. Among these, both pathotypes 77-5 and 104-2 occurred in eight states of India and three neighboring countries. Pathotype 77-9 was observed only in seven states of India but not in the neighboring countries. Remaining 22 pathotypes occurred in few samples only. Population of brown rust of wheat in the region was avirulent to *Lr*24, *Lr*25, *Lr*29, *Lr*32, *Lr*39, *Lr*42 and *Lr*45. Two new pathotypes designated as 107-2 and 20-1 were identified. These are less virulent than the existing pathotypes and do not have any epidemiological consequence.

National Repository of Rust Pathotypes
More than 127 pathotypes of three rust pathogens of wheat, barley, rusts of oat, linseed were maintained in pure form as live cultures and also cryo-preserved for long term storage. Nucleus and bulk inocula of urediospres were supplied to 59 Scientists in different parts of India.

POST HARVEST ANALYSIS

Karnal Bunt and black point
A total of 12295 grain samples collected from various mandies in different zones, were analyzed for Karnal bunt (KB). The highest incidence (94.04%) was recorded from Punjab followed by Himachal Pradesh and Haryana. Based on the overall KB occurrence, it emerged that the KB incidence this year was more than the previous year. No sample from Bihar, Gujarat (Vijapur), Maharashtra (Pune) and Karnataka (Dharwad) was found infected with KB. Out of 8021 grain samples analyzed for black point from different zones in the country, 67.41 per cent samples were found black point infected.

Management of diseases and pests through chemical control: Chemical control has gained attention under the present scenario due to the wide spread occurrence of yellow rust in most of the varieties in the NWPZ. Similarly chemical control is needed for the management of insect pests, since there is no resistance available in wheat against the insect pests. New molecules were also tested for stripe rust management. Different doses of Propiconazole and other fungicides were also tested for leaf and stem rusts.

EVALUATION OF WHEAT GENOTYPES FOR INSECT PEST RESISTANCE AND MANAGEMENT

AVT lines were evaluated at multilocations for shoot fly, brown wheat mite, foliar aphid and root aphid. None of the genotype had average incidence of shootfly below 10%. Of the 73 AVT II year lines, HS 542 (C), WH 1021 (C), WH 1105 (C), K 8027 (C), HD 2864 (C), HI 1544 (C), MP 4010 (C), NIAW 2030, DBW 93 (I) (C), UAS 347 (I) (C), MMBL 283, DBW 14 (C), Kharchia 65 (C) and KRL 210 (C) showed moderately resistant reaction. Imidacloprid 600 FS (Gaucho) @ 0.72 g a.i. /kg seed treatment was found effective at Durgapura and Kanpur, wheraes at Ludhiana the same insecticide at higher dose @ 0.96 g a.i. /kg proved effective. At Vijapur, Fipronil 5 SC @ 0.3 g a.i. /kg and Bifenthrin 10 % EC@ 0.2 g a.i. /kg gave promising results against termite. Fipronil 5% SC@ 125 g a. i./ ha was identified as effective management of termite damage through broadcasting of insecticides in standing wheat crop at Durgapura and Vijapur and its lower dose 80 g a. i./ ha was effective at Vijapur. However, at Ludhiana, imidacloprid 600 FS @ 1.0 lt/ha was effective. The foliar application of Dantotsu (Clothianidin 50 WDG) @ 15 g a.i. /ha was found to be quite effective for the management of aphids in wheat at most of the tested locations. Fenazquine10 EC (Majester) @ 2.0 ml/l of water was proved most effective after 15 days of spraying for brown wheat management at Durgapura. Amongst the tested biopesticides, *Metarhizium anisopliae* @ 3g/l was found to be effective for the management of aphids at Karnal and Kharibari while *Verticillium lecanni* @ 3g/l was found effective at Pantanagar. Out of tested insecticides used for stored grain pest management, treatments of spinosad (Tracer 4.4 mg/kg) and Emamectin benzoate (Proclaim @ 40.0 mg/kg) as seed protectant were quite effective for the management of wheat seeds. During 2014-15, to verify the results of IPM modules on farmers field, the module was validated at farmers' fields. The IPM module was evaluated with two varieties NIAW 1415 and MACS 6478 in ten locations at farmers fields in Nasik district of Maharashtra. The module consisted of seed treatment with Azotobactor, PSB and Cruiser spray for the management of aphids. The wheat grain yield with farmers practice ranged from 28.00 to 38.00 q/ha whereas, yield in IPM module ranged from 32.50 to 45.00 q/ha. Average difference in yield was 5.11 q/ha. The infestation of aphids was observed during the initial stages of crop growth, which was low in IPM plots as compared to the plots in which farmers practice was followed. Rust incidence was not observed throughout the season in the trial plots.

EVALUATION OF WHEAT GENOTYPES FOR NEMATODES RESISTANCE AND MANAGEMENT

At Hisar, among 1st year lines, two genotypes (HS 596, K 1313) were found moderately resistant to cereal cyst nematode (CCN), *Heterodera avenae*. Among AVT II lines, HW 1098 and NIAW 1415 were resistant. At Durgapura, only one line, DBW 185 showed moderately resistant reaction. At Ludhiana, only one entry was found resistant to *H. avenae*. The biotypes studies of cereal cyst nematode was carried out during the crop season 2014-15 i.e Jaipur population of cereal cyst nematode, *Heterodera avenae* . Out of 26 differentials of wheat and barley eleven showed resistant reaction i..e. AUS-15854, AUS-7869,KVL-191, Harlan, Dalmitsche, Morocco, P-313221, Martin, La-estanzuella ,L-62, Nidar-2 and only AUS-15895 was found moderately resistance while rest showed susceptible reaction

Durgapura centre conducted survey in eight district of Rajasthan for studying the incidence of Cereal Cyst Nematode (CCN). Cereal cyst infestation was recorded in Ajmer, Alwar, Dausa, Jaipur, Tonk, Sikar, Sawaimadhopur and Hanumangarh districts. A large number of infested fields were observed in Amber, Bassi Chomu Jamwa Ramgarh, Kotputli, Sahapura, Sanganer (Shikarpura), Viratnagar, and tehsil of Jaipur district. About 350 hector field of wheat infested with CCN in Nohar and Bhadra Tehsil of Hanuman garh district. Higher population densities were recorded in Bassi and Sanganer (Shikarpura) Tehsil in both crops (wheat & barley). To find out the incidence of Ear cockle disease, *Anguina tritici* grain samples were collected from various grain Mandies of eight districts, Ajmer, Alwar, Dausa, Jaipur, Kota, Karoli, Sikar and Tonk. A total of four hundred seventy eight samples were collected of various local grown cultivars. Out of which 30 were found infected with ear cockle disease. Highest percentages of infestation were recorded form Mandawri (Dausa) (16.66) followed by Beawar (Ajmer) (15.00) and Devli (Tonk) (12.50). Samples collected from Jaipur, Kota and Palsana (Sikar) area were free from disease.

Evaluation of ecofriendly approaches in management of CCN, *Heterodera avenae* in wheat

An experiment was conducted from 2011-12 to 2014-15 at Rajasthan Agricultural Research Institute, Durgapura, Jaipur in naturally infested soil. Inoculum level was 11.6 larvae/g soil of cereal cyst nematode. The experiment consisted of eight treatments *viz* Neem cake 10q/ha (soil application), Neem oil (10 ml/Kg) (seed treatment), Neem gold (Azadirachtin) (10 ml/kg), Nimicidine (10 ml/kg), Carbosulfan 2% 25 EC (Seed soaking), Raj MR1 (Resistant variety) along with treated check (Carbofuran@ 1.5 kg ai/ha) and untreated check (Raj 1482) in a completely randomized block design and replicated. The results revealed that all the treatments gave significantly higher grain yield and reduced number of cysts/plant over control. The maximum grain yield (37.72 q/ha) was recorded in Raj MR-1 (CCN counts- 1.09 cyst/ plant) followed by carbofuran (Grain yield - 34.87q/ha; CCN counts-2.51 cysts/plant) , Carbosulfan 25 EC (Grain yield - 31.99 q/ha; CCN counts-3.16 cysts/plant) and Neem gold (Grain yield - 30.84 q/ha; CCN counts-3.31 cysts/plant) over untreated control (Grain yield-13.71q/ha; CCN counts- 4.91 cysts/plant).

Diversification in existing wheat based systems for CCN management

An experiment was conducted from 2011-12 to 2014-15 at Rajasthan Agricultural Research Institute, Durgapura, Jaipur in naturally infested soil. Inoculum level was 11.0 to 12.0 larvae/g soil of cereal cyst nematode. The experiment consisted of eight treatments viz Mustard, Pea, Gram, Fenugreek, Cabbage, Raj MR 1 (Resistant variety) along with treated check (Carbofuran @ 1.5 kg ai/ha) and untreated check (Raj 1482) in a completely randomized block design. All the treatments significantly reduced the cyst in the soil as compared the control (Higher cyst). Carbofuran @ 1.5 kg ai/ha reduces the cereal cyst nematode population followed by cabbage, resistant variety, mustard, fenugreek, gram and Pea as compared to the control.

Strategy Meetings: A meeting on evolving strategies for enhancing wheat production with special reference to management of wheat rusts and Karnal bunt was organized by DAC on Oct. 16, 2014 in Lucknow under the Chairmanship of Dr. J.S. Sandhu, Agriculture Commissioner, Govt. of India. Strategy meeting for managing stripe rust and Karnal bunt was organized by DAC, New Delhi at Panchkula on January 20, 2015. Dr. J. S. Sandhu, Agriculture Commissioner, G. O. I. chaired the meeting. Dr. Indu Sharma, Director, IIWBR, Karnal made presentation on stripe rust and Karnal bunt management. A meeting for reviewing the status of Karnal bunt management was organized by DAC at Bhopal on January 28, 2015. Dr. J. S. Sandhu, Agriculture Commissioner, G. O. I. chaired the meeting.

Advisory for stripe rust management: Advisory for stripe rust management was issued during December, 2014 - March, 2015 for northern states. Awareness among farmers for stripe rust management was created through newspapers and delivering lectures in farmers training programmes.

Interactive workshop-cum-training programme on wheat and barley aphids and their management: A one day "Interactive Workshop-cum-Training Programme on Wheat and Barley Aphids and Their Management" was organized at IIBWR, Karnal on 24th November, 2014 in response to mounting evidence of crop damage from aphids in peninsular and northwestern India. This programme was conducted in collaboration of IIWBR and CIMMYT. From CIMMYT, the lead role was played by Dr. Arun Joshi. Eight entomologists of AICRP on Wheat & Barley from different parts of India participated. The entomologists from IIBWR, Karnal also actively participated. The main resource person of this programme was Dr. Urs Wyss, former Professor and Director of Institute for Phytopathology, University of Kiel, Germany. The other resource person was Professor C.P. Srivastava, Head, Department of Entomology, Institute of Agricultural Sciences, Banaras Hindu University has also the experience of working on wheat aphids with Dr. Urs. Wyss at Germany.

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PROGRAMME OF WORK 2014-2015

The programme for the crop year 2014-2015 was chalked out in the 53rd All India Wheat and Barley Research Workers Meet held at JNKVV, Jabalpur during August 22-25, 2014. The various activities to be executed at respective centres are given below:

PROGRAMME 1: HOST RESISTANCE: IPPSN AND PPSN

Adult Plant Resistance for rusts & other diseases

i. **Initial Plant Pathological Screening Nursery (IPPSN)**

Objectives

To evaluate breeding materials generated at various centres against rusts and foliar blights for promoting to coordinated multi-location trials. (Under artificial inoculated conditions)

(a) **Rusts:**

North:

Leaf Rust: Delhi, Hisar, Karnal, Durgapura, Ludhiana (5)

Yellow Rust: Gurdaspur, Dhaulakuan, Malan, Karnal, Durgapura, Ludhiana and Jammu (7)

South: No. of Centres, 5

Stem Rust + Leaf Rust: Mahabaleshwar, Wellington, Powarkheda, Niphad and Indore

(b) **Leaf Blight:** No. of centres: 7

Faizabad, Pusa (Bihar), Varanasi, Kalyani, Sabour, Ranchi and Coochbehar

ii. **Plant Pathological Screening Nursery (PPSN)**

Objectives

Promotion of entries from one stage to the other in the coordinated trials and identification of varieties after AVT level on the basis of their level of disease resistance.

Rusts:

North:

Yellow Rust: Dhaulakuan, Gurdaspur, Malan, Bajaura, Karnal, Delhi, Ludhiana, Pantnagar, Durgapura, Jammu, Kudwani (Kashmir) (11)

AVT material will also be evaluated under natural conditions at Nawan Shahar (Punjab) and Yamunanagar (Haryana) for yellow rust.

Leaf Rust : Delhi, Hisar, Jammu, Kanpur, Karnal, Ludhiana, Pantnagar, Durgapura (8)

South: No. of Centres: 9

Leaf and Stem Rusts: Wellington, Mahabaleshwar, Niphad, Vijapur, Pune, Junagarh, Powarkheda, Dharwad and Indore

AVT material will also be evaluated under natural conditions at Kharibari, West Bengal for leaf rust.

Note: The samples of leaves of AVT IInd year entries in PPSN and the varieties (checks) showing resistance in the past but now showing rust severity of 40S or more at any of the centres, should be sent immediately to the Head, DWR Regional Station Flowerdale, Shimla for pathotype analysis, with information to P.I. (Crop Protection).

Monitoring of PPSN

A team of Plant Pathologists was constituted during the work-planning meeting for effective monitoring and data recording in PPSN at various locations in NWPZ. The team consists of Drs. M. S. Saharan, V. K. Singh (Delhi) and Dr. P. S. Shekhawat (Durgapura) will monitor PPSN at Ludhiana, Karnal, Dhaulakuan and Delhi. Dr. R. Selva Kumar and Dr. Deep Shikha will monitor PPSN at Pantnagar. Dr. S. K. Rana, Dr. Sudheer Kumar and Dr. M. K. Pandey will monitor PPSN in Bajoura, Malan and Jammu. Dr. P. V. Patil, Dr. B. C. Game, Dr B K Honrao and Parmod Parsad (Shimla) will monitor PPSN in PZ. Dr. T. L. Prakash, Dr. K. K. Mishra and Dr. O. P. Gangwar will monitor PPSN in CZ.

iii **AUDPC based identification of slow rusters in AVT material:**
Leaf and yellow rusts - DWR, Karnal; stem and leaf rusts - Mahabaleshwar; stem rust - Indore; Yellow rust - Ludhiana.

PROGRAMME 2: RUSTS (BROWN, YELLOW AND BLACK)

A. APR: Race specific and slow rusting

i. Leaf rust: AVT entries of NWPZ, NHZ and NEPZ, alongwith the check entries of the respective zones.
Centres: New Delhi and Ludhiana under field conditions and Flowerdale (under controlled conditions)

ii. Stem rust: AVT of CZ and PZ, along with the check varieties of the respective zone.
Centres: Indore, Pune, Powarkheda and Mahabaleshwar

iii. Yellow rust: AVT entries of NWPZ and NHZ alongwith the checks of the respective zones.
Centres: Ludhiana and N. Delhi under field conditions and Flowerdale (under controlled condition),

Race inoculum to be supplied by Flowerdale: Races should be the same for all the respective centres.

(i)	Leaf rust:	77-5 and 104-2
(ii)	Yellow rust:	46S119 and 78S84
(iii)	Stem rust:	40A and 117-6

B. Seedling Resistance Tests and postulation of Rust Resistance Genes

i. Leaf, Stem and Yellow rusts (All races): DWR, Regional Station, Flowerdale, Shimla for AVT's (aestivum) entries. Flowerdale centre to generate data on rust resistance genes of all the AVT entries. Besides, this, identification of Rust Resistance genes to be done in selected entries of MDSN, MPSN and EPPSN.

ii. Stem and Leaf rusts: Mahabaleshwar for SRT on AVT entries of CZ, PZ and NIVT, durum entries.

PROGRAMME 3: LEAF BLIGHT

i. **Leaf Blight Screening Nursery (LBSN):** No. of Centres: 14
This nursery will consist of earlier identified resistant materials as well as the AVT's and special trials.

NWPZ: Pantnagar, Ludhiana, Karnal and Hisar.

NEPZ: Varanasi, Faizabad, IARI Pusa, Coochbehar, Shillongani, Ranchi and Kalyani.

PZ: Dharwad
SHZ: Wellington
CZ Gwalior

ii **Management of foliar blight of wheat through chemicals**
Centres: Faizabad, Kanpur, Varanasi, Kalyani, Pusa (Bihar), Ranchi, Sabour and under controlled conditions at Karnal

iii. **Basic studies on foliar blights:** These will be undertaken at Karnal, Faizabad, Varanasi and Delhi.

PROGRAMME 4: KARNAL BUNT

Karnal Bunt Screening Nursery (KBSN): This nursery will consist of the earlier identified resistant materials, released varieties during last ten years and the AVT-II year entries of 2014-2015. AVT-1st year entries will also be evaluated. These evaluations will be done under artificially inoculated conditions.
No. of Centres, 7
Dhaulakuan, Ludhiana, Delhi, Pantnagar, Hisar, Karnal and Jammu.
Ludhiana and DhaulaKuan will also evaluate NIVT entries.

PROGRAMME 5: LOOSE SMUT

Loose smut Screening Nursery: It will contain resistant materials identified in the past and AVT Ist year entries.
Centres: Ludhiana, Almora, Durgapura and Hisar.

PROGRAMME 6: POWDERY MILDEW

Powdery Mildew Screening Nursery: No. of Centres: 8
Almora, Pantnagar, Ranichauri, Shimla, Malan, Bajaura, Dhaulakuan, Wellington.

PROGRAMME 7: REGION SPECIFIC DISEASES

Disease Screening Nurseries of the region specific diseases will include resistant materials identified during the past, along with AVT entries at the locations given below:

i. **Head scab:** Karnal, Gurdaspur, Dhaulakuan and Wellington (AVT). At Gurdaspur and Wellington, evaluation for head scab will be done under natural conditions. Evaluation at Gurdaspur will be done by Ludhiana centre.
ii. **Flag smut:** Ludhiana, Hisar, Karnal and Durgapura
iii. **Foot rot:** Sagar and Dharwad
iv **Hill bunt:** Malan, Bajaura and Almora

PROGRAMME 8: CROP HEALTH

Crop Health Monitoring: Pre harvest surveys

- All the centres associated with Crop Protection Programme will supply information fortnightly on crop health from the areas of their jurisdiction to P.I. Crop Protection starting from November 2014 till the harvest of crop.
- 'Wheat Crop Health Newsletter' will be issued on monthly basis from DWR, Karnal, during the crop season. Information on off season crop will also be included.

Monitoring of new virulences of rusts in NWPZ by specially constituted teams: Specially constituted teams will visit the areas as per the schedules given below for effective monitoring of crop health in general and appearance and spread of yellow rust in particular, along the areas near the western border and foothills / sub-mountaneous areas in NWPZ. Entomologists will also accompany the teams.

Team 1: Last week of December 2014 (Dr. O. P. Gangwar, Dr. Sudheer Kumar and Dr. R. Devlash)

Team 2: Mid January, 2015 (Drs. M. S. Saharan, Dr. Madhu Meeta Jindal and Dr. M. K. Pandey)

Team 3: 1st week of February, 2015 (Dr. Selva R Kumar, Dr. Ritu Bala and Dr. V. K. Singh).

Team 4: Last week of Feb. (Dr. S. S. Karwasara, Dr. P. S. Shekhawat and Dr. Parmod Parsad)

(Visits in March will be arranged as per need).

Teams will cover the yellow rust prone areas in Punjab, Haryana, HP and J & K. Monitoring of yellow rust in hills in HP, J & K and Uttarakhand in off season will also be undertaken by a team of Plant Pathologists.

Monitoring the pathotype distribution of rust pathogens: It will be undertaken by DWR, Regional Station, Flowerdale, Shimla (all three rusts from all zones) and Rust Research Station, Mahabaleshwar (brown and black rust from CZ and PZ). All the cooperating centres are required to send the rust infected samples (natural infection) for pathotype analysis to the concerned centres.

Wheat Disease Monitoring Nursery (To be co-ordinated by Flowerdale, Shimla): The nursery will be planted at 38 locations including Kudwani (Srinagar), Varanasi and Yamunanagar (Haryana). Samples from this nursery should be sent regularly to R.S. Flowerdale, Shimla for virulence analysis and information. Information on rust appearance to be provided at monthly intervals, starting from end of December to the P.I. (Crop Protection).

Reconstitution of Wheat Disease Monitoring Nursery (WDMN): Keeping into account the changed varietal situation, the zone specific varieties of NWPZ and NEPZ were recasted. The detailed constituents of WDMN from 2014 onwards would be as given below:

Common set of varieties of wheat disease monitoring nursery

WL 711, HD 2329, Agra Local, HD 2160, Lal Bahadur, WL 1562, HW 2021(*Sr26/Sr24*), HD 2204, C 306, WH 147, HW 2008 (*Sr24/Lr24*), Kharchia mutant, HP 1633, DL 784-3 and RNB 1001.

Zone specific varieties

NWPZ: WH 1105, WH 542, PBW 343, DPW 621-50 and WH 896

NEPZ: K 8804, HD 2402, HP 1102, HUW 468 and NW 1014

CZ: HI 8381, DL 803-3, Lok -1, GW273 and GW322

PZ and SHZ: MACS 2496, Bijaga Yellow, HW 971, HD 2501 and HW 2022 (*Sr24/Lr24*)

NHZ and High Altitude Zone: HPW 349, VL892, HS 420, Sonalika, HS 507 and Barley Local

Off-season Disease Monitoring Nursery (To be coordinated by DWR Reg. Station, Flowerdale): This nursery will be planted in Dalang Maidan, Kukumseri, Sangla, Sarahan (HP) and Leh (J&K). High altitude varieties and one hulless barley variety will also be included in this nursery.

SAARC- Nursery (To be co ordinated by Flowerdale, Shimla): Nursery will be planted at 15 Indian locations, *viz.*, Ludhiana, Delhi, Dhaulakuan, Gurdaspur, Dera-Baba-Nanak, Abohar, Sri Ganganagar, Chattha, Kathua, Rajouri, Almora, Durgapura, Faizabad, Pantnagar and Wellington.

Monitoring of Karnal bunt and blackpoint in harvested grains

Post harvest monitoring will be undertaken by cooperating centres by analysing samples from grain *mandies* in each district of their respective states. Centres from C.Z. (Indore, Sagar, Powarkheda, Junagarh, Vijapur) and PZ (Pune, Niphad and Dharwad) may also supply grain samples to DWR Karnal for analysis.

PROGRAMME 9: IPM IN WHEAT

A. GENETICAL (HOST RESISTANCE)

(a) **Elite Plant Pathological Screening Nursery (EPPSN) :**

North: No. of Centres, 8

Delhi, Karnal, Ludhiana, Pantnagar, Durgapura, Hisar, Chattha and Almora

South: No. of Centres, 4

Wellington, Mahabaleshwar, Dharwad and Indore.

(b) **Multiple Disease Screening Nursery (MDSN):** It will be subjected to artificial epiphytotics as detailed below:-

(i) **DISEASES**

North: No. of Centres, 14

Yellow rust: Karnal, Ludhiana, Dhaulakuon, Pantnagar

Brown rust: Karnal, Ludhiana, Delhi

Karnal Bunt: Karnal, Ludhiana, Dhaula kuan

Powdery mildew: Dhaulakuan, Almora, Pantnagar, Chattha

Foliar blights: Kaul, Faizabad, Varanasi, Coochbehar

Loose smut: Hisar, Durgapura, Ludhiana

Flag smut: Hisar, Durgapura, Ludhiana

Head scab: Karnal, Dhaulakuan and Wellington

South: No. of Centres, 3

Leaf and Stem rust: Mahabaleshwar, Indore and Wellington

(ii)**Nematodes (CCN) :** Durgapura, Hisar, Ludhiana

(c) **Contribution to NGSN:** The resistant entries to major diseases identified after multilocation & over years of testing will be contributed to NGSN for the use of breeders in crossing programme. (Centre: Karnal)

B. MANAGEMENT OF DISEASES

(a) **Chemical control of Yellow Rust:** Karnal, Ludhiana, Bajoura, Pantnagar, Jammu and Dhaula Kuan

(b) **Chemical control of Stem rust:** Mahabaleshwar, Niphad, Powarkheda and Dharwad

(c) **Pest Dynamics in different RCT's:** Karnal

(d) **Evaluation and Promotion of IPM modules:** Kanpur and Niphad

PROGRAMME 10. WHEAT ENTOMOLOGY

The Entomology programme for the crop year 2014-2015 formulated at the 53rd All India Wheat and Barley Research Workers Meet held at Jabalpur during August 22-25, 2014. The various activities to be executed at respective centres after the deliberations with all the entomologists are given below:

(A) HOST PLANT RESISTANCE

EXPT.1 ENTOMOLOGICAL SCREENING NURSERY FOR

(a) Shoot fly (Dharwad, Durgapura, Ludhiana, Kanpur, Niphad)
(b) Brown wheat mite (Durgapura and Ludhiana)
(c) Wheat Aphids (Niphad, Ludhiana, Karnal, Shillongani, Pantnagar, Kharibari and Kanpur)
(d) Root aphid (Entkhedi, Niphad, Karnal and Ludhiana)

EXPT.2 MULTIPLE PEST SCREENING NURSERY

(a) Shoot fly (Dharwad, Durgapura, Ludhiana, Kanpur and Niphad)
(b) Brown mite (Durgapura and Ludhiana)
(c) Foliar aphids (Niphad, Ludhiana, Karnal, Shillongani, Pantnagar, Kharibari and Kanpur)
(d) Root aphid (Entkhedi, Niphad, Karnal and Ludhiana)

(B) CHEMICAL CONTROL

EXPT.3 Effect of insecticidal seed treatment on germination, termite damage and yield. (Centres: Durgapura, Kanpur, Ludhiana and Vijapur).

EXPT.4 Management of termite damage through broadcasting of newer insecticides in standing wheat crop. (Centres: Durgapura, Ludhiana, and Vijapur).

EXPT.5 Chemical control of foliage feeding wheat aphids.
(Centres: Karnal, Ludhiana, Niphad, Kharibari and Pantnagar).

EXPT.6 Eco-friendly management of aphids through biorational approaches.
(Centres: Pantnagar and Kharibari).

EXPT.7 Management of brown wheat mite with different pesticides/acricides.
(Durgapura and Ludhiana)

EXPT.8 Integrated management of shoot fly in wheat.
(Dharwad)

(C) INTEGRATED PEST MANAGEMENT

EXPT.9 Survey of pests infesting wheat and barley and their natural enemies. (All centres)

EXPT.10 Incidence and population build of major insect pest indifferent dates of sowing. (Niphad, Ludhiana, Kharibari and Karnal)

EXPT.11 Basic studies for development of IPM strategies

(a) Pest modeling for Foliage aphids
(Niphad, Ludhiana, Karnal & Pantnagar)
(b) Brown mite ETL (Durgapura)
(c) Root aphid (Entkhedi)
(d) Thrips (Pantnagar)
(e) *Helicoverpa armigera* (Pantnagar)

(D) STORED GRAIN PESTS

EXPT.12 Management of stored grain insect pest.
(Durgapura, Pantnagar, Kharibari and Ludhiana)

PROGRAMME 11. WHEAT NEMATOLOGY

The Nematology programme for the crop year 2014-2015 formulated at the 53rd All India Wheat and Barley Research Workers Meet held at Jabalpur during August 22-25, 2014. The various activities to be executed at respective centres after the deliberations with all the Nematologists are given below:

1. **Monitoring of Nematodes:**
   - i) *Anguina tritici*: Pusa (Bihar), Durgapura, Ludhiana, Varanasi and Palampur
   - ii) *Heterodera avenae*: Durgapura, Hisar, Ludhiana and Malan,
   - iii) **Mapping of nematode population:** Durgapura, Hisar, Ludhiana, and Malan
   - iv) **Soil borne nematodes:** Survey will be conducted in Bihar (RAU Pusa centre), Varanasi commissionery (BHU Centre), parts of Rajasthan (Durgapura centre), southern Haryana (Hisar centre), Punjab (Ludhiana centre) and HP (Malan)
2. **System based Research:**
   - i) **Population monitoring in wheat based systems:**

     Rice - Wheat : Ludhiana, Pusa (Bihar), Varanasai and Kangra (Palampur).
     Cotton – Wheat : Hisar and Ludhiana.
     Bajra – Wheat : Durgapura.
     Groundnut - Wheat: Durgapura.
     Til - Wheat: Pusa (Bihar)
     Cowpea - Wheat: Durgapura.
     Wheat - Moong: Durgapura
   - ii) **Diversification in existing wheat based systems for CCN management-** Durgapura, Ludhiana and Hisar
   - iii) **Biofumigation as management tool for nematodes:** Ludhiana, Durgapura and Hisar
3. **Evaluation of resistance against Nematodes parasitizing wheat:**
   - (i) *Heterodera avenae*: Hisar and Durgapura
   - (ii) *Heterodera filipjevi*: Ludhiana.
   - (iii) **Screening against** ***M graminicola***: Pusa (Bihar), Ludhiana.
   - (iv) **Testing of advanced breeding materials generated at Durgapura and Delhi against CCN:** Durgapura, Hisar and Ludhiana
   - (v) **Evaluation of international nurseries against CCN:** All centres (subject to availability of materials from the overseas source).
4. **Evaluation of ecofriendly approaches in management of CCN:** Hisar, Ludhiana and Durgapura.

Monitoring of Nematodes: Team (Drs DJ Kaur, Indra Rajvanshi and RS Kanwar): 1st week of Feb., 2015.

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PROGRAMME 1. HOST RESISTANCE: IPPSN AND PPSN

1.1 INITIAL PLANT PATHOLOGICAL SCREENING NURSERY (IPPSN)

OBJECTIVES

Evaluation of breeding materials generated at various centers against rusts and foliar blights for inclusion in the coordinated multilocational yield evaluation trials.

SIZE AND COMPOSITION

No. of entries: 1624
No. of breeding centers: 37

TEST LOCATIONS

North:

Leaf Rust: Delhi, Hisar, Karnal, Durgapura, Ludhiana (5 locations)
Yellow Rust: Gurdaspur, Dhaulakuan, Malan, Karnal, Durgapura, Ludhiana and Jammu (7 locations)

South:

Stem Rust + Leaf Rust: Mahabaleshwar, Wellington, Powarkheda, Niphad and Indore (5 locations)

Leaf Blight: Faizabad, Ranchi, Pusa (Bihar), Varanasi, Kalyani, Sabour and Coochbehar (7 locations)

Data was not considered due to poor/erratic disease development from the following centres:
Leaf rust: Indore

Evaluation under artificial epiphytotics

Uniform procedure was adopted for evaluation of IPPSN at all the test centers. Rust inoculum represented by a wide spectrum of pathotypes, was used in artificial inoculation of IPPSN materials. Rust inocula were supplied by IIWBR Regional Station Flowerdale and Mahabaleshwar centers. Following pathotypes were supplied for inoculation:

STEM RUST PATHOTYPES

Flowerdale (Shimla)
11(79G31), 40A (62G29), 42 (19G35), 122(7G11), 117-6 (37G19)
Mahabaleshwar
11 (79G31), 40A (62G29), 42 (19G35), 122(7G11), 117-6 (37G19)

LEAF RUST PATHOTYPES

Flowerdale (Shimla)
12-2 (1R5), 77-2(109R31-1), 77-5 (121R63-1) and 104-2(21R55)
Mahabaleshwar
12-2 (1R5), 77-2(109R31-1), 77-5 (121R63-1) and 104-2(21R55)

STRIPE RUST PATHOTYPES

Flowerdale (Shimla)

K(47S102), P(46S103), L(70S69), 13(67S8) , 46S119 and 78S84

An account of entries exhibiting rust response upto ACI 15 to three rusts is given in Table 1.1. and Figs. 1.1-1.5. The disease data was sent to the concerned breeders in first week of July, 2015 and was also uploaded on IIWBR website.

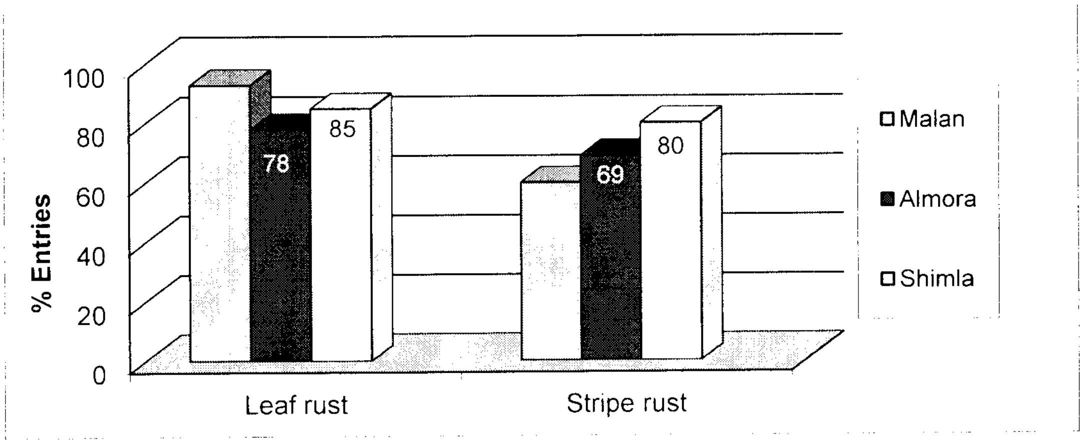

Fig. 1.1 Percent of rust resistant entries in IPPSN slots belonging to cooperating centres of NHZ (Leaf and Stripe rust)

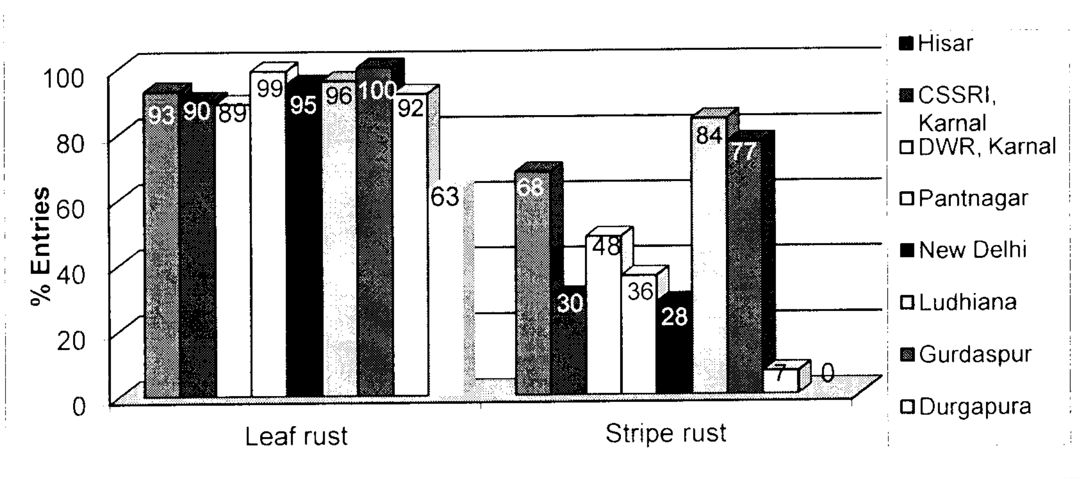

Fig. 1.2 Percent of rust resistant entries in IPPSN slots belonging to cooperating centres of NWPZ (Leaf and Stripe rust)

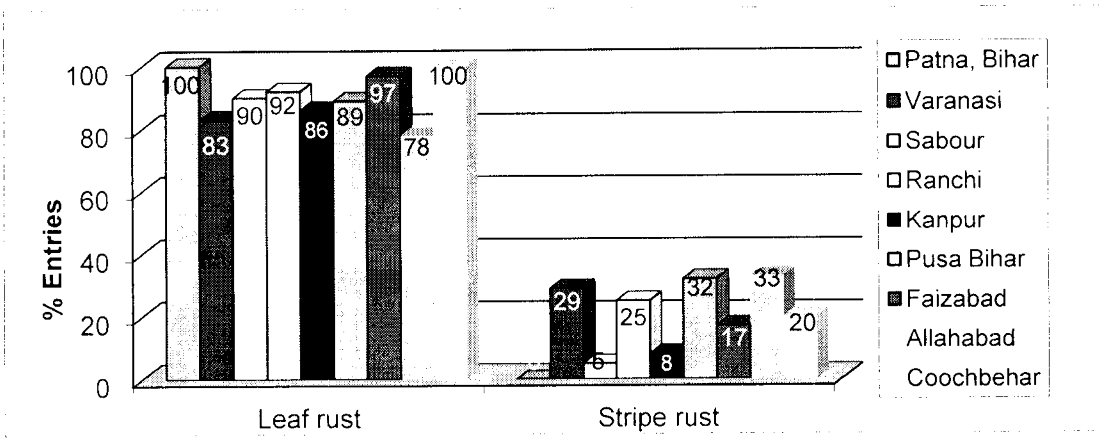

Fig. 1.3 Percent of rust resistant entries in IPPSN slots belonging to cooperating centres of NEPZ (Leaf and Stripe rust)

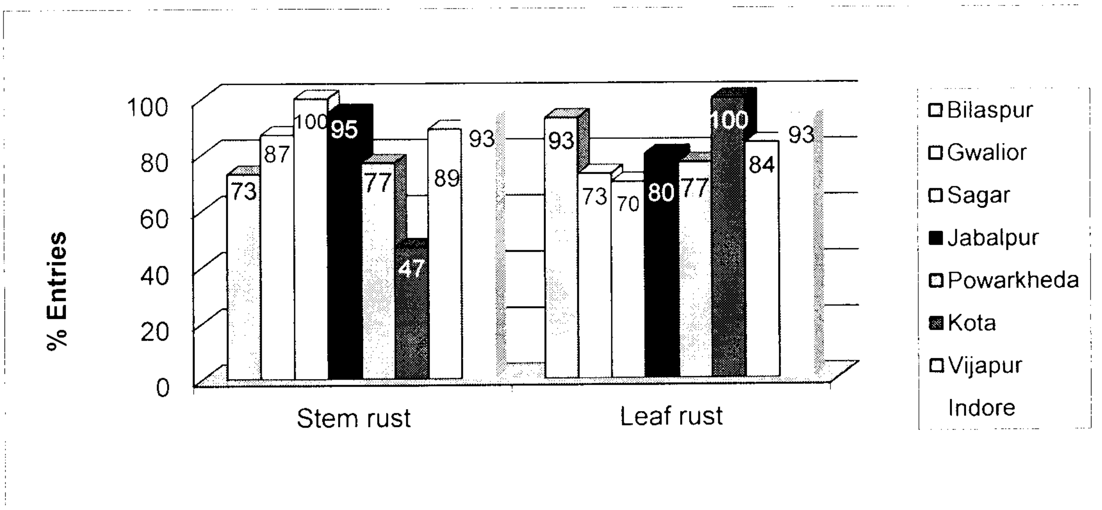

Fig. 1.4 Percent of rust resistant entries in IPPSN slots belonging to cooperating centres of CZ (Stem and Leaf rust)

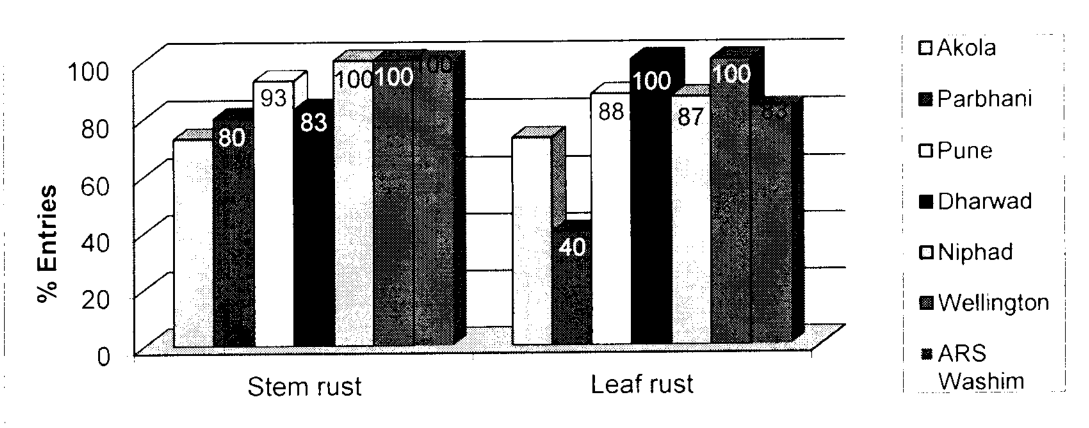

Fig. 1.5 Percent of rust resistant entries in IPPSN slots belonging to cooperating centres of PZ and SHZ (Stem and Leaf rust)

Table 1.1 Percent of rust resistant lines (ACI up to 15) in IPPSN slots of different centres

Sr. No.	Name of Centre	Total	PERCENT ENTRIES RESISTANT TO			
			SOUTH		NORTH	
			STEM	LEAF	LEAF	STRIPE
I. NORTHERN HILL ZONE						
1	VPKAS, Almora	65	80	63	78	69
2	CSK, HPKVV, Malan	30	100	77	93	60
3	Tutikandi, Shimla	40	98	90	85	80
II. NORTH WESTERN PLAIN ZONE						
4	CCS HAU, Hisar	122	89	84	93	68
5	CSSRI, Karnal	20	80	50	90	30
6	IIWBR, Karnal	174	87	81	89	48
7	GBPUA&T, Pantnagar	70	99	93	99	36
8	IARI, New Delhi.	155	91	85	95	28
9	PAU, Ludhiana	170	95	91	96	84
10	PAU, RS, Gurdaspur	30	93	90	100	77
11	RAU, ARS, Durgapura	90	98	63	92	7
12	SKUAS&T, Chatha, Jammu	8	50	75	63	0
III. NORTH EASTERN PLAIN ZONE						
13	Coochbehar (WB)	10	100	100	100	20
14	ARI, Patna, Bihar	4	0	100	100	0
15	B.H.U., Varanasi	35	94	86	83	29
16	BAC, Sabour	20	85	75	90	5
17	BAU, Kanke, Ranchi	12	100	100	92	25
18	CSAUA&T, Kanpur	100	77	65	86	8
19	IARI, Pusa, Samastipur	28	89	46	89	32
20	Kumarganj, Faizabad	30	87	97	97	17
21	SHIAT&S, Allahabad	9	44	78	78	33
VI. CENTRAL ZONE						
22	ARS, Ummedganj, Kota	15	47	100	93	60
23	Bilaspur	15	73	93	80	7
24	College of Agriculture, Gwalior	15	87	73	87	27
25	Indore	82	93	93	96	68
26	JNKVV, Jabalpur	20	95	80	95	10
27	JNKVV, ZARS, Powarkheda	30	77	77	93	53
28	RARS, Sagar	10	100	70	80	20
29	SDAU, Vijapur	76	89	84	91	9
V. PENINSULAR ZONE						
30	ARI, Pune	40	93	88	85	25
31	MAU, Parbhani	5	80	40	80	20
32	MPKV, ARS, Niphad	23	100	87	96	26
33	UAS, Dharwad	30	83	100	97	27
34	Wheat Research Unit, Akola	15	73	73	73	13
35	ARS Washim (MS)	6	100	83	83	17
VI. SOUTHERN HILLS ZONE						
36	IARI, RS, Wellington	19	100	100	95	11
37	Maharashtra Hybrid Seeds Co. Ltd.	1	100	100	100	100

1.2 PLANT PATHOLOGICAL SCREENING NURSERY (PPSN)

OBJECTIVES

To help in promotion of entries from one stage to the other in the coordinated trials and identification of varieties after AVT level on the basis of their level of disease resistance.

SIZE AND COMPOSITION

PPSN, 2014-2015 included AVT, NIVT and the special trials (497 entries) including checks. The released / identified varieties as per respective trials, were used as checks and a mixture of susceptible varieties like Agra Local, A-9-30-1, WL-711, PBW 343, Sonalika, C-306, Kharchia 65, VL 804, K 8027, HD 2932, NI 5439, Cow(W) -1, GW 322, HD 2864, NIAW 1415, MACS 2496, MACS 2946, MP 4010 and B. Yellow were used as infectors.

The PPSN was evaluated nationwide under artificially created epiphytotics at respective hot spot locations against three rusts. AVT entries were also evaluated against Karnal bunt, Foliar blight, Powdery mildew, Loose smut, Flag smut, Hill bunt, Head scab and Foot rot under respective disease screening nurseries (Fig. 1.6).

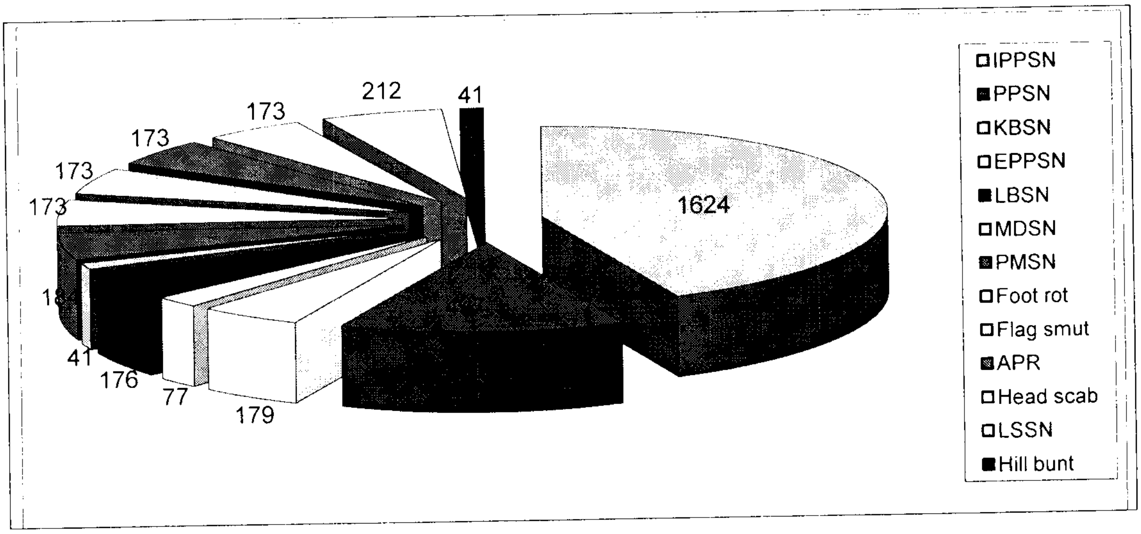

Fig. 1.6 Constitution of different plant pathological nurseries during 2014-15

TEST LOCATIONS

North:

Yellow Rust: Dhaulakuan, Malan, Karnal, Delhi, Ludhiana, Pantnagar, Bajaura, Gurdaspur, Durgapura, Jammu, Kudwani (J & K) (11 locations)

Leaf Rust: Delhi, Hisar, Jammu, Kanpur, Karnal, Ludhiana, Pantnagar, Durgapura (8 locations)

South:

Leaf and Stem Rusts: Wellington, Mahabaleshwar, Niphad, Vijapur, Pune, Junagarh, Powarkheda, Dharwad and Indore (9 locations)

Data was not considered due to poor/erratic disease development from the following centres:

Leaf rust: Vijapur and Dharwad
Stem rust: Wellington and Dharwad
Yellow rust: Kudwani (J & K)

Evaluation under artificial epiphytotics

Uniform procedure was adopted for scoring of PPSN at all the test centers. Rust inoculum represented by a wide spectrum of pathotypes, was used in artificial inoculation of PPSN materials. Inoculum of yellow, brown and black rusts was supplied by IIWBR Regional Research Station, Flowerdale, Shimla. Mahabaleshwar center also supplied the inoculum to Centres in CZ and PZ. The mixture of pathotypes supplied by Flowerdale and Mahabaleshwar centres are given in IPPSN.

Disease data of AVT II year entries recorded at the hot spot locations is given in Table 1.2 that of AVT-I and NIVT (three rusts) is presented in Tables 1.3 and 1.4. Rust resistant genes postulated in AVT IInd year and AVT Ist year by IIWBR Regional Station Flowerdale have also been given in the respective tables and also in Tables 1.2 and 1.3.

AVT material was also evaluated under natural conditions at Langroya (Punjab). The data is depicted in Table 1.6. Other diseases data is presented in Table 1.5

Rust Resistance materials in AVT IInd and Ist Year (2014-15) with ACI upto 10.0 are given below:

Stem, Leaf and Stripe Rusts
AVT IInd Year

HD 4728 (d), HD 4730, HI 8498 (D) (C), HI 8737 (D)(I) (C), HS 507 (C), MPO 1215 (d) (C), PBW 723, PDW 233 (C), TL 2942 (C) and TL 2969 (C).

AVT Ist Year

DBW 181, DDW 31, HI 8759 (d), HI 8765 (d), HPBW 02, HPBW 08, HPBW 09, HPW 394, HPW 422, HS 580, HS 596, HS 597, HS 599, HUW 695, HUW 712, K 1312, K 1314, MACS 3949, MACS 3970 (d), MACS 3972 (d), MACS 4024, PBW 709, PBW 718, TL 3001, TL 3002, TL 3003, TL 3004, TL 3005, UAS 453 (d), UAS 455 (d), VL 3002, VL 3007, VL 3008, WB 1 and WB 5.

Stem and Stripe Rusts
AVT IInd Year
UAS 428 (d) (C)
AVT Ist Year
DBW 184, HI 1604, HPBW 07, HPW 421, HS 601, PBW 707 and VL 1006.

Stem and Leaf Rusts
AVT IInd Year

DBW 14 (C), DBW 88 (C), DPW 621-50 (C), GW 322 (C), HD 2864 (C), HD 2888 (C), HD 2967 (C), HD 3043 (C), HD 3059 (C), (HD 2932 + *Lr* 19/*Sr25*), HI 1544 (C), HI 1563 (C), HD 4730 (d), HPW 251 (C), HPW 349 (C), HS 490 (C), HS 542 (C), HW 1098(C), MACS 6222 (C), MP 3336 (C), PBW 644 (C), Raj 4083 (C), VL 829 (C), VL 892 (C), VL 907 (C), WH 1021 (C), WH 1080 (C) and WH 1105 (C).

Table 1.2. Adult plant response of AVT IInd year material against wheat rusts under field conditions (artificial inoculations) during 2014-15

Sr. No.	Variety	RUST RESPONSE (HIGHEST SCORE AND ACI)								Postulated Gene		
		Stem rust		Lear rust				Stripe Rust				
				South		North						
		HS	ACI	HS	ACI	HS	ACI	HS	ACI	*Sr*	*Lr*	*Yr*
I. NORTHERN HILL ZONE												
1	HS 562	30S	16.6	60S	17.4	20S	8.0	40S	13.0	Sr8a+9b+	Lr23+	YrA+
2	HPW 251 (C)	10S	2.8	20MR	2.6	10S	2.4	80S	33.0	Sr2+31+	Lr23+26+	Yr9+
3	HPW 349 (C)	30S	7.5	20S	7.5	10S	3.4	40S	15.8	Sr2+	Lr10+13+	Yr2+
4	HS 375 (C)	10MS	1.9	30S	10.7	20S	5.1	60S	36.8	Sr2+5+31+	Lr1+26+34+	Yr9+18+
5	HS 490 (C)	20MS	5.6	10MS	3.1	10S	1.8	60S	18.1	Sr2+9b+	Lr23+	-
6	HS 507 (C)	10MR	0.7	15MR	1.1	10MS	1.0	60S	9.8	Sr31+	Lr1+26++	Yr9+
7	HS 542 (C)	20MR	1.3	5S	1.3	10S	1.3	40S	12.0	Sr2+5+8a+9b+11+	Lr10+13+	Yr2+
8	VL 804 (C)	20MS	4.3	15MS	3.4	60S	15.6	60S	27.0	Sr2+5+31+	Lr26+34+	Yr9+18+
9	VL 829 (C)	10S	2.0	20S	6.4	20MS	5.0	60S	28.6	Sr5+31+	Lr26+34+	Yr9+18+
10	VL 892 (C)	20S	6.6	20S	8.1	60S	8.2	80S	25.4	Sr2+	Lr10+13+	YrA+
11	VL 907 (C)	10S	2.9	15MR	2.1	40S	6.5	40S	14.5	Sr2+31+	Lr26+	Yr9+18+
II. NORTH WESTERN PLAIN ZONE												
12	HD 4730	10S	3.6	20MR	2.1	5MR	0.4	20S	3.3	Sr2+11+	R	Yr2+
13	MP 1277	20S	12.6	10S	2.4	10MS	1.6	40S	12.3	Sr2+7b+11+	Lr13+	-
14	WH 1164	20S	6.0	40S	11.1	10MS	1.2	40S	13.2	Sr2+	Lr10+13+	-
15	DBW 88 (C)	10S	4.0	20S	6.4	10MS	1.6	60S	20.2	Sr2+11+	Lr3+10+13+	-
16	DBW 90 (C)	40S	14.3	20S	5.7	20S	4.0	40S	12.7	Sr2+13+	Lr3+10+13+	-
17	DPW 621-50 (C)	20MS	4.1	5S	2.1	5S	0.6	40S	19.0	Sr2+	Lr10+13+	-
18	HD 2967 (C)	20MS	6.6	10MS	3.2	10S	1.9	60S	22.7	Sr2+8a+11+	Lr23+	Yr2+
19	HD 3043 (C)	10MS	3.1	20S	7.3	20MS	3.5	60S	18.0	-	Lr23+	R
20	HD 3059 (C)	20MS	3.2	20S	5.9	10MS	1.1	60S	22.3	Sr2+11+*	Lr13+*	R
20. A	INFECTOR	100S	74.3	100S	71.4	100S	71.3	100S	82.0	-	-	-
21	HD 3086 (C)	40S	26.6	10S	3.4	20S	4.4	80S	16.0	Sr2+7b+	Lr3+10+13+	Yr2+
22	PBW 644 (C)	25S	9.9	20S	6.9	5S	1.3	40S	13.5	Sr2+11+	Lr1+13+	Yr2+
23	PDW 233 (C)	60S	9.8	20S	7.6	0	0.0	40S	8.0	Sr2+9e+	Lr23+	-
24	PDW 291 (C)	60S	13.6	15MS	2.9	10MS	1.5	60S	10.8	Sr2+9e+	Lr23+	-
25	PDW 314 (C)	60S	16.2	5S	1.3	10S	1.3	40S	4.7	Sr2+9e+	Lr23+	Yr2+

Sr. No.	Variety	RUST RESPONSE (HIGHEST SCORE AND ACI)								Postulated Gene		
		Stem rust		Lear rust				Stripe Rust				
				South		North						
		HS	ACI	HS	ACI	HS	ACI	HS	ACI	*Sr*	*Lr*	*Yr*
26	WH 1021 (C)	15S	5.0	15MR	2.1	10S	1.8	80S	37.4	Sr2+31+	Lr1+26+	Yr9+
27	WH 1080 (C)	10S	3.5	10MS	1.9	10S	1.8	60S	16.5	Sr2+9e+	Lr13+	Yr2+
28	WH 1105 (C)	20S	5.2	20S	6.2	5S	0.7	40S	11.8	Sr2+11+	Lr13+	Yr2+
29	WH 1124 (C)	30S	15.7	20S	6.9	30S	5.0	60S	21.1	Sr2+7b+	Lr10+13+	Yr2+
30	WH 1142 (I) C)	20MS	6.5	30MS	13.3	20S	6.0	30S	12.6	Sr2+31+	Lr26+26+	Yr9+
III. NORTH EASTERN PLAIN ZONE												
31	C 306 (C)	20MS	9.3	40MS	9.6	40S	25.6	60S	25.1	-	Lr34+	Yr18+
32	HD 2888 (C)	10MS	3.2	15MS	2.3	5S	0.8	80S	26.9	Sr2+24+	Lr24+	Yr2+
33	K 8027 (C)	60S	23.1	40S	20.0	60S	25.0	80S	34.0	Sr2+11+	Lr13+	Yr2+
IV. CENTRAL ZONE												
34	HD 4728 (d)	5MS	1.2	5S	1.0	5MS	0.5	20S	3.0	Sr2+11+	R	Yr2+
35	HD 4730 (d)	20S	4.5	10S	3.1	5MS	0.6	60S	10.5	Sr2+11+	R	-
36	GW 322 (C)	15S	5.7	20S	9.2	40S	8.8	70S	52.0	Sr2+11+	Lr13+	-
37	HD 2864 (C)	20S	5.4	10S	2.6	20S	8.8	60S	43.0	-*	R	Yr2+
38	HD 2932 (C)	20S	7.3	40S	13.9	20S	6.9	60S	46.0	-	Lr13+	-
39	HI 1544 (C)	5MR	0.6	5MR	0.6	60S	9.4	80S	48.2	Sr2+24+R+	Lr24+	Yr2+
40	HI 8498 (D) (C)	40S	8.9	5S	2.3	5MS	0.6	60S	7.1	Sr2+11+	Lr23+	Yr2+
40. A	INFECTOR	100S	74.3	100S	64.3	100S	70.0	100S	81.0	-	-	-
41	HI 8737 (D)(I) (C)	30MR	5.6	5S	1.6	5MR	0.3	60S	7.7	Sr2+9e+	Lr23+	Yr2+
42	MP 3336 (C)	20S	4.1	40S	9.6	60S	8.8	60S	33.0	Sr2+	Lr13+	Yr2+
43	MP 4010 (C)	20S	4.2	10MS	1.9	90S	12.5	90S	45.0	Sr2+24+	Lr24+	Yr2+
44	MPO 1215 (d) (C)	20S	7.7	10MR	1.2	TMR	0.1	40S	5.0	Sr11+	Lr23+	-
V. PENINSULAR ZONE												
45	MACS 3927 (d)	20S	13.0	20MS	6.3	20MS	3.6	60S	11.1	Sr2+11+	-	R
46	NIAW 2030	40S	9.1	5S	1.5	80S	11.5	80S	65.0	Sr2+24+	Lr24+	Yr2+
47	AKDW 2997-16(d) (C)	30S	10.3	40S	8.1	20MS	2.6	60S	13.9	Sr2+7b+	-	-
48	DBW 93 (I) (C)	40S	6.1	40S	7.5	60S	10.6	60S	32.4	Sr2+31+	Lr123+26+	Yr9+
49	MACS 6222 (C)	10S	2.5	20S	4.0	40S	6.3	60S	36.4	Sr2+31+	Lr1+26+	Yr9+27+
50	MACS 6478 (C)	40MS	11.9	40S	8.6	20S	3.5	80S	31.3	-	Lr1+23+	Yr2+
51	NI 5439 (C)	40S	17.1	60S	37.1	80S	15.0	100S	75.0	Sr11+	Lr34+	Yr2+18+

Sr. No.	Variety	RUST RESPONSE (HIGHEST SCORE AND ACI)								Postulated Gene		
		Stem rust		Lear rust				Stripe Rust				
				South		North						
		HS	ACI	HS	ACI	HS	ACI	HS	ACI	*Sr*	*Lr*	*Yr*
52	NIAW 1415 (C)	10S	3.3	10S	2.2	80S	10.3	100S	65.0	Sr2+31+	Lr26+	Yr9+
53	UAS 347 (I) (C)	40MS	11.7	60S	12.4	5MS	0.5	60S	19.2	Sr2+7b+11+	Lr10+13+	Yr2+
54	UAS 428 (d) (C)	20S	4.8	40S	11.2	10MS	1.1	40S	8.3	Sr2+11+	Lr23+	-
55	UAS 446 (d) (I) (C)	40S	10.7	10S	3.0	5MS	0.6	40S	6.0	Sr2+11+	R	Yr2+
VII. SPECIAL TRIAL												
56	(HD 2932 + Lr 19/Sr25)	20S	6.1	5S	1.4	40MS	4.5	60S	34.2	Sr2+25+	Lr19+	Yr2+
57	MMBL 283	40S	15.3	50S	17.0	20S	2.5	60S	28.8	-	-	-
58	PBW 723	30MR	2.5	10MS	1.6	10S	1.3	20S	6.4	Sr2+R	R	-
59	DBW 14 (C)	20S	5.4	30S	9.6	60S	8.8	60S	25.4	Sr2+	Lr23+	-
60	DDK 1029 (C)	20S	4.1	20MR	1.4	80S	10.3	80S	40.0	Sr2+11+	Lr13+	-
60. A	INFECTOR	100S	71.4	100S	75.7	100S	67.5	100S	83.0	-	-	-
61	HD 2985 (C)	40S	21.7	40S	18.2	40S	9.8	60S	31.8	Sr7b+	Lr23+	Yr2+
62	HI 1563 (C)	10S	1.9	TS	0.2	40S	6.3	80S	34.8	Sr2+R	R	Yr2+
63	HUW 234 (C)	40S	26.4	60S	26.0	20S	5.6	60S	31.0	Sr9b+11+	Lr14a+	Yr2+
64	HW 1098 (C)	20MR	2.0	10MS	2.3	60S	8.1	60S	38.0	Sr2+11+	-	-
65	K 0307 (C)	15S	4.8	60S	16.4	30S	6.3	60S	22.1	Sr2+	Lr1+23+	Yr2+
66	Kharchia 65 (C)	70S	37.4	80S	46.5	90S	60.0	100S	74.0	-	-	-
67	KRL 19 (C)	30S	9.9	40S	11.5	80S	22.5	100S	57.0	Sr2+8b+9b+11+	Lr13+	-
68	KRL 210 (C)	40S	23.1	20S	9.6	50S	13.8	40S	14.5	Sr7b+	Lr10+13+	-
69	PBW 343 (C)	20S	7.3	40S	21.9	100S	21.0	100S	63.0	Sr2+31+	Lr26+	Yr9+
70	Raj 4083 (C)	20S	4.3	40S	7.5	20S	3.8	80S	25.0	Sr2+11+	Lr23+	Yr2+
71	TL 2942 (C)	5S	1.1	TMR	0.1	5MR	0.4	10S	2.3	Sr2+R	Lr10+13+	-
72	TL 2969 (C)	5S	1.2	5S	0.7	TMS	0.1	20S	2.5	Sr2+R	Lr23+	-
73	WH 542 (C)	10S	3.0	40S	11.2	20S	3.8	80S	28.0	Sr31+	Lr23+26+34+	Yr9+
73. A	INFECTOR	100S	74.3	100S	75.7	100S	72.5	100S	79.0	-	-	-

Table 1.3. Adult plant response of AVT Ist year material against wheat rusts under field conditions (artificial inoculations) during 2014-15

Sr. No.	Variety	RUST RESPONSE (HIGHEST SCORE AND ACI)								Postulated Gene		
		Stem rust		Lear rust				Stripe Rust				
				South		North						
		HS	ACI	HS	ACI	HS	ACI	HS	ACI	*Sr*	*Lr*	*Yr*
I. NORTHERN HILL ZONE												
1	HPW 393	80S	33.4	15S	4.6	5MS	0.5	60S	20.8	*Sr11+*	*Lr1+10+23+*	*Yr2+*
2	HPW 394	10S	4.6	20S	3.8	10S	1.9	40S	6.1	*Sr11+*	*Lr1+13+10+*	-
3	HPW 413	40S	14.7	60S	14.6	20S	5.5	20S	6.3	*Sr7b+*	*Lr10+23+*	*Yr 2+*
4	HPW 421	20S	7.8	40S	14.9	20S	8.8	40S	7.4	*Sr5+8a+11+*	*Lr23+*	*Yr 2+*
5	HPW 422	10MS	1.6	30S	8.7	20S	3.6	40S	7.6	*Sr11+*	*Lr23+*	*Yr 2+*
6	HS 580	20MR	1.4	30S	9.8	10S	1.8	40S	9.2	*Sr5+31+*	*Lr1+26+*	*Yr 9+A+*
7	HS 583	30MS	14.0	10S	2.5	TMS	0.1	40S	9.3	*Sr2+9b+11+*	*Lr10+13+*	*Yr 2+*
8	HS 590	40S	10.0	20MS	3.4	5S	1.1	60S	10.3	*Sr2+7b+*	*Lr13+*	-
9	HS 596	10S	2.5	20S	5.9	5S	0.7	60S	7.5	*Sr11+*	*Lr23+*	*R*
10	HS 597	30S	8.8	20S	8.6	10S	1.9	20S	3.6	*Sr2+11+*	*Lr13+*	-
11	HS 598	40MS	11.0	30MS	7.5	10S	1.3	40S	19.4	*Sr2+30+*	*Lr2a+13+*	*Yr A+*
12	HS 599	10S	5.1	20S	5.3	5S	0.6	20S	2.1	*Sr2+31+*	*Lr10+26+*	*Yr9+A+*
13	HS 600	40S	10.6	10S	2.2	10MR	0.6	40S	6.6	*Sr2+7b+*	*Lr1+13+23+*	*YrA+*
14	HS 601	20S	7.3	40S	16.7	10S	2.5	20S	7.3	*Sr5+7b+*	*Lr13+*	*Yr2+*
15	UP 2917	20S	4.2	5S	0.9	10S	1.3	60S	27.0	*Sr2+31+*	*Lr10+26+*	*Yr9+A+*
16	UP 2918	20MR	2.9	20S	6.6	5S	0.7	60S	18.2	*Sr2+31+*	*Lr1+23+26+*	*Yr9+*
17	VL 1005	10MS	1.5	20S	5.9	0	0.0	60S	20.9	*Sr2+31+*	*Lr1+23+26+*	*Yr9+A+*
18	VL 1006	20S	8.3	40S	12.9	20S	3.6	40S	6.0	*Sr2+11+*	*Lr10+13+23+*	-
19	VL 1007	30MR	4.6	30S	14.9	20S	4.2	60S	11.8	*Sr2+31+*	*Lr26+*	*Yr9+A+*
20	VL 3002	20MR	1.4	20S	8.1	0	0.0	10S	2.6	*Sr2+R+*	*Lr10+13+*	*R*
20. A	INFECTOR	100S	71.4	100S	78.6	100S	70.0	100S	83.0	-	-	-
21	VL 3007	20MR	1.9	20S	7.1	20S	2.5	60S	9.4	*Sr2+31+*	*Lr1+26+*	*Yr9+A+*
22	VL 3008	10MS	1.2	TS	0.2	20S	2.8	40S	8.6	*Sr31+*	*Lr26+*	*Yr9+A+*
23	VL 3009	40S	11.7	20S	8.3	5MR	0.3	40S	10.8	*Sr30+*	*Lr2b+13+*	*YrA+*
24	VL 4001	20MR	1.2	15MS	1.7	10S	1.3	60S	15.0	*Sr2+31+*	*Lr10+26+*	*Yr9+*
II. NORTH WESTERN PLAIN ZONE												
25	DBW 147	10S	2.7	5S	0.7	5S	1.3	40S	12.4	*Sr2+30+*	-	*YrA+*

Sr. No.	Variety	RUST RESPONSE (HIGHEST SCORE AND ACI)								Postulated Gene		
		Stem rust		Lear rust				Stripe Rust				
				South		North						
		HS	ACI	HS	ACI	HS	ACI	HS	ACI	*Sr*	*Lr*	*Yr*
26	DBW 148	60S	24.3	40S	13.2	5S	1.1	40S	15.3	*Sr2+7b+*	*Lr10+23+*	*Yr2+*
27	DBW 150	40MS	7.9	5S	1.5	5MS	0.5	60S	22.9	*Sr2+7b+*	*Lr1+10+23+*	*Yr2+*
28	DDW 31	10S	5.4	5S	1.9	TR	0.0	60S	10.0	*Sr2+11+*	*Lr13+23+*	-
29	DDW 32	40S	14.9	20MS	4.9	5MR	0.3	60S*	6.1	*Sr2+7b+*	*Lr23+*	*R*
30	HD 3159	20S	6.4	20S	8.0	10S	1.3	40S	11.8	*Sr5+11+13+*	*Lr13+*	*Yr2+*
31	HD 3165	40MS	11.1	10S	4.0	10S	1.3	40S	9.3	*Sr2+7b+*	*Lr13+*	*Yr2+*
32	HD 3174	30MS	11.7	15MS	3.5	5S	1.2	60S	11.5	*Sr2+7b+*	*Lr13+*	*Yr2+*
33	HI 1604	15S	7.3	30S	14.1	5MS	1.0	20S	7.3	*Sr11+*	*Lr1+23+*	*Yr2+*
34	HI 1605	20S	3.9	20S	5.9	15S	1.9	40S	11.8	*Sr5+11+*	*Lr13+*	*Yr2+*
35	HUW 688	40S	11.9	15MS	3.9	5MS	0.5	80S	20.0	*Sr5+11+*	-	*R*
36	K 1312	10MS	3.7	10S	2.9	5S	0.6	40S	7.1	*Sr5+11+*	*Lr10+13+*	*Yr2+*
37	K 1313	5MS	1.7	10MS	2.1	10MS	1.0	60S	23.8	*Sr2+5+30+*	*Lr13+*	*YrA+*
38	K 1314	40MR	6.0	5S	1.8	20S	3.1	20S	6.6	*Sr2+5+7b+*	*Lr13+*	*YrA+*
39	MACS 3949	30MS	7.8	20MR	2.3	0	0.0	40S*	4.8	*Sr2+7b+*	*R*	*Yr2+*
40	MACS 4024	20MR	2.9	5MR	0.3	0	0.0	40S*	4.0	*Sr2+11+*	*R*	-
40. A	INFECTOR	100S	75.7	100S	80.0	100S	65.0	100S	84.0	-	-	-
41	NW 6024	-	-	-	-	-	-	-	-	-		-
42	PBW 707	10S	5.0	40S	19.9	20S	8.8	20S	3.5	*Sr9b+11+*	*Lr13+*	*Yr2+*
43	PBW 709	20MS	5.0	20S	6.1	0	0.0	40S	8.5	*Sr9b+11+*	*Lr10+13+23+*	*R*
44	PBW 716	20S	8.9	20MR	2.6	5MS	0.5	80S	28.6	*Sr2+7b+*	*Lr10+13+23+*	*YrA+*
45	PBW 718	10S	5.7	10MS	1.6	0	0.0	20S	4.0	*Sr9e+*	*Lr13+*	*Yr2+*
46	PBW 719	20MS	2.6	10S	1.4	5MS	0.5	60S	18.8	*Sr31+*	*Lr23+26+*	*Yr9+A+*
47	UP 2883	10MS	1.9	20S	7.9	5S	1.2	80S	24.0	*Sr11+*	*Lr13+*	*R*
48	WH 1179	30MS	10.0	40S	19.9	20S	6.4	40S	20.0	*Sr7b+*	*Lr10+13+*	*Yr2+*
III. NORTH EASTERN PLAIN ZONE												
49	HD 3171	20S	6.0	10S	5.3	20S	3.6	40S	12.4	*Sr7b+*	*Lr10+13+*	*R*
50	K 1317	10MS	1.7	20S	7.7	40S	6.3	60S	19.9	*Sr2+31+*	*Lr1+26+*	*Yr9+A+*
IV. CENTRAL ZONE												
51	CG 1015	10S	6.1	40S	14.5	20S	6.9	80S	43.6	*Sr2+5+7b+*	*Lr13+23+*	-
52	GW 463	40MR	5.5	20S	5.0	10MS	1.1	80S	43.0	*Sr2+11+*	*Lr1+23+*	-

Sr. No.	Variety	RUST RESPONSE (HIGHEST SCORE AND ACI)								Postulated Gene		
		Stem rust		Lear rust				Stripe Rust				
				South		North						
		HS	ACI	HS	ACI	HS	ACI	HS	ACI	*Sr*	*Lr*	*Yr*
53	HI 8759 (d)	20MR	1.6	5S	1.5	5S	0.7	60S	7.7	*Sr2+11+*	*Lr23+*	-
V. PENINSULAR ZONE												
54	GW 1315 (d)	10S	2.7	20MR	2.2	20S	3.8	100S	78.0	*Sr7b+11+*	*Lr13+*	-
55	HD 3164	10S	4.7	5S	1.3	20S	3.5	60S	25.2	*Sr7b+*	*Lr13+*	*YrA+*
56	HI 8765 (d)	40MR	3.1	5S	1.9	5MS	0.5	40S	4.9	*Sr9b+11+*	*Lr23+*	*Yr2+*
57	JWS 712	30MS	7.4	10MS	2.0	5S	0.6	60S	27.4	*Sr2+24+*	*Lr24+*	*Yr2+*
58	K 1315	10S	5.4	5S	1.3	0	0.0	60S	27.1	*Sr2+7b+13+*	*Lr1+23+*	*Yr2+*
59	MACS 3970 (d)	30S	8.2	20MS	4.6	TS	0.2	40S	7.1	*Sr7b+*	*Lr13+*	-
60	MACS 3972 (d)	20S	3.3	10MS	2.3	20S	3.5	40S	6.5	*Sr2+11+12+*	*Lr13+*	*R*
60. A	INFECTOR	100S	71.4	100S	78.6	100S	60.0	100S	82.0	-	-	-
61	MACS 4020 (d)	10S	3.0	20MR	4.6	10S	2.4	40S	13.7	*Sr2+11+12+*	-	-
62	PBW 721	60S	12.9	5S	1.3	10S	1.3	20S	6.5	*Sr5+9e+11+*	*Lr13+*	-
63	UAS 360	15MS	4.0	20S	11.5	20S	3.0	80S	32.0	*Sr30+*	*Lr2a+13+*	*Yr2+*
64	UAS 361	20MS	5.9	40S	14.6	5S	0.9	80S	43.0	*Sr2+31+*	*Lr1+23+26+*	*Yr9+A+*
65	UAS 453 (d)	20S	6.4	5S	2.2	20S	2.5	40S*	4.0	*Sr2+7b+9e+*	*Lr13+*	*Yr2+*
66	UAS 455 (d)	20S	5.4	5S	2.3	10S	1.8	40S*	4.5	*Sr2+7b+9e+*	*Lr13+*	-
VI. SPECIAL TRIAL (Dicoccum and Sailinity and Alkalinity)												
67	DBW 181	40MS	7.7	20MS	2.9	20S	3.1	40S	9.0	*Sr2+7b+9e+*	*Lr13+*	*Yr2+*
68	DBW 182	20MR	2.1	10MR	1.0	10S	1.3	60S	16.2	*Sr2+5+11+13+*	*Lr10+13+*	*R*
69	DBW 183	20S	5.0	20S	7.3	5MS	0.6	40S	13.4	*Sr2+8a+*	*Lr13+*	-
70	DBW 184	10MS	4.0	20S	9.4	50S	11.8	10S	1.6	*Sr2+7b+11+*	-	*Yr2+*
71	DBW 185	10S	3.3	60S	22.7	20S	6.3	40S	16.2	*Sr2+5+7b+*	*Lr10+13+*	*Yr2+*
72	DDK 1048	30MS	5.0	5S	1.3	5S	0.6	40S	25.0	*Sr7b+*	-	-
73	DDK 1049	10S	2.1	10MR	0.6	0	0.0	60S	27.3	*Sr7b+*	-	-
74	KRL 350	10MR	1.7	TS	0.2	0	0.0	40S	11.2	*Sr2+7b+11+*	*Lr1+23+*	*Yr2+*
75	KRL 351	40MR	5.0	10MS	2.7	5MS	0.5	40S	14.5	*Sr5+9e+*	*Lr10+13+*	-
76	MACS 5041	10S	2.7	5MS	1.1	0	0.0	100S	43.0	*Sr2+7b+15+*	*Lr20+*	-
77	MACS 5043	10S	2.6	20MR	1.2	0	0.0	80S	39.2	*Sr7b+11+*	-	*Yr2+*
78	WH 1309	30MR	7.7	10S	2.1	10S	1.9	60S	14.7	*Sr2+5+7b+9b+*	*Lr10+13+*	*Yr2+*
VII. SPECIAL TRIAL (TRITICALE)												

Sr. No.	Variety	RUST RESPONSE (HIGHEST SCORE AND ACI)								Postulated Gene		
		Stem rust		Lear rust				Stripe Rust				
				South		North						
		HS	ACI	HS	ACI	HS	ACI	HS	ACI	Sr	Lr	Yr
79	TL 3001	10S	2.8	10S	1.7	0	0.0	20S	2.9	*Sr2+*	*Lr13+*	*Yr2+*
80	TL 3002	TS	0.2	5S	0.7	10MS	1.0	40S*	4.2	*Sr2+31+*	*Lr1+26+*	*Yr9+*
80. A	INFECTOR	100S	75.7	100S	75.7	100S	63.8	100S	85.0	-	-	-
81	TL 3003	TR	0.1	0.0	0.0	0	0.0	20S	2.2	*Sr2+31+*	*Lr1+26+*	*Yr9+*
82	TL 3004	5S	1.5	5S	1.0	0	0.0	20S	2.2	*Sr2+5+*	*Lr13+*	*Yr2+*
83	TL 3005	5S	0.9	5MR	0.5	0	0.0	20S	2.4	*Sr2+5+7b+*	*Lr13+*	*Yr2+*
VIII. SPECIAL TRIAL (MABB/NIL (KB) ENTRIES)												
84	DWR-NIL-01	30MR	3.6	40S	19.7	50S	12.4	80S	43.4	*Sr31+*	*Lr23+26+*	*Yr9+*
85	DWR-NIL-02	5MR	0.4	40S	14.6	5MR	0.4	60S	30.5	*Sr31+*	*Lr26+*	*Yr9+*
86	HD 3209	30MR	3.9	15MS	3.7	5S	0.6	60S	44.2	*Sr2+11+25+*	*Lr19+*	*Yr2+*
87	KB 2012-03	40MR	8.0	40S	14.3	5S	0.6	80S	38.8	*Sr2+5+11+*	*Lr10+23+*	*Yr2+*
IX. SPECIAL TRIAL (Wheat Biofortification)												
88	HPBW 01	10MS	3.7	30S	5.1	5MR	0.3	40S	10.5	*Sr2+31+*	*Lr10+23+26+*	*Yr9+*
89	HPBW 02	15S	5.3	30S	7.0	0	0.0	40S	9.6	*Sr2+31+*	*Lr10+23+26+*	*Yr9+*
90	HPBW 05	40MR	4.9	30MS	6.5	10MS	1.6	40S	11.9	*Sr2+5+8a+*	*Lr13+*	*Yr2+*
91	HPBW 07	10S	3.4	40S	12.9	60S	21.3	20S	3.3	*Sr7b+11+*	*Lr13+*	*R*
92	HPBW 08	30MR	5.8	15MS	2.4	0	0.0	40S	8.7	*Sr2+9e+11+*	*R*	-
93	HPBW 09	20MR	1.7	TR	0.1	0	0.0	40S*	5.4	*Sr2+5+*	*R*	*R*
94	HUW 695	15S	4.6	20S	5.1	0	0.0	40S	9.4	*Sr2+5+11+13+*	*Lr10+23+*	*R*
95	HUW 711	30S	12.3	30X	8.7	5MS	0.5	40S	12.0	*Sr2+5+11+13+*	*Lr23+*	*Yr2+*
96	HUW 712	40MR	8.6	30S	8.7	0	0.0	40S	9.4	*Sr2+11+13+*	*Lr13+*	*Yr2+*
97	MACS 6507	5MS	2.4	30S	13.1	TR	0.0	60S	20.0	*Sr2+5+11+*	*Lr13+*	*Yr2+*
98	WB 1	15MS	3.8	20S	4.6	0	0.0	40S	8.5	*Sr2+7b+*	*Lr13+*	*Yr2+*
99	WB 2	15MS	3.6	20S	4.3	5MS	0.5	40S	10.5	*Sr2+7b+*	*Lr13+*	*Yr2+*
100	WB 5	10MS	2.3	15MS	2.3	5MS	0.5	40S	7.5	*Sr2+31+*	*Lr1+26+*	*Yr9+*
100. A	INFECTOR	100S	72.9	100S	71.4	100S	70.0	100S	83.0	-	-	-

Table 1.4. Adult plant response of NIVT material against wheat rusts under field conditions (artificial inoculations) during 2014-15

Sr. No.	Variety	RUST RESPONSE (HIGHEST SCORE AND ACI)							
		Stem rust		Lear rust				Stripe Rust	
				South		North			
		HS	ACI	HS	ACI	HS	ACI	HS	ACI
NIVT 1A									
1	WH 1182	40S	15.9	15MS	5.0	0	0.0	20S	4.5
2	HD 2733 (C)	20MR	2.1	40S	12.1	TMR	0.1	80S	62.0
3	DBW 158	60S	20.3	20MS	5.3	40S	12.5	40S	6.8
4	BRW 3762	40MR	6.2	10MS	1.4	TS	0.1	60S	18.0
5	HUW 701	20S	8.3	40S	12.1	10S	1.5	20S	5.9
6	PBW 724	60S	17.9	10MS	2.6	20MR	1.2	40S	5.0
7	HD 3186	20S	8.6	20S	5.6	15S	2.5	20S	7.6
8	HD 3180	60S	17.9	10S	3.0	40S*	5.0	60S	25.1
9	UP 2901	10S	2.1	5MS	0.9	5MS	0.5	80S	22.3
10	JAUW 635	30MS	6.8	20MS	2.7	5S	0.7	40MS	6.7
11	WH 1186	20MS	6.2	5S	0.8	10S	1.3	20S	6.9
12	DBW 159	20MS	5.1	30S	6.9	5S	0.8	80S	17.7
13	DBW 156	40MR	5.3	30S	5.1	20S	2.6	60S	20.6
14	HS 602	15MS	2.8	30S	9.1	10S	3.1	20S	6.7
15	K 1401	30S	10.6	30S	7.2	10S	1.3	20MS	6.2
16	PBW 725	20MR	3.1	20MS	2.5	5S	0.6	0	0.0
17	WH 1184	20S	9.9	20S	4.9	20MR	1.1	20S	2.4
18	Raj 4418	40MS	9.7	40S*	6.5	20S	2.5	80S	19.0
19	K 1402	15MS	6.3	20S	5.7	20MR	1.0	20S	4.8
20	HD 3182	40MS	18.0	10MS	2.5	40S*	5.1	20S	3.4
20. A	INFECTOR	100S	74.3	100S	78.6	80S	57.5	100S	80.0
21	JKW 205	40MS	9.6	5S	0.8	20S	3.8	60S	13.6
22	PBW 727	30MS	9.1	10MS	2.0	20MS	2.0	60S	19.2
23	NW 6047	10S	3.5	15MS	3.0	20S	2.6	60S	16.5
24	PBW 726	60S	19.7	20MS	2.4	30S	3.8	30S	5.2
25	WH 1183	60S	15.5	30S	6.6	20MS	2.0	40S	9.0
26	UP 2904	60S	29.0	60S	24.6	20S	2.5	80S	46.1
27	DBW 160	40MS	9.6	20MS	3.8	10S	1.4	40S	11.6
28	DBW 162	40MS	15.5	20MS	5.1	15MR	0.8	40S	18.9
29	BRW 3763	30MS	8.7	10S	3.9	0	0.0	40MS	8.7
30	UP 2903	30MS	10.1	10S	4.1	0	0.0	40MS	7.2
31	Mahyco-Goal	30S	13.1	10MS	1.9	5S	0.6	60S	22.0
32	DBW 161	40S	14.3	40S	9.9	10MS	2.6	40S	12.3
33	HD 3181	40S	18.1	20MS	3.9	10S	1.4	40S	12.3
34	DBW 157	20S	5.3	10S	1.5	20MR	1.0	40S	12.9
35	HD 3184	60S	25.1	20MR	1.9	20S	2.5	40S	6.1
36	NW 6050	40MS	9.3	40S	10.1	0	0.0	60S	21.8
37	HD 3183	60S	24.6	15MS	3.5	10S	1.4	60S	19.3
38	PBW 728	20MS	6.1	80S	22.9	20MS	2.5	40S	6.3
39	Raj 4421	10MR	1.2	10MS	2.9	5S	0.6	60S	24.0
40	Raj 4419	40S	9.6	10MS	1.2	0	0.0	60S	12.4
40. A	INFECTOR	100S	74.3	100S	78.6	100S	67.5	100S	84.0
41	HUW 702	20MR	1.9	10MS	1.1	0	0.0	20S	4.8
42	UP 2905	40S*	6.0	20S	4.3	0	0.0	60S	15.4
43	UP 2902	10S	5.2	5S	1.5	40S*	5.6	40S	9.5
44	HD 3185	60S	18.2	10S	2.9	10S	1.3	60S	10.5
45	WH 1185	40S	19.4	10S	4.2	40S	6.4	40S	15.3
46	Raj 4417	40S	11.5	10MS	1.2	20S	2.5	40S	6.9

Sr. No.	Variety	RUST RESPONSE (HIGHEST SCORE AND ACI)							
		Stem rust		Lear rust				Stripe Rust	
				South		North			
		HS	ACI	HS	ACI	HS	ACI	HS	ACI
NIVT 1B									
47	Raj 4422	30S	4.9	10MS	3.3	40S	11.8	60S	15.5
48	K 1404	40S	7.2	10MR	0.6	20S	4.4	40S	18.0
49	NW 6056	5MR	0.6	15MS	1.8	10S	1.9	40S	7.0
50	NW 6048	10MS	1.7	20MS	2.3	10MS	1.0	20S	7.6
51	K 1406	40S	12.6	60S	22.4	20S	4.5	100S	63.0
52	DBW 166	40S	12.2	20S	2.9	20S	2.5	60S	20.3
53	HUW 705	60S	25.0	15MS	3.0	10MS	2.0	40S	15.5
54	PBW 729	30S	13.6	15MS	6.9	20S	3.5	30S	3.5
55	Raj 4423	5S	1.5	30S	7.4	10S	1.3	40S	20.5
56	DBW 165	20S	6.9	10S	5.0	0	0.0	40S	6.5
57	HD 3188	20S	7.9	10MS	1.4	20S	2.5	40S	13.5
58	BRW 3759	40S	19.3	30S	7.3	20S	2.5	30S	10.6
59	WH 1187	40MR	6.6	TS	0.2	10S	1.3	20S	5.5
60	K 1405	10MS	2.6	20MS	2.6	0	0.0	60S	14.0
60. A	INFECTOR	100S	74.3	100S	78.6	100S	65.0	100S	78.0
61	HUW 706	5S	2.0	15MS	2.3	20MS	2.0	40S	14.0
62	NW 6052	30S	17.5	40S	18.3	20S	3.8	20S	11.0
63	WH 1189	40S	22.9	20S	6.3	10S	1.9	80S	25.0
64	K 1408	30MR	2.0	10MS	1.1	0	0.0	60S	20.7
65	HD 3191	40S	11.7	5S	0.9	10S	1.3	80S	29.5
66	HD 3193	25S	9.6	20S	8.0	0	0.0	60S	14.4
67	HD 3192	60S	23.3	10S	5.0	10MS	3.0	40MS	12.7
68	Raj 4415	60S	19.3	40S	9.8	TMS	0.1	80S	27.8
69	HUW 703	40S	16.0	40S	11.3	10S	1.4	40S	13.3
70	JKW 208	40S	9.4	30S	6.2	10S	2.6	60S	13.0
71	HD 3194	40S	23.4	20MS	3.7	10S	1.4	40S	14.6
72	WH 1188	15S	7.6	40S	12.1	10S	1.5	20S	6.9
73	HD 3187	30MS	13.7	40S	19.9	20S	3.3	40S	11.8
74	K 1407	10S	2.5	20S	11.0	15S	2.8	60S	24.6
75	HUW 704	30S	9.7	20MS	7.0	5S	0.7	40S	7.4
76	BRW 3767	15MS	3.6	20MR	1.7	0	0.0	20S	6.5
77	BRW 3765	40S	15.6	40S	15.0	10S	1.3	60S	11.2
78	HUW 707	20S	5.3	20MS	3.0	10MR	0.5	40S	5.4
79	PBW 730	20S	8.0	5S	1.3	TS	0.1	20S	2.4
80	JKW 207	40S	17.6	40S	14.9	10MS	1.6	40S	13.8
80. A	INFECTOR	100S	78.6	100S	80.0	100S	65.0	100S	78.0
81	HD 3190	40S	15.3	20S	8.3	5S	0.6	40S	6.0
82	DBW 164	20MS	9.0	60S	23.0	60S	20.0	40S	10.9
83	UP 2907	40MS	16.5	20S	5.6	30S	5.0	60S	18.7
84	PBW 731	30MS	9.5	10MS	1.6	5S	0.7	60S	14.0
85	HD 3189	40MS	18.1	20S	6.4	5S	1.0	40S	21.0
86	UP 2906	30MR	3.1	40S	11.5	0	0.0	20S	2.0
87	DBW 167	60S	17.6	10S	3.0	5S	0.6	20S	5.9
88	UP 2908	80S	32.3	40S	10.6	5MR	0.3	60S	25.5
89	NW 6054	30S	12.4	30S	13.6	20S	3.8	60S	15.4
90	NW 6049	60S	24.4	40S	23.4	10MS	1.0	30S	10.1
91	DBW 163	60S	19.6	30S	4.9	0	0.0	40S	7.8
NIVT 2									
92	DBW 170	20MR	2.0	10S	2.6	60S*	7.5	40S	19.6
93	DBW 169	30S	12.0	5S	1.1	0	0.0	40S	8.4
94	UAS 372	30S	11.3	40S	11.7	5S	1.3	80S	51.8

Sr. No.	Variety	RUST RESPONSE (HIGHEST SCORE AND ACI)							
		Stem rust		Lear rust				Stripe Rust	
				South		North			
		HS	ACI	HS	ACI	HS	ACI	HS	ACI
95	HI 1610	15S	5.4	40S	12.1	10MR	0.5	80S	23.5
96	UP 2909	30S	8.7	60S	17.8	5MR	0.3	60S	22.4
97	HI 1608	40MR	6.0	30MS	3.8	10MS	1.6	60S	30.0
98	GW 468	20S	3.9	10MS	1.4	20MS	2.0	100S	68.0
99	JWS 147	30S	6.2	10MR	0.7	TS	0.1	100S	74.0
100	MACS 6671	10S	4.2	15MS	1.9	0	0.0	60S	21.5
100. A	INFECTOR	100S	78.6	100S	80.0	100S	63.8	100S	80.0
101	DBW 168	20MR	2.1	20S	5.8	40S*	5.0	80S	29.4
102	MP 1309	40S	16.4	60S	31.7	20S	6.3	100S	68.0
103	HI 1607	15MR	1.9	5S	2.0	5S	1.5	40S	16.2
104	Raj 4424	10S	4.0	10S	1.4	30S	3.9	80S	28.0
105	UAS 370	5S	2.9	20S	9.1	5MS	0.5	80S	42.0
106	WH 1190	40MS	8.9	20S	7.3	5S	1.4	30S	6.1
107	HI 1609	20S	6.6	10MS	3.9	5MS	0.5	30S	8.4
108	HP 1960	20S	8.0	10S	1.7	20S	2.5	60S	30.6
109	MP 1310	20S	8.0	30S	12.6	10S	2.0	60S	27.9
110	RVW 4232	20S	8.4	40S	7.7	20S	2.5	60S	33.8
111	UAS 369	20S	5.3	40S	15.4	10S	1.3	60S	35.0
112	MP 3440	20S	5.2	15MS	2.9	5MR	0.4	40S	12.9
113	NIAW 2595	15MS	6.1	80S	21.1	10MR	0.5	40S	15.8
114	NIAW 2495	20S	4.9	40S	7.1	30S	5.1	80S	65.0
115	GW 473	15MS	5.0	5MR	0.3	0	0.0	100S	58.8
116	AKAW 4798	20S	4.1	20S	3.8	5MS	1.0	80S	22.1
117	UAS 371	10MS	3.5	10S	1.7	5S	0.6	40S	7.6
118	MACS 6668	10S	2.6	15S	2.1	40S	6.3	100S	54.0
119	GW 471	10MS	1.8	10MR	0.6	20S	2.6	100S	41.0
120	MP 1311	20S	9.6	60S	22.6	20S	3.8	100S	68.0
120. A	INFECTOR	100S	75.7	100S	77.1	100S	58.8	100S	80.0
121	NIAW 2539	10S	4.6	15MS	3.3	10S	1.3	40S	11.5
122	PBW 732	20S	6.4	15MS	2.5	0	0.0	60S	12.5
123	GW 469	10S	3.1	15MS	3.1	5S	0.6	100S	67.0
124	GW 470	10S	2.6	20S	5.0	40S	7.1	80S	27.2
125	CG 1016	10S	4.3	40S	15.7	10S	1.5	80S	50.8
NIVT - 3A									
126	HD 3199	40MR	6.3	40S	8.9	10S	2.3	80S	28.1
127	WH 1191	20S	9.9	10MR	1.2	10MR	0.5	40S	18.5
128	NW 6066	30MS	12.6	10MS	3.7	20S	2.6	30S	8.5
129	HUW 710	30MS	10.6	20S	5.9	10S	1.4	40S	7.0
130	NW 6044	30S	6.8	10MS	1.9	5S	0.6	40S	17.2
131	MP 1316	30MR	6.0	5MR	0.3	5S	0.6	60S	23.1
132	HP 1961	40MS	15.4	80S	21.2	40S	16.3	40S	11.4
133	HD 3197	30S	11.0	20S	3.6	10MR	0.5	80S	21.0
134	HUW 709	50S	15.2	40S	15.5	15S	2.4	40S	18.5
135	RAJ 4429	40S	12.3	10S	1.5	0	0.0	40S	11.7
136	HD 3198	30MS	9.9	20S	9.5	0	0.0	40S	10.5
137	DBW 172	60S	15.7	20MS	3.9	0	0.0	40S	13.5
138	DBW 171	20S	9.2	20MR	2.5	5S	1.2	60S	10.7
139	UP 2913	20S	8.3	20S	4.9	40S*	5.0	60S	25.0
140	K 1412	30MS	8.3	10S	2.1	10MS	1.0	80S	21.0
140. A	INFECTOR	100S	75.7	100S	77.1	100S	62.5	100S	80.0
141	WH 1192	40MS	11.4	5MR	0.8	20S	2.5	60S	22.8
142	UP 2910	20MR	3.1	40S	9.4	20S	2.8	80S	17.1

Sr. No.	Variety	RUST RESPONSE (HIGHEST SCORE AND ACI)							
		Stem rust		Lear rust				Stripe Rust	
				South		North			
		HS	ACI	HS	ACI	HS	ACI	HS	ACI
143	PBW 735	30MS	11.0	10S	1.8	20S	2.5	40S	10.7
144	HUW 708	30MS	5.6	5S	1.3	0	0.0	40S	9.4
145	HD 3200	10MS	3.6	10S	2.7	TS	0.1	60S	21.0
146	WH 1193	30MR	2.4	TS	0.2	20MR	1.5	40S	13.8
147	K 1413	30MS	3.6	15MS	3.2	5S	0.6	40S	14.3
148	PBW 736	20MS	6.2	20S	4.1	TMR	0.1	20S	6.8
149	DBW 173	15S	2.7	20MR	1.2	0	0.0	60S	15.2
150	DBW 174	30MS	11.5	15MS	3.0	20S	3.0	40S	12.2
151	UP 2911	10S	3.4	20S	8.3	5S	0.6	40S	7.9
152	PBW 734	40MS	9.2	5S	1.2	5S	0.6	40S	8.1
153	K 1414	20S	9.0	5MS	1.0	0	0.0	10S	1.6
154	PBW 733	20S	8.7	5S	1.3	0	0.0	20S	4.1
155	JKW 206	20MS	8.2	40S	12.1	10S	1.3	40S	10.9
156	HD 3201	10S	4.5	20MR	2.1	0	0.0	80S	29.6
157	RAJ 4428	15MR	1.9	10MS	2.6	20S	2.5	60S	17.9
NIVT 3B									
158	CG 1019	40S	12.2	20S	7.1	20S	2.5	80S	23.3
159	MP 3436	30S	5.4	5MR	0.4	60S*	8.1	80S	26.1
160	MP 3433	60S	16.5	20S	5.6	10S	2.4	80S	29.6
160. A	INFECTOR	100S	74.3	100S	75.7	100S	71.3	100S	79.0
161	GW 477	15MS	4.1	10MS	1.6	5S	0.6	80S	39.6
162	MACS 6669	20S	5.3	15MS	6.1	5S	0.6	60S	21.0
163	UAS 371	15S	6.0	20MS	3.3	10MR	0.6	20S	7.1
164	UAS 373	40MR	4.1	20S	3.1	40S*	5.0	80S	35.0
165	HI 1611	10MS	3.9	20S	4.9	20S	2.5	80S	25.3
166	MACS 6635	10S	4.5	40S	13.9	0	0.0	80S	30.6
167	GW 475	20S	5.0	20S	7.0	20S	3.9	80S	54.8
168	AKAW 4842	10S	5.1	20MS	2.8	0	0.0	80S	45.0
169	RVW 4235	15MS	3.1	10S	1.8	10S	1.9	80S	25.8
170	DBW 175	20S	12.0	20S	8.1	TMR	0.1	100S	22.0
171	MP 1313	20S	12.7	60S	31.0	20S	5.6	60S	41.0
172	MP 1312	40S	9.6	10MS	2.3	10S	1.4	40S	25.2
173	WH 1195	15MS	4.2	20MS	2.7	0	0.0	30S	11.3
174	NIAW 34 (C)	20MS	3.7	20S	3.1	15S	3.1	60S	16.4
175	DBW 176	40S	20.1	10MS	2.6	5S	1.4	10S	3.4
176	NIAW 2613	30S	11.6	10S	2.7	20S	2.5	60S	34.0
177	RAJ 4427	20S	7.7	10S	3.0	20S	2.5	60S	20.0
178	PBW 743	40MS	6.9	20S	6.0	10S	1.4	20S	3.0
179	WH 1194	10S	4.0	20S	6.7	20S	3.0	20MS	6.1
180	PBW 739	10MS	2.0	15MS	1.7	0	0.0	20S	4.6
180. A	INFECTOR	100S	75.7	100S	77.1	100S	60.0	100S	80.0
181	HI 8767	10MS	3.7	15MS	2.0	5S	0.9	10S	3.0
182	HW 3906	5S	2.0	5MR	0.7	10S	1.3	60S	21.0
183	NIAW 2565	20S	6.5	10MR	0.8	20S	2.6	40S	22.6
184	CG 1017	30S	7.3	5MS	1.0	10S	1.3	80S	45.0
185	GW 478	15MS	4.7	5MS	0.8	40S*	5.6	80S	39.8
186	GW 474	10MS	1.3	10S	2.9	10S	1.3	60S	18.4
187	UP 2912	5S	1.8	10S	4.3	20S	2.5	20S	6.4
188	DBW 177	60S	14.0	15MS	1.9	20S	2.5	20S	3.5
189	HD 3206	20MS	5.0	10MS	1.3	40S*	5.1	80S	35.5
190	RAJ 4426	20S	7.1	10MS	1.9	10MR	0.5	80S	30.2
NIVT - 4									

Sr. No.	Variety	RUST RESPONSF (HIGHFST SCORE AND ACI)							
		Stem rust		Lear rust				Stripe Rust	
				South		North			
		HS	ACI	HS	ACI	HS	ACI	HS	ACI
191	MACS 4035	25S	11.7	20S	6.9	20S	3.0	40S	13.5
192	UAS 456	20S	6.9	5MR	0.5	0	0.0	10S	1.1
193	UAS 457	20MS	3.4	5MS	1.0	0	0.0	60S	8.0
194	MPO 1314	40S	14.9	5MR	0.5	5MR	0.4	10S	1.6
195	GW 1318	15MS	5.1	10MS	2.1	10MR	0.5	20S	10.3
196	RKD 291	30S	10.9	20MS	5.3	15S	1.9	20S	5.6
197	DDW 36	20S	8.7	10MS	3.0	0	0.0	20S	5.4
198	PDW 343	30S	11.5	10MS	3.8	10MS	1.0	20S	3.2
199	MACS 3973	40S	10.6	5S	2.0	10MS	1.0	60S	32.8
200	WHD 957	40S	10.8	5MS	1.4	10MR	0.5	10S	1.6
200. A	INFECTOR	100S	75.7	100S	74.3	100S	66.3	100S	75.0
201	NIDW 295 (C)	30S	5.5	5MR	0.5	10S	1.3	20S	2.1
202	PDW 345	40S	15.9	10MS	3.0	5MR	0.3	20S	2.4
203	NIDW 950	15S	6.0	5S	0.9	15MR	0.8	10S	1.0
204	GW 1321	30MS	5.4	5S	1.4	TMR	0.1	20S	2.9
205	HI 8772	20S	10.0	10MR	0.9	0	0.0	40S	6.5
206	GW 1319	30S	7.9	10MS	2.9	5S	0.7	60S*	6.0
207	GW 1320	30S	13.0	10S	3.0	5MR	0.3	40S	5.1
208	UPD 97	20S	8.8	15MS	2.5	5MR	0.3	20S	3.2
209	PBND 5175	15MS	3.9	20MR	2.5	10S	1.3	40S	11.7
210	HI 8770	20MR	1.4	TS	0.2	TS	0.1	20S	4.8
211	PDW 346	20MS	7.3	5S	1.1	20S	2.5	40S	5.0
212	HI 8771	30MS	11.6	TS	0.2	0	0.0	10S	1.2
213	DDW 35	30S	9.9	10S	4.4	0	0.0	20S	3.9
214	RKD 282	10S	5.9	15MS	2.4	10MR	0.5	40MS	9.6
215	HI 8768	40S	10.4	20MS	2.7	10MR	0.5	40S	8.3
216	HI 8769	30S	6.3	5S	1.2	TMR	0.1	40S	5.6
217	HI 8773	40MS	8.3	5MR	0.4	0	0.0	30S	5.8
218	PDW 344	20S	8.9	10S	2.1	TR	0.0	20S	3.1
219	WHD 958	20S	5.3	10MS	3.2	TMR	0.1	10S	1.1
220	HI 8774	40MR	5.5	5MS	0.8	5MR	0.3	20S	5.3
220. A	INFECTOR	100S	78.6	100S	75.7	100S	65.0	100S	76.0
221	MPO 1315	20S	8.3	10MS	2.4	0	0.0	20S	3.2
222	AKDW 4525	40S	14.6	10S	2.6	0	0.0	10S	3.0
223	MACS 4029	20S	4.9	20MR	2.4	20S	3.8	60S	8.0
224	NIDW 989	30MR	5.6	20MR	1.9	10MS	1.5	60S	7.0
NIVT - 5A									
225	MACS 6660	30MR	4.2	20S	6.5	60S	12.6	80S	66.0
226	HD 3204	15MS	3.7	10S	5.6	0	0.0	40S	16.3
227	UP 2914	40MR	4.2	40S	12.3	10MS	1.6	60S	37.3
228	WH 1181	15MS	5.6	40S	9.2	TMR	0.1	60S	12.2
229	MP 3429	20S	8.4	15MR	1.1	10S	1.4	80S	41.8
230	AKAW 3891	40S	14.7	80S	30.9	40S	8.8	100S	55.0
231	NW 6046	40S	18.7	20S	5.6	10S	1.3	30S	16.0
232	JWS 146	10MS	3.3	20MS	3.5	0	0.0	60S	23.6
233	BRW 3761	15MS	4.1	80S	29.2	60S	17.5	80S	43.0
234	K 1415	15MS	2.4	10MR	0.7	10S	1.3	40S	10.8
235	MP 1304	30MS	7.6	20MS	2.5	0	0.0	80S	22.0
236	MP 3288 (C)	10S	4.9	30MS	7.9	TS	0.2	60S	22.0
237	UP 2915	30S	13.3	80S	26.4	60S	22.5	80S	29.1
238	UAS 375	20S	12.1	40S	15.0	40S*	5.6	80S	40.6
239	MP 1303	20MR	2.6	40S	15.1	40MS	6.5	40S	12.9

Sr. No.	Variety	RUST RESPONSE (HIGHEST SCORE AND ACI)							
		Stem rust		Lear rust				Stripe Rust	
				South		North			
		HS	ACI	HS	ACI	HS	ACI	HS	ACI
240	HD 3205	20MS	5.8	TS	0.2	20S	2.5	60S	19.6
240. A	INFECTOR	100S	72.9	100S	75.7	100S	72.5	100S	77.0
241	DBW 178	40MS	15.6	10MS	1.3	10MR	0.5	60S	13.5
242	HI 1612	60S	24.7	10MS	3.3	20S	2.6	40S	8.2
243	NIAW 2547	30MS	12.3	20MS	4.4	0	0.0	60S	14.4
244	MP 1305	40S	20.1	60S	25.1	15S	2.5	100S	63.0
245	HD 3203	40MR	7.7	20MS	3.9	20S	2.6	80S	23.3
246	HD 3202	10S	6.4	20S	4.7	10S	1.3	60S	12.6
247	MP 1306	40S	15.9	40S	10.3	10MR	0.9	80S	22.4
248	WH 1180	20MS	3.9	40S	15.7	TS	0.1	60S	15.4
249	MACS 6659	20MS	3.2	40S	14.4	10S	2.4	80S	58.0
250	K 1417	20S	7.0	40MS	8.7	20MR	1.0	20S	4.6
251	CG 1018	20S	6.0	30MS	3.9	10S	1.3	80S	37.4
252	DBW 179	40MS	8.3	10MR	1.0	20S	2.5	20S	4.8
253	DBW 180	40MS	9.2	15MS	3.3	0	0.0	60S	20.4
254	UAS 374	20MS	5.7	30S	6.6	0	0.0	40S	16.2
255	PBW 737	40MS	17.9	30MS	7.4	15MS	2.5	40S	8.2
256	K 1416	40MS	16.7	15MS	4.9	20S	3.8	40S	14.5
257	PBW 738	10S	4.7	20S	3.2	20S	2.5	30S	5.8
NIVT - 5B									
258	GW 1324	20S	3.7	20MS	5.9	20S	3.5	80S	43.8
259	MPO 1307	20S	5.9	5MS	0.6	0	0.0	60S*	6.0
260	RKD 283	10S	3.7	20MR	1.4	0	0.0	100S	12.0
260. A	INFECTOR	100S	74.3	100S	78.6	100S	72.5	100S	80.0
261	GW 1325	20S	5.3	70S	15.9	10S	2.0	100S	59.6
262	KD 1418	10S	4.9	10S	2.5	0	0.0	60S	17.8
263	MACS 4027	20S	4.7	20S	3.5	5S	0.8	40S	16.2
264	HI 8778	20S	5.6	10MS	3.0	5S	1.3	40S	7.1
265	HI 8776	20S	3.9	15MS	2.1	5MR	0.3	40S	5.8
266	HI 8775	10S	4.3	10MR	1.0	0	0.0	40S*	5.5
267	HI 8777	20S	5.3	10MS	3.2	10MS	1.5	40S	8.5
268	GW 1323	40S	14.0	20S	4.7	20MS	2.0	80S	58.2
269	GW 1327	40MS	8.8	5MR	0.3	5S	0.6	100S	23.0
270	MPO 1308	40MS	9.9	TR	0.0	TMR	0.1	40S*	4.4
271	MACS 4028	20S	9.3	20S	5.3	10S	1.9	80S	34.0
272	DDW 38	20S	7.2	10MR	1.0	20S	2.5	20S	2.0
273	NIDW 937	20MS	4.0	10MS	2.2	5S	0.6	40S	7.5
274	HI 8779	20MS	8.1	5MS	1.2	5MR	0.3	20S	2.1
275	MACS 4030	10S	4.1	15MS	2.1	5MR	0.5	60S	7.1
276	RKD 292	20S	5.3	10MS	3.0	40S*	5.6	80S*	8.7
277	HI 8627 (C)	20S	5.7	10MS	1.1	0	0.0	20S	3.3
278	UAS 458	20S	5.8	20S	4.0	10S	1.5	20S	2.5
279	UAS 459	20S	5.8	20MR	1.9	15MR	0.8	40S	5.0
280	GW 1326	20S	4.3	10MS	1.8	0	0.0	100S	76.7
280. A	INFECTOR	100S	74.3	100S	75.7	100S	67.5	100S	80.0
281	DDW 37	20S	8.7	5MS	0.9	10S	2.4	40S*	4.9
IVT									
I. NORTHERN HILL ZONE									
282	VL 2015	40S	23.2	20S	6.9	10S	2.5	30S	3.6
283	HS 605	20S	4.1	10MS	1.3	TMR	0.1	30S	5.9
284	HS 608	20S	6.5	10MS	2.6	10S	1.3	60S*	6.4
285	VL 2013	15MS	2.3	10MS	1.6	0	0.0	40S	7.0

Sr. No.	Variety	RUST RESPONSE (HIGHEST SCORE AND ACI)							
		Stem rust		Lear rust				Stripe Rust	
				South		North			
		HS	ACI	HS	ACI	HS	ACI	HS	ACI
286	HPW 420	20MR	2.9	TR	0.0	0	0.0	20S	6.3
287	VL 2017	20MR	1.9	20S	5.4	10MS	1.0	40S	9.5
288	VL 2016	10MS	3.1	TR	0.0	20S	2.5	40S	8.8
289	HPW 418	20S	7.9	20S	8.0	TMR	0.1	20S	9.9
290	VL 2018	40S	16.0	40S	13.6	20S	3.8	60S	8.7
291	HS 606	20S	14.3	20S	7.9	20S	3.9	40S	8.1
292	HPW 414	20S	7.2	40S	16.1	20S	6.3	80S	20.8
293	HS 603	20S	9.4	60S	22.6	30MS	6.2	60S	9.0
294	HPW 415	30S	11.6	40S	19.9	30S	3.8	60S	14.2
295	UP 2916	60S	23.3	15MS	3.4	5MS	0.6	60S	17.9
296	HPW 417	20MS	8.2	40S	19.6	40S	10.8	60S	13.3
297	VL 2014	40S	14.0	20S	4.0	5S	0.6	60S	9.3
298	HS 597	30MS	9.4	20S	4.6	20S	2.5	40S	5.5
299	HS 604	20S	9.0	10MS	1.7	60S*	7.5	20S	4.0
300	HPW 416	20S	7.4	40S	12.1	0	0.0	30S	9.7
300. A	INFECTOR	100S	74.3	100S	75.7	100S	60.0	100S	82.0
301	HS 607	15MS	3.0	30MS	8.6	20S	3.1	40S	9.9
302	HPW 419	10S	4.2	40S	14.7	40S*	5.3	20S	4.9
II. SOUTHERN HILLS ZONE									
303	HW 5248	20MR	2.6	5MR	0.3	20S	3.0	80S	26.0
304	HW 4206	10MR	1.0	TS	0.2	20MS	2.0	100S	46.0
305	HW 4207	10MS	1.4	10S	1.4	0	0.0	100S	57.0
306	HW 2044 (C)	20MS	5.7	15MS	2.3	0	0.0	60S	18.8
307	HW 4501	10MR	1.0	20MS	2.3	10MR	0.5	80S	27.7
308	HW 5216 (C)	10MS	3.0	10MR	0.6	0	0.0	60S	28.2
309	HW 3624-1	15S	2.5	10S	1.4	20S	2.5	80S	31.0
310	HW 4305-2	15MS	3.4	10MR	0.6	40S	5.6	80S	45.6
311	HW 3658	5MR	0.3	5MR	0.6	20S	3.0	80S	37.0
312	HW 4205-2	5MR	0.3	10S	1.4	10MS	1.6	80S	24.7
313	MACS 6670	30S	6.7	15MS	1.7	20S	2.5	80S	27.5
314	HW 5246	10S	2.7	5S	2.0	20S	2.5	80S	35.5
315	CoW (W) 1 (C)	10MS	3.0	20S	4.3	30S	3.8	40S	14.5
316	HW 5245	10MS	4.0	20S	11.0	5S	0.6	20S	5.5
317	UAS 376	10MR	1.3	20S	4.7	10S	2.5	80S	33.5
318	NIAW 2613	20S	6.6	20S	3.2	40S*	5.1	80S	27.7
319	HS 609	40MS	16.7	20S	3.0	10MR	0.5	80S	33.0
320	HS 610	60S	23.2	10MS	1.7	10MR	0.5	80S	22.2
321	UAS 377	20S	8.6	40S	14.0	5S	0.6	60S	32.0
322	HW 5247	10S	2.9	20S	2.9	TMR	0.1	80S	36.4
III. SPECIAL MATERIAL									
323	HW 5050	40MR	7.0	40S	15.4	10MS	2.0	80S	21.0
324	HW 5051	15MS	4.6	5MR	0.3	20S	2.5	80S	27.7
324.A	INFECTOR	100S	74.3	100S	75.7	100S	68.8	100S	75.0

Table 1.5: Performance of AVT IInd Year material against different diseases under multilocational testing during 2014-15

Sr. No.	Entries	LS %		LB (dd)		PM 0-9		KB %		FS %		FHB		HB %	
		HS	AV	HS	AV	HS	AV	HS	AV	HS	AV.	HS	AV.	HS	AV.
I. NORTHERN HILL ZONE															
1	HS 562	50.7	26.4	67	24	7	4	42.5	11.2	9.1	2.8	3	2	38.9	26.2
2	HPW 251 (C)	51.4	23.1	89	45	5	2	35.9	11.5	5.3	1.3	4	2	7.0	2.3
3	HPW 349 (C)	52.9	32.8	89	35	6	3	91.5	28.5	37.7	10.8	4	3	29.2	15.4
4	HS 375 (C)	60	21.6	69	46	9	4	34.8	11.3	8.3	2.1	5	3	16.0	12.2
5	HS 490 (C)	80.6	31.3	78	35	5	3	17.8	3.8	22.2	10.1	5	3	3.3	1.1
6	HS 507 (C)	60.4	27.6	79	46	7	3	60.9	16.4	5.9	1.6	5	3	27.1	10.8
7	HS 542 (C)	55.2	20.1	78	35	9	4	60.7	26.3	0.7	0.2	5	3	13.5	11.4
8	VL 804 (C)	42.8	16.5	89	46	9	5	84.5	24.1	0	0	5	3	3.2	2.0
9	VL 829 (C)	23.3	5.9	79	35	9	5	31.8	10.9	0	0	5	3	6.8	4.2
10	VL 892 (C)	40.5	24.4	99	57	7	4	92.6	30.7	28.6	7.1	5	3	35.1	18.6
11	VL 907 (C)	46.1	18.9	69	36	9	5	70	13.4	40	10	5	3	55.4	28.2
II. NORTH WESTERN PLAIN ZONE															
12	HD 4730	60.2	15	99	46	9	5	36.7	10	0	0	3	3	-	-
13	MP 1277	40.3	15	69	36	9	4	63.8	23.9	5.3	1.3	3	2	-	-
14	WH 1164	50.4	33.4	89	46	9	6	38.2	14.3	0	0	5	3	-	-
15	DBW 88 (C)	80	41.2	79	45	9	5	43.2	17.7	18.8	4.7	4	3	-	-
16	DBW 90 (C)	60.1	12	79	46	9	5	48.7	14.2	18.2	5.1	5	3	-	-
17	DPW 621-50 (C)	80.5	31.7	79	35	9	5	89.8	29.1	13.3	3.8	5	3	-	-
18	HD 2967 (C)	86.2	37.8	79	35	9	5	47.4	26.5	13	4.3	5	4	-	-
19	HD 3043 (C)	40.2	15.8	68	35	5	2	32.7	18.1	0	0	4	3	-	-
20	HD 3059 (C)	43.6	23.3	79	46	7	4	51	20.2	27.3	10	5	3	-	-
21	HD 3086 (C)	37.2	7.4	89	46	9	5	51.8	19.3	3.7	0.9	5	3	-	-
22	PBW 644 (C)	40.9	19.7	78	35	9	6	43.7	14.2	14.3	8.1	4	3	-	-
23	PDW 233 (C)	47.2	9.4	79	36	9	6	15.3	4	0	0	5	4	-	-
24	PDW 291 (C)	39.7	7.9	79	35	9	7	10	2.9	0	0	5	4	-	-
25	PDW 314 (C)	54.2	24	78	24	9	6	15.8	4.3	0	0	5	4	-	-

Sr. No.	Entries	LS %		LB (dd)		PM 0-9		KB %		FS %		FHB		HB %	
		HS	AV	HS	AV	HS	AV	HS	AV	HS	AV.	HS	AV.	HS	AV.
26	WH 1021 (C)	60.7	28.3	89	46	9	7	39.3	11.2	18.2	8.4	5	3	-	-
27	WH 1080 (C)	50.7	25	79	46	9	6	56.7	14.1	12.5	3.1	3	2	-	-
28	WH 1105 (C)	87.3	43.3	89	46	9	6	58.8	28.4	0	0	5	3	-	-
29	WH 1124 (C)	60.3	12.1	79	46	9	6	84.5	24.5	12.5	3.3	5	3	-	-
30	WH 1142 (I) C)	50.2	23.9	69	35	9	6	32.6	16.6	10.5	4	5	3	-	-
III. NORTH EASTERN PLAIN ZONE															
31	C 306 (C)	56.2	27.8	78	35	7	5	100	40.8	38.5	15.9	5	3	-	-
32	HD 2888 (C)	50	25.2	78	45	9	6	71.2	25.9	20	10.7	5	3	-	-
33	K 8027 (C)	45.9	24.2	78	35	9	7	54.3	21.4	0	0	4	2	-	-
IV. CENTRAL ZONE															
34	HD 4728 (d)	25.7	8.7	89	35	8	6	8.1	3.1	0	0	5	3	-	-
35	HD 4730 (d)	-	-	79	46	7	5	11.2	4.3	0	0	4	3	-	-
36	GW 322 (C)	62	31.2	89	57	9	6	42.4	17.3	27.3	7	5	3	-	-
37	HD 2864 (C)	43.4	27.5	89	57	9	6	50	16.7	18.8	5.2	5	3	-	-
38	HD 2932 (C)	42.2	19	89	57	9	6	24.7	9.6	42.9	11	5	3	-	-
39	HI 1544 (C)	70.6	25.3	89	57	9	7	94.8	33.7	53.3	21.1	5	3	-	-
40	HI 8498 (D) (C)	3.1	0.8	89	46	9	8	47.9	9	0	0	4	3	-	-
41	HI 8737 (D)(I) (C)	60.6	12.7	79	45	9	7	2.2	1.1	2	0.5	5	4	-	-
42	MP 3336 (C)	25.3	13.2	89	57	9	6	61.5	14.8	33.3	9.2	5	3	-	-
43	MP 4010 (C)	81	35.4	89	57	9	6	38.2	14.3	0	0	4	3	-	-
44	MPO 1215 (d) (C)	-	-	79	45	9	6	19.4	6.9	0	0	5	4	-	-
V. PENINSULAR ZONE															
45	MACS 3927 (d)	37.2	13.9	89	46	7	6	64.1	14	0	0	5	3	-	-
46	NIAW 2030	45.3	24	58	35	9	6	80	22.8	36.4	11.7	5	3	-	-
47	AKDW 2997-16(d) (C)	9.9	2.5	89	57	9	6	5.6	1.4	0	0	5	3	-	-
48	DBW 93 (I) (C)	-	-	89	45	9	6	29.3	8.6	29.4	7.4	5	3	-	-
49	MACS 6222 (C)	51.1	18.6	67	35	9	6	42.4	16.4	14.3	7.4	5	3	-	-
50	MACS 6478 (C)	35.2	20.3	68	36	9	5	45.4	15.6	10.5	4.3	5	3	-	-
51	NI 5439 (C)	81.2	27.9	78	46	9	5	96	38.8	20	8.1	5	3	-	-
52	NIAW 1415 (C)	60.2	36.1	79	46	9	5	78.3	18.8	14.3	3.6	5	3	-	-

		LS %		LB (dd)		PM 0-9		KB %		FS %		FHB		HB %	
Sr. No.	Entries	HS	AV	HS	AV	HS	AV	HS	AV	HS	AV.	HS	AV.	HS	AV.
53	UAS 347 (I) (C)	64.7	14.6	79	35	9	4	35.6	11.9	16	4.2	5	3	-	-
54	UAS 428 (d) (C)	21.1	4.5	79	36	9	5	30.3	9.8	0	0	4	3	-	-
55	UAS 446 (d) (I) (C)	60.2	7.6	89	38	9	5	9.4	4.2	0	0	5	3	-	-
VII. SPECIAL TRIAL															
56	(HD 2932 + Lr 19/Sr25)	70.3	30	89	46	9	5	24.4	10.9	0	0	5	3	-	-
57	MMBL 283	70.6	41.5	89	57	9	6	94	21.4	1.2	0.3	5	3	-	-
58	PBW 723	61.5	32.3	79	46	9	5	16.3	7.9	33.3	16.2	4	3	-	-
59	DBW 14 (C)	70.3	31.6	89	46	9	5	21.2	7.4	8.7	5.9	5	3	-	-
60	DDK 1029 (C)	2.3	0.8	89	46	6	2	50	17.6	0	0	5	4	-	-
61	HD 2985 (C)	60.4	30	89	46	9	6	61.4	21.7	21.4	7.2	5	3	-	-
62	HI 1563 (C)	60	37.9	89	57	9	6	67.3	22.9	64.7	24.5	5	3	-	-
63	HUW 234 (C)	80	38.9	89	46	9	7	50	11.4	5.6	1.4	5	3	-	-
64	HW 1098 (C)	-	-	79	46	6	3	43.5	11.2	0	0	5	3	-	-
65	K 0307 (C)	70.3	26.2	89	46	9	5	39.5	13.7	0	0	5	3	-	-
66	Kharchia 65 (C)	60.3	29	79	46	9	5	86.6	32.2	51.9	13.4	5	3	-	-
67	KRL 19 (C)	50.4	20.9	99	56	9	5	45.5	15.2	15.4	5	4	3	-	-
68	KRL 210 (C)	60.2	23.3	99	46	6	4	40.6	10.7	9.1	2.3	5	3	-	-
69	PBW 343 (C)	80.2	33.2	89	46	9	6	29.3	14	61.1	22.6	5	3	-	-
70	Raj 4083 (C)	81.1	42	99	56	9	6	58.3	18.8	30.8	14.8	5	3	-	-
71	TL 2942 (C)	9.6	1.9	99	35	1	0	21.7	3.1	0	0	4	2	-	-
72	TL 2969 (C)	9.6	1.9	79	35	1	0	15.5	5.8	0	0	5	3	-	-
73	WH 542 (C)	55.2	30.1	79	35	9	5	18.2	7.8	27.3	15	5	4	-	-

LS = Loose Smut, LB= Leaf Blight, PM = Powdery Mildew, , KB = Karnal Bunt, , FS = Flag Smut, FHB = Fusarium Head Blight, , HB = Hill Bunt, NS = No Seed, HS = Highest Score, AV = Average

AVT Ist Year

Nil

Leaf and Stripe rusts

AVT IInd Year

PDW 314 (C) and UAS 446 (d) (I) (C)

AVT Ist Year

DDW 32, HD 3165, HS 583, HS 600 and PBW 721.

Table 1.6: AVTs entries evaluated under natural conditions for stripe rust at Langroya (Punjab) during 2014-15

Sr. No.	Variety	Yellow rust
AVT II[nd] Year 2014-15		
I. NORTHERN HILL ZONE		
1	HS 562	0
2	HPW 251 (C)	10S
3	HPW 349 (C)	0
4	HS 375 (C)	40S
5	HS 490 (C)	0
6	HS 507 (C)	0
7	HS 542 (C)	0
8	VL 804 (C)	10S
9	VL 829 (C)	10S
10	VL 892 (C)	5
11	VL 907 (C)	5MS
II. NORTH WESTERN PLAIN ZONE		
12	HD 4730	0
13	MP 1277	0
14	WH 1164	0
15	DBW 88 (C)	20S
16	DBW 90 (C)	5MS
17	DPW 621-50 (C)	20MS
18	HD 2967 (C)	20S
19	HD 3043 (C)	0
20	HD 3059 (C)	10S
20. A	INFECTOR	20S
21	HD 3086 (C)	0
22	PBW 644 (C)	TR
23	PDW 233 (C)	0
24	PDW 291 (C)	0
25	PDW 314 (C)	5MS
26	WH 1021 (C)	20MS
27	WH 1080 (C)	0
28	WH 1105 (C)	0
29	WH 1124 (C)	0
30	WH 1142 (I) C)	0
III. NORTH EASTERN PLAIN ZONE		
31	C 306 (C)	10S
32	HD 2888 (C)	5S
33	K 8027 (C)	40S
IV. CENTRAL ZONE		
34	HD 4728 (d)	0
35	HD 4730 (d)	0
36	GW 322 (C)	10S
37	HD 2864 (C)	40S
38	HD 2932 (C)	10S
39	HI 1544 (C)	40S
40	HI 8498 (D) (C)	TR
40. A	INFECTOR	40S
41	HI 8737 (D)(I) (C)	0
42	MP 3336 (C)	40S
43	MP 4010 (C)	40S
44	MPO 1215 (d) (C)	5MR
V. PENINSULAR ZONE		
45	MACS 3927 (d)	5
46	NIAW 2030	40
47	AKDW 2997-16(d) (C)	0
48	DBW 93 (I) (C)	20
49	MACS 6222 (C)	TR
50	MACS 6478 (C)	10S
51	NI 5439 (C)	40S
52	NIAW 1415 (C)	40S
53	UAS 347 (I) (C)	5MS
54	UAS 428 (d) (C)	0
55	UAS 446 (d) (I) (C)	0
VII. SPECIAL TRIAL		
56	(HD 2932 + Lr 19/Sr25)	10S
57	MMBL 283	5S
58	PBW 723	5MS
59	DBW 14 (C)	5MS
60	DDK 1029 (C)	10MS
60. A	INFECTOR	20S
61	HD 2985 (C)	5S
62	HI 1563 (C)	10S
63	HUW 234 (C)	10S
64	HW 1098 (C)	10MS
65	K 0307 (C)	5S
66	Kharchia 65 (C)	60S
67	KRL 19 (C)	5S
68	KRL 210 (C)	0
69	PBW 343 (C)	40S
70	Raj 4083 (C)	5S
71	TL 2942 (C)	0
72	TL 2969 (C)	0
73	WH 542 (C)	10S
73. A	INFECTOR	40S
AVT Ist Year		
I. NORTHERN HILL ZONE		
1	HPW 393	20S

Sr. No.	Variety	Yellow rust
2	HPW 394	0
3	HPW 413	0
4	HPW 421	0
5	HPW 422	0
6	HS 580	0
7	HS 583	0
8	HS 590	0
9	HS 596	0
10	HS 597	0
11	HS 598	0
12	HS 599	0
13	HS 600	0
14	HS 601	0
15	UP 2917	0
16	UP 2918	TS
17	VL 1005	10S
18	VL 1006	TS
19	VL 1007	0
20	VL 3002	0
20. A	INFECTOR	20S
21	VL 3007	TS
22	VL 3008	5MS
23	VL 3009	5MS
24	VL 4001	5S
II. NORTH WESTERN PLAIN ZONE		
25	DBW 147	0
26	DBW 148	5MS
27	DBW 150	10S
28	DDW 31	0
29	DDW 32	0
30	HD 3159	TS
31	HD 3165	5S
32	HD 3174	5MS
33	HI 1604	20S
34	HI 1605	10S
35	HUW 688	10S
36	K 1312	5MS
37	K 1313	10S
38	K 1314	5S
39	MACS 3949	0
40	MACS 4024	0
40. A	INFECTOR	40S
41	NW 6024	-
42	PBW 707	5S
43	PBW 709	5S
44	PBW 716	60S
45	PBW 718	0
46	PBW 719	5S
47	UP 2883	20S
48	WH 1179	10S
III. NORTH EASTERN PLAIN ZONE		
49	HD 3171	0
50	K 1317	10S
IV. CENTRAL ZONE		
51	CG 1015	10S
52	GW 463	60S
53	HI 8759 (d)	0

Sr. No.	Variety	Yellow rust
V. PENINSULAR ZONE		
54	GW 1315 (d)	40S
55	HD 3164	20S
56	HI 8765 (d)	0
57	JWS 712	20MS
58	K 1315	20S
59	MACS 3970 (d)	0
60	MACS 3972 (d)	0
60. A	INFECTOR	40S
61	MACS 4020 (d)	10MS
62	PBW 721	5MS
63	UAS 360	40S
64	UAS 361	0
65	UAS 453 (d)	0
66	UAS 455 (d)	0
VI. SPECIAL TRIAL (Dicoccum and Sailinity and Alkalinity)		
67	DBW 181	0
68	DBW 182	40S
69	DBW 183	0
70	DBW 184	0
71	DBW 185	20S
72	DDK 1048	20MS
73	DDK 1049	20MS
74	KRL 350	10S
75	KRL 351	TS
76	MACS 5041	20MS
77	MACS 5043	40MS
78	WH 1309	5MS
VII. SPECIAL TRIAL (TRITICALE)		
79	TL 3001	TS
80	TL 3002	0
80. A	INFECTOR	40S
81	TL 3003	0
82	TL 3004	0
83	TL 3005	0
VIII. SPECIAL TRIAL (MABB/NIL (KB) ENTRIES)		
84	DWR-NIL-01	80S
85	DWR-NIL-02	60S
86	HD 3209	20S
87	KB 2012-13	40S
IX. SPECIAL TRIAL (Wheat Biofortification)		
88	HPBW 01	TS
89	HPBW 02	0
90	HPBW 05	0
91	HPBW 07	0
92	HPBW 08	0
93	HPBW 09	0
94	HUW 695	0
95	HUW 711	TS
96	HUW 712	TS
97	MACS 6507	5S
98	WB 1	TS
99	WB 2	5MS
100	WB 5	0
100. A	INFECTOR	40S

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PROGRAMME 2. RUSTS: BROWN, YELLOW AND BLACK

RACE SPECIFIC APR

AVT entries were evaluated at specific locations for Race Specific Adult Plant Resistance (APR) to three rusts (brown, black and yellow).

Locations:

Yellow rust - Ludhiana and New Delhi (Table 2.1)

Black rust- Indore, Pune and Powarkheda (Table 2.2)

Brown rust - New Delhi and Ludhiana (Table 2.3)

Flowerdale centre evaluated AVTs lines for rusts under controlled conditions (Table 2.4 and 2.5)

Mahabaleshwar centre evaluated AVT-II entries of CZ and PZ against black rust pathotypes under controlled conditions (Table 2.6).

The following pathotypes were used for these studies at the respective locations.

1. *P. recondita tritici* : 77-5, 104-2
2. *P. graminis tritici* : 40 A, 117-6
3. *P. striiformis* : 46 S 119, 78 S 84

Table 2.1: APR response of AVT IInd and Ist year entries to individual races of *Puccinia striiformis tritici*

Sr. No.	Variety	46 S 119		78 S 84	
		Ludhiana	Delhi	Ludhiana	Delhi
AVT IInd Year					
I. NORTHERN HILL ZONE					
1	HS 562	10S	10S	5S	TR
2	HPW 251 (C)	40S	TR	80S	TR
3	HPW 349 (C)	20S	TR	20S	10MS
4	HS 375 (C)	40S	20S	60S	40S
5	HS 490 (C)	20MS	5MR	60S	TR
6	HS 507 (C)	5S	0	10S	TR
7	HS 542 (C)	0	0	40S	5MR
8	VL 804 (C)	40MS	0	60S	0
9	VL 829 (C)	40S	0	60S	10MR
10	VL 892 (C)	20S	0	80S	0
11	VL 907 (C)	5S	0	20S	0
II. NORTH WESTERN PLAIN ZONE					
12	HD 4730	10S	5MR	TR	0
13	MP 1277	10S	0	5S	0
14	WH 1164	10S	0	TR	0
15	DBW 88 (C)	40S	0	60S	0
16	DBW 90 (C)	10S	0	10S	10S
17	DPW 621-50 (C)	40S	0	40S	5MR
18	HD 2967 (C)	60S	0	60S	TR
19	HD 3043 (C)	10S	0	20S	0
20	HD 3059 (C)	20S	0	60S	0
20. A	INFECTOR	80S	100S	80S	100S
21	HD 3086 (C)	10S	5MR	5S	TR
22	PBW 644 (C)	10S	0	40S	20S
23	PDW 233 (C)	10S	20S	5S	0

Sr. No.	Variety	46 S 119 Ludhiana	46 S 119 Delhi	78 S 84 Ludhiana	78 S 84 Delhi
24	PDW 291 (C)	10S	30MS	5S	TR
25	PDW 314 (C)	5S	0	TS	TR
26	WH 1021 (C)	60S	TR	60S	TR
27	WH 1080 (C)	20S	0	TS	10MS
28	WH 1105 (C)	5S	0	40S	5MR
29	WH 1124 (C)	10S	0	40S	TR
30	WH 1142 (I) C)	20S	0	10S	5MR
III. NORTH EASTERN PLAIN ZONE					
31	C 306 (C)	60S	0	60S	5MR
32	HD 2888 (C)	40S	0	60S	0
33	K 8027 (C)	60S	0	60S	0
IV. CENTRAL ZONE					
34	HD 4728 (d)	5S	TR	0	0
35	HD 4730 (d)	10S	-	-	-
36	GW 322 (C)	60S	80S	60S	60S
37	HD 2864 (C)	40S	0	60S	60S
38	HD 2932 (C)	40S	0	60S	60S
39	HI 1544 (C)	60S	TR	60S	40S
40	HI 8498 (D) (C)	10S	TR	0	5S
40. A	INFECTOR	80S	100S	60S	100S
41	HI 8737 (D)(I) (C)	40S	0	5MR	5MR
42	MP 3336 (C)	40S	TR	40S	40S
43	MP 4010 (C)	60S	0	40S	20S
44	MPO 1215 (d) (C)	40S	0	0	0
V. PENINSULAR ZONE					
45	MACS 3927 (d)	5S	0	0	5MR
46	NIAW 2030	80S	60S	80S	60S
47	AKDW 2997-16(d) (C)	10S	TR	0	20S
48	DBW 93 (I) (C)	60S	80S	60S	40S
49	MACS 6222 (C)	60S	20MS	10S	30S
50	MACS 6478 (C)	40S	TR	60S	40S
51	NI 5439 (C)	80S	60S	80S	80S
52	NIAW 1415 (C)	80S	60S	80S	80S
53	UAS 347 (I) (C)	20S	80S	10MS	40S
54	UAS 428 (d) (C)	10S	10S	0	20MS
55	UAS 446 (d) (I) (C)	10S	5MR	0	5MS
VII. SPECIAL TRIAL					
56	(HD 2932 + *Lr* 19/*Sr* 25)	60S	40S	60S	60S
57	MMBL 283	40MS	20S	60S	60S
58	PBW 723	20MS	TR	20S	5S
59	DBW 14 (C)	20MS	TR	60S	0
60	DDK 1029 (C)	40S	20S	40S	40S
60. A	INFECTOR	80S	100S	80S	100S
61	HD 2985 (C)	40S	0	60S	0
62	HI 1563 (C)	40S	5MR	60S	20S
63	HUW 234 (C)	40S	20MS	60S	40S
64	HW 1098 (C)	40S	10S	40S	40MS
65	K 0307 (C)	40S	0	60S	0
66	Kharchia 65 (C)	80S	80S	80S	40S
67	KRL 19 (C)	40S	40S	60S	40S
68	KRL 210 (C)	10S	5MS	0	20S
69	PBW 343 (C)	-	-	80S	60S
70	Raj 4083 (C)	10MS	10MS	40S	20MS
71	TL 2942 (C)	0	0	5MR	TR
72	TL 2969 (C)	10S	0	5MR	0
73	WH 542 (C)	40S	0	80S	0
73. A	INFECTOR	60S	100S	80S	100S
AVT Ist					
I. NORTHERN HILL ZONE					
1	HPW 393	10S	0	40MS	0

Sr. No.	Variety	46 S 119 Ludhiana	46 S 119 Delhi	78 S 84 Ludhiana	78 S 84 Delhi
2	HPW 394	0	0	0	0
3	HPW 413	10S	0	TS	0
4	HPW 421	10S	0	0	0
5	HPW 422	0	0	10S	0
6	HS 580	5S	0	10S	0
7	HS 583	10S	0	5S	10S
8	HS 590	5S	0	60S	30S
9	HS 596	0	0	0	0
10	HS 597	0	0	5S	0
11	HS 598	20S	0	0	20S
12	HS 599	0	0	0	0
13	HS 600	5S	0	40S	0
14	HS 601	5S	0	10S	0
15	UP 2917	20S	0	60S	0
16	UP 2918	5S	0	60S	10S
17	VL 1005	20S	0	60S	0
18	VL 1006	10S	5MR	0	0
19	VL 1007	5S	10S	0	0
20	VL 3002	0	0	10S	0
20. A	INFECTOR	80S	100S	80S	100S
21	VL 3007	5S	0	10MS	0
22	VL 3008	20MS	0	10S	0
23	VL 3009	10S	0	0	0
24	VL 4001	40S	0	60S	0
II. NORTH WESTERN PLAIN ZONE					
25	DBW 147	10S	0	0	0
26	DBW 148	5S	0	10S	10MR
27	DBW 150	40S	TR	60S	0
28	DDW 31	10S	0	0	5MR
29	DDW 32	10S	0	0	10MR
30	HD 3159	5S	5MR	10S	0
31	HD 3165	10S	0	0	0
32	HD 3174	10S	0	10S	TR
33	HI 1604	5S	0	10S	0
34	HI 1605	10S	0	40S	0
35	HUW 688	20S	0	60S	0
36	K 1312	40S	0	20S	0
37	K 1313	20S	0	60S	0
38	K 1314	5S	TR	5MS	0
39	MACS 3949	5S	0	0	30S
40	MACS 4024	5S	0	0	TR
40. A	INFECTOR	80S	100S	60S	100S
41	NW 6024	-	-	-	-
42	PBW 707	5S	0	0	0
43	PBW 709	20S	0	40S	0
44	PBW 716	60S	0	60S	0
45	PBW 718	20S	0	0	0
46	PBW 719	5S	0	60S	0
47	UP 2883	20MS	0	60S	5MS
48	WH 1179	10S	30MS	40S	0
III. NORTH EASTERN PLAIN ZONE					
49	HD 3171	40S	10MR	40S	0
50	K 1317	20S	0	40S	0
IV. CENTRAL ZONE					
51	CG 1015	40MS	10MR	60S	40MS
52	GW 463	60S	0	60S	10S
53	HI 8759 (d)	10S	0	0	50S
V. PENINSULAR ZONE					
54	GW 1315 (d)	80S	80S	80S	80S
55	HD 3164	40MS	0	20MS	30S

Sr. No.	Variety	46 S 119 Ludhiana	46 S 119 Delhi	78 S 84 Ludhiana	78 S 84 Delhi
56	HI 8765 (d)	10S	TR	0	40S
57	JWS 712	60S	40S	10MS	0
58	K 1315	40S	0	60S	40S
59	MACS 3970 (d)	5S	TR	0	0
60	MACS 3972 (d)	40S	0	0	60S
60. A	INFECTOR	80S	100S	80S	100S
61	MACS 4020 (d)	20S	0	0	0
62	PBW 721	10S	0	5MS	0
63	UAS 360	20S	20MS	80S	30MS
64	UAS 361	60S	0	40S	0
65	UAS 453 (d)	10S	0	0	0
66	UAS 455 (d)	0	0	0	0
VI. SPECIAL TRIAL (Dicoccum and Sailinity and Alkalinity)					
67	DBW 181	5S	0	40S	0
68	DBW 182	40S	0	60S	0
69	DBW 183	10S	0	0	0
70	DBW 184	0	0	0	0
71	DBW 185	40S	0	40S	0
72	DDK 1048	40MS	5MR	20MS	60S
73	DDK 1049	40S	TS	10MS	80S
74	KRL 350	5S	0	10S	30MS
75	KRL 351	5S	TR	0	10MR
76	MACS 5041	40MS	0	20MS	80S
77	MACS 5043	60MS	0	20MS	80S
78	WH 1309	10MS	5MR	0	10MR
VII. SPECIAL TRIAL (TRITICALE)					
79	TL 3001	0	0	5MR	0
80	TL 3002	TR	0	5MR	0
80. A	INFECTOR	80S	100S	80S	100S
81	TL 3003	10S	0	5MR	0
82	TL 3004	TR	0	5MR	0
83	TL 3005	0	5MR	5MR	0
VIII. SPECIAL TRIAL (MABB/NIL (KB) ENTRIES)					
84	DWR-NIL-01	80S	0	80S	10S
85	DWR-NIL-02	60S	0	60S	0
86	HD 3209	60S	0	60S	0
87	KB 2012-03	60S	10MS	60S	0
IX. SPECIAL TRIAL (Wheat Biofortification)					
88	HPBW 01	40S	0	40S	0
89	HPBW 02	40S	0	40S	10MS
90	HPBW 05	40S	0	40S	40S
91	HPBW 07	0	0	10MS	0
92	HPBW 08	10S	0	10MS	10S
93	HPBW 09	20S	0	40S	0
94	HUW 695	40S	0	40S	0
95	HUW 711	40S	0	40S	5S
96	HUW 712	20S	0	40S	0
97	MACS 6507	40S	0	40S	0
98	WB 1	40S	20MR	40S	0
99	WB 2	20S	0	40S	0
100	WB 5	10S	0	5MR	5MR
100. A	INFECTOR	80S	100S	80S	100S

Table 2.2. APR response of AVT IInd and Ist year entries to individual races of *Puccinia graminis tritici*.

Sr. No.	Variety	40A			117-6	
		Indore	Pune	Powerkheda	Indore	Pune
AVT IInd Year						
I. NORTHERN HILL ZONE						
1	HS 562	50X	30MSS	5MS	30MRMS	20MS
2	HPW 251 (C)	5R	10MR	TR	5R	5MR
3	HPW 349 (C)	40MSS	20S	0	10RMR	20MS
4	HS 375 (C)	5RMR	20MS	10MS	0	10MR
5	HS 490 (C)	TR	5MR	15MS	10MR	5MR
6	HS 507 (C)	5R	10MR	TR	TR	5MR
7	HS 542 (C)	TR	5MR	TR	TS	TR
8	VL 804 (C)	5RMR	5MR	20MS	5R	5MR
9	VL 829 (C)	0	10MR	TR	TR	TR
10	VL 892 (C)	5R	20MR	10MS	0	5MR
11	VL 907 (C)	0	10MR	10MS	TR	5MR
II. NORTH WESTERN PLAIN ZONE						
12	HD 4730	TMR	20MR	5MR	10MSS	20MS
13	MP 1277	60MSS	10MS	0	40MRMS	20S
14	WH 1164	5MR	5MR	TR	20MRMS	5MR
15	DBW 88 (C)	TS	10MR	10MR	5R	5MR
16	DBW 90 (C)	50X	20MS	TR	30MRMS	10MR
17	DPW 621-50 (C)	20RMR	10MS	15MS	5MR	5MR
18	HD 2967 (C)	20MSS	20MR	10MR	10MRMS	10MR
19	HD 3043 (C)	20R	20MS	20MS	5R	30MS
20	HD 3059 (C)	10MR	20MS	TR	TR	10MR
20. A	INFECTOR	100S	90S	70S	100S	80S
21	HD 3086 (C)	40MSS	40S	15MR	60MSS	20MR
22	PBW 644 (C)	20MRMS	10MR	TR	20MSS	5MR
23	PDW 233 (C)	20RMR	20MS	TR	10MSS	20S
24	PDW 291 (C)	20MR	20MR	TR	15MSS	30MS
25	PDW 314 (C)	40MSS	30MSS	10MR	30MSS	30S
26	WH 1021 (C)	10R	10MR	10MS	20RMR	20MR
27	WH 1080 (C)	30MRMS	20MR	5MR	30MR	20MR
28	WH 1105 (C)	40MRMS	20MS	TR	30MR	20S
29	WH 1124 (C)	30X	30S	TR	30MR	20MR
30	WH 1142 (I) C)	20X	10MR	5MS	20MRMS	5MR
III. NORTH EASTERN PLAIN ZONE						
31	C 306 (C)	20S	40S	40MS	5RMR	30S
32	HD 2888 (C)	5MR	10MR	10MS	TR	10MR
33	K 8027 (C)	50S	30MS	20MS	5S	20S
IV. CENTRAL ZONE						
34	HD 4728 (d)	10RMR	20MRMS	5MS	5S	20S
35	HI 4730 (d)	10RMR	10MR	TR	10MSS	30MS
36	GW 322 (C)	10RMR	10MR	10MS	10MRMS	10MR
37	HD 2864 (C)	10R	10MR	TR	TR	5MR
38	HD 2932 (C)	40MSS	20MS	10MR	10RMR	10MR
39	HI 1544 (C)	TR	20MR	TR	TR	5MR
40	HI 8498 (D) (C)	30X	10MR	TR	20X	20MS
40. A	INFECTOR	100S	80S	70S	100S	80S
41	HI 8737 (D)(I) (C)	30X	30S	0	30MRMS	20MR
42	MP 3336 (C)	10RMR	10MR	TR	10RMR	5MR

Sr. No.	Variety	40A			117-6	
		Indore	Pune	Powerkheda	Indore	Pune
43	MP 4010 (C)	10R	5MR	10MR	10R	5MR
44	MPO 1215 (d) (C)	30X	10MR	0	20MRMS	30S
V. PENINSULAR ZONE						
45	MACS 3927 (d)	30X	10MR	TR	20MRMS	30MSS
46	NIAW 2030	5R	10MR	0	10R	5MR
47	AKDW 2997-16(d) (C)	10MRMS	20MR	TR	20MRMS	30S
48	DBW 93 (I) (C)	5MR	10MR	0	10R	5MR
49	MACS 6222 (C)	5RMR	5MR	TR	10R	5MR
50	MACS 6478 (C)	30X	30MS	R	20MSS	5MR
51	NI 5439 (C)	40MSS	30MS	10MR	30MSS	40S
52	NIAW 1415 (C)	10R	20MR	0	5R	5MR
53	UAS 347 (I) (C)	30RMR	30S	10MR	20MRMS	20MR
54	UAS 428 (d) (C)	30RMR	20MR	TR	5R	30S
55	UAS 446 (d) (I) (C)	20RMR	20MR	10MS	5S	20S
VII. SPECIAL TRIAL						
56	(HD 2932 + *Lr* 19/*Sr* 25)	20R	10MR	0	10R	5MR
57	MMBL 283	40MSS	5MR	10MR	20MSS	5MR
58	PBW 723	0	5MR	5MR	5R	10MR
59	DBW 14 (C)	20MR	0	10MS	10MR	10MR
60	DDK 1029 (C)	20RMR	5MR	0	10R	10MR
60. A	INFECTOR	100S	80S	70S	100S	80S
61	HD 2985 (C)	30MR	40S	TR	20MSS	20MR
62	HI 1563 (C)	5R	5MR	0	10R	TR
63	HUW 234 (C)	50MSS	30S	15MS	60MSS	TR
64	HW 1098 (C)	10RMR	20MR	TR	20MRMS	0
65	K 0307 (C)	20MR	10MR	TR	10MR	5MR
66	Kharchia 65 (C)	60MSS	60S	5MR	60MSS	40S
67	KRL 19 (C)	30RMR	40MR	TR	30MR	20MR
68	KRL 210 (C)	40MSS	20S	15MS	30X	20MS
69	PBW 343 (C)	30RMR	20MR	TR	10MR	5MR
70	Raj 4083 (C)	20RMR	10MR	TR	5R	5MR
71	TL 2942 (C)	20MSS	0	0	0	0
72	TL 2969 (C)	20RMR	0	0	0	0
73	WH 542 (C)	5MR	5MR	10MS	TR	0
73. A	INFECTOR	100S	80S	80S	100S	80S
AVT Ist						
I. NORTHERN HILL ZONE						
1	HPW 393	80MSS	20MSS	10MR	80MSS	10MR
2	HPW 394	60MSS	0	0	10MSS	5MR
3	HPW 413	40MSS	30S	0	40MSS	10MR
4	HPW 421	30RMR	5MR	10MR	20RMR	5MR
5	HPW 422	10RMR	10MR	10MS	10R	TR
6	HS 580	20R	5MR	0	10R	5MR
7	HS 583	60MSS	10MR	TR	30X	5MR
8	HS 590	40MSS	40MSS	0	40X	20MR
9	HS 596	5MSS	20MR	10MR	5MR	10MR
10	HS 597	50MSS	40MS	TR	10MRMS	20MR
11	HS 598	40MRMS	20MR	15MS	20MRMS	10MR
12	HS 599	40RMR	5MR	10MS	20RMR	TR
13	HS 600	50MSS	5MR	0	20RMR	TR
14	HS 601	60MSS	5MR	5MS	20RMR	0

Sr. No.	Variety	40A			117-6	
		Indore	Pune	Powerkheda	Indore	Pune
15	UP 2917	10R	20MS	0	20R	5MR
16	UP 2918	10R	20MS	10MR	20RMR	5MR
17	VL 1005	10RMR	10MR	10MS	5R	10MR
18	VL 1006	40MRMS	20MR	15MR	20MRMS	5MR
19	VL 1007	20R	20MR	0	10R	5MR
20	VL 3002	10R	20MR	0	10MRMS	5MR
20. A	INFECTOR	100S	90S	70S	100S	80S
21	VL 3007	10R	10MR	0	5R	TR
22	VL 3008	0	10MR	10MS	5R	5MR
23	VL 3009	30MSS	20S	TR	40X	5MR
24	VL 4001	0	5MR	0	TR	TR
II. NORTH WESTERN PLAIN ZONE						
25	DBW 147	30RMR	0	0	20RMR	TR
26	DBW 148	60MSS	20MR	0	60MSS	5MR
27	DBW 150	30MSS	30MS	0	30MSS	10MR
28	DDW 31	10MSS	20MR	10MR	30MSS	20S
29	DDW 32	30X	10MR	0	40X	20S
30	HD 3159	10R	20MR	0	10R	TR
31	HD 3165	40X	40MS	0	40X	10MR
32	HD 3174	30X	40MS	0	40MSS	5MR
33	HI 1604	10RMR	10MR	10MR	30X	TR
34	HI 1605	20RMR	20MR	0	10RMR	5MR
35	HUW 688	20RMR	40MSS	15MS	20MRMS	10MR
36	K 1312	10R	20MR	10MS	5RMR	20MR
37	K 1313	5R	10MR	5MR	5R	5MR
38	K 1314	40X	20MS	0	30MR	20MR
39	MACS 3949	20X	20MS	TR	40X	20MS
40	MACS 4024	10RMR	20MS	0	20MSS	20MR
40. A	INFECTOR	100S	90S	80S	100S	80S
41	NW 6024	-	-	-	-	-
42	PBW 707	30MRMS	20MR	10MR	20MR	10MR
43	PBW 709	10MR	10MR	TR	20MRMS	20MR
44	PBW 716	20MSS	5MR	10MS	30MRMS	5MR
45	PBW 718	20RMR	20MR	TR	20RMR	TR
46	PBW 719	TR	5MR	20MS	TR	20MR
47	UP 2883	TR	10MR	10MS	TMS	5MR
48	WH 1179	40MSS	20MS	10MS	20MSS	TR
III. NORTH EASTERN PLAIN ZONE						
49	HD 3171	30RMR	30MS	0	30X	20MR
50	K 1317	5R	20MR	10MS	5R	5MR
IV. CENTRAL ZONE						
51	CG 1015	60MSS	10MR	5MR	20X	TR
52	GW 463	20RMR	5MR	10MS	10RMR	5MR
53	HI 8759 (d)	10RMR	20MR	TR	10MR	20MSS
V. PENINSULAR ZONE						
54	GW 1315 (d)	TR	30MR	0	5S	20MS
55	HD 3164	30RMR	40MR	5MR	20MRMS	TR
56	HI 8765 (d)	20RMR	20MR	TR	5S	30MS
57	JWS 712	30RMR	30MR	15MS	10RMR	10MR
58	K 1315	30MSS	5MR	0	5RMR	20MR
59	MACS 3970 (d)	40X	10MR	TR	60MSS	20MS

Sr. No.	Variety	40A			117-6	
		Indore	Pune	Powerkheda	Indore	Pune
60	MACS 3972 (d)	5MR	20MR	0	15MSS	10MR
60. A	INFECTOR	100S	80S	70S	100S	80S
61	MACS 4020 (d)	5MR	10MR	10MR	5S	5MR
62	PBW 721	20MSS	10MR	TR	30MRMS	10MR
63	UAS 360	20RMR	5MR	15MS	30MRMS	5MR
64	UAS 361	20RMR	5MR	10MR	10RMR	TR
65	UAS 453 (d)	20X	10MR	10MR	20MRMS	20MS
66	UAS 455 (d)	20RMR	10MR	TR	5MSS	20MS
VI. SPECIAL TRIAL (Dicoccum and Sailinity and Alkalinity)						
67	DBW 181	20MRMS	5MR	15MS	20MRMS	5MR
68	DBW 182	5MR	10MR	TR	10MR	TR
69	DBW 183	30X	5MR	0	20MRMS	0
70	DBW 184	10RMR	30MR	10MS	TMR	0
71	DBW 185	20RMR	10MR	TR	10MR	0
72	DDK 1048	10R	5MR	TR	10MR	0
73	DDK 1049	10RMR	20MR	0	10RMR	0
74	KRL 350	30RMR	5MR	10MR	10R	0
75	KRL 351	30X	5MR	0	10MR	TR
76	MACS 5041	10R	5MR	TR	10MRMS	0
77	MACS 5043	20RMR	10MR	10MR	10RMR	TR
78	WH 1309	60MSS	20MR	5MR	10MRMS	0
VII. SPECIAL TRIAL (TRITICALE)						
79	TL 3001	60MSS	5MR	0	5MRMS	0
80	TL 3002	5R	0	TR	0	0
80. A	INFECTOR	100S	90S	80S	100S	80S
81	TL 3003	0	TR	TR	TR	0
82	TL 3004	20MSS	5MR	0	TR	0
83	TL 3005	30MSS	TR	0	TMR	0
VIII. SPECIAL TRIAL (MABB/NIL (KB) ENTRIES)						
84	DWR-NIL-01	20R	40MR	10MS	20R	20MR
85	DWR-NIL-02	5R	5MR	TR	TR	5MR
86	HD 3209	10R	10MR	10MR	10R	TR
87	KB 2012-03	20RMR	20MR	15MS	30MRMS	5MR
IX. SPECIAL TRIAL (Wheat Biofortification)						
88	HPBW 01	30X	20MR	TR	30MRMS	5MR
89	HPBW 02	30MSS	5MR	TR	20MRMS	TR
90	HPBW 05	40MSS	40MR	5MS	30MRMS	10MR
91	HPBW 07	20MRMS	10MR	TR	5R	5MR
92	HPBW 08	40X	20MR	TR	5MR	5MR
93	HPBW 09	0	5MR	10MR	0	5MR
94	HUW 695	30X	30MR	0	20RMR	10MR
95	HUW 711	50MSS	10MR	10MS	30MRMS	TR
96	HUW 712	50MSS	5MR	5MS	20MRMS	0
97	MACS 6507	10R	10MR	10MR	10R	5MR
98	WB 1	40MSS	20MR	10MR	20MR	5MR
99	WB 2	50MSS	10MR	15MS	10MR	5MR
100	WB 5	20RMR	20MR	10MS	5R	10MR
100. A	INFECTOR	100S	90S	60S	100S	80S

Table 2.3. APR response of AVT IInd and Ist year entries to individual races of Puccinia triticina.

Sr. No.	Variety	77-5 Ludhiana	Delhi	Powerkheda	104-2 Ludhiana	Delhi
AVT IInd Year						
I. NORTHERN HILL ZONE						
1	HS 562	20S	TR	10MS	5MS	20MR
2	HPW 251 (C)	0	TR	10MR	0	10MS
3	HPW 349 (C)	0	TR	TR	0	TR
4	HS 375 (C)	0	TR	10MS	5MS	10MR
5	HS 490 (C)	0	0	10MS	0	TMR
6	HS 507 (C)	0	5R	15MR	0	TR
7	HS 542 (C)	0	0	10MR	0	0
8	VL 804 (C)	0	30S	15MS	10S	40S
9	VL 829 (C)	0	TMR	0	10S	5R
10	VL 892 (C)	0	TR	10MS	0	TR
11	VL 907 (C)	0	TR	15MR	0	TR
II. NORTH WESTERN PLAIN ZONE						
12	HD 4730	0	10R	10MR	0	10R
13	MP 1277	0	TR	0	0	5R
14	WH 1164	0	5R	R	0	TR
15	DBW 88 (C)	0	0	10MR	0	0
16	DBW 90 (C)	20S	10MR	10MS	0	10MR
17	DPW 621-50 (C)	0	TR	10MR	0	0
18	HD 2967 (C)	0	5R	10MS	0	5R
19	HD 3043 (C)	0	TR	15MR	0	TR
20	HD 3059 (C)	0	TR	10MS	0	TMR
20. A	INFECTOR	60S	70S	80S	40S	80S
21	HD 3086 (C)	40S	TR	10MR	0	5MR
22	PBW 644 (C)	0	TR	15MS	0	TR
23	PDW 233 (C)	0	20R	15MS	0	10RMR
24	PDW 291 (C)	0	20RMR	20MS	0	20R
25	PDW 314 (C)	0	30MR	TR	0	5R
26	WH 1021 (C)	0	TR	15MR	0	TR
27	WH 1080 (C)	0	10MS	10MS	0	20MR
28	WH 1105 (C)	5S	10MS	10MS	0	TR
29	WH 1124 (C)	10S	10MRR	5MS	0	TR
30	WH 1142 (I) C)	20S	10MRMS	10MR	0	TR
III. NORTH EASTERN PLAIN ZONE						
31	C 306 (C)	40S	40S	40MS	40S	40MSS
32	HD 2888 (C)	0	TR	15MS	0	TR
33	K 8027 (C)	80S	40MSS	30MS	60S	30MSS
IV. CENTRAL ZONE						
34	HD 4728 (d)	0	5R	TR	0	TR
35	HI 4730 (d)	0	10R	10MS	0	TMR
36	GW 322 (C)	0	TR	15MS	0	TR
37	HD 2864 (C)	0	TR	15MR	0	TMR
38	HD 2932 (C)	0	40S	15MS	0	50S
39	HI 1544 (C)	0	TR	5MR	0	TR
40	HI 8498 (D) (C)	0	20R	10MR	0	10R
40. A	INFECTOR	60S	70S	80S	60S	70S
41	HI 8737 (D)(I) (C)	0	20R	0	0	TR
42	MP 3336 (C)	10S	5MR	R	0	TR
43	MP 4010 (C)	0	TR	10MS	0	TR
44	MPO 1215 (d) (C)	0	5R	0	0	5R
V. PENINSULAR ZONE						
45	MACS 3927 (d)	20S	60S	5MR	10S	80S

Sr. No.	Variety	77-5 Ludhiana	77-5 Delhi	Powerkheda	104-2 Ludhiana	104-2 Delhi
46	NIAW 2030	0	TR	TR	0	5R
47	AKDW 2997-16(d) (C)	5S	30MR	0	0	40MR
48	DBW 93 (I) (C)	0	TR	0	0	TR
49	MACS 6222 (C)	0	TR	10MS	0	0
50	MACS 6478 (C)	0	TR	10MR	0	0
51	NI 5439 (C)	20S	50S	40S	40S	60S
52	NIAW 1415 (C)	0	TR	TR	0	TR
53	UAS 347 (I) (C)	0	TR	0	0	5RMR
54	UAS 428 (d) (C)	0	40MR	0	0	40MRMR
55	UAS 446 (d) (I) (C)	0	TR	TR	0	TR
VII. SPECIAL TRIAL						
56	(HD 2932 + Lr 19/Sr25)	0	5R	0	0	TR
57	MMBL 283	20S	5MR	5MR	0	TR
58	PBW 723	0	TR	10MS	0	TR
59	DBW 14 (C)	0	TR	15MR	0	TR
60	DDK 1029 (C)	0	20R	0	0	30R
60. A	INFECTOR	60S	80S	80S	60S	90S
61	HD 2985 (C)	10S	10R	TR	0	10R
62	HI 1563 (C)	0	TR	0	0	TR
63	HUW 234 (C)	40S	60S	20MS	0	40S
64	HW 1098 (C)	0	20R	0	0	20MR
65	K 0307 (C)	0	TR	5MR	0	TR
66	Kharchia 65 (C)	80S	80S	TR	60S	80S
67	KRL 19 (C)	0	40S	TR	0	30MR
68	KRL 210 (C)	10S	TR	10MS	0	5R
69	PBW 343 (C)	0	30MSS	15MS	0	40S
70	Raj 4083 (C)	0	TR	R	0	TR
71	TL 2942 (C)	0	TR	0	0	0
72	TL 2969 (C)	0	TR	0	0	0
73	WH 542 (C)	10S	5R	10MS	0	TR
73. A	INFECTOR	60S	80S	70S	40S	60S
AVT Ist						
I. NORTHERN HILL ZONE						
1	HPW 393	0	TR	5MS	0	TR
2	HPW 394	40S	TMR	0	0	5R
3	HPW 413	10S	TR	5MS	5S	5MR
4	HPW 421	10S	30MRMS	10MS	5S	30MR
5	HPW 422	0	TR	TR	0	0
6	HS 580	0	TR	5MR	0	TR
7	HS 583	0	0	0	0	0
8	HS 590	0	0	0	0	TR
9	HS 596	10S	TR	5MS	0	TR
10	HS 597	40S	20RMR	0	20S	TMR
11	HS 598	0	TR	10MR	0	0
12	HS 599	0	TR	5MS	0	TR
13	HS 600	0	0	0	0	0
14	HS 601	0	TR	10MS	0	TR
15	UP 2917	0	TR	0	0	TMR
16	UP 2918	0	5R	TR	0	TR
17	VL 1005	0	0	15MS	0	TR
18	VL 1006	5S	TMR	TR	0	TMR
19	VL 1007	10S	5R	20MS	0	10MR
20	VL 3002	0	TR	10MR	0	5R
20. A	INFECTOR	60S	80S	80S	40S	70S
21	VL 3007	0	TR	5MS	0	TR
22	VL 3008	0	TR	TR	0	TMR

Sr. No.	Variety	77-5 Ludhiana	Delhi	Powerkheda	104-2 Ludhiana	Delhi
23	VL 3009	0	30MR	10MS	0	10MR
24	VL 4001	0	0	5MS	0	0
II. NORTH WESTERN PLAIN ZONE						
25	DBW 147	0	0	0	0	5R
26	DBW 148	5S	TR	0	0	TR
27	DBW 150	0	TR	TR	0	TR
28	DDW 31	0	30R	TR	0	20R
29	DDW 32	0	60S	0	0	10MS
30	HD 3159	0	TR	0	0	5MR
31	HD 3165	0	5R	10MS	0	TR
32	HD 3174	0	5R	15MS	0	TR
33	HI 1604	0	TR	15MS	0	TR
34	HI 1605	10S	10R	TR	0	10R
35	HUW 688	0	0	10MS	0	TR
36	K 1312	0	TR	TR	0	TR
37	K 1313	0	0	10MS	0	0
38	K 1314	0	TR	10MS	0	TR
39	MACS 3949	0	10R	TR	0	TR
40	MACS 4024	0	5R	0	0	5R
40. A	INFECTOR	60S	70S	70S	60S	80S
41	NW 6024	-	-	-	-	-
42	PBW 707	10S	5MR	10MS	10S	5R
43	PBW 709	5S	5R	0	0	5R
44	PBW 716	0	TR	10MS	0	TR
45	PBW 718	0	TR	0	0	TR
46	PBW 719	0	0	10S	0	TR
47	UP 2883	20S	5R	15MS	0	TR
48	WH 1179	20S	10R	10MS	0	5MR
III. NORTH EASTERN PLAIN ZONE						
49	HD 3171	0	TR	0	0	TMR
50	K 1317	0	TR	10MS	20S	TR
IV. CENTRAL ZONE						
51	CG 1015	0	5MR	TR	40S	TR
52	GW 463	0	TR	10MS	0	TR
53	HI 8759 (d)	0	20RMR	0	5S	10R
V. PENINSULAR ZONE						
54	GW 1315 (d)	60S	10R	TR	20S	20R
55	HD 3164	0	5R	R	0	TR
56	HI 8765 (d)	0	20R	0	0	10R
57	JWS 712	0	5MR	10MS	0	5MR
58	K 1315	0	TR	10MR	0	TR
59	MACS 3970 (d)	0	50MRMS	5MR	0	40MRMS
60	MACS 3972 (d)	0	20MR	10MS	5MS	30MR
60. A	INFECTOR	60S	80S	80S	60S	70S
61	MACS 4020 (d)	20S	40MR	TR	10S	50MRMS
62	PBW 721	0	TR	R	0	TR
63	UAS 360	0	TR	20MR	0	0
64	UAS 361	40S	5R	TR	5S	TR
65	UAS 453 (d)	0	10R	TR	0	10R
66	UAS 455 (d)	0	30R	R	0	20RMR
VI. SPECIAL TRIAL (Dicoccum and Sailinity and Alkalinity)						
67	DBW 181	0	0	20MS	0	0
68	DBW 182	0	TR	10MR	0	TR
69	DBW 183	10S	T\10R	15MS	0	5R
70	DBW 184	60S	20MSS	10MR	40S	30MS
71	DBW 185	40S	20MR	5MS	5S	20MRMS

Sr. No.	Variety	77-5 Ludhiana	Delhi	Powerkheda	104-2 Ludhiana	Delhi
72	DDK 1048	0	10R	0	0	10R
73	DDK 1049	0	30R	0	0	20R
74	KRL 350	0	TR	TR	0	TR
75	KRL 351	0	5R	10MS	0	TR
76	MACS 5041	0	10R	5MS	0	5R
77	MACS 5043	0	20R	TR	0	10R
78	WH 1309	10S	20MR	0	0	20MR
VII. SPECIAL TRIAL (TRITICALE)						
79	TL 3001	0	5R	5MR	0	5R
80	TL 3002	0	TR	0	0	5R
80. A	INFECTOR	60S	70S	70S	40S	80S
81	TL 3003	0	TR	0	0	TR
82	TL 3004	0	5R	R	0	10RMR
83	TL 3005	0	10R	R	0	5MR
VIII. SPECIAL TRIAL (MABB/NIL (KB) ENTRIES)						
84	DWR-NIL-01	0	50S	10MS	5S	60S
85	DWR-NIL-02	0	20RMR	0	0	10R
86	HD 3209	0	TR	10MS	0	TR
87	KB 2012-13	0	10R	10MS	0	5R
IX. SPECIAL TRIAL (Wheat Biofortification)						
88	HPBW 01	0	TR	10MR	0	TR
89	HPBW 02	0	TR	0	0	TR
90	HPBW 05	0	5R	10MS	10S	TR
91	HPBW 07	40S	20RMR	15MS	20S	5MR
92	HPBW 08	0	TR	15MS	0	TR
93	HPBW 09	0	TR	TR	0	TR
94	HUW 695	0	5MR	0	0	TR
95	HUW 711	0	TR	TR	10S	5R
96	HUW 712	0	TR	10MS	0	TMR
97	MACS 6507	20S	20MR	15MS	0	10R
98	WB 1	0	TR	20MS	0	TR
99	WB 2	0	TR	10MS	0	TR
100	WB 5	0	TR	15MS	0	TR
100. A	INFECTOR	60S	90S	70S	60S	80S

COOPERATORS

NAME	CENTRE
(A) BROWN RUST	
J.B. SHARMA	NEW DELHI
JASPAL KAUR	LUDHIANA
K.K. MISHRA	POWARKHEDA
(B) BLACK RUST	
B.K. HONRAO	PUNE
A.N. MISHRA, PRAKASHA, T.L., K. KAUSHAL,	INDORE
K.K. MISHRA	POWARKHEDA
(C) YELLOW RUST	
JASPAL KAUR	LUDHIANA
V.K. SINGH, R.C. MATHURIA	NEW DELHI

Table.2.4. Race specific Adult plant resistance of AVT II entries to individual races of brown, yellow and black rust during 2014-15 at RS Flowerdale Shimla

S. No.	VARIETY	Brown rust					Yellow rust					Black rust				
		77-5		104-2		APR to	46S119		78S84		APR to	40A		117-6		APR to
		SRT	APR	SRT	APR		SRT	APR	SRT	APR		SRT	APR	SRT	APR	
Northern Hills Zone																
1	HS562	S	5R	S	10R	Both	S	0	S	5MS	46S119	S	40S	MS	20MSS	-
2	HPW251 (C)	S	5R	R	0R	77-5	MS	0	MS	0	both	R	20MR	R	5MR	-
3	HPW349 (C)	S	0	S	10R	Both	S	0 (LTN)*	MS	0 (LTN)	both	S	60S	MS	5MSS	-
4	HS375 (C)	MS	5R	R	0R	77-5	S	0	S	0	both	R	0	R	0	-
5	HS490 (C)	R	5R	S	0R	104-2	MX	TMR	R	0	-	MR	0	R	TMRMS	-
6	HS507 (C)	R	0	R	0R	-	MS	0	MS	TMR	both	R	0	R	TMR	-
7	HS542 (C)	M	0	S	0R	-	MS	0	MS	0	both	R	0	R	0	-
8	VL804 (C)	S	0	S	20MS	77-5	MS	0	S	5MR	both	R	0	R	TMR	-
9	VL829 (C)	S	0	S	0R	Both	MS	TMS	S	0	78S84	R	5MR	R	TMR	-
10	VL892 (C)	R	0	S	0R	104-2	MS	0 (LTN)	R	0 (LTN)	46S119	MS	20MS	MS	5MS	-
11	VL907 (C)	R	0	R	0R	-	MS	0	MS	0	both	R	10MR	R	0	-
North Western Plain Zone																
12	HD4730	R	5R	R	0R	-	MS	-	S	0	both	MR	10MR	S	TMS	-
13	MP1277	R	5R	S	0R	104-2	R	0	S	5MS	-	MS	40MSS	MR	TMR	-
14	WH1164	M	0	S	0R	104-2	R	0 (LTN)	MS	0(LTN)	78S84	R	TMR	S	10S	-
15	DBW88 (C)	S	0	R	0R	77-5	MS	0	R	0	46S119	R	5MSS	S	TS	-
16	DBW90 (C)	S	0	S	0R	both	MX	0	MS	TMR	46S119	MR	5MS	S	10MSS	-
17	DPW621-50 (C)	R	0	R	0R	-	MS	0	MS	0	both	R	5MS	R	0	-
18	HD2967 (C)	S	0	R	0R	77-5	S	0	MS	0	both	MR	10MRMS	R	5MSS	-
19	HD3043 (C)	S	0	S	0R	both	R	0	R	0	-	R	0	R	0	-
20	HD3059 (C)	MS	0R	R	0R	77-5	R	0	R	0	-	MS	5MRMS	R	0	-
21	HD3086 (C)	S	0R	S	0R	both	S	TMR	MS	0	both	R	5MR	R	40MSS	-
22	PBW644 (C)	MS	0R	S	0R	both	MS	0	S	0	both	S	10MS	R	5MRMS	-
23	PDW233 (C)	S	TR	S	20R	both	S	0	S	0	both	R	5MR	S	5MSS	-
24	PDW291 (C)	R	5R	MS	20MS	-	S	0	S	0	both	R	10MRMS	S	10MS	-

S. No.	VARIETY	Brown rust					Yellow rust					Black rust				
		77-5		104-2		APR to	46S119		78S84		APR to	40A		117-6		APR to
25	PDW314 (C)	S	5R	MS	40MS	77-5	MX	0	S	0	78S84	MR	20MS	S	10S	-
26	WH1021 (C)	MS	TR	R	TMS	77-5	S	0	MS	TS	46S119	R	10MRMS	R	TMSS	-
27	WH1080 (C)	S	10R	S	0R	77-5	MS	0	MS	0	both	MS	20MS	MS	TMSS	-
28	WH1105 (C)	R	0R	R	0R	-	MS	0	MS	TMR	both	MS	30MS	MS	TMSS	-
29	WH1124 (C)	S	5R	S	0R	both	S	0	MS	0	both	MR	10MR	MS	40MSS	-
30	WH1142 (C)	S	20MS	S	0R	104-2	S	0	MS	5MR	both	R	0	MS	10MSS	-
North Eastern Plain Zone																
31	C306 (C)	R	0R	S	0R	104-2	R	0	MR	10MR	-	MS	10MSS	MS	20MSS	-
32	HD2888 (C)	R	0R	R	0R	-	S	0	S	TMR	both	MR	10MR	MR	5MR	-
33	K8027 (C)	S	20S	S	60S	-	S	0	MS	-	46S119	S	60S	S	40MSS	-
	Central Zone															
34	HD4728 (D)	R	0R	R	0R	-	MS	0	MS	0	both	MR	20MR	S	5MSS	-
35	HD4730 (D)	R	0R	R	0R	-	S	0	S	0	both	MS	20MRMS	S	5MS	-
36	GW322 (C)	M	0R	R	0R	-	S	40MSS	S	5MRMS	-	MS	20MS	MS	TMS	-
37	HD2864 (C)	R	0R	R	0R	-	S	10MRMS	S	20 MRMS	-	MR	10MR	MR	10MR	-
38	HD2932 (C)	S	40MS	S	20MS	-	S	20MRMS	S	10MS	-	MS	30MS	MS	5MS	-
39	HI1544 (C)	R	0R	R	0R	-	R	TMR	MS	10MRMS	-	MR	30MR	MR	5MR	-
40	HI8498 (D) (C)	MS	10R	S	20S	-	R	0	MS	0	-	MR	20MR	MS	5MS	-
41	HI8737 (D) (C)	S	5R	S	0R	both	MS	0	S	0	78S84	MR	5MR	MS	TMS	--
42	MP3336 (C)	S	10MS	S	0R	104-2	S	5MR	MX	40S	46S119	MR	30MR	MS	10MS	-
43	MP4010 (C)	S	0R	R	0R	77-5	S	5MRMS	S	50MRMS	-	MR	20MR	MR	10MR	-
44	MPO1215 (D) (C)	MS	0R	-	0R	-		-	S	-	-	MR	10MR	MS	20MS	-
	Peninsular Zone															
45	MACS3927 (D)	S	40S	S	10R	104-2	R	0	R	0	-	MS	TMS	MS	5MRMS	-
46	NIAW2030	R	0R	R	0R	-	S	20MS	S	40MSS	-	MR	40MR	MR	30MR	-
47	AKDW2997-16 (D) (C)	MS	0R	R	0R	-	MR	-	S	-	-	MR	20MR	S	0	117-6
48	DBW93 (I) (C)	MS	0R	S	0R	104-2	MS	5MRMS	S	20MRMS	-	MR	20MR	MR	TMR	-
49	MACS6222 (C)	R	0R	R	0R	-	S	40MSS	S	20MRMS	-	MR	TMR	MR	TMR	-
50	MACS6478 (C)	R	0R	MS	0R	-	MS	0	MS	0	both	MS	10MS	MS	30MSS	-

S. No.	VARIETY	Brown rust					Yellow rust					Black rust				
		77-5		104-2		APR to	46S119		78S84		APR to	40A		117-6		APR to
51	NI5439 (C)	S	80S	S	100S	-	MX	60MSS	S	60MSS	-	S	80S	MS	40MSS	-
52	NIAW1415(C)	R	0R	R	0R	-	S	60MS	MS	40MRMS	-	MR	5MR	TMR	TMR	-
53	UAS347 (I) (C)	S	80S	S	10R	104-2	S	5MR	S	20MRMS	-	MS	30MRMS	MS	20MS	-
54	UAS428 (D) (C)	S	5MS	S	0R	-	S	0	MS	0	both	R	0	S	5MR	117-6
55	UAS446 (D) (I) (C)	R	10R	R	0R	-	R	0	S	0	78S84	MR	30MR	MS	20MSS	-
	Special trial															
56	HD2932+*Lr19*/*Sr25*	R	0R	R	0R	-	MS	30MRMS	S	40MRMS	-	MR	40MR	MR	20MR	-
57	MMBL283	S	5R	S	20S	77-5	MS	20MR	S	10MR	both	MS	30MSS	S	10MSS	-
58	PBW723	R	0R	R	0R	-	R	-	R	0	-	MR	TMR	R	0	-
59	DBW14 (C)	S	10R	R	0R	77-5	MS	0(LTN)	S	5MR	both	MS	20MS	MS	5MS	-
60	DDK1029 (C)	R	20R	S	20R	104-2	MR	20MRMS	S	20MRMS	-	MS	20MR	S	40MRMS	-
61	HD2985 (C)	S	0R	S	0R	104-2	S	5MRMS	S	10MRMS	-	MS	10MS	MS	TMS	-
62	HI1563 (C)	R	0R	R	0R	104-2	MS	0	MS	0(LTN)	both	MR	10MR	R	0	-
63	HUW234 (C)	S	60S	S	0R	104-2	MS	10MRMS	S	5MR	78S84	MS	30MSS	MS	30MRMS	-
64	HW1098 (C)	S	20R	S	10R	both	MS	60MSS	S	40MRMS	-	MR	20MR	MS	20MS	-
65	K0307 (C)	S	40MS	R	5R	-	MS	20MR	S	10MR	both	MR	TMR	MR	20MR	-
66	KARCHIA65 (C)	S	80S	S	0R	104-2	S	80S	S	-	-	MS	60MSS	S	80MSS	-
67	KRL19 (C)	S	10MS	R	0R	-	MS	60MSS	S	80MSS	-	MS	20MRMS	MS	20MRMS	-
68	KRL210 (C)	S	5MS	S	0R	104-2	MS	5MR	MX	5MR	-	S	10S	MS	60MSS	-
69	PBW343 (C)	MS	10R	S	10R	both	S	30MRMS	S	30MRMS	-	MS	10MRMS	R	10MR	-
70	RAJ4083 (C)	S	0R	S	0R	both	MS	0	S	5MR	both	MS	10MS	R	0	-
71	TL2942 (C)	S	0R	S	0R	both	S	0	S	0	both	MR	5MR, 1P5MS	R	0	-
72	TL2969 (C)	S	0R	MS	0R	both	MS	0	S	0	both	MR	20MR	MR	TMR	-
73	WH542 (C)	S	10MS	S	0R	104-2	MR	TMR	MS	5MRMS	-	MR	5MR	MR	5MR	-

*Leaf tip necrosis

Table.2.5. Race specific Adult plant resistance of AVT I entries to individual races of brown, yellow and black rust during 2014-15* at RS Flowerdale, Shimla

S. No.	VARIETY	Brown rust					Yellow rust					Black rust				
		77-5		104-2		APR to	46S119		78S84		APR to	40A		117-6		APR to
		SRT	APR	SRT	APR		SRT	APR	SRT	APR		SRT	APR	SRT	APR	
Northern Hills Zone																
1	HPW393	S	0	R	0	both	S	TMR	S	0	78S84	MS	0	R	0	40A
2	HPW394	S	5S	S	0	104-2	R	0	R	0	-	S	40S	R	0	-
3	HPW413	S	40MS	S	0	104-2	S	0	S	0	both	MS	0	R	0	40A
4	HPW421	MS	40MS	S	0	104-2	S	0	MS	0	both	R	0	R	0	-
5	HPW422	S	0	S	0	both	MS	TMR	MS	TMR	-	R	0	MS	TS	-
6	HS580	S	TR	R	0	-	S	20MR	R	0	46S119	R	0	R	0	
7	HS583	R	0	S	0	104-2	S	30MRMS	S	TMR	-	MS	0	MS	-	40A
8	HS590	R	0	R	0	-	R	0	R	0	-	MR	0	MR	-	-
9	HS596	R	-	R	0	-	R	0	R	0	-	R	0	R	-	-
10	HS597	S	0	S	0	both	R	0	R	0	-	S	10S	S	0	117-6
11	HS598	S	0	S	0	both	S	10S	TS	TS	-	R	0	R	0	-
12	HS599	R	0	R	TR	-	S	0	R	0	46S119	R	0	R	0	-
13	HS600	R	0	MS	10MS	-	MS	0(LTN)	R	0	-	S	20S	R	0	-
14	HS601	R	0	S	0	104-2	S	5MR	S	TMR	-	MS	TS	R	0	-
15	UP2917	S	-	R	0	-	S	10MR	R	TMR	-	R	0	R	0	-
16	UP2918	S	TS	R	0	-	MS	0	S	10MR	46S119	R	0	R	0	-
17	VL1005	R	0	R	TR	-	MS	0	R	0	-	R	0	R	0	-
18	VL1006	S	0	R	0	77-5	S	10MRMS	S	TMR	-	MS	TS	R	0	-
19	VL1007	S	0	S	0	both	S	5MRMS	R	0	-	R	0	R	0	-
20	VL3002	R	0	S	TR	-	R	0	R	0	-	R	0	R	0	-
21	VL3007	R	0	R	0	-	MS	0	R	0	-	R	0	R	0	-
22	VL3008	R	0	R	0	-	S	0	R	0	46S119	R	0	R	0	-
23	VL3009	R	0	S	0	104-2	S	0	R	TMR	46S119	S	TS	R	0	-
24	VL4001	R	0	R	0	-	MS	0(LTN)	S	0	both	R	0	R	0	-
North Western Plain Zone																
25	DBW147	R	0	R	0	-	S	0	R	0	46S119	R	0	R	0	
26	DBW148	S	40MS	S	0	104-2	S	TMR	MS	5MRMS	-	S	40S	MS	0	117-6
27	DBW150	R	0	R	TR	-	MS	0	R	TMR	-	S	5S	R	0	-
28	DDW31	S	0	R	0	77-5	S	0	S	5MR	both	R	0	S	0	117-6

S. No.	VARIETY	Brown rust					Yellow rust					Black rust				
		77-5		104-2		APR to	46S119		78S84		APR to	40A		117-6		APR to
		SRT	APR	SRT	APR		SRT	APR	SRT	APR		SRT	APR	SRT	APR	
29	DDW32	S	0	R	0	77-5	R	0	R	TMR	-	S	0	S	-	both
30	HD3159	S	-	S	0	104-2	S	TMRMS	S	-	-	R	TR	R	0	-
31	HD3165	S	0	S	0	both	S	20MRMS	MS	0	-	MR	0	MS	0	117-6
32	HD3174	S	0	S	0	both	S	10MR	MS	5MRMS	-	MR	0	R	0	-
33	HI1604	S	0	R	0	77-5	S	5MR	MS	5MR	-	R	0	R	0	-
34	HI1605	S	0	S	0	both	S	0	S	0	both	R	0	R	0	-
35	HUW688	R	0	R	0	-	R	TMR	R	0	-	MS	0	R	-	40A
36	K1312	R	0	R	0	-	S	0	MS	0	46S119	MS	0	R	0	40A
37	K1313	M	0	R	0	-	MS	0	R	-	-	R	0	R	0	-
38	K1314	M	0	S	0	104-2	S	0	R	0	46S119	S	5S	R	0	-
39	MACS3949	R	0	R	0	-	MS	0	R	0	-	R	0	S	-	-
40	MACS4024	R	0	MR	20MR	-	R	0	R	0	-	R	0	S	0	117-6
41	NW6024	-	-	-	-	-		-		-	-		-	-	-	-
42	PBW707	S	5S	S	0	104-2	S	10MRMS	MS	-	-	R	0	R	0	-
43	PBW709	MX	0	S	80S	-	R	0	R	0	-	MR	TR	R	0	-
44	PBW716	R	0	R	0	-	MS	0	R	0	-	S	40S	R	0	-
45	PBW718	S	0	S	0	both	S	TMR	MS	TMR	-	R	0	R	0	-
46	PBW719	S	0	R	0	77-5	S	0	R	0	46S119	R	0	R	0	-
47	UP2883	S	0	S	0	both	R	0	R	TMR	-	MR	TR	R	0	-
48	WH1179	S	20MS	S	0	104-2	S	TMR	MS	0	78S84	R	0	R	0	-
North Eastern Plain Zone																
49	HD3171	MR	20MR	S	0	104-2	R	0	R	0	-	MS	0	R	0	40A
50	K1317	S	10MR	R	0	-	MS	0	R	0	46S119	R	0	R	0	-
Central Zone																
51	CG1015	S	0	R	0	77-5	MR	5MR	MS	5MRMS	-	MS	0	R	-	40A
52	GW463	S	0	R	-	77-5	S	10MRMS	S	60MS	-	R	0	R	0	-
53	HI8759 (D)	S	0	S	0	both	MR	0	MS	0	-	R	0	S	-	-
Peninsular Zone																
54	GW1315(D)	S	0	S	TR	77-5	S	30MS	S	60MSS	-	MR	0	S	0	117-6
55	HD3164	R	TR	S	0	-	S	20MRMS	R	5MR	-	R	TR	R	0	-
56	HI8765 (D)	R	0	R	0	-	S	0	S	10MR	both	R	0	MS	0	117-6
57	JWS712	R	0	MS	10MS	-	S	30MRMS	MS	30MRMS	-	R	0	R	0	-

S. No.	VARIETY	Brown rust					Yellow rust					Black rust				
		77-5		104-2		APR to	46S119		78S84		APR to	40A		117-6		APR to
		SRT	APR	SRT	APR		SRT	APR	SRT	APR		SRT	APR	SRT	APR	
58	K1315	S	0	R	0	77-5	S	0	MS	0	46S119	MR	0	R	0	40A
59	MACS3970(D)	MS	20MS	R	10R	-	MS	0	MS	0	both	S	40S	S	0	117-6
60	MACS3972(D)	S	0	S	-	both	R	0	R	0	-	R	0	R	0	-
61	MACS4020(D)	MS	40MS	S	-	-	S	0	S	0	both	MR	0	S	0	117-6
62	PBW721	R	0	R	0	-	S	TMR	S	0	78S84	R	0	R	0	-
63	UAS360	R	5R	S	0	104-2	S	5MR	S	20MRMS	-	MS	0	R	0	40A
64	UAS361	R	0	S	20S	-	S	20MRMS	MS	20MS		R	0	R	0	-
65	UAS453(D)	R	0	R	0	-	MX	-	S	0	46S119	MR	0	MS	-	-
66	UAS455(D)	S	TS	S	0	both	R	0	MS	0	both	S	0	MS	-	40A
Special Trial (Dicoccum, Salinity and Alkalinity)																
67	DBW181	S	0	S	0	both	S	0	S	0	both	S	40S	R	TR	-
68	DBW182	S	0	R	10R	both	R	0	R	0	-	MS	TS	R	0	
69	DBW183	S	TS	S	0	104-2	S	10MR	MX	5MR	-	S	20S	R	0	-
70	DBW184	S	0	S	0	both	MS	0	MS	0	both	S	60S	R	0	-
71	DBW185	R	0	S	0	104-2	S	0	MS	0	both	MR	0	R	0	-
72	DDK1048	R	0	S	20R	104-2	MR	20MRMS	R	20MRMS	-	MR	0	S	TR	-
73	DDK1049	MS	40MS	S	0	104-2	R	60MSS	MR	20MRMS	-	R	0	S	10S	-
74	KRL350	MS	0	R	0	-	S	0	S	0	both	S	20S	R	0	-
75	KRL351	S	0	S	;R	77-5	S	TMR	S	TMR	-	S	0	R	0	40A
76	MACS5041	R	;R	S	;R	104-2	MR	50MRMS	MS	60MS	-	R	0	S	0	117-6
77	MACS5043	R	;R	S	60S	-	MX	50MRMS	S	60MS	-	R	0	S	0	117-6
78	WH1309	S	0	S	20MS	77-5	S	10MRMS	S	5MR	-	MS	0	R	0	40A
Special Trial (Triticale)																
79	TL3001	R	0	S	0	104-2	S	20MR	MS	0	-	S	40S	R	0	-
80	TL3002	R	0	R	0	-	S	5MR	S	0	78S84	R	0	R	0	-
81	TL3003	R	0	R	0	-	MS	TMR	S	0	78S84	R	0	R	0	-
82	TL3004	S	0	S	0	both	S	0	S	0	78S84	S	60S	R	0	-
83	TL3005	S	0	S	80S	77-5	S	0	S	5MR	46S119	S	20S	R	0	-
Special Trial (MABB/NIL (KB) entries)																
84	DWR-NIL-01	R	20MS	S	40S	-	MS	20MRMS	S	40MRMS	-	S	10MS	R	0	-
85	DWR-NIL-02	S	20MS	S	0	104-2	S	TMR	MS	10MRMS	-	R	0	R	0	-
86	HD3209	R	0	R	0	-	S	10MRMS	S	30MRMS	-	S	TS	S	TS	-

S. No.	VARIETY	Brown rust					Yellow rust					Black rust				
		77-5		104-2		APR to	46S119		78S84		APR to	40A		117-6		APR to
		SRT	APR	SRT	APR		SRT	APR	SRT	APR		SRT	APR	SRT	APR	
87	KB2012-03	S	0	R	0	77-5	S	10MRMS	S	30MRMS	-	S	40S	R	0	-
Special Trial (Wheat Bifortification)																
88	HPBW01	MS	0	S	0	104-2	S	0	MS	0	46S119	S	40S	R	0	-
89	HPBW02	R	0	R	0	-	MS	0	MS	0	both	S	40S	R	0	-
90	HPBW05	S	0	R	TR	77-5	MS	0	MS	0	both	S	20S	R	0	-
91	HPBW07	R	0	S	0	104-2	R	0	R	TMR	-	R	0	R	-	-
92	HPBW08	R	0	MS	TS	-	S	TR	S	0	78S84	R	0	R	0	-
93	HPBW09	R	0	R	0	-	R	0	R	0	-	R	0	R	-	-
94	HUW695	R	0	R	0	-	R	0	R	0	-	S	40S	R	0	-
95	HUW711	MS	0	R	0	-	S	0	MS	0	both	S	40S	R	0	-
96	HUW712	S	0	R	0	77-5	S	0	MS	0	both	S	20S	R	0	-
97	MACS6507	S	0	S	0	both	S	0	MS	0,1P 20MS	46S119	R	0	R	0	-
98	WB1	R	0	R	0	-	MS	0	MS	0, 1P 20MRMS	both	MR	0	R	0	-
99	WB2	R	0	R	0	-	MS	0	MS	0	both	MS	-	R	0	-
100	WB5	R	0	R	0	-	S	0	S	0	both	MR	0	R	0	-

*=Infection was poor, needs confirmation

Table 2.6. **APR results of AVT genotypes against 40A and 117-6 stem rust pathotypes Under controlled condition at Mahabaleswar**

Sr. No.	Genotype	40A	117-6
AVT - I :CENTRAL ZONE			
1	CG 1015	10S	TS
2	GW 463	20S	5S
3	HI 8759 (d)	30S	20S
AVT - I :PENINSULAR ZONE			
1	GW 1315(d)	10S	5S
2	HD 3164	10S	10S
3	HI 8765 (d)	30S	20S
4	JWS 712	TS	TR
5	K 1315	20S	TMR
6	MACS 3970(d)	30S	5S
7	MACS 3972 (d)	20S	TS
9	MACS 4020 (d)	40S	20S
10	PBW 721	30S	10S
11	UAS 360	10S	5S
12	UAS 361	5S	5S
13	UAS 453 (d)	40S	20S
14	UAS 455 (d)	60S	30S
AVT - II :CENTRAL ZONE			
1	HD 4728 (d)	30S	10S
2	HD 4730(d)	30S	20S
3	GW 322 (C)	10S	5S
4	HD 2864(C)	TS	TR
5	HD 2932(C)	10S	5S
6	HI 1544(C)	TR	TS
7	HI 8498 (D) (C)	10S	5S
8	HI 8737(D)(I) (C)	40S	5S
9	MP 3336 (C)	TS	0
10	MP 4010 (C)	TR	10S
11	MPO 1215 (d) (C)	30S	20S
AVT - II :PENINSULAR ZONE			
1	MACS 3927 (d)	40S	30S
2	NIAW 2030	20S	10S
3	AKDW 2997-16 (d) (C)	5S	40S
4	DBW 93 (I) (C)	TS	10S
5	MACS 6222 (C)	5S	TR
6	MACS 6478(C)	20S	20S
7	NI 5439 (C)	30S	30S
8	NIAW 1415 (C)	TMR	20S
9	UAS 347 (I) (C)	10S	30S
10	UAS 428 (d) (C)	20S	40S
11	UAS 446 (d) (i) (C)	10S	40S

2.2 IDENTIFICATION OF SLOW RUSTER LINES IN AVT MATERIAL 2014-15

Yellow rust

The delay in progress of epiphytotic development is attributed to several factors including latent period, number of uredosori per unit area, size of uredosori, rate of sporulation, etc. Chances of new variants or pathotypes are minimized due to reduced selection pressure. A convenient option of identifying slow ruster lines is the estimation of the Area Under Disease Progress Curve (AUDPC) which takes into account all the factors collectively leading to manifestation of slow rusting in a genotype. AVT entries were sown in single rows, each of 1 meter length with an interception of the spreader row after every 20th line for identifying the slow ruster lines at Karnal and Mahabaleshwar. For creating a load of inoculum pressure, four rows of mixture of susceptible genotypes were sown as border rows (infector/spreader). The infector/spreader rows were syringe inoculated at growth stage 37 (Zadoks growth scale for cereals) when flag leaf was just emerging out of boot. On appearance of rust pustules on flag leaf, the high humidity was maintained for rust development.

AUDPC was calculated for yellow rust data of Karnal centre and brown rust and stem rust data of Mahabaleshwar centres.

0: It represents high level of resistance controlled by major genes. This type of resistance exerts a strong selection pressure on pathogen, compelling it to mutate, resulting in short field life of a cultivar. Genotypes possessing this kind of resistance should be particularly avoided in inoculum source areas, however, they can be satisfactorily grown in target areas to seek protection against specified pathotypes.

1 - 10: This type of resistance also represents strong vertical resistance as described in group 0. This category includes those entries on which disease initiated as traces of resistant pustules (TR infection type) not exceeding 10R as terminal reaction. It may also not impart a durable protection and is likely to be lost owing to adaptations in the pathogen.

11 - 100: The incipient reaction appears as pustules of moderately susceptible (MS) infection type. Subsequent progression of disease occurs at a quite slower rate as compared to the fast ruster check genotype. Such genotypes possess adult plant resistance (APR) genes in addition to the vertical resistance genes. Such genotypes may exhibit a better field durability than those possessing the vertical resistance genes only.

101 - 200: Genotypes falling in this range of AUDPC truly represent the slow rusters. Disease initiates in the form of susceptible (S) type pustules on these genotypes but subsequent progression remains slower than the fast ruster check. The terminal severity in these genotypes does not exceed 20S as compared to 80 - 100S in fast rusting genotypes. Genotypes belonging to this category carry a long lasting field resistance and must be preferred while breeding to develop cultivars possessing durable resistance.

Entries showing various ranges of AUDPC are shown below:

A. DWR, Karnal

The data of stripe rust intensities recorded at different dates of equal intervals were subjected to AUDPC analysis. Coefficient of Infection (CI) was calculated. Entries were grouped according to their AUDPC values and are described below.

AUDPC OF YELLOW RUST

AVT II^nd Year 2014-15

0	DBW 14 (C), HS 507 (C), HS 542 (C), MACS 3927 (d), PBW 723, UAS 428 (d) (C) and UAS 446 (d) (I) (C)
1-100	AKDW 2997-16(d) (C), HD 3043 (C), HD 4730, MPO 1215 (d) (C), PDW 233 (C), PDW 314 (C), TL 2969 (C), VL 907 (C), WH 1021 (C), WH 1105 (C)
101-500	C 306 (C), DBW 88 (C), DBW 90 (C), DBW 93 (I) (C), DPW 621-50 (C), (HD 2932 + Lr 19/Sr25), HD 2888 (C), HD 2967 (C), HD 2985 (C), HD 3059 (C), HD 3086 (C), HD 4728 (d), HI 1544 (C), HI 1563 (C), HI 8498 (D) (C), HI 8737 (D)(I) (C), HPW 251 (C), HPW 349 (C), HS 490 (C), HS 562, HW 1098 (C), K 0307 (C), K 8027 (C), KRL 19 (C), KRL 210 (C), MP 1277, MP 3336 (C), NIAW 1415 (C), PBW 343 (C), PBW 644 (C), PDW 291 (C), Raj 4083 (C), TL 2942 (C), UAS 347 (I) (C), VL 804 (C), VL 829 (C), VL 892 (C), WH 1124 (C), WH 1164
501-1000	HD 2864 (C), HD 2932 (C), HS 375 (C), HUW 234 (C), MACS 6222 (C), MMBL 283, MP 4010 (C), WH 1080 (C), WH 1142 (I) C), WH 542 (C)
>1000	DDK 1029 (C), GW 322 (C), Kharchia 65 (C), MACS 6478 (C), NI 5439 (C) and NIAW 2030

AVT I^st Year 2014-15

0	DBW 181, DBW 182, DBW 184, DBW 185, HI 1605, HPBW 01, HPBW 02, HPBW 07, HPBW 09, HPW 394, HS 590, HS 600, HUW 688, HUW 695, HUW 711, HUW 712, MACS 3949, PBW 719, TL 3001, TL 3002, TL 3003, TL 3004, TL 3005, UAS 453 (d), UAS 455 (d), UP 2883, VL 1005, VL 3002, VL 3007, VL 3008, VL 3009 and VL 4001
1-100	DBW 150, DDW 32, HD 3171, HI 8765 (d), HPBW 05, HS 599, K 1314, K 1315, KRL 350, MACS 3970 (d), MACS 3972 (d), MACS 4024, MACS 6507, PBW 709, PBW 716,

	WB 1, WB 2 and WB 5
101-500	CG 1015, DBW 147, DBW 148, DBW 183, DDW 31, DWR-NIL-02, GW 463, HD 3159, HD 3164, HD 3165, HD 3174, HD 3209, HI 1604, HI 8759 (d), HPBW 08, , HPW 421, HPW 422, HS 580, HS 583, HS 596, HS 597, JWS 712, K 1312, K 1313, K 1317, KB 2012-13, KRL 351, MACS 4020 (d), PBW 707, PBW 718, PBW 721, UAS 360, UP 2917, UP 2918, VL 1006, VL 1007, WH 1179 and WH 1309
501-1000	DDK 1048, DWR-NIL-01, HPW 393, HPW 413, HS 598, HS 601, MACS 5041, MACS 5043 and UAS 361
>1000	DDK 1049 and GW 1315 (d)

B. MAHABALESHWAR

AUDPC based identification of slow rusters

Genotypes showing AUDPC value below 200 for stem and leaf rust at Mahabaleshwar Centre are described below:

AUDPC value	Genotypes
Stem Rust, AVT - I year, 2014 - 15	
0	Nil
01 - 100	HPW 422, HS 580, HS 583, HS 590, HS 596, HS 597, HS 598, HS 599, HS 600, HS 601, UP 2918, VLL 1005, VL 1007, VL 3002, VL 3007, VL 3008, VL 3009, VL 4001, DBW 147, DBW 148, DBW 150, HD 3165, HD 3174, HI 1604, HI 1605, HUW 688, K 1312, K 1313, MACS 4024, PBW 707, PBW 709, PBW 716, PBW 718, PBW 719, UP 2883, WH 1179, HD 3171, K 1317, CG 1015, GW 463, HI 8759 (d), GW 1315 (d), HD 3164, HI 8765 (d), JWS 712, K 1315, MACS 4020 (d), PBW 721, UAS 360, UAS 361, DBW 181, DBW 182, DBW 183, DBW 184, DBW 185, DDK 1048, DDK 1049, KRL 350, KRL 351, MACS 5041, MACS 5043, WH 1309, TL 3001, TL 3002, TL 3003, TL 3004, TL 3005, DWR-NIL-01, DWR-NIL-02, HD 3209, HPBW 01, HPBW 02, HPBW 05, HPBW 07, HPBW 08, HPBW 09, HUW 695, HUW 711, MACS 6507, WB 1, WB 2 and WB 5
101 - 200	HPW 394, HPW 413, HPW 421, DDW 31, HD 3159, MACS 3970 (d), MACS 3972 (d), UAS 453 (d), UAS 455 (d), KB 2012-13 and HUW 712

Leaf Rust, AVT – I year, 2014-15	
0	HS 600, DBW 147, K 1313, PBW 718, TL 3002, TL 3003 and HUW 695.
01-100	HPW 393, HPW 394, HS 583, HS 590, HS 596, HS 597, HS 598, HS 599, UP 2917, VL 3007, VL 3008, VL 3009, VL 4001, DBW 148, DBW 150, DDW 31, HD 3165, HD 3174,HI 1605, HUW 688, K 1312, K 1314, MACS 3949, MACS 4024, PBW 709, PBW 716, PBW 719, GW 463, HI 8759 (d), GW 1315(d), HD 3164 , HI 8765(d), JWS 712, K 1315, MACS 3970 (d), MACS 3972 (d), MACS 4020(d), PBW 721, UAS 453, UAS 455(d), DBW 181,DBW 182, DBW 183, DDK 1048, DDK 1049, KRL 350,KRL 351, MACS 5041, MACS 5043, WH 1309, TL 3001, HD 3209,HPBW 01,HPBW 02, HPBW 05, HPBW 07,HPBW 08, HPBW 09, WB 1, WB 2 and WB 5
101 - 200	UP 2918, VL 1005, VL 3002, DDW 32, HD 3159, HI 1604, UP 2883, HD 3171, K 1317, DBW 184, TL 3004, TL 3005 and HUW 712
Stem Rust, AVT – II year, 2014 - 15	
0	HS 507 (C), HS 542 (C), VL 829 (C), DPW 621-50(C), HD 2967 (C), HD 3043 (C), HD 3059 (C) and PBW 723
01 - 100	HPW 251 (C), HPW 349 (C), HS 375 (C), HS 490 (C), VL 804 (C), VL 907 (C), HD 4730, PBW 644 (C), WH 1021 (C), WH 1080 (C), WH 1105 (C), WH 1142 (I) (C), C 306 (C), HD 2888 (C), HD 4728 (d), GW 322 (C), HI 1544 (C), HI

	8737 (D)(I) (C), NIAW 1415 (C), HI 1563 (C), HW 1098 (C), K 0307 (C), PBW 343 (C), Raj 4083 (C), TL 2942 (C), TL 2969 (C)
101 - 200	VL 892 (C), MP 1277, WH 1164, DBW 88 (C), HI 4730 (d), HD 2864 (C), HI 8498 (D) (C), MACS 6222 (C), KRL 19 (C) and WH 542 (C)
Leaf Rust, AVT - II year, 2014-15	
0	Nil
01 - 100	HPW 251(C), HS 490(C), HS 507(C), HS 542(C), VL 804(C), VL 907(C), HD 4730, MP 1277, DPW 621-50 (C), HD 2967 (C), HD 3086 (C) , PDW 291(C) , PDW 314(C), WH 1021 (C) , WH 1080 (C) , WH 1105(C) , WH 1124(C) , C 306(C) , HD 2888(C) , HD 4728 (d) , HD 2864(C) ,HI 1544(C) , HI 8498(D)(C) , HI 8737(D) (I) (C) , MP 4010(C) , MPO 1215(D) (C) , NIAW 2030, NIAW 1415(C) , UAS 446(d) (I) (C) , (HD 2932 + *Lr* 19/ *Sr* 25), PBW 723, DDK 1029(C) , HI 1563 (C) , HW 1098(C) , TL 2942 (C) and TL 2969 (C).
101 - 200	HPW 349(C), VL 829(C), VL 892(C), DBW 88(C), DBW 90(C), HD3043(C), HD 3059(C), PBW 644 (C) , PDW 233(C) , WH 1142 (I) (C) , HI 4730 (d) , MACS 3927(d) , MACS 6222(C) and KRL 210(C)

COOPERATORS

NAME	CENTRE
M.S. SAHARAN	KARNAL
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2.3 SEEDLING RESISTANCE TEST AGAINST PATHOTYPES OF WHEAT RUSTS

A. Flowerdale, Shimla

(a) Rust resistance

To identify rust resistant lines of wheat and characterize rust resistance genes, 173 lines of AVT I and II were evaluated at seedling stage using an array of pathotypes of black (*Puccinia graminis tritici*), brown (*P. triticina*) and yellow rust (*P. striiformis*) having different avirulence/virulence structures. None of the lines was resistant to all the rusts. Three lines of AVT II and one line of AVT I exhibited resistance to the two rusts. In addition to all the lines having *Sr*31 were resistant to black rust of wheat, whereas lines possessing *Lr*24, some with *Lr*26 were resistant to brown rust and few lines with *Yr*9 showed resistance to yellow rust of wheat. Details of the wheat rust resistant lines are given below:

AVT 2nd Year

Resistant to black and brown rusts: HI 1563(C), PBW 723

Resistant to black and yellow rusts: HD 3043(C)

Resistant to yellow rust only: HD 3059(C), MACS 3927(D)

Resistant to black rust only: HD 2932(C), HI 1544(C),TL 2942(C), TL 2969(C)

Resistant to brown rust only: HD 2684(C), HD 4728(D), HD 4730(D), MACS 6222(C), NIAW 2030, UAS 446 (D) (C)

AVT I year

Resistant to black and brown rusts: HPBW 09

Resistant to yellow rust only: DBW 182, DDW 32, HD 3171, HPBW 07, HS 596, HUW 688, HUW 695, MACS 3972, PBW 709, UP 2883, VL 3002

Resistant to brown rust only: DBW 147, HPBW 08, MACS 3949, MACS 4024, TL 302, TL 303, WB 5

a. **Rust resistance genes in AVT lines**

To know the genetic diversity in Advance Varietal Trial material, rust resistance genes were characterized using host- pathogen interaction data and applying gene matching technique. Mostly rust resistance genes were inferred in those wheat lines where differential response to rust pathotypes were observed, however, morphological markers, genetic linkage and characteristic infection types were also used to reach at a conclusion.

***Yr* genes**

AVT II

Five rust resistance genes (*Yr*2, A, 9, 18 and 27) to yellow rust of wheat were characterized in 47 lines of AVT II. Among these *Yr*2 was inferred in more than70 % lines followed by *Yr*9 gene which was characterized in about 30% lines. Other resistance genes were postulated in few lines only (Table 2.7).

AVT I

Three *Yr* genes (*Yr*2, A and 9) were observed in 67 lines. *Yr*2 was postulated in 40 lines followed by *Yr*9 in 19 lines and *Yr*A in 7 lines only (Table 2.8).

***Sr* genes**

AVT II

Ten *Sr* genes (*Sr*2, 5, 8a, 9b, 9e, 11, 13, 24, 25 and 31) were postulated in 65 lines. *Sr*2 based on characteristic mottling was observed in 56 lines followed by *Sr*11 in 23 lines and *Sr*31 based on its linkage to *Lr*26/*Yr*9 in 13 lines. The resistance of most of the durums was based on *Sr*7b, 9e and *Sr*11. Other *Sr* genes were inferred only in few lines (Table 2.9).

AVT I

Fourteen *Sr* genes (*Sr*2, 5, 7b, 8a, 9b, 9e, 11, 12, 13, 15, 24, 25, 30 and 31) were postulated in 99 lines. *Sr*2, known adult plant resistance gene to stem rust was observed in 63 lines followed by *Sr*11 in 37, *Sr*7b in 34 and *Sr*31 in 19 lines. *Sr*9e was characterized in 7, *Sr*13 in 6 lines whereas remaining eight *Sr* genes were postulated in few lines only (Table 2.10).

***Lr* genes**

AVT II

Nine *Lr* genes (*Lr*1,10,13,14a,19,23,24,26,34) in 60 lines where differential host pathogen interactions were observed. Like AVT I, *Lr*13 was postulated in 22 lines followed by *Lr*23 in 21, *Lr*26 in 13 and *Lr*10 in 11 lines. *Lr*1, *Lr*34 and *Lr*24 were found to confer brown rust resistance in 8, 6 and 4 lines, respectively. In addition *Lr*14a and *Lr*19 were characterized in one line each (Table 2.11).

AVT I

Nine *Lr* genes viz. *Lr*1, 2a, 10, 13, 19, 20, 23, 24 and 26 were characterized in 87 lines. Among these *Lr*13 was most common and was observed in 48 lines. This gene is known widely for conferring resistance to brown rust at high temperatures. *Lr*23 was characterized in 30 lines followed by *Lr*10 in 23, *Lr*26 in 19 and *Lr*1 in 16 lines. Other resistance genes namely *Lr*2a, *Lr*19 and *Lr*24 were observed in 3, 1 and 1 lines, respectively (Table 2.12). These had been further decrease in the proportion of *Lr*26 in AVT I accessions in comparison to the previous years.

Table 2.7. Postulation of *Yr* genes in AVT II^nd material during 2014-15

Yr Genes	No. of Lines	Details of Lines
2+	30	HD2864(C), HD2932+*Lr*19/*Sr*25, HD2967(C), HD2985(C), HD3086(C), HD4728(D), HD4730, HD2888(C), HI1544(C), HI1563(C), HI8498(D) (C), HI8737 (D)(I)(C), HPW349(C), HS542(C), HUW234(C), K0307(C), K8027(C), MACS6478(C), MP3336(C), MP4010(C), NIAW2030, PBW343, PBW644(C), PDW314(C), RAJ4083, UAS347(I)(C), UAS446(D)(I)(C), WH1080(C), WH1105(C), WH1129(C)
2+18+	1	NI5439
9+	8	DBW93(I) (C), HPW251(C), HS507(C), NIAW1415(C), PBW343(C), WH542 (C), WH1021(C), WH1142(C)
9+18+	4	HS375 (C), VL804(C), VL829(C), VL907(C)
18+	1	C306(C)
9+27+	1	MACS6222(C)
A+	2	HS562, VL892(C)
Total	47	

Table 2.8. Postulation of *Yr* genes in AVT I^st material during 2014-15

Yr Genes	No. of Lines	Details of Lines
2+	40	DBW148, DBW150, DBW181, DBW184, DBW185, HD3159, HD3165, HD3174, HD3209, HI1604, HI1605, HI8765(D), HPBW05, HPW393, HPW413, HPW421, HPW422, HS583, HS601,HUW711, HUW712, JWS712, K1312, K1315, KB2012-03, KRL350, MACS3949, MACS5043, MACS6507, PBW707, PBW718, TL3001, TL3004, TL3005, UAS360, UAS453(D), WB1, WB2, WH1179 and WH1309
9+	9	DWR-NIL-01, DWR-NIL-02, HPBW01, HPBW02, TL3002, TL3003, UP2918, VL4001 and WB5
9+A+	10	HS580, HS599, K1317, PBW719, UP2917, UAS361, VL1005, VL1007, VL3007 and VL3008
A+	8	DBW147, HD3164 (D), HS598, HS600, K1313, K1314, PBW716 and VL3009
Total	67	

Table 2.9. Postulation of *Sr* genes in AVT II^nd material during 2014-15

Sr Genes	No. of Lines	Details of Lines
31+5+2+	2	HS375 (C), VL804 (C)
31+2+	8	DBW93(I) (C), HPW251 (C), MACS6222 (C), NIAW1415 (C), PBW343 (C), VL907 (C), WH1021 (C), WH1142 (C)
31+	3	HS507 (C), WH542 (C),VL829(C)
24+2+	4	HD2888 (C), HI1544 (C), MP4010 (C), NAW2030
25+2+	1	HD2932+*Lr*19/*Sr*25
13+2+	1	DBW90 (C)
5+8a+9b+11+2+	1	HS542 (C)
8a+9b+11+2+	1	KRL19 (C)
8a+11+2+	1	HD2967 (C)
8a+9b+	1	HS562
9e+2+	5	HI8737 (D) (C), PDW233 (C), PDW291 (C), PDW314 (C), WH1080 (C)
11+2+	15	DBW88 (C), DDK1029 (C), GW322 (C), HD3059 (C),

Sr Genes	No. of Lines	Details of Lines
		HD4728 (D), HD4730, HI8498 (D) (C), HW1098 (C), K8027 (C), MACS3927 (D), PBW644 (C), RAJ4083 (C), UAS428 (D)(C), UAS446 (D) (I) (C), WH1105 (C)
11+7b+2+	2	MP1277, UAS347 (I) (C)
9b+11+	1	HUW234 (C)
11+	2	MPO1215 (D) (C), NI5439 (C)
9b+2+	1	HS490 (C)
7b+2+	3	AKDW2997-16 (D), HD3086 (C), WH1124 (C)
7b+	2	HD2985 (C), KRL210 (C)
2+	11	DBW14 (C), HI1563 (C), HPW349 (C), K0307 (C), MP3336 (C), PBW621-50 (C), PBW723, TL2942 (C), TL2969 (C), VL892 (C), WH1164
Total	**65**	

Table 2.10. Postulation of *Sr* genes in AVT Ist material during 2014-15

Sr Genes	No. of Lines	Details of Lines
31+5+	1	HS580
31+2+	14	HPBW01, HPBW02, HS599, K1317, TL3002, TL3003, UAS361, UP2917, UP2918, VL1005, VL1007, VL3007, VL4001, WB5
31+	4	DWR-NIL-01, DWR-NIL-02, PBW719, VL3008
24+2+	1	JWS712
25+11+2+	1	HD3209
30+5+2+	1	K1313
30+2+	2	DBW147, HS598
30+	2	UAS360, VL3009
11+	6	HI1604, HPW393, HPW394, HPW422, HS596, UP2883
2+	2	TL3001, VL3002
11+2+	6	DDW31, GW463, HI8759 (D), HS597, MACS4024, VL1006
11+12+2+	2	MACS3972 (D), MACS4020 (D)
11+13+2+	1	HUW712
13+7b+2+	1	K1315
9e+11+5+	1	PBW721
9e+11+2+	1	HPBW08
9e+5+	1	KRL351
9e+7b+2+	3	DBW181, UAS453 (D), UAS455(D)
9e+	1	PBW718
9b+11+2+	1	HS583
9b+11+	3	HI8765 (D), PBW709, PBW707
8a+11+5+	1	HPW421
8a+5+2+	1	HPBW05
8a+2+	1	DBW183
5+11+13+2+	3	DBW182, HUW695, HUW711
5+11+13+	1	HD3159
5+7b+9b+2+	1	WH1309
5+11+2+	2	KB2012, MACS6507
5+11+	3	HI1605, HUW688, K1312
5+7b+2+	4	CG1015, DBW185, K1314, TL3005
5+7b+	1	HS601
5+2+	2	HPBW09, TL3004
7b+2+	11	DBW148, DBW150, DDW32, HD3165, HD3174, HS590 HS600, MACS3949, PBW716, WB1, WB2

Sr Genes	No. of Lines	Details of Lines
7b+11+2+	2	DBW184, KRL350
7b+15+2+	1	MACS5041
7b+11+	3	GW1315 (D), HPBW07, MACS5043
7b+	7	DDK1048, DDK1049, HD3164, HD3171, HPW413, Macs3970(D), WH1179
Total	**99**	

Table 2.11. Postulation of *Lr* genes in AVT II^nd^ material during 2014-15

Lr gene/s	No. of Lines	Details of Lines
26+23+34+	1	WH542 (C)
26+23+1+	1	DBW93 (I) (C)
26+34+1+	1	HS375 (C)
26+34+	2	VL804 (C), VL829(C)
26+23+	2	HPW251 (C), WH1142 (C)
26+1+	3	HS507 (C), MACS 6222 (C), WH1021 (C)
26+	3	NIAW1415 (C), PBW343 (C), VL907 (C)
24+	4	HD2888 (C), HI1544 (C), MP4010 (C), NIAW2030
23+1+	2	K0307(C), MACS6478(C)
23+	15	DBW14(C), HD2958(C), HD2967(C), HD3043(C), HI8498 (D) (C), HI8737 (D) (C), HS490(C), HS562, MPO1215(D) (C), PDW233 (C), PDW291 (C), PDW314 (C), RAJ4083(C), TL2969(C), UAS428(D) (C)
19+	1	HD2932+Lr19/Sr25
13+10+3+	2	DBW90(C), HD3086(C)
13+10+	9	HPW349(C), KRL210(C), HS542(C), PBW621-50(C), TL2942(C). UAS347(I) (C), VL892(C),WH1124(C), WH1164
13+1+	1	PBW644(C)
13+	10	DDK1029(C), GW322(C), HD2932(C), HD3059*, K8027(C), KRL19(C), MP1277, MP3336(C), WH1080(C), WH1105(C)
14a+	1	HUW234(C)
34+	2	C306, NI5439
Total	**60**	

*Different seed lot than previous year

Table 2.12. Postulation of *Sr* genes in AVT I^st^ material during 2014-15

Lr gene/s	No. of Lines	Details of Lines
26+23+1+	3	UAS361, UP2918, VL1005
26+23+10+	2	HPBW01, HPBW02
26+23+	2	DWR NIL01, PBW719
26+10+	3	HS599, UP2917,VL4001
26+1+	6	HS580, K1317, TL3002, TL3003, VL3007,WB5
26+	3	DWRNIL02, VL1007, VL3008
24+	1	JWS712
23+13+10+	3	PBW709, PBW716, VL1006
23+13+1+	1	HS600
23+13+	2	CG1015, DDW31
23+10+1+	2	DBW150,HPW393
23+10+	4	DBW148, HPW413, HUW695, KB2012-03
23+1+	4	GW463, HI1604, K1315, KRL350
23+	7	DDW32, HD8765 (D), HI8759(D), HPW421,HPW422, HS596,HUW711

Lr gene/s	No. of Lines	Details of Lines
19+	1	HD3209
13+10+	10	DBW182, DBW185, HD3171, HPW394,HS583, K1312, KRL351, TL3001, VL3002, WH1309
13+2a+	3	HS598, UAS360, VL3009
13+	30	DBW181, DBW183, GW1315(D), HD3159, HD3164, HD3165, HD3174, HI1605, HPBW05, HPBW07, HS590, HS597, HS601, HUW712, K1313, K1314, MACS3970 (D), MACS3972 (D) , MACS6507 , PBW707, PBW718, PBW721, TL3004, TL3005, UAS453 (D),UAS455(D), UP2883, WH1179, WB2, WB9
Total	87	

b. **MAHABALESHWAR**

AVT genotypes of CZ & PZ were tested against selective pathotypes of stem and leaf rusts under glass house condition. These were tested at seedling stage against 8 pathotypes of stem rust and 12 pathotypes of leaf rust as detailed below.

Pathotypes used :

Stem Rust : 11, 11A, 21-1, 40A, 40-1, 42, 117-A, 117-3, 117-4, 117-5 117-6, 122 and 295.

Leaf Rust : 77A-1, 77-1, 77-2, 77-3, 77-4, 77-5, 77-6 , 77-7, 77-8, 104A, 104B, 104-1, 104-2, 104-3, 104, 12A, 12-2, 12-3, 12-4, 12-5, 162-1, 17 and 108.

Wheat genotypes found resistant are depicted in Table 2.13

Table 2.13. Resistant genotypes of wheat from AVT trial against selective pathotypes at seedling stage under glass house condition.

Resistant genotypes		
Stem rust	**Leaf rust**	**Both the rusts**
HD 3164, K 1315, MACS 4020 (d), UAS 361, HI 1544 (C), MACS 6222 (C) and UAS 347(I) (C)	GH1315 (d), K 1315, MACS 3970 (d), PBW 721, UAS 455 (d), HD 4278 (D), HD 2864 (C), HI 1544 (C), HI 8737 (D) (I) (C), MP 4010 (C), MPO 1215 (d) (C) and UAS 446 (d) (I) (C)	HI 1544 (C) and K 1315

COOPERATORS

NAME	CENTRES
S.C. BHARDWAJ, O P GANGWAR, P PARSAD	FLOWERDALE, SHIMLA
S.G. SAWASHE	MAHABALESHWAR

PROGRAMME 3. LEAF BLIGHT

3.1. LEAF BLIGHT SCREENING NURSERY (LBSN), 2014-15

Leaf blight (spot blotch) complex of wheat is a major disease in north eastern plains zone (NEPZ) and Peninsular zone (PZ). In recent years, the incidence in NWPZ is increasing as the temperature during crop season rises above 25°C. The grain yield losses may vary from 10-50%. In addition to yield losses, the quality also deteriorates depending on the level of susceptibility of a cultivar against the pathogen. Since leaf blight occurs in all the wheat growing agro-climatic zones, deployment of resistant cultivars remains the most effective strategy for the management of disease. The present chapter deals with the monitoring of the associated pathogens, status of resistance in advanced wheat entries against leaf blight, identification of stable sources of resistance and management of seed and soil borne inoculum using fungicidal seed treatment in popular wheat varieties.

Objective:

To know the status of resistance against leaf blight in the entries of advanced varietal trial (AVT I and II year) as well as retesting of other known resistant entries.

Composition:

This nursery was having 176 test entries comprising of previously identified promising leaf blight resistant entries (3 Nos.) and entries of AVT I year (100 entries) and II year (73 entries).

This nursery was planted at 14 centres listed below:

Zone	Test locations
NEPZ	Faizabad, Varanasi, Pusa (IARI), Coochbehar, Shillongani, Kalyani, Ranchi (7)
NWPZ	Karnal, Pantnagar, Ludhiana, Hisar, (4)
PZ	Dharwad (1)
SHZ	Wellington (1)
CZ	Gwalior (1)

Each entry was planted in one row of 1m length and a row of a highly susceptible entry RAJ4015 was repeatedly planted after every 20 test entries. The inoculations of pathogens were done right from the month of January at 15 days intervals with frequent irrigations till development of disease. The recording of disease was done on 0-9 double digit scale at three stages, flowering, dough and hard dough stages to observe response of each entry against leaf blight at various stages. The left side digit indicates the score of blight on flag leaf (F) and right side digit of score represents the per cent blighted area of flag-1 leaf (F-1) and the score (0-9) was as follows:

0-No blight, **1**-Up to 10% leaf area blighted, **2**-11-20% leaf area blighted, **3**-21-30% leaf area blighted, **4**-31-40% leaf area blighted, **5**-41-50% leaf area blighted, **6**-51-60% leaf area blighted, **7**-61-70% leaf area blighted, **8**-71-80% leaf area blighted, **9**->80% leaf area blighted.

Amongst three stages, blight record at hard dough stage was most distinct in terms of giving clear comparison between resistant and susceptible stage and therefore data at hard dough stage was used for final categorization of resistance of test entries including AVT II year and data is also presented in Table 1.5 of chapter 1.

The highest as well as average blight score was also calculated at three growth stages separately and data are given in the following Table 3.1.

Table 3.1 Leaf blight score of different entries at three different growth stages 2014-15

S.No.	Entry	Leaf Blight Score (0-9dd)					
		Ist (Flowering)		IInd (Dough)		IIIrd (Hard dough)	
AVT IInd Year							
I. NORTHERN HILL ZONE		HS	Av.	HS	Av.	HS	AV.
1	HS 562	25	01	34	13	67	24
2	HPW 251(C)	34	12	69	24	89	45
3	HPW 349 (C)	23	01	79	23	89	35
4	HS 375 (C)	25	02	47	23	69	46
5	HS 490 (C)	24	02	46	23	78	35
6	HS 507 (C)	24	12	45	24	79	46
7	HS 542 (C)	23	01	45	13	78	35
8	VL 804 (C)	27	12	79	35	89	46
9	VL 829 (C)	23	01	32	13	79	35
10	VL 892 (C)	48	12	79	35	99	57
11	VL 907 (C)	25	01	34	23	69	36
II. NORTH WESTERN PLAIN ZONE							
12	HD 4730	45	12	79	24	99	46
13	MP 1277	25	01	37	13	69	36
14	WH 1164	36	12	69	24	89	46
15	DBW 88 (C)	47	01	49	23	79	45
16	DBW 90 (C)	25	01	47	24	79	46
17	DPW 621-50 (C)	16	01	26	13	79	35
18	HD 2967 (C)	27	01	46	12	79	35
19	HD 3043 (C)	28	01	35	13	68	35
20	HD 3059 (C)	24	01	35	24	79	46
20A	RAJ 4015 (Check)	46	23	89	46	99	68
21	HD 3086 (C)	25	12	79	35	89	46
22	PBW 644 (C)	16	01	37	13	78	35
23	PDW 233 (C)	24	01	47	24	79	36
24	PDW 291 (C)	24	01	47	23	79	35
25	PDW 314 (C)	25	01	34	13	78	24
26	WH 1021(C)	16	12	69	24	89	46
27	WH 1080(C)	27	02	38	24	79	46
28	WH 1105(C)	56	01	89	35	89	46
29	WH 1124(C)	15	02	47	24	79	46
30	WH 1142 (I)(C)	26	01	35	24	69	35
III. NORTH EASTERN PLAIN ZONE							
31	C 306 (C)	24	12	45	23	78	35
32	HD 2888 (C)	22	11	45	23	78	45
33	K 8027 (C)	34	11	36	23	78	35
IV. CENTRAL ZONE							
34	HD 4728 (d)	25	01	79	23	89	35
35	HD 4730 (d)	24	11	37	24	79	46
36	GW 322 (C)	33	11	89	34	89	57

S.No.	Entry	Leaf Blight Score (0-9dd)					
		Ist (Flowering)		IInd (Dough)		IIIrd (Hard dough)	
37	HD 2864 (C)	34	13	89	35	89	57
38	HD 2932 (C)	34	12	89	35	89	57
39	HI 1544 (C)	38	12	79	36	89	57
40	HI 8498 (C) (d)	44	11	79	24	89	46
40A	RAJ 4015 (Check)	36	23	89	46	99	68
41	HI 8737 (d) (I) (C)	25	12	46	24	79	45
42	MP 3336 (C)	24	12	89	35	89	57
43	MP 4010 (C)	44	12	89	46	89	57
44	MPO 1215 (d) (C)	23	01	35	13	79	45
V. PENINSULAR ZONE							
45	MACS 3927 (d)	27	12	69	34	89	46
46	NIAW 2030	24	12	45	23	58	35
47	AKDW 2997-16 (d) (C)	26	12	89	35	89	57
48	DBW 93 (I) (C)	27	12	79	24	89	46
49	MACS 6222 (C)	23	12	34	24	67	35
50	MACS 6478 (C)	26	01	28	13	68	36
51	NI 5439 (C)	28	12	55	34	78	46
52	NIAW 1415 (C)	17	02	58	24	79	46
53	UAS 347 (I) (C)	28	01	55	23	79	35
54	UAS 428 (d) (C)	23	12	47	24	79	36
55	UAS 446 (d) (C) (I)	28	02	35	24	89	36
VII. SPECIAL TRIAL							
56	HD 2932+ Lr 19/Sr 25)	35	12	89	36	89	46
57	MMBL 283	45	12	89	36	89	57
58	PBW 723	28	12	37	24	79	46
59	DBW 14 (C)	27	12	89	35	89	46
60	DDK 1029 (C)	34	11	68	24	89	46
60A	RAJ 4015 (Check)	35	23	89	46	99	67
61	HD 2985 (C)	25	12	47	24	89	46
62	HI 1563 (C)	35	12	79	35	89	57
63	HUW 234 (C)	24	12	89	35	89	46
64	HW 1098 (C)	24	01	55	24	79	46
65	K 0307 (C)	26	12	69	24	89	46
66	Kharchia 65 (C)	25	12	47	24	79	46
67	KRL 19 (C)	45	13	89	46	99	56
68	KRL 210 (C)	23	12	57	25	99	46
69	PBW 343 (C)	39	12	46	23	89	46
70	RAJ 4083 (C)	45	12	89	46	99	56
71	TL 2942 (C)	25	01	57	24	99	35
72	TL 2969 (C)	28	01	47	13	79	35
73	WH 542 (C)	27	02	35	23	79	35
AVT Ist Year							
I. NORTHERN HILL ZONE							
74	HPW 393	16	01	34	24	69	46
75	HPW 394	25	12	46	35	79	46
76	HPW 413	37	12	39	24	79	46
77	HPW 421	34	11	48	24	89	46

S.No.	Entry	Leaf Blight Score (0-9dd)					
		Ist (Flowering)		IInd (Dough)		IIIrd (Hard dough)	
78	HPW 422	34	12	79	35	89	46
79	HS 580	26	12	79	25	89	46
80	HS 583	34	11	46	24	78	46
80A	RAJ 4015 (Check)	35	23	89	46	99	68
81	HS 590	15	01	35	13	69	35
82	HS 596	27	01	34	13	79	35
83	HS 597	24	12	34	13	79	35
84	HS 598	17	01	35	23	69	36
85	HS 599	56	12	89	35	99	46
86	HS 600	39	12	36	13	78	46
87	HS 601	18	02	24	23	59	35
88	UP 2917	17	02	37	24	69	36
89	UP 2918	28	12	45	24	78	46
90	VL 1005	23	12	35	13	57	24
91	VL 1006	27	12	47	24	78	35
92	VL 1007	26	13	79	46	89	67
93	VL 3002	35	12	69	35	89	46
94	VL 3007	35	13	79	35	89	46
95	VL 3008	27	12	79	35	79	46
96	VL 3009	16	12	35	13	68	35
97	VL 4001	16	02	46	13	68	35
II. NORTH WESTERN PLAIN ZONE							
98	DBW 147	27	12	38	14	78	35
99	DBW 148	36	13	79	24	99	46
100	DBW 150	35	13	58	24	78	46
100A	RAJ 4015 (Check)	37	23	89	56	89	68
101	DDW 31	35	12	79	24	99	35
102	DDW32	35	01	79	24	99	46
103	HD 3159	34	12	79	24	99	46
104	HD3165	22	12	79	25	89	46
105	HD 3174	36	02	69	24	89	46
106	HI 1604	38	02	79	24	99	46
107	HI 1605	25	12	44	23	89	35
108	HUW 688	27	01	36	13	78	35
109	K 1312	38	12	68	24	89	46
110	K 1313	27	13	45	24	89	46
111	K 1314	25	12	69	35	89	57
112	MACS 3949	37	12	79	24	99	46
113	MACS 4024	23	01	36	13	78	35
114	NW 6024	NS	NS	NS	NS	NS	NS
115	PBW 707	24	11	45	13	89	35
116	PBW 709	45	01	69	23	89	45
117	PBW 716	13	11	24	12	79	35
118	PBW 718	35	12	79	24	99	46
119	PBW 719	26	12	59	24	89	46
120	UP 2883	24	01	46	13	79	45
120A	RAJ 4015 (Check)	35	23	89	46	99	67

S.No.	Entry	Leaf Blight Score (0-9dd)					
		Ist (Flowering)		IInd (Dough)		IIIrd (Hard dough)	
121	WH 1179	23	11	35	23	68	45
III. NORTH EASTERN PLAIN ZONE							
122	HD 3171	23	01	34	13	68	35
123	K 1317	25	12	35	13	68	35
IV. CENTRAL ZONE							
124	CG 1015	24	12	79	35	89	46
125	GW 463	25	01	57	23	78	46
126	HI 8759 (d)	24	12	57	24	99	46
V. PENINSULAR ZONE							
127	GW 1315 (d)	36	12	79	46	99	57
128	HD 3164	34	12	79	35	99	56
129	HI 8765 (d)	35	12	59	34	99	46
130	JWS 712	34	12	68	46	89	57
131	K 1315	24	12	47	13	89	35
132	MACS 3970 (d)	37	12	89	34	99	46
133	MACS 3972 (d)	44	11	89	24	99	46
134	MACS 4020 (d)	54	12	69	35	99	56
135	PBW 721	33	11	47	24	79	46
136	UAS 360	23	11	69	24	89	46
137	UAS 361	24	01	57	23	89	46
138	UAS 453 (d)	25	12	46	23	78	35
139	UAS 455 (d)	25	01	38	13	78	35
VI. SPECIAL TRIAL (Dicoccum and salinity and Alkalinity)							
140	DBW 181	24	01	44	12	89	34
140A	RAJ 4015 (Check)	35	23	89	46	99	68
141	DBW 182	24	12	56	23	89	35
142	DBW 183	25	12	59	35	89	46
143	DBW 184	23	12	47	24	78	36
144	DBW 185	35	11	56	24	89	46
145	DDK 1048	35	11	79	24	89	35
146	DDK 1049	24	11	57	23	89	35
147	KRL 350	23	01	45	23	89	35
148	KRL 351	23	12	56	24	79	46
149	MACS 5041	34	01	59	24	99	57
150	MACS 5043	34	11	56	24	89	46
151	WH 1309	22	01	47	24	89	46
VII. SPECIAL TRIAL (TRITICALE)							
152	TL 3001	34	11	79	24	89	36
153	TL 3002	34	12	79	34	89	46
154	TL 3003	24	12	79	34	89	46
155	TL 3004	23	11	79	24	89	46
156	TL 3005	23	12	78	24	89	46
VIII. SPECIAL TRIAL (MABB/ NIL (KB) ENTRIES)							
157	DWR-NIL-01	23	01	37	13	79	35
158	DWR-NIL-02	45	12	56	24	79	45
159	HD 3209	23	12	79	24	89	46
160	KB 2012-03	25	11	36	13	79	35

S.No.	Entry	Leaf Blight Score (0-9dd)					
		Ist (Flowering)		IInd (Dough)		IIIrd (Hard dough)	
160A	RAJ 4015 (Check)	35	24	89	56	99	68
IX. SPECIAL TRIALS (Wheat Biofortification)							
161	HPBW 01	25	12	69	24	99	46
162	HPBW 02	45	11	79	24	99	46
163	HPBW 05	27	12	79	24	99	46
164	HPBW 07	29	12	57	24	99	46
165	HPBW 08	27	01	38	12	57	24
166	HPBW 09	37	01	47	12	89	24
167	HUW 695	35	01	79	23	89	35
168	HUW 711	28	12	69	23	89	45
169	HUW 712	27	01	57	23	78	35
170	MACS 6507	28	12	47	23	78	35
171	WB1	45	11	57	23	89	35
172	WB2	27	01	57	23	89	35
173	WB5	35	01	46	23	79	35
Resistant : (Av. score range 14-35, highest score upto 57)							
Source: AVT IInd Year 2001-02							
174	KARAWANI/4NIF-/3/ SOFY/NAD63/CHRIS	27	01	38	12	57	23
Source: AVT IInd Year 2010-11							
175	VL 829	29	01	38	13	57	34
Source: AVT IInd Year 2011-12							
176	PBW 660	24	11	36	13	89	35

HS= Highest score, Av.= Average Score, dd=Double digit

The entry KARAWANI/4NIF-/3/SOTY//NAD63/CHRIS and VL 829 remained moderately resistance within average score below 35 and the HS of 57 whereas PBW 660 entry also showed moderate resistance to leaf blight with average score upto 35 but the highest score exceeded 57 due to high disease at one locations.

Among AVT I Year, the entries VL 1005 and HPBW 08 recorded average score up to 35 but the highest score reached more than 57. Whereas HS 596, HS 597, HS 601, VL 3009, VL 4001, DBW 147, HUW 688, MACS 4024, PBW 716, HD 3171, KRL 350 and HPBW 09 entry also showed moderate resistance to leaf blight with average score upto 35 but the highest score exceeded 57 due to high disease at one location.

Among AVT II year, lines HS 562, HS 542 (C), HD 3043 (C), PDW 314 (C), NIAW 2030 and MACS 6222 (C) recorded average score up to 35 but the highest score reached more than 57 due to high disease at one location.

COOPERATORS:

NAME	CENTRE
SATYAJIT HEMBRAM	COOCHBEHAR
P. V. PATIL	DHARWAD
S. P. SINGH, SAVITA GUPTA	FAIZABAD
V.S. KANDALKAR	GWALIOR
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ASHEESH KUMAR	IARI, PUSA
S.K. MUKHOPADHYAY AND S. DUTTA	KALYANI
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H.C. LAL	RANCHI
R. CHAKRABARTY	SHILLONGANI
S.S. VAISH	VARANASI
P. NALLATHAMBI AND C. UMA MAHESHWARI	WELLINGTON
R. SELVAKUMAR	KARNAL

3.2. Management of leaf blight using chemical sprays

For the evaluation of different chemicals during 2014-15, field trials were conducted at Faizabad, Varanasi, Ranchi, Pusa (Bihar), Karnal, Kanpur and Sabour for management of leaf blight of wheat.
All the treatments were done as mentioned in Tables 3.2 & 3.3. First spray of fungicide was given at the initiation of disease followed by 2nd and 3rd sprays at 20 and 10 days intervals, respectively, whenever required.

The seed treatment was also used alone and in combination with foliar sprays. The foliar sprays were given on initiation of disease and in few treatments repeated after 15 days interval.

On the basis of average disease score seed treatment with Vitavax Power and two sprays of Tilt @0.1% found superior in reducing disease severity. The maximum disease was recorded upto 99 in untreated control plot at Kanpur centre. However, at Sabour and Ranchi centers three sprays with Dithane M-45@0.25% and Tilt @0.1% - two sprays recorded lowest blight severity, respectively. In general, seed treatment with Vitavax Power and two sprays of Tilt @0.1% gave higher yield followed by seed treatment with Vitavax Power along with single spray of Tilt@0.1%.

COOPERATORS

NAME	**CENTRE**
S. P. SINGH, SAVITA GUPTA	FAIZABAD
ASHEESH KUMAR	IARI, PUSA
H.C. LAL	RANCHI
JAVED BAHAR KHAN	KANPUR
S. SARKHEL	SABOUR
S.S. VAISH	VARANASI
R. SELVAKUMAR , SUDHEER KUMAR	KARNAL

Table 3.2. Effect of fungicidal sprays on leaf blight incidence during 2014-15 crop season

S. No.	Treatment	Leaf blight score (0-9, dd)								
		Varanasi	Kanpur	Pusa (Bihar)	Sabour	Faizabad	Ranchi	Karnal	AV	HS
1	Untreated seed	89	99	78	67	89	57	68	78	99
2	Seed treatment with Captaf @ 3g/Kg seed	68	79	78	46	67	24	35	57	79
3	Seed treatment with Vitavax Power @2.5g/Kg seed	79	67	78	45	67	35	35	57	79
4	Seed treatment with Vitavax Power + Tilt spray@0.1%	13	24	24	35	47	24	24	24	47
5	Seed treatment with Vitavax Power +Tilt @0.1%-two sprays	12	12	14	23	35	24	24	23	35
6	Tilt spray@0.1% - one spray	13	57	35	35	57	23	24	35	57
7	Tilt @0.1% - two sprays	14	57	24	23	46	13	24	24	57
8	Folicur spray @0.1% - one spray	37	89	34	25	57	24	24	46	89
9	Folicur @0.1% -two sprays	47	68	23	13	46	23	35	35	68
10	Dithane M-45@ 0.25% -three sprays	13	89	46	12	67	46	35	45	89

Table 3.3. Effect of fungicidal sprays on grain yield of wheat during 2014-15 crop season.

S. No.	Treatment	Yield (q/ha)							
		Varanasi	Kanpur	Pusa (Bihar)	Sabour	Faizabad	Ranchi	Karnal	AV
1.	Untreated seed	43.7	21.2	43.2	-	24.0	28.3	32.2	32.1
2.	Seed treatment with Captaf @ 3g/Kg seed	42.9	23.6	44.1	-	26.2	30.2	34.6	33.6
3.	Seed treatment with Vitavax Power @2.5g/Kg seed	44.2	23.9	46.4	-	24.3	31.7	34.1	34.1
4.	Seed treatment with Vitavax Power + Tilt spray@0.1%	45.6	36.2	55.3	-	27.8	33.2	33.6	38.6
5.	Seed treatment with Vitavax Power + Tilt @0.1% - two sprays	45.1	46.1	58.4	-	30.5	35.3	33.6	41.5
6.	Tilt @0.1% - one spray	43.9	26.7	53.2	-	27.5	33.0	35.2	36.6
7.	Tilt @0.1% - two sprays	45.6	27.8	54.2	-	29.9	34.8	32.4	37.5
8.	Folicur @0.1% - one spray	44.2	22.5	51.1	-	26.9	32.3	34.5	35.3
9.	Folicur @0.1% - two sprays	38.6	25.8	53.2	-	29.6	34.2	31.8	35.5
10.	Dithane M-45@0.25% -three sprays	47.0	22.6	51.5	-	27.8	31.1	33.0	35.5

PROGRAMME 4. KARNAL BUNT

4.1 KARNAL BUNT SCREENING NURSERY (KBSN) 2014-2015

Wheat entries alongwith checks were evaluated for resistance to Karnal bunt under Karnal Bunt Screening Nursery (KBSN) at multilocations (Hisar, Ludhiana, Dhaula Kuan, Karnal, Pantnagar, Delhi & Jammu) during 2014-15 crop season under artificially inoculated conditions. Nursery was inoculated at boot stage of the crop with *Tilletia indica* (location -specific isolates). The per cent incidence was calculated by taking into account the number of infected grains of the inoculated spikes. Various aspects of KBSN are discussed below:

OBJECTIVE

- Characterization of resistance to Karnal bunt in wheat entries proposed to be identified as cultivars for Karnal Bunt prone areas
- To identify KB resistant genetic stocks through repetitive tests

SIZE AND COMPOSITION:

KBSN 2014-2015 was constituted as follows:

Component	No. of entries
AVT II Year, 2014-15	73
AVT II Year, 2013-14	4
AVT II Year, 2012-13	2
Total	**79**

Test Locations: Hisar, Dhaulakuan, Ludhiana, Delhi, Karnal, Jammu and Pantnagar

Each entry was sown in one meter row. Recommended cultural practices were followed to grow the crop till harvest. To determine the response of genotypes to Karnal bunt, earheads were injected with hypodermic syringe with adequate amount of inoculum (10,000 allantoids/ml water) at crop growth stage 49. The local isolates were used at all the test centres. Five earheads were inoculated in each entry during evening hours. After inoculation, high humidity was maintained for proper development of disease. The disease incidence in the earheads was recorded at crop maturity and was calculated by reckoning the infected and the total number of grains (both diseased and healthy) of 5 earheads per entry. Entries showing response of upto 5 per cent coefficient of infection (average) were rated as resistant. KB incidence of AVT 2nd year entries of all centres is given in Table 4.1 and average KB incidence of all centres is given in Table 1.5. The resistant entries identified are listed below:

AVT IInd Year 2013-14
Resistant (Av. Incidence upto 5%): NIDW 295
AVT IInd Year 2014-15
HS 490, PDW 233, PDW 291, PDW 314, HD 4728, HI 8737, MPO 1215, AKDW 2997-16, UAS 446 and TL 2942
AVT 1st Year, 2013-14
Test Locations: Hisar, Dhaulakuan, Ludhiana, Delhi, Karnal, Pantnagar and Jammu.

AVT 1st year entries (100) were sown in one meter row at seven locations. Location specific *Tilletia indica* inoculum was used for inoculating each entry at Zadoks' stage 49. KB incidence of AVT 1st year entries of all centres and average KB incidence is given in Table 4.2. Among AVT 1st year entries, following entries showed < 5 % KB incidence.

AVT Ist Year 2014-15
Resistant (Av. Incidence upto 5%): VL 1007, VL 3009, DDW 31, MACS 4024, MACS 3949, GW 1315, HI 8765, MACS 3970, MACS 4020, UAS 361, UAS 453, UAS 455, DBW 181, TL 3002 AND KB 2012-03

NIVT entries were evaluated for KB resistance at Dhaulakuan and Ludhiana (Table 4.3).

COOPERATORS:

NAME	**CENTRE**
RITU BALA	LUDHIANA
ROBIN GOGOI AND RASHMI AGGARWAL	DELHI
S. S. KARWASARA, R. S. BENIWAL	HISAR
DHANBIR SINGH	DHAULAKUAN
J KUMAR, DEEP SHIKHA	PANTNAGAR
M K PANDEY	JAMMU
M. S. SAHARAN AND INDU SHARMA	KARNAL

Table 4.1: Karnal bunt incidence in KBSN entries evaluated under artificially inoculated conditions at multilocations during 2014-15

		% Karnal bunt incidence								
Sr. No.	Variety	Delhi	Dhaulakuan	Ludhiana	Karnal	Pantnagar	Hisar	Jammu	HS	Av.
AVT IInd Year 2014-15										
I. NORTHERN HILL ZONE										
1	HS 562	42.5	0.0	0.0	26.2	1.3	0.8	7.7	42.5	11.2
2	HPW 251 (C)	34.4	2.9	4.0	35.9	0.8	0.5	2.3	35.9	11.5
3	HPW 349 (C)	91.5	10.4	25.3	39.8	3.0	3.5	26.0	91.5	28.5
4	HS 375 (C)	34.8	4.3	3.0	29.1	3.2	2.1	2.5	34.8	11.3
5	HS 490 (C)	5.4	0.1	0.0	17.8	2.5	0.6	0.0	17.8	3.8
6	HS 507 (C)	60.9	3.3	2.3	33.0	0.6	2.5	12.5	60.9	16.4
7	HS 542 (C)	60.7	5.0	42.2	55.6	2.1	0.0	18.2	60.7	26.3
8	VL 804 (C)	84.5	7.7	8.8	41.5	3.5	3.7	19.2	84.5	24.1
9	VL 829 (C)	0.0	0.1	29.2	31.8	2.2	2.3	10.6	31.8	10.9
10	VL 892 (C)	92.6	22.6	38.3	35.9	3.4	3.1	19.0	92.6	30.7
11	VL 907 (C)	70.0	3.9	4.1	4.7	0.5	0.6	10.0	70.0	13.4
II. NORTH WESTERN PLAIN ZONE										
12	HD 4730	6.8	0.0	25.6	36.7	0.8	0.0	0.0	36.7	10.0
13	MP 1277	50.0	3.4	41.6	63.8	1.2	0.0	7.4	63.8	23.9
14	WH 1164	18.0	9.7	6.4	38.2	6.5	0.1	21.0	38.2	14.3
15	DBW 88 (C)	41.2	9.2	8.5	43.2	1.6	2.9	17.2	43.2	17.7
16	DBW 90 (C)	48.7	12.8	0.7	-	2.5	5.0	15.7	48.7	14.2
17	DPW 621-50 (C)	89.8	21.6	27.7	40.0	3.4	0.1	21.2	89.8	29.1
18	HD 2967 (C)	47.4	20.5	36.3	46.8	3.8	0.0	30.8	47.4	26.5
19	HD 3043 (C)	22.5	13.5	6.3	32.7	4.2	22.0	25.2	32.7	18.1

Sr. No.	Variety	% Karnal bunt incidence								
		Delhi	Dhaulakuan	Ludhiana	Karnal	Pantnagar	Hisar	Jammu	HS	Av.
20	HD 3059 (C)	51.0	7.8	11.9	48.1	2.1	2.2	18.4	51.0	20.2
20. A	INFECTOR	35.1	30.0	41.5	41.0	4.6	0.1	32.5	41.5	26.4
21	HD 3086 (C)	51.8	6.8	17.3	27.6	5.2	4.9	21.3	51.8	19.3
22	PBW 644 (C)	23.1	13.8	0.0	43.7	0.6	0.1	18.2	43.7	14.2
23	PDW 233 (C)	11.8	0.0	0.0	15.3	0.2	1.0	0.0	15.3	4.0
24	PDW 291 (C)	10.0	0.0	2.2	6.5	0.1	0.1	1.2	10.0	2.9
25	PDW 314 (C)	15.8	0.0	2.1	8.6	0.5	0.5	2.5	15.8	4.3
26	WH 1021 (C)	21.6	4.1	39.3	6.5	1.9	2.6	2.6	39.3	11.2
27	WH 1080 (C)	19.0	5.6	3.1	56.7	3.0	0.0	11.1	56.7	14.1
28	WH 1105 (C)	52.7	8.3	54.0	58.8	3.1	0.1	21.6	58.8	28.4
29	WH 1124 (C)	84.5	28.5	10.0	26.9	4.1	6.2	11.1	84.5	24.5
30	WH 1142 (I) C)	32.6	7.4	8.3	30.1	5.1	7.4	25.2	32.6	16.6
III. NORTH EASTERN PLAIN ZONE										
31	C 306 (C)	100.0	18.3	41.0	91.1	2.9	2.1	30.2	100.0	40.8
32	HD 2888 (C)	40.3	48.5	4.1	71.2	6.1	0.0	11.1	71.2	25.9
33	K 8027 (C)	31.6	16.5	27.3	54.3	4.6	0.0	15.6	54.3	21.4
IV. CENTRAL ZONE										
34	HD 4728 (d)	8.1	0.0	0.0	5.0	4.6	0.0	4.2	8.1	3.1
35	HD 4730 (d)	9.3	1.2	0.0	6.1	2.1	0.0	11.2	11.2	4.3
36	GW 322 (C)	21.4	28.5	0.0	42.4	3.1	0.0	25.5	42.4	17.3
37	HD 2864 (C)	22.7	50.0	32.9	4.1	1.6	0.1	5.5	50.0	16.7
38	HD 2932 (C)	24.7	5.2	3.5	23.0	3.1	1.3	6.6	24.7	9.6
39	HI 1544 (C)	94.8	14.3	39.4	43.0	5.2	9.6	29.6	94.8	33.7
40	HI 8498 (D) (C)	47.9	2.1	2.2	0.0	1.6	0.0	8.8	47.9	9.0
40. A	INFECTOR	79.8	51.1	43.3	64.6	3.9	4.9	30.6	79.8	39.8
41	HI 8737 (D)(I) (C)	-	2.2	0.8	-	1.9	0.0	0.5	2.2	1.1
42	MP 3336 (C)	12.0	8.2	15.7	61.5	4.1	2.2	0.0	61.5	14.8
43	MP 4010 (C)	38.2	16.3	0.0	21.7	5.6	2.0	16.2	38.2	14.3
44	MPO 1215 (d) (C)	19.4	0.0	2.5	4.2	3.8	0.0	18.2	19.4	6.9
V. PENINSULAR ZONE										
45	MACS 3927 (d)	64.1	2.5	4.5	18.0	2.8	0.0	6.1	64.1	14.0
46	NIAW 2030	5.4	55.8	4.5	80.0	5.9	0.0	8.2	80.0	22.8
47	AKDW 2997-16(d) (C)	5.6	0.0	3.2	0.0	0.8	0.2	0.0	5.6	1.4
48	DBW 93 (I) (C)	29.3	10.9	0.0	10.0	1.0	0.1	9.3	29.3	8.6
49	MACS 6222 (C)	42.4	9.0	12.3	28.6	2.1	2.4	18.2	42.4	16.4
50	MACS 6478 (C)	45.4	21.4	3.0	22.7	3.1	2.3	11.3	45.4	15.6
51	NI 5439 (C)	36.2	91.5	26.6	96.0	5.2	0.0	16.3	96.0	38.8
52	NIAW 1415 (C)	78.3	6.4	8.0	19.2	3.1	5.4	11.1	78.3	18.8
53	UAS 347 (I) (C)	20.0	3.7	2.1	35.6	3.6	3.2	15.2	35.6	11.9
54	UAS 428 (d) (C)	30.3	0.0	0.0	17.5	4.6	6.1	10.0	30.3	9.8
55	UAS 446 (d) (I) (C)	7.9	0.9	4.7	9.4	3.1	3.5	0.0	9.4	4.2
VII. SPECIAL TRIAL										
56	(HD 2932 + Lr 19/Sr25)	17.9	14.0	4.6	24.4	0.0	0.0	15.2	24.4	10.9
57	MMBL 283	94.0	9.7	3.6	25.6	5.9	0.0	11.3	94.0	21.4
58	PBW 723	7.6	11.1	0.0	16.3	6.8	2.2	11.1	16.3	7.9
59	DBW 14 (C)	9.5	4.2	3.8	21.2	1.9	4.2	6.8	21.2	7.4
60	DDK 1029 (C)	33.3	0.0	28.7	50.0	0.0	3.4	8.1	50.0	17.6

Sr. No.	Variety	% Karnal bunt incidence Delhi	Dhaulakuan	Ludhiana	Karnal	Pantnagar	Hisar	Jammu	HS	Av.
60. A	INFECTOR	49.2	33.2	52.7	42.6	4.1	9.9	32.6	52.7	32.0
61	HD 2985 (C)	37.0	16.3	0.0	61.4	6.1	6.3	25.0	61.4	21.7
62	HI 1563 (C)	67.3	6.3	10.0	52.8	3.6	4.3	16.4	67.3	22.9
63	HUW 234 (C)	50.0	14.9	0.0	7.1	0.0	1.3	6.1	50.0	11.4
64	HW 1098 (C)	43.5	0.0	3.4	25.0	0.4	3.4	2.5	43.5	11.2
65	K 0307 (C)	37.9	2.0	39.5	12.8	1.0	0.2	2.5	39.5	13.7
66	Kharchia 65 (C)	9.8	86.6	17.5	82.3	4.8	3.2	21.1	86.6	32.2
67	KRL 19 (C)	45.5	8.3	5.8	39.4	1.5	0.0	6.2	45.5	15.2
68	KRL 210 (C)	40.6	13.8	3.8	13.0	0.8	0.6	2.1	40.6	10.7
69	PBW 343 (C)	7.6	14.8	18.7	29.3	4.1	5.2	18.2	29.3	14.0
70	Raj 4083 (C)	58.3	13.0	5.0	43.3	0.8	0.0	11.2	58.3	18.8
71	TL 2942 (C)	21.7	0.0	0.0	0.0	0.1	0.0	0.0	21.7	3.1
72	TL 2969 (C)	15.5	0.0	12.3	9.8	0.1	0.1	2.9	15.5	5.8
73	WH 542 (C)	5.1	17.8	1.9	-	0.0	3.6	18.2	18.2	7.8
AVT IInd Year 2013-14										
74	HPW 376	6.1	0.0	11.5	18.8	0.1	0.1	10.1	18.8	6.7
75	NW 2036	33.7	15.5	4.0	41.8	3.8	0.0	4.7	41.8	14.8
76	DBW 110	38.3	1.1	0.0	4.7	0.4	0.0	17.2	38.3	8.8
77	NIDW 295	0.0	0.0	1.1	0.0	1.0	0.0	1.2	1.2	0.5
AVT IInd Year 2012-13										
78	HD 3091	15.6	3.8	31.6	25.0	2.6	0.0	2.1	31.6	11.5
79	UAS 334	96.0	23.0	10.4	46.3	2.4	0.0	4.5	96.0	26.1
79. A	INFECTOR	56.7	18.6	34.8	28.1	4.4	-	30.6	56.7	28.9

Table 4.2: Karnal bunt incidence in AVT Ist year entries evaluated under artificially inoculated condotions at multilocations during 2014-15

Sr. No.	Variety	% Karnal bunt incidence Delhi	Dhaulakuan	Ludhiana	Karnal	Pantnagar	Hisar	Jammu	HS	Av.
AVT Ist year - 2014-15										
I. NORTHERN HILL ZONE										
1	HPW 393	35.5	28.5	19.0	37.0	2.1	1.8	9.3	37.0	19.0
2	HPW 394	11.1	14.5	27.9	-	4.2	0.1	14.2	27.9	12.0
3	HPW 413	12.7	9.0	4.0	14.6	5.0	1.1	12.6	14.6	8.4
4	HPW 421	11.2	3.8	1.9	3.8	5.8	0.0	18.2	18.2	6.4
5	HPW 422	25.8	17.4	53.1	7.8	4.7	0.0	13.9	53.1	17.5
6	HS 580	15.0	10.0	35.5	12.7	1.1	0.0	4.2	35.5	11.2
7	HS 583	18.2	3.9	22.3	18.8	3.6	0.0	9.2	22.3	10.9
8	HS 590	10.8	8.6	2.8	18.9	0.6	0.0	6.2	18.9	6.8
9	HS 596	16.3	1.4	18.3	0.0	1.9	0.0	4.1	18.3	6.0
10	HS 597	100.0	18.1	38.1	52.5	4.9	0.1	12.3	100.0	32.3
11	HS 598	17.6	1.3	2.7	7.7	2.5	0.0	8.1	17.6	5.7
12	HS 599	28.6	8.5	0.0	5.9	0.8	0.0	4.2	28.6	6.9
13	HS 600	11.6	3.9	26.2	15.6	3.8	0.0	7.1	26.2	9.7
14	HS 601	46.2	27.8	18.7	45.2	2.8	2.0	8.3	46.2	21.6

Sr. No.	Variety	% Karnal bunt incidence Delhi	Dhaulakuan	Ludhiana	Karnal	Pantnagar	Hisar	Jammu	HS	Av.
15	UP 2917	14.8	2.4	39.2	39.2	5.2	0.1	18.7	39.2	17.1
16	UP 2918	29.4	14.6	0.0	4.0	4.3	0.0	16.1	29.4	9.8
17	VL 1005	30.6	1.3	4.4	0.0	0.9	1.1	3.6	30.6	6.0
18	VL 1006	12.9	10.5	40.4	34.0	1.1	0.0	4.9	40.4	14.8
19	VL 1007	6.3	0.2	0.0	0.0	0.1	0.0	0.0	6.3	0.9
20	VL 3002	47.2	0.4	0.0	0.0	2.6	1.0	7.5	47.2	8.4
20. A	INFECTOR	61.8	6.8	48.2	84.9	5.1	-	29.6	84.9	39.4
21	VL 3007	7.4	0.0	15.3	19.1	2.6	3.1	6.2	19.1	7.7
22	VL 3008	15.7	13.1	21.2	44.8	2.6	0.1	9.1	44.8	15.2
23	VL 3009	8.2	7.2	2.6	8.3	0.2	0.0	0.0	8.3	3.8
24	VL 4001	13.8	10.3	36.7	41.3	3.2	0.1	6.8	41.3	16.0
II. NORTH WESTERN PLAIN ZONE										
25	DBW 147	41.8	20.5	17.0	54.9	3.9	0.0	14.6	54.9	21.8
26	DBW 148	20.9	12.2	23.8	43.5	5.3	0.0	24.3	43.5	18.6
27	DBW 150	18.3	12.2	4.3	16.6	4.9	0.0	12.4	18.3	9.8
28	DDW 31	18.4	0.0	1.2	0.9	0.0	2.2	2.1	18.4	3.6
29	DDW 32	15.6	20.2	3.8	28.5	1.5	0.0	8.2	28.5	11.1
30	HD 3159	22.0	34.0	19.6	39.6	4.8	2.0	14.2	39.6	19.5
31	HD 3165	50.2	11.2	1.9	44.6	3.6	2.0	12.2	50.2	18.0
32	HD 3174	53.2	31.2	4.7	25.4	4.4	0.0	18.6	53.2	19.6
33	HI 1604	54.8	12.1	24.3	77.5	2.2	0.0	4.2	77.5	25.0
34	HI 1605	21.2	11.6	4.9	25.7	0.2	0.0	5.6	25.7	9.9
35	HUW 688	25.0	13.8	1.1	35.7	1.1	0.0	4.5	35.7	11.6
36	K 1312	24.8	7.9	4.4	33.3	4.1	0.0	12.2	33.3	12.4
37	K 1313	31.5	19.6	33.5	41.7	6.0	1.2	20.5	41.7	22.0
38	K 1314	16.2	7.6	26.0	27.5	3.0	0.0	8.5	27.5	12.7
39	MACS 3949	0.0	0.0	0.0	0.0	2.4	0.0	6.6	6.6	1.3
40	MACS 4024	6.1	0.0	0.0	1.1	1.1	0.0	4.2	6.1	1.8
40. A	INFECTOR	30.8	11.4	37.0	77.9	4.0	-	31.6	77.9	32.1
41	NW 6024	-	-	-	-	-	-	-	-	-
42	PBW 707	7.5	5.0	32.0	16.9	4.0	0.0	17.8	32.0	11.9
43	PBW 709	26.1	27.2	0.0	25.0	3.5	1.0	15.6	27.2	14.0
44	PBW 716	45.0	11.6	18.0	25.6	6.0	0.0	20.2	45.0	18.1
45	PBW 718	37.1	37.3	14.0	67.6	5.4	0.0	27.6	67.6	27.0
46	PBW 719	27.9	29.7	10.0	42.5	5.1	0.0	21.6	42.5	19.5
47	UP 2883	20.6	12.9	22.3	32.8	3.0	0.0	18.2	32.8	15.7
48	WH 1179	9.3	11.9	0.0	22.3	2.4	0.1	9.2	22.3	7.9
III. NORTH EASTERN PLAIN ZONE										
49	HD 3171	33.0	10.9	12.5	45.7	3.2	0.1	12.5	45.7	16.8
50	K 1317	32.1	14.0	12.5	42.4	1.2	0.0	4.2	42.4	15.2
IV. CENTRAL ZONE										
51	CG 1015	43.5	6.9	27.8	-	0.9	0.0	4.6	43.5	13.9
52	GW 463	84.5	7.7	15.6	0.0	4.8	0.0	10.5	84.5	17.6
53	HI 8759 (d)	16.7	0.0	4.7	15.2	3.4	1.0	8.8	16.7	7.1
V. PENINSULAR ZONE										
54	GW 1315 (d)	11.1	0.0	0.0	11.4	0.0	0.0	0.0	11.4	3.2
55	HD 3164	20.5	20.4	48.1	18.8	6.4	0.1	16.2	48.1	18.6
56	HI 8765 (d)	13.2	1.6	0.0	0.0	0.6	0.0	8.4	13.2	3.4

Sr. No.	Variety	% Karnal bunt incidence								
		Delhi	Dhaulakuan	Ludhiana	Karnal	Pantnagar	Hisar	Jammu	HS	Av.
57	JWS 712	30.3	0.0	16.1	16.7	6.9	0.0	21.4	30.3	13.1
58	K 1315	11.3	0.5	1.8	18.9	2.4	0.1	4.7	18.9	5.7
59	MACS 3970 (d)	8.2	1.6	0.0	-	0.0	0.0	2.2	8.2	2.0
60	MACS 3972 (d)	37.0	1.2	4.0	15.5	2.1	0.3	6.1	37.0	9.5
60. A	INFECTOR	37.4	17.3	39.1	82.5	6.8		26.8	82.5	35.0
61	MACS 4020 (d)	27.9	1.2	0.0	0.0	0.0	0.4	2.1	27.9	4.5
62	PBW 721	52.4	1.3	39.1	16.5	4.1	0.0	17.9	52.4	18.7
63	UAS 360	-	10.3	21.5	40.7	1.8	0.0	5.5	40.7	13.3
64	UAS 361	10.5	2.3	17.9	3.2	0.0	0.0	0.0	17.9	4.8
65	UAS 453 (d)	0.0	0.0	0.0	0.0	0.0	0.2	2.0	2.0	0.3
66	UAS 455 (d)	0.0	0.6	1.3	4.3	3.9	0.2	6.8	6.8	2.4
VI. SPECIAL TRIAL (Dicoccum and Sailinity and Alkalinity)										
67	DBW 181	0.0	1.9	0.0	2.9	6.4	0.0	15.2	15.2	3.8
68	DBW 182	70.1	1.6	24.4	54.3	2.6	0.0	8.1	70.1	23.0
69	DBW 183	18.9	10.6	4.7	39.5	1.8	0.0	6.2	39.5	11.7
70	DBW 184	20.3	4.6	1.4	5.8	4.0	1.6	12.2	20.3	7.1
71	DBW 185	46.9	4.6	13.1	54.9	4.3	0.0	12.5	54.9	19.5
72	DDK 1048	22.2	0.0	0.0	64.7	2.1	0.2	6.4	64.7	13.7
73	DDK 1049	6.3	0.0	41.3	72.5	2.6	0.0	10.5	72.5	19.0
74	KRL 350	34.8	0.0	28.6	0.0	3.5	0.6	9.6	34.8	11.0
75	KRL 351	12.2	5.1	17.4	16.3	3.9	0.0	12.1	17.4	9.6
76	MACS 5041	9.4	0.0	3.3	87.9	2.3	0.0	8.4	87.9	15.9
77	MACS 5043	41.2	0.0	2.4	60.2	1.6	0.0	8.4	60.2	16.2
78	WH 1309	63.2	24.4	22.2	23.8	3.0	0.0	19.2	63.2	22.2
VII. SPECIAL TRIAL (TRITICALE)										
79	TL 3001	20.0	17.9	14.0	9.9	1.9	0.0	5.7	20.0	9.9
80	TL 3002	27.6	0.0	1.8	0.0	0.0	0.0	0.0	27.6	4.2
80. A	INFECTOR	49.6	20.0	42.3	43.9	4.3	-	32.6	49.6	32.1
81	TL 3003	33.3	0.0	0.0	7.2	0.0	0.0	2.9	33.3	6.2
82	TL 3004	34.8	4.0	4.4	43.1	2.0	0.0	8.1	43.1	13.8
83	TL 3005	20.5	1.5	5.7	15.8	0.0	0.0	0.5	20.5	6.3
VIII. SPECIAL TRIAL (MABB/NIL (KB) ENTRIES)										
84	DWR-NIL-01	19.1	1.4	0.0	17.4	1.5	0.0	4.5	19.1	6.3
85	DWR-NIL-02	50.0	2.9	14.5	43.9	2.0	0.0	7.2	50.0	17.2
86	HD 3209	22.5	43.7	10.6	20.9	0.0	0.0	2.6	43.7	14.3
87	KB 2012-03	12.0	7.3	1.6	-	0.0	0.5	0.0	12.0	3.6
IX. SPECIAL TRIAL (Wheat Biofortification)										
88	HPBW 01	57.1	36.3	23.2	45.0	3.4	0.0	10.2	57.1	25.0
89	HPBW 02	21.1	24.9	28.1	46.5	2.9	0.0	2.6	46.5	18.0
90	HPBW 05	52.3	47.7	27.4	27.9	0.0	0.0	0.0	52.3	22.2
91	HPBW 07	31.4	25.2	19.6	27.3	2.1	0.4	7.2	31.4	16.2
92	HPBW 08	17.0	6.2	23.0	27.6	2.2	0.0	7.1	27.6	11.9
93	HPBW 09	46.6	2.3	10.4	17.3	0.0	0.0	0.4	46.6	11.0
94	HUW 695	17.9	26.1	18.5	43.6	3.5	0.2	10.1	43.6	17.1
95	HUW 711	44.6	15.0	19.5	64.4	0.6	0.0	4.2	64.4	21.2
96	HUW 712	7.8	22.9	23.6	56.8	3.5	0.1	12.4	56.8	18.2
97	MACS 6507	18.4	12.3	2.0	27.3	2.5	0.2	8.8	27.3	10.2
98	WB 1	16.7	5.6	12.8	39.0	3.8	0.0	16.2	39.0	13.4

Sr. No.	Variety	% Karnal bunt incidence Delhi	Dhaulakuan	Ludhiana	Karnal	Pantnagar	Hisar	Jammu	HS	Av.
99	WB 2	14.5	17.4	50.0	73.4	6.9	0.0	21.4	73.4	26.2
100	WB 5	16.2	4.3	2.7	37.9	3.0	0.0	8.4	37.9	10.3
100. A	INFECTOR	47.2	11.9	50.3	70.1	4.0	-	29.6	70.1	35.5

Table 4.3: Evaluation of NIVT entries against KB (% incidence) under artificially inoculated conditions

Sr. No.		Ludhiana	Dhaulakuan	HS
NIVT 1A				
1	WH 1182	17.2	2.5	17.2
2	HD 2733 (C)	3.6	0.0	3.6
3	DBW 158	22.8	10.3	22.8
4	BRW 3762	14.8	2.0	14.8
5	HUW 701	11.2	7.6	11.2
6	PBW 724	16.6	15.3	16.6
7	HD 3186	15.9	7.5	15.9
8	HD 3180	33.3	6.2	33.3
9	UP 2901	35.0	14.8	35.0
10	JAUW 635	27.5	7.9	27.5
11	WH 1186	0.0	3.9	3.9
12	DBW 159	66.3	19.8	66.3
13	DBW 156	31.8	14.4	31.8
14	HS 602	11.2	17.4	17.4
15	K 1401	5.0	13.7	13.7
16	PBW 725	4.3	21.8	21.8
17	WH 1184	27.9	4.8	27.9
18	Raj 4418	1.3	4.0	4.0
19	K 1402	25.0	13.7	25.0
20	HD 3182	0.7	0.0	0.7
20. A	INFECTOR	41.8	17.4	41.8
21	JKW 205	21.0	7.2	21.0
22	PBW 727	19.3	62.3	62.3
23	NW 6047	2.3	12.5	12.5
24	PBW 726	28.3	22.6	28.3
25	WH 1183	18.3	4.4	18.3
26	UP 2904	15.2	0.0	15.2
27	DBW 160	32.4	4.7	32.4
28	DBW 162	14.8	6.7	14.8
29	BRW 3763	7.5	2.8	7.5
30	UP 2903	31.1	12.5	31.1
31	Mahyco-Goal	7.6	24.4	24.4
32	DBW 161	12.4	5.0	12.4
33	HD 3181	29.3	32.0	32.0
34	DBW 157	25.0	9.0	25.0
35	HD 3184	32.1	5.9	32.1
36	NW 6050	40.3	8.0	40.3
37	HD 3183	22.7	15.5	22.7
38	PBW 728	2.1	2.9	2.9
39	Raj 4421	18.8	7.0	18.8

Sr. No.		Ludhiana	Dhaulakuan	HS
40	Raj 4419	3.8	22.6	22.6
40. A	INFECTOR	57.6	16.6	57.6
41	HUW 702	21.2	9.8	21.2
42	UP 2905	40.0	3.1	40.0
43	UP 2902	18.6	2.7	18.6
44	HD 3185	19.3	8.6	19.3
45	WH 1185	27.3	3.1	27.3
46	Raj 4417	4.4	19.0	19.0
NIVT 1B				
47	Raj 4422	31.0	6.6	31.0
48	K 1404	5.8	0.5	5.8
49	NW 6056	28.5	0.0	28.5
50	NW 6048	27.2	0.0	27.2
51	K 1406	33.3	34.5	34.5
52	DBW 166	35.0	0.0	35.0
53	HUW 705	23.7	11.4	23.7
54	PBW 729	8.5	3.2	8.5
55	Raj 4423	23.9	15.0	23.9
56	DBW 165	24.5	37.6	37.6
57	HD 3188	8.0	3.5	8.0
58	BRW 3759	24.1	4.2	24.1
59	WH 1187	16.5	21.7	21.7
60	K 1405	13.6	7.0	13.6
60. A	INFECTOR	33.2	41.6	41.6
61	HUW 706	0.0	2.6	2.6
62	NW 6052	6.0	6.4	6.4
63	WH 1189	8.0	44.7	44.7
64	K 1408	0.0	1.8	1.8
65	HD 3191	43.3	9.1	43.3
66	HD 3193	3.5	0.0	3.5
67	HD 3192	0.0	4.8	4.8
68	Raj 4415	16.2	4.7	16.2
69	HUW 703	30.8	38.3	38.3
70	JKW 208	27.6	4.7	27.6
71	HD 3194	20.6	0.0	20.6
72	WH 1188	55.6	1.6	55.6
73	HD 3187	8.0	7.9	8.0
74	K 1407	42.5	5.3	42.5
75	HUW 704	39.0	11.2	39.0
76	BRW 3767	30.1	25.3	30.1
77	BRW 3765	30.8	2.8	30.8
78	HUW 707	0.0	4.1	4.1
79	PBW 730	29.1	11.6	29.1
80	JKW 207	19.2	14.2	19.2
80. A	INFECTOR	28.6	14.6	28.6
81	HD 3190	20.8	0.0	20.8
82	DBW 164	8.7	13.7	13.7
83	UP 2907	43.0	9.5	43.0
84	PBW 731	30.9	14.8	30.9
85	HD 3189	2.7	20.8	20.8
86	UP 2906	19.4	18.8	19.4
87	DBW 167	16.1	26.6	26.6
88	UP 2908	0.0	3.9	3.9

Sr. No.		Ludhiana	Dhaulakuan	HS
89	NW 6054	0.0	15.4	15.4
90	NW 6049	0.0	1.1	1.1
91	DBW 163	6.4	64.5	64.5
NIVT 2				
92	DBW 170	21.3	20.2	21.3
93	DBW 169	9.4	10.0	10.0
94	UAS 372	7.3	20.1	20.1
95	HI 1610	5.3	7.5	7.5
96	UP 2909	15.3	5.2	15.3
97	HI 1608	48.0	5.4	48.0
98	GW 468	10.7	0.0	10.7
99	JWS 147	13.9	13.7	13.9
100	MACS 6671	29.2	23.3	29.2
100. A	INFECTOR	71.1	30.0	71.1
101	DBW 168	3.1	18.1	18.1
102	MP 1309	33.6	25.3	33.6
103	HI 1607	6.8	2.8	6.8
104	Raj 4424	42.2	22.1	42.2
105	UAS 370	23.6	0.7	23.6
106	WH 1190	0.6	4.7	4.7
107	HI 1609	20.0	10.4	20.0
108	HP 1960	10.8	7.0	10.8
109	MP 1310	5.4	3.2	5.4
110	RVW 4232	4.8	6.4	6.4
111	UAS 369	6.0	1.6	6.0
112	MP 3440	19.4	0.0	19.4
113	NIAW 2595	17.1	5.0	17.1
114	NIAW 2495	13.2	2.7	13.2
115	GW 473	16.0	7.0	16.0
116	AKAW 4798	2.0	3.1	3.1
117	UAS 371	3.5	5.5	5.5
118	MACS 6668	49.3	3.9	49.3
119	GW 471	0.0	0.5	0.5
120	MP 1311	6.7	1.5	6.7
120. A	INFECTOR	43.4	25.0	43.4
121	NIAW 2539	4.3	9.0	9.0
122	PBW 732	22.4	22.5	22.5
123	GW 469	28.0	0.0	28.0
124	GW 470	40.2	4.5	40.2
125	CG 1016	22.5	12.6	22.5
NIVT - 3A				
126	HD 3199	5.4	2.0	5.4
127	WH 1191	7.1	5.0	7.1
128	NW 6066	7.5	7.8	7.8
129	HUW 710	2.1	1.8	2.1
130	NW 6044	22.8	36.7	36.7
131	MP 1316	3.8	9.7	9.7
132	HP 1961	1.8	1.5	1.8
133	HD 3197	13.3	1.3	13.3
134	HUW 709	4.6	2.9	4.6
135	RAJ 4429	5.2	15.5	15.5
136	HD 3198	2.8	2.1	2.8
137	DBW 172	19.8	20.5	20.5

Sr. No.		Ludhiana	Dhaulakuan	HS
138	DBW 171	1.1	15.1	15.1
139	UP 2913	15.2	5.5	15.2
140	K 1412	30.3	17.1	30.3
140. A	INFECTOR	53.1	4.6	53.1
141	WH 1192	24.4	6.6	24.4
142	UP 2910	13.0	12.8	13.0
143	PBW 735	5.2	0.0	5.2
144	HUW 708	19.6	0.0	19.6
145	HD 3200	16.5	29.8	29.8
146	WH 1193	2.1	15.7	15.7
147	K 1413	11.1	2.1	11.1
148	PBW 736	1.1	2.7	2.7
149	DBW 173	17.9	6.8	17.9
150	DBW 174	5.7	4.6	5.7
151	UP 2911	10.5	9.0	10.5
152	PBW 734	7.7	13.5	13.5
153	K 1414	8.3	15.6	15.6
154	PBW 733	29.0	37.8	37.8
155	JKW 206	20.9	14.6	20.9
156	HD 3201	20.0	12.8	20.0
157	RAJ 4428	1.9	2.3	2.3
NIVT 3B				
158	CG 1019	5.0	11.2	11.2
159	MP 3436	7.6	0.0	7.6
160	MP 3433	4.6	0.0	4.6
160. A	INFECTOR	32.0	81.4	81.4
161	GW 477	13.0	6.5	13.0
162	MACS 6669	20.0	13.7	20.0
163	UAS 371	2.8	10.0	10.0
164	UAS 373	10.7	5.6	10.7
165	HI 1611	37.4	13.9	37.4
166	MACS 6635	31.3	46.2	46.2
167	GW 475	2.1	0.0	2.1
168	AKAW 4842	42.9	4.8	42.9
169	RVW 4235	31.3	7.1	31.3
170	DBW 175	0.8	3.7	3.7
171	MP 1313	2.6	24.3	24.3
172	MP 1312	30.0	9.1	30.0
173	WH 1195	2.0	20.1	20.1
174	NIAW 34 (C)	17.3	0.0	17.3
175	DBW 176	5.7	16.0	16.0
176	NIAW 2613	22.2	34.3	34.3
177	RAJ 4427	53.5	17.4	53.5
178	PBW 743	26.0	17.3	26.0
179	WH 1194	17.4	10.3	17.4
180	PBW 739	33.2	11.7	33.2
180. A	INFECTOR	31.0	41.0	41.0
181	HI 8767	8.0	0.0	8.0
182	HW 3906	22.5	6.8	22.5
183	NIAW 2565	22.4	8.2	22.4
184	CG 1017	2.1	6.6	6.6
185	GW 478	3.6	16.2	16.2

Sr. No.		Ludhiana	Dhaulakuan	HS
186	GW 474	5.3	4.4	5.3
187	UP 2912	7.6	3.3	7.6
188	DBW 177	0.0	11.3	11.3
189	HD 3206	48.0	10.2	48.0
190	RAJ 4426	37.5	2.2	37.5
NIVT - 4				
191	MACS 4035	2.0	4.5	4.5
192	UAS 456	0.0	0.0	0.0
193	UAS 457	1.3	0.0	1.3
194	MPO 1314	1.1	1.0	1.1
195	GW 1318	3.4	0.0	3.4
196	RKD 291	2.0	0.0	2.0
197	DDW 36	0.7	0.0	0.7
198	PDW 343	0.0	0.0	0.0
199	MACS 3973	0.0	0.0	0.0
200	WHD 957	0.0	0.0	0.0
200. A	INFECTOR	31.1	3.2	31.1
201	NIDW 295 (C)	0.0	0.0	0.0
202	PDW 345	18.7	2.2	18.7
203	NIDW 950	0.0	1.3	1.3
204	GW 1321	1.9	0.0	1.9
205	HI 8772	3.6	0.6	3.6
206	GW 1319	1.0	2.1	2.1
207	GW 1320	0.6	2.1	2.1
208	UPD 97	19.3	0.0	19.3
209	PBND 5175	2.3	0.0	2.3
210	HI 8770	0.0	0.0	0.0
211	PDW 346	0.0	0.9	0.9
212	HI 8771	2.3	0.0	2.3
213	DDW 35	0.8	5.1	5.1
214	RKD 282	26.5	4.2	26.5
215	HI 8768	7.3	3.2	7.3
216	HI 8769	0.4	0.0	0.4
217	HI 8773	3.1	1.1	3.1
218	PDW 344	0.0	0.0	0.0
219	WHD 958	2.1	0.0	2.1
220	HI 8774	0.0	1.1	1.1
220. A	INFECTOR	51.1	17.7	51.1
221	MPO 1315	0.0	2.1	2.1
222	AKDW 4525	15.9	0.0	15.9
223	MACS 4029	1.7	0.0	1.7
224	NIDW 989	0.9	0.0	0.9
NIVT - 5A				
225	MACS 6660	3.6	0.0	3.6
226	HD 3204	4.7	3.5	4.7
227	UP 2914	4.7	3.5	4.7
228	WH 1181	15.2	11.0	15.2
229	MP 3429	16.0	13.1	16.0
230	AKAW 3891	4.4	7.3	7.3
231	NW 6046	4.6	20.2	20.2
232	JWS 146	4.4	41.3	41.3
233	BRW 3761	13.2	32.9	32.9
234	K 1415	28.9	4.9	28.9

Sr. No.		Ludhiana	Dhaulakuan	HS
235	MP 1304	6.4	5.8	6.4
236	MP 3288 (C)	9.8	17.9	17.9
237	UP 2915	8.0	9.3	9.3
238	UAS 375	15.5	37.6	37.6
239	MP 1303	3.8	16.8	16.8
240	HD 3205	6.0	23.3	23.3
240. A	INFECTOR	42.6	15.3	42.6
241	DBW 178	19.5	0.0	19.5
242	HI 1612	10.0	23.5	23.5
243	NIAW 2547	13.7	5.9	13.7
244	MP 1305	6.8	17.2	17.2
245	HD 3203	10.0	7.7	10.0
246	HD 3202	4.7	15.7	15.7
247	MP 1306	2.0	11.1	11.1
248	WH 1180	7.9	16.2	16.2
249	MACS 6659	0.0	20.0	20.0
250	K 1417	0.6	6.1	6.1
251	CG 1018	4.7	22.9	22.9
252	DBW 179	4.0	26.4	26.4
253	DBW 180	25.4	18.7	25.4
254	UAS 374	8.2	4.2	8.2
255	PBW 737	7.9	6.5	7.9
256	K 1416	40.4	20.4	40.4
257	PBW 738	23.6	21.4	23.6
NIVT - 5B				
258	GW 1324	0.0	1.3	1.3
259	MPO 1307	0.0	0.0	0.0
260	RKD 283	2.8	0.0	2.8
260. A	INFECTOR	44.7	33.1	44.7
261	GW 1325	5.0	0.0	5.0
262	KD 1418	3.5	1.4	3.5
263	MACS 4027	1.2	0.0	1.2
264	HI 8778	2.5	0.0	2.5
265	HI 8776	2.0	1.1	2.0
266	HI 8775	0.0	0.0	0.0
267	HI 8777	0.0	0.0	0.0
268	GW 1323	6.6	6.1	6.6
269	GW 1327	0.0	0.0	0.0
270	MPO 1308	0.0	4.4	4.4
271	MACS 4028	0.0	0.0	0.0
272	DDW 38	0.0	0.0	0.0
273	NIDW 937	0.0	0.0	0.0
274	HI 8779	0.0	1.4	1.4
275	MACS 4030	3.6	0.0	3.6
276	RKD 292	0.0	0.0	0.0
277	HI 8627 (C)	0.0	1.1	1.1
278	UAS 458	0.0	0.0	0.0
279	UAS 459	0.0	0.6	0.6
280	GW 1326	3.3	0.0	3.3
280. A	INFECTOR	35.5	47.4	47.4
281	DDW 37	2.0	0.0	2.0
IVT				
I. NORTHERN HILL ZONE				

Sr. No.		Ludhiana	Dhaulakuan	HS
282	VL 2015	3.9	8.0	8.0
283	HS 605	0.0	2.0	2.0
284	HS 608	4.0	0.0	4.0
285	VL 2013	0.0	0.0	0.0
286	HPW 420	0.8	1.2	1.2
287	VL 2017	0.0	3.2	3.2
288	VL 2016	2.5	2.9	2.9
289	HPW 418	34.6	11.6	34.6
290	VL 2018	5.0	0.0	5.0
291	HS 606	0.0	5.2	5.2
292	HPW 414	2.1	13.9	13.9
293	HS 603	14.3	16.3	16.3
294	HPW 415	0.0	0.0	0.0
295	UP 2916	0.4	13.3	13.3
296	HPW 417	4.7	2.1	4.7
297	VL 2014	7.5	2.1	7.5
298	HS 597	58.6	41.5	58.6
299	HS 604	36.7	12.0	36.7
300	HPW 416	17.6	20.0	20.0
300. A	INFECTOR	27.6	43.9	43.9
301	HS 607	4.5	4.7	4.7
302	HPW 419	3.2	4.3	4.3
II. SOUTHERN HILLS ZONE				
303	HW 5248	0.0	0.0	0.0
304	HW 4206	21.7	12.8	21.7
305	HW 4207	17.4	6.8	17.4
306	HW 2044 (C)	1.8	3.9	3.9
307	HW 4501	11.5	13.7	13.7
308	HW 5216 (C)	15.0	16.7	16.7
309	HW 3624-1	30.1	43.0	43.0
310	HW 4305-2	12.7	18.5	18.5
311	HW 3658	2.7	1.6	2.7
312	HW 4205-2	10.9	21.8	21.8
313	MACS 6670	1.8	9.7	9.7
314	HW 5246	1.5	2.6	2.6
315	CoW (W) 1 (C)	5.6	25.4	25.4
316	HW 5245	3.0	10.6	10.6
317	UAS 376	0.0	0.6	0.6
318	NIAW 2613	28.7	3.2	28.7
319	HS 609	0.0	6.5	6.5
320	HS 610	3.3	6.0	6.0
321	UAS 377	3.5	5.4	5.4
322	HW 5247	2.3	5.1	5.1
III. SPECIAL MATERIAL				
323	HW 5050	4.0	16.9	16.9
324	HW 5051	12.4	32.8	32.8
324. A	INFECTOR	18.8	0.0	18.8

Karnal Bunt
Basic Studies

IIWBR, Karnal and PAU, Ludhiana
(Satish Kumar, Ritu Bala, N S Bains, M S Saharan and Indu Sharma*)

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Development of Karnal bunt (KB) resistant near isogenics lines in the background of PBW 343 and WH 542

Karnal bunt (KB) disease of wheat holds importance due to its prime role in quarantine process for export of wheat grain. Studies on screening of wheat grain samples for Karnal bunt have been reported since early 1980s. Preliminary studies at PAU, Ludhiana over the years led to the identification of KB resistant stocks, which were used to develop resistant lines. Mainly six KB resistant stocks, *viz.* Aldan, CMH 77.308, H 567.71, HD 29, HP 1531 and W 485 were used for incorporation of resistance into high yielding wheat varieties PBW 343 and WH 542. Crosses were made between donor and recipient parents and F_1's were again backcrossed with the high yielding varieties PBW 343 and WH 542. In each backcross generation, about 150 plants were simultaneously screened against KB and involved in backcrossing with both the parents. Backcross seed, set on KB free plants was retained for growing in the next season. Subsequently selfing and backcrossing was carried out upto BC_6F_1. Finally, ~ 80 BC_6F_1 plants were screened for KB resistance and the resistant plants were advanced to obtain BC_6F_6 generations. These established near isogenics lines (NILs) for KB in PBW 343 and WH 542 background were subjected to screening under artificial inoculations at Karnal for three years (2012-13, 2013-14 and 2014-15). The resistant lines were used for yield evaluation.

Screening against Karnal bunt fungus:
Evaluation for KB resistance was carried out using syringe method of inoculation. From each line, 10 ear heads were inoculated. At maturity the inoculated heads were threshed manually. The total and infected grains from each plant in every plot were counted and per cent infection was calculated.

Field Evaluation for yield and KB resistance:
KB resistant NILs form following crosses, were evaluated for yield and other agronomic characteristics for three consecutive seasons during 2012-13, 2013-14 and 2014-15. These lines were also screened with KB by artificial inoculations:

Name	Number of lines
i) KBRL 57/*6PBW 343	55
ii) ALDAN/*6WH 542	26
iii) CMH 77.308/*6WH 542	22
iv) H 567.71/*6WH 542	20
v) HD 29/*6WH 542	15
vi) HP 1531/*6WH 542	15
vii) W 485/*6WH 542	15

Based on field evaluation for yield, from each cross five top yielding NILs were identified. Yield performance over three years along with KB (%) score of selected NILs is given in table 4.4. The performance of these lines for various agronomic traits such as plant height, maturity, number of tiller/meter, grains per spike and 1000 grains weight is given in table 4.5.

Table 4.4: Karnal bunt infection (%) and yield of five top yielding near isogenics lines in each cross along with parental performance

S. No.	Name	Pedigree	KB infection (%)			Yield (q/ha)			
			2012-13	2013-14	2014-15	2012-13	2013-14	2014-15	Average
1	KBRL 77-1	KBRL 57/*6PBW 343	0.8	0.4	0.5	51.6	44.9	52.3	49.6
2	KBRL 77-2	KBRL 57/*6PBW 343	0.0	0.1	0.1	50.6	44.6	49.3	48.2
3	KBRL 77-3	KBRL 57/*6PBW 343	0.7	0.4	0.3	48.9	47.5	45.7	47.4
4	KBRL 77-4	KBRL 57/*6PBW 343	0.3	0.2	0.5	49.2	43.7	45.6	46.2
5	KBRL 77-5	KBRL 57/*6PBW 343	0.0	0.0	0.1	44.6	44.9	46.7	45.4
6	KBRL 57	Donor Parent	0.0	0.0	0.3	41.3	39.2	41.3	40.6
7	PBW 343	Recipient parent	15.3	11.4	19.7	43.5	39.8	44.2	42.5
8	KBRL 78-1	ALDAN/*6WH 542	3.6	4.1	4.0	49.6	52.6	52.6	51.6
9	KBRL 78-2	ALDAN/*6WH 542	1.7	1.7	2.0	51.2	49.6	46.8	49.2
10	KBRL 78-3	ALDAN/*6WH 542	1.2	1.9	1.5	48.2	51.3	46.8	48.8
11	KBRL 78-4	ALDAN/*6WH 542	2.0	1.8	2.1	47.3	50.2	46.7	48.1
12	KBRL 78-5	ALDAN/*6WH 542	1.3	1.9	1.4	46.8	46.8	49.2	47.6
13	KBRL 79-1	CMH 77.308/*6WH 542	3.2	2.3	2.1	49.2	56.3	52.6	52.7
14	KBRL 79-2	CMH 77.308/*6WH 542	2.5	2.3	1.9	49.7	51.3	52.6	51.2
15	KBRL 79-3	CMH 77.308/*6WH 542	1.6	1.4	1.9	50.3	54.2	46.7	50.4
16	KBRL 79-4	CMH 77.308/*6WH 542	0.6	1.2	1.7	46.1	54.2	44.9	48.4
17	KBRL 79-5	CMH 77.308/*6WH 542	1.3	2.1	2.0	47.8	48.6	45.8	47.4
18	KBRL 80-1	H 567.71/*6WH 542	1.3	2.1	2.6	45.2	47.6	47.3	46.7
19	KBRL 80-2	H 567.71/*6WH 542	2.1	2.0	1.3	42.8	46.5	47.6	45.6
20	KBRL 80-3	H 567.71/*6WH 542	1.3	2.6	1.4	42.6	45.2	46.8	44.9
21	KBRL 80-4	H 567.71/*6WH 542	4.5	3.9	4.2	43.0	44.6	46.0	44.5
22	KBRL 80-5	H 567.71/*6WH 542	3.5	3.6	1.2	43.7	44.6	45.2	44.5
23	KBRL 81-1	HD 29/*6WH 542	3.4	2.9	4.7	54.3	44.8	49.2	49.4
24	KBRL 81-2	HD 29/*6WH 542	2.6	2.5	2.1	50.1	49.2	47.2	48.8
25	KBRL 81-3	HD 29/*6WH 542	0.6	2.7	1.6	46.7	47.6	51.0	48.4

S. No.	Name	Pedigree	KB infection (%)			Yield (q/ha)			
			2012-13	2013-14	2014-15	2012-13	2013-14	2014-15	Average
26	KBRL 81-4	HD 29/*6WH 542	3.7	4.1	2.6	46.9	46.7	50.0	47.9
27	KBRL 81-5	HD 29/*6WH 542	2.1	3.9	3.8	48.2	45.8	46.9	47.0
28	KBRL 82-1	HP 1531/*6WH 542	4.0	2.1	2.7	53.6	47.3	52.0	51.0
29	KBRL 82-2	HP 1531/*6WH 542	2.1	3.6	4.5	52.7	47.6	49.9	50.1
30	KBRL 82-3	HP 1531/*6WH 542	1.4	0.9	3.7	48.2	47.8	51.0	49.0
31	KBRL 82-4	HP 1531/*6WH 542	2.6	0.8	3.1	51.3	48.2	46.9	48.8
32	KBRL 82-5	HP 1531/*6WH 542	3.7	4.2	5.1	53.8	44.9	46.7	48.5
33	KBRL 83-1	W 485/*6WH 542	4.1	3.8	2.1	47.8	54.2	51.0	51.0
34	KBRL 83-2	W 485/*6WH 542	2.1	2.0	2.0	48.6	50.3	53.4	50.8
35	KBRL 83-3	W 485/*6WH 542	3.6	1.5	2.7	51.3	51.6	49.3	50.7
36	KBRL 83-4	W 485/*6WH 542	3.9	1.9	0.9	49.3	51.2	48.7	49.7
37	KBRL 83-5	W 485/*6WH 542	2.6	4.2	3.4	46.3	44.9	49.6	46.9
38	ALDAN	Donor Parent	3.2	0.8	1.6	35.0	34.0	32.5	33.8
39	CMH 77.308	Donor Parent	1.9	3.2	2.4	32.0	36.0	38.0	35.3
40	HS 567.71	Donor Parent	3.0	1.9	2.8	36.2	32.1	31.6	33.3
41	HD 29	Donor Parent	4.1	2.8	3.9	31.0	34.8	38.1	34.6
42	HP 1531	Donor Parent	2.8	1.7	3.1	29.1	34.5	33.7	32.4
43	W 485	Donor Parent	2.4	3.4	3.3	36.1	37.0	35.6	36.2
44	WH 542	Recipient parent	42.1	37.9	46.4	47.3	44.7	45.3	45.8

Table 4.5: Performance of five top yielding near isogenics lines in each cross for agronomic characteristics

S. No.	Name	Pedigree	Plant height (cm)	Days to maturity	Number of tiller/meter	Grains per spike	1000-grains weight
1	KBRL 77-1	KBRL 57/*6PBW 343	92	146	114	63	46
2	KBRL 77-2	KBRL 57/*6PBW 343	96	148	119	64	45
3	KBRL 77-3	KBRL 57/*6PBW 343	94	147	124	57	45
4	KBRL 77-4	KBRL 57/*6PBW 343	89	146	132	56	48
5	KBRL 77-5	KBRL 57/*6PBW 343	90	146	143	54	42
6	KBRL 57	Donor Parent	97	149	123	54	46
7	PBW 343	Recipient parent	93	142	134	55	43
8	KBRL 78-1	ALDAN/*6WH 542	96	143	116	61	46
9	KBRL 78-2	ALDAN/*6WH 542	94	148	114	63	51

S. No.	Name	Pedigree	Plant height (cm)	Days to maturity	Number of tiller/meter	Grains per spike	1000-grains weight
10	KBRL 78-3	ALDAN/*6WH 542	95	147	119	58	42
11	KBRL 78-4	ALDAN/*6WH 542	94	142	123	54	46
12	KBRL 78-5	ALDAN/*6WH 542	95	142	126	56	47
13	KBRL 79-1	CMH 77.308/*6WH 542	99	139	127	52	49
14	KBRL 79-2	CMH 77.308/*6WH 542	97	137	146	57	53
15	KBRL 79-3	CMH 77.308/*6WH 542	98	145	128	59	46
16	KBRL 79-4	CMH 77.308/*6WH 542	94	145	134	64	42
17	KBRL 79-5	CMH 77.308/*6WH 542	95	142	133	63	47
18	KBRL 80-1	H 567.71/*6WH 542	93	139	141	67	49
19	KBRL 80-2	H 567.71/*6WH 542	94	138	121	64	51
20	KBRL 80-3	H 567.71/*6WH 542	96	147	123	70	50
21	KBRL 80-4	H 567.71/*6WH 542	92	146	106	62	49
22	KBRL 80-5	H 567.71/*6WH 542	90	146	119	51	43
23	KBRL 81-1	HD 29/*6WH 542	89	148	116	58	45
24	KBRL 81-2	HD 29/*6WH 542	87	142	131	63	41
25	KBRL 81-3	HD 29/*6WH 542	93	146	130	64	47
26	KBRL 81-4	HD 29/*6WH 542	94	146	124	65	46
27	KBRL 81-5	HD 29/*6WH 542	96	147	106	58	50
28	KBRL 82-1	HP 1531/*6WH 542	92	142	104	57	43
29	KBRL 82-2	HP 1531/*6WH 542	91	139	143	54	47
30	KBRL 82-3	HP 1531/*6WH 542	90	139	142	52	41
31	KBRL 82-4	HP 1531/*6WH 542	94	144	136	60	46
32	KBRL 82-5	HP 1531/*6WH 542	93	144	121	63	48
33	KBRL	W 485/*6WH	97	146	117	59	42

S. No.	Name	Pedigree	Plant height (cm)	Days to maturity	Number of tiller/meter	Grains per spike	1000-grains weight
	83-1	542					
34	KBRL 83-2	W 485/*6WH 542	98	147	114	59	45
35	KBRL 83-3	W 485/*6WH 542	89	149	142	54	49
36	KBRL 83-4	W 485/*6WH 542	97	142	136	58	47
37	KBRL 83-5	W 485/*6WH 542	96	145	124	53	42
38	ALDAN	Donor Parent	101	150	103	45	49
39	CMH 77.308	Donor Parent	103	149	92	43	46
40	HS 567.71	Donor Parent	105	146	104	46	45
41	HD 29	Donor Parent	96	145	106	48	42
42	HP 1531	Donor Parent	107	147	107	49	49
43	W 485	Donor Parent	99	149	116	45	49
44	WH 542	Recipient parent	92	142	129	67	39

PROGRAMME 5. LOOSE SMUT

5.1 EVALUATION OF AVT MATERIAL (2013-14) AGAINST *Ustilago segetum tritici*

Loose smut is an internally seed borne disease caused by *Ustilago segetum tritici* and mainly prevalent in northern hills and plains zone. Though the disease can be managed my seed treatment but resistant varieties are always liked by the farmers to manage loose smut as it is economical and convenient. Keeping in view of higher preference of host resistance, the entries of AVT I & II year (2013-14), were inoculated with local isolates of loose smut pathogen using 'Go go' method at hot spot locations like Hisar, Ludhiana, Durgapura, Karnal and Almora. These inoculated seeds were sown again during 2014-15 crop season at these locations of NWPZ and NHZ for expression of disease. A total of 206 entries out of which 93 from AVT II year 2013-14 and 113 from AVT I year 2013-14 were screened. Both healthy as well as smutted tillers were counted and per cent infected tillers were calculated.

The variations were also observed amongst different genotypes at different locations under artificially inoculated conditions. The loose smut incidence in check variety 'Sonalika' was in the range of 5.9 -90.3% at different locations. The highest and average disease score was taken for each entry. The detailed data of AVT II year and AVT I year of 2013-14 are presented in Table 5.1 and Table 5.2, respectively. The promising entries in AVTs are:

AVT IInd year, 2013-14

Free (No infection at any location):
MACS 2971 (C)

Resistant (Average score: 0.1-5.0 % infection):
HI 8498 (D) (C), HI 8627 (D) (C), AKDW 2997-16(D) (C), NIDW 295 (d) (C), UAS 428 (d) (C) and DDK 1029 (C)

AVT Ist Year, 2013-14

Free (No infection at any location):
VL 1003, VL 3002, SPL-DIC-07, SPL-DIC-08, SPL-DIC-09, SPL-DIC-10 and TL 2999

Resistant (Average score: 0.1-5.0% infection):
HPW 410, SPL-DIC-03, SPL-DIC-04, SPL-DIC-06, TL 2997, TL 2942 (C) and TL 2969 (C)

COOPERATORS:

NAME	CENTRE
RITU BALA	LUDHIANA
S. K. JAIN	ALMORA
S. S. KARWASRA, R.S. BENIWAL	HISAR
P.S. SHEKHAWAT & NITIN CHAWLA	DURGAPURA
SUDHEER KUMAR	DWR, KARNAL

Table 5.1. Per cent infected tillers due to loose smut in the entries of AVT II[nd] year 2013-14 expressed during 2014-15 crop season

S.No.	Entry	Ludhiana	Hisar	Almora	Durgapura	Karnal	HS.	AV.
I. NORTH HILL ZONE								
1	HPW 376	13.2	30.7	61.3	0.0	10.1	61.3	23.1
2	VL 967	22.1	0.0	16.9	12.2	6.3	22.1	11.5
3	HPW 251 (C)	10.0	51.4	45.7	0.0	8.4	51.4	23.1
4	HPW 349 (C)	52.8	43.6	52.9	6.7	8.1	52.9	32.8
5	HS 277 (C)	9.7	0.0	50.7	0.0	5.1	50.7	13.1
6	HS 375 (C)	0.0	39.3	60.0	0.0	8.9	60.0	21.6
7	HS 490 (C)	17.1	80.6	52.4	0.0	6.5	80.6	31.3
8	HS 507 (C)	29.1	60.4	38.3	0.0	10.5	60.4	27.6
9	HS 542 (I) (C)	22.6	21.0	55.2	0.0	1.9	55.2	20.1
10	VL 804 (C)	12.5	21.8	42.8	2.3	3.0	42.8	16.5
11	VL 829 (C)	6.3	23.3	0.0	0.0	0.0	23.3	5.9
12	VL 892 (C)	0.0	30.7	40.5	14.9	35.7	40.5	24.4
13	VL 907 (C)	10.3	23.9	46.1	0.0	14.4	46.1	18.9
II. NORTH WESTERN PLAIN ZONE								
14	HUW 666	38.5	50.3	81.1	13.6	5.7	81.1	37.8
15	PBW 681	23.4	49.1	61.4	23.0	13.8	61.4	34.1
16	WH 1129	16.3	37.2	24.4	0.0	3.3	37.2	16.2
17	WH 1138	31.2	27.8	38.1	0.0	0.0	38.1	19.4
18	WH 1142	0.0	50.2	47.5	7.3	14.8	50.2	23.9
19	DBW 88 (I) (C)	23.3	80.0	57.3	31.7	13.7	80.0	41.2
20	DBW 90 (I) (C)	0.0	60.1	0.0	0.0	0.0	60.1	12.0
20A	Sonalika (Check)	42.9	80.8	64.7	37.7	73.3	80.8	59.9
21	DPW 621-50 (C)	7.1	80.5	59.5	0.0	11.4	80.5	31.7
22	HD 2967 (C)	27.2	50.6	86.2	0.7	24.5	86.2	37.8
23	HD 3043 (C)	0.0	40.2	29.6	0.0	9.1	40.2	15.8
24	HD 3059 (C)	14.8	43.6	38.3	0.0	19.8	43.6	23.3
25	HD 3086 (I) (C)	0.0	37.2	0.0	0.0	0.0	37.2	7.4
26	PBW 590 (C)	40.0	40.3	59.9	29.6	24.3	59.9	38.8
27	PBW 644 (C)	38.7	40.9	11.6	1.4	5.7	40.9	19.7
28	PBW 660 (I) (C)	19.4	60.7	36.1	7.1	9.9	60.7	26.7
29	PDW 233 (C)	0.0	47.2	0.0	0.0	0.0	47.2	9.4
30	PDW 291 (C)	0.0	39.7	0.0	0.0	0.0	39.7	7.9
31	PDW 314 (C)	0.0	49.3	54.2	0.0	16.7	54.2	24.0
32	WH 1021 (C)	17.3	60.7	52.9	0.0	10.7	60.7	28.3
33	WH 1080 (C)	13.6	50.7	44.3	2.9	13.5	50.7	25.0
34	WH 1105 (C)	33.3	47.8	87.3	16.7	31.6	87.3	43.3
35	WH 1124 (I) (C)	0.0	60.3	0.0	0.0	0.0	60.3	12.1
III. NORTH EASTERN PLAIN ZONE								
36	BRW 3723	14.1	60.0	46.9	0.0	3.9	60.0	25.0
37	DBW 107	32.5	80.0	83.6	25.0	16.4	83.6	47.5

S.No.	Entry	Ludhiana	Hisar	Almora	Durgapura	Karnal	HS.	AV.
38	HD 3118	30.8	80.2	45.7	16.2	11.1	80.2	36.8
39	K 1114	10.9	40.9	28.0	28.4	8.9	40.9	23.4
40	C 306 (C)	17.5	39.3	56.2	2.1	23.9	56.2	27.8
40A	Sonalika (Check)	26.6	80.9	79.4	37.0	74.5	80.9	59.7
41	DBW 14 (C)	22.0	70.3	40.6	0.0	25.0	70.3	31.6
42	DBW 39 (C)	27.1	80.0	53.1	0.0	6.7	80.0	33.4
43	HD 2733 (C)	6.6	40.6	43.9	0.0	7.0	43.9	19.6
44	HD 2888 (C)	20.8	50.0	26.3	0.0	28.9	50.0	25.2
45	HD 2985 (C)	3.4	60.4	54.5	8.9	22.8	60.4	30.0
46	HI 1563 (C)	38.8	60.0	58.4	14.5	17.7	60.0	37.9
47	K 0307 (C)	37.9	70.3	20.0	0.0	2.6	70.3	26.2
48	K 1006 (I) (C)	10.1	80.0	48.3	0.0	6.7	80.0	29.0
49	K 8027 (C)	23.8	40.4	45.9	0.0	10.7	45.9	24.2
50	NW 2036 (C)	14.9	70.2	38.4	2.8	32.9	70.2	31.8
51	NW 5054 (I) (C)	23.8	60.4	56.8	1.8	21.3	60.4	32.8
IV. CENTRAL ZONE								
52	DBW 110	14.9	90.3	42.8	0.0	8.2	90.3	31.2
53	HI 8736 (D)	21.3	60.0	0.0	0.0	2.1	60.0	16.7
54	HI 8737 (D)	0.0	60.6	0.0	0.0	2.7	60.6	12.7
55	MP 3382	0.0	50.6	42.4	0.0	23.6	50.6	23.3
56	NIAW 1885	24.1	80.0	42.1	11.4	11.4	80.0	33.8
57	PBW 689	29.6	60.3	37.7	0.0	4.4	60.3	26.4
58	A 9-30-1 (D) (C)	28.5	-	0.0	0.0	0.0	28.5	7.1
59	GW 322 (C)	0.0	60.2	62.0	22.1	11.7	62.0	31.2
60	HD 2864 (C)	15.3	39.2	43.4	4.8	34.7	43.4	27.5
60A	Sonalika (Check)	5.9	90.2	58.6	24.7	87.2	90.2	53.3
61	HD 2932 (C)	9.2	35.7	42.2	1.3	6.6	42.2	19.0
62	HI 1500 (C)	-	40.3	30.4	16.7	10.1	40.3	24.4
63	HI 1544 (C)	18.3	70.6	20.0	0.0	7.3	70.6	23.3
64	HI 8498 (D) (C)	3.1	-	0.0	0.0	0.0	3.1	0.8
65	HI 8627 (D) (C)	20.0	-	0.0	0.0	0.0	20.0	5.0
66	MP 3288 (C)	0.0	-	62.9	22.1	26.6	62.9	27.9
67	MP 3336 (C)	0.0	-	25.3	9.1	18.6	25.3	13.2
68	MP 4010 (C)	3.8	81.0	54.5	12.1	25.8	81.0	35.4
69	MPO 1215 (d) (C)	25.6	90.2	0.0	0.0	0.0	90.2	23.2
V. PENINSULAR ZONE								
70	NIAW 1994	0.0	0.0	51.6	NG	17.2	51.6	17.2
71	UAS 347	0.0	0.0	64.7	4.3	3.9	64.7	14.6
72	UAS 446 (D)	28.1	60.2	0.0	0.0	0.0	60.2	17.6
73	AKDW 2997-16(D) (C)	9.9	-	0.0	0.0	0.0	9.9	2.5
74	HD 3090 (I) (C)	0.0	30.9	18.9	0.0	21.8	30.9	14.3
75	MACS 6222 (C)	0.0	29.3	51.1	0.0	12.8	51.1	18.6

S.No.	Entry	Ludhiana	Hisar	Almora	Durgapura	Karnal	HS.	AV.
76	MACS 6478 (C)	11.4	31.9	35.2	4.3	18.6	35.2	20.3
77	NI 5439 (C)	21.1	-	81.2	0.0	9.3	81.2	27.9
78	NIAW 1415 (C)	21.4	60.2	29.6	0.0	19.3	60.2	26.1
79	NIDW 295 (d) (C)	16.7	-	0.0	0.0	2.1	16.7	4.7
80	Raj 4083 (C)	12.0	80.3	81.1	20.0	16.8	81.1	42.0
80A	Sonalika (Check)	24.3	90.3	44.2	36.4	63.8	90.3	51.8
81	UAS 428 (d) (C)	0.0	21.1	0.0	0.0	1.5	21.1	4.5
VI. SOUTHERN HILLS ZONE								
82	CoW(W) 1 (C)	16.3	-	33.4	3.9	2.2	33.4	13.9
83	HW 2044 (C)	0.0	-	74.4	11.7	-	74.4	28.7
84	HW 5216 (C)	12.5	50.4	61.1	9.3	2.6	61.1	27.2
VII. SPECIAL TRIAL								
85	DDK 1042	NS	NS	NS	NS	NS	NS	NS
86	MACS 5022	31.8	50.9	0.0	0.0	-	50.9	20.7
87	DDK 1029 (C)	-	-	0.0	0.0	2.3	2.3	0.8
88	HW 1098 (I) (C)	NS	NS	NS	NS	NS	NS	NS
89	Kharchia 65 (C)	15.5	60.3	42.8	8.4	18.1	60.3	29.0
90	KRL 19 (C)	0.0	50.4	29.9	19.2	5.1	50.4	20.9
91	KRL 210 (C)	56.3	60.2	0.0	0.0	0.0	60.2	23.3
92	MACS 2496 (C)	31.8	-	20.9	1.0	20.7	31.8	18.6
93	MACS 2971 (C)	0.0	-	0.0	0.0	0.0	0.0	0.0
93A	Sonalika (Check)	36.6	87.2	47.7	30.5	83.3	87.2	57.1

Table 5.2. Per cent infected tillers due to loose smut in the entries of AVT Ist year 2013-14 expressed during 2014-15 crop season

S.No.	Entry	Ludhiana	Hisar	Almora	Durgapura	Karnal	HS.	AV.
I. NORTHERN HILL ZONE								
1	HPW 373	26.7	5.1	23.4	0.0	12.7	26.7	13.6
2	HPW 400	15.3	10.0	48.7	1.8	3.5	48.7	15.9
3	HPW 401	22.9	15.2	20.4	3.5	7.7	22.9	13.9
4	HPW 410	0.0	20.5	0.0	0.0	3.4	20.5	4.8
5	HPW 411	27.4	20.0	48.0	18.8	11.0	48.0	25.0
6	HPW 412	28.3	25.4	46.9	0.0	14.1	46.9	22.9
7	HS 547	0.0	30.1	30.6	0.0	6.0	30.6	13.3
8	HS 558	20.2	30.3	35.7	0.0	4.4	35.7	18.1
9	HS 562	33.9	50.7	32.5	2.9	12.3	50.7	26.4
10	HS 577	23.6	30.3	41.2	5.9	42.0	42.0	28.6
11	HS 590	8.8	60.0	28.3	3.9	13.1	60.0	22.8
12	HS 591	9.4	90.1	43.8	0.0	19.0	90.1	32.5

S.No.	Entry	Ludhiana	Hisar	Almora	Durgapura	Karnal	HS.	AV.
13	HS 592	42.9	40.3	18.0	31.8	27.3	42.9	32.0
14	HS 593	21.2	40.0	28.9	84.4	0.7	84.4	35.0
15	HS 594	0.0	60.2	41.3	4.2	21.4	60.2	25.4
16	HS 595	21.2	30.2	9.6	0.0	19.2	30.2	16.0
17	UP 2890	30.4	90.3	17.2	5.2	32.1	90.3	35.0
18	UP 2891	10.5	30.2	61.5	19.4	36.9	61.5	31.7
19	VL 976	15.6	30.3	56.9	14.3	6.5	56.9	24.7
20	VL 977	7.1	40.2	38.0	0.0	0.0	40.2	17.1
20. A	Sonalika (Check)	38.2	90.7	58.1	46.2	65.5	90.7	59.7
21	VL 1003	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	VL 1004	19.5	0.0	79.7	0.7	10.3	79.7	22.0
23	VL 3002	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	VL 3004	9.5	30.2	63.5	35.7	29.8	63.5	33.8
25	VL 3005	28.8	40.2	39.5	0.0	5.6	40.2	22.8
26	VL 3006	6.6	30.7	49.4	0.0	2.4	49.4	17.8
II. NORTH WESTERN PLAIN ZONE								
27	DBW 95	7.1	50.4	60.0	18.0	33.6	60.0	33.8
28	DBW 128	11.7	60.1	24.8	0.0	5.9	60.1	20.5
29	DBW 129	18.9	50.2	36.3	13.4	13.1	50.2	26.4
30	HD 3128	5.8	60.3	42.5	17.9	72.2	72.2	39.7
31	HD 3132	13.5	70.3	41.2	4.0	2.6	70.3	26.3
32	HD 3133	32.8	50.0	6.4	5.6	8.9	50.0	20.7
33	HD 3139	26.4	70.3	16.0	1.7	3.4	70.3	23.6
34	HD 4730	-	60.2	0.0	0.0	0.0	60.2	15.0
35	HUW 675	0.0	80.2	51.8	0.0	11.5	80.2	28.7
36	K 1204	24.3	50.0	34.6	3.0	17.9	50.0	26.0
37	MP 1277	33.3	40.3	0.0	0.0	1.5	40.3	15.0
38	PBW 677	13.0	30.3	54.4	23.9	13.4	54.4	27.0
39	PBW 692	26.7	45.1	32.9	0.0	9.7	45.1	22.9
40	PBW 695	10.6	60.2	47.9	11.3	12.1	60.2	28.4
40. A	Sonalika (Check)	30.6	90.3	58.0	32.8	73.8	90.3	57.1
41	PBW 697	32.5	50.0	63.8	73.7	9.8	73.7	46.0
42	PBW 698	18.8	40.2	71.4	7.3	19.7	71.4	31.5
43	PBW 702	17.9	60.0	57.5	17.3	26.9	60.0	35.9
44	PBW 703	10.6	60.2	59.8	7.2	30.1	60.2	33.6
45	PBW 706	40.4	40.4	42.6	0.0	21.6	42.6	29.0
46	TL 2995	29.3	10.1	0.0	0.0	0.8	29.3	8.0
47	UAS 356	0.0	40.5	27.5	0.0	9.0	40.5	15.4
48	WH 1154	38.7	20.2	0.0	2.1	0.0	38.7	12.2
49	WH 1156	0.0	30.3	59.2	2.2	2.8	59.2	18.9
50	WH 1157	2.9	20.4	15.7	38.1	2.8	38.1	16.0
51	WH 1164	17.7	50.4	49.0	28.6	21.6	50.4	33.4
III. NORTH EASTERN PLAIN ZONE								

S.No.	Entry	Ludhiana	Hisar	Almora	Durgapura	Karnal	HS.	AV.
52	DBW 126	31.4	60.1	56.2	2.1	17.6	60.1	33.5
53	DBW 98	22.0	25.7	0.0	0.0	0.0	25.7	9.5
54	HD 3127	0.0	50.4	27.5	1.7	12.5	50.4	18.4
55	HUW 661	16.3	40.2	30.2	0.7	0.0	40.2	17.5
56	HUW 677	29.0	40.8	27.4	0.0	13.8	40.8	22.2
57	HUW 679	36.8	50.0	3.3	2.2	0.0	50.0	18.5
58	PBW 693	19.4	70.2	48.4	22.7	16.7	70.2	35.5
59	PBW 701	42.3	60.3	39.5	16.9	6.1	60.3	33.0
60	PBW 704	25.3	40.2	35.0	1.8	22.5	40.2	24.9
60. A	Sonalika (Check)	32.5	81.0	50.2	44.4	73.3	81.0	56.3
61	UP 2855	9.1	50.3	45.3	7.7	19.2	50.3	26.3
62	WH 1132	12.7	25.3	0.0	0.0	0.0	25.3	7.6
IV. CENTRAL ZONE								
63	CG 1010	0.0	0.0	65.6	78.2	13.7	78.2	31.5
64	DDW 30 (D)	25.4	0.0	0.0	0.0	0.0	25.4	5.1
65	GW 451	0.0	30.1	55.2	26.1	15.3	55.2	25.3
66	GW 455	3.5	30.7	24.4	9.4	20.0	30.7	17.6
67	HD 3146	22.3	50.2	6.5	14.3	6.9	50.2	20.0
68	HD 4728 (D)	18.0	25.5	0.0	0.0	0.0	25.5	8.7
69	HI 8750 (D)	0.0	37.2	0.0	0.0	0.0	37.2	7.4
70	HI 8755 (D)	0.0	27.8	0.0	0.0	0.0	27.8	5.6
71	K 1215	0.0	50.5	25.2	8.1	2.4	50.5	17.2
72	K 1217	1.5	40.6	71.1	0.0	18.9	71.1	26.4
73	MACS 3916 (D)	25.8	35.3	0.0	0.0	0.0	35.3	12.2
74	MACS 3927 (D)	0.0	37.2	32.4	0.0	0.0	37.2	13.9
75	MACS 6604	0.0	27.6	43.0	3.1	12.0	43.0	17.1
76	MP 1279	65.1	25.8	52.6	17.2	28.6	65.1	37.9
77	NIAW 2030	16.0	30.6	45.3	15.4	12.9	45.3	24.0
78	UAS 451 (D)	23.7	0.0	0.0	0.0	4.8	23.7	5.7
V. PENINSULAR ZONE								
79	DDW 27 (D)	0.0	29.1	17.5	0.0	4.1	29.1	10.1
80	HI 8751 (D)	3.6	33.2	0.0	0.0	0.0	33.2	7.4
80. A	Sonalika (Check)	0.0	86.3	39.3	29.4	77.9	86.3	46.6
81	HI 8754 (D)	34.1	37.2	0.0	0.0	13.3	37.2	16.9
82	K 1213	38.8	41.2	51.5	2.8	8.9	51.5	28.6
83	UP 2864	0.0	40.3	58.7	30.4	14.8	58.7	28.8
VI. SOUTHERN HILLS ZONE								
84	MACS 6507	2.0	40.6	50.8	39.3	13.6	50.8	29.3
85	UAS 358	13.8	0.0	41.1	15.8	10.8	41.1	16.3
VII. SPECIAL TRIAL (Dicoccum and Sailinity and Alkalinity)								
86	DBW 154	12.5	57.1	40.6	0.0	20.0	57.1	26.0
87	DBW 155	16.2	63.2	49.0	0.0	26.5	63.2	31.0
88	SPL-DIC-01	19.0	23.4	0.0	0.0	0.9	23.4	8.7

S.No.	Entry	Ludhiana	Hisar	Almora	Durgapura	Karnal	HS.	AV.
89	SPL-DIC-02	0.0	27.6	0.0	0.0	0.0	27.6	5.5
90	SPL-DIC-03	0.0	19.5	0.0	0.0	0.0	19.5	3.9
91	SPL-DIC-04	0.0	21.3	0.0	0.0	0.0	21.3	4.3
92	SPL-DIC-05	0.0	27.1	0.0	0.0	0.0	27.1	5.4
93	SPL-DIC-06	0.0	13.7	0.0	0.0	0.0	13.7	2.7
94	SPL-DIC-07	0.0	-	0.0	0.0	0.0	0.0	0.0
95	SPL-DIC-08	0.0	-	0.0	0.0	0.0	0.0	0.0
96	SPL-DIC-09	0.0	-	0.0	0.0	0.0	0.0	0.0
97	SPL-DIC-10	0.0	-	0.0	0.0	0.0	0.0	0.0
98	SPL-DIC-11	0.0	-	50.5	0.0	1.5	50.5	13.0
III. SPECIAL TRIAL (TRITICALE)								
99	TL 2996	14.6	29.3	0.0	0.0	0.0	29.3	8.8
100	TL 2997	0.0	21.6	0.0	0.0	0.0	21.6	4.3
100. A	Sonalika (Check)	36.3	90.3	52.2	39.6	61.9	90.3	56.1
101	TL 2998	44.0	-	0.0	0.0	0.0	44.0	11.0
102	TL 2999	0.0	-	0.0	0.0	0.0	0.0	0.0
103	TL 3000	1.1	60.7	0.0	0.0	0.0	60.7	12.4
104	TL 2942 (C)	0.0	0.0	9.6	0.0	0.0	9.6	1.9
105	TL 2969 (C)	9.6	0.0	0.0	0.0	0.0	9.6	1.9
IV. SPECIAL TRIAL (MABB/NIL ENTRIES)								
106	PBW 722	22.1	70.6	47.2	50.0	10.8	70.6	40.1
107	PBW 723	10.1	61.5	42.2	31.2	16.5	61.5	32.3
108	KB 2012-03	11.8	60.3	67.5	3.0	6.7	67.5	29.9
109	HD 2932+Sr26	22.2	27.1	59.0	2.3	17.5	59.0	25.6
110	HD 2932-Lr19/Sr25	17.6	70.3	33.1	15.8	13.3	70.3	30.0
111	MMBL 283	60.3	70.6	50.4	0.0	25.9	70.6	41.5
112	HUW 234 (C)	15.4	80.0	67.5	13.7	17.8	80.0	38.9
113	PBW 343 (C)	24.1	80.2	56.7	0.0	4.9	80.2	33.2
Source:DR.S.K. Jain Almora								
114	V W 0565	4.4	33.2	0.0	0.0	0.0	33.2	7.5
115	V W 0636	0.0	29.1	0.0	0.0	0.0	29.1	5.8
116	V W 0752	0.0	-	0.0	0.0	0.0	0.0	0.0
117	V W 0810	0.0	-	0.0	0.0	0.0	0.0	0.0
118	V W 0855	0.0	-	0.0	0.0	0.0	0.0	0.0
119	V W 0912	0.0	-	0.0	0.0	0.0	0.0	0.0

Basic studies

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Development of loose smut resistant near isogenic lines (NILs)

Loose smut of wheat, caused by *Ustilago tritici* (Pers.) Rostr., occurs throughout the world wherever wheat is grown. Yield losses resulting from the pathogen are typically small but even a 1-2 % infection can reduce profit to the farmers by 5-20% and if unchecked, the infection can build up over years to inflict substantial damage. Loose smut is an internally seed borne disease and can be effectively controlled by treating seed with systemic fungicides like carboxin, carbendazim and the triazole group of chemicals. At this point of time, environmental concerns, along with the availability of rapid and precise molecular techniques for gene transfer favor the exploration of the resistance option. This approach requires cataloging of resistance genes and their incorporation and pyramiding in the relevant germplasm. The majority of the studies carried out on resistance thus far have indicated a simple genetic basis for loose smut resistance, with resistance being complete and governed by major genes. This augurs well for marker-assisted selection, which also provides a solution to screening related problems i.e. two generation screening cycle and the need for individual floret inoculations.

Evaluation for loose smut resistance using artificial inoculation techniques was initiated in 1976 at Punjab Agricultural University, Ludhiana. While a set of lines representing breeding material which has been advanced to the replicated yield testing stage is screened every year, the resistant material identified in previous years is also carried forward and re-evaluated. Because of this continuing activity, PAU has accumulated 622 lines, which have remained resistant for at least 15 years with some having maintained the resistant status over 35 years of testing against a mixture of prevalent races of Ustilago tritici. This material has already been deposited with National Bureau of Plant Genetic Resources, New Delhi.

Out of these 622 lines, a set of 20 lines namely ML 521, W 59, W 1616, W 2139, W 2484, W 2531, W 2615, W 3899, W 4461, W 4985, W 5100, W 5450, W 5792 , W 5915, W 6202, WL 1786, WL 2956 ,WL 3450, WL 3951 and WL5907 was selected for genetic analysis of resistance and development of near isogenic lines for loose smut resistance. These 20 resistant lines were crossed with the widely grown but susceptible cultivar, PBW343(=Attila's'=ND/VG 9144/3/KAL/BB//YACO/VEE#5). The F1 s were backcrossed with the susceptible cv. PBW 343. Subsequent selfing, selection and backcrossing was carried out up to BC4F7 stage. Resistant plants were selected and evaluated for loose smut resistance for three years (2012-13, 2013-14 and 2014-15). These loose smut resistant lines over the three years were designated as NILs for loose smut resistance.

Screening against *Ustilago* segetum *tritici*, the causal organism of Loose smut

Artificial inoculations were done using smutted heads from a susceptible genotype, PBW 343 which was inoculated in the previous year with mixture of prevalent isolates. The inoculations were done by dusting of chalamydospores from the smutted earheads as described by Saini *et al* (1989). At mid anthesis stage, upper $1/4^{th}$ portion of the spikelets was cut with scissors, covered over with the crossing paper bag stapled along the stalk followed by opening from top and dusting of spores from the smutted earhead and again stapling the bag from top. Two earheads in each line were inoculated and data was recorded as follows:

Loose smut percent infection=No of tillers infected/Total number of tillers x 100

Loose smut resistance

Loose smut resistant NILs from the crosses of 20 parents as listed above in the background of PBW343 were evaluated for resistance against the loose smut fungus by artificial inoculations and percent infection is given in the Table 5..

Table 5.3.Loose smut infection of near isogenic lines

S.No	Name	Pedigree	Number of lines	Percent loose smut infection			
				2012-13	2013-14	2014-15	Average
1	LSRL-1	ML 521 /*5 PBW 343	18	0.0	0.0	0.0	0.0
2	LSRL-2	W 59 /*5 PBW 343	16	0.0	0.0	0.0	0.0
3	LSRL-3	W 1616 /*5 PBW 343	12	0.0	0.0	0.0	0.0
4	LSRL-4	W 2139 /*5 PBW 343	57	0.0	0.0	0.0	0.0
5	LSRL-5	W 2484 /*5 PBW 343	21	0.0	0.0	0.0	0.0
6	LSRL-6	W 2531 /*5 PBW 343	5	0.0	0.0	0.0	0.0
7	LSRL-7	W 2615 /*5 PBW 343	65	0.0	0.0	0.0	0.0
8	LSRL-8	W 3899 /*5 PBW 343	49	0.0	0.0	0.0	0.0
9	LSRL-9	W 4461 /*5 PBW 343	59	0.0	0.0	0.0	0.0
10	LSRL-10	W 4985 /*5 PBW 343	50	0.0	0.0	0.0	0.0
11	LSRL-11	W 5100 /*5 PBW 343	53	0.0	0.0	0.0	0.0
12	LSRL-12	W 5450 /*5 PBW 343	38	0.0	0.0	0.0	0.0
13	LSRL-13	W 5792 /*5 PBW 343	69	0.0	0.0	0.0	0.0
14	LSRL-14	W 5915 /*5 PBW 343	19	0.0	0.0	0.0	0.0
15	LSRL-15	W 6202 /*5 PBW 343	22	0.0	0.0	0.0	0.0
16	LSRL-16	WL 1786 /*5 PBW 343	20	0.0	0.0	0.0	0.0
17	LSRL-17	WL 2956 /*5 PBW 343	14	0.0	0.0	0.0	0.0
18	LSRL-18	WL3450 /*5 PBW 343	19	0.0	0.0	0.0	0.0
19	LSRL-19	WL 3951 /*5 PBW 343	45	0.0	0.0	0.0	0.0
20	LSRL-20	WL 5907 /*5 PBW 343	28	0.0	0.0	0.0	0.0
21	ML 521	Donor parent	10	0.0	0.0	0.0	0.0
22	W 59	Donor parent	10	0.0	0.0	0.0	0.0
23	W 1616	Donor parent	10	0.0	0.0	0.0	0.0
24	W 2139	Donor parent	10	0.0	0.0	0.0	0.0
25	W 2484	Donor parent	10	0.0	0.0	0.0	0.0
26	W 2531	Donor parent	10	0.0	0.0	0.0	0.0
27	W 2615	Donor parent	10	0.0	0.0	0.0	0.0
28	W 3899	Donor parent	10	0.0	0.0	0.0	0.0
29	W 4461	Donor parent	10	0.0	0.0	0.0	0.0
30	W 4985	Donor parent	10	0.0	0.0	0.0	0.0
31	W 5100	Donor parent	10	0.0	0.0	0.0	0.0
32	W 5450	Donor parent	10	0.0	0.0	0.0	0.0
33	W 5792	Donor parent	10	0.0	0.0	0.0	0.0
34	W 5915	Donor parent	10	0.0	0.0	0.0	0.0
35	W 6202	Donor parent	10	0.0	0.0	0.0	0.0
36	WL 1786	Donor parent	10	0.0	0.0	0.0	0.0
37	WL 2956	Donor parent	10	0.0	0.0	0.0	0.0
38	WL3450	Donor parent	10	0.0	0.0	0.0	0.0
39	WL 3951	Donor parent	10	0.0	0.0	0.0	0.0
40	WL 5907	Donor parent	10	0.0	0.0	0.0	0.0
41	PBW343	Recipient parent	10	53.78	42.85	32.73	43.12

PROGRAMME 6. POWDERY MILDEW

6.1: POWDERY MILDEW SCREENING NURSERY (PMSN)

Most of the popularly grown varieties of wheat in NWPZ are susceptible to this disease. Powdery mildew is emerging as an important disease of wheat in NWPZ and NHZ during cool years and may cause heavy losses in susceptible varieties. During favourable environment, the varieties are prone to powdery mildew and may suffer heavily if infected at early stage of their growth. Keeping in view the importance of powdery mildew, during 2014-15 crop season, 184 entries including AVT I and II year along with entries found resistant during previous crop seasons were screened against powdery mildew at hot spot locations in NHZ and NWPZ. The data of six locations, viz., Shimla, Almora, Pantnagar, Malan, Wellington and Dhaulakuan were taken into consideration. (disease development was not good at Bajaura and Ranichauri). Inoculations were done with the local isolate by dusting the inoculum on the test entries. Scoring was done at dough stage on 0-9 scale representing incidence of disease vertically in height of plants. The disease scores of AVT entries along with check varieties have been presented in Table 6.1 and that of resistant entries identified during previous years. The entries found promising against powdery mildew are:

Resistant Entries: Twenty five entries showed resistance (Av. score 0-3, highest score upto 5) : HPW 251 (C), HS 490 (C), HD 3043 (C), TL 2942 (C), TL 2969 (C), VL 1007, VL 3002, MACS 972 (d), MACS 4020 (d), DBW 184, DDK 1048, TL 3002, TL 3003, TL 3004, TL 3005, HPBW 01, HPBW 02, HUW 711, HW 1095, PBW 677, MACS 5022 (dic.), TL 2996 (T), TL 2998 (T), TL 2999 (T) and TL 3000 (T)

COOPERATORS:

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J. KUMAR, DEEPSHIKHA, K SRIVASTAVA	PANTNAGAR
R. SELVAKUMAR , SUDHEER KUMAR	DWR, KARNAL (COORDINATING UNIT)

Table 6.1. Powdery mildew screening nursery, 2014-15

S.No.	Entries	Almora	Pantnagar	Shimla	Malan	Dhaulakuan	Wellington	AV.	HS
I. NORTHERN HILL ZONE									
1	HS 562	5	5	0	5	7	2	4	7
2	HPW 251 (C)	3	1	0	5	3	1	2	5
3	HPW 349 (C)	1	3	0	5	6	0	3	6
4	HS 375 (C)	3	1	4	5	9	1	4	9
5	HS 490 (C)	1	1	4	5	4	0	3	5
6	HS 507 (C)	1	5	0	7	2	0	3	7
7	HS 542 (C)	1	1	6	5	9	1	4	9
8	VL 804 (C)	1	3	7	7	9	1	5	9
9	VL 829 (C)	1	5	6	7	9	0	5	9
10	VL 892 (C)	3	1	6	5	7	1	4	7
11	VL 907 (C)	1	9	5	7	9	1	5	9
II. NORTH WESTERN PLAIN ZONE									
12	HD 4730	1	1	8	7	9	2	5	9
13	MP 1277	1	1	6	7	9	2	4	9
14	WH 1164	1	7	6	7	9	3	6	9
15	DBW 88 (C)	3	1	6	5	9	3	5	9
16	DBW 90 (C)	3	1	6	7	9	2	5	9
17	DPW 621-50 (C)	3	5	6	5	9	1	5	9
18	HD 2967 (C)	1	9	4	5	9	1	5	9
19	HD 3043 (C)	1	1	4	5	2	0	2	5
20	HD 3059 (C)	1	5	4	7	5	3	4	7
20A	PBW 343 (Check)	7	9	4	8	9	5	7	9
21	HD 3086 (C)	1	5	3	7	9	4	5	9
22	PBW 644 (C)	5	5	4	7	9	4	6	9
23	PDW 233 (C)	1	7	8	7	9	6	6	9
24	PDW 291 (C)	1	9	8	8	9	6	7	9
25	PDW 314 (C)	1	7	8	8	9	4	6	9
26	WH 1021 (C)	7	9	6	7	9	4	7	9
27	WH 1080 (C)	7	7	4	7	9	3	6	9
28	WH 1105 (C)	3	7	6	7	9	5	6	9
29	WH 1124 (C)	3	5	6	7	9	3	6	9
30	WH 1142 (I) C)	3	7	6	7	9	5	6	9
III. NORTH EASTERN PLAIN ZONE									
31	C 306 (C)	3	7	6	5	6	5	5	7
32	HD 2888 (C)	3	5	6	7	9	5	6	9
33	K 8027 (C)	9	3	5	8	9	7	7	9
IV. CENTRAL ZONE									
34	HD 4728 (d)	3	5	8	7	6	7	6	8
35	HD 4730 (d)	3	5	5	7	6	4	5	7
36	GW 322 (C)	3	3	6	8	9	4	6	9
37	HD 2864 (C)	7	5	6	7	9	2	6	9
38	HD 2932 (C)	7	5	4	7	9	4	6	9
39	HI 1544 (C)	9	9	4	8	9	2	7	9
40	HI 8498 (D) (C)	7	9	8	7	9	6	8	9
40A	PBW 343 (Check)	7	9	6	8	9	5	7	9
41	HI 8737 (D)(I) (C)	7	5	7	7	9	5	7	9

S.No.	Entries	Almora	Pantnagar	Shimla	Malan	Dhaulakuan	Wellington	AV.	HS
42	MP 3336 (C)	7	7	2	7	9	5	6	9
43	MP 4010 (C)	5	7	3	8	9	5	6	9
44	MPO 1215 (d) (C)	5	3	5	7	9	6	6	9
V. PENINSULAR ZONE									
45	MACS 3927 (d)	3	5	6	7	5	7	6	7
46	NIAW 2030	3	7	4	5	9	5	6	9
47	AKDW 2997-16(d) (C)	9	7	2	5	9	4	6	9
48	DBW 93 (I) (C)	5	3	4	7	9	5	6	9
49	MACS 6222 (C)	7	3	6	7	9	5	6	9
50	MACS 6478 (C)	3	3	5	7	9	5	5	9
51	NI 5439 (C)	5	1	4	5	9	5	5	9
52	NIAW 1415 (C)	5	1	4	7	9	3	5	9
53	UAS 347 (I) (C)	1	3	3	7	9	3	4	9
54	UAS 428 (d) (C)	3	1	4	5	9	5	5	9
55	UAS 446 (d) (I) (C)	3	3	6	5	9	5	5	9
VII. SPECIAL TRIAL									
56	(HD 2932 + Lr 19/Sr25)	3	3	2	7	9	5	5	9
57	MMBL 283	5	5	3	7	9	5	6	9
58	PBW 723	3	5	2	8	9	3	5	9
59	DBW 14 (C)	3	3	2	7	9	4	5	9
60	DDK 1029 (C)	3	0	2	0	1	6	2	6
60A	PBW 343 (Check)	5	7	7	8	9	6	7	9
61	HD 2985 (C)	3	5	6	7	9	6	6	9
62	HI 1563 (C)	3	7	4	7	9	5	6	9
63	HUW 234 (C)	5	7	7	7	9	5	7	9
64	HW 1098 (C)	1	1	6	5	1	5	3	6
65	K 0307 (C)	3	5	3	7	9	2	5	9
66	Kharchia 65 (C)	5	1	3	8	9	4	5	9
67	KRL 19 (C)	3	0	2	8	9	5	5	9
68	KRL 210 (C)	3	0	6	5	6	3	4	6
69	PBW 343 (C)	3	3	8	7	9	5	6	9
70	Raj 4083 (C)	3	7	7	7	9	5	6	9
71	TL 2942 (C)	1	0	0	0	1	0	0	1
72	TL 2969 (C)	1	0	0	0	1	0	0	1
73	WH 542 (C)	3	0	4	7	9	5	5	9
AVT Ist Year									
I. NORTHERN HILL ZONE									
74	HPW 393	3	5	6	7	9	3	6	9
75	HPW 394	3	1	6	7	2	2	4	7
76	HPW 413	1	3	6	7	9	3	5	9
77	HPW 421	1	1	4	7	9	2	4	9
78	HPW 422	1	1	6	7	1	1	3	7
79	HS 580	1	1	4	7	9	3	4	9
80	HS 583	3	7	6	7	9	5	6	9
80A	PBW 343 (Check)	5	7	8	8	9	5	7	9
81	HS 590	3	5	6	5	9	5	6	9
82	HS 596	3	1	4	7	9	3	5	9
83	HS 597	3	3	8	7	9	3	6	9

S.No.	Entries	Almora	Pantnagar	Shimla	Malan	Dhaulakuan	Wellington	AV.	HS
84	HS 598	3	1	6	7	9	3	5	9
85	HS 599	1	3	4	7	9	3	5	9
86	HS 600	1	1	5	7	9	2	4	9
87	HS 601	1	3	2	7	9	2	4	9
88	UP 2917	1	5	3	7	9	3	5	9
89	UP 2918	1	3	7	7	9	3	5	9
90	VL 1005	1	3	6	7	9	5	5	9
91	VL 1006	1	5	7	5	9	4	5	9
92	VL 1007	1	5	0	3	3	3	3	5
93	VL 3002	1	1	4	3	1	2	2	4
94	VL 3007	3	3	2	7	9	2	4	9
95	VL 3008	1	3	6	5	9	2	4	9
96	VL 3009	1	3	8	7	9	2	5	9
97	VL 4001	3	0	4	7	9	1	4	9
II. NORTH WESTERN PLAIN ZONE									
98	DBW 147	1	1	6	7	9	2	4	9
99	DBW 148	3	7	8	7	9	4	6	9
100	DBW 150	1	7	8	7	9	3	6	9
100A	PBW 343 (Check)	5	9	9	7	9	6	8	9
101	DDW 31	3	3	7	5	9	3	5	9
102	DDW 32	1	5	7	5	9	6	6	9
103	HD 3159	3	5	7	7	9	4	6	9
104	HD 3165	5	3	6	7	9	2	5	9
105	HD 3174	3	3	6	7	9	4	5	9
106	HI 1604	1	5	7	7	9	5	6	9
107	HI 1605	1	3	7	7	9	6	6	9
108	HUW 688	1	5	9	7	9	7	6	9
109	K 1312	1	1	8	5	9	3	5	9
110	K 1313	3	3	8	7	9	3	6	9
111	K 1314	1	1	7	5	9	3	4	9
112	MACS 3949	1	3	7	5	9	6	5	9
113	MACS 4024	3	3	6	7	9	6	6	9
114	NW 6024	N. S.	N. S.	N. S.	N. S.	N S	N. S.	N. S.	N S
115	PBW 707	3	7	4	7	9	5	6	9
116	PBW 709	3	5	8	7	9	3	6	9
117	PBW 716	3	7	8	7	9	5	7	9
118	PBW 718	5	7	7	7	9	4	7	9
119	PBW 719	5	3	8	7	9	3	6	9
120	UP 2883	3	7	8	7	9	3	6	9
120A	PBW 343 (Check)	5	9	9	8	9	4	7	9
121	WH 1179	3	9	8	7	9	3	7	9
III. NORTH EASTERN PLAIN ZONE									
122	HD 3171	3	5	8	7	9	3	6	9
123	K 1317	3	3	7	7	1	3	4	7
IV. CENTRAL ZONE									
124	CG 1015	5	3	7	7	9	6	6	9
125	GW 463	7	1	8	8	9	4	6	9
126	HI 8759 (d)	7	3	8	7	9	7	7	9

S.No.	Entries	Almora	Pantnagar	Shimla	Malan	Dhaulakuan	Wellington	AV.	HS
V. PENINSULAR ZONE									
127	GW 1315 (d)	5	0	6	3	5	6	4	6
128	HD 3164	5	5	4	7	9	3	6	9
129	HI 8765 (d)	3	3	6	8	9	7	6	9
130	JWS 712	5	0	3	7	6	2	4	7
131	K 1315	3	5	4	5	5	2	4	5
132	MACS 3970 (d)	1	0	6	3	9	3	4	9
133	MACS 3972 (d)	3	0	3	5	1	3	3	5
134	MACS 4020 (d)	1	3	4	5	2	2	3	5
135	PBW 721	1	5	6	7	9	3	5	9
136	UAS 360	1	3	7	7	1	3	4	7
137	UAS 361	3	3	6	5	9	3	5	9
138	UAS 453 (d)	3	0	8	6	1	5	4	8
139	UAS 455 (d)	3	5	6	7	9	5	6	9
VI. SPECIAL TRIAL (Dicoccum and Sailinity and Alkalinity)									
140	DBW 181	1	3	7	5	1	6	4	7
140A	PBW 343 (Check)	5	9	7	7	8	5	7	9
141	DBW 182	5	3	6	7	3	4	5	7
142	DBW 183	3	0	2	7	9	4	4	9
143	DBW 184	3	3	3	5	1	3	3	5
144	DBW 185	3	5	6	7	3	4	5	7
145	DDK 1048	3	1	2	5	1	3	3	5
146	DDK 1049	1	1	7	5	3	3	3	7
147	KRL 350	1	3	7	5	6	2	4	7
148	KRL 351	3	1	6	7	3	2	4	7
149	MACS 5041	3	1	6	3	1	3	3	6
150	MACS 5043	3	3	8	7	9	3	6	9
151	WH 1309	5	5	7	5	6	5	6	7
VII. SPECIAL TRIAL (TRITICALE)									
152	TL 3001	1	0	8	0	1	3	2	8
153	TL 3002	1	3	0	0	1	3	1	3
154	TL 3003	1	0	0	0	1	3	1	3
155	TL 3004	1	0	0	0	1	2	1	2
156	TL 3005	1	0	0	0	1	2	1	2
VIII. SPECIAL TRIAL (MABB/NIL (KB) ENTRIES)									
157	DWR-NIL-01	5	5	0	7	9	3	5	9
158	DWR-NIL-02	5	3	8	7	9	5	6	9
159	HD 3209	1	1	8	7	9	4	5	9
160	KB 2012-03	5	7	7	7	2	5	6	7
160A	PBW 343 (Check)	5	9	7	7	9	6	7	9
IX. SPECIAL TRIAL (Wheat Biofortification)									
161	HPBW 01	1	0	4	0	1	3	2	4
162	HPBW 02	1	0	2	0	1	3	1	3
163	HPBW 05	1	3	4	5	5	3	4	5
164	HPBW 07	5	5	8	7	6	2	6	8
165	HPBW 08	1	3	8	7	6	2	5	8
166	HPBW 09	1	0	8	7	1	3	3	8
167	HUW 695	5	0	6	0	1	3	3	6

S.No.	Entries	Almora	Pantnagar	Shimla	Malan	Dhaulakuan	Wellington	AV.	HS
168	HUW 711	1	0	4	3	1	2	2	4
169	HUW 712	1	0	6	3	1	2	2	6
170	MACS 6507	1	3	4	7	9	3	5	9
171	WB 1	1	0	6	3	1	2	2	6
172	WB 2	5	0	6	3	1	2	3	6
173	WB 5	1	5	0	7	1	1	3	7
A. Resistant to (Av.0-3 Score, Highest Score up to 5)									
Source: AVT IInd Year 2004-05									
174	TL 2934 (T)	1	0	6	0	1	2	2	6
Source: AVT IInd Year 2007-08									
175	HW 1095	1	0	0	0	2	3	1	3
Source: AVT Ist Year 2013-14									
176	PBW 677	1	0	0	5	1	2	2	5
177	NIAW 2030	1	3	2	5	9	2	4	9
178	MACS 5031 (dic.)	1	1	6	0	1	3	2	6
179	MACS 5022 (dic.)	1	0	0	0	1	3	1	3
180	TL 2996 (T)	1	0	4	0	1	3	2	4
180A	PBW 343 (Check)	5	7	7	7	9	5	7	9
181	TL 2997 (T)	1	0	7	0	1	4	2	7
182	TL 2998 (T)	1	0	0	0	1	2	1	2
183	TL 2999 (T)	1	0	0	0	1	2	1	2
184	TL 3000 (T)	1	0	0	0	1	2	1	2

*Powdery Mildew Score (0-9)

PROGRAMME 7. REGION SPECIFIC DISEASES OF LIMITED IMPORTANCE

7.1 FUSARIUM HEAD BLIGHT (FHB) OR HEAD SCAB

Fusarium graminearum Schwabe (***Gibberella zeae*** **(Schwein) Petch.)**
Evaluation of AVT materials

Test Locations: Karnal , Dhaulakuan and Gurdaspur

AVT entries alongwith checks were evaluated under artificially inoculated conditions at Karnal and Dhaulakuan in polyhouse. *Fusarium graminearum* culture was supplied to Dhaulakuan center by IIWBR, Karnal for artificial inoculation. Disease development was good at all centres. Disease scoring scale (0-5) has been used. Entry-wise reaction of AVT-II and AVT-Ist year entries (2014-2015) has been given in Tables 7.1 and 7.2, respectively. Data for 2nd year entries has also been given in Table 1.5. On the basis of highest score, none of the genotype was found resistant. Following lines showed moderate resistance (av. Score upto 2):

AVT 2nd Year

HS 562, HPW 251 (C), MP 1277, WH 1080 (C), K 8027 (C) and TL 2942 (C)

AVT 1st Year

HPW 394, HPW 413, HPW 421, HS 583, HS 590, HS 596, HS 597, HS 598, UP 2918, VL 1005, VL 1006, VL 4001, DBW 150, K 1317, MACS 4020 (d), UAS 360, DBW 184, MACS 5041, MACS 5043, DWR NIL 02

COOPERATORS

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JASPAL KAUR	GURDASPUR
P. NALLATHAMBI & C. UMA MAHESHWARI	WELLINGTON

Table 7.1. Performance of AVT 2nd year material against head scab under multilocational testing during 2014-2015

S. No.	Entry	Wellington	Dhaulakuan	Gurdaspur	Karnal	HS	AV
AVT II nd Year							
	I. NORTHERN HILL ZONE						
1	HS 562	0	3	0	3	3	2
2	HPW 251(C)	1	4	0	3	4	2
3	HPW 349 (C)	1	4	2	3	4	3
4	HS 375 (C)	1	5	0	-	5	3
5	HS 490 (C)	1	5	0	3	5	3
6	HS 507 (C)	1	5	0	3	5	3
7	HS 542 (C)	1	5	0	3	5	3
8	VL 804 (C)	1	5	0	3	5	3
9	VL 829 (C)	2	5	0	3	5	3
10	VL 892 (C)	1	5	0	3	5	3
11	VL 907 (C)	1	5	0	3	5	3
II. NORTH WESTERN PLAIN ZONE							
12	HD 4730	1	3	3	3	3	3
13	MP 1277	1	2	0	3	3	2
14	WH 1164	1	3	0	5	5	3
15	DBW 88 (C)	1	4	0	4	4	3

S. No.	Entry	Wellington	Dhaulakuan	Gurdaspur	Karnal	HS	AV
16	DBW 90 (C)	1	5	0	4	5	3
17	DPW 621-50 (C)	1	5	0	4	5	3
18	HD 2967 (C)	1	5	3	5	5	4
19	HD 3043 (C)	1	4	0	4	4	3
20	HD 3059 (C)	1	5	0	3	5	3
21	HD 3086 (C)	1	4	0	5	5	3
22	PBW 644 (C)	2	4	0	3	4	3
23	PDW 233 (C)	2	5	5	4	5	4
24	PDW 291 (C)	2	5	5	3	5	4
25	PDW 314 (C)	1	5	5	3	5	4
26	WH 1021(C)	1	4	0	5	5	3
27	WH 1080(C)	1	3	0	3	3	2
28	WH 1105(C)	1	5	0	4	5	3
29	WH 1124(C)	1	5	0	-	5	3
30	WH 1142 (I)(C)	1	5	0	3	5	3
III. NORTH EASTERN PLAIN ZONE							
31	C 306 (C)	1	5	2	4	5	3
32	HD 2888 (C)	1	5	0	5	5	3
33	K 8027 (C)	1	4	0	3	4	2
IV. CENTRAL ZONE							
34	HD 4728 (d)	1	3	5	3	5	3
35	HD4730 (d)	1	3	4	3	4	3
36	GW 322 (C)	1	5	0	4	5	3
37	HD 2864 (C)	2	5	0	5	5	3
38	HD 2932 (C)	1	5	0	5	5	3
39	HI 1544 (C)	1	5	0	5	5	3
40	HI 8498 (C) (d)	1	4	3	4	4	3
41	HI 8737 (d) (I) (C)	2	4	5	4	5	4
42	MP 3336 (C)	1	5	0	5	5	3
43	MP 4010 (C)	1	4	0	4	4	3
44	MPO 1215 (d) (C)	1	4	5	3	5	4
V. PENINSULAR ZONE							
45	MACS 3927 (d)	0	2	5	5	5	3
46	NIAW 2030	0	3	0	5	5	3
47	AKDW 2997-16 (d) (C)	1	5	0	4	5	3
48	DBW 93 (I) (C)	1	5	0	3	5	3
49	MACS 6222 (C)	2	5	1	3	5	3
50	MACS 6478 (C)	1	5	0	5	5	3
51	NI 5439 (C)	1	5	0	4	5	3
52	NIAW 1415 (C)	2	5	0	4	5	3
53	UAS 347 (I) (C)	1	5	0	5	5	3
54	UAS 428 (d) (C)	2	4	3	3	4	3
55	UAS 446 (d) (C) (I)	1	5	1	4	5	3
VII. SPECIAL TRIAL							
56	HD 2932+ Lr 19/Sr 25)	1	3	1	5	5	3
57	MMBL 283	1	3	0	5	5	3
58	PBW 723	1	4	0	4	4	3
59	DBW 14 (C)	2	5	0	5	5	3
60	DDK 1029 (C)	0	5	5	3	5	4
61	HD 2985 (C)	2	5	0	4	5	3
62	HI 1563 (C)	2	5	0	4	5	3
63	HUW 234 (C)	1	3	0	5	5	3
64	HW 1098 (C)	0	5	0	3	5	3

S. No.	Entry	Wellington	Dhaulakuan	Gurdaspur	Karnal	HS	AV
65	K 0307 (C)	2	5	0	5	5	3
66	Kharchia 65 (C)	2	5	0	5	5	3
67	KRL 19 (C)	1	4	0	4	4	3
68	KRL 210 (C)	2	5	0	5	5	3
69	PBW 343 (C)	1	5	0	5	5	3
70	RAJ 4083 (C)	2	4	0	5	5	3
71	TL 2942 (C)	0	4	0	3	4	2
72	TL 2969 (C)	1	4	0	5	5	3
73	WH 542 (C)	1	5	5	4	5	4

Table 7.2. Performance of AVT 1st year material against head scab (% incidence) under multilocational testing during 2014-2015

S. No.	Entry	Wellington	Dhaulakuan	Gurdaspur	Karnal	HS	AV
AVT Ist Year							
I. NORTHERN HILL ZONE							
1	HPW 393	1	2	1	5	5	3
2	HPW 394	1	3	1	3	3	2
3	HPW 413	1	3	0	4	4	2
4	HPW 421	0	3	1	4	4	2
5	HPW 422	1	4	1	5	5	3
6	HS 580	0	5	0	4	5	3
7	HS 583	0	3	1	3	3	2
8	HS 590	0	2	0	3	3	2
9	HS 596	0	2	0	3	3	2
10	HS 597	1	0	2	3	3	2
11	HS 598	1	3	0	3	3	2
12	HS 599	1	4	0	4	4	3
13	HS 600	1	4	3	3	4	3
14	HS 601	1	3	3	5	5	3
15	UP 2917	0	2	3	4	4	3
16	UP 2918	0	3	0	3	3	2
17	VL 1005	1	3	0	4	4	2
18	VL 1006	0	2	0	4	4	2
19	VL 1007	0	5	0	4	5	3
20	VL 3002	1	5	0	5	5	3
21	VL 3007	1	4	0	5	5	3
22	VL 3008	1	4	0	4	4	3
23	VL 3009	1	3	0	5	5	3
24	VL 4001	2	2	0	3	3	2
II. NORTH WESTERN PLAIN ZONE							
25	DBW 147	1	2	0	5	5	3
26	DBW 148	1	2	0	5	5	3
27	DBW 150	1	3	0	4	4	2
28	DDW 31	1	3	4	3	4	3
29	DDW32	1	4	5	5	5	4
30	HD 3159	2	4	0	4	4	3
31	HD3165	1	5	0	5	5	3
32	HD 3174	1	5	0	5	5	3
33	HI 1604	1	5	0	5	5	3
34	HI 1605	1	5	0	5	5	3
35	HUW 688	1	4	0	5	5	3
36	K 1312	2	1	0	5	5	3

S. No.	Entry	Wellington	Dhaulakuan	Gurdaspur	Karnal	HS	AV
37	K 1313	1	3	1	4	4	3
38	K 1314	1	4	0	5	5	3
39	MACS 3949	0	5	3	5	5	4
40	MACS 4024	1	5	3	5	5	4
41	NW 6024	-	-	-	-	0	0
42	PBW 707	0	5	0	5	5	3
43	PBW 709	1	5	0	4	5	3
44	PBW 716	1	5	0	4	5	3
45	PBW 718	1	5	0	5	5	3
46	PBW 719	1	5	0	5	5	3
47	UP 2883	1	5	1	4	5	3
48	WH 1179	1	4	0	5	5	3
III. NORTH EASTERN PLAIN ZONE							
49	HD 3171	1	3	1	5	5	3
50	K 1317	1	3	0	3	3	2
IV. CENTRAL ZONE							
51	CG 1015	1	2	0	5	5	3
52	GW 463	2	3	2	5	5	3
53	HI 8759 (d)	1	5	4	5	5	4
V. PENINSULAR ZONE							
54	GW 1315 (d)	1	5	3	5	5	4
55	HD 3164	1	4	-	4	4	3
56	HI 8765 (d)	1	5	0	5	5	3
57	JWS 712	1	5	0	5	5	3
58	K 1315	1	5	0	5	5	3
59	MACS 3970 (d)	1	5	3	5	5	4
60	MACS 3972 (d)	1	5	5	5	5	4
61	MACS 4020 (d)	1	3	0	3	3	2
62	PBW 721	2	2	0	5	5	3
63	UAS 360	1	1	0	5	5	2
64	UAS 361	1	2	2	5	5	3
65	UAS 453 (d)	1	5	4	5	5	4
66	UAS 455 (d)	1	3	5	3	5	3
VI. SPECIAL TRIAL (Dicoccum and salinity and Alkalinity)							
67	DBW 181	1	4	1	4	4	3
68	DBW 182	1	4	0	5	5	3
69	DBW 183	0	4	0	5	5	3
70	DBW 184	0	4	0	3	4	2
71	DBW 185	1	4	0	4	4	3
72	DDK 1048	0	5	4	4	5	4
73	DDK 1049	0	5	4	4	5	4
74	KRL 350	1	5	3	5	5	4
75	KRL 351	1	5	0	5	5	3
76	MACS 5041	0	0	3	4	4	2
77	MACS 5043	0	0	3	4	4	2
78	WH 1309	1	5	0	5	5	3
VII. SPECIAL TRIAL (TRITICALE)							
79	TL 3001	1	3	0	5	5	3
80	TL 3002	1	4	0	5	5	3
81	TL 3003	1	5	0	5	5	3
82	TL 3004	1	3	0	5	5	3
83	TL 3005	1	4		5	5	4
VIII. SPECIAL TRIAL (MABB/ NIL (KB) ENTRIES)							

S. No.	Entry	Wellington	Dhaulakuan	Gurdaspur	Karnal	HS	AV
84	DWR-NIL-01	2	2	0	5	5	3
85	DWR-NIL-02	1	1	0	5	5	2
86	HD 3209	0	4	0	5	5	3
87	KB 2012-03	1	4	0	5	5	3
IX. SPECIAL TRIALS (Wheat Biofortification)							
88	HPBW 01	0	5	1	5	5	3
89	HPBW 02	1	5	3	5	5	4
90	HPBW 05	1	5	0	5	5	3
91	HPBW 07	1	5	0	5	5	3
92	HPBW 08	1	5	3	-	5	4
93	HPBW 09	2	4	0	3	4	3
94	HUW 695	1	3	3	5	5	3
95	HUW 711	1	5	0	5	5	3
96	HUW 712	1	-	0	5	5	3
97	MACS 6507	1	5	0	5	5	3
98	WB1	1	4	0	5	5	3
99	WB2	0	4	0	5	5	3
100	WB5	0	3	0	5	5	3

7.2 FLAG SMUT, *Urocystis agropyri* (Preuss) Sch.

Test Locations: Karnal, Hisar, Ludhiana and Durgapura
Flag smut is soil and externally seed bone disease caused by *Urocyctis agropyri*. The spore of the pathogen can survive for longer period in the soil. Disease development was good at all the centres. In AVT-2nd year genotypes (2014-15), the highest disease level of 64.7 per cent was observed in check variety HI 1563 at Durgapura centre. Entry-wise reaction of AVT-II and AVT-Ist year entries (2014-15) has been given in Tables 7.3 and 7.4, respectively. Data for 2nd year entries has also been given in Table 1.5. The entries mentioned below were found resistant (upto 10 % average disease incidence) at all the three centres.

AVT IInd Year 2014-15

Free: VL 804 (C), VL 829 (C), HD 4730, WH 1164, HD 3043 (C), PDW 233 (C), PDW 291 (C), PDW 314 (C), WH 1105 (C), K 8027 (C), HD 4728 (d), HD 4730 (d), HI 8498 (D) (C), MP 4010 (C), MPO 1215 (d) (C), MACS 3927 (d), AKDW 2997-16(d) (C), UAS 428 (d) (C), UAS 446 (d) (I) (C), (HD 2932 + Lr 19/Sr25), DDK 1029 (C), HW 1098 (C), K 0307 (C), TL 2942 (C) and TL 2969 (C)

Resistant (upto 10% infection): HS 562, HPW 251 (C), HS 375 (C), HS 507 (C), HS 542 (C), VL 892 (C), VL 907 (C), MP 1277, DBW 88 (C), DBW 90 (C), DPW 621-50 (C), HD 2967 (C), HD 3059 (C), HD 3086 (C), PBW 644 (C), WH 1021 (C), WH 1080 (C), WH 1124 (C), WH 1142 (I) C), GW 322 (C), HD 2864 (C), HI 8737 (D)(I) (C), MP 3336 (C), DBW 93 (I) (C), MACS 6222 (C), MACS 6478 (C), NI 5439 (C), NIAW 1415 (C), UAS 347 (I) (C), MMBL 283, DBW 14 (C), HD 2985 (C), HUW 234 (C), KRL 19 (C) and KRL 210 (C)

AVT Ist Year 2014-15

Free: HPW 393, HPW 413, HPW 422, HS 580, HS 590, HS 596, HS 598, HS 599, HS 600, VL 1005, VL 1006, VL 1007, VL 3002, DDW 31, HI 1604, HUW 688, MACS 3949, MACS 4024, PBW 718, PBW 719, K 1317, HI 8759 (d), GW 1315 (d), JWS 712, MACS 3970 (d), MACS 4020 (d), DBW 182, DBW 183, DBW 184, DBW 185, KRL 351, MACS

5043, WH 1309, TL 3001, TL 3002, TL 3003, TL 3004, TL 3005, HD 3209, HPBW 01, HPBW 02, HPBW 09, HUW 695, HUW 711, MACS 6507, WB 2 and WB 5

Resistant (upto 10% infection): HPW 394, HPW 421, HS 583, HS 597, HS 601, UP 2917, UP 2918, VL 3007, VL 3008, VL 3009, VL 4001, DBW 147, DBW 148, DBW 150, DDW 31, DDW 32, HD 3159, HD 3165, HD 3174, HI 1605, K 1312, K 1313, K 1314, PBW 707, PBW 709, PBW 716, UP 2883, WH 1179, HD 3171, CG 1015, GW 463, HD 3164, HI 8765 (d), K 1315, MACS 3972 (d), PBW 721, UAS 360, UAS 361, UAS 453 (d), UAS 455 (d), DBW 181, DDK 1048, DDK 1049, KRL 350, MACS 5041, KB 2012-13, HPBW 05, HPBW 07, HPBW 08, HUW 712 and WB 1

COOPERATORS

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SUDHEER KUMAR	KARNAL

Table 7.3. Performance of AVT 2nd year material against flag smut (% incidence) under multilocational testing during 2014-15

S.No.	Entry	Ludhiana	Hisar	Durgapura	Karnal	HS	AV
I. NORTHERN HILL ZONE							
1	HS 562	9.1	0	0	2.2	9.1	2.8
2	HPW 251 (C)	5.3	0	0	0	5.3	1.3
3	HPW 349 (C)	0	4.2	37.7	1.5	37.7	10.8
4	HS 375 (C)	8.3	0	0	0	8.3	2.1
5	HS 490 (C)	18.2	0	22.2	0	22.2	10.1
6	HS 507 (C)	5.9	0	0	0.6	5.9	1.6
7	HS 542 (C)	0	0	0	0.7	0.7	0.2
8	VL 804 (C)	0	0	0	0	0.0	0.0
9	VL 829 (C)	0	0	0	0	0.0	0.0
10	VL 892 (C)	28.6	0	0	0	28.6	7.1
11	VL 907 (C)	0	0	40.0	0	40.0	10.0
II. NORTH WESTERN PLAIN ZONE							
12	HD 4730	0	0	0	0	0.0	0.0
13	MP 1277	5.3	0	0	0	5.3	1.3
14	WH 1164	0	0	0	0	0.0	0.0
15	DBW 88 (C)	18.8	0	0	0	18.8	4.7
16	DBW 90 (C)	18.2	2.2	0	0	18.2	5.1
17	DPW 621-50 (C)	13.3	0	0	2.0	13.3	3.8
18	HD 2967 (C)	13.0	2.2	0	1.9	13.0	4.3
19	HD 3043 (C)	0	0	0	0	0.0	0.0
20	HD 3059 (C)	11.8	0	27.3	0.8	27.3	10.0
20A	PBW 343(Check)	16.7	21.3	52.4	0	52.4	22.6
21	HD 3086 (C)	3.7	0	0	0	3.7	0.9
22	PBW 644 (C)	14.3	5.2	8.3	4.7	14.3	8.1
23	PDW 233 (C)	0	0	0	0	0.0	0.0
24	PDW 291 (C)	0	0	0	0	0.0	0.0
25	PDW 314 (C)	0	0	0	0	0.0	0.0
26	WH 1021 (C)	14.8	0	18.2	0.7	18.2	8.4
27	WH 1080 (C)	12.5	0	0	0	12.5	3.1
28	WH 1105 (C)	0	0	0	0	0.0	0.0
29	WH 1124 (C)	12.5	0	0	0.7	12.5	3.3

S.No.	Entry	Ludhiana	Hisar	Durgapura	Karnal	HS	AV
30	WH 1142 (I) C)	10.5	4.2	0	1.2	10.5	4.0
III. NORTH EASTERN PLAIN ZONE							
31	C 306 (C)	14.3	10.9	38.5	0	38.5	15.9
32	HD 2888 (C)	20.0	2.6	20.0	0	20.0	10.7
33	K 8027 (C)	0	0	0	0	0.0	0.0
IV. CENTRAL ZONE							
34	HD 4728 (d)	0	0	0	0	0.0	0.0
35	HD 4730 (d)	0	0	0	0	0.0	0.0
36	GW 322 (C)	27.3	0	0	0.9	27.3	7.0
37	HD 2864 (C)	18.8	0	0	2.0	18.8	5.2
38	HD 2932 (C)	42.9	0	0	1.0	42.9	11.0
39	HI 1544 (C)	16.7	3.2	53.3	11.2	53.3	21.1
40	HI 8498 (D) (C)	0	0	0	0	0.0	0.0
40A	PBW 343(Check)	13.3	13.7	42.1	0	42.1	17.3
41	HI 8737 (D)(I) (C)	0	0	0	2.0	2.0	0.5
42	MP 3336 (C)	0	3.3	33.3	0	33.3	9.2
43	MP 4010 (C)	0	0	0	0	0.0	0.0
44	MPO 1215 (d) (C)	0	0	0	0	0.0	0.0
V. PENINSULAR ZONE							
45	MACS 3927 (d)	0	0	0	0	0.0	0.0
46	NIAW 2030	10.5	0	36.4	0	36.4	11.7
47	AKDW 2997-16(d) (C)	0	0	0	0	0.0	0.0
48	DBW 93 (I) (C)	29.4	0	0	0	29.4	7.4
49	MACS 6222 (C)	14.3	0	14.3	0.9	14.3	7.4
50	MACS 6478 (C)	10.5	0	0	6.7	10.5	4.3
51	NI 5439 (C)	12.5	0	20.0	0	20.0	8.1
52	NIAW 1415 (C)	14.3	0	0	0	14.3	3.6
53	UAS 347 (I) (C)	16.0	0	0	0.8	16.0	4.2
54	UAS 428 (d) (C)	0	0	0	0	0.0	0.0
55	UAS 446 (d) (I) (C)	0	0	0	0	0.0	0.0
VII. SPECIAL TRIAL							
56	(HD 2932 + Lr 19/Sr25)	0	0	0	0	0.0	0.0
57	MMBL 283	0	0	0	1.2	1.2	0.3
58	PBW 723	33.3	0	29.4	1.9	33.3	16.2
59	DBW 14 (C)	8.7	5.2	4.0	5.7	8.7	5.9
60	DDK 1029 (C)	0	0	0	0	0.0	0.0
60A	PBW 343(Check)	11.1	15.7	32.5	0	32.5	14.8
61	HD 2985 (C)	4.6	0	21.4	2.9	21.4	7.2
62	HI 1563 (C)	15.8	6.3	64.7	11.1	64.7	24.5
63	HUW 234 (C)	5.6	0	0	0	5.6	1.4
64	HW 1098 (C)	0	NG	0	0	0.0	0.0
65	K 0307 (C)	0	0	0	0	0.0	0.0
66	Kharchia 65 (C)	0	0	51.9	1.6	51.9	13.4
67	KRL 19 (C)	4.8	0	15.4	0	15.4	5.0
68	KRL 210 (C)	9.1	0	0	0	9.1	2.3
69	PBW 343 (C)	14.3	12.5	61.1	2.5	61.1	22.6
70	Raj 4083 (C)	13.0	12.7	30.8	2.9	30.8	14.8
71	TL 2942 (C)	0	0	0	0	0.0	0.0
72	TL 2969 (C)	0	0	0	0	0.0	0.0
73	WH 542 (C)	27.3	4.2	23.5	4.8	27.3	15.0

Table 7.4. Performance of AVT 1st year material against flag smut (% incidence) under multilocational testing during 2014-15

S.No.	Entry	Ludhiana	Hisar	Durgapura	Karnal	HS	AV
I. NORTHERN HILL ZONE							
1	HPW 393	0	0	0.0	0	0.0	0.0
2	HPW 394	9.1	2.1	31.8	0	9.1	3.7
3	HPW 413	0	0	0	0	0.0	0.0
4	HPW 421	11.8	0	0	0	11.8	2.9
5	HPW 422	0	0	0	0	0.0	0.0
6	HS 580	0	0	0	0	0.0	0.0
7	HS 583	5.6	0	18.8	2.2	18.8	6.6
8	HS 590	0	0	0	0	0.0	0.0
9	HS 596	0	0	0	0	0.0	0.0
10	HS 597	0	2.1	0	0	2.1	0.5
11	HS 598	0	0	0	0	0.0	0.0
12	HS 599	0	0	0	0	0.0	0.0
13	HS 600	0	0	0	0	0.0	0.0
14	HS 601	12.5	0	16.0	0	16.0	7.1
15	UP 2917	0	4.1	0	0	4.1	1.0
16	UP 2918	4.6	5.7	0	0	5.7	2.6
17	VL 1005	0	0	0	0	0.0	0.0
18	VL 1006	0	0	0	0	0.0	0.0
19	VL 1007	0	0	0	0	0.0	0.0
20	VL 3002	0	0	0	0	0.0	0.0
21	VL 3007	0	2.2	0	0	2.2	0.5
22	VL 3008	0	0	33.3	1.2	33.3	8.6
23	VL 3009	13.0	0	10.0	2.8	13.0	5.3
24	VL 4001	0	12.1	0.00	0	12.1	4.0
II. NORTH WESTERN PLAIN ZONE							
25	DBW 147	0	0	0.00	0.9	0.9	0.3
26	DBW 148	0	0	6.7	7.3	7.3	2.4
27	DBW 150	10.0	0	16.7	9.3	10.0	6.4
28	DDW 31	0	0	0.00	0	0.0	0.0
29	DDW 32	0	0	0.00	1.3	1.3	0.4
30	HD 3159	4.8	0	5.9	0	4.8	1.6
31	HD 3165	5.9	0	28.5	0	5.9	2.0
32	HD 3174	4.6	0	0	0	4.6	1.1
33	HI 1604	0	0	0	0	0.0	0.0
34	HI 1605	0	3.9	0	0	3.9	1.0
35	HUW 688	0	0	0	0	0.0	0.0
36	K 1312	0	1.1	0	0	1.1	0.3
37	K 1313	0	0	10.5	2.8	2.8	0.9
38	K 1314	8.3	0	12.5	1.6	8.3	3.3
39	MACS 3949	0	0	0.0	0	0.0	0.0
40	MACS 4024	0	0	28.6	0	0.0	0.0
41	NW 6024	No Seed	No Seed	No Seed	No Seed	No Seed	No Seed

S.No.	Entry	Ludhiana	Hisar	Durgapura	Karnal	HS	AV
42	PBW 707	0	0	0.0	0.7	0.7	0.2
43	PBW 709	0	0	0.0	1.4	1.4	0.5
44	PBW 716	8.3	4.1	21.1	3.1	8.3	5.2
45	PBW 718	0	0	0.0	0	0.0	0.0
46	PBW 719	0	0	0.0	0	0.0	0.0
47	UP 2883	15.4	4.8	18.5	0	15.4	6.7
48	WH 1179	0	2.3	20.0	0	2.3	0.8
III. NORTH EASTERN PLAIN ZONE							
49	HD 3171	5.0	0	0.0	0.8	5.0	1.9
50	K 1317	0	0	0.0	0	0.0	0.0
IV. CENTRAL ZONE							
51	CG 1015	0	6.3	0.0	0	6.3	2.1
52	GW 463	0	4.1	30.8	5.1	5.1	3.1
53	HI 8759 (d)	0	0	0.0	0	0.0	0.0
V. PENINSULAR ZONE							
54	GW 1315 (d)	0	0	0.0	0	0.0	0.0
55	HD 3164	8.7	3.7	13.3	1.3	8.7	4.6
56	HI 8765 (d)	0	0	0.0	1.2	1.2	0.4
57	JWS 712	0	0	21.1	0	0.0	0.0
58	K 1315	5.0	0	14.3	0	5.0	1.7
59	MACS 3970 (d)	0	0	0.0	0	0.0	0.0
60	MACS 3972 (d)	0	0	0.0	1.5	1.5	0.5
61	MACS 4020 (d)	0	0	0.0	0	0.0	0.0
62	PBW 721	0	1.2	0.0	0	1.2	0.4
63	UAS 360	0	0	0.0	3.5	3.5	1.2
64	UAS 361	0	0	0.0	3.7	3.7	1.2
65	UAS 453 (d)	0	0	0.0	2.0	2.0	0.7
66	UAS 455 (d)	0	0	0.0	3.0	3.0	1.0
VI. SPECIAL TRIAL (Dicoccum and Sailinity and Alkalinity)							
67	DBW 181	0	0	13.0	0	13.0	3.3
68	DBW 182	0	0	0.0	0	0.0	0.0
69	DBW 183	0	0	0.0	0	0.0	0.0
70	DBW 184	0	0	0.0	0	0.0	0.0
71	DBW 185	0	0	0.0	0	0.0	0.0
72	DDK 1048	0	0	0.0	4.5	4.5	1.5
73	DDK 1049	0	0	0.0	7.4	7.4	2.5
74	KRL 350	6.3	1.1	10.0	3.1	6.3	3.5
75	KRL 351	0	0	0.0	0	0.0	0.0
76	MACS 5041	0	0	0.0	2.7	2.7	0.9
77	MACS 5043	0	0	0.0	0	0.0	0.0
78	WH 1309	0	0	0.0	0	0.0	0.0
VII. SPECIAL TRIAL (TRITICALE)							
79	TL 3001	0	0	0.0	0	0.0	0.0
80	TL 3002	0	0	0.0	0	0.0	0.0
81	TL 3003	0	0	0.0	0	0.0	0.0
82	TL 3004	0	0	0.0	0	0.0	0.0

S.No.	Entry	Ludhiana	Hisar	Durgapura	Karnal	HS	AV
83	TL 3005	0	0	0.0	0	0.0	0.0
VIII. SPECIAL TRIAL (MABB/NIL (KB) ENTRIES)							
84	DWR-NIL-01	30.0	2.6	15.8	0	30.0	10.9
85	DWR-NIL-02	26.7	3.2	0.0	10.4	26.7	13.4
86	HD 3209	0	0	0.0	0	0.0	0.0
87	KB 2012-03	0	10.7	0.0	4.5	10.7	5.1
IX. SPECIAL TRIAL (Wheat Biofortification)							
88	HPBW 01	0	0	0.0	0	0.0	0.0
89	HPBW 02	0	0	0.0	0	0.0	0.0
90	HPBW 05	0	3.2	0.0	0	3.2	1.1
91	HPBW 07	5.9	0	0.0	0.9	5.9	2.2
92	HPBW 08	10.0	1.6	0.0	0	10.0	3.9
93	HPBW 09	0	0	0.0	0	0.0	0.0
94	HUW 695	0	0	0.0	0	0.0	0.0
95	HUW 711	0	0	0.0	0	0.0	0.0
96	HUW 712	0	3.3	0.0	0	3.3	1.1
97	MACS 6507	0	0	0.0	0	0.0	0.0
98	WB 1	0	0	0.0	1.6	1.6	0.5
99	WB 2	0	0	0.0	0	0.0	0.0
100	WB 5	0	0	0.0	0	0.0	0.0

7.3 FOOT ROT (*Sclerotium rolfsii*)

Test Locations: Dharwad

AVT entries along with checks were evaluated at Dharwad centres. Disease data of Sagar was not received. AVT IInd year and AVT-Ist year (2014-2015) entries data were received from Dharwar. Entry-wise reaction of AVT IInd year and AVT-Ist has been given in Tables 7.5 and Table 7.6, respectively. Data for 2nd year entries has also been given in Table 1.5. The entries showing upto 5 and 10.00 per cent incidence were categorized as highly resistant and resistant, respectively and are listed below:

AVT IInd Year 2014-15
Resistant (5-10 % disease): PBW 644 (C), PBW 343 (C)

AVT Ist Year 2014-15
Resistant (5-10 % disease): WH 1309

COOPERATORS

NAME	CENTER
P.V. PATIL	DHARWAD

Table 7.5. Performance of AVT IInd year material against foot rot (% incidence) during 2014-2015

Sl. No.	Entries	Dharwar
AVT IInd Year		
I. NORTHERN HILL ZONE		
1	HS 562	33.33
2	HPW 251(C)	25.00
3	HPW 349 (C)	56.25
4	HS 375 (C)	56.25
5	HS 490 (C)	38.89
6	HS 507 (C)	44.44
7	HS 542 (C)	58.33
8	VL 804 (C)	35.71
9	VL 829 (C)	30.00
10	VL 892 (C)	37.50
11	VL 907 (C)	25.00
II. NORTH WESTERN PLAIN ZONE		
12	HD 4730	15.00
13	MP 1277	16.67
14	WH 1164	41.67
15	DBW 88 (C)	15.00
16	DBW 90 (C)	15.00
17	DPW 621-50 (C)	37.50
18	HD 2967 (C)	33.33
19	HD 3043 (C)	15.00
20	HD 3059 (C)	20.00
20A	INFECTOR	30.00
21	HD 3086 (C)	15.00
22	PBW 644 (C)	6.25
23	PDW 233 (C)	21.43
24	PDW 291 (C)	35.71
25	PDW 314 (C)	22.22
26	WH 1021(C)	50.00
27	WH 1080(C)	31.25
28	WH 1105(C)	22.22
29	WH 1124(C)	20.00
30	WH 1142 (I)(C)	45.00
III. NORTH EASTERN PLAIN ZONE		
31	C 306 (C)	33.33
32	HD 2888 (C)	30.00
33	K 8027 (C)	27.78
IV. CENTRAL ZONE		
34	HD 4728 (d)	40.00
35	HD 4730 (d)	21.43
36	GW 322 (C)	25.00
37	HD 2864 (C)	61.11

Sl. No.	Entries	Dharwar
38	HD 2932 (C)	15.00
39	HI 1544 (C)	16.67
40	HI 8498 (C) (d)	16.67
40A	INFECTOR	35.00
41	HI 8737 (d) (I) (C)	22.22
42	MP 3336 (C)	16.67
43	MP 4010 (C)	50.00
44	MPO 1215 (d) (C)	70.00
V. PENINSULAR ZONE		
45	MACS 3927 (d)	45.00
46	NIAW 2030	16.67
47	AKDW 2997-16 (d) (C)	25.00
48	DBW 93 (I) (C)	40.00
49	MACS 6222 (C)	37.50
50	MACS 6478 (C)	37.50
51	NI 5439 (C)	16.67
52	NIAW 1415 (C)	25.00
53	UAS 347 (I) (C)	15.00
54	UAS 428 (d) (C)	41.67
55	UAS 446 (d) (C) (I)	50.00
VII. SPECIAL TRIAL		
56	HD 2932+ Lr 19/Sr 25)	31.25
57	MMBL 283	42.86
58	PBW 723	18.75
59	DBW 14 (C)	33.33
60	DDK 1029 (C)	30.00
60A	INFECTOR	42.86
61	HD 2985 (C)	25.00
62	HI 1563 (C)	27.78
63	HUW 234 (C)	25.00
64	HW 1098 (C)	45.00
65	K 0307 (C)	30.00
66	Kharchia 65 (C)	18.75
67	KRL 19 (C)	45.00
68	KRL 210 (C)	25.00
69	PBW 343 (C)	10.00
70	RAJ 4083 (C)	27.78
71	TL 2942 (C)	25.00
72	TL 2969 (C)	60.00
73	WH 542 (C)	38.89
73 A	INFECTOR	31.25

Table 7.6. Performance of AVT 1st year material against foot rot (% incidence) during 2014-2015

S. No.	Entries	Dharwad
AVT Ist Year		
I. NORTHERN HILL ZONE		
1	HPW 393	38.9
2	HPW 394	27.8
3	HPW 413	20.0
4	HPW 421	16.7

S. No.	Entries	Dharwad
5	HPW 422	38.9
6	HS 580	22.2
7	HS 583	50.0
8	HS 590	21.4
9	HS 596	25.0
10	HS 597	33.3

S. No.	Entries	Dharwad
11	HS 598	11.1
12	HS 599	27.8
13	HS 600	25.0
14	HS 601	38.9
15	UP 2917	33.3
16	UP 2918	33.3
17	VL 1005	11.1
18	VL 1006	16.7
19	VL 1007	18.8
20	VL 3002	33.3
20A	INFECTOR	22.2
21	VL 3007	43.8
22	VL 3008	25.0
23	VL 3009	15.0
24	VL 4001	45.0
II. NORTH WESTERN PLAIN ZONE		
25	DBW 147	21.4
26	DBW 148	35.0
27	DBW 150	31.3
28	DDW 31	72.2
29	DDW32	27.8
30	HD 3159	22.2
31	HD3165	16.7
32	HD 3174	38.9
33	HI 1604	37.5
34	HI 1605	12.5
35	HUW 688	25.0
36	K 1312	44.4
37	K 1313	33.3
38	K 1314	22.2
39	MACS 3949	33.3
40	MACS 4024	37.5
40A	INFECTOR	16.7
41	NW 6024	-
42	PBW 707	44.4
43	PBW 709	16.7
44	PBW 716	27.8
45	PBW 718	16.7
46	PBW 719	27.8
47	UP 2883	31.3
48	WH 1179	25.0
III. NORTH EASTERN PLAIN ZONE		
49	HD 3171	31.3
50	K 1317	16.7
IV. CENTRAL ZONE		
51	CG 1015	31.3
52	GW 463	22.2
53	HI 8759 (d)	31.3
V. PENINSULAR ZONE		
54	GW 1315 (d)	81.3
55	HD 3164	18.8
56	HI 8765 (d)	50.0
57	JWS 712	16.7
58	K 1315	16.7
59	MACS 3970 (d)	18.8
60	MACS 3972 (d)	38.9
60A	INFECTOR	37.5
61	MACS 4020 (d)	31.3
62	PBW 721	22.2
63	UAS 360	25.0
64	UAS 361	33.3
65	UAS 453 (d)	18.8
66	UAS 455 (d)	38.9
VI. SPECIAL TRIAL (Dicoccum and salinity and Alkalinity)		
67	DBW 181	72.2
68	DBW 182	22.2
69	DBW 183	22.2
70	DBW 184	25.0
71	DBW 185	44.4
72	DDK 1048	44.4
73	DDK 1049	31.3
74	KRL 350	22.2
75	KRL 351	27.8
76	MACS 5041	37.5
77	MACS 5043	33.3
78	WH 1309	5.6
VII. SPECIAL TRIAL (TRITICALE)		
79	TL 3001	44.4
80	TL 3002	50.0
80A	INFECTOR	43.8
81	TL 3003	27.8
82	TL 3004	50.0
83	TL 3005	38.9
VIII. SPECIAL TRIAL (MABB/ NIL (KB) ENTRIES)		
84	DWR-NIL-01	55.6
85	DWR-NIL-02	11.1
86	HD 3209	40.0
87	KB 2012-03	40.0
IX. SPECIAL TRIALS (Wheat Biofortification)		
88	HPBW 01	30.0
89	HPBW 02	16.7
90	HPBW 05	25.0
91	HPBW 07	37.5
92	HPBW 08	44.4
93	HPBW 09	38.9
94	HUW 695	40.0
95	HUW 711	22.2
96	HUW 712	22.2
97	MACS 6507	18.8
98	WB1	15.0
99	WB2	30.0
100	WB5	18.8
100A	INFECTOR	11.1

7.4 HILL BUNT (*Tilletia foetida, T. caries*)

Test Locations: Almora, Bajoura and Malan

AVT entries were evaluated at three locations and disease development was good at all centres. The data was taken by counting infected and healthy ear heads, for calculating per cent infected ear heads. There were differences in the disease incidence at three locations, hence the highest disease level as well as average was considered and has been given in Table 7.7.

AVT IInd Year 2014-15
Free: Nil
Resistant (1-10 % disease): HPW 251(C), HS 490 (C), VL 804 (C) and VL 829 (C)

AVT Ist Year 2014-15
Free: VW 0751 and VW 0810
Resistant (1-10 % disease): HPW 393, HPW 413, HS 590, HS 598, HS 601, UP 2917, VL 1007, VL 3007, VL 3009, VL 4001, VW 0835, VW 0856 and VW 0924

COOPERATORS

NAME	CENTRE
S. K. JAIN	ALMORA
S. K. RANA	MALAN
DEVLASH KUMAR	BAJAURA
SUDHEER KUMAR	KARNAL

Table 7.7. Performance of AVT material against hill bunt (% incidence) under multilocational testing during 2014-2015

S. No.	Entry	Almora	Malan	Bajaura	HS	AV
AVT II nd Year						
I. NORTHERN HILL ZONE						
1	HS 562	10.8	28.9	38.9	38.9	26.2
2	HPW 251(C)	0.0	7.0	0.0	7.0	2.3
3	HPW 349 (C)	0.0	17.0	29.2	29.2	15.4
4	HS 375 (C)	16.0	13.5	7.2	16.0	12.2
5	HS 490 (C)	0.0	3.3	0.0	3.3	1.1
6	HS 507 (C)	0.0	5.2	27.1	27.1	10.8
7	HS 542 (C)	13.5	7.9	12.8	13.5	11.4
8	VL 804 (C)	0.0	3.2	2.8	3.2	2.0
9	VL 829 (C)	0.0	5.7	6.8	6.8	4.2
10	VL 892 (C)	2.0	-	35.1	35.1	18.6
11	VL 907 (C)	1.0	-	55.4	55.4	28.2
AVT Ist Year						
12	HPW 393	0.0	4.3	0.0	4.3	1.4
13	HPW 394	15.1	21.2	50.0	50.0	28.8
14	HPW 413	0.0	3.0	15.6	15.6	6.2
15	HPW 421	14.6	8.3	57.0	57.0	26.6
16	HPW 422	15.0	8.2	22.6	22.6	15.3
17	HS 580	0.0	33.6	57.7	57.7	30.4
18	HS 583	0.0	12.8	21.8	21.8	11.5
19	HS 590	0.0	2.9	11.3	11.3	4.7
20	HS 596	15.9	5.1	25.9	25.9	15.6

S. No.	Entry	Almora	Malan	Bajaura	HS	AV
20A	Infector	15.3	10.7	-	15.3	13.0
21	HS 597	14.6	11.0	5.3	14.6	10.3
22	HS 598	0.0	4.4	13.6	13.6	6.0
23	HS 599	13.7	6.8	40.2	40.2	20.2
24	HS 600	13.9	2.2	33.6	33.6	16.6
25	HS 601	0.0	11.6	11.0	11.6	7.5
26	UP 2917	14.4	14.1	0.0	14.4	9.5
27	UP 2918	14.1	19.6	7.1	19.6	13.6
28	VL 1005	0.0	7.2	26.8	26.8	11.3
29	VL 1006	0.0	26.6	44.4	44.4	23.7
30	VL 1007	0.0	8.5	0.0	8.5	2.8
31	VL 3002	3.1	14.6	13.0	14.6	10.2
32	VL 3007	0.0	0.0	18.6	18.6	6.2
33	VL 3008	4.7	3.0	22.6	22.6	10.1
34	VL 3009	0.0	0.0	28.1	28.1	9.4
35	VL 4001	0.0	0.0	28.8	28.8	9.6
Special material						
36	VW 0751	0.0	0.0	0.0	0.0	0.0
37	VW 0810	0.0	0.0	0.0	0.0	0.0
38	VW 0835	0.0	2.8	0.0	2.8	0.9
39	VW 0856	0.0	3.3	0.0	3.3	1.1
40	VW 0911	0.0	6.2	32.4	32.4	12.9
41	VW 0924	0.0	8.6	0.0	8.6	2.9
41A	Infector	10.6	20.4	-	20.4	15.5

PROGRAMME 8. CROP HEALTH

8.1 PRE- HARVEST CROP HEALTH MONITORING

Crop health was rigorously monitored during the crop season as well during the off season in the high hills of Himachal Pradesh (Lahaul, Spiti, Kullu), Nilgiri hills (Tamil Nadu) and J & K (Ladakh). Major focus was on the occurrence of yellow rust and surveillance for the stem rust pathotype, Ug99. Status of other diseases, including leaf rust was also monitored during these survey trips. The extensive surveys were also conducted by the wheat crop protection scientists of different cooperating centers including IIWBR Karnal. Special teams of scientists were also constituted during the 53rd All India Wheat Workers' Meet held at Jabalpur during August, 2014. Advisory for stripe rust management was issued during December-March regularly. Information on wheat crop health was disseminated through the "*Wheat Crop Health Newsletter*", Vol. 20 which was issued on monthly basis during the crop season. This was also put on IIWBR website (http://www.dwr.in). All the issues of the Newsletter brought out during the crop season, are given as an annexure at the end of this report. Except for the yellow rust in NHZ and NWPZ, the overall crop health status was satisfactory in the country. Details are given below:

Punjab

On December 8, 2014, Dr. Subash Katare conducted insect pest survey in villages, Mundiala Kalan(Ludhiana), Bakhada (Main Sirhand), Basant Pura (Fatehgarh) and in Karnal (Haryana). No insect pest was found in any wheat field. A team of scientist comprising of Dr Beant Singh (Assistant Entomologist) Wheat Section, and Dr Jaspal Kaur, Plant Pathologist, Department of Plant Breeding and Genetics, PAU, Ludhiana surveyed the wheat crop on 6 January, 2015 in different districts of Punjab enrouting Ladhowal, Rahon, Phillaur, Langroya, Nawanshahr Garshankar and adjoining areas. Mild incidence of pink stem borer was observed in some villages *viz.*, Ladhowal, Rasolpur and Longroya. Incidence of root aphid was also recorded in village Rasolpur. Termite damage (1-2 %) was recorded in some fields near Rahon village. In general, the wheat crop was healthy and free from all major diseases of wheat.

On 24-12-2014, Dr. P.P.S Pannu, Senior Plant Pathologist, Department of Plant Pathology and Dr. (Mrs.) Jaspal Kaur, Plant Pathologist, PAU, Ludhiana visited the field area enroute Ludhiana-Samrala-Chamkaur Sahib-Ropar-Kiratpur Sahib-Anandpur Sahib-Noorpur Bedi-Nangal-Garhshankar-Pozewal-SBS, Nagar-Rahon-Macchiwara. In most of the areas, the crop condition was good, however yellow rust was reported in one field in the village Daroli Upper near Anandpur Sahib on unrecommended wheat variety Berbet. There was only one patch in an area of about 2 Kanal field. The concerned farmer Mr. Bahadur Singh was advised to spary the fungicide. He immediately sparyed Propiconazole (Tilt) on 24-12-2014. The farmer noticed this patcth of infection 5 days back (Probably on 19.12.2014).

Dr. R. Selvakumar, Sr. Scientist (Plant Pathology), IIWBR and Dr. (Mrs.) Jaspal Kaur, Plant Pathologist, PAU, Ludhiana conducted survey on December 28, 2014 in Nawan -Shahr, Harshankar, Balachur, Rahon, Machiiwara and Prata Garh areas for observation of any plants / grasses showing stripe rust. The rust was not observed on any of the grasses / wheat fields.

In 2nd week of January, Dr. P. P. S. Pannu, Dr.(Mrs.) Jaspal Kaur, Dr. Beant Singh, Mr. Gurinder Singh (PAU, Ludhiana), Mrs.Anju Bala (KVK Langroya, SBS Nagar), Dr. Ravinder Ghuman and Dr. Ashok Kumar (FASS & KVK, Ropar) observed one foci of infection of yellow rust each in villages of Chhidauri (on var. DBW-17) and Kharod (on var. HD-2967) in SBS Nagar and in Mohan Mazra (on var. HD 2967) in Ropar. During January 8-9, Dr. Sudheer Kumar (IIWBR, Karnal) and Dr. O. P. Gangwar (IIWBR Regional Station, Shimla) did not observe any rust in Ropar, Mohali and Ludhiana areas. Deputy Director (Training) KVK, Ropar reported appearance of yellow rust in the fields of Sh. Bhagvant Singh, Sh. Ajit Singh and Sh. Sarabjeet Singh of village Dakal, Ropar in variety HD 2967 on 29.1.2015.

A team of scientists comprising of Dr Jaspal Kaur, Plant Pathologist, Dr Achla Sharma, Assistant Breeder, Dr Beant Singh, Assistant Entomologist, Wheat Section, Department of Plant Breeding and Genetics, PAU, Ludhiana surveyed the wheat crop on 13^{th} February, 2015 in villages enrouting Ladhowal, Phillaur, Langroya, Balachour, Ropar and adjoining areas. In most of the areas the crop condition was good; however minor incidence of yellow rust was observed in few fields namely Langroya, Jagmeenpur, Rattewal etc. Minor incidence of aphid was also observed in all the places visited but it was severe in village Jagmeenpur (Ropar). In general, the wheat crop was healthy and free from all other diseases and insect pests.

On February 18, 2015, Dr. Sudheer Kumar, IIWBR and Dr. Sujay Dutta, ISRO, Ahemdabad observed yellow rust at farmers fields in villages Pasredi Jatta Chamkaur Sahib, Morinda and Ropar. Disease foci were of 2 m^2 but one foci was of 80S in100 m^2.

Survey of wheat crop for incidence of diseases was conducted by Dr P. P. S. Pannu, Sr. Plant Pathologist, Deptt. of Plant Pathology and Dr Jaspal Kaur, Plant Pathologist, Deptt of Plant Breeding and Genetics on 19.2.2015 on the route Ludhiana-Machhiwara-Rahon-Langroya-Saroa-Balachour-Ropar and adjoining areas. There was incidence of yellow rust in few villages on the route but from Langroya to Saroa, almost all the fields were infected with yellow rust but severity was very low (upto 10S) except for the village Diyall where one field (var. HD 2967) around one acre was severely infected with yellow rust (60S). In addition in the TRAP plot nurseries (TPN) sown at KVK Lngroya and KVK Ropar, symptoms of yellow rust were also observed. Brown rust upto 10S was also observed in entries in TPN planted at Gurdaspur.

Haryana

Dr. S. S. Karwasra, Head, Plant Pathology, CCS HAU, Hisar surveyed the wheat crop from Hisar to Kurukshetra on January 3, 2015. Most of the crop has been sown on normal date of sowing. However, about 10% farmers had sown wheat in 2nd week of December in areas where *basmati* rice was harvested late. Nearly about 20% farmers are still growing PBW 343. No rust was observed in any field. However, in some fields there was yellowing of the crop, that may be due to cold weather. Overall the crop stand was good. Dr. R. S. Taya, Pathologist, KVK, Damla (Yamunanagar) survey the farmers fields in Yamunanagar area during 1^{st} week of January, 2015. No rust was observed.

Dr. Subhash Katare (Sr. Scientist, Entomology, IIWBR, Karnal) visited wheat crop in Nissing area on December 4, 2014. Incidence of pink stem (*Sesemia inference*) borer was observed in some wheat fields in Nising area under rice-wheat cropping system. The farmers were advised to follow the recommended insecticide for insect management.

Dr. R. Selvakumar and Mr Ishwar Singh of IIWBR, Karnal visited the fields in Jagadhri on January 16, 2015. Stripe rust was observed (10 MS-S) in one field.
Survey was carried out by Dr. R. Selvakumar, Mr. Ishwar Singh along with Dr. R. S. Taya, KVK, Damla in Yamunanagar area. In Munda khera village, Chhachhurali, stripe rust was severe (40-60S) in 10m x 7 m area in the early sown crop (var. Barbat). The late sown crop is having few plants infected with yellow rust. In another field of Mr. Joneykumar, Pahadipur village, Sadhaura, Super 172 was infected with stripe rust (trace-10MS). The other fields were free from any rust.

On 27th Jan. 2015, Mr. Vipin Panwar, SRF, IIWBR, Karnal visited the TPN nursery planted at KVK, Saharanpur and no rust was observed.

On 28th Jan. 2015 Dr R. S. Taya informed about the appearance of yellow rust on variety HD 2851 at one farmers field in village Mahua Kheri, Babbain (Kurukshetra). Dr. Girish Naybal, DDA, Ambala informed on 31.1.2015 for appearance of yellow rust on the field of Sh. Sunder, village chhapra, Ambala. Dr Indu Sharma, Director, IIWBR and Dr. M.S. Saharan observed yellow rust (10S) in variety HD 2967 at Jaloda, Yamunanagar on 9.2.2015. Dr. Mangal Singh, IIWBR, surveyed Yamunanagar area on 12th Feb. 2015. Yellow rust was observed only at Bharwabgarh, Budhia (5S) and Fatehgarh (20 - 40S) villages. Dr. R. S. Beniwal surveyed the districts Hisar, Fatehabad and Sirsa on 5.2.2015. In Hisar district, there was no yellow rust. Yellow rust was noticed in village Ding on HD 2851 in Sirsa district in traces. There was no yellow rust incidence in Panniwala Mota and Bhagsar. No rust was observed in villages Matana, Dharnia, badopal and Kharakheri (Fatehabad).

On the way from Delhi to Chandigarh on Feb. 17, 2015, Dr S C Bhardwaj, Head, DWR Regional Station, Flowerdale, Shimla and Dr Sujay Dutta surveyed the wheat fields. On the way from Chandigarh to Karnal via Yamunanagar, yellow rust was observed in five fields. These were only 1-2 sq m foci on susceptible varieties. Dr. Sudheer Kumar, IIWBR and Dr. Sujay Dutta, ISRO, Ahemdabad observed some patches of yellow rust at village Khukhari Near Bilaspur (Yamunanagar) on Feb., 18, 2015. Mr. Surendra Singh, ADO and his team reported yellow rust in the village Shargarh (Karnal) on 19.2.2015.

Himachal Pradesh
On Jan.10-11, Dr. S. C. Bhardwaj surveyed different areas in Shimla, Solan and Bilaspur districts of HP. The wheat crop was in good condition and free from rusts.
Dr. S. K. Rana, Malan, Palampur conducted surveys in parts of Bhavarna, Nagrota Bagwan, Kangra, Dehra, Rait, Nagrota Surian and Fatehpur blocks of district Kangra during the last week of January. Yellow rust was recorded with minor incidence and severity less than 10S on PBW 550 at Nagrota Suria Dam area (Nagrota Surian block) and HD 2967 at Lunj Kahlian (Kangra block) and Bhanth (Fatehpur block). However, the disease was observed in severe form touching severity 60S on varietal mixture (Raj 3765 main) in a large patch (Focus) at Bhanth-Sthana (Fatehpur block). Wheat Disease Monitoring Nursery/ Trap Plot Nursery of wheat planted at SAREC Kangra, was found free from rust in the last week of January. Powdery mildew was recorded in severe form (5-6 on 0-9 scale) on varietal mixture (Raj 3765 main) at Bhanth-Sthana in Fatehpur block. Flag smut was also recorded at some locations in Nagrota Surian, Kangra and Fatehpur blocks with incidence varying from 2-7%. Yellowing of wheat crop due to water stagnation and low temperatures was observed at few locations

especially under Rice- wheat system. The grasses in vicinity of fields were critically examined/ observed for rusts, especially yellow rust but no rust was found.

Survey was conducted by Dr Dhanbir Singh, Principal Scientist (Plant Pathology), CSKHPKV HAREC, DhaulaKuan during the last week of January in Nahan and Paonta blocks of Sirmoor. No yellow rust appearance was noticed in the farmers field. However, yellowing of crop was recorded due to water stagnation in some fields near Kodhanwala. Severe attack of cut worms was recorded in one field in Khadar near Kolar village. Good rains were received during Jan. and low temperature was recorded with foggy weather. The crop condition was excellent in all the areas under survey. In hilly areas, crop condition was poor due to delayed sowing in rainfed areas. No rust and other diseases were recorded in Trap and SAARC nurseries.

Dr. Dhanbir Singh, conducted survey in Nahan and Paonta Blocks of Sirmour district on 4.2.2015 for recording the appearance of wheat diseases. Yellow rust was noticed in Barotiwala (Paonta) on wheat variety HD 2967 at 3-4 locations in traces. Yellow rust was also recorded in traces on local variety in village Shivpur. High severity of yellow rust up to 60S was recorded on HD 2967 and HD 2380 in village Bharapur on 16.2.2015. Similarly, high severity of yellow rust up to 40S noticed in village Kolar at three locations. However, mild incidence/infestation of powdery mildew and aphids were recorded in both the blocks under survey. Yellow rust in Trap and SAARC nurseries was recorded on 10.2.2015 on wheat varieties WL-711 (10S), HD-2329 (5S), Agra local (10S), HW2021 (10S), Lal Bhadur (10S), Kharchia mutant (10S), HP-1633 (5S), WH-147 (10S), Anna Purna (5S), HD 2189 (10S), Pak 81 (5S) and susceptible check (30S). Good rains were received on 18 &19th February.

Director Agriculture, Himachal Pradesh informed the status of yellow rust regularly during January-February. Yellow rust was reported from same places of district Bilaspur, Hamirpur, Kangra, Mandi, Sirmour and Una was in traces during 1st week of February. During 2nd week of February, yellow rust was observed in traces in Bilaspur (villages, Nanawan and Bhatoli), in Mandi (villages, Mehar, Surahi, Tandu), in Una (villages, Adarsh Nagar, Amb, Athwan, Krishna Nagar, Busal, Dehar, Badoh, Jalgran) and in Sirmour (villages, Dhaun, Bhangani, Nagal, Phoolpur, Shivpur, Subhkhera, Surajpur).

Jammu & Kashmir

On 8th January, 2015, Dr. M. K. Pandey surveyed the areas in the route starting from Anand Nagar to Udhywalla via Puni chak, Sari Rakhawllan, Gao Manahansa, Gajansoo and Marh. The presence of any yellow rust was not observed in any of the field of the farmers in the surveyed areas except two small pustules of brown rust and one pustules of yellow rust was observed in SAARC and TPN nursery (Village-Saharan) on Agra Local.

An extensive survey was carried out on 25th & 26th January, 2015 by Dr. M. K. Pandey, SKUAS&T, Jammu. On 25th January, 2015, fields were surveyed the areas in the route starting from Anand Nagar to Udhywalla via Puni chak, Sari Rakhawallan, Gao Manahansa, Gajansoo, Jiri and Mishriwalla (Jammu). During survey, stripe rust was observed on PBW-175 with some pustules with 5S severity at Lalyal Camp (Jammu) at the field of Yash Paul Sharma. One field of Oats was also severely affected with stripe rust and blight with 80S and 40% severity respectively. On 26th

January, 2015, fields were surveyed in Jammu, Kathua and Samba areas via Raipur, Khandwal, Chatha, R S Pura, Saikalan Ramgarh, Chadwal Rajbag and Khanpur. The field of Taj Ram (Chak Gogal) of wheat variety HD-2967, stripe rust was observed in 2-3 patches with 20MS severity. One field of Bal Dev Singh (Nagari, Kathua) many foci of stripe rust with severity of 10-20MS were observed. One field in Arnia of unknown wheat varieties was also infected with stripe rust (0.05 ha) with 10-20S severity. Stripe rust was also observed on wheat varieties HD-2967 and RSP-561 with 10-20MS severity in 4-5 patches (1 meter) in experimental field of Chatha, SKUAST - Jammu on 20th January.

On February 10, 2015, The farmer's fields were surveyed by Dr. Sudheer Kumar along with Dr. Vaibhav Kumar Singh, Scientist (Plant Pathology), Division of Plant Pathology, IARI, New Delhi and Dr M.K. Pandey, Scientist (Plant Pathology), SKUAST-Jammu observed four farmers field patches of yellow rust in Jammu and Samba district in Jammu region. These patched were of 2 - 10 m^2 with the severity of 10-60S. In area surveyed all the fields were found free from yellow rust infection.

Uttarakhand

Dr. Deepshikha, JRO, Plant Pathology, Dr. J.P. Jaiswal, Professor, Genetics and Plant Breeding and Dr. Kanak Srivastava, STA/Jr. Scientist, Plant Pathology surveyed Distt. Udham Singh Nagar Bazpur (Talli farm, Karbola and Doraha), Kashipur (Jaitpur, Jaganathpur and Bhogpur), Gadarpur (Mukundpur, Bagwala and Bhagwanpur), Dineshpur (Durgapur, Anandkhera and Makrandpur mauza), Rudarpur, Kichha (Shankar farm and Pulbhatta), Sitarganj (Gurunanak Farm, Manjeet farm, Kathni, Karghata and Khempur), Sara Saria, Nanakmatta and Khatima (Jhankat and Jungle Jogi kher), Kathgodam (Devlatalla, Madanpur, Golapar, Sitapur and Kuwarpur) and Gorapadao (Haripur Tularam) of Uttarakhand for yellow rust during January 21-23, 2015. No rust or any other insect pest was observed in any field. It was observed that small farmers of Sitarganj, Nanakmatta and Khatima are predominately growing rust susceptible varieties PBW 343, UP 2338 and PBW 373.
Wheat crop was monitored for rust in the farmers' field by Dr. Deepshikha, JRO ; Dr. Kanak Srivastava, STA Plant Pathology and Dr. Anil Kumar, J.R.O., Genetics and Plant Breeding on 16 Feb 2015 enroute Rudurpur (Vill. Jafarpur, Premnagar and Narainpur), Dineshpur, Gadarpur (Mukundpur, Langra bhoj, Motipur, Abadnagar, Kundan nagar and Chunpuri), Bajpur (vill. Bajpur, Tanda Azam, Maheshpur Doraha, and Namoona), and Bajpur (Vill. Khalo farm and Dehori yadav farm). The varieties sown in the areas were WH 1105, HD 2967, PBW 550, PBW 502, PBW 226, PBW 154 and PBW 343. The crop health was good, in some places yellow rust was observed in traces. One of the farmer's field at village Chunpuri (Gadarpur) yellow rust was observed in patches showing severity of 70S in PBW 343 (1Ha). On 18 Feb., 2015, area between Pantnagar and Khatima enroute Kichha (Vill. Shankar farm (Bhanga), Chacher farm, Pipalia and Gurunanak farm (Bari), Sitarganj (Katangari, Bara, Jungle jogi ther and Nakha farm), Nanakmatta and Khatima (Vill. Sara Saria, Jhankat, and Lohiyapul) were surveyed. Varieties sown in these areas are HD 2967, PBW 550, WH 711, PBW 226, DBW 17, PBW 343, PBW 373 and PBW 154. Yellow rust was in trace and in some area powdery mildew was also noticed. Survey was conducted from Pantnagar to Haldwani on 19 Feb, 2015, places visited were Golapar (Devlatalla, Kuwarpur naya gaon, Naya gaon Mehra and Sambal), Gorapadao (Haripur tula and Haripur punanand), Teenpani, Motinagar and Motahaldu. Varieties sown in these areas were HD 2967, PBW 154, UP 2425 and DBW 17. One of the farmer at Motinagar had sown RR- 21 in one Ha. Overall crop was good, rust was

not observed but between Pantnagar to Haldwani the problem of Powdery mildew was severe in many places.Survey reports were received from the Director, Agriculture, Uttarakhandregularly. No rust was reported during January-February in Uttarakhand.

Rajasthan

Survey was carried out on 14th and 15th January, 2015 in the area of Dausa and Jaipur districts by Dr K.K. Bhargava, Dr P.S. Shekhawat & Dr Nitin Chawla. None of the rust was observed in wheat and barley crop. However, 1-2 per cent incidence of flag smut was observed in variety Raj1482 and Raj 3077 at Lalsot area (Dausa) and in variety PBW 343 at Paota area of district Jaipur. In most of the area the wheat crop was at flag leaf stage (37-41 of Zadok's scale). Traces to 5 per cent Incidence of loose smut was noted in most of the barley fields having variety RD2035 and RD2552. Incidence of covered smut, *Drechslera* stripe and bacterial streak *in traces* were also noted in few fields of barley. The barley crop was at ear-head emergence to beginning of anthesis stage (54-60 of Zadok's scale). In some fields the early sowing crop of barley was facing infertility problem due to adverse effect of cold. Mild infestation of termite was also noted in few fields of wheat crop. Overall both wheat and barley crop were healthy in the area surveyed. During 16.2.2015 to 18.2.2015 a monitoring team comprising Dr. R. Selvakumar and Dr. Jogendra Singh from ICAR-IIWBR and Dr. Shekhawat from ARS, RAU, Durgapura visited farmers fields in SK Nagar (Gujarat), Udaipur (Rajasthan), Banswara (Rajasthan) and Kota, Rajasthan. There was no rust incidence in any of wheat and barley crop in the visited areas. Leaf blight and foliar aphids were present in few areas.

Maharashtra

Dr. B. K. Honrao conducted survey on 23rd and 30th January covering Ahmednagar district (Shrigonda, Loni and Belwandi) and Baramatitaluka of Pune district area respectively. First natural incidence of leaf rust was found in ARI germplasm nursery on 2nd February 2015. (varieties:- Agralocal, Morocco and *T. turgidum* sp. zukovsky). No natural incidence of rust was observed on farmer's fields. Incidence of foliar blight was observed in farmer's fields in Shrigonda area. Foliar blight incidence was also found on varieties like HD 2204, HW 2021, WH 147, LalBahadur, Gulab, HD 2189 and entries in coordinated trials .Viz. N-2-14, N-2-15, N-2-17, N-2-34, N-4-26 etc. with severity ranging upto 35. Aphids were observed in majority of farmer's fields with low to high population. In TPN nursery, foliar blight was observed and leaf rust just started appearing on Agra local (traces). Dr B C Game, Jr. Wheat Pathologist, Agricultural Research Station, Niphad visited the wheat disease monitoring nursery sown at Pimpalgaon Baswant on January 15, 2015. The nursery was free from rust. Incidence of leaf blight was recorded on two entries viz., WL 1562 (03) and HW 2021 (02). Survey was undertaken by Dr. B. C. Game and Mr.V. S. Pawar, Sr. Research Asstt. (Pathology) in Dindori and Surgana tehsils of Nashik district (Maharashtra) on 29/01/2015 for monitoring rust and other diseases of wheat crop on farmers field. The villages visited were, Materewadi, Jopul, Rajapur, Varkheda, Parmori, Lakhmapur, Karanjvan, Pimperkhed, Sangpada, Pandane and Sarat. The varieties grown in the area were NIAW 917, NIAW 34, Lok-1, Ajay 72, Ajeet 102, Mohan wonder etc. Incidence of rust was not observed in any field from the area surveyed. Majority of the fields were found infested with aphids. Leaf rust was observed on January 28, 2015 at the field of Mr. Santosh Shankar Gaikwad of village Kenjal (Satara), Maharashtra on var. Lok-1. On Feb. 16, 2015 Dr.Indu Sharma, Director, ICAR-IIWBR and Dr. R Chatrath, ICAR-IIWBR surveyed Farmers fields in Rahuri areas and observed no rusts.

Karnataka

Dr. P. V. Patil Principal Scientist (Plant Pathology), Dr. Arunkumar G. S. Research Associate and Dr. Sudhakar V. Kulkarni Technical Assistant, UAS., Dharwad conducted survey on January 2, 2014 in Lokur area of Dharwad. At the field of Shri. arasinganavar, leaf rust (40S) and spot blotch (46) were observed in Local bread wheat variety (parrot green colour ear head). The farmer planted the variety in four acres in rainfed condition.**UP**

No rust was observed. On 25th Feb. 2015 a monitoring team comprising Dr. R. Selvakumar and Dr. Vishnukumar from ICAR-IIWBR visited the farmers' fields as well as field trials in Mathura, Morena districts in Uttar Pradesh. There was no rust incidence in any of wheat and barley crop. In few plants leaf blight was observed. Foliar aphid is also emerging in few fields.

MP

On 25th Feb. 2015 a monitoring team comprising Dr. R. Selvakumar and Dr. Vishnukumar from ICAR-IIWBR visited farmers fields and experimental farm in Gwalior (Madhya Pradesh) were visited. The fields were free from rusts. Only leaf blight and foliar aphids were observed.

Gujarat

On January 28, 2015, Dr. M. S. Saharan and Dr. Upkar S. Sadana, National Consultant (Soil Science), National Food Security Mission, DAC, New Delhi alongwith State Department Officers of Bhopal visited the farmers fields near to Bhopal. No rust was observed. During Feb. 13-14, 2015 Dr.Indu Sharma, Director, ICAR-IIWBR surveyed Junagarh and Dantewara areas for appearance of any rust in the field.

Off season survey

During off season, survey for stripe rust was conducted in Lahaul valley and Kullu valley of Himachal Pradesh. Foot hills areas of Haryana (Yamunanagar) adjoining Himachal Pradesh were surveyed for rusts observation on grasses on October 7-8, 2014 by Dr. M. S. Saharan (DWR, Karnal) and O. P. Gangwar (DWR, Flowerdale, Shimla). Dr. S. C. Bhardwaj, Head, DWR Regional Station, Flowerdale, Shimla observed stripe rust on Sept.12,2014 in the form of a mild flecking on Agra Local bordering the off-season in Wheat Disease Monitoring Nursery (WDMN) sown at Flowerdale, Shimla on August 1, 2014. During 1st week of October, it had been observed on few more lines and samples were picked up for pathotype analyses. It is for the first time that the stripe rust was observed on off- season WDMN. Telia formation in yellow rust since Oct. 6, 2014 and simultaneous appearance of brown rust with two distinct types of pustules were observed by 2nd week of October in WDMN at Flowerdale, Shimla. On 20.12.14, Dr. S. C. Bhardwaj (Head, IIWBR Regional Station, Flowerdale, Shimla), Dr. M. S. Saharan (PI, Crop Protection, IIWBR, Karnal), Dr. O. P. Gangwar (Scientist, Flowerdale, Shimla) and Dr. Parmod Parsad (Scientist, Flowerdale, Shimla) surveyed wheat and grass rusts in Yamuna Nagar, Ambala and Panchkula districts of Haryana. Wheat crop was rust free at all the locations. Rust was observed on some of the grasses in villages, Padlu, Jatarpur, Barara, Saravan and the samples were collected and taken to Shimla for further analysis.

Strategy Meetings: A meeting on evolving strategies for enhancing wheat production with special reference to management of wheat rusts and Karnal bunt was organized by DAC on Oct. 16, 2014 in Lucknow under the Chairmanship of Dr. J. S. Sandhu, Agriculture Commissioner, Govt. of India. From DWR, Karnal, Drs. R. Chatrath, S. C. Tripathi and M. S. Saharan participated in the meeting. Dr. M. S. Saharan presented a talk on involving strategies for enhancing wheat crop production with special emphasis on stripe rust and Karnal bunt management. Strategy meeting for managing stripe rust and Karnal bunt was organized by DAC, New Delhi at Panchkula on January 20, 2015. Dr. J. S. Sandhu, Agriculture Commissioner, G. O. I. chaired the meeting. Dr. Indu Sharma, Director, IIWBR, Karnal made presentation on stripe rust and Karnal bunt management. A meeting for reviewing the status of Karnal bunt management was organized by DAC at Bhopal on January 28, 2015. Dr. J. S. Sandhu, Agriculture Commissioner, G. O. I. chaired the meeting. Dr. M. S. Saharan, Principal Scientist-Plant Pathology, IIWBR made presentation on Karnal bunt management.

Advisory for stripe rust management: Advisory for stripe rust management was issued three times i.e. in December, January and February for northern states. Awareness among farmers for stripe rust management was created through newspapers and delivering lectures in farmers training programmes.

8.2 POST HARVEST SURVEYS

KARNAL BUNT

A total of 12295 grain samples collected from various mandies in different zones, were analyzed by IIWBR, Karnal as well as other cooperating centers (Table 8.1). The number of samples analyzed by various centres were: IIWBR-2975, Ludhiana-1662, Hisar-1342, Pantnagar-2497, Dhaulakuan-500, Vijapur-536, Chatta (Jammu)-327 and Durgapura-2006. From Central and Peninsular zones, 1297 and 697 samples, respectively, were analyzed to know the distribution and disease situation in these zones. The Karnal bunt situation in the country has been depicted in the Table 8.2. The highest incidence (94.04%) was recorded from Punjab. A total of 1662 samples were collected from 110 grain markets of Punjab state in the month of April, May 2015. Out of 1562, 1563 samples were found to be infected with KB. None of the district was free from KB in the current year. In districts, Amritsar, Kapurthalla, Moga, Mohali, Pathankot , Sangrur and Tarantarn had 100 % KB infected samples. There was a range of per cent KB infected samples was 72.92-100.The highest KB infection was in the districts Kapurthalla followed by Moga and Mohali (Table 8.4). An overall infection in rest districts ranged between 0.69-4.73 with average infection in the state 2.20.There has been a ten fold increase in the disease from year 2013-14 (0.241%) due to highly conducive environmental conditions at anthesis stage of the crop. Five hundred samples were collected from different villages and wheat procurement centre Paonta Sahib and analyzed for karnal bunt infection (8.6). Out of 500 samples collected, 390 were found infected with karnal bunt i.e. 78% prevalence of diseases was recorded in Sirmour district. Maximum incidence of karnal bunt infection was recorded upto 5.8% on wheat varieties HPW 155 and HD 2380. In most of the samples wheat varieties HPW 326 was found free from karnal bunt. However, infection level varied between 0.1 to 5.8% in rest of the samples.

A total of 2006 wheat grain samples were collected from 36 grain mandies of 17 major wheat growing districts of Rajasthan during Rabi, 2014-15. About 28 percent samples (556) were infected with Karnal bunt with incidence ranging from 0.1 to 9.0

per cent being maximum was found in a sample collected from Khertal mandi of district Alwar. More than 50 per cent samples collected from Alwar, Khertal, Bansur, Kotputali, Shri Ganganagar, Hanumangarh and Hindoli (Bundi) mandies were found Karnal bunt infected. Although, majority of the infected samples (482) were not having >0.5 per cent disease incidence. However, in four samples the incidence was >5 per cent. None of the location was found free from Karnal bunt except Mandalgarh (Bheelwara) and Udaipur (Table 8.7).

In Uttarakhand 2,479 wheat samples were analyzed (Table 8.8), out of which 458 samples had Karnal bunt infection. These samples were collected from the seed growers of four districts of Uttarakhand namely, Udham Singh Nagar, Nainital, Dehradun and Haridwar. About 83.41 per cent of the total infected samples were in the category of below 0.25 per cent, which is the tolerance limit of Karnal bunt for certified seeds. The rest 17.03% samples had more than 0.25 per cent infected grains. Maximum incidence 54.46 per cent was observed in the district Nainital (Kotabagh) followed by Dehradun (49.52%), Haridwar (48.06%) and Udham Singh Nagar (Khatima) (17.24%). In Nainital (Kotabagh) district the prevalence of Karnal bunt recorded was high (122 samples out of 224 samples) and severity was also high. Based on the overall KB occurrence, it emerged that this year KB incidence was low and less prevalent than that of previous year.

Table 8.1. Karnal bunt situation in the country during 2014-15 crop season

State	Total samples	Infected samples	% infected samples	Range of infection
Punjab	1662	1563	94.04	0.07-2.56
Haryana	2396	1824	76.13	0-5.15
Rajasthan	2194	682	31.08	0-1.55
Uttarakhand	2579	486	18.84	-
HP	500	390	78.00	
U.P.	181	39	21.55	0-0.15
M.P.	761	159	20.89	0-0.65
Maharashtra	519	0	0	--
Karnataka	178	0	0	--
Bihar	12	0	0	-
Gujarat	536	0	0	-
Jammu	327	104	31.80	
Total	**12295**	**5247**	**42.67**	**0-5.15**

Table 8.2. Karnal bunt situation (district wise) in Haryana during 2014-15 crop season (Analysis by IIWBR, Karnal)

Sr. No.	Districts	Total Samples	Infected Samples	Percentage of infected samples	Range of infection
1	Rewari	30	18	60	0-1.2
2	Bhiwani	72	45	62.5	0-0.95
3	Taraori	35	29	82.85	0-3.7
4	Pipli	30	15	50	0-0.75
5	Nilokheri	10	10	100	0.05-2.05
6	Karnal	51	39	76.47	0-2.45
7	Kurukhsetra	84	72	85.71	0-0.9
8	Kaithal	49	41	83.67	0-1.85
9	Ladwa	53	35	66.03	0-0.85
10	Ambala	57	43	75.43	0-2.95
11	Ganaur	54	41	75.92	0-1.5

Sr. No.	Districts	Total Samples	Infected Samples	Percentage of infected samples	Range of infection
12	Sahabad	101	56	55.44	0-0.95
13	Gharonda	77	71	92.20	0-5.15
14	Guhana	59	36	61.01	0-0.5
15	Sonipat	68	58	85.29	0-2.8
16	Safidon	47	36	76.59	0-3.6
17	Indri	47	34	72.34	0-0.9
18	Yamunanagar	21	15	71.42	0-0.95
19	Panipat	57	47	82.45	0-1.85
20	Radaour	30	26	86.66	0-1.7
21	Samalkha	22	18	81.81	0-1.0
Total		1054	785	74.47	0-5.15

Average % infection in the state was 0.269

Table 8.3. Grain samples analysis for KB at IIWBR Karnal during 2014-15 crop season

State	Total samples	Total no. of infected samples	% infected samples	Range of infection
Haryana	1054	785	74.47	0-5.15
Rajasthan	188	126	67.02	0-1.55
Uttarakhand	82	13	15.85	0-0.5
U.P.	181	39	21.55	0-2.25
M.P.	761	159	20.89	0-0.65
Maharashtra	519	0	0	--
Karnataka	178	0	0	--
Bihar	12	0	0	-
Total	**2975**	**1122**	**37.71**	**0-5.15**

Table 8.4. Spectrum of Karnal bunt in Punjab during 2014-15 crop season (Ludhiana centre)

S. No.	District	Total samples	KB Infection		
			Samples Infected	Infected Samples (%)	Average Infection (%)
1	Amritsar	64	64	100.00	2.93
2	Barnala	72	70	97.22	1.71
3	Bathinda	64	56	87.50	0.97
4	Faridkot	96	89	92.71	1.25
5	Fatehgarh Sahib	38	34	89.47	1.71
6	Fazilka	96	70	72.92	0.69
7	Ferozepur	147	141	95.92	1.25
8	Gurdaspur	102	101	99.02	2.86
9	Hoshiarpur	115	103	89.57	1.73
10	Jallandhar	93	92	98.92	3.34
11	Kapurthala	72	72	100.00	4.73
12	Ludhiana	125	123	98.40	2.66
13	Mansa	30	25	83.33	1.54
14	Moga	132	132	100.00	3.87
15	Mohali	14	14	100.00	3.78
16	Muktsar	64	53	82.81	0.87
17	Nawanshar	48	45	93.75	1.66
18	Pathankot	53	53	100.00	3.10
19	Patiala	56	47	83.93	1.53
20	Ropar	80	78	97.50	1.53

S. No.	District	Total samples	KB Infection		
			Samples Infected	Infected Samples (%)	Average Infection (%)
21	Sangrur	53	53	100.00	2.46
22	Tarantarn	48	48	100.00	2.75
% infected samples			**1662**	**1563**	**94.04**

Table 8.5. Spectrum of Karnal bunt in Haryana during 2014-15 crop season (Hisar centre)

District	Total samples	Range of infection	Average infection
Hisar	143	0.05-1.30	0.257
Rohtak	59	0.05-0.35	0.198
Bhiwani	76	0.05-1.00	0.294
Mahendergarh	38	0.05-1.40	0.367
Rewari	37	0.05-0.55	0.148
Jhajjar	53	0.05-0.70	0.149
Gurgaon	40	0.05-0.40	0.115
Mewat	43	0.05-0.80	0.147
Jind	124	0.05-1.50	0.229
Fatehabad	98	0.05-1.00	0.058
Sirsa	76	0.05-0.40	0.068
Mean South west zone	787	0.05-1.50	0.184
Karnal	70	0.05-1.30	0.307
Ambala	44	0.05-0.90	0.273
Kurukshetra	74	0.05-1.30	0.331
Kaithal	46	0.05-0.60	0.179
Sonipat	50	0.05-1.40	0.286
Panipat	65	0.05-1.45	0.334
Palwal	50	0.05-0.75	0.117
Faridabad	46	0.05-0.65	0.246
Yamuna Nagar	85	0.05-1.30	0.327
Panchkula	25	0.05-0.45	0.264
MeanNorth East Zone	555	0.05-1.45	0.266
State Mean	1342; Infected samples : 1039 (% infected samples): 77.42	0.05-1.50	0.225

Table 8.6. Spectrum of KB in Jammu province in wheat cultivars during 2014-15 (Chatta, Jammu centre)

Districts	Total Samples	No. of infected samples	% infected samples	<0.25%	0.26-1%	1.1-5%	>5%
Jammu	105	33	31.42	12	10	3	8
Samba	80	27	33.75	10	5	5	7
Kathua	102	35	34.31	11	7	8	9
Udhampur	40	09	22.50	5	2	2	0
Total	327	104	31.80	38	24	18	24

Table 8.7. Spectrum of KB in Rajasthan in wheat cultivars during 2014-15 (Durgapura centre)

S. No.	Name of Mandi	No. of samples showing different levels of KB incidence						Total samples	Per cent infected samples	Incidence Range (%)
		0	0.1-0.5	0.5-1.0	1.0-5.0	5.0-10	>10.0			
1	Ajmer	27	03	0	0	0	0	30	10.0	0.1 - 0.2
2	Beawar	19	05	0	0	0	0	24	20.83	0.1 - 0.2
3	Dausa	53	11	0	0	0	0	64	17.19	0.1 - 0.3
4	Lalsot	59	09	0	01	0	0	69	14.49	0.1 - 1.0
5	Mandawari	36	01	0	0	0	0	37	2.7	0.1
6	Jaipur	30	09	01	0	0	0	40	25.0	0.1 - 0.6
7	Bagru	37	13	0	0	0	0	50	26.0	0.1 - 0.2
8	Bassi	33	07	0	0	0	0	40	17.5	0.1 - 0.4
9	Chomu	30	16	0	0	0	0	46	34.78	0.1 - 0.4
10	Kotputli	22	19	01	7	1	0	50	56.0	0.1 - 7.5
11	Tonk	81	04	0	0	0	0	85	4.71	0.1 - 0.5
12	Deoli	111	19	02	02	0	0	134	17.16	0.1 - 3.0
13	Uniara	42	03	01	01	0	0	47	10.64	0.1 - 2.2
14	Alwar	27	49	11	03	0	0	90	70.0	0.1 - 1.3
15	Khertal	28	24	04	01	01	0	58	51.72	0.1 - 9.0
16	Bansur	23	24	01	06	0	0	54	57.41	0.1 - 4.0
17	Hindon (Karoli)	39	19	03	0	0	0	61	36.07	0.1 - 7.0
18	Swaimadhopur	35	11	0	1	0	0	47	25.53	0.1 - 1.3
19	Gangapur	30	15	03	02	0	0	50	40.0	0.1 - 3.2
20	Sikar	36	02	0	01	02	0	41	12.0	0.1 - 6.0
21	Palsana	22	04	0	0	0	0	26	15.38	0.1 - 0.5
22	Bheelwara	88	14	02	0	0	0	104	15.38	0.1 - 0.9
23	Mandalgarh	06	0	0	0	0	0	06	0.00	-
24	Bijolia	32	03	01	0	0	0	36	11.1	0.1 - 0.6
25	Bundi	78	27	02	01	0	0	108	27.78	0.1 - 2.3
26	Hindoli	13	15	01	0	0	0	29	55.17	0.1 - 0.6
27	Kota	54	37	06	0	0	0	97	44.33	0.1 - 0.8
28	Chittourgarh	21	03	0	0	0	0	24	12.5	0.1 - 0.5
29	Nimaheda	77	06	0	0	0	0	83	7.23	0.1 - 0.4
30	Udaipur	29	0	0	0	0	0	29	0.00	-
31	Fatehnagar	113	06	01	0	0	0	120	5.8	0.1 - 0.8
32	Rajsamand	25	03	0	0	0	0	28	10.71	0.1
33	Sri Ganganagar	22	40	0	0	0	0	62	64.52	0.1 - 0.5
34	Bhadra	29	22	0	01	0	0	52	44.23	0.1- 1.4
35	Hanumangarh	30	39	0	01	0	0	70	57.14	0.1 - 2.0
36	Jodhpur	13	02	0	0	0	0	15	13.33	0.1
Total		**1450**	**484**	**40**	**28**	**04**	0	**2006**	**27.72**	**0.1 - 9.0**
Per cent		72.28	24.13	1.99	1.4	0.2	0.0	-	-	-

Table 8.8. Incidence of KB in different districts of Uttarakhand during 2014-15 crop season (Pantnagar centre)

Districts	Total samples	No. of infected samples	% infected Samples	No. of samples in different range of infection			
				Below 0.25%	0.26-1%	1.1-5%	5.1-10%
Pantnagar	1279	146	11.42	145	1	0	0

Districts	Total samples	No. of infected samples	% infected Samples	No. of samples in different range of infection			
				Below 0.25%	0.26-1%	1.1-5%	5.1-10%
Kashipur	122	06	4.92	4	2	0	0
Bajpur	439	50	11.39	47	3	0	0
Khatima	87	15	17.24	14	1	0	0
Sitarganj	94	05	5.32	5	0	0	0
Dehradun	105	52	49.52	29	14	9	0
Haridwar	129	62	48.06	47	12	3	0
Nainital (Kotabagh)	224	122	54.46	89	32	1	0
Total	**2497**	**458**		**382**	**65**	**13**	**0**

Table 8.9. Spectrum of KB in Vijapur, Gujarat during 2014-15 (Vijapur centre)

Location	Total samples	Infected samples	% infected samples
Mansa	45	0	0.0
Dehgam	38	0	0.0
Khedbrahma	45	0	0.0
Vadali	45	0	0.0
Talod	37	0	0.0
Prantij	48	0	0.0
Visnagar	46	0	0.0
Mehsana	54	0	0.0
Kukarwada	45	0	0.0
Vijapur	68	0	0.0
Farmers' fields	65	0	0.0
Total	536	0	0.0

BLACK POINT

Out of 8021 grain samples (Table 8.10) analyzed for black point from different zones in the country, 67.41 per cent samples showed black point. From Rajasthan, out of 2006 wheat grain samples collected, 1849 samples (92.17) were infected with black point and the disease incidence was ranging from 0.1 to 45.0 per cent being maximum was noted in a sample collected from Deoli mandi of district Tonk (Table 14b). Grain samples analyzed by IIWBR, Karnal, Ludhiana, Hisar, Vijapur are presented in Tables 8.10-8.15, respectively.

GRAIN DISCOLOURATION

Out of 2975 grain samples (Table 8.16) analyzed from different zones in the country, 40.64 per cent samples showed grain discolouration. Status of grain discolouration in Haryana samples is given in Table 8.17.

Table 8.10. Spectrum of black point in the country during 2014-15 crop season

State	Total samples	Infected samples	% infected samples	Range of infection
Punjab	1662	1660	99.86	-
Haryana	2396	1539	64.23	0-2.75
Rajasthan	2194	1899	86.55	0-0.25
Uttarakhand	82	28	34.14	0-0.2
UP	181	163	90.05	0-1.25

State	Total samples	Infected samples	% infected samples	Range of infection
M.P.	761	389	51.11	0-1.15
Maharashtra	519	333	64.16	0-0.60
Karnataka	178	105	58.98	0-0.45
Bihar	12	8	66.66	0-0.35
Gujarat	536	117	21.8	0.0 - 5.6
Total	6515	4392	67.41	0-2.75

Table 8.11. Analysis of grain samples for black point at IIWBR Karnal during 2014-15 crop season

State	Total samples	Total no. of infected samples	% infected samples	Range of infection
Haryana				
Rajasthan	188	50	26.59	0-0.25
Uttarakhand	82	28	34.14	0-0.2
U.P.	181	163	90.05	0-1.25
M.P.	761	389	51.11	0-1.15
Maharashtra	519	333	64.16	0-0.60
Karnataka	**178**	**105**	58.98	**0-0.45**
Bihar	**12**	**8**	66.66	**0-0.35**
Total	**2975**	**1672**	56.20	**0-2.75**

Table 8.12. Black Point situation in Haryana during 2014-15 crop season (By IIWBR, Karnal)

Sr. No.	Districts	Total Samples	Infected Samples	Percentage of infected samples	Range of infection
1	Rewari	30	29	96.66	0-1.3
2	Bhiwani	72	50	69.44	0-1.35
3	Taraori	35	33	94.28	0-4.15
4	Pipli	30	22	73.33	0-4.5
5	Nilokheri	10	09	90.00	0-2.75
6	Karnal	51	45	88.23	0-1.5
7	Kurukhsetra	84	67	79.76	0-0.5
8	Kaithal	49	38	77.55	0-0.65
9	Ladwa	53	30	56.60	0-0.55
10	Ambala	57	25	43.85	0-1.3
11	Ganaur	54	43	79.62	0-0.45
12	Sahabad	101	28	27.72	0-0.2
13	Gharonda	77	23	29.87	0-0.2
14	Guhana	59	06	10.16	0-0.1
15	Sonipat	68	47	69.11	0-0.65
16	Safidon	47	15	31.91	0-0.2
17	Indri	47	29	61.70	0-0.4
18	Yamunanagar	21	10	47.61	0-0.15
19	Panipat	57	16	28.07	0-0.15
20	Radaour	30	17	56.66	0-0.3
21	Samalkha	22	14	63.63	0-0.25
Total		1054	596	56.54	0-4.15

Table 8.13. Analysis of grain samples for black point in Punjab during 2014-15 crop season (Ludhiana centre)

S. No.	District	Total samples	Incidence of Infected samples (%)	Black point (%)	Shivelled grainS (%)
1	Amritsar	64	100	1.11	2.07
2	Bathinda	64	100	0.68	1.09
3	Barnala	72	100	0.92	1.47
4	Faridkot	96	100	0.66	1.10
5	Ferozepur	147	100	0.83	1.23
6	Fatehgarh sahib	38	100	1.23	1.11
7	Fazilka	96	100	0.69	1.03
8	Gurdaspur	102	100	1.54	2.16
9	Hoshiarpur	115	100	1.12	2.31
10	Jallandhar	93	100	1.29	1.89
11	Kapurthala	72	100	1.37	1.71
12	Ludhiana	125	100	0.84	1.51
13	Moga	132	100	1.18	1.33
14	Mansa	30	100	0.83	1.04
15	Mukatsar	64	96.88	0.79	1.01
16	Mohali	14	100	0.43	1.26
17	Nawanshar	48	100	0.91	1.67
18	Pathankot	53	100	1.88	4.35
19	Patiala	56	100	0.57	1.03
20	Ropar	80	100	0.87	2.21
21	Sangrur	53	100	0.67	1.38
22	Tarantaran	48	100	3.63	6.46
Total		1662	99.86		

Table 8.14a. Analysis of grain samples for black point in Haryana during 2014-15 crop season (Hisar centre)

District	Total samples	Range of infection	Average infection
Hisar	143	0.05-1.40	0.084
Rohtak	59	0.05-0.25	0.074
Bhiwani	76	0.05-0.75	0.200
Mahendergarh	38	0.05-0.65	0.092
Rewari	37	0.05-1.00	0.158
Jhajjar	53	0.05-0.35	0.115
Gurgaon	40	0.05-0.25	0.106
Mewat	43	0.05-0.40	0.084
Jind	124	0.05-0.65	0.059
Fatehabad	98	0.05-0.75	0.124
Sirsa	76	0.05-0.40	0.103
Mean South west zone	787	0.05-1.40	0.109
Karnal	70	0.05-1.00	0.196
Ambala	44	0.05-0.90	0.107
Kurukshetra	74	0.05-0.50	0.118
Kaithal	46	0.05-0.40	0.075
Sonipat	50	0.05-0.45	0.250
Panipat	65	0.05-0.65	0.183
Palwal	50	0.05-0.80	0.286
Faridabad	46	0.05-0.70	0.195
Yamuna Nagar	85	0.05-0.60	0.214
Panchkula	25	0.05-0.45	0.164

District	Total samples	Range of infection	Average infection
MeanNorth East Zone	555	0.05-1.00	0.178
State Mean	1342 Infected samples: 943	0.05-1.40	0.143

Table 8.14b. Analysis of grain samples for black point in Rajasthan during 2014-15 crop season (Durgapura centre)

S. No.	Name of mandi	Total samples	BP infected samples	Per cent BP incidence	Range of BP incidence (%)
1	**Ajmer**	30	28	93.3	0.2 - 5.1
2	Beawar	24	23	95.8	0.2 - 7.8
3	**Dausa**	64	59	92.19	0.2 - 15.9
4	Lalsot	69	65	94.2	0.2 - 8.9
5	Mandawari	37	36	97.3	0.2 - 4.1
6	**Jaipur**	40	35	87.5	0.2 - 31.5
7	Bagru	50	48	96.0	0.2 - 10.6
8	Bassi	40	37	92.5	0.2 - 15.7
9	Chomu	46	45	97.83	0.1 - 4.1
10	Kotputli	50	50	100	0.2 - 41.5
11	**Tonk**	85	79	92.9	0.2 - 8.5
12	Deoli	134	131	97.77	0.2 - 45.0
13	Uniara	47	46	97.87	0.2 - 5.9
14	**Alwar**	90	73	80.0	0.1 - 11.8
15	Khertal	58	57	98.28	0.1 - 19.7
16	Bansur	54	50	92.59	0.2 - 16.5
17	Hindon **(Karoli)**	61	54	88.52	0.2 - 18.2
18	**Swaimadhopur**	47	44	93.62	0.1 - 3.0
19	Gangapur	50	44	88.00	0.1 - 8.8
20	**Sikar**	41	40	97.56	0.2 - 4.6
21	Palsana	26	26	100	0.6 - 5.6
22	**Bheelwara**	104	79	75.96	0.1 - 12.1
23	Mandalgarh	06	06	100	0.4 - 2.3
24	Bijolia	36	35	97.2	0.2 - 2.2
25	**Bundi**	108	106	98.15	0.2 - 5.4
26	Hindoli	29	27	93.1	0.3 - 3.1
27	**Kota**	97	93	95.88	0.1 - 15.4
28	**Chittourgarh**	24	22	91.67	0.4 - 7.0
29	Nimaheda	83	70	84.34	0.1 - 9.5
30	**Udaipur**	29	18	62.07	0.2 - 10.4
31	Fatehnagar	120	116	96.67	0.2 - 10.4
32	**Rajsamand**	28	27	96.43	0.2 - 3.2
33	**Sri Ganganagar**	62	60	98.39	0.1 - 1.4
34	Bhadra	52	44	84.62	0.1- -3.6
35	**Hanumangarh**	70	63	90.0	0.2 - 5.6
36	**Jodhpur**	15	13	86.67	0.1 - 3.1
	Total	**2006**	**1849**	**92.17**	**0.1 - 45.0**

Table 8.15. Spectrum of black point in Vijapur district of Gujarat during 2014-15 season (Vijapur centre)

Location	Total samples	Infected samples	% infected samples	Infection range
Mansa	45	09	20.0	0.0 - 3.5
Dehgam	38	08	21.0	0.0 - 4.2
Khedbrahma	45	10	22.2	0.0 - 4.6
Vadali	45	08	17.8	0.0 - 4.0
Talod	37	10	27.0	0.0 - 5.2
Prantij	48	10	20.8	0.0 - 2.7
Visnagar	46	12	26.0	0.0 - 4.5
Mehsana	54	11	20.4	0.0 - 3.7
Kukarwada	45	10	22.2	0.0 - 3.2
Vijapur	68	15	22.1	0.0 - 5.6
Farmers' fields	65	14	21.5	0.0 - 5.4
Total	536	117	21.8	0.0 - 5.6

Table 8.16. Analysis of grain samples for grain discolouration at IIWBR Karnal during 2014-15 crop season

State	Total samples	Total no. of infected samples	% infected samples	Range of infection
Haryana	1054	619	28.72	0-1.50
Rajasthan	188	31	16.48	0-0.15
Uttarakhand	82	1	1.21	0-0.05
U.P.	181	117	64.64	0-0.95
M.P.	761	374	49.14	0-1.25
Maharashtra	519	40	7.70	0-0.1
Karnataka	178	21	11.79	0-0.15
Bihar	12	6	50.0	0-0.15
Total	2975	1209	40.64	0-1.50

Table 8.17 Grain discolouration in Haryana during 2014-15 crop season (By IIWBR, Karnal)

Sr. No.	Districts	Total Samples	Infected Samples	Percentage of infected samples	Range of infection
1	Rewari	30	22	73.33	0-0.55
2	Bhiwani	72	27	37.5	0-0.6
3	Taraori	35	25	71.42	0-0.7
4	Pipli	30	20	66.66	0-0.35
5	Nilokheri	10	08	80.00	0-0.35
6	Karnal	51	44	86.27	0-1.0
7	Kurukhsetra	84	48	57.14	0-0.45
8	Kaithal	49	30	61.22	0-0.2
9	Ladwa	53	21	39.62	0-0.15
10	Ambala	57	47	82.45	0-0.55
11	Ganaur	54	37	68.51	0-0.4
12	Sahabad	101	86	85.14	0-1.5
13	Gharonda	77	70	90.90	0-0.85
14	Guhana	59	45	76.27	0-0.35
15	Sonipat	68	22	32.35	0-0.15
16	Safidon	47	10	21.27	0-0.15
17	Indri	47	19	40.42	0-0.2
18	Yamunanagar	21	06	28.57	0-0.1
19	Panipat	57	10	17.54	0-0.25

Sr. No.	Districts	Total Samples	Infected Samples	Percentage of infected samples	Range of infection
20	Radaour	30	15	50.00	0-0.1
21	Samalkha	22	07	31.81	0-0.2
Total		1054	619	58.72	0-1.5

COOPERATORS

NAME	CENTRE
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8.3: RUST PATHOTYPE DISTRIBUTION

A. SHIMLA CENTRE

Incidence of wheat rusts in India

All the wheat rusts were observed in India during 2014-15. This year was marked by the low incidence of wheat rusts. Black rust (*Puccinia graminis tritici*) was restricted to peninsular India whereas brown rust (*P. triticina*) of wheat was widely distributed with low incidence. Yellow rust (*P. striiformis*) was restricted to northern India in some pockets in endemic form. Yellow rust was reported almost one month late to the previous years and remained below the threshold level because of the joint efforts of ICAR, SAUs and state department of agriculture. During the year 1262 samples of three rusts of wheat and barley were received from ten states of India and neighboring countries Bangladesh, Bhutan and Nepal.

Sample analysis and pathotype distribution of wheat and barley rusts

So far 793 samples of three rusts of wheat and yellow rust of barley have been analyzed from India and neighboring countries.

Yellow rust of wheat and barley (*P. striiformis*)

Ten pathotypes of wheat yellow rust were identified in 335 samples from seven states of India, Nepal and Bhutan. In yellow rust of wheat ten pathotypes were identified. Among these pathotypes 46S119 was the most predominant and was observed in72% of the samples, whereas pathotype 78S84 which used to be a predominant pathotype prior to 2010 was identified in 3 % of the samples only. Except for the pathotypes T, CI , P and 7S0 which were identified in one sample each, four new pathotypes were recorded in remaining samples. These new pathotypes have more virulence than the existing pathotypes and appear to be mutation in existing pathotypes on Suwon x Omar and Riebesel 47/51. These new pathotypes have been designated as 110S119, 238S119, 46S117 and 110S84. Among these pathotype 110S119 was most common and was identified in about 12% samples. Further studies on these pathotypes are being conducted (Table 8.18).

In yellow rust of barley two pathotypes i.e. M and 57 were analyzed in 10 samples received from Himachal Pradesh, Uttarakhand, Rajasthan and Nepal. Pathotype M prevailed more than 57 in these samples (Table 8.18).

Black rust of wheat (*P. graminis tritici*)

Seventy two samples were analyzed from six states of India. Among the eight pathotypes identified in black rust samples, pathotype 11 was observed in more than 50% of the samples followed by 40A and 21-1 (Table 8.19). Remaining pathotypes were identified in few samples only. Characteristic feature of this analysis was the predominance of pathotype 11 instead of pathotype 40A which used to be the predominant during the previous years.

Brown rust of wheat (*P. triticina*)

Twenty five pathotypes were identified in 379 samples received from 9 states of India and three neighboring countries. There was a shift in virulence pattern with pathotype 77-9 becoming more frequent in Tamil Nadu, Karnataka, Maharashtra, Madhya Pradesh and Punjab. Three predominant pathotypes i.e. 77-9 (38%), 77-5(32%) and 104-2 (14%) comprised of 85% of the flora. Among these, both pathotypes 77-5 and 104-2 occurred in eight states of India and three neighboring countries. Pathotype 77-9 was observed only in seven states of India but not in the neighboring countries. Remaining 22 pathotypes occurred in few samples only (Table 8.20).

Table 8.18. Pathotype distribution of yellow rust (*Puccinia striiformis*) in India and neighboring country during 2014-15

S. No.	States/ Countries	Rust samples		Pathotypes identified										Barley Pathotypes Identified	
		Received	Analyzed	46S119	78S84	T(47S103)	P (46S103)	110S119 *	238S119 *	46S117 *	110S84 *	7S0	CI (14S64)	M (1S0)	57 (0S0)
1	Jammu & Kashmir	91	46	21	01	-	-	16	02	04	01	-	01	-	-
2	Himachal Pradesh	262	142	112	04	01	01	08	08	03	01	01	-	03	-
3	Punjab	101	37	26	02	-	-	05	-	04	-	-	-	-	-
4	Haryana	32	10	06	-	-	-	02	-	-	02	-	-	-	-
5	Uttarakhand	104	42	28	01	-	-	10	-	-	-	-	-	02	01
6	Rajasthan	38	14	10	03	-	-	-	-	-	-	-	-	-	01
7	Tamil Nadu	13	12	05	-	-	-	04	03	-	-	-	-	-	-
Other countries															
1	Nepal	77	30	27	-	-	-	-	-	-	-	-	-	02	01
2	Bhutan	07	02	02	-	-	-	-	-	-	-	-	-	-	-
	Total	718	335	237	11	01	01	45	13	11	04	01	01	07	03

*New pathotypes

Table 8.19. Pathotype distribution of black rust of wheat (*Puccinia graminis* f. sp. *tritici*) in India and neighboring country during 2014-15

S. No.	States/ Countries	Rust samples		Pathotypes identified							
		Received	Analyzed	11 (79G31)	40A (62G29)	40-3 (127G29)	21 (9G5)	21-1 (24G5)	21A-2 (75G5)	34-1 (10G13)	122 (7G11)
1	Tamil Nadu	34	14	04	09	-	-	-	-	-	01
3	Maharashtra	07	07	07	-	-	-	-	-	-	-
4	Madhya Pradesh	07	06	02	-	03	-	01	-	-	-
5	Gujarat	24	26	24	02	-	-	-	-	-	-
2	Uttarakhand	28	13	-	-	-	01	08	04	-	-
6	Jammu and Kashmir	06	06	-	-	-	-	-	-	06	
	Total	106	72	37	11	03	01	09	04	06	01

Table 8.20. Pathotype distribution of brown rust (*P. triticina*) in India and neighboring country during 2014-15

S. No.	State	Rust samples		Pathotypes identified																								
		Received	Analyzed	10 (13R19)	12-2 (1R5)	12-3(49R37)	12-4 (69R13)	12-5 (29R45)	12-7 (93R45)	12 A (5R13)	77-1 (109R63)	77-2(109R31-1)	77-5(121R63-1)	77-6(121R55-1)	77-9(121R60-1)	77-10(377R60-1)	77-11(125R28)	77-12(121R52-1)	77A(109R31)	104-2(21R55)	104-3(21R63)	104-4(93R57)	104B(29R23)	162(93R7)	162-2(93R39)	162-3(29R7)	162A(93R15)	162-1(93R47)
1	Tamil Nadu	72	74			1							30	1	33	2		5		1	1							
2	Maharashtra	38	37										7		29	1												
3	Karnataka	120	109								1		26		56	1				21	1				2	1		
4	Gujarat	05	05																	5								
5	Madhya Pradesh	31	30		1			3					13		11					2								
6	Punjab	19	18										1		15					2								
7	Haryana	09	06										1		1					4								
8	Uttarakhand	32	32					1			1		8		2					9	4	5		1			1	
9	Himachal Pradesh	16	18					1	1				6				1			5	2	1						1
10	Jammu & Kashmir	01	-																									
	Other Countries																											
1	Nepal	48	42				5				2	1	25						1	5	1	1	1					
2	Bangladesh	39	11	1						2			4							1	2	1						
3	Bhutan	08	04										3							1								
	Total	**438**	**386**	**1**	**1**	**1**	**5**	**5**	**1**	**2**	**4**	**1**	**124**	**1**	**147**	**4**	**1**	**5**	**1**	**56**	**11**	**8**	**1**	**1**	**2**	**1**	**1**	**1**

8.4. PREPARENESS TO COMBAT Ug99

Extensive surveys were conducted in the country to monitor the occurrence of stem rust pt. Ug99. Till today, there has not been any report from anywhere in the country. As a part of our preparedness, AICW&BIP/ICAR, in collaboration with CIMMYT, Mexico have continued with the testing programme of wheat at Njoro in Kenya and Ethiopia. During 2014, AVT entries, of 2013-2014 alongwith checks, numbering 200 were evaluated at Kenya and Ethiopia for Ug99 resistance.

8.5 47th Wheat Disease Monitoring Nursery (WDMN) 2014-15

Over the years wheat disease monitoring nursery (earlier trap plot nursery) is working as a logistic and effective tool for monitoring the occurrence of rusts, blights, powdery mildew and other wheat diseases across different wheat growing zones of India. Additionally, it has helped in knowing the seasonal progress of these diseases over different wheat growing zones. Wheat and barley rust samples collected from WDMN gives an overview of area wise distribution and load of rust pathotypes. The effectiveness of different wheat lines or resistance genes has been assessed through the WDMNs. The 47th wheat disease monitoring nursery was planted at 43 locations (Table 8.21) covering all the major wheat growing areas in the country, especially those situated near the bordering areas to the neighboring countries.

Table 8.21. List of co-operators and locations where WDMN was planted

Northern Hills and High Altitude Zone		
Himachal Pradesh	Dhanbir Singh S.K. Rana and Ashok Kumar S.K. Rana and Pankaj Sood R. Devlash S.K. Sharma B.S. Mankotiya Head, Flowerdale S.K. Rana and Akhilesh Singh S.K. Rana and S.K. Sharma S.K. Rana and B.K. Verma S.K. Rana and Anand Singh	Dhaulakuan Malan (Kangra) *Sundernagar* Bajaura Sangla (Kinnaur) Kukumseri Shimla Berthin, Bilaspur Una Akrot Bara, Hamirpur
Jammu & Kashmir	M.K. Pandey M.K. Pandey M.K. Pandey and Deepak Kumar	Udhaywalla (Jammu) Kathua Rajouri
Uttarakhand	J. Kumar, Deep Shikha & Kanak Srivastava S.K. Jain Officer in-charge Officer in-charge	Pantnagar Hawalbagh (Almora) KVK, Mukteshwar, Nainital KVK, Kafligar, Bageshwar
North Western Plains Zone		
Haryana	S.S. Karwasra and R.S. Beniwal M.S Saharan and R.S. Taya	Hisar Yamunanagar
Punjab	Jaspal Kaur	Abohar, Ludhiana Gurdaspur, Dera-Baba-Nanak , Langroya Ropar
North Eastern Plains Zone		
Bihar	S. Sarkhel Ashish Kumar and I.S. Solanki	Sabour Pusa

Jharkhand	H.C. Lal	Kanke , Ranchi
Uttar Pradesh	S.P. Singh, S. Gupta, and J.P.Verma J.B. Khan and C. Kanchan M. S. Saharan	Faizabad Araul (Kanpur) Saharanpur
West Bengal	S.K. Mukhopadhyay, D. Mukherjee and S. Mahapatra	Kalyani
Central Zone		
Gujarat	S.I. Patel I.B. Kapadiya and K.H. Dabhi	Ladol (Vijapur) Mangrol (Junagadh)
Chhatisgarh	A.P. Agarwal	Bilaspur
Madhya Pradesh	Prakasha T.L., Dr. V.G.Dubey, Dr. Kamini Kaushal, Dr. A.N.Mishra and Avinash Verma K. K. Mishra	Indore Khojanpur (Powarkheda)
Peninsular and Southern Hills Zone		
Maharashtra	B.K. Honrao, V.M. Khade and S.C. Misra B.C.Game, G.T.Bhangale, A.P.Padhye, S.Pawar, C.B.Beldar S.G. Bharad, N. R. Potdukhe and H.S. Gaukar	A.R.S. Baner, (Pune) ARS, Niphad Akola
Karnataka	P. V. Patil, Mr. S. V. Kulkarni, Mr. Pradeep P.E. and Mr. S. C. Patil	Ugar Khurd (Dharwad)
Tamil Nadu	Dr P Nallathambi	Wellington

There were 20/21 (High Altitude Zone and North Hills Zone) entries in the nursery during 2014-15. Of these, first 15 entries were common to all zones, rest of the five/six (northern hills and high altitude zone) entries were zone specific varieties. Keeping into account the changed varietal situation along with pathogen dynamics, some changes were made in the composition of WDMN entries for some of the zones. The detailed updated constituent of WDMN for 2014-15 crop season was as given below:

Common set of varieties for all zones

WL711, HD2329, Agra Local, HD2160, Lal Bahadur, WL1562, HW2021 (Lr24/Sr26), HD2204, C306, WH147, HW2008 (*Lr*24/*Sr*26), Kharchia Mutant, HP1633, DL 784-3 and RNB1001

Zone specific varieties

i) **North Western Plains Zone**
WH1105, WH542, PBW343, DPBW621-50 and WH896

ii) **North Eastern Plains Zone**
K 8804, HD2402, HP1102, HUW468 and NW1014

iii) **Central Zone**
HI 8381, DL803-3, LOK-1, GW273 and GW 322

iv) **Peninsular and Southern Hills Zone**
MACS2496, Bijaga Yellow, HW971, HD2501 and HW2022 (*Sr*24/*Lr*24)

v) **Northern Hills and High Altitude Zone**
HPW349, VL 892, HS420, Sonalika, HS507 and Barley Local

Seeds of all the entries along with the data booklets containing sowing plan, procedures and data sheets were sent to co-operators early in the season to ensure timely planting of the nursery. Each entry of the nursery was planted in two consecutive rows with two rows of Agra local as spreader row covering the periphery of nursery area. Observations on diseases were generally recorded five times during the crop season. The co-operators were advised to plant wheat disease monitoring nursery in time, in isolation and away from the artificially inoculated fields. The disease situation was monitored at regular intervals and the rust disease samples from these nurseries were analyzed at Flowerdale, Shimla.

Disease incidence in WDMN

Information on wheat disease situation was received from Dhaulakuan, Malan (Kangra), Sunder Nagar, Bajaura, Sangla (Kinnaur), Kukumseri, Shimla, Berthin, Bilaspur (HP), Una, Akrot and Bara (Hamirpur) in Himachal Pradesh; Udhaywalla (Jammu), Kathua and Rajouri in Jammu and Kashmir; Pantnagar, Hawalbagh (Almora), KVK, Mukteshwar, Nainital and KVK, Kafligar, Bageshwar in Uttarakhand; Hisar and Yamunanagar in Haryana; Abohar, Ludhiana, Gurdaspur, Dera-Baba-Nanak, Langroya and Ropar in Punjab; Sabaur and Pusa in Bihar; Kanke, Ranchi in Jharkhand; Faizabad, Araul (Kanpur) and Saharanpur in Uttar Pradesh; Kalyani in West Bengal; Ladol (Vijapur) and Mangrol (Junagarh) in Gujarat; Bilaspur in Chhattisgarh; Indore and Khojanpur (Powerkheda) in Madhya Pradesh; A.R.S. Baner, (Pune), ARS, Niphad and Akola in Maharashtra; Ugar Khurd (Dharwad) in Karnataka and Wellington (Tamil Nadu).

Disease incidence in WDMN

Diseases in WDMN during crop season 2014-15 were noticed a bit later than they appear during past few years. Yellow rust was noticed at all the location of NHZ and NWPZ. All the entries of WDMN in other zones including SHZ, where yellow rust appears regularly, were free from yellow rust. It was very severe at many locations at NWPZ and NHZ and severity of up to 100S is reported on some entries. Brown rust was reported from few locations of NHZ viz. Shimla, Una, Akrot in HP and Almora & Kafligar in Uttarakhand. In NWPZ brown rust appeared at all the locations except Rajouri (Jammu and Kashmir), Yamuna Nagar (Haryana), Dera Baba Nanak, Langroya and Ropar (Punjab). In NEPZ all the entries of WDMN were free from brown rust except at few locations such as Pusa, Faizabad and Kanpur. Bilaspur (C.garh) was the only location in CZ, where brown rust was absent on WDMN entries. There was no brown rust on WDMN entries at Niphad and Akola in PZ and SHZ. Of the 43 locations of WDMNs black rust was observed only at Wellington in SHZ, and Junagarh, Indore & Powerkheda in central zone. This suggests that the climatic conditions were not favorable for black rust disease development. Leaf blight is reported from WDMN planted at Udhaywalla, Kathua, Rajouri, Almora, Hisar, Sabaur, Pusa, Ranchi, Faizabad, Kanpur, Kalyani, Pune, Niphad, Dharwad and Wellington. Udhaywalla, Kathua and Almora were the only locations of WDMN where powdery mildew was observed.

Appearance of Wheat rusts in WDMN

High altitude, Northern Hills Zone and North Western Plain Zone

The data on first appearance of the wheat diseases on WDMN was not available for most of the locations. Of the data we have yellow rust was first observed at Udhaywalla (10.01.15) followed by Pantnagar (30.01.15), Kathua (02.02.15), Dhaulakuan (12.02.15), Almora (28.02.15), Rajouri (10.03.15) and Bajaura (11.03.15). Brown rust was first observed at Pantnagar (28.02.15) followed by Udhaywalla (19.03.15), Kathua (21.03.15) and Almora (22.04.15). Black rust was absent in High altitude and NHZ.

North Eastern Plain Zone, Central Zone, Peninsular Zone and Southern Hill Zone
Yellow rust was absent on WDMN entries in these zones. Brown rust was first observed at Pune (02.02.15) followed by Powerkheda (06.02.15), Sabaur (15.02.15), Indore (21.02.15), Vijapur (24.02.15), Faizabad and Kanpur on 25.02.15. Black rust was first observed at Powerkheda (15.02.15) followed by Junagarh (15.03.15).

Varietal Performance against wheat rusts
High Altitude and Northern Hills Zone
All the entries of WDMN were susceptible to yellow rust at Malan. Maximum severity of yellow rust was recorded at Una, where seventeen entries of WDMN showed 60S or more yellow rust severity. At least ten entries were showing yellow rust severity of 60S or more at Malan, Bajaura, Shimla, Una and Sundar Nagar. Lal Bahadur and Kharchia Mutant were showing more than 40S yellow rust severity at all the locations. Eleven entries including WL711, HP2160, HW2021, WH147, HW2008, HP1633 and RNB1001 showed more than 80S yellow rust severity at Bajaura. HPW349 was the least susceptible entry at all the locations except at Shimla, where it showed 60S yellow rust severity.
Brown rust appeared at Shimla on WL711 (40S), HD2329 (20S), HD2160 (10S), Lal Bahadur (20S) and HS420 (10S). At Almora WL711 showed 5S severity of brown rust, whereas Agra Local, HD2160, Lal Bahadur and WL1562 showed TS type of infection. Black rust did not appear on WDMN entries in this zone.

North Western Plain Zone
All the WDMN entries were showing yellow rust infection at Dhaulakuan and Ludhiana. There was 100S yellow rust severity on entries WL711, Agra Local, Lal Bahadur, WH147, Kharchia Mutant and HP1633. RNB1001 and WH896 were the least susceptible entries to yellow rust at all the locations of NWPZ. WH1105 showed less than 5S severity among different locations except at Ludhiana, where 60S yellow rust severity was reported on it.
Four entries viz. HW2021, Kharchia Mutant, DL784-3 and WH896 were free from brown rust infection at all the locations of NWPZ. WH1105 and PBW343 were also free from brown rust infection except at Pantnagar, where it was showing TR type of infection. At Udhaywalla few entries i.e. Agra Local (5S), Lal Bahadur (5S), WL1562 (10S), HD2204 (10S), C306 (TS) and DPBW621-50 (5S) were infected with brown rust, while other entries were free. All the WDMN entries except Agra Local (10S) were free from brown rust infection at Ludhiana. Black was not reported from this zone.

North Eastern Plain Zone
All the entries of WDMN entries were free from yellow rust infection in this zone. Brown rust appeared only at Pusa, Faizabad and Kanpur. At Pusa all the entries except HD2329 (TR) and Agra Local (15S) were brown rust free and entries WL1562, HD2021, HD2008, HP1633, DL784-3, HD2402, HP1102 and NW1014 were brown rust free at Faizabad as well as at Kanpur. Black rust did not appear on any of the entries of WDMN in this zone.

Central Zone
Yellow rust did not appear in this zone. Brown rust was observed at all the locations except at Bilaspur (C.garh). At Vijapur only three entries viz. Agra local (10R), Lal Bahadur (10R) and HW2008 (10R) were showing brown rust infection rest entries were free. At Junagarh brown rust severity was very low (TR or TS) on all the entries except HD2329, Agra Local, Lal Bahadur, HW2021, HD2204, HI8381, DL803-3 and

GW322 which were brown rust free. Lal Bahdur and HD2204 were showing 100S brown rust severity at Indore. Black rust was observed at Indore, Junagarh and Powerkheda on few entries.

Peninsular Zone and Southern Hill Zone

Yellow rust did not appear on any of the locations of these zones. Brown rust appeared at Pune, Dharwad and Wellington. At Pune three entries i.e. Agra Local (TS), Lal Bahadur (TS) and C306 (TR) were infected with brown rust, while rest of the entries were free. Entries WL711, HD2329, Agra Local, HD2160, Lal Bahadur, HD2204, WH147, Kharchia Mutant, MACS2496 and HW971 were showing more than 60S brown rust severity at Dhardwad. From Wellington there is no report on brown rust infection on eight WDMN entries viz. HW2021, HD2204, C306, WH147, HW2008, Kharchia Mutant, DL784-3 and HD2501. Black rust appeared on twelve entries of WDMN in SHZ (Wellington). Peninsular Zone was black rust free.

Other diseases

Blights

Information on foliar blights was received from 15 locations. Incidence of blight was high in comparison to the previous year. Earliest record of blight was from Pune (31.12.14) followed by Ranchi (11.01.15), Pusa (22.01.15), Faizabad (25.01.15), Kalyani (Feb 2nd week) and Sabaur (16.02.15). Blight was absent in all the locations of Northern hills zone except Almora, where up to 23 severity was reported on WDMN entries. Among the NWPZ locations wheat leaf blight was reported from Udhaywalla, Rajouri, Kathua and Hisar. As expected all the entries of WDMNs in NEPZ were infected with leaf blight. There was no leaf blight infection on any of the entries in central zone. In PZ blight was reported from Pune, Niphad and Dharwad. At Niphad only 6 entries of WDMN viz. HD23629, WL1562, HW2021, HD2204, HP1633 and MACS2496 were infected with leaf blight.

Powdery mildew

Powdery mildew was reported only from 3 locations viz. Udhaywalla and Kathua in Jammu and Kashmir and Almora in Uttarakhand. The order of appearance of Powdery mildew in these locations was as Almora (05.02.15), Udhaywalla (11.02.15) and Kathua (26.02.15). All the entries of WDMN were susceptible to powdery mildew disease at all these locations. Maximum severity of PM was observed at Udhaywalla with eleven entries showing PM severity of 7 or more.

Loose smut

There is no report of Loose smut from any of the locations.

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8.6 SAARC WHEAT DISEASE MONITORING NURSERY (2014-15)

Under the umbrella of Regional Station, ICAR-IIWBR, Shimla and CIMMYT, Nepal, SAARC wheat disease monitoring nursery is being conducted in SAARC countries with the objectives similar to the wheat disease monitoring nursery (WDMN) in India. During 2014-15, SAARC wheat disease monitoring nursery was planted at 27 locations across the six SAARC countries (Table 8.22).

Table 8.22. Details of locations of SAARC nurseries during 2014-15

S. No.	Country/ Locations	Contact person
1.	Nepal (3 sets)	CIMMYT, Nepal*
2.	Bangladesh (5 sets)	CIMMYT, Nepal
3.	Pakistan (2 sets)	CIMMYT, Nepal
4.	**Bhutan (1 set)**	CIMMYT, Nepal
5.	**Afghanistan (1set)**	CIMMYT, Nepal
6.	India (15 sets)	Head, RS, ICAR-IIWBR, Shimla
Total	**27 location**	
*Coordinator: Dr. A.K. Joshi, CIMMYT, Nepal.		

Information on wheat diseases in SAARC Wheat Disease Monitoring Nursery has been received from all the locations in India, Bangladesh and Bhutan. Data from other locations is awaited. In India SAARC wheat disease nursery was planted at 15 locations as detailed below (Table 8.23, 8.24)

Table 8.23. Locations of SAARC wheat Disease Trap Nursery in India during 2014-15

State	Co-operator	Locations
Delhi	V. K. Singh	New Delhi
Himachal Pradesh	Dhanbir Singh	Dhaulakuan
Jammu & Kashmir	M.K. Pandey and Deepak Kumar	Jammu (Udhaywalla) Kathua Rajauri
Punjab	Jaspal Kaur	Dera-Baba-Nanak, Abohar, Ludhiana, Gurdaspur
Bihar	I. S. Solanki and Ashish Kumar	Pusa, Bihar
Rajasthan	P. S. Shekhawat	Durgapura (Jaipur)
Tamil Nadu	P. Nallathambi	Wellington
Uttar Pradesh	S. P. Singh	Faizabad
Uttarakhand	J. Kumar, Deepshikha and Kanak S. S. K. Jain	Pantnagar Almora

The SAARC wheat disease monitoring nursery comprised of 20 lines contributed by four SAARC countries.

Table 8.24. Composition of SAARC wheat disease monitoring nursery

S. No.	Variety	S. No.	Variety
1.	Annapurna-1	11.	Punjab 85
2.	WL1562	12.	Chakwal 86
3.	HD2204	13.	Faisalabad 85
4.	PBW343	14.	Inquilab 91
5.	HD2687	15.	Faisalabad 83
6.	HD2189	16.	Rawal 87
7.	HP1633	17.	Kohsar
8.	RAJ3765	18.	Bakhtawar 94
9.	PBW373	19.	Gourab
10.	Pak 81	20.	Susceptible Check

Wheat Disease Situation in SAARC countries

Disease situation in India

Rusts

SAARC nursery was planted at 12 locations of NHZ and NWPZ, Faizabad, Pusa and Wellington. Yellow rust was observed at all the SAARC nursery locations in India except at Pusa, Faizabad and Wellington. Yellow rust was first observed at Udhaywalla (10.01.15) followed by Pantnagar (30.01.15), Kathua (02.02.15), Dhaulakuan (13.02.15), Almora (4th week of February, 2015) and Jaipur (28.02.15). All the entries of SAARC nursery were infected at Dhaulakuan, where 19 entries of the SAARC nursery were showing more than 40S yellow rust severity. At Delhi only 6 entries viz. Annapurna (5S), PBW343 (10S), HD2687 (5S), HP1633 (TR), Kohsar (20S) and Susceptible check (50S) were showing yellow rust infection. During last year crop season there was no yellow rust on SAARC nursery at Jaipur however during 2014-15 all the entries except PBW660 were infected with it. PBW343 was showing more than 40S severity of yellow rust at 7 locations (Table 8.25).

Brown rust was observed at all the SAARC nursery locations except at Dhaulakuan, Rajauri, Dera Baba Nanak and Jaipur. First report of brown rust was from Pusa (20.02.15) followed by Faizabad (24.02.15), Pantnagar (05.03.15), Delhi (09.03.15), Udhaywalla (19.03.15) and Kathua (21.03.15). At Abohar and Ludhiana only susceptible check was showing brown rust infection with 40S and 10S severity, respectively. Only three entries viz. PBW343 (TR), Kohsar (TR) and susceptible check (10S) were infected with brown rust at Pusa. Similarly at Faizabad Annapurna (30S), PBW343 (20S) and Check (80S) were the only entries showing brown rust infection. All the entries except Raj3765 and Bakhtawar 94 were the only brown rust free entries at Wellington. At Pantnagar six SAARC nursery entries viz. HD2204 (TR), HD2687 (TR), Rawal 87 (5S), Kohsar (15S), Bakhtawar 94 (TR) and Susceptible check (10S) were infected with brown rust.

Black rust was observed only at Wellington, Where the all the entries of SAARC nursery were infected with black rust. Black rust severity at Wellington was ranging from 10S in PBW343 and Inquilab 91 to 80S in HP1633.

Blights

Leaf Blight of wheat was observed only at seven locations of SAARC nursery. All the entries at Delhi, Dhaulakuan, Dera Baba Nanak, Abohar, Ludhiana, Gurdaspur, Jaipur and Pantnagar were free from leaf blight. All the entries were showing blight infection at the locations where blight was observed except at Wellington, where only 10 entries viz. Annapurna-1, WL1562, HD2204, PBW343, RAJ3765, Pak 81, Faisalabad 83, Rawal 87, Gourab and Susceptible Check were free from blight infection. There was severe leaf blight infection on all the entries of SAARC nursery at Faizabad and Pusa (Table 8.26).

Powdery Mildew

Powdery mildew has been reported only from two locations i.e. Almora and Udhaywalla. It was first reported at Almora (06.02.15) and then at Udhaywalla on 11.02.15. All the entries were infected with powdery mildew at both the locations. Ten entries had more than 6 severity of powdery mildew at Udhaywalla, whereas 19 entries were showing less than 5 severity at Almora (Table 8.27).

Loose Smut

There was no report of loose smut from any of the locations of SAARC nursery in India.

Disease situation in Bhutan

SAARC wheat disease monitoring nursery was planted only at one location in Bhutan. Yellow rust and leaf blight have been reported from the nursery planted in Bhutan. Here nine entries were free from yellow rust and remaining 11 entries were showing yellow rust severity between 10S to 60S. HP1633 was the only entry here with 60S yellow rust severity. Leaf blight was observed only on six entries viz. Annapurna-1, WL1563, Pak 81, Faisalabad 85, Kohsar and Gourab (Table 8.28).

Disease situation in Bangladesh

SAARC wheat disease monitoring nursery was planted at five locations in Bangladesh i.e. Jamalpur, Jessore, Joydebpur, Rajshahi and Dinajpur by Dr. Malaker and his group. Only leaf blight disease of wheat was observed at all five locations (Table 8.29). Brown rust was observed only at Jamalpur and Dinajpur. At Jamalpur seven entries viz. Annapurna-1 (20R), HD2687 (10R), HP1633, (10R), PBW373 (10R), Pak 81 (10R), Chakwal 86 (10R) and check (20MS) were infected with brown rust whereas at Dinajpur all the entries except HP1633, Raj3765 and Gourab were showing brown rust infection, though the severity was very low. Leaf blight was very severe at all the locations.

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Table 8.25. Incidence of rusts on SAARC Wheat Disease Monitoring Nursery in India during 2014-15

S.No.	Varieties	Yellow												Brown										Black	
		ALM	ABO	DBN	DEL	DKN	GUR	JAI	KAT	LUD	PAN	RAJ	UDH	ABO	DEL	FAZ	GUR	KAT	LUD	PAN	PUS	UDH	WEL	WEL
1	Annapurana-1	60S	20S	5S	5S	100S	60S	20S	40S	5MS	50S	20S	60S	0	TS	30S	10S	5S	0	0	0	10S	40S	40S
2	WL1562	20MS	TS	TS	0	60S	20S	10S	5S	0	10S	5S	5S	0	5S	0	10S	0	0	0	0	0	20S	40S
3	HD2204	20MS	TS	5S	0	60S	5S	5S	5S	5MS	0	0	10MS	0	TS	0	10S	0	0	TR	0	0	40S	60S
4	PBW343	60S	20S	20S	10S	100S	60S	20S	40S	40S	30S	40S	60S	0	10S	20S	5S	TS	0	0	Traces	0	80S	20S
5	HD2687	30S	20S	5S	5S	100S	40S	20S	40S	40S	40S	20S	40S	0	0	0	5S	TS	0	TR	0	0	40S	10S
6	HD2189	10MS	5MS	10S	0	40S	40S	10S	0	40S	20S	10S	5MS	0	0	0	20S	0	0	0	0	0	60S	20S
7	HP1633	10S	10S	5S	TR	60S	40S	5S	5S	40S	50S	0	5S	0	0	0	5S	0	0	0	0	0	60S	80S
8	RAJ3765	5S	10S	5S	0	40S	20S	100S	0	10MS	0	20S	10S	0	0	0	5S	0	0	0	0	0	0	20S
9	PBW373	0	0	0	0	40S	0	0	20S	0	TR	40S	60S	0	0	0	0	0	0	0	0	0	60S	20S
10	PAK81	60S	5MS	5S	0	80S	40S	20S	20S	60S	50S	10S	40S	0	0	0	10S	10S	0	0	0	5S	10S	20S
11	Punjab-85	10S	0	0	0	40S	0	10S	0	0	5S	5S	5S	0	0	0	0		0	0	0	0	40S	40S
12	Chakwal-86	TS	TS	TS	0	40S	10S	10MS	0	10MS	TR	0	10MS	0	0	0	0	5S	0	0	0	0	60S	60S
13	Faisalabad-85	60S	40S	5S	0	80S	40S	20S	20S	60S	70S	10S	20S	0	20S	0	0	0	0	0	0	10S	20S	20S
14	Inquilab-91	40S	5S	5S	0	60S	20S	20S	40S	60S	0	20S	40S	0	0	0	0	10S	0	0	0	TR	60S	10S
15	Faisalbad-83	10S	5S	TS	0	60S	10S	10S	5MR	40MS	5S	5S	5MR	0	0	0	0	0	0	0	0	0	20S	20S
16	Rawal87	5S	0	5S	0	20S	10S	5S	0	40S	0	20S	0	0	0	0	10S	0	0	5S	0	TS	20S	40S
17	Kohsar	10S	0	5S	20S	40S	5S	5S	10S	60S	TR	0	10S	0	0	0	0	0	0	15S	Traces	0	20S	40S
18	Bakhtawar 94	5S	0	TS	0	40S	10S	10S	0	40S	TR	20S	10MS	0	0	0	0	TS	0	TR	0	5S	0	20S
19	Gourab	30S	10S	5S	0	80S	20S	10S	0	60S	50S	0	10S	0	0	0	0	10S	0	0	0	0	20S	20S
20	Susceptible Check	60S	40S	20S	50S	100S	60S	40S	30S	60S	80S	40S	40S	40S	40S	80S	5S	10S	10S	10S	10S	20S	20S	60S
Date of first Appearance		4th wk, Feb, 15	-	-	02.03.15	13.02.15	-	28.02.15	02.02.15	-	30.01.15	10.03.15	10.01.15	-	09.03.15	24.02.15	-	21.03.15	-	05.03.15	20.02.15	19.03.15	-	-

*ALM= Almora; ABO=Abohar; DBN=Dera-Baba-Nanak; DEL=New Delhi; DKN=Dhaulakuan; GUR=Gurdaspur; JAI=Jaipur; , KAT=Kathua; LUD=Ludhiana; PAN=Pantnagar; RAJ=Rajauri; UDH= Udhaywalla; FAZ= Faizabad; PUS=Pusa; WEL=Wellington

Table 8.26. Incidence of leaf blight in SAARC Wheat Disease Monitoring Nursery during 2014-15 in India

S. No.	Varieties	Leaf blight severity						
		Almora	Faizabad	Kathua	Pusa	Rajouri	Udhaywalla	Wellington
1	Annapurna-1	12	57	24	67	24	23	12
2	WL1562	12	78	36	78	24	13	12
3	HD2204	23	79	21	78	24	23	12
4	PBW343	23	57	21	46	13	23	45
5	HD2687	12	69	21	56	12	12	00
6	HD2189	02	68	21	67	12	12	00
7	HP1633	12	78	21	78	24	23	00
8	Raj3765	13	68	36	67	24	24	45
9	PBW373	23	46	21	35	12	12	00
10	Pak 81	13	57	16	57	12	12	12
11	Punjab 85	01	46	16	57	12	16	12
12	Chakwal 86	01	46	11	35	12	12	23
13	Faisalabad 85	01	57	21	35	24	12	12
14	Inquilab 91	01	46	21	68	12	23	00
15	Faisalabad 83	12	57	36	67	24	16	00
16	Rawal 87	01	35	24	57	12	23	01
17	Kohsar	11	46	11	67	12	12	01
18	Bakhtawar 94	12	35	11	24	12	23	00
19	Gourab	13	57	36	45	12	23	00
20	S. Check	23	78	21	67	16	23	00
Date of first appearance		07.03.15	25.01.15	26.02.15	22.01.15	28.03.15	19.03.15	-

Table 8.27. Incidence of Powdery Mildew in SAARC Wheat Disease Monitoring Nursery during 2014-15 in India

S.No.	Varieties	Powdery Mildew	
		Almora	Udhaywalla
1	Annapurna-1	3	6
2	WL1562	5	6
3	HD2204	5	7
4	PBW343	5	5
5	HD2687	3	5
6	HD2189	3	3
7	HP1633	5	6
8	Raj3765	3	7
9	PBW373	3	4
10	Pak 81	3	6
11	Punjab 85	3	5
12	Chakwal 86	3	6
13	Faisalabad 85	1	4
14	Inquilab 91	5	6
15	Faisalabad 83	3	5
16	Rawal 87	5	5
17	Kohsar	7	6
18	Bakhtawar 94	3	3
19	Gourab	5	4
20	Susceptible check	5	6
Date of first appearance		**06.02.15**	**11.02.15**

Table 8.28. Incidence of wheat diseases on SAARC wheat disease monitoring nursery 2014-15 in Bhutan

S. No.	Varieties	Yellow Rust				Leaf Blight			
		7/3/2015	14/3/2015	18/3/2015	27/3/2015	7/3/2015	14/3/2015	18/3/2015	27/3/2015
1	Annapurna-1	0	0	0	0	0	0	✓	✓
2	WL1563	T	T	10S	20S	0	0	✓	✓
3	HD2204	0	0	0	0	0	0	0	0
4	PBW343	0	0	0	10S	0	0	0	0
5	HD2687	0	0	10S	10S	0	0	0	0
6	HD2189	T	T	10S	40S	0	0	0	0
7	HP1633	0	10S	40S	60S	0	0	0	0
8	Raj3765	0	0	0	0	0	0	0	0
9	PBW660	0	0	0	0	0	0	0	0
10	Pak 81	0	0	0	0	0	0	✓	✓
11	Punjab 85	0	10S	20S	40S	0	0	0	0
12	Chakwal 86	0	T	10S	10S	0	0	0	0
13	Faisalabad 85	0	T	20S	20S	0	0	✓	✓
14	Inquilab 85	0	0	0	0	0	0	0	0
15	Faisalabad 83	T	10S	20S	40S	0	0	0	0
16	Rawal 87	T	10S	20S	40S	0	0	0	0
17	Kohsar	0	0	0	0	0	0	✓	✓
18	Bakhtawar 94	0	0	0	0	0	0	0	0
19	Gourab	0	0	0	0	0	0	✓	✓
20	Sonalika	10S	20S	30S	40S	0	0	0	0

Table 8.29. Incidence of wheat diseases on SAARC wheat disease monitoring nursery 2014-15 in Bangladesh

S. No.	Variety	Brown rust					Leaf Blight				
		Jamalpur	Jessore	Joydebpur	Rajshahi	Dinajpur	Jamalpur	Jessore	Joydebpur	Rajshahi (% DLA)*	Dinajpur
1	Annapurna-1	20R	0	0	0	5S	75	52	73	37.04	64
2	WL1567	0	0	0	0	TS	75	64	75	100.00	85
3	HD2204	0	0	0	0	TS	75	64	75	100.00	85
4	PBW343	0	0	0	0	TS	35	62	63	44.44	75
5	HD2687	10R	0	0	0	TMSS	55	62	63	51.85	64
6	HD2189	0	0	0	0	TMSS	55	61	74	44.44	75

S. No.	Variety	Brown rust					Leaf Blight				
		Jamalpur	Jessore	Joydebpur	Rajshahi	Dinajpur	Jamalpur	Jessore	Joydebpur	Rajshahi (% DLA)*	Dinajpur
7	HP1633	10R	0	0	0	0	75	74	75	44.44	85
8	Raj 3765	0	0	0	0	0	74	51	74	44.44	85
9	PBW373	10R	0	0	0	TMSS	35	42	63	37.04	64
10	Pak 81	10R	0	0	0	5S	55	42	74	51.85	74
11	Punjab 85	0	0	0	0	TMSS	54	52	74	59.26	75
12	Chakwal 86	10R	0	0	0	TS	54	61	64	44.44	64
13	Faisalabad 85	0	0	0	0	5S	53	42	64	29.63	64
14	Inquilab 91	0	0	0	0	TMSS	74	71	75	44.44	85
15	Faisalabad 83	0	0	0	0	TMSS	75	52	75	51.85	85
16	Rawal 87	0	0	0	0	2S	55	51	63	44.44	64
17	Kohsar	0	0	0	0	TMSS	55	52	74	51.85	74
18	Bakhtwar 94	0	0	0	0	TMS	54	61	74	51.85	74
19	Gourab	0	0	0	0	0	53	52	63	51.85	85
20	Susceptible check	20MS	0	0	0	5S	76	62	64	44.44	75

***DLA diseased leaf area**

PROGRAMME 9. INTEGRATED PEST MANGEMENT IN WHEAT

9.1 HOST RESISTANCE AGAINST DISEASES AND INSECT PESTS

I. Elite Plant Pathological Screening Nursery (EPPSN), 2014-15

Breeding for disease and insect pests resistance in wheat is an important component of crop improvement. The use of resistant cultivars has been the most effective and easy way to minimize losses due to biotic stresses in wheat in India. The breeders are, however, in need of new sources of resistance to incorporate these in the future cultivars to tackle the threat of evolving new virulences of pathogens as well as new biotypes in insects. The present chapter deals with identification and utilization of multiple disease and insect pests resistant genotypes.

Total 77 entries.
Diseases: Stripe, Leaf and Stem rusts
Centres: North: Karnal, Ludhiana, New Delhi, Ranichauri, Pantnagar, Hisar, Durgapura, Almora, Jammu (9)
South: Wellington, Mahabaleshwar, Dharwad, Indore (4)

The nursery was inoculated with most virulent and prevalent pathotypes of stripe, leaf and stem rusts as in case of PPSN (given earlier under Chapter 1). The record on rusts was taken at dough stage. The stripe or yellow rust records were taken from five centres situated in the north. These were Durgapura, Karnal, Ludhiana, Almora and Pantnagar. The stem rust data of Indore and leaf rust and stem rust data of Mahabaleshwar, Wellington and Dharwad were taken for calculating ACI in South. In north, the leaf rust data of New Delhi, Pantnagar, Ludhiana, Durgapura and Karnal centres were considered. The highest score and ACI were calculated. Entries with ACI up to 10.0, were categorized as resistant (Table 9.1).

COOPERATORS:

NAME	CENTRE	RUSTS
JASPAL KAUR	LUDHIANA	STRIPE
S. S. KARWASRA, R.S. BENIWAL	HISAR	LEAF
J. KUMAR, DEEPSHIKHA, K.SRIVASTAVA	PANTNAGAR	STRIPE AND LEAF
P.S. SHEKHAWAT	DURGAPURA	STRIPE AND LEAF
P.V. PATIL	DHARWAD	STEM AND LEAF
T.L. PRAKASHA, AND A. N. MISHRA	INDORE	STEM AND LEAF
S.G. SAWASHE	MAHABALESHWAR	STEM AND LEAF
V.K. SINGH AND R. C. MATHURIA	NEW DELHI	LEAF
S.K.JAIN	ALMORA	STRIPE
M.K. PANDEY	JAMMU	STRIPE
P. NALLATHAMBI, C. UMA MAHESHWARI	WELLINGTON	LEAF, STRIPE STEM,
M.S. SAHARAN, SUDHEER KUMAR AND R. SELVAKUMAR	KARNAL (CO-ORDINATING UNIT)	STRIPE AND LEAF

Table 9.1. Entries tested in Elite Plant Pathological Screening Nursery, 2014-15

Sr. No.	Entry	Stem Rust		Leaf Rust		Leaf Rust		Stripe Rust	
		South		South		North		North	
		HS	ACI	HS	ACI	HS	ACI	HS	ACI
A. Resistant to all three rusts									
Source: AVT II Year 2013-14									
1	HI 8737 (d)	10MS	4.6	TR	0.0	5MR	0.3	5MS	0.4
2	PBW 681	20S	9.0	TR	0.0	0	0.0	TR	0.0
Source: AVT Ist Year 2013-14									
3	DBW 95	20MS	7.1	5S	1.7	5MR	1.8	20S	4.8
4	DBW 129	5S	3.1	TR	0.0	TR	0.0	10S	2.5
5	DDW 30 (d)	5S	3.0	5S	2.4	5S	0.9	5MR	0.4
6	HD 4728 (d)	5S	1.7	10MR	2.0	5MR	0.3	50S	9.4
7	HD 4730 (d)	5S	2.3	20MR	2.6	5S	0.8	5MS	1.3
8	HI 8750 (d)	5MS	1.6	10MR	2.6	TR	0.0	10S	3.0
9	HI 8751 (d)	20S	10.6	20MR	2.6	5S	1.2	5MS	1.8
10	HPW 373	20X	5.3	10R	0.6	0	0.0	10S	1.8
11	HPW 411	5MR	1.3	40MR	8.9	TS	0.1	5S	1.6
12	HS 593	20R	1.4	20MR	4.3	5S	0.8	5S	1.1
13	HUW 661	30S	10.6	5S	3.0	10S	1.8	5MS	3.8
14	K 1204	30S	14.0	20R	1.3	20MS	3.5	5MS	0.8
15	PBW 677	20S	8.0	5S	1.7	5S	0.8	5MS	0.8
16	PBW 697	30S	15.0	20R	1.3	0	0.0	20S	6.5
17	PBW 703	30S	13.0	TR	0.0	0	0.0	5MS	0.6
18	PBW 723	10MR	1.4	5R	0.3	5MR	0.3	20S	6.3
19	TL 2995 (T)	5MR	0.7	5R	0.3	0	0.0	20S	3.3
20	TL 2996 (T)	10X	2.0	10MR	2.6	0	0.0	10S	2.0
20A	INFECTOR	100S	55.0	60S	41.3	100S	63.3	90S	75.0
21	TL 2999 (T)	10MS	2.7	10R	0.6	5MR	0.3	5MR	0.3
22	TL 3000 (T)	20MS	5.4	10R	0.6	0	0.0	40MR	2.8
23	UAS 451 (d)	10S	3.6	20R	1.3	0	0.0	5S	1.8
24	VL 1003	10MR	1.3	20R	6.6	TS	0.1	40S	9.0
25	VL 3004	10MR	1.3	20S	6.7	TS	0.1	60S	15.6
B. Resistant to Stem and Leaf rusts									
Source: AVT IInd Year 2013-14									
26	BRW 3723	30S	16.6	20S	13.8	10S	3.3	60S	19.8
27	DBW 107	20S	9.0	20S	11.3	TR	0.1	20S	10.8
28	DBW 110	20S	8.3	TR	0.0	10MS	2.0	60S	27.0
29	DDK 1042 (dic)	20S	11.0	TR	0.0	20S	4.6	40MS	20.3
30	HD 3118	40S	20.3	20MR	4.3	10S	1.6	20MS	8.5
31	HUW 666	20MR	3.0	5S	3.0	5S	1.5	40S	8.7
32	NIAW 1994	20S	13.0	5S	1.7	TS	0.3	80S	53.3
33	PBW 689	40S	16.0	10S	3.3	10MS	2.6	20S	8.6
34	VL 967	20S	8.0	40MR	10.0	5S	0.8	15S	4.1
Source: AVT Ist Year 2013-14									
35	DBW 128	20S	10.6	20MR	2.6	10MS	2.0	60S	18.0
36	DBW 154	5S	2.4	10S	6.0	20MS	2.8	80S	22.5
37	GW 451	20S	8.6	5S	1.7	10S	1.4	60S	32.3
38	GW 455	10MR	1.6	TR	0.0	10S	1.6	80S	25.8
39	HD 2932- Lr 19 / Sr 25	20S	9.0	5S	1.7	TS	0.1	60S	24.8
40	HD 3128	30S	14.3	5S	3.6	10S	2.0	20S	5.1
40A	INFECTOR	100S	56.6	60S	34.6	100S	56.6	90S	75.0
41	HD 3132	20S	6.6	5S	2.0	TS	0.1	40S	16.6
42	HD 3133	20S	8.0	10S	4.0	5S	0.8	60S	27.6
43	HD 3146	20S	7.3	10S	4.0	20S	3.3	60S	25.8
44	HPW 400	30S	12.6	20S	7.3	10S	2.5	30S	10.6
45	HPW 401	10MR	1.3	5R	0.3	10MS	2.0	40S	12.5
46	HPW 410	30S	12.0	30S	16.6	10S	1.6	20S	12.6
47	HS 547	20MR	3.0	20S	7.0	TS	0.1	40S	20.0

Sr. No.	Entry	Stem Rust		Leaf Rust		Leaf Rust		Stripe Rust	
		South		South		North		North	
		HS	ACI	HS	ACI	HS	ACI	HS	ACI
48	HS 577	20S	7.0	30MS	12.3	TS	0.2	60S	20.0
49	HS 595	5MS	1.6	5S	1.7	5MS	0.8	10S	4.3
50	HUW 675	10S	4.0	0	0.0	TR	0.0	60S	13.5
51	HUW 677	20MR	3.3	5S	2.3	5S	0.8	60S	25.8
52	HUW 679	60S	30.6	5S	2.3	5MR	0.3	20S	6.6
53	MACS 5031	10S	9.3	TR	0.0	5MS	0.6	20S	9.6
54	NIAW 2030	5S	4.0	10R	0.6	TR	0.0	70S	45.0
55	PBW 701	20MR	4.4	10R	0.6	10MS	2.0	40S	15.5
56	PBW 704	TMR	0.1	20S	7.0	0	0.0	60S	24.1
57	PBW 706	40S	14.6	40R	4.3	0	0.0	10S	3.6
58	UP 2864	20MR	2.8	TR	0.0	10MS	1.7	40S	18.0
59	UP 2891	20MR	5.3	TR	0.0	0	0.0	60S	45.0
60	VL 1004	20S	9.6	20R	1.3	0	0.0	40S	13.4
60A	INFECTOR	100S	53.3	60S	42.6	100S	60.0	80S	71.6
61	VL 3005	0	0.0	10S	3.3	5S	1.0	60S	21.3
62	VL 976	10S	6.0	20S	16.6	TR	0.0	40S	13.1
63	VL 977	5S	1.8	TR	0.0	0	0.0	40S	13.3
C. Resistant to Leaf and Stripe rusts									
Source: AVT IInd Year 2013-14									
64	UAS 446	TMR	0.1	TR	0.0	0	0.0	5S	1.8
65	WH 1129	10MR	2.0	0	0.0	5MR	0.3	40S	11.5
Source: AVT Ist Year 2013-14									
66	HI 8755 (d)	10MS	3.3	20MR	2.6	10S	2.0	15S	2.8
67	HS 590	10MS	3.3	10S	5.0	5MS	0.6	40S	7.3
68	HS 592	30MS	8.0	10R	0.6	10S	1.6	20S	3.5
69	HS 594	30S	10.3	5S	2.3	0	0.0	40S	9.1
70	PBW 695	40MS	10.8	20S	6.7	5MS	0.6	5MS	0.6
71	PBW 698	30MS	11.0	TR	0.0	10MS	1.3	10MS	2.1
72	PBW 722	30MR	6.6	TR	0.0	TR	0.0	5R	0.3
73	TL 2997 (T)	50MS	13.4	40MR	5.3	5MS	1.6	40S	6.6
D. Resistant to Stem and Stripe rusts									
Source: AVT IInd Year 2013-14									
74	K 1217	5R	0.4	20S	12.0	10MR	0.6	10S	3.1
75	MACS 3916 (d)	60MS	18.3	10S	3.6	TMS	0.2	30S	6.0
76	PBW 692	10MR	1.4	20S	6.7	20S	3.3	10S	4.0
77	VL 3002	5MS	2.0	5S	1.7	20S	6.0	10S	2.0
77A	INFECTOR	100S	60.0	60S	40.0	100S	53.3	90S	78.3

II. Multiple Disease Screening Nursery, 2014-15

Forty one resistant sources identified in EPPSN against rusts are cross checked for resistance to other diseases at hot spot multi-locations under artificially created conditions to reconfirm their resistance. Data were considered for stem rust: Mahabaleshwar, Indore and Wellington; for stripe rust: Ludhiana, Pantnagar, Dhaulakuan, and Karnal; for leaf rust (N): Delhi and Karnal; for leaf rust (S): Mahabaleshwar, Dharwar and Wellington; for Karnal bunt: Karnal, Ludhiana and Dhaulakuan; for leaf blight: Faizabad, Karnal, Coachbehar, Dharwar, Wellington; for Head scab: Wellington and Karnal; for flag smut: Karnal, Ludhiana and Durgapura; for loose smut: Hisar, Ludhiana and Durgapura; for powdery mildew: Wellington, Jammu, Pantnagar, Dhaulakuan, and Almora; and for cereal cyst nematode: Hisar, Ludhiana and Durgapura. Based on the ACI up to 10.0, Karnal bunt up to 5.0%, Flag smut up to 5% and powdery mildew up to 3 and leaf blight up to 35 (R) and 36-57 (MR) entries were categorized resistant (Table 9.2). Following entries were found to possess multiple disease resistance:

Resistant to all three rust +LB+KB+FS
HI 8738 (d)
Resistant to all three rust +LB+PM
PBW 660
Resistant to all three rust +FS
HI 8724 (d), HI 8725 (d), HI 8728 (d)
Resistant to all three rust
HPW 381, UP 2871, WH 1098
Resistant to Stem and leaf rust+KB+FS
HI 8739 (d), HI 8742 (d), HS 578, NIDW 699 (d)
Resistant to Stem and leaf rust +LB+PM
HW 1900, HW 4042, HW 5237, MACS 5031,
Resistant to Stem and leaf rust +PM+FS
DDK 1044 (dic.), DDK 1045 (dic.)
Resistant to Stem and leaf rust +LB
KRL 348, VL 3001, GW 432, HUW 668, HW 4013, UP 2872, WH 1137
Resistant to Stem and leaf rust
RAJ 4250, HI 1588 Q, HW 1099, HW 5235, JAUW 598, RAJ 4324, UP 2843, UP 2847
Resistant to leaf and yellow rust +LB+KB+FS
NIDW 706 (d)
Resistant to leaf and yellow rust +LB+PM+FS
HW 5224
Resistant to stem and yellow rust+LB
HD 3121

COOPERATORS

CENTERS	COOPERATORS
LUDHIANA	JASPAL KAUR, RITU BALA
ALMORA	S. K. JAIN
HISAR	S. S. KARWASRA, R.S. BENIWAL
DHAULAKUAN	DHANBIR SINGH
PANTNAGAR	J. KUMAR, DEEPSHIKHA, K. SRIVASTAVA
INDORE	T.L. PRAKASHA, A.N. MISHRA, K. KAUSHAL
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FAIZABAD	S.P. SINGH, SAVITA GUPTA
DURGAPURA	P.S. SHEKHAWAT
JAMMU	M. K. PANDEY
DHARWAD	P.V. PATIL
NEW DELHI	V.K. SINGH AND R.C. MATHURIA
VARANASI	S.S. VAISH
KARNAL	M.S.SAHARAN, SUDHEER KUMAR AND R. SELVAKUMAR (COORDINATING UNIT)
FOR CCN	
DURGAPURA	INDIRA RAJAVANSHI
HISAR	R.S.KANWAR
LUDHIANA	DAMANJIT KAUR

Table 9.2 Reactions of different entries of Multiple Disease Screening Nursery, 2014-15 against diseases and CCN

S. No.	Entry	Stem rust		Leaf rust		Leaf rust	Stripe rust		LB.(DD)		PM		KB		FS		FHB	CCN
		South				North			0-9		0-9		%		%			
A. Resistant to all three rusts																		
Source: EPPSN 2013-14		HS	AV.	HS	AV.	HS	HS	AV.	HS	AV.	HS	AV.	HS	AV.	HS	AV.	HS	HS
AVT IInd Year 2012-13																		
1	HI 8724 (d)	10S	7.0	5MS	2.0	5S	20S	5.0	67	45	7	4	15.5	6.7	0.2	0.1	4	HS
2	HI 8725 (d)	10S	4.0	20S	6.6	TR	10S	2.0	67	35	6	5	15.3	8.5	0	0	4	HS
3	HI 8728 (d)	5MR	1.0	20S	6.6	5MR	20S	7.5	79	46	7	5	41	16	0	0	0	HS
4	PBW 660	10R	0.6	0	0.0	10S	5S	1.2	79	34	5	3	18.9	15	50	17.5	5	HS
Source: AVT Ist Year 2012-13																		
5	DDW 23 (d)	10MS	4.3	40S	15.0	10MR	40S	10.1	89	35	6	5	0	0	0	0	10	HS
6	HI 8735 (d)	5S	2.3	0	0.0	20MS	60S	21.5	79	46	7	3	4.09	1.8	0	0	40	HS
7	HI 8739 (d)	5S	2.3	20S	6.6	TR	40S	13.5	78	45	6	4	3	1.8	0	0	5	HS
8	HI 8742 (d)	10MR	1.3	5R	0.3	10MS	40S	16.0	79	36	7	3	2.03	1.3	0	0	5	HS
9	HPW 381	5S	2.0	20MR	2.6	TR	20S	5.0	47	34	6	4	77.1	42	35.7	11.9	5	HS
10	HS 578	5S	1.6	20R	1.3	10S	60S	27.1	49	24	5	4	5	3.7	9.5	3.2	5	HS
11	KRL 348	5S	1.8	20MR	2.6	5MS	40S	15.0	34	23	7	4	41.1	19	30	10.4	5	HS
12	VL 3001	5MS	2.0	20R	1.3	5MR	40S	20.0	47	35	6	4	36.4	19	0	0	5	HS
B. Resistant to Stem & Leaf rusts																		
AVT IInd Year 2012-13																		
13	GW 432	5S	3.0	5S	3.0	5MS	100S	75.0	89	35	5	4	26.9	19	23.5	7.8	10	HS
14	HD 3095	5MR	1.3	10R	0.6	20MR	60S	35.0	89	45	6	4	53.9	41	18.2	7	15	HS
15	RAJ 4250	5MS	2.6	5S	1.7	5MR	60S	35.0	79	45	8	5	30.5	20	33.3	19.4	5	HS
Source: AVT Ist Year 2012-13																		
16	DDK 1044 (dic.)	10S	4.0	10MR	1.6	10MS	40S	29.0	58	46	5	2	27.6	10	0	0	5	HS
17	DDK 1045 (dic.)	10MR	2.0	20R	1.4	5S	60S	39.0	67	45	4	2	31.9	11	0	0	10	HS
18	HI 1588 Q	5S	2.0	20R	1.3	TR	100S	47.5	67	56	7	5	54	40	4.3	1.4	5	HS
19	HUW 668	10S	5.0	20S	9.3	5MS	60S	30.0	46	35	7	5	58.7	36	23.1	10.6	5	HS
20	HW 1099	10S	3.6	20MR	3.0	TS	80S	34.5	67	46	6	3	36.7	19	78.6	26.2	10	HS
20A	Infector for Rust	100S	53.3	80S	53.3	100S	100S	67.5	-	-	-	-	12.3	10	-	-	10	-
20B	WL 711 for K.B.	-	-	-	-	-	-	-	-	-	-	-	32.3	21	-		10	HS
20C	PBW 343 for P.M.	-	-	-	-	-	-	-	-	-	8	7	20.8	14	54.5	28.6	0	HS
20D	RAJ 4015 for L.B.	-	-	-	-	-	-	-	89	57	-	-	20	12	11.1	11.1	5	HS

S. No.	Entry	Stem rust		Leaf rust		Leaf rust	Stripe rust		LB.(DD)		PM		KB		FS		FHB	CCN
		South				North			0-9		0-9		%		%			
21	HW 1900	5R	0.4	5S	3.0	10MS	80S	55.0	45	35	6	3	53.5	35	14.3	7.9	15	HS
22	HW 4013	TMR	0.2	20R	1.3	5MR	40S	21.0	68	35	5	4	38.1	23	80	45.7	5	HS
23	HW 4042	TR	0.0	0	0.0	5MS	60S	38.8	47	34	6	3	45.6	26	1.3	0.4	10	HS
24	HW 5235	0	0.0	10R	0.6	TMS	70S	57.5	89	46	6	3	36	26	18.2	6.1	5	HS
25	HW 5237	0	0.0	20R	1.3	0	60S	50.0	89	34	6	2	30.1	15	92.3	37.4	10	HS
26	JAUW 598	20S	8.0	20R	1.3	5MS	60S	32.5	89	46	6	3	33.1	19	24.1	8	5	HS
27	MACS 5031	10S	4.6	5S	2.3	5S	40S	29.0	78	35	4	2	28	14	47.3	15.8	5	HS
28	RAJ 4324	10MS	4.0	20R	1.3	10MS	60S	31.3	89	56	9	4	23.1	16	20	7.7	10	HS
29	UP 2843	5MR	0.8	40MR	8.6	10S	60S	22.3	89	45	7	5	18.4	8.9	25	12.1	15	HS
30	UP 2847	5R	0.3	0	0.0	10S	40S	15.0	79	45	8	5	47.5	37	50	28.4	5	HS
31	UP 2871	10MR	1.6	20R	1.3	10S	20S	7.5	79	56	8	5	31.7	19	61.9	21.7	15	HS
32	UP 2872	20MS	5.3	TR	0.0	10MS	40S	16.7	79	35	6	5	52.8	38	40	16.5	15	HS
C. Resistant to Leaf & Stripe rusts																		
AVT IInd Year 2012-13																		
33	HW 5224	30MS	12.3	20MR	2.6	10S	15S	6.2	89	34	5	3	28	20	1.7	0.6	5	HS
34	WH 1098	30X	8.6	10R	0.6	10S	15S	5.0	89	45	7	5	14.4	8.2	11.1	7.8	5	HS
Source: AVT Ist Year 2012-13																		
35	HD 3121	20X	4.1	10R	0.6	20S	20S	7.7	89	35	9	5	34.6	14	40	14.7	10	HS
36	HI 8738 (d)	10S	6.0	20MR	2.6	TS	40S	10.0	79	34	9	5	5	2.2	0	0	15	HS
37	NIDW 706 (d)	40MS	17.3	10MS	3.3	5S	20S	7.2	79	35	6	5	4.5	3.3	0	0	5	HS
38	WH 1129	10MS	2.6	10R	0.6	TMS	40S	16.2	34	13	9	4	23.6	8.4	23.1	7.7	10	HS
39	WH 1137	20S	8.0	20MR	2.6	5S	40S	15.0	35	23	6	4	50	19	8.3	3.7	10	HS
40	NIDW 699 (d)	20MS	8.6	20MR	2.6	10MS	40S	15.7	89	45	7	6	0	0	0	0	10	HS
41	UPD 94 (d)	30MS	8.0	5MR	1.0	5MR	60S	16.2	69	34	9	5	10.2	4.4	0	0	15	HS

III. Screening of MDSN 2013-14 entries against loose smut during 2014-15

Forty nine entries of MDSN 2013-14 were inoculated with loose smut during 2013-14 crop season and expression of loose smut was observed during 2014-15 season at Hisar, Durgapura and Ludhiana centres. The smutted and healthy tillers were counted and per cent infected tillers were calculated. The entries showing 0-5% infection were resistant to loose smut (Table 9.3).

Table 9.3. Performance of Multiple Disease Screening Nursery, 2013-14, against loose smut during 2014-15 crop season

S. No.	Entry	Loose smut (%)				
		Durgapura	Hisar	Ludhiana	HS	AV
A. Resistant to all three rusts						
Source: AVT IInd Year 2011-12						
1	HW 1098	0	0	0	0	0.0
2	HW 5216	0	30.13	31.96	31.96	20.7
Source: AVT Ist Year 2011-12						
3	GW 433	5.45	30.35	45.26	45.26	27.0
4	GW 1276 (d)	0	0	0	0	0.0
5	HD 3076	1.65	40.21	19.8	40.21	20.6
6	HD 3098	0	40	24.44	40	21.5
7	HPW 385	0	0	0	0	0.0
8	KRL 327	24.05	60	25	60	36.4
9	PBW 670	0	60.71	0	60.71	20.2
10	PDW 329 (d)	0	28.71	0	28.71	9.6
11	TL 2978 (T)	0	30.71	0	30.71	10.2
12	VL 971	0	-	59.13	59.13	29.6
13	MP 1259	0	0	11.09	11.09	3.7
14	Raj 4220	0	45.65	31.7	45.65	25.8
15	Raj 4270	5.34	40.21	14.77	40.21	20.1
16	UP 2825	56.25	51.25	48.93	56.25	52.1
17	UP 2852	60	60.25	17.28	60.25	45.8
B. Resistant to Stem & Leaf rusts						
Source: AVT IInd Year 2011-12						
18	Raj 4238	30.23	60.51	31.4	60.51	40.7
19	DDK 1042	0	0	0	0	0.0
Source: AVT Ist Year 2011-12						
20	GW 1280 (d)	0	0	0	0	0.0
20A	Sonalika for L.S.	44.38	80.75	44.13	80.75	56.4
21	HI 1584	3.85	60.5	26.04	60.5	30.1
22	KLP 402	0	50.71	19.79	50.71	23.5
23	MP 3353	4.41	50.65	55.77	55.77	36.9
24	Raj 4245	11.39	70.25	19.1	70.25	33.6
25	UP 2824	7.89	70.23	15.94	70.23	31.4
26	UP 2828	1.79	20	16.47	20	12.8
27	UAS 336	7.69	40.15	17.3	40.15	21.7
C. Resistant to Leaf & Stripe rusts						
Source: AVT IInd Year 2011-12						
28	HS 526	0	50.31	20.23	50.31	23.5
29	HD 3065	0	30.21	0	30.21	10.1
30	HI 1579	0	40	16.47	40	18.8
31	WH 1105	1.01	30.61	14.81	30.61	15.5
32	MACS 3828	0	0	0	0	0.0
33	PBW 658	0	40.13	19.32	40.13	19.8
Source: AVT Ist Year 2011-12						
34	AKDW 4749	0	0	0	0	0.0
35	HD 3075	0	40.21	0	40.21	13.4
36	HD 3081Q	0	30.33	7.27	30.33	12.5

S. No.	Entry	Loose smut (%)				
		Durgapura	Hisar	Ludhiana	HS	AV
37	HPW 368	0	0	12.03	12.03	4.0
38	HPW 376	0	0	13.04	13.04	4.3
39	HS 557	2.22	0	2.75	2.75	1.7
40	NIAW 1846	1.39	20.55	16.83	20.55	12.9
41	RW 3705	11.11	60.41	11.22	60.41	27.6
42	VL 972	0	-	18.18	18.18	9.1
43	PBW 661	9.09	50.53	33.34	50.53	31.0
44	HD 3077	9.84	50.25	34.61	50.25	31.6
45	HD 4725	0	-	1.78	1.78	0.9
46	HI 8626 (d)	0	0	0	0	0.0
47	HUW 652	14.29	30.33	29.52	30.33	24.7
48	K 1016	6.54	60	32	60	32.8
49	Raj 4246 Q	26.15	60	16.9	60	34.4

IV. Multiple pest Screening nursery for 2014-15
Evaluation for insect pest resistance

Shoot fly: Forty one MPSN lines were screened against shoot fly at six locations viz. Dharwad, Durgapura, Ludhiana, Niphad, Kanpur and Kharibari out of which average maximum score was 30.66 for DDK 1045 (dic.) entry and minimum score was 6.66% for HI 8724 (d) entry (Table 9.4a).

Brown wheat mite: Forty one entries were screened against brown mite at three locations viz. Durgapura , Ludhiana and Niphad out of which maximum score was 22.20/10 cm sq area for UPD 94 (d) and minimum score was 10.00/10 cm sq area for HW 5237entry (Table 9.4a). Brown wheat mite was not observed on any genotype at Niphad.

Foliar aphid: Forty one entries were screened against wheat aphid at Niphad, Ludhiana, Kanpur, Kharibari (W.B.), Karnal, Pantnagar and Shillongani. All the entries were susceptible (grade 4) or highly susceptible (grade 5) to wheat aphid (Table 9.4b). Infestation of foliar aphid was not observed at Shillongani. Low infestation of foliar aphid were observed at Kanpur.

Root aphid: The screening consists of Forty one entries. The data was collected from Ludhiana and Karnal locations from each entry by uprooting the seedling when the crop was 3-4 weeks old. The entries PBW 660, DDK1044, HW 1099, HW 5237, MACS 5031, UP 2843 and HD 3121 were found to be moderately resistant and rest of them were susceptible (grade 4) or highly susceptible (grade 5) to wheat root aphid (Table 9.4b).

COOPERATORS

NAME	CENTRE
SUBHASH KATARE	KARNAL
BEANT SINGH	LUDHIANA
S.D. PATIL	NIPHAD
J.K. SINGH	KANPUR
K.K. BHARGAVA	DURGAPURA
P.V. PATIL	DHARWAD
K.K. SARMA	SHILLONGANI
RUCHIRA TIWARI	PANTNAGAR
WASIM REZA	KHARIBARI (WB)

Table .9.4a Screening of MPSN nursery against shootfly and Brown Wheat mite 2014-15

S.No.	Entry	Shoot fly incidence (%)								Brown Wheat mite		
		Dharwad	Durgapura	Ludhiana	Niphad	Kanpur	Kharibari	HS.	AV.	Ludhiana	Durgapura	HS
A. Resistant to all three rusts												
Source: EPPSN 2013-14												
AVT IInd Year 2012-13												
1	HI 8724 (d)	11.54	4.16	8.60	3.33	2.50	7.20	11.54	6.22	10.00	13.50	13.50
2	HI 8725 (d)	14.63	5.26	19.35	-	13.33	2.40	19.35	10.99	12.33	15.00	15.00
3	HI 8728 (d)	36.36	6.81	23.82	-	15.00	6.40	36.36	17.68	14.33	10.60	17.68
4	PBW 660	44.68	9.58	27.47	-	13.63	2.10	44.68	19.49	16.66	10.00	19.49
Source: AVT Ist Year 2012-13												
5	DDW 23 (d)	10.17	13.63	25.77	-	6.66	5.40	25.77	12.33	18.00	20.40	20.40
6	HI 8735 (d)	27.59	14.7	29.34	-	6.66	3.60	29.34	16.38	12.66	25.00	25.00
7	HI 8739 (d)	17.86	6.34	12.37	-	9.09	3.20	17.86	9.77	14.33	14.00	14.33
8	HI 8742 (d)	50.00	10.41	22.03	3.33	2.33	6.40	50.00	15.75	11.00	13.40	15.75
9	HPW 381	52.94	11.95	29.74	-	13.63	4.10	52.94	22.47	17.00	15.00	22.47
10	HS 578	39.29	7.46	26.92	8.33	12.5	2.20	39.29	16.12	11.33	mis	11.33
11	KRL 348	25.64	12.85	15.31	6.66	5.00	3.20	25.64	11.44	11.66	15.00	15.00
12	VL 3001	28.57	6.94	14.55	-	6.66	5.40	28.57	12.42	-	18.60	18.60
B. Resistant to Stem & Leaf rusts												
AVT IInd Year 2012-13												
13	GW 432	33.33	8.7	20.29	-	6.66	3.20	33.33	14.44	15.00	16.00	16.00
14	HD 3095	27.08	11.76	21.11	6.66	11.11	2.10	27.08	13.30	18.00	20.00	20.00
15	RAJ 4250	36.36	8.44	16.84	3.33	4.09	3.10	36.36	12.03	13.00	18.00	18.00
Source: AVT Ist Year 2012-13												

S.No.	Entry	Shoot fly incidence (%)								Brown Wheat mite		
		Dharwad	Durgapura	Ludhiana	Niphad	Kanpur	Kharibari	HS.	AV.	Ludhiana	Durgapura	HS
16	DDK 1044 (dic.)	75.86	21.95	25.00	-	10.18	5.40	75.86	27.68	15.00	16.00	16.00
17	DDK 1045 (dic.)	100.00	13.33	15.38	-	18.19	6.40	100.00	30.66	13.66	12.60	13.66
18	HI 1588 Q	39.62	10.52	11.94	5.00	13.33	3.10	39.62	13.92	16.66	10.00	16.66
19	HUW 668	38.30	11.32	20.51	3.33	12.66	6.40	38.30	15.42	15.00	10.60	15.00
20	HW 1099	81.48	5.88	18.75	6.66	6.66	4.40	81.48	20.64	9.66	15.00	15.00
20A	SONALIKA (C) FOR SF	26.98	15.06	24.79	10.00	22.72	7.10	26.98	17.78	-	-	-
20B	IWP 72 (C) FOR BWM	40.00	-	-	10.00	13.33	5.40	40.00	17.18	20.66	20.80	20.80
20C	A 9-30-1 (C) FOR FA	65.22	-	-	1.66	20.00	6.40	65.22	23.32	-	-	-
20 D	GW 173 (C) FOR RA	27.27	-	-	5.00	20.00	7.10	27.27	14.84	-	-	-
21	HW 1900	32.69	9.52	21.15	3.33	13.33	2.10	32.69	13.69	14.00	20.00	20.00
22	HW 4013	51.79	6.65	27.11	6.66	16.66	3.40	51.79	18.71	13.33	15.00	15.00
23	HW 4042	82.61	7.35	29.57	5.00	9.09	4.10	82.61	22.95	-	18.40	18.40
24	HW 5235	39.71	8.00	8.73	8.33	13.33	2.30	39.71	13.40	12.00	15.00	15.00
25	HW 5237	37.21	8.25	21.58	8.33	16.66	2.10	37.21	15.69	10.00	10.00	10.00
26	JAUW 598	57.69	15.00	14.29	6.66	9.09	3.40	57.69	17.69	12.66	20.20	20.20
27	MACS 5031	100.00	8.55	27.78	6.66	13.33	2.10	100.00	26.40	16.66	18.00	18.00
28	RAJ 4324	41.30	6.12	21.91	6.66	16.66	4.10	41.30	16.13	12.00	14.00	14.00
29	UP 2843	57.97	13.15	26.67	6.66	12.50	5.10	57.97	20.34	12.33	10.60	12.33
30	UP 2847	55.56	13.2	9.48	6.66	16.66	3.20	55.56	17.46	11.00	15.00	15.00
31	UP 2871	26.67	11.32	21.31	6.66	12.5	3.50	26.67	13.66	15.33	20.40	20.40
32	UP 2872	22.06	15.73	17.17	1.66	15	2.60	22.06	12.37	16.33	10.00	16.33
C. Resistant to Leaf & Stripe rusts												
AVT IInd Year 2012-13												

S.No.	Entry	Shoot fly incidence (%)								Brown Wheat mite		
		Dharwad	Durgapura	Ludhiana	Niphad	Kanpur	Kharibari	HS.	AV.	Ludhiana	Durgapura	HS
33	HW 5224	17.02	25.33	-	5.00	3.33	3.50	25.33	10.84	10.33	-	10.33
34	WH 1098	19.15	23.68	19.32	8.33	11.11	2.90	23.68	14.08	-	15.00	15.00
Source: AVT Ist Year 2012-13												
35	HD 3121	53.09	12.50	21.28	6.66	20.00	4.10	53.09	19.60	15.00	12.00	15.00
36	HI 8738 (d)	52.83	20.00	20.00	6.66	7.14	2.70	52.83	18.22	12.00	10.20	12.00
37	NIDW 706 (d)	33.33	6.54	22.86	6.66	15.00	4.10	33.33	14.75	-	12.00	12.00
38	WH 1129	71.79	24.39	13.18	8.33	14.28	5.10	71.79	22.85	13.33	10.00	13.33
39	WH 1137	32.69	12.82	12.77	11.66	15.00	6.20	32.69	15.19	10.00	15.60	15.60
40	NIDW 699 (d)	21.88	6.45	9.23	13.33	6.66	5.20	21.88	10.46	10.66	15.00	15.00
40 A	SONALIKA (C) FOR SF	50.91	19.64	20.97	10.00	12.66	6.10	50.91	20.05	-	-	-
40 B	IWP 72 (C) FOR BWM	32.05	-	-	8.33	14.36	7.10	32.05	15.46	19.66	10.00	19.66
40 C	A 9-30-1 (C) FOR FA	47.62	-	-	3.33	15.00	6.20	47.62	18.04	-	-	-
40 D	GW 173 (C) FOR RA	24.00	-	-	5.00	13.33	5.40	24.00	11.93	-	-	-
41	UPD 94 (d)	72.00	9.43	27.42	6.66	2.33	3.20	72.00	20.17	10.66	22.20	22.20

Niphad : Brown wheat mite was not observed on any genotype.

Table 9.4b. Screening of MPSN nursery against foliar aphid and root aphid 2014-15

S.No.	Entry	Foliar aphids (1-5 scale)							Root aphid(1-5 scale)		
		Niphad	Ludhiana	Kharibari	Karnal	Pantnagar	HS.	AV.	Ludhiana	Karnal	HS
A. Resistant to all three rusts											
Source: EPPSN 2013-14											
AVT IInd Year 2012-13											
1	HI 8724 (d)	5	4	2	5	5	5	4.2	5	3	5
2	HI 8725 (d)	5	4	1	5	4	5	3.8	4	4	4
3	HI 8728 (d)	5	4	4	5	4	5	4.4	4	4	4
4	PBW 660	4	4	3	5	4	5	4.0	3	3	3
Source: AVT Ist Year 2012-13											
5	DDW 23 (d)	5	4	4	5	4	5	4.4	4	4	4
6	HI 8735 (d)	5	4	3	5	4	5	4.2	3	4	4
7	HI 8739 (d)	5	4	2	5	4	5	4.0	4	4	4
8	HI 8742 (d)	5	3	4	5	4	5	4.2	5	4	5
9	HPW 381	4	3	3	5	3	5	3.6	4	4	4
10	HS 578	4	3	2	5	3	5	3.4	5	4	5
11	KRL 348	5	4	4	5	3	5	4.2	4	3	4
12	VL 3001	4	4	4	5	4	5	4.2	4	3	4
B. Resistant to Stem & Leaf rusts											
AVT IInd Year 2012-13											
13	GW 432	4	4	4	5	2	5	3.8	4	3	4
14	HD 3095	5	4	3	5	3	5	4.0	4	3	4
15	RAJ 4250	4	4	5	5	3	5	4.2	4	3	4
Source: AVT Ist Year 2012-13											
16	DDK 1044 (dic.)	5	4	2	5	3	5	3.8	3	3	3
17	DDK 1045 (dic.)	5	4	3	5	3	5	4.0	4	3	4
18	HI 1588 Q	4	4	5	5	4	5	4.4	4	3	4

S.No.	Entry	Foliar aphids (1-5 scale)							Root aphid(1-5 scale)		
		Niphad	Ludhiana	Kharibari	Karnal	Pantnagar	HS.	AV.	Ludhiana	Karnal	HS
19	HUW 668	4	5	5	5	4	5	4.6	4	4	4
20	HW 1099	5	5	5	5	4	5	4.8	3	3	3
20A	SONALIKA (C) FOR SF	5	-	5	5	2	5	4.3	-	-	-
20B	IWP 72 (C) FOR BWM	4	-	5	5	3	5	4.3	-	-	-
20C	A 9-30-1 (C) FOR FA	5	5	5	5	4	5	4.8	-	-	-
20 D	GW 173 (C) FOR RA	5	-	5	5	4	5	4.8	4	4	4
21	HW 1900	5	5	4	5	4	5	4.6	4	4	4
22	HW 4013	5	4	4	5	4	5	4.4	5	4	5
23	HW 4042	5	5	3	5	3	5	4.2	5	4	5
24	HW 5235	5	5	4	5	3	5	4.4	4	3	4
25	HW 5237	5	5	5	5	4	5	4.8	2	3	3
26	JAUW 598	5	4	4	5	4	5	4.4	4	4	4
27	MACS 5031	5	4	5	5	4	5	4.6	2	3	3
28	RAJ 4324	5	5	4	5	4	5	4.6	4	3	4
29	UP 2843	5	4	4	5	2	5	4.0	3	3	3
30	UP 2847	5	4	3	5	3	5	4.0	4	3	4
31	UP 2871	5	4	3	5	3	5	4.0	5	4	5
32	UP 2872	5	4	4	5	2	5	4.0	4	4	4
C. Resistant to Leaf & Stripe rusts											
AVT IInd Year 2012-13											
33	HW 5224	5	4	4	5	2	5	4.0	3	4	4
34	WH 1098	5	4	4	5	2	5	4.0	4	3	4
Source: AVT Ist Year 2012-13											
35	HD 3121	5	4	3	5	3	5	4.0	3	3	3
36	HI 8738 (d)	5	4	2	5	3	5	3.8	4	4	4
37	NIDW 706 (d)	5	4	5	5	2	5	4.2	4	4	4

S.No.	Entry	Foliar aphids (1-5 scale)							Root aphid(1-5 scale)		
		Niphad	**Ludhiana**	**Kharibari**	**Karnal**	**Pantnagar**	**HS.**	**AV.**	**Ludhiana**	**Karnal**	**HS**
38	WH 1129	4	4	4	5	2	5	3.8	4	4	4
39	WH 1137	4	5	3	5	3	5	4.0	3	4	4
40	NIDW 699 (d)	5	5	4	5	2	5	4.2	4	4	4
40 A	SONALIKA (C) FOR SF	5	-	4	5	3	5	4.3	-	-	-
40 B	IWP 72 (C) FOR BWM	4	-	3	5	4	5	4.0	-	-	-
40 C	A 9-30-1 (C) FOR FA	5	4	4	5	3	5	4.2	-	-	-
40 D	GW 173 (C) FOR RA	5	-	4	5	4	5	4.5	5	4	5
41	UPD 94 (d)	5	5	4	5	4	5	4.6	4	4	4

*Shillongani-:Infestation of foliar aphid was not observed

Niphad : Root aphid was not observed on any genotype.

V. National Genetic Stock Nursery (NGSN), 2014-15

The confirmed sources of multiple disease and insect pests resistance were contributed in the NGSN and were planted at 23 breeding centers across different agro climatic zones of country for their utilization in breeding for resistance to biotic stresses. All 15 entries were utilized in the range of 8.7 - 52.2% by most of the breeding centres (Fig. 9.1). The most utilized entries at many centres were HI 1579, HD 3098, PBW 658, Raj 4270, HS 526 and HS 557 (Table 9.5). The Kanpur centre, utilized 12 entries in their breeding programme followed by Powerkheda (Fig. 9.2).

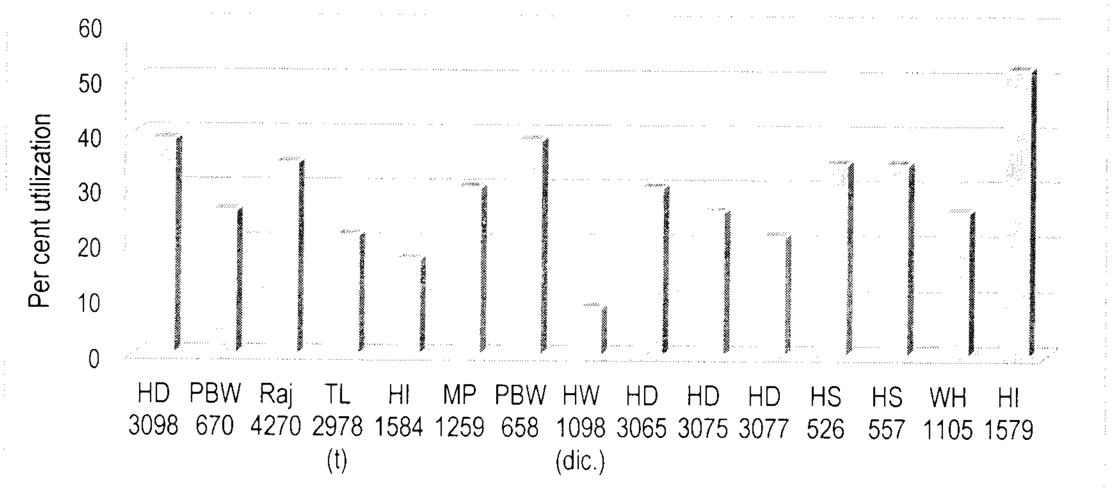

Fig.9.1. Percent utilization of promising resistant genotypes at different breeding centres in NGSN, 2014-15

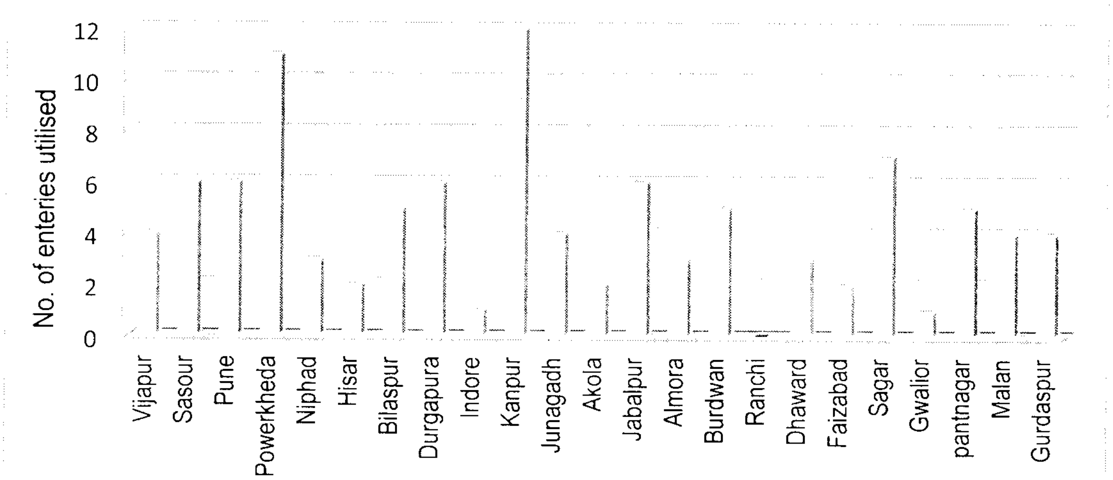

Fig.9.2. Centre wise utilization of promising resistant genotypes from NGSN, 2014-15

Table 9.5. National genetic stock nursery (NGSN), 2014-15

S. No.	Entry	Vijapur	Sasour	Pune	Powerkheda	Niphad	Hisar	Bilaspur	Durgapura	Indore	Kanpur	Junagadh	Akola	Jabalpur	Almora	Burdwan	Ranchi	Dhaward	Faizabad	Sagar	Gwalior	pantnagar	Malan	Gurdaspur	Total
1	HD 3098		1		1	1		1			1		1		1					1		1			9
2	PBW 670	1	1		1			1			1									1					6
3	Raj 4270	1				1		1			1					1		1		1		1			8
4	TL 2978 (t)	1	1								1	1				1									5
5	HI 1584				1						1	1				1									4
6	MP 1259			1	1				1		1	1								1		1			7
7	PBW 658	1		1	1	1					1		1	1				1		1					9
8	HW 1098 (dic.)			1																		1			2
9	HD 3065				1				1					1	1				1				1	1	7
10	HD 3075				1						1					1						1	1	1	6
11	HD 3077		1	1	1						1			1											5
12	HS 526		1		1		1		1	1	1			1										1	8
13	HS 557			1	1				1		1			1		1		1						1	8
14	WH 1105							1	1		1			1						1			1		6
15	HI 1579		1	1	1		1	1	1			1			1				1	1	1		1		12
Centre wise total		**4**	**6**	**6**	**11**	**3**	**2**	**5**	**6**	**1**	**12**	**4**	**2**	**6**	**3**	**5**	**0**	**3**	**2**	**7**	**1**	**5**	**4**	**4**	**102**

Cooperators: M.S. SAHARAN, SUDHEER KUMAR, SELVA R. KUMAR AND S. K. SINGH

9.2 MANAGEMENT OF DISEASES: CHEMICAL CONTROL

Once disease has been initiated and weather is favourable chemical control becomes very important under the present scenario due to the wide spread occurrence of yellow rust in most of the varieties in the NWPZ. A strategy to combat the threat of rusts, the chemical control has to be an important component in the contingent plan.

Stripe rust

Experiments on chemical control of stripe rust were conducted at five locations viz., Karnal, Pantnagar, Ludhiana, Durgapura and Jammu during 2014-15 crop season.

At Karnal centre during 2014-15, for evaluation of different fungicides at various concentrations against stripe rust, susceptible variety PBW 343 was sown in field i.e. on 15th November 2014 as proposed in the technical programme. The experiment was laid out in RBD with seven treatments and three replications per treatment at DWR experimental farm, Karnal. Immediately after appearance of stripe rust pustules, first spray was given on 23rd February, 2015 as per treatment. Second spray was given after 10 day of first application i.e. on 10th March, 2015. Third spray was not at all required as the rust was under control in the fungicide treated plots. The observations were made at frequent intervals as per standard methods (modified Cobb's scale by Peterson *et al*, 1948). The crop was harvested on 23rd April, 2015 (during Rabi, 2014-15). Finally the yield per treatment was calculated plot wise and converted into q/ha. Data clearly indicated that the tested chemical Azoxystrobin 11%+Tebuconazole 18.3% SC at various concentrations reduced disease severity at significant level. The highest stripe rust severity was observed in untreated control plot.

At Pantnagar center, during crop season 2014-15, for evaluation of different fungicides at various concentrations against stripe rust, susceptible variety PBW 343 was sown in field on 1st Dec. 2014 in RBD design. There were nine treatments with tree replication. After the appearance of disease first, second and third spray of fungicides were given on 05-02-2015, 21-02-2015 and 09-03-2015, respectively. The data on the severity of the rust was recorded before first spray and final data was observed after the last spray. Disease severity was recorded as percent infection according to the modified Cobb's scale. After harvesting, the grain yield of each plot was recorded and one thousand grains per plot were counted and weight separately.

The results (Table 9.6) revealed that all the treatments recorded significant reduction of disease incidence. One and two spray of Tilt @ 0.1 % followed by two sprays of Bayleton and Folicur @ 0.1% gave good control of yellow rust giving 94.59%, 93.34, 89.21% and 88.34% disease control, respectively. One spray of Bayleton and Folicur @ 0.1% gave 86.84% and 86.71% disease control. All treatments were significantly superior compared to untreated check. The yield was found to be highest in the plot treated with two sprays of Tilt @ 0.1% i.e. 3.70 kg per plot followed by two sprays of Bayleton @ 0.1% gave 3.65 kg yield /plot whereas one spray of Tilt, Folicur and Bayleton @ 0.1% gave 3.60 kg yield /plot each. Two sprays of Folicur @ 0.1% also recorded better yield (3.55 kg/plot) as compared to control (2.90 kg/plot). Highest thousand grain weight i.e. 44.40gms was recorded in two sprays of Tilt @ 0.1% followed by two sprays of Folicur and Bayleton @0.1% i.e. 44.00 and 43.70 gms respectively. One spray of Folicur and Bayleton also gave good result i.e. 43.62 gms and 43.45 gms respectively. One spray of Tilt@0.1% gave 42.86gms which were significantly superior over control (41.29gms).

Table 9.6. Management of yellow rust of wheat (var. PBW 343) through fungicides at Pantnagar centre

S. No.	Treatments	Dose	Disease Severity	% Disease control	1000 grain wt.(gm)	Yield/plot (Kg)
T_1	One Spray of Tilt	0.1%	5.33	93.34	42.86	3.60
T2	Two Sprays of Tilt	0.1%	4.33	94.59	44.40	3.70
T3	Two Sprays of Mancozeb	0.25%	14.66	81.68	41.51	3.30
T4	Three Sprays of Mancozeb	0.25%	15.00	81.25	41.64	3.40
T5	One Spray of Folicur	0.1%	10.63	86.71	43.62	3.60
T6	Two Sprays of Folicur	0.1%	9.33	88.34	44.00	3.55
T7	One Spray of Bayleton	0.1%	10.53	86.84	43.45	3.60
T8	Two Sprays of Bayleton	0.1%	8.63	89.21	43.70	3.65
T9	Control		80.00	-	41.29	2.90

At Durgapura center, during crop season 2014-15, for evaluation of different fungicides at various concentrations against stripe rust, susceptible variety Raj 1482 was sown in field in RBD design. There were ten treatments with four replications. The data on the severity of the rust was recorded before first spray and final data was observed after the last spray. Disease severity was recorded as percent infection according to the modified Cobb's scale. After harvesting, the grain yield of each plot and converted in q/ha.

The data presented in Table 9.7 reveals that minimum (9.96%) yellow rust severity was recorded on spray of Tebuconazole 25.9%EC @ 0.1% followed by Triadimefon 25%WP @ 0.1% and Propiconazole 25%EC @ 0.1%. All the treatment significantly reduced the disease over control. However maximum yield (52.92 q/ha) was recorded in Triadimefon 25%WP @ 0.1% followed by Propiconazole 25%EC @ 0.1% and Tebuconazole 25.9%EC @ 0.1%. All the fungicide as well as organic treatment gave better yield over the control (32.07 q/ha).

Table 9.7. Management of yellow rust of wheat (var. Raj 1482) through fungicides at Durgapura centre

Treatments	YR severity (%)	Yield (q/ha)
T_1 Spray with Propiconazole 25%EC @ 0.1%	12.80	52.67
T_2 Spray with Propiconazole 25%EC @ 0.05%	23.33	48.33
T_3 Spray with Tebuconazole 25.9%EC @ 0.1%	9.96	51.67
T_4 Spray with Tebuconazole 25.9%EC @ 0.05%	20.58	46.67
T_5 Spray with Triadimefon 25%WP @ 0.1%	10.33	52.92
T_6 Spray with Triadimefon 25%WP @ 0.05%	17.60	49.58
T_7 Spray with Mancozeb 75% WP @ 0.2%	56.54	41.67
T_8 Spray with Sulphur 80% WG @ 0.25%	47.04	45.0
T_9 Spray with Cow urine based organic pesticide @ 10%	72.42	40.83
T_{10} Control	82.95	32.07

At Ludhiana centre, the chemical management of wheat stripe rust was conducted on susceptible variety PBW 343 on 29.11.2014 in field with 8 treatments and three replications in RBD (Table 9.8). Stripe rust appeared on 8. 1. 2015. Fungicides sprays were given on 12.1.15, 29.1.15 and 21.2.15. Amistar Extra spray resulted in maximum reduction in disease severity and highest yield was obtained in spraying with Nativo followed by Tilt and Amistar Extra and found better over control.

Table 9.8. Management of yellow rust of wheat (var. PBW 343) through fungicides at Ludhiana centre

S. No.	Fungicide	Conc.(%)	YR Severity (ACI)	1000 grains weight (g)	Yield (q/ha)
1	Nativo	0.1	1.33	37.24	45.00
2	Tilt	0.1	1.67	33.70	44.43
3	Folicur	0.1	2.00	37.09	42.50
4	Bayleton	0.1	1.33	35.24	41.25
5	Built	0.1	2.00	37.43	39.58
6	Stilt	0.1	6.67	36.89	33.53
7	Amistar Extra	0.1	0.67	38.60	43.75
8	Control	-	80.00	19.02	8.53

At Jammu center, during crop season 2014-15, for evaluation of different fungicides at various concentrations against stripe rust, susceptible variety PBW 343 was sown in field in RBD design. The experiment was laid out with nine treatments and four replications. Stripe rust was created by artificial inoculation of mixed pathotypes spores. Fungicidal sprays were given at 15 days interval. The data on the severity of the rust was recorded before first spray and final data was observed after the last spray. Disease severity was recorded as percent infection according to the modified Cobb's scale. After harvesting, the grain yield of each plot and converted in q/ha.

The result (Table 9.9) reveals that all the treatments records significant reduction in disease incidence. Two sprays of Tilt (0.01%) and Folicur at 15 days interval gave complete control of yellow rust. The highest yield (43.2q/ha) was found in the plot treated with two sprays of Tilt @0.1% followed by two spray of Folicur @0.01% (42.8q/ha) and Bayleton @0.01% (42.2q/ha), respectively.

Table 9.9. Management of yellow rust of wheat (var. PBW 343) through fungicides at Chatha farm, Jammu Centre

S. No.	Treatment	Concentration (%)	YR Severity	Grain Yield (q/ha)	Yield increase (%)
1	One spray of Tilt	0.01 %	10S	40.1	28.6
2	Two sprays of Tilt	0.01 %	0	43.2	33.6
3	Two sprays of Mancozeb	0.25 %	40S	32.2	11.1
4	Three sprays of Mancozeb	0.25 %	60S	35.4	19.2
5	One spray of Folicur	0.01 %	10S	39.8	28.1
6	Two sprays of Folicur	0.01 %	0	42.8	33.1
7	One spray of Bayleton	0.01 %	20S	38.9	26.4
8	Two sprays of Bayleton	0.01 %	10S	42.2	32.2
9	Control (No spray)		90S	28.6	

Stem rust and leaf rust:
To evolve suitable spraying schedule for the management of stem and leaf rust diseases of wheat the trials were conducted at Mahabaleshwar and Niphad centres during 2014-15 crop season.

At Mahabaleshwar centre, experiment was conducted for evaluation of different fungicides at various concentrations against stem rust on wheat variety NI 5439. There were six rows in each treatment of three meter length, sown at 22.5 cm apart. The experiment was sown in randomized block design with three replications. Fungicidal sprays were commenced after appearance of the disease. Observations in respect of stem rust were recorded a day earlier to each spray. Final observation was recorded at 10 days after last spray of fungicides. Grain yield at harvest was recorded per treatment per replication.

The data presented in Table 9.10 reveals that, all the fungicidal treatments gave significantly less disease intensity of stem rust over control. Three fungicidal treatments viz., two sprays of Tilt 25 EC @ 0.1%, three sprays of Mancozeb @ 0.25% and two sprays of Folicure 250EC @ 0.1% recorded less disease whereas these were at par with each other. The lowest disease intensity (ACI-3.67) was recorded in two sprays of Tilt 25 EC @ 0.1%, three sprays of Mancozeb @ 0.25% (ACI-4.73) and two sprays of Folicure 250EC @ 0.1% (ACI-5.40). Results regarding the grain yield indicated that all the fungicidal treatments significantly increased grain yield (q/ha) over control. The highest grain yield 24.69 q/ha was recorded in the treatments viz. two sprays of Tilt 25 EC @ 0.1% followed by two sprays of Folicure 250EC @ 0.1% (22.42 q/ha) and three sprays of Mancozeb @ 0.25% (21.95 q/ha) which were at par with each other.

Table 9.10. ACI of stem rust and grain yield as influenced by fungicidal treatments (2014-15).

S. No.	Treatments	Stem rust Severity (ACI)	Grain yield (Q/ha)
1	One spray of Tilt 25 EC@ 0.1%	7.07	20.78
2	Two sprays of Tilt 25 EC @ 0.1%	3.67	24.69
3	Two sprays of Mancozeb @ 0.25%	7.67	19.40
4	Three sprays of Mancozeb @ 0.25%	4.73	21.95
5	One spray of Folicur 250 EC @ 0.1%	7.33	22.42
6	Two sprays of Folicur 250 EC @ 0.1%	5.40	21.13
7	One spray of Bayleton 25 WP @ 0.1%	14.00	18.08
8	Two sprays of Bayleton 25 WP @ 0.1%	12.67	19.40
9	Control (No spray)	25.33	17.12
	S.E$\pm$	0.86	0.56
	C.D. at 0.05	2.41	1.58
	C.V.	13.27	4.73

At Niphad center, the trial was conducted experiment was conducted for evaluation of different fungicides at various concentrations against stem and leaf rust with variety NI 5439. The experiment was planted in RBD with four replications. The trial was conducted under artificial epiphytic conditions by spraying of mass inoculum of stem and leaf rust. The data on the severity of the rust was recorded before first spray and final data was observed after the last spray. Disease severity was recorded as percent infection according to the modified Cobb's scale. After harvesting, the grain yield of each plot and converted in q/ha.

The disease severity of stem rust ranged from 5 to 60% as per modified Cobb's scale (Table 9.11). The stem rust severity was significantly lower with the treatment two sprays of tilt @ 0.1% (7.50%) followed by treatment with two spray of Folicur @ 0.1% (15.00%). The highest stem rust severity of 50% was recorded in the untreated control. The disease severity of leaf rust was also significantly lower with the treatment of two sprays of tilt @ 0.1% (5.00%) followed by treatment with two sprays of Folicur @ 0.1% (6.25%) as against 37.50% in the control. Statistically significant differences were also noted in 1000 grain weight due to different fungicidal treatments. The highest 1000 grain weight (32.04 g) was recorded in the treatment with two sprays of tilt @ 0.1% and the treatment with three sprays of Mancozeb @ 0.25%, while lowest 1000 grain weight was recorded in control treatment (28.71 g). The yield in different treatments differed significantly. Highest yield was recorded with the treatment of two sprays of tilt @ 0.1% (35.77 q/ha) while lowest yield was recorded in the control treatment (22.06 q/ha).

Table 9.11. Effect of spraying schedule on disease severity of stem rust & leaf rust at Niphad centre

S. No.	Treatment	Mean stem rust severity	Mean leaf rust severity	1000 grain weight (gm)	Grain yield of wheat (q/ha.)
1	One spray of Tilt @0.1%	16.25 (23.73)	7.50 (15.67)	31.34	28.71
2	Two sprays of Tilt @0.1%	7.50 (15.67)	5.00 (12.92)	32.04	35.77
3	Two sprays of Mancozeb @0.25%	27.50 (31.55)	21.25 (27.28)	31.51	25.00
4	Three sprays of Mancozeb @0.25%	21.25 (27.28)	8.75 (16.76)	32.04	32.63
5	One spray of Folicur @0.1%	22.50 (28.23)	12.50 (20.61)	31.36	28.13
6	Two sprays of Folicur @0.1%	15.00 (22.79)	6.25 (14.30)	31.67	29.20
7	One spray of Bayleton @0.1%	27.50 (31.55)	21.25 (27.28)	30.35	25.01
8	Two sprays of Bayleton @0.1%	22.50 (28.23)	18.75 (25.62)	31.05	27.48
9	Control	50.00 (45.00)	37.50 (37.32)	28.71	22.06
	S.E. ±	1.57	1.55	0.48	1.52
	C.D. at 5 %	4.57	4.51	1.40	4.42

* Figures in parenthesis are arcsin transformed values

Validation and promotion of IPM

Niphad Centre:

To verify the results of IPM modules on farmers field, the module was validated at farmers' fields in Nasik district of Mahrashtra. The IPM module was evaluated with two varieties NIAW 1415 and MACS 6478 in eleven locations at farmers fields (Table 9.12). The module consisted of seed treatment with Azotobactor, PSB and Cruiser for the management of aphids.

The wheat grain yield with farmers practice ranged from 28.00 to 38.00 q/ha whereas, yield in IPM module ranged from 32.50 to 45.00 q/ha (Table 9.12). Average difference in yield was 5.11 q/ha. The infestation of aphids was observed during the initial stages of crop growth, which was low in IPM plots as compared to the plots in which farmers practice was followed. Rust incidence was not observed throughout the season in the trial plots.

Table 9.12. Grain yield of wheat q/ha under IPM and non-IPM at farmers fields in District Nasik, Maharashtra

Sr. No.	Name and Address of Farmers	Variety	Date of sowing	Yield (q/ha)		Difference (q/ha)
				IPM	Farmers practice	
1	Mr. M.B. Gotis Babhulgaon (Bk), Tal. Yeola, Dist. Nashik	NIAW 1415	25/11/2014	39.00	35.00	4.00
2	Mr. N.R. Londhe Babhulgaon (Bk), Tal. Yeola, Dist. Nashik	NIAW 1415	8/12/2014	32.50	28.00	4.50
3	Mrs. S.S. Pangavhane Babhulgaon (Bk), Tal. Yeola, Dist. Nashik	NIAW 1415	28/11/2014	34.00	29.50	4.50
4	Mrs. T.T. Bansode Babhulgaon (Bk), Tal. Yeola, Dist. Nashik	NIAW 1415	9/12/2014	40.25	35.00	5.25
5	Mr. B.S. Khadke Babhulgaon (Bk), Tal. Yeola, Dist. Nashik	NIAW 1415	6/11/2014	35.00	31.50	3.50
6	Mr. R.K. Bornare Babhulgaon (Kh), Tal. Yeola, Dist. Nashik	NIAW 1415	6/11/2014	35.00	30.00	5.00
7	Mr. S.S. Gotis Babhulgaon (Bk), Tal. Yeola, Dist. Nashik	MACS 6478	9/12/2014	37.50	33.00	4.50
8	Mr. B.D. Gaikwad Babhulgaon (Kh), Tal. Yeola, Dist. Nashik	MACS 6478	5/11/2014	45.00	37.50	7.50
9	Mr. S.R. Bornare Babhulgaon (Kh), Tal. Yeola, Dist. Nashik	MACS 6478	28/11/2014	40.00	34.50	5.50
10	Mr. K.N. Bornare Babhulgaon (Kh), Tal. Yeola, Dist. Nashik	MACS 6478	8/12/2014	44.00	37.50	6.50
11	Agricultural Research Station, Niphad, Dist. Nashik	NIAW 1415	2/11/2014	43.50	38.00	5.50
Mean Difference						**5.11**

COOPERATORS

NAME	CENTRE
P.S. SHEKHAWAT	DURGAPURA
DEEPSHIKHA	PANTNAGAR
JASPAL KAUR	LUDHIANA
M.K. PANDEY	JAMMU
G.T. BHANGALE, B.C. GAME, A.P. PADHYE	NIPHAD
S.G. SAWASHE	MAHABALESHWAR
M S SAHARAN, SUDHEER KUMAR AND SELVA R. KUMAR	KARNAL (CO-ORDINATING CENTRE)

PROGRAMME 10. ENTOMOLOGY

RESULTS OF COORDINATED ENTOMOLOGICAL EXPERIMENTS

Wheat entomology programme covers four aspects viz. host plant resistance, chemical control, integrated pest management (IPM) and management of stored grain pests. During 2014-15 crop season, the experiments were conducted covering all above mentioned aspects of entomology. The host plant resistance studies included screening of wheat nurseries against shoot fly, brown wheat mite and, foliar and root aphids, preliminary screening of elite lines for different pests and multiple pest screening nursery. Under chemical control, experiments were conducted to determine of efficacy of chemical insecticides against termites and, foliar and root aphids. In addition, experiments were also carried out on management of foliar feeding aphids through biopesticides and botanicals. Insect-pest management trials were also conducted on termites and brown wheat mite with additional trials on need based sporadic pests at specific locations. Another study on insect-pest dynamics was carried out for the second time to know the incidence and population build-up of major insect-pests on wheat sown on different dates of sowing. IPM studies included basic work on pest management issues and regular surveys activities in the jurisdiction of each centre. The summary containing highlights of this report is given here:

SUMMARY

Host Plant Resistance

Screening against Shoot fly

A total of 73 AVT II year and 97 AVT I year entries were screened against shoot fly at six hot-spot locations viz. Dharwad, Durgapura, Niphad, Ludhiana, Kanpur and Kharibari. Amongst 73 screened AVT II year genotypes, the average incidence levels ranged from 10.05 % (HI 8498(D) (C)) to 26.70 % (PDW314 -C). While amongst 97 screened AVT I year genotypes, the average incidence levels ranged from 13.93 % (DDK-1048) to 30.59 % (TL-3004). None of the entry had average incidence of shootfly below 10% (Table 10.1a and 10.1b).

Screening against brown wheat mite

A total of 73, AVT II year and 97, AVT I year entries were screened against brown wheat mite at Ludhiana and Durgapura.The incidence of BWM infestation was recorded to be low during 2014-15 as compared to last two years. Most of the entries showed infestation below 10% at Durgapura location. Amongst AVT II year genotypes, the average number of mites per 10 cm^2 area ranged from 5.00 to 18.00 while amongst AV I year genotypes, the number varied from 5.00 to 21.23 mites per 10 cm^2 (Table 10.2a and 10.2b).

Screening against foliar aphid:

A total of 73AVT II year and 97 AVT I year entries were screened against wheat aphid at Niphad, Ludhiana, Kharibari, Karnal, Pantnagar, Kanpur and Shillongani. The screened entries were either categorized as moderately resistant (grade 3) or susceptible (grade 4) to wheat aphid (Table 10.4a and 10.4b). Infestation of wheat aphid at Shillongani was not observed.

Screening against Root aphid:

A total of 73 AVT II year and 97 AVT I year entries were screened against root aphid at Ludhiana, Entkhedi, Niphad and Karnal locations. However, aphid infestation was not observed at Niphad. The data was collected from each entry by uprooting the seedling when the crop was 3-4 weeks old. Of the 73 AVT II year entries, HS 542 (C), WH 1021 (C), WH 1105 (C), K 8027 (C), HD 2864 (C), HI 1544 (C), MP 4010 (C), NIAW 2030, DBW 93 (I) (C), UAS 347 (I) (C), MMBL 283, DBW 14 (C), Kharchia 65 (C) and KRL 210 (C) showed moderately resistant reaction based on higest score of 3 and rest of entries were either susceptible (grade 4) or highly susceptible (grade 5) to wheat root aphid. Among 97 AVT I year, fifteen entries viz. HS 583, VL 1005, VL 1006, HD 3165, HI 1604, MACS 4024, PBW 709, PBW 719, WH 1179, CG 1015, HI 8765 (d), UAS 361, DBW 182, DDK 1048 and MACS 5041 were moderately resistant (grade 3) based on higest score values and rest of them were either susceptible (grade 4) or highly susceptible (grade 5) to wheat root aphid (Table 10.5a and 10.5b).

Screening against multiple pests

Shoot fly: Forty one MPSN lines were screened against shoot fly at six locations viz. Dharwad, Durgapura, Ludhiana, Niphad, Kanpur and Kharibari, out of which average maximum score was 30.66 for DDK 1045 (dic) entry at and minimum score was 6.66% for HI 8724 (d) entry (Chapter 9; Table 9.4a).

Brown wheat mite: Forty one entries were screened against brown mite at three locations viz. Durgapura, Ludhiana and Niphad, out of which highest score of 22.20/10 cm sq area was observed for UPD 94 (d) whereas lowest score of 10.00/10 cm sq area was observed for HW 5237 entry. Brown wheat mite was not observed on any genotype at Niphad (Chapter 9; Table 9.4a).

Foliar aphid: Forty one entries were screened against wheat aphid at Niphad Ludhiana, Kharibari (W.B.), Karnal, Pantnagar and Shillongani. Though the material was screened at Shillongani, the pest did not appear therefore, the data was not considered. Low infestation of foliar aphid was observed at Kanpur so data was not included in report. The entries were found to be either moderately resistant (grade 3) or susceptible (grade 4) to wheat aphid based on average score data (Chapter 9; Table 9.4b).

Root aphid: The screening was carried out using forty one entries. The data was collected from Ludhiana and Karnal locations for each entry by uprooting the seedling when the crop was 3-4 weeks old. The seven entries viz. PBW 660, DDK1044, HW 1099, HW 5237, MACS 5031, UP 2843 and HD 3121 were found to be moderately resistant (grade 3) and rest of them were found to be susceptible (grade 4) or highly susceptible (grade 5) to wheat root aphid (Chapter 9; Table 9.4b).

II. Chemical Control

- Imidacloprid 600 FS (Gaucho) @ 0.72 g a.i. /kg seed treatment was found effective at Durgapura and Kanpur, wheraes at Ludhiana the same insecticide at higher dose @ 0.96 g a.i. /kg proved effective. At Vijapur, Fipronil 5 SC @ 0.3 g a.i. /kg and Bifenthrin 10 % EC@ 0.2 g a.i. /kg gave promising results against termite.
- Fipronil 5% SC@ 125 g a. i./ ha was identified as effective management of termite damage through broadcasting of insecticides in standing wheat crop at Durgapura and Vijapur and its lower dose 80 g a. i./ ha was effective at Vijapur. However, at Ludhiana, imidacloprid 600 FS @ 1.0 lt/ha was effective.

- The foliar application of Dantotsu (Clothianidin 50 WDG) @ 15 g a.i. /ha was found to be quite effective for the management of aphids in wheat at most of the tested locations.
- Fenazquine10 EC (Majester) @ 2.0 ml/l of water was proved most effective after 15 days of spraying for brown wheat management at Durgapura.
- Amongst the tested biopesticides, *Metarhizium anisopliae* @ 3g/l was found to be effective for the management of aphids at Karnal and Kharibari while *Verticillium lecanni* @ 3g/l was found effective at Pantanagar.
- Out of tested insecticides used for stored grain pest management, treatments of spinosad (Tracer 4.4 mg/kg) and Emamectin benzoate (Proclaim @ 40.0 mg/kg) as seed protectant were quite effective for the management of wheat seeds.

III. Integrated Pest Management

- The survey in Jaipur district of Rajasthan recorded heavy damage by wireworms at early crop stages, in certain areas of a field, 20-25% percent losses were noticed. Also damage by third instars larvae of white grub species of *Holotrichia* and another two species of *Meladera* and (*Anomola* sp.) was observed. The shootfly infestation was observed low but heavy infestation by wheat termites at Jodhpua-Viratnagar was recorded. The attack of pink stem borer in wheat was also observed during survey of wheat crop. The incidence of *Spodoptera litura* and *Helicoverpa armigera* was very low but widespread. The shootfly infestation was low at few places of area surveyed in wheat crop.
- In Maharashtra, survey was carried out in the villages of Nashik district at different crop stages. Heavy incidence of aphids was recorded in Nasik district. The Coccinellid predatory grubs, beetles and Chrysopa feeding on the aphid infested fields were also observed. The incidence of jassids and earhead caterpillar were recorded in medium intensity.
- In Punjab, sporadic incidence of termites was observed in village Bargari, District Faridkot. Severe incidence of foliar aphids was observed in some villages viz. Jagmeenpur and Balowal Saunkhari etc. in Ropar district. Mild incidence of pink stem borer, termite etc. was observed in some places viz. Ladhowal, Rasolpur, Longroya, Rahon, Phillaur, Nawanshahr, Garshankar and adjoining areas. Incidence of root aphid was also recorded in village Rasolpur. Termite damage (1-2 %) was recorded in some fields near Rahon village. The grubs and adults of coccinellid beetles were observed frequently in fields infested with aphids.
- In Vijapur, survey of wheat and barley fields were carried out in the state during the crop season. The termite damage in wheat fields remained low to moderate through the crop season. The population of *H. armigera*, pink stem borer, aphid , surface grasshopper, spodoptera , thrips, shoot fly, brown mite, jassids and cut worm were negligible. In barley fields, the aphid population was low to moderate. Among natural enemies, *Campoletis chlorideae* a larval parasite of *H. armigera* was observed. Predators like coccinellid beetles, chrysoperla and syrphid fly were frequently noticed predating wheat and barley aphids.
- In Kanpur (Uttar Pradesh), survey was made at Khurdh, Pali and Sawali, the incidence of shootfly was observed 10 per cent and rainfed termite infestation was 18 per cent, in varieties PBW343, K0307 and Halna. The incidence of termite was observed in irrigated crop 10 per cent, pink stem borer infestation 2.0 per cent. Aphid infestation was observed in highly susceptible barley crop varieties and in different wheat cultivar on varieties K502, Halna, HD 2733, DBW 39, K 0307 and K551 (Barley). The infestation of shoot flies was 13.0 per cent in wheat

crop. The minor incidence of pink stemborer i.e. 2.0 per cent was observed (Table-10.26).

- The survey of wheat in Punjab and Haryana state were undertaken by Karnal centre during 2014-15 crop season. Moderate to severe incidence of wheat aphid and minor root aphid and pink stemborer was observed in some village of Karnal (HR) and Punjab; Mundiala Kalan (LDH), Bakhada (Main Sarandh), Basant Pura (Fatehgarh) and near Karnal (Pir Ki Mazar). Moderate termite damage was recorded in some parts of Karnal. Minor incidence of Pink stem borer was observed in village-Nising and adjoining areas of district Karnal. The grubs and adults of coccinellid beetles were seen frequently in fields infested with aphids.
- In Pantnagar, during survey of wheat fields, the other insects such as thrips, armyworm, spodopterta, wheat mite, termite, grasshopper, jassids, shoot fly armyworm, stem borers, cutworm, leaf miners, and wireworm were not observed in any of the wheat fields during the survey programme. It has been observed that to control aphid, farmers sprayed their fields 6-7 times but even then aphid population increased upto 500-600 aphids/plant after every spray, showed development of resistance in aphids against insecticides whereas on the other hand, in some fields farmers were not spraying chemicals and the population of natural enemies was more in those wheat fields as compared to the sprayed fields.

10.1. HOST PLANT RESISTANCE

Plant breeders have traditionally focused more on disease resistance than developing varieties for insect resistance. Over the years, plants have developed a variety of resistance mechanisms to deter feeding and damage by insects. The cultivated cereal crops originated from genetically diverse plant types and these are now grown in large, genetically homogeneous stands, a practice that decreases genetic and species diversity and increase the likelihood of economically significant insect pest infestations. Defense mechanisms of plants can be re-created in resistant plants. These defense mechanisms include escape in space and time, incompatible biological associations, physically and chemically derived barriers and accommodation by replacement or repair of damaged plant parts. Keeping these things in mind the wheat entomological work formulates pest specific hot spot screening of advanced wheat lines in the pursuit of identifying resistant sources. The summary of the result are described here in the following paragraphs.

1: Entomological Screening Nurseries

(1a) Shoot fly screening nursery

A total of 73AVT II year and 97 AVT I year wheat genotypes were screened against shoot fly, at six hotspot locations viz. Dharwad, Durgapura, Niphad, Ludhiana, Kanpur and Kharibari. The average infestation levels of AVT II year genotypes ranged from 10.05 % (HI 8498 (D) (C)) to 26.70 % (PDW314 (C)) (Table 10.1a). However, for AVT I year lines the average infestation levels ranged from 13.93% (DK 1048) to 30.59% (TL 3004) (Table 10.1b). Amongst all screened genotypes, none of entry was found resistant to shoot fly on the basis of its average incidence at all locations.

Table 10.1a. Screening against Shoot fly: AVT II year genotypes (Year-2014-15)

S. No.	Entry	Shootfly Incidence (%)						Average
		Dharwad	Durgapura	Niphad	Ludhiana	Kanpur	Kharibari	
1	HS 562	73.47	5.47	6.66	20.43	6.10	6.00	19.69
2	HPW 251 (C)	72.62	14.70	8.33	24.00	11.66	4.30	22.60
3	HPW 349 (C)	97.56	4.91	6.66	20.77	9.09	2.56	23.59
4	HS 375 (C)	40.79	11.94	10.00	26.67	17.81	8.00	19.20
5	HS 490 (C)	55.22	6.38	6.66	28.00	17.14	0.00	18.90
6	HS 507 (C)	44.78	5.55	8.33	27.18	8.33	5.60	16.63
7	HS 542 (C)	65.08	10.81	6.66	27.18	16.66	7.90	22.38
8	VL 804 (C)	67.95	6.86	6.66	20.80	15.00	7.00	20.71
9	VL 829 (C)	62.69	5.61	8.33	23.94	8.33	8.00	19.48
10	VL 892 (C)	46.38	5.93	5.00	28.71	16.66	7.30	18.33
11	VL 907 (C)	66.67	5.64	6.66	19.79	21.42	6.60	21.13
12	HD 4730	36.67	8.03	3.33	19.42	2.33	6.50	12.71
13	MP 1277	79.66	7.40	8.33	23.75	1.05	12.00	22.03
14	WH 1164	50.00	12.69	8.33	26.67	13.33	16.00	21.17
15	DBW 88 (C)	80.39	8.97	10.00	20.20	1.33	8.00	21.48
16	DBW 90 (C)	54.81	12.38	10.00	20.22	9.99	7.00	19.07
17	DPW 621-50 (C)	100.00	8.33	6.66	26.73	11.66	6.00	26.56
18	HD 2967 (C)	73.02	11.82	8.33	20.20	12.66	9.40	22.57
19	HD 3043 (C)	53.68	4.12	5.00	5.24	13.80	16.00	16.31
20	HD 3059 (C)	73.97	11.83	5.00	12.33	12.50	15.00	21.77
20A	SONALIKA (C) FOR SF	80.82	12.63	10.00	24.30	12.00	10.00	24.96
21	HD 3086 (C)	67.03	11.70	5.00	6.32	6.66	8.70	17.57
22	PBW 644 (C)	68.67	7.44	8.33	26.73	6.66	4.40	20.37
23	PDW 233 (C)	71.15	12.69	6.66	15.86	13.63	7.20	21.20
24	PDW 291 (C)	51.28	5.94	6.66	29.63	16.66	**6.60**	19.46
25	PDW 314 (C)	97.56	7.14	10.00	23.80	14.82	6.90	26.70
26	WH 1021 (C)	81.00	11.76	8.33	9.09	2.33	9.70	20.37
27	WH 1080 (C)	62.24	7.79	5.00	11.81	8.33	7.70	17.15
28	WH 1105 (C)	45.45	16.07	6.66	11.20	9.09	6.66	15.86
29	WH 1124 (C)	75.95	10.93	11.66	5.56	6.66	6.25	19.50
30	WH 1142 (I) C)	53.06	5.45	6.66	3.64	15.38	6.10	15.05

S. No.	Entry	Shootfly Incidence (%)						Average
		Dharwad	Durgapura	Niphad	Ludhiana	Kanpur	Kharibari	
31	C 306 (C)	84.62	22.44	11.66	21.36	13.33	6.66	26.68
32	HD 2888 (C)	48.10	11.94	10.00	23.94	12.66	11.10	19.62
33	K 8027 (C)	45.16	14.75	10.00	20.00	16.66	8.20	19.13
34	HD 4728 (d)	41.18	7.77	11.66	29.09	14.33	6.20	18.37
35	HD 4730 (d)	23.17	8.62	6.66	23.73	11.11	10.40	13.95
36	GW 322 (C)	45.76	16.66	6.66	22.94	17.42	9.10	19.76
37	HD 2864 (C)	44.68	5.33	10.00	19.59	13.33	6.40	16.56
38	HD 2932 (C)	68.83	7.35	8.33	17.09	16.66	5.90	20.69
39	HI 1544 (C)	59.09	17.39	8.33	5.23	14.99	3.30	18.06
40	HI 8498 (D) (C)	26.09	6.69	8.33	4.13	6.66	8.40	10.05
40A	SONALIKA (C) FOR SF	59.49	13.58	10.00	14.93	15.47	9.40	20.48
41	HI 8737 (D)(I) (C)	26.92	9.09	5.00	17.50	5.66	11.25	12.57
42	MP 3336 (C)	52.94	13.04	6.66	21.33	NG	16.50	22.09
43	MP 4010 (C)	57.50	5.40	13.33	25.36	12.50	18.00	22.02
44	MPO 1215 (d) (C)	90.91	7.14	6.66	18.97	3.22	12.00	23.15
45	MACS 3927 (d)	96.55	6.92	8.33	11.82	7.81	16.00	24.57
46	NIAW 2030	93.22	11.94	8.33	24.59	11.11	8.20	26.23
47	AKDW 2997-16(d) (C)	50.00	6.59	6.66	23.33	16.66	7.50	18.46
48	DBW 93 (I) (C)	71.43	11.11	8.33	6.25	15.00	6.20	19.72
49	MACS 6222 (C)	58.21	5.88	10.00	8.05	9.09	6.10	16.22
50	MACS 6478 (C)	55.26	14.81	10.00	7.89	3.33	6.20	16.25
51	NI 5439 (C)	85.23	8.62	6.66	10.34	4.54	7.30	20.45
52	NIAW 1415 (C)	66.04	14.92	10.00	13.95	17.85	4.10	21.14
53	UAS 347 (I) (C)	56.41	15.78	8.33	12.50	2.33	5.20	16.76
54	UAS 428 (d) (C)	23.53	12.38	8.33	19.74	11.11	8.80	13.98
55	UAS 446 (d) (I) (C)	23.53	9.09	8.33	6.25	16.66	**4.60**	11.41
56	(HD 2932 + Lr 19/Sr25)	43.59	10.89	6.66	20.66	5.33	10.50	16.27
57	MMBL 283	38.18	23.11	10.00	14.17	13.33	9.40	18.03
58	PBW 723	67.31	11.62	6.66	14.29	16.00	6.50	20.40
59	DBW 14 (C)	44.64	11.53	10.00	1.37	9.09	10.20	14.47
60	DDK 1029 (C)	69.05	13.72	6.66	13.60	8.00	4.20	19.20
60 A	SONALIKA (C) FOR SF	63.01	14.62	11.66	21.14	13.33	**9.40**	22.19

S. No.	Entry	Shootfly Incidence (%)						Average
		Dharwad	Durgapura	Niphad	Ludhiana	Kanpur	Kharibari	
61	HD 2985 (C)	92.59	18.66	6.00	7.07	9.09	12.20	24.27
62	HI 1563 (C)	67.95	10.44	8.33	2.24	9.09	9.80	17.97
63	HUW 234 (C)	78.95	9.52	6.66	6.06	11.11	7.90	20.03
64	HW 1098 (C)	62.96	9.09	5.00	7.87	12.00	9.40	17.72
65	K 0307 (C)	100.00	18.36	13.33	4.55	2.33	10.80	24.90
66	Kharchia 65 (C)	98.41	12.08	6.66	10.67	1.66	12.20	23.61
67	KRL 19 (C)	98.55	5.74	6.66	12.50	9.37	8.80	23.60
68	KRL 210 (C)	56.99	19.79	8.33	6.76	7.14	12.20	18.53
69	PBW 343 (C)	98.21	18.08	8.33	13.57	5.55	9.40	25.52
70	Raj 4083 (C)	49.12	10.46	8.33	9.29	3.68	12.40	15.55
71	TL 2942 (C)	52.56	10.41	8.33	12.12	4.74	14.40	17.09
72	TL 2969 (C)	68.18	11.84	8.33	8.62	7.14	7.40	18.59
73	WH 542 (C)	60.20	17.14	8.33	17.92	9.09	5.60	19.71

Table 10.1b. Screening against Shoot fly: AVT I year genotypes (Year-2014-15)

S. No.	Entry	Shootfly Incidence (%)						Average
		Dharwad	Durgapura	Niphad	Ludhiana	Kanpur	Kharibari	
1	HPW 393	66.67	11.42	6.66	24.66	5.55	15.50	21.74
2	HPW 394	80.65	12.77	11.66	16.25	4.45	11.50	22.88
3	HPW 413	98.63	12.88	10.00	20.74	9.09	12.60	27.32
4	HPW 421	90.63	9.74	10.00	18.67	8.69	7.90	24.27
5	HPW 422	100.00	12.27	6.66	20.35	3.33	14.50	26.19
6	HS 580	100.00	14.04	6.66	24.39	15.00	8.90	28.17
7	HS 583	67.65	17.44	6.66	14.49	6.66	4.70	19.60
8	HS 590	41.18	16.25	10.00	13.33	5.00	14.50	16.71
9	HS 596	41.27	15.49	6.66	9.72	15.38	13.00	16.92
10	HS 597	93.94	12.50	16.66	20.24	4.54	7.60	25.91
11	HS 598	76.83	19.30	10.00	9.02	3.33	9.10	21.26
12	HS 599	98.25	19.80	13.33	14.08	22.85	8.50	29.47
13	HS 600	100.00	17.60	13.33	23.53	21.21	6.50	30.36
14	HS 601	77.63	16.15	6.66	10.67	13.33	5.40	21.64
15	UP 2917	68.66	10.14	11.66	8.84	18.75	8.40	21.07

S. No.	Entry	Shootfly Incidence (%)						Average
		Dharwad	Durgapura	Niphad	Ludhiana	Kanpur	Kharibari	
16	UP 2918	42.31	17.14	10.00	9.60	18.18	11.60	18.14
17	VL 1005	72.22	15.97	10.00	11.54	16.66	7.50	22.32
18	VL 1006	25.00	17.31	6.66	15.00	21.42	8.40	15.63
19	VL 1007	60.98	10.81	13.33	21.11	16.00	11.50	22.29
20	VL 3002	89.47	14.49	6.66	9.52	7.89	5.90	22.32
20A	SONALIKA(C) for SF	91.89	16.34	10.00	23.08	12	24.40	29.62
21	VL 3007	81.48	17.40	5.00	9.09	6.66	2.40	20.34
22	VL 3008	75.56	10.00	6.66	6.67	1.87	2.80	17.26
23	VL 3009	98.53	14.54	6.66	13.64	10.71	4.40	24.75
24	VL 4001	98.15	13.92	6.66	4.00	3.33	1.50	21.26
25	DBW 147	67.27	16.06	6.66	13.08	5.00	3.20	18.55
26	DBW 148	94.74	16.81	3.33	13.19	15.00	5.86	24.82
27	DBW 150	59.00	15.71	10.00	14.93	10.00	7.70	19.56
28	DDW 31	41.67	15.76	10.00	21.25	14.28	5.80	18.13
29	DDW 32	48.44	11.75	10.00	18.75	5.55	8.30	17.13
30	HD 3159	98.15	16.66	6.66	8.64	7.14	3.90	23.52
31	HD 3165	66.13	15.55	6.66	13.68	20.00	5.70	21.29
32	HD 3174	84.06	16.45	6.66	12.93	12.50	8.10	23.45
33	HI 1604	94.34	11.81	10.00	23.85	9.37	5.60	25.83
34	HI 1605	74.32	12.27	6.66	17.39	8.00	9.80	21.41
35	HUW 688	90.91	13.57	6.66	24.36	20.00	7.80	27.22
36	K 1312	100.00	13.44	3.33	11.24	9.09	5.60	23.78
37	K 1313	72.97	11.81	10.00	11.11	8.33	6.10	20.05
38	K 1314	100.00	15.26	10.00	11.84	8.78	7.90	25.63
39	MACS 3949	39.47	14.54	6.66	16.49	18.18	4.80	16.69
40	MACS 4024	94.74	15.26	6.66	29.87	6.66	5.20	26.40
40A	SONALIKA(C) for SF	89.69	16.52	10.00	13.73	6.66	6.10	23.78
41	NW 6024	No seed	No seed	No seed	No seed	No seed	No seed	No seed
42	PBW 707	87.34	8.16	10.00	29.85	11.11	9.09	25.93
43	PBW 709	98.28	16.52	8.33	9.09	9.09	10.12	25.24
44	PBW 716	100.00	18.62	10.00	20.59	17.14	6.20	28.76
45	PBW 718	100.00	18.69	11.66	29.74	8.33	4.10	28.75

S. No.	Entry	Shootfly Incidence (%)						Average
		Dharwad	Durgapura	Niphad	Ludhiana	Kanpur	Kharibari	
46	PBW 719	91.38	10.16	13.33	11.03	14.28	7.20	24.56
47	UP 2883	100.00	16.12	10.00	17.32	7.14	8.40	26.50
48	WH 1179	97.06	11.11	10.00	28.24	16.66	10.10	28.86
49	HD 3171	95.74	18.51	6.66	22.95	1.33	8.50	25.62
50	K 1317	74.74	11.29	3.33	12.94	5.50	9.05	19.47
51	CG 1015	100.00	18.10	3.33	28.33	3.33	8.00	26.85
52	GW 463	57.30	20.86	5.00	4.55	8.00	4.80	16.75
53	HI 8759 (d)	84.62	16.77	8.33	2.75	13.33	1.80	21.27
54	GW 1315 (d)	42.11	12.50	8.33	5.38	12.50	3.30	14.02
55	HD 3164	53.00	8.95	8.33	14.29	16.66	2.60	17.31
56	HI 8765 (d)	68.18	15.26	5.00	4.80	9.09	4.80	17.86
57	JWS 712	41.43	16.81	6.66	27.50	7.69	5.90	17.66
58	K 1315	52.22	18.96	10.00	13.75	11.11	5.00	18.51
59	MACS 3970 (d)	54.41	12.89	6.66	11.67	12.50	8.40	17.76
60	MACS 3972 (d)	34.29	17.69	3.00	16.36	16.66	7.66	15.94
60A	SONALIKA(C) for SF	74.67	23.68	10.00	28.75	15.00	6.30	26.40
61	MACS 4020 (d)	39.02	12.28	5.00	18.42	7.14	3.40	14.21
62	PBW 721	55.95	16.41	5.00	7.89	12.50	6.10	17.31
63	UAS 360	67.05	19.87	6.66	19.08	10.52	4.40	21.26
64	UAS 361	90.28	15.90	6.66	11.33	6.66	5.20	22.67
65	UAS 453 (d)	36.73	15.25	5.00	2.84	16.66	8.10	14.10
66	UAS 455 (d)	58.42	12.08	8.33	10.83	5.00	2.10	16.13
67	DBW 181	61.67	14.92	10.00	22.73	16.66	7.10	22.18
68	DBW 182	45.12	15.49	5.00	25.69	6.25	6.50	17.34
69	DBW 183	100.00	12.76	3.33	27.20	5.00	3.40	25.28
70	DBW 184	90.00	14.08	5.00	15.31	12.50	4.10	23.50
71	DBW 185	89.47	23.21	5.00	11.49	6.25	2.10	22.92
72	DDK 1048	45.61	9.09	6.66	16.28	2.85	3.10	13.93
73	DDK 1049	88.24	10.81	6.66	16.44	5.55	5.60	22.22
74	KRL 350	77.14	11.47	5.00	2.86	8.00	7.10	18.60
75	KRL 351	100.00	13.50	6.66	22.32	9.09	8.20	26.63
76	MACS 5041	76.00	15.38	8.33	23.73	3.33	7.10	22.31

S. No.	Entry	Shootfly Incidence (%)						Average
		Dharwad	Durgapura	Niphad	Ludhiana	Kanpur	Kharibari	
77	MACS 5043	55.17	16.38	5.00	29.81	13.33	6.10	20.97
78	WH 1309	62.50	14.81	6.66	13.85	3.33	1.10	17.04
79	TL 3001	50.00	10.76	6.66	22.93	5.71	6.20	17.04
80	TL 3002	57.35	9.86	6.66	13.41	18.18	8.40	18.98
80A	SONALIKA(C) for SF	95.95	11.94	10.00	43.48	11.11	3.40	29.31
81	TL 3003	93.10	9.09	6.66	14.52	11.11	8.10	23.76
82	TL 3004	96.15	17.54	8.33	28.57	22.85	10.10	30.59
83	TL 3005	86.79	11.53	6.66	27.42	17.14	4.10	25.61
84	DWR-NIL-01	100.00	23.18	8.33	24.75	11.42	5.60	28.88
85	DWR-NIL-02	96.00	14.08	13.33	21.14	9.09	9.10	27.12
86	HD 3209	69.12	13.65	11.66	25.74	3.33	6.20	21.62
87	KB 2012-13	89.19	18.33	13.33	24.07	5.55	2.20	25.44
88	HPBW 01	58.33	13.79	8.33	17.78	6.25	6.20	18.45
89	HPBW 02	79.17	19.14	8.33	11.90	9.09	5.40	22.17
90	HPBW 05	74.07	17.50	8.33	16.15	12.50	7.20	22.63
91	HPBW 07	No seed	No seed	No seed	No seed	No seed	No seed	No seed
92	HPBW 08	79.31	16.12	10.00	8.33	5.55	5.30	20.77
93	HPBW 09	70.00	19.37	10.00	13.33	9.09	9.10	21.82
94	HUW 695	63.89	9.09	6.66	12.30	3.33	2.80	16.34
95	HUW 711	68.75	8.69	5.00	15.38	4.00	2.40	17.37
96	HUW 712	45.61	8.16	5.00	10.00	14.50	NO SEED	16.65
97	MACS 6507	93.33	20.00	8.33	14.52	8.33	2.40	24.49
98	WB 1	No seed	No seed	No seed	No seed	No seed	No seed	No seed
99	WB 2	85.96	8.47	10.00	10.00	NG	4.40	23.77
100	WB 5	89.09	9.52	10.00	13.33	NG	3.00	24.99
100 A	SONALIKA (C) FOR SF	78.75	20.04	8.33	12.03	13.33	5.70	23.03

(1b) Brown wheat mite screening nursery

A total of 170 lines were screened against brown wheat mite at two locations viz. Durgapura and Ludhiana. The brown wheat mite screening nursery, consisted of 73AVT II year lines and 97 AVT I year lines which were screened at Ludhiana and Durgapura centres. All the entries harboured the low levels of BWM infestation during 2014-15 season as compared to previous two seasons. Most of the entries showed infestation below 10% at Durgapura location. Amongst AVT II year genotypes, the average number of mites per 10 cm^2 area ranged from 5.00 to 18.00 while amongst AV I year genotypes, the number varied from 5.00 to 21.23 mites per 10 cm^2 (Table 10.2a and 10.2b). Though the material was screened at Niphad the pest did not appear and the data was not considered.

Centre: Durgapura

One hundred seventy wheat lines were planted in two rows replicated thrice were screened during 2014-15 against brown wheat mite under irrigated conditions. Two observations for mite population were recorded at 20 days intervals during peak infestation period. The infested plants were tapped over 4 glycerine-smeared slides held in a thermo Cole sampler at ground level for recording the mite population. The observations were recorded from 3 spots per plot. The average of the data was computed to number of mites/10 cm^2 area. The rankings were given for different entries in the last. The data presented in the Table 10.2a and 10.2b.

Centre: Ludhiana

In this trial, a total of 170 genotypes were sown under rainfed conditions for screening against brown mite at Plant Breeding Research Farm, PAU, Ludhiana in the year 2014-15. The varieties were sown in one-meter row length, with three replications of each line. The observations on mite population were recorded at 15-20 days interval during March-April. For recording mite population, infested plants were tapped over 4 glycerine-smeared slides held in thermocole sampler at ground level. Among AVT II screening nursery, the maximum mite population was observed in NIAW 1415 (14.70/10 cm^2 area) while K 8027, HI 4730, HD 2864 and HI 8737 (4/10cm^2 area) recorded the minimum mite population (Table 1b1). The maximum mite infestation was recorded in VL 3007, DDW 32 and JWS 712 (20/m2 area) and minimum in HPBW 09 (4/10 m2 area) in AVT I screening nursery (Table 10.2a and 10.2b).

Table 10.2a. Brown wheat mite screening nursery: AVT II year lines (Year-2014-15)

S. No.	Entry	No. of mites/10cmsq area		Average
		Ludhiana	Durgapura	
1	HS 562	12.00	7.20	9.60
2	HPW 251 (C)	14.33	8.00	11.17
3	HPW 349 (C)	15.00	9.00	12.00
4	HS 375 (C)	10.00	4.40	7.20
5	HS 490 (C)	13.00	8.00	10.50
6	HS 507 (C)	20.66	7.70	14.18
7	HS 542 (C)	11.66	10.00	10.83
8	VL 804 (C)	13.66	11.00	12.33
9	VL 829 (C)	12.66	4.60	8.63
10	VL 892 (C)	-	5.00	5.00
11	VL 907 (C)	8.66	9.00	8.83
12	HD 4730	10.33	7.00	8.67

S. No.	Entry	No. of mites/10cmsq area		Average
		Ludhiana	Durgapura	
13	MP 1277	10.66	8.50	9.58
14	WH 1164	10.00	12.00	11.00
15	DBW 88 (C)	16.00	5.00	10.50
16	DBW 90 (C)	12.00	14.00	13.00
17	DPW 621-50 (C)	10.00	10.60	10.30
18	HD 2967 (C)	10.00	11.00	10.50
19	HD 3043 (C)	10.66	6.00	8.33
20	HD 3059 (C)	14.00	9.60	11.80
20A	IWP 72 (C) FOR BWM	20.00	16.00	18.00
21	HD 3086 (C)	12.66	4.10	8.38
22	PBW 644 (C)	12.33	14.00	13.17
23	PDW 233 (C)	16.33	5.00	10.67
24	PDW 291 (C)	8.66	7.00	7.83
25	PDW 314 (C)	-	5.00	5.00
26	WH 1021 (C)	10.66	8.40	9.53
27	WH 1080 (C)	10.33	7.00	8.67
28	WH 1105 (C)	14.66	8.00	11.33
29	WH 1124 (C)	-	9.60	9.60
30	WH 1142 (I) C)	11.66	7.00	9.33
31	C 306 (C)	-	7.00	7.00
32	HD 2888 (C)	14.00	5.00	9.50
33	K 8027 (C)	11.33	4.00	7.67
34	HD 4728 (d)	17.00	8.00	12.50
35	HD 4730 (d)	10.00	4.00	7.00
36	GW 322 (C)	12.00	8.80	10.40
37	HD 2864 (C)	10.66	4.00	7.33
38	HD 2932 (C)	8.66	10.00	9.33
39	HI 1544 (C)	10.33	8.60	9.47
40	HI 8498 (D) (C)	-	9.00	9.00
40A	IWP 72 (C) FOR BWM	15.00	14.00	14.50
41	HI 8737 (D)(I) (C)	8.66	4.00	6.33
42	MP 3336 (C)	10.66	8.20	9.43
43	MP 4010 (C)	-	6.00	6.00
44	MPO 1215 (d) (C)	11.00	7.00	9.00
45	MACS 3927 (d)	11.66	9.00	10.33
46	NIAW 2030	13.00	10.00	11.50
47	AKDW 2997-16(d) (C)	14.33	14.00	14.17
48	DBW 93 (I) (C)	10.00	6.80	8.40
49	MACS 6222 (C)	10.33	7.00	8.67
50	MACS 6478 (C)	12.00	8.50	10.25
51	NI 5439 (C)	13.00	11.00	12.00
52	NIAW 1415 (C)	-	14.70	14.70
53	UAS 347 (I) (C)	10.66	11.00	10.83
54	UAS 428 (d) (C)	-	11.00	11.00
55	UAS 446 (d) (I) (C)	12.00	12.60	12.30
56	(HD 2932 + Lr 19/Sr25)	8.66	4.20	6.43
57	MMBL 283	16.66	6.00	11.33
58	PBW 723	12.00	9.60	10.80
59	DBW 14 (C)	10.00	7.00	8.50
60	DDK 1029 (C)	12.00	8.40	10.20
60A	IWP 72 (C) FOR BWM	21.00	14.20	17.60
61	HD 2985 (C)	12.33	5.00	8.67

S. No.	Entry	No. of mites/10cmsq area		Average
		Ludhiana	Durgapura	
62	HI 1563 (C)	10.00	8.60	9.30
63	HUW 234 (C)	10.66	7.00	8.83
64	HW 1098 (C)	-	7.00	7.00
65	K 0307 (C)	9.33	6.00	7.67
66	Kharchia 65 (C)	12.00	7.00	9.50
67	KRL 19 (C)	-	5.50	5.50
68	KRL 210 (C)	-	7.00	7.00
69	PBW 343 (C)	10.00	8.00	9.00
70	Raj 4083 (C)	-	9.00	9.00
71	TL 2942 (C)	10.33	10.60	10.47
72	TL 2969 (C)	-	11.00	11.00
73	WH 542 (C)	10.00	8.20	9.10

Table 10.2b. Brown wheat mite screening nursery: AVT I year lines (Year-2014-15)

S. No.	Entry	No. of mites/10cmsq area		Average
		Ludhiana	Durgapura	
1	HPW 393	10.66	14.50	12.58
2	HPW 394	-	5.60	5.60
3	HPW 413	22.00	10.20	16.10
4	HPW 421	18.66	10.30	14.48
5	HPW 422	20.33	14.40	17.37
6	HS 580	14.66	10.50	12.58
7	HS 583	12.00	8.80	10.40
8	HS 590	15.00	12.20	13.60
9	HS 596	20.33	10.50	15.42
10	HS 597	12.66	10.50	11.58
11	HS 598	14.00	15.20	14.60
12	HS 599	22.66	8.40	15.53
13	HS 600	16.33	14.20	15.27
14	HS 601	10.33	7.40	8.87
15	UP 2917	8.33	12.40	10.37
16	UP 2918	20.66	8.40	14.53
17	VL 1005	15.00	8.60	11.80
18	VL 1006	15.66	10.20	12.93
19	VL 1007	12.66	8.60	10.63
20	VL 3002	13.00	15.00	14.00
20 A	IWP 72 (C) FOR BWM	23.00	18.80	20.90
21	VL 3007	10.66	20.00	15.33
22	VL 3008	8.66	14.00	11.33
23	VL 3009	12.00	8.00	10.00
24	VL 4001	10.00	8.80	9.40
25	DBW 147	12.00	13.40	12.70
26	DBW 148	13.00	7.40	10.20
27	DBW 150	21.00	13.00	17.00
28	DDW 31	-	8.80	8.80
29	DDW 32	11.00	20.00	15.50
30	HD 3159	13.00	9.40	11.20
31	HD 3165	9.00	10.00	9.50
32	HD 3174	12.66	10.00	11.33
33	HI 1604	10.00	7.40	8.70
34	HI 1605	10.66	9.20	9.93

S. No.	Entry	No. of mites/10cmsq area		Average
		Ludhiana	Durgapura	
35	HUW 688	-	12.30	12.30
36	K 1312	13.00	10.50	11.75
37	K 1313	11.66	15.00	13.33
38	K 1314	-	15.60	15.60
39	MACS 3949	-	18.70	18.70
40	MACS 4024	-	16.00	16.00
40A	IWP 72 (C) FOR BWM	21.66	20.80	21.23
41	NW 6024	-	mis	
42	PBW 707	11.00	15.40	13.20
43	PBW 709	10.00	5.50	7.75
44	PBW 716	-	5.60	5.60
45	PBW 718	-	10.80	10.80
46	PBW 719	18.00	7.40	12.70
47	UP 2883	12.00	9.50	10.75
48	WH 1179	16.33	19.50	17.92
49	HD 3171	12.66	13.00	12.83
50	K 1317	12.00	16.00	14.00
51	CG 1015	15.66	10.00	12.83
52	GW 463	20.66	10.20	15.43
53	HI 8759 (d)	16.00	8.00	12.00
54	GW 1315 (d)	-	5.00	5.00
55	HD 3164	11.66	5.40	8.53
56	HI 8765 (d)	10.33	17.00	13.67
57	JWS 712	-	20.00	20.00
58	K 1315	15.33	12.20	13.77
59	MACS 3970 (d)	11.00	10.00	10.50
60	MACS 3972 (d)	-	13.00	13.00
60A	IWP 72 (C) FOR BWM	23.00	13.40	18.20
61	MACS 4020 (d)	9.00	7.00	8.00
62	PBW 721	17.33	5.40	11.37
63	UAS 360	-	12.00	12.00
64	UAS 361	12.33	10.00	11.17
65	UAS 453 (d)	10.00	5.00	7.50
66	UAS 455 (d)	12.00	10.00	11.00
67	DBW 181	10.66	15.00	12.83
68	DBW 182	-	7.40	7.40
69	DBW 183	22.00	15.00	18.50
70	DBW 184	20.00	9.00	14.50
71	DBW 185	15.66	8.40	12.03
72	DDK 1048	12.33	10.00	11.17
73	DDK 1049	-	11.00	11.00
74	KRL 350	18.00	10.20	14.10
75	KRL 351	10.00	9.00	9.50
76	MACS 5041	12.66	9.60	11.13
77	MACS 5043	-	10.00	10.00
78	WH 1309	11.00	7.00	9.00
79	TL 3001	-	10.00	10.00
80	TL 3002	-	5.20	5.20
80A	IWP 72 (C) FOR BWM	24.33	12.00	18.17
81	TL 3003	10.00	10.00	10.00
82	TL 3004	13.00	15.00	14.00

S. No.	Entry	No. of mites/10cmsq area		Average
		Ludhiana	Durgapura	
83	TL 3005	11.33	5.00	8.17
84	DWR-NIL-01	11.00	8.00	9.50
85	DWR-NIL-02	10.33	10.00	10.17
86	HD 3209	15.00	10.50	12.75
87	KB 2012-13	22.00	11.00	16.50
88	HPBW 01	11.66	10.00	10.83
89	HPBW 02	10.66	10.70	10.68
90	HPBW 05	20.00	9.00	14.50
91	HPBW 07	-	8.40	8.40
92	HPBW 08	15.33	7.00	11.17
93	HPBW 09	10.00	4.00	7.00
94	HUW 695	12.66	8.40	10.53
95	HUW 711	18.00	9.00	13.50
96	HUW 712	-	8.00	8.00
97	MACS 6507	12.00	7.00	9.50
98	WB 1	-	8.00	8.00
99	WB 2	13.00	7.60	10.30
100	WB 5	12.66	7.00	9.83

Niphad: Brown wheat mite was not observed on any genotype.

(1c) Screening nursery for wheat aphids

The foliar wheat aphid screenings nursery consisting of 73 AVT II and 97AVT I year genotypes were screened at six locations viz. Niphad, Ludhiana, Kharibari, Karnal, Pantnagar and Kanpur. Though the material was screened at Shillongani, the pest did not appear and the data was not considered. Aphid count/shoots were recorded at weekly interval from all these genotypes and grades were given according to 5 point system described below:

Table 10.3: Grading and rating of foliar aphid on the basis of population in wheat.

Grade	Approx. numbers of aphids/shoot	Rating
1	0	Immune
2	1-5	Resistant
3	6-10	Moderately resistant
4	11-20	Susceptible
5	21 and above	Highly susceptible

The data suggests that the aphid incidence was high at the locations viz. Niphad, Ludhiana, Kharibari, Karnal and medium at Pantnagar and Kanpur. Of 73 AVT II and 97 AVT I year genotypes, on the basis of average grading of the locations all entries were susceptible against foliar wheat aphids (Table 10.4a and 10.4b). Though the material was screened at Shillongani the pest did not appear and the data was not considered.

Table 10.4a: Screening against foliar wheat aphids: AVT II year lines (Year-2014-15)

S.No.	Entry	Aphid score (1-5)						AV	HS
		Niphad	Ludhiana	Kharibari	Karnal	Pantnagar	Kanpur		
1	HS 562	4	4	5	5	3	3	4.0	5
2	HPW 251 (C)	4	5	5	5	3	2	4.0	5
3	HPW 349 (C)	4	5	5	5	3	2	4.0	5
4	HS 375 (C)	4	5	5	5	3	2	4.0	5
5	HS 490 (C)	4	5	5	5	4	2	4.2	5
6	HS 507 (C)	4	5	5	5	4	3	4.3	5
7	HS 542 (C)	4	4	4	5	4	2	3.8	5
8	VL 804 (C)	4	4	3	5	3	2	3.5	5
9	VL 829 (C)	4	5	5	5	4	2	4.2	5
10	VL 892 (C)	4	4	5	5	4	3	4.2	5
11	VL 907 (C)	4	4	5	5	5	3	4.3	5
12	HD 4730	5	5	5	5	5	3	4.7	5
13	MP 1277	4	4	5	5	5	3	4.3	5
14	WH 1164	4	5	5	5	3	2	4.0	5
15	DBW 88 (C)	4	5	4	5	3	2	3.8	5
16	DBW 90 (C)	4	4	3	5	3	3	3.7	5
17	DPW 621-50 (C)	4	4	5	5	5	3	4.3	5
18	HD 2967 (C)	4	4	5	5	4	3	4.2	5
19	HD 3043 (C)	4	4	5	5	4	2	4.0	5
20	HD 3059 (C)	5	5	5	5	4	2	4.3	5
20A	A 9-30-1 (C) FOR FA	5	5	5	5	3	4	4.5	5
21	HD 3086 (C)	4	5	4	5	3	3	4.0	5
22	PBW 644 (C)	4	5	4	5	3	3	4.0	5
23	PDW 233 (C)	4	5	4	5	3	3	4.0	5
24	PDW 291 (C)	4	5	3	5	4	3	4.0	5
25	PDW 314 (C)	4	5	5	5	3	3	4.2	5
26	WH 1021 (C)	4	5	4	5	4	2	4.0	5
27	WH 1080 (C)	4	4	5	5	3	2	3.8	5
28	WH 1105 (C)	4	5	4	5	3	2	3.8	5
29	WH 1124 (C)	4	4	3	5	4	3	3.8	5
30	WH 1142 (I) C)	4	5	5	5	3	3	4.2	5

S.No.	Entry	Aphid score (1-5)						AV	HS
		Niphad	Ludhiana	Kharibari	Karnal	Pantnagar	Kanpur		
31	C 306 (C)	4	4	5	5	2	3	3.8	5
32	HD 2888 (C)	4	4	5	5	2	3	3.8	5
33	K 8027 (C)	4	4	4	5	2	3	3.7	5
34	HD 4728 (d)	5	5	5	5	4	4	4.7	5
35	HD 4730 (d)	5	5	5	5	4	2	4.3	5
36	GW 322 (C)	4	4	4	5	3	4	4.0	5
37	HD 2864 (C)	4	4	4	5	3	3	3.8	5
38	HD 2932 (C)	4	4	5	5	2	3	3.8	5
39	HI 1544 (C)	4	4	5	5	5	3	4.3	5
40	HI 8498 (D) (C)	4	4	5	5	3	3	4.0	5
40 A	A 9-30-1 (C) FOR FA	5	5	5	5	3	4	4.5	5
41	HI 8737 (D)(I) (C)	4	4	5	5	4	3	4.2	5
42	MP 3336 (C)	4	4	5	5	4	NG	4.4	5
43	MP 4010 (C)	4	4	4	5	3	4	4.0	5
44	MPO 1215 (d) (C)	4	5	5	5	5	3	4.5	5
45	MACS 3927 (d)	4	5	5	5	3	3	4.2	5
46	NIAW 2030	3	4	4	5	4	3	3.8	5
47	AKDW 2997-16(d) (C)	4	5	5	5	4	3	4.3	5
48	DBW 93 (I) (C)	4	5	5	5	4	2	4.2	5
49	MACS 6222 (C)	4	5	5	5	3	2	4.0	5
50	MACS 6478 (C)	4	4	4	5	4	2	3.8	5
51	NI 5439 (C)	4	4	5	5	4	3	4.2	5
52	NIAW 1415 (C)	4	4	5	5	5	3	4.3	5
53	UAS 347 (I) (C)	4	4	4	5	4	3	4.0	5
54	UAS 428 (d) (C)	4	5	4	5	4	3	4.2	5
55	UAS 446 (d) (I) (C)	4	4	5	5	4	3	4.2	5
56	(HD 2932 + Lr 19/Sr25)	4	4	5	5	4	3	4.2	5
57	MMBL 283	4	4	5	5	4	2	4.0	5
58	PBW 723	4	4	5	5	4	3	4.2	5
59	DBW 14 (C)	4	4	4	5	4	3	4.0	5
60	DDK 1029 (C)	4	4	5	5	4	2	4.0	5
60 A	A 9-30-1 (C) FOR FA	5	5	5	5	4	3	4.5	5

S.No.	Entry	Aphid score (1-5)						AV	HS
		Niphad	Ludhiana	Kharibari	Karnal	Pantnagar	Kanpur		
61	HD 2985 (C)	4	4	5	5	4	3	4.2	5
62	HI 1563 (C)	4	4	5	5	4	2	4.0	5
63	HUW 234 (C)	4	4	5	5	4	2	4.0	5
64	HW 1098 (C)	4	4	5	5	3	3	4.0	5
65	K 0307 (C)	4	4	5	5	3	2	3.8	5
66	Kharchia 65 (C)	3	4	4	5	4	3	3.8	5
67	KRL 19 (C)	4	5	5	5	3	3	4.2	5
68	KRL 210 (C)	4	4	5	5	4	3	4.2	5
69	PBW 343 (C)	4	4	4	5	4	3	4.0	5
70	Raj 4083 (C)	4	4	5	5	5	3	4.3	5
71	TL 2942 (C)	4	4	4	5	3	2	3.7	5
72	TL 2969 (C)	4	4	5	5	3	2	3.8	5
73	WH 542 (C)	4	4	4	5	3	2	3.7	5

*Shillongani:- Infestation by wheat aphid was not observed

Table 10.4b: Screening against foliar wheat aphids: AVT I year lines (Year-2014-15)

S.No.	Entry	Aphid score (1-5)						AV	HS
		Niphad	Ludhiana	Kharibari	Karnal	Pantnagar	Kanpur		
1	HPW 393	4	4	4	5	4	3	4.0	5
2	HPW 394	4	5	3	5	3	3	3.8	5
3	HPW 413	4	5	5	5	4	3	4.3	5
4	HPW 421	5	4	5	5	4	3	4.3	5
5	HPW 422	5	5	4	5	4	3	4.3	5
6	HS 580	5	4	5	5	3	3	4.2	5
7	HS 583	5	5	5	5	2	3	4.2	5
8	HS 590	5	5	5	5	4	3	4.5	5
9	HS 596	5	4	4	5	3	3	4.0	5
10	HS 597	4	4	5	5	3	3	4.0	5
11	HS 598	4	5	5	5	2	3	4.0	5
12	HS 599	5	4	5	5	3	3	4.2	5
13	HS 600	5	4	4	5	4	3	4.2	5
14	HS 601	4	4	5	5	3	2	3.8	5

S.No.	Entry	Aphid score (1-5)						AV	HS
		Niphad	Ludhiana	Kharibari	Karnal	Pantnagar	Kanpur		
15	UP 2917	5	4	5	5	3	2	4.0	5
16	UP 2918	5	4	5	5	3	3	4.2	5
17	VL 1005	5	4	4	5	5	3	4.3	5
18	VL 1006	5	4	5	5	4	3	4.3	5
19	VL 1007	5	5	5	5	4	3	4.5	5
20	VL 3002	4	4	5	5	2	3	3.8	5
20 A	A 9-30-1 (C) FOR FA	5	5	4	5	4	3	4.3	5
21	VL 3007	5	4	4	5	4	3	4.2	5
22	VL 3008	5	4	3	5	4	3	4.0	5
23	VL 3009	4	4	4	5	3	3	3.8	5
24	VL 4001	4	5	5	5	4	3	4.3	5
25	DBW 147	4	5	4	5	4	2	4.0	5
26	DBW 148	4	4	5	5	4	2	4.0	5
27	DBW 150	4	4	5	5	4	2	4.0	5
28	DDW 31	4	4	4	5	4	2	3.8	5
29	DDW 32	4	4	5	5	3	3	4.0	5
30	HD 3159	4	3	5	5	4	3	4.0	5
31	HD 3165	4	4	4	5	3	3	3.8	5
32	HD 3174	4	4	5	5	4	3	4.2	5
33	HI 1604	4	4	4	5	4	3	4.0	5
34	HI 1605	4	5	5	5	4	3	4.3	5
35	HUW 688	4	5	5	5	4	4	4.5	5
36	K 1312	5	5	4	5	3	3	4.2	5
37	K 1313	4	5	5	5	4	2	4.2	5
38	K 1314	4	5	5	5	5	3	4.5	5
39	MACS 3949	5	4	4	5	5	2	4.2	5
40	MACS 4024	5	5	4	5	5	2	4.3	5
40 A	A 9-30-1 (C) FOR FA	5	5	4	5	5	4	4.7	5
41	NW 6024	No seed	No seed	No seed	No seed	No seed	No seed	No seed	No seed
42	PBW 707	4	4	5	5	4	3	4.2	5
43	PBW 709	4	4	4	5	3	2	3.7	5
44	PBW 716	4	4	3	5	3	2	3.5	5

S.No.	Entry	Aphid score (1-5)						AV	HS
		Niphad	Ludhiana	Kharibari	Karnal	Pantnagar	Kanpur		
45	PBW 718	4	5	5	5	3	3	4.2	5
46	PBW 719	5	4	5	5	3	3	4.2	5
47	UP 2883	5	4	4	5	3	3	4.0	5
48	WH 1179	4	5	5	5	2	3	4.0	5
49	HD 3171	4	4	5	5	3	3	4.0	5
50	K 1317	5	4	4	5	4	2	4.0	5
51	CG 1015	4	3	4	5	3	3	3.7	5
52	GW 463	5	5	3	5	4	3	4.2	5
53	HI 8759 (d)	5	5	5	5	3	3	4.3	5
54	GW 1315 (d)	5	4	5	5	5	3	4.5	5
55	HD 3164	4	5	4	5	4	3	4.2	5
56	HI 8765 (d)	4	5	5	5	4	3	4.3	5
57	JWS 712	4	3	4	5	4	3	3.8	5
58	K 1315	4	4	5	5	4	3	4.2	5
59	MACS 3970 (d)	4	4	3	5	4	3	3.8	5
60	MACS 3972 (d)	4	4	4	5	4	2	3.8	5
60 A	A 9-30-1 (C) FOR FA	5	5	5	5	4	3	4.5	5
61	MACS 4020 (d)	4	4	4	5	3	3	3.8	5
62	PBW 721	4	3	5	5	3	3	3.8	5
63	UAS 360	4	4	4	5	3	3	3.8	5
64	UAS 361	4	4	5	5	4	3	4.2	5
65	UAS 453 (d)	5	4	4	5	5	3	4.3	5
66	UAS 455 (d)	5	4	4	5	4	3	4.2	5
67	DBW 181	3	4	5	5	4	4	4.2	5
68	DBW 182	4	4	4	5	5	3	4.2	5
69	DBW 183	4	4	4	5	4	4	4.2	5
70	DBW 184	4	4	5	5	4	3	4.2	5
71	DBW 185	4	4	4	5	4	3	4.0	5
72	DDK 1048	5	4	4	5	5	3	4.3	5
73	DDK 1049	5	4	3	5	5	3	4.2	5
74	KRL 350	4	4	3	5	5	3	4.0	5
75	KRL 351	4	3	5	5	5	3	4.2	5

S.No.	Entry	Aphid score (1-5)						AV	HS
		Niphad	Ludhiana	Kharibari	Karnal	Pantnagar	Kanpur		
76	MACS 5041	5	4	5	5	4	3	4.3	5
77	MACS 5043	5	5	5	5	4	3	4.5	5
78	WH 1309	4	4	4	5	4	3	4.0	5
79	TL 3001	3	4	5	5	4	3	4.0	5
80	TL 3002	3	4	5	5	5	3	4.2	5
80A	A 9-30-1 (C) FOR FA	5	5	5	5	5	3	4.7	5
81	TL 3003	3	4	4	5	5	3	4.0	5
82	TL 3004	3	5	4	5	4	3	4.0	5
83	TL 3005	3	4	4	3	4	3	3.5	5
84	DWR-NIL-01	5	4	3	5	5	2	4.0	5
85	DWR-NIL-02	5	4	3	5	5	2	4.0	5
86	HD 3209	5	4	4	5	5	3	4.3	5
87	KB 2012-13	5	4	5	5	4	3	4.3	5
88	HPBW 01	4	5	5	5	4	3	4.3	5
89	HPBW 02	4	5	5	5	4	3	4.3	5
90	HPBW 05	4	4	5	5	4	3	4.2	5
91	HPBW 07	No seed	No seed	No seed	No seed	No seed	No seed	No seed	No seed
92	HPBW 08	5	5	5	5	3	3	4.3	5
93	HPBW 09	5	4	5	5	3	3	4.2	5
94	HUW 695	5	5	4	5	4	3	4.3	5
95	HUW 711	5	4	4	5	5	3	4.3	5
96	HUW 712	5	4	4	5	4	3	4.2	5
97	MACS 6507	5	4	5	5	4	3	4.3	5
98	WB 1	No seed	No seed	No seed	No seed	No seed	No seed	No seed	No seed
99	WB 2	4	4	5	5	4	NG	4.4	5
100	WB 5	4	4	5	5	3	NG	4.2	5

***Shillongani:- Infestation by wheat aphid was not observed**

Table 10.5a: Screening of AVT II material against root aphid of wheat (Year-2014-15)

S. No.	Entry	Root Aphid Score (1-5)			AVG.	HS
		Ludhiana	Entkhedi	Karnal		
1	HS 562	4	2	4	3.3	4
2	HPW 251 (C)	4	2	4	3.3	4
3	HPW 349 (C)	3	2	4	3.0	4
4	HS 375 (C)	4	3	4	3.7	4
5	HS 490 (C)	4	2	4	3.3	4
6	HS 507 (C)	4	3	4	3.7	4
7	HS 542 (C)	3	2	3	2.7	3
8	VL 804 (C)	4	2	3	3.0	4
9	VL 829 (C)	4	2	4	3.3	4
10	VL 892 (C)	4	3	4	3.7	4
11	VL 907 (C)	3	3	4	3.3	4
12	HD 4730	4	2	3	3.0	4
13	MP 1277	4	3	4	3.7	4
14	WH 1164	3	3	4	3.3	4
15	DBW 88 (C)	4	2	3	3.0	4
16	DBW 90 (C)	5	3	3	3.7	5
17	DPW 621-50 (C)	4	2	3	3.0	4
18	HD 2967 (C)	4	3	3	3.3	4
19	HD 3043 (C)	2	No seed	4	3.0	4
20	HD 3059 (C)	4	2	3	3.0	4
20A	GW 173 (C) FOR RA	5	3	5	4.3	5
21	HD 3086 (C)	4	3	3	3.3	4
22	PBW 644 (C)	4	3	3	3.3	4
23	PDW 233 (C)	3	2	4	3.0	4
24	PDW 291 (C)	4	2	4	3.3	4
25	PDW 314 (C)	4	2	3	3.0	4
26	WH 1021 (C)	3	2	3	2.7	3
27	WH 1080 (C)	4	3	3	3.3	4
28	WH 1105 (C)	3	2	3	2.7	3
29	WH 1124 (C)	4	2	3	3.0	4
30	WH 1142 (I) C)	4	2	4	3.3	4
31	C 306 (C)	4	2	4	3.3	4
32	HD 2888 (C)	4	2	3	3.0	4
33	K 8027 (C)	3	2	3	2.7	3
34	HD 4728 (d)	4	2	4	3.3	4
35	HD 4730 (d)	3	2	4	3.0	4
36	GW 322 (C)	4	2	3	3.0	4
37	HD 2864 (C)	3	2	3	2.7	3
38	HD 2932 (C)	4	2	4	3.3	4
39	HI 1544 (C)	3	2	3	2.7	3
40	HI 8498 (D) (C)	4	2	3	3.0	4
40 A	GW 173 (C) FOR RA	5	3	4	4.0	5
41	HI 8737 (D)(I) (C)	4	2	4	3.3	4
42	MP 3336 (C)	4	3	4	3.7	4
43	MP 4010 (C)	3	2	3	2.7	3
44	MPO 1215 (d) (C)	4	2	3	3.0	4
45	MACS 3927 (d)	4	2	3	3.0	4
46	NIAW 2030	3	2	3	2.7	3
47	AKDW 2997-16(d) (C)	4	2	3	3.0	4

S. No.	Entry	Root Aphid Score (1-5)			AVG.	HS
		Ludhiana	Entkhedi	Karnal		
48	DBW 93 (I) (C)	3	2	3	2.7	3
49	MACS 6222 (C)	4	2	3	3.0	4
50	MACS 6478 (C)	5	2	4	3.7	5
51	NI 5439 (C)	3	2	4	3.0	4
52	NIAW 1415 (C)	4	2	3	3.0	4
53	UAS 347 (I) (C)	3	2	3	2.7	3
54	UAS 428 (d) (C)	4	2	3	3.0	4
55	UAS 446 (d) (I) (C)	4	2	4	3.3	4
56	(HD 2932 + Lr 19/Sr25)	4	3	3	3.3	4
57	MMBL 283	3	2	3	2.7	3
58	PBW 723	4	2	4	3.3	4
59	DBW 14 (C)	3	2	3	2.7	3
60	DDK 1029 (C)	4	2	3	3.0	4
60 A	GW 173 (C) FOR RA	4	3	4	3.7	4
61	HD 2985 (C)	5	2	4	3.7	5
62	HI 1563 (C)	4	2	3	3.0	4
63	HUW 234 (C)	3	2	4	3.0	4
64	HW 1098 (C)	4	2	3	3.0	4
65	K 0307 (C)	4	2	2	2.7	4
66	Kharchia 65 (C)	3	2	2	2.3	3
67	KRL 19 (C)	4	2	3	3.0	4
68	KRL 210 (C)	3	2	3	2.7	3
69	PBW 343 (C)	4	2	2	2.7	4
70	Raj 4083 (C)	4	2	4	3.3	4
71	TL 2942 (C)	4	2	3	3.0	4
72	TL 2969 (C)	4	2	4	3.3	4
73	WH 542 (C)	5	2	3	3.3	5

Niphad : Root aphid was not observed on any genotype.

The screening nursery for root aphid was consisted of 73 AVT II and 97AVT I year entries. The data was collected at Ludhiana, Entkhedi and Karnal centre for each entry by uprooting the seedling when the crop was 3-4 weeks old. Though the material was screened at Niphad, the pest did not appear and the data was not considered. Of the 73AVT II year entries HS 542 (C), WH 1021 (C), WH 1105 (C), K 8027 (C), HD 2864 (C), HI 1544 (C), MP 4010 (C), NIAW 2030, DBW 93 (I) (C), UAS 347 (I) (C), MMBL 283, DBW 14 (C), Kharchia 65 (C) and KRL 210 (C) showed moderately resistant reaction at both locations against root aphid (Table 10.5a). Among 97 AVT I year, eight entries viz. HS 583, VL 1005, VL 1006, HD 3165, HI 1604, MACS 4024, PBW 709, PBW 719, WH 1179, CG 1015, HI 8765 (d), UAS 361, DBW 182, DDK 1048 and MACS 5041 showed the moderately resistant reaction at both locationsand rest of them were susceptible (grade 4) or highly susceptible (grade 5) to wheat root aphid (Table 10.5b).

Table 10.5b: Screening of AVT I material against root aphid of wheat (Year-2014-15)

S. No.	Entry	Root Aphid Score (1-5)			AVG	HS
		Ludhiana	Entkhedi	Karnal		
1	HPW 393	4	2	4	3.3	4
2	HPW 394	4	2	4	3.3	4
3	HPW 413	4	2	4	3.3	4

S. No.	Entry	Root Aphid Score (1-5)			AVG	HS
		Ludhiana	Entkhedi	Karnal		
4	HPW 421	5	2	4	3.7	5
5	HPW 422	4	2	4	3.3	4
6	HS 580	4	2	2	2.7	4
7	HS 583	3	2	3	2.7	3
8	HS 590	4	2	3	3.0	4
9	HS 596	4	2	4	3.3	4
10	HS 597	4	2	3	3.0	4
11	HS 598	5	3	2	3.3	5
12	HS 599	5	3	3	3.7	5
13	HS 600	4	No Seed	3	3.5	4
14	HS 601	4	2	4	3.3	4
15	UP 2917	4	2	3	3.0	4
16	UP 2918	4	2	3	3.0	4
17	VL 1005	3	2	3	2.7	3
18	VL 1006	3	2	3	2.7	3
19	VL 1007	4	2	4	3.3	4
20	VL 3002	4	2	3	3.0	4
20 A	GW 173 (C) FOR RA	5	3	3	3.7	5
21	VL 3007	4	2	2	2.7	4
22	VL 3008	4	2	3	3.0	4
23	VL 3009	5	2	3	3.3	5
24	VL 4001	5	2	4	3.7	5
25	DBW 147	4	2	3	3.0	4
26	DBW 148	4	2	2	2.7	4
27	DBW 150	4	2	3	3.0	4
28	DDW 31	4	2	3	3.0	4
29	DDW 32	5	2	4	3.7	5
30	HD 3159	4	3	2	3.0	4
31	HD 3165	3	2	3	2.7	3
32	HD 3174	4	2	3	3.0	4
33	HI 1604	3	2	3	2.7	3
34	HI 1605	4	2	3	3.0	4
35	HUW 688	4	2	3	3.0	4
36	K 1312	4	2	3	3.0	4
37	K 1313	3	2	4	3.0	4
38	K 1314	4	2	2	2.7	4
39	MACS 3949	4	2	3	3.0	4
40	MACS 4024	3	2	3	2.7	3
40 A	GW 173 (C) FOR RA	5	3	3	3.7	5
41	NW 6024	No Seed	No Seed	No Seed	No Seed	No Seed
42	PBW 707	4	2	2	2.7	4
43	PBW 709	3	2	3	2.7	3
44	PBW 716	4	2	3	3.0	4
45	PBW 718	4	2	2	2.7	4
46	PBW 719	3	2	3	2.7	3
47	UP 2883	4	2	4	3.3	4
48	WH 1179	3	2	2	2.3	3
49	HD 3171	4	2	2	2.7	4
50	K 1317	4	2	3	3.0	4
51	CG 1015	3	2	3	2.7	3
52	GW 463	4	2	2	2.7	4
53	HI 8759 (d)	4	2	3	3.0	4

S. No.	Entry	Root Aphid Score (1-5)			AVG	HS
		Ludhiana	Entkhedi	Karnal		
54	GW 1315 (d)	4	2	3	3.0	4
55	HD 3164	4	2	3	3.0	4
56	HI 8765 (d)	3	2	2	2.3	3
57	JWS 712	4	2	3	3.0	4
58	K 1315	4	No Seed	3	3.5	4
59	MACS 3970 (d)	3	2	3	2.7	3
60	MACS 3972 (d)	4	2	3	3.0	4
60 A	GW 173 (C) FOR RA	5	3	3	3.7	5
61	MACS 4020 (d)	4	2	3	3.0	4
62	PBW 721	4	2	3	3.0	4
63	UAS 360	4	2	3	3.0	4
64	UAS 361	3	3	3	3.0	3
65	UAS 453 (d)	4	2	3	3.0	4
66	UAS 455 (d)	4	2	2	2.7	4
67	DBW 181	4	2	3	3.0	4
68	DBW 182	3	No Seed	3	3.0	3
69	DBW 183	4	2	2	2.7	4
70	DBW 184	4	2	4	3.3	4
71	DBW 185	4	2	3	3.0	4
72	DDK 1048	3	2	3	2.7	3
73	DDK 1049	4	3	3	3.3	4
74	KRL 350	4	2	4	3.3	4
75	KRL 351	4	2	4	3.3	4
76	MACS 5041	3	2	2	2.3	3
77	MACS 5043	4	2	3	3.0	4
78	WH 1309	4	No Seed	3	3.5	4
79	TL 3001	4	2	3	3.0	4
80	TL 3002	4	2	4	3.3	4
80 A	GW 173 (C) FOR RA	5	4	3	4.0	5
81	TL 3003	4	2	3	3.0	4
82	TL 3004	4	2	4	3.3	4
83	TL 3005	5	No Seed	4	4.5	5
84	DWR-NIL-01	4	2	4	3.3	4
85	DWR-NIL-02	4	2	3	3.0	4
86	HD 3209	3	2	4	3.0	4
87	KB 2012-13	4	2	4	3.3	4
88	HPBW 01	4	2	3	3.0	4
89	HPBW 02	4	2	4	3.3	4
90	HPBW 05	3	2	4	3.0	4
91	HPBW 07	No Seed	No Seed	No Seed	No Seed	No Seed
92	HPBW 08	4	3	4	3.7	4
93	HPBW 09	4	3	4	3.7	4
94	HUW 695	4	3	3	3.3	4
95	HUW 711	4	2	3	3.0	4
96	HUW 712	3	2	4	3.0	4
97	MACS 6507	4	2	3	3.0	4
98	WB 1	No Seed	No Seed	No Seed	No Seed	No Seed
99	WB 2	4	3	3	3.3	4
100	WB 5	5	2	3	3.3	4

*** Niphad: Root aphid was not observed on any genotype.**

EXPT.2 MULTIPLE PEST SCREENING NURSERY
Given in plant pathology section of this report.

10.2 CHEMICAL CONTROI: Effect of insecticidal seed treatment on germination, termite damage and yield.

All the treatments were applied a day before sowing. The EC formulations equivalent to a.i. amounts, were diluted with 50 ml water and sprayed with hand sprayer over seed uniformly spread in a tray or polythene sheet on *pucca* floor. The seeds were turned over frequently to ensure proper application and left over night for drying.

Observations Recorded:

1. Earmarked five spots of 2m-row length in each plot and counted the total number of seedlings three weeks after sowing (for subsequent germination, the observations may be deferred till few days after first irrigation) and data was presented as plant population per meter row in final table.
2. Recorded the total number of affected and healthy tillers in these spots 3, 4 and 5 weeks after sowing. Also recorded total number of effective tillers and those damaged in these spots at crop maturity and given as % damaged effective tillers / m row. For analysis, angular transformations of the percentages were used.
3. When the crop was nearing maturity but still green, then damaged ear heads were counted and removed. The total number of damaged ear heads from net plot (except the two border rows and 25 cm space at each end but inclusive of the damaged ear heads in premarked spots) was expressed as number of effective damaged tillers per hectare.
4. Recorded grain yield (a) from pre marked spots and expressed in g/m row length (b) from net plot (including the pre marked spots) and expressed in q/ha.
5. In the final table, the mean values followed by alphabets indices were given to denote statistical variations based on C.D. values.
6. This trial was not conducted at Bansathali centres
7. The details of results at each experimental site are given below:

Centre: Durgapura

To studies on the effect of insecticidal seed treatments on the termite control in wheat crop under irrigated conditions, an experiment was carried out at RARI, Durgapura, Jaipur and the results are summarized in Table 10.6. The Wheat variety Raj-4229 was sown on 02.12.2014. Before sowing, the seeds were properly treated with six insecticidal formulations one day before sowing separately by spraying on the spread layer of equal quantity of seed on polythene sheet. The treated seeds were dried over night before sowing. There were eight treatments including untreated check and each was replicated thrice. For recording observations the plant population and damaged plant, five spots of 2-meter row length each, were earmarked in each plot. The plant population/m row counts were made after 3 weeks of sowing revealed that non-significant difference among all the treatments. Hence, none of the treatments used, affected the seed germination. No termite damage was observed during 3 to 4 weeks after sowing. The percent damaged shoots/m row after 5 weeks of sowing was maximum in untreated check, whereas it was negligible in the seed treatment with fipronil 5% SC, imidacloprid 17.8% SL, imidacloprid 600 FS and clothianidin 50 WDG, all these treatments were at par each with higher dose of chlorantaniliprid 18.5 SC and its lower dose, followed by thiamethoxam 30 FS treatment. The seed treatment with imidacloprid 600 FS was found to be best treatment exhibiting lowest per cent damaged effective tillers/m row, at ear head stage of crop/ maturity stage which was at par with clothianidin, imidacloprid, fipronil and higher dose of chlorantaniliprid, followed by lower dose of chlorantaniliprid and thiamethoxam when compared with maximum in untreated check. On the basis of number of damaged effective tillers/ha, the highest damage was recorded in untreated check. The lowest damage was observed in the imidacloprid 600 FS which was at par with fipronil, clothianidin, imidacloprid 17.8% SL and higher dose of chlorantaniliprid, followed by lower dose of chlorantaniliprid and thiamethoxam treatment against termite as compared untreated check.

The maximum grain yield data computed on q/ha basis revealed that the highest yield was obtained in imidacloprid 600 FS (32.00) and it was at par with fipronil (31.66), imidacloprid 17.8% SL (31.00) and clothianidin (30.66) and higher dose of chlorantaniliprid (29.66) followed by thiamethoxam (27.33) and lower dose of chlorantaniliprid (25.33) and as compared to minimum yield obtained in untreated check (21.33).

Centre: Ludhiana

This experiment was conducted in the rainfed fields at new experimental area, Dept. of Plant Breeding and Genetics, PAU Ludhiana. The wheat variety PBW 660 was sown on 25th Nov 2014. Before sowing, the seed was treated with seven different insecticides separately by spraying on the spreaded layer of equal quantity of seed on polyethene sheet. The treated seed was dried overnight before sowing. There were eight treatments including untreated check and each was replicated thrice. For recording observations on the plant population and damage plants, five spots of 2 m row lengths each, were ear marked in each plot.

The data presented in Table 10.7 revealed that plant population/m row recorded after 3 weeks of germination was non-significant among all the treatments. Hence, none of treatment used, affected the seed germination. Per cent damaged effective tillers/m row after 3, 4 & 5 weeks of germination indicated that all the insecticidal treatments recorded significantly lower per cent damaged effective tillers/ m row than the untreated check.

At ear head stage, the per cent damaged effective tillers per meter row (in marked spots) were minimum in the plots treated with clothianidin and imidacloprid 600 FS @ 2 ml/kg of seed (0.38) and these were on par with all the other treatments except untreated check. The number of damaged effective tillers/ha were lowest in plots treated with imidacloprid 600 FS @ 2.0 ml/kg of seed (6000). All these insecticide treated plots recorded significantly lower number of damaged tillers/ha as compare to untreated check.

The maximum grain yield (g/m row) was obtained in the plot treated with imidacloprid 600 FS @ 1.0 ml/kg of seed (81.33) and there were non-significant differences among all the treatment. The grain yield (q/ha) obtained from different treatments revealed that all the insecticide treated plots showed significantly higher yield than the untreated check, however imidacloprid 600 FS@ 2.0 ml/kg treated plots recorded maximum yield (47.55).

Centre: Kanpur

The experiment was conducted at Research Farm, Nawabganj, Kanpur, under irrigated condition in 23 rows of 4 x 5m in treated check sown on 20.11.2014 and each was replicated thrice (Table 10.8). The initial plant population counts indicated had no significant difference among all the treatments. The incidence of termite after three weeks of sowing ranged from 0.33 to 0.60, while in untreated plot it was 2.52. However, the incidence of termite after four weeks of sowing ranged from 0.36 to 0.61 while in untreated plot, it was 2.72 per cent. The incidence of termite after five weeks of sowing ranged from 0.38 to 0.71 per cent, while in untreated plot it was 2.63 per cent. Significantly less damaged shoots were recorded in treated plot fipronil 5SC @ 2.5 liter/ha, imidacloprid 600 FS @ 1.5 liter/ha, which was at par imidacloprid 17.8 per cent @ 500ml/ha and imidacloprid 600FS @ 1.0 liter/ha. It did not differ significantly from imidacloprid 17.8 per cent @ 400ml/ha and chlorpyriphos 20 EC @ 4.5 liter/ha.

All the insecticidal treatment showed superiority over untreated check in minimizing the per cent damage effective tillers. The number of effective tillers/ha in different treatments ranged from 3416.66 to 8766.66 while it was 14250.00 in untreated plots. The minimum damaged effective tillers/ha were recorded in fipronil 5SC @ 2.5 liter/ha and imidacloprid 600 FS @ 1.5 lier/ha treated plot followed by imidacloprid 17.8 per cent @ 500ml/ha and imidacloprid 600 FS @1.0 liter/ha. All the treatments showed minimum damaged number of effective tillers /ha as grain yield g/m row and q/ha was significantly higher in treated plot with fipronil 5SC @ 2.5 liter/ha and imidacloprid 600 FS @ 1.5 liter/ha followed by imidacloprid 17.8 per cent @ 500ml/ha and imidacloprid 600 FS @ 1.0 liter/ha. It is concluded that the insecticide fipronil 5SC @ 2.5 liter/ha and imidacloprid 600 FS @ 1.5 liter/ha were superior to imidacloprid 17.8 per cent @ 500ml, imidacloprid 600 FS @ 1.0 liter/ha, fipronil 5SC @ 3 liter, imidaclorpid 17.8 per cent SL @ 400ml and chlorpyriphos 4.5 liter/ha treated plots.

Centre: Vijapur

The experiment for the control of termite through seed treatment was carried out at Centre of Excellence for Research on Wheat, Vijapur under irrigated conditions and the results are summarized in Table 10.9.The plant population/m. row counts made after 3 weeks of sowing revealed non-significant differences among all the treatments. In confirmative test on germination, the counted no. of seeds of different treatments were sown separately in small replicated trial under field conditions also showed non-significant difference. Hence, none of the insecticidal treatments affected the seed germination. There was no termite damage noticed during 3, 4 & 5 weeks after sowing in all the treatments. The data on per cent damaged effective tillers per meter row showed no damage in bifenthrin and fipronil treatments which differed significantly from rest of the treatments. However, the untreated check had significantly highest termite damage. On the basis of number of damaged effective tillers/ha, the highest damage was recorded in untreated check. Whereas, lowest damage was recorded in bifenthrin and which was at par with fipronil. The grain yield on the basis of g/m row as well as q/ha were found non-significant. Amongst the insecticidal treatments it was the highest in bifenthrin treated plot. Fipronil was next in order of effectiveness.

Table10.6: Effect of insecticidal seed treatment on the germination, termite damage and yield during 2014-15 (Location: Durgapura)

S. No	Treatments	Dose g a.i./ ml/kg seed	Plant population/m row	Per cent damaged shoots/m row after 5 weeks	Per cent damaged effective tillers/m row at ear head stage	No. of damaged effective tillers/ha	Grain yield	
							g/m row	q/ha
1	Imidacloprid 600 FS Gaucho	0.72g (1.5 ml)	32.33a	0.06 (1.20)a*	0.50 (4.04)a*	4222 (65.00)a*	32.66a	32.00a
2	Chlorantranilipride 18.5 SC Coragen	0.185g (1.0 ml)	31.46a	0.26 (2.94)b	1.40 (6.79)b	15283 (123.33)b	26.00c	25.33c
3	Clothianidin 50WDG Dantosau	0.75g (1.5g)	30.66a	0.06 (1.20)a	0.56 (4.31)a	4917 (70.00)a	32.00a	30.66a
4	Thiamethoxam 35 FS Cruiser	0.7g (2.0 ml)	30.66a	0.13 (2.06)ab	0.66 (4.67)ab	7808 (88.33)a	29.33a	29.66a
5	Carbosulfan 25DS Marshal	1.0g (4.0 ml)	31.13a	0.46 (3.91)c	3.33 (10.51)c	20017 (153.33)c	24.66c	27.33b
6	Imidacloprid 17.8 % SL Confidor	0.6g (3.0ml)	31.26a	0.03 (0.60)a	0.63 (4.67)a	5208 (71.66)ab	31.00ab	31.00a
7	Fipronil 5% SC Regent	0.3g (6.0ml)	31.66a	0.03 (0.60)a	0.60 (4.43)a	4225 (66.66)a	32.00a	31.66a
8	Untreated		30.33a	5.06 (12.99)d	10.33 (18.75)d	62966 (250.00)d	20.00d	21.33d
	S. Em ±	-	0.55	0.49	0.20	7.36	0.82	0.65
	CD at 5%	-	NS	1.49	0.62	22.35	2.51	1.97

* Transformed values, Figures within parenthesis represent actual mean values; Figures with same alphabets are statistically at par

Date of sowing	: 02.12.2014	Plot size Gross	: 8 x 3 m	No. of rows/plot	: 10
Date of insecticidal application	: 01.12.2014	Net	: 7.5 x 2.5 m	Design	: RBD
Date of plant population counts	: 23.12.2014	Variety	: Raj 4229	Replication	: 3
Date of harvest	: 15.04. 2015	Condition	: Irrigated		

Table 10.7 : Effect of insecticidal seed treatment on germination, termite damage and yield during 2014-15 (Location: Ludhiana)

S. No	Treatments	Dose g a.i./ kg seed	Dose g or ml / Kg seed	Plant population/m row	Per cent damaged shoots/m row			Per cent damaged tillers/m row at ear head stage	No. of damaged effective tillers/ha	Grain yield	
					3 weeks	4 weeks	5 weeks			g/m row	q/ha
1	Imidacloprid 600 FS (Gaucho)	480	1.0 ml	53.96	0.64 (6.11)	0.57 (5.93)	0.50 (5.74)	0.55 (5.87)	7500 (86.44)	81.33	46.86
2	Imidacloprid 600 FS (Gaucho)	720	1.5 ml	51.20	0.48 (5.69)	0.47 (5.64)	0.49 (5.42)	0.47 (5.65)	6666 (81.49)	76.00	47.28
3	Imidacloprid 600 FS (Gaucho)	960	2.0 ml	52.63	0.44 (5.57)	0.39 (5.43)	0.37 (5.35)	0.38 (5.36)	6000 (77.38)	74.66	47.55
4	Clothianidin 50 WDS (Dantotsu)	0.75	1.5 g	52.96	0.45 (5.58)	0.41 (5.47)	0.32 (5.16)	0.38 (5.37)	6250 (79.03)	74.00	46.38
5	Chlorantranilipride 18.5 SC(Coragen)	0.185	1.0 ml	52.00	0.85 (6.66)	0.84 (6.62)	0.64 (6.14)	0.50 (5.73)	8000 (89.33)	71.33	45.28
6	Chlorantranilipride 18.5 SC(Coragen)	0.370	2.0 ml	51.86	0.65 (6.15)	0.59 (5.98)	0.49 (5.71)	0.43 (5.53)	7000 (83.55)	71.33	46.35
7	Fipronil 5 SC (Regent)	0.3	6.0 ml	52.13	0.64 (6.14)	0.60 (6.01)	0.52 (5.79)	0.53 (5.83)	7583 (86.88)	72.00	47.06
8	Untreated check	-	-	51.63	3.00 (10.78)	3.15 (11.01)	3.22 (11.12)	2.20 (9.45)	14833 (121.49)	66.00	44.25
	CD (p=0.05)			NS	(0.63)	(0.59)	(0.72)	(0.64)	(9.39)	NS	1.59

* Figures in parentheses are transformed means

Date of sowing	:	25.11.2014	Plot size	:	40 m^2
Date of insecticidal application	:	04.11.2014	Variety	:	PBW 660
Date of harvest	:	24.04.2015	Replications	:	Three

Table 10.8 : Effect of insecticidal seed treatment on germination termite damage and yield during 2014-15 (Location: Kanpur)

S. No	Treatments	Dose g a.i./ kg/ ha.	Plant population/m row	Per cent damaged shoots/m row			Per cent damaged effective tillers/m row at crop maturity	No. of damaged effective tillers/ha at harvest	Grain yield	
				3 weeks	4 weeks	5 weeks			g/m row	q/ha
1	Imidacloprid 600 FS (48%)	0.72	36.93	0.0 (0.284)	0.019 (2.538)	0.33 (3.214)	0.36 (3.450)	3526.66 (59.389)	69.02	28.42
2	Chlorantaniliprid(Coragen) 18.5 SC	0.370	38.80	0.0 (0.284)	0.50 (4.054)	0.66 (4.673)	0.54 (4.085)	5200.33 (72.103)	63.00	27.00
3	Clothianidin 50 WDG	0.75	34.70	0.0 (0.284)	0.32 (3.182)	0.39 (3.465)	0.36 (3.452)	3573.33 (59.524)	68.18	28.22
4	Thiamethoxam 70 WS	0.70	31.96	0.0 (0.284)	0.36 (3.452)	0.53 (4.176)	0.40 (3.594)	4416.66 (66.417)	65.58	28.00
5	Carbosulfan 25 DS	1.0	37.73	0.0 (0.284)	0.60 (4.458)	0.73 (4.918)	0.68 (4.706)	5358.71 (72.735)	61.08	26.63
6	Imidacloprid 17.8 %	0.6	36.56	0.0 (0.284)	0.67 (4.695)	0.70 (4.792)	0.70 (4.820)	5566.93 (74.606)	60.25	26.47
7	Fipronil 5 SC (regent)	0.3	34.63	0.0 (0.284)	0.43 (3.762)	0.60 (4.435)	0.53 (4.186)	5066.88 (71.177)	65.85	27.63
8	Untreated	-	36.36	1.02 (6.149)	2.16 (8.405)	2.86 (9.707)	2.94 (9.862)	15033.33 (122.606)	53.22	21.67
	S. Em ±	-	-	0.0912	0.327	0.346	0.316	0.958	2.719	0.288
	CD at 5%	-	-	0.260	0.991	1.062	0.395	2.963	5.004	0.878

* Ttransformed values, Figures within parenthesis represent actual mean values; Figures with same alphabets are statistically at par

Date of sowing : 20.11.2014
Date of insecticidal application : 19.11.2014
Date of plant population counts : 18.12.2014
Date of harvest : 12.04.2015
Irrigated/ Unirrigated : Unirrigated

Plot size Gross : 4 x 5m = 20 Sqm.
Design : R.B.D.
Variety : K8027
No. of rows/plot : 23
Replication : Three

Table-10.9: Effect of insecticidal seed treatment on germination termite damage and yield during 2014-15 (Location: Vijapur)

Sr. No.	Treatment	Dose g a.i./ kg seed	Plant population /m row length	Confirmative test for seed germination	Per cent damaged shoots/m row after sowing			% Damaged effective tillers/ m row	No. of damaged effective tillers/ha	Grain yield	
					3 week	4 week	5 week			G/m	q/ha
1.	Imidacloprid 48 % (Gaucho 600 FS)	0.72	56	90.00	0.00* (0.00)	0.00* (0.00)	0.00* (0.00)	3.53b* (0.39)	2374b** (12019)	71	31.52
2.	Clothianidin 50WDG (Dontotsu)	0.75	61	88.33	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	4.01b (0.51)	2533b (13462)	69	31.11
3.	Chlorantranilipride 18.5 SC (Coragen)	0.185	58	90.67	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	4.55b (0.63)	2803bc (16346)	67	28.57
4.	Chlorantranilipride 18.5 SC (Coragen)	0.37	60	91.00	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	3.94b (0.51)	2640bc (14904)	68	30.69
5.	Fipronil 5 SC (Regent)	0.3	61	89.33	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00a (0.00)	1841a (7212)	72	31.67
6.	Bifenthrin 10 % EC (Talstar)	0.2	62	89.00	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00a (0.00)	1538a (4968)	76	31.76
7.	Untreated Check	-	61	91.00	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	6.96c (1.48)	3113c (20192)	63	27.53
	S.Em.±		4	1.81	-	-	-	0.45	157	5	1.99
	C.D. at 5%		NS	NS	-	-	-	1.39	485	NS	NS
	C.V.%		-	-	-	-	-	-	-	11.54	11.34

* Figures followed within same column are Arcsin percentage transformation ** Figures followed within same column are square root transformation

Figures given in parenthesis are actual mean value Figures followed with same letter(s) are not differed statistically

Date of seed treatment : 22/11/2014 Date of sowing : 23/11/2014
Date of Plant population count : 10 /12/2014 Date of harvesting : 14 /03/2015
Design : R.B.D Replications : Three
Spacing : 20 cms between row No. of rows / plot : 12
Plot size : Gross : 14.0m x 2.40m Net : 13.0m x 1.60m Variety : GW 496 Condition : Irrigated

II: Management of termite damage through broadcasting of newer insecticides in standing wheat crop.

Centre: Ludhiana

This trial was also conducted under rainfed conditions at New Experimental Area, Department of Plant Breeding and Genetics, PAU, Ludhiana. The wheat variety PBW 660 was sown on 25th Nov, 2014 in the replicated trial in 40 sq. m. plots. The seeds treated with fipronil 5 SC were kept as standard check for comparing different treatments. The treated seed were dried overnight before sowing. There were eight treatments including broadcasting of fipronil 0.3 G granules at two different dosages, broadcasting of imidacloprid 600 FS at two different dosages, broadcasting imidacloprid 17.8 SL and fipronil 5 SC at one dose, and untreated check. Each treatment was replicated thrice. The different were broadcasted 3-4 weeks after emergence of seedling. For recording observations on the plant population and damage plants, five spots of 2 m row lengths each, were ear marked in each plot.

The observations on the termite damage at the seedling stage (Table 10.10) revealed that 3, 4 & 5 weeks after sowing, fipronil 0.3 G granules @ 35 kg/ha have lowest termite damage but it was at par with all other treatments except untreated control.

At ear head stage, the percent damaged effective tillers/m row were lowest (0.60) in fipronil 0.3 G @ 35 kg/ha and imidacloprid 17.8 SL @ 0.4 l/ha broadcasted plots. All the insecticides recorded significantly less percent damaged effective tiller/m row than untreated check. The number of damaged effective tillers/ha recorded were also lowest (6416) in imidacloprid 600 FS @ 1.0 lt/ha broadcast plots and fipronil 5 SC seed treated plots. All the treatments recorded significantly lower number of damaged effective tillers/ha than untreated check. Among different broadcasting treatments, grain yield (q/ha) obtained from was maximum (47.51) in imidacloprid 600 FS @ 1 l/ha treated plot. However, all treatments produced significantly higher grain yield than untreated check and were statistically at par with each other.

Centre: Durgapura

A trial was carried out at RARI, Durgapura, Jaipur under irrigated conditions for management of termite through broadcasting of newer insecticides those belong to the neonicotinoid group of insecticide in wheat standing crop. The different formulations of insecticides broadcasted at the time of termite infestation in standing wheat of crop for the management of termite damage were compared with fipronil 5% SC as seed treatment at 0.3 g a.i. /kg seed as it was kept a standard check for comparing the different treatments (Table 10.11). Three different doses of fipronil 0.3 G at 45, 52.5 and 60 g a.i. /ha, imidacloprid 600 FS at 480 and 720 g a.i. /ha and fipronil 5 % SC at 125 g a.i. /ha were applied in standing wheat crop along with recommended insecticide chlopyriphos at 1000 g a. i. / ha, all these insecticides were mixed with soil/ sand at 80-100 Kg /ha and then broadcasted evenly in the plots at the time of termite appearance at crown root stage of crop (CRI) followed by irrigation. For recording observations on the termite damage plant, five spots of 2-meter row length each were earmarked in each plot at ear head stage. No termite damage was recorded at 3 and 4 weeks of sowing. At 5 weeks of sowing the termite damage was negligible in fipronil 5 % SC at 0.3 g a.i. /kg seed and all treatments were at par with untreated check. The minimum percent damaged effective tillers / m row was lowest in fipronil 5 % SC at 0.3 g a.i. /kg seed applied as seed treatment, followed by broadcasting of imidacloprid 17.8% SL at 80g a.i./ha, fipronil 5% SC at 125 g a. i. / ha, fipronil 0.3 G at 60 g a. i./ha and imidacloprid 600 FS at 720 g a. i. / ha, followed by imidacloprid 600 FS at 480 g a. i. / ha , fipronil 0.3 G at 52.5 g a. i. /

ha and fipronil 0.3 G at 45 g a.i./ha. The recommended insecticide chlopyriphos was less effective as compared to other tested insecticides in protection as compared to maximum damaged in untreated check. On the basis of number of damaged effective tillers/ha showed that highest damage was recorded in untreated check. Whereas, the lowest damage was observed in the seed treatment of fipronil 5 % SC at 0.3 g a.i. /kg seed followed by broadcasting of fipronil 5 % SC at 125 g a. i. and imidacloprid 17.8%, fipronil 0.3 G at 60 g a. i. /ha imidacloprid 600 FS at 720 g a. i. / ha, followed lower dose of imidacloprid 600 FS at 480 g a. i. / ha. The chlopyriphos treatment was least effective against termite as compared to other treatments.

The grain yield data computed on q/ha basis revealed that the highest yield was obtained in fipronil 5 % SC at 0.3 g a.i. /kg seed (33.33), followed by Fipronil 5% SC at 125 g a.i. /ha, (31.66), imidacloprid 17.8% (30.99) at par with fipronil 0.3 G at 60 g a. i./ha (30.33) treatments broadcasted at the time of termite infestation Whereas, chlopyriphos treatment gave significantly higher yield (26.11) as compared to minimum yield (21.33 q/ha) in the untreated check. However, chlopyriphos treatment was least effective and gave poor protection as compared to newer tested insecticides applied as seed treatment and broadcasting in wheat standing crop. Overall the experiment showed that the seed treatment with fipronil 5 % SC at 0.3 g a.i. /kg seed was gave higher protection as compared to insecticides applied as broadcasting in wheat standing crop.

III: Management of termite damage through broadcasting of insecticides in standing wheat crop.

Centre: Vijapur

To test the efficacy of two different doses of fipronil 5 SC, one dose of imidacloprid 600 FS, two different doses of imidacloprid 17.8 % SL, three different doses of fipronil 0.3 G and one dose of Chlorpyriphos 20 EC as broadcasting for the control of termite in wheat crop, an experiment was conducted under irrigated conditions at Centre of Excellence for Research on Wheat, Vijapur. The application of insecticides was made on 15-12-2014. No termite damage was noticed up to 5 weeks after sowing in all the treatments. At ear head stage, per cent damaged effective tillers/m row was zero in broadcasting of fipronil 5 SC @ 125 and 80 g a.i./ha whereas, it was significantly the highest in untreated check. The number of damaged effective tillers/ha was significantly higher in untreated check as compared to insecticidal treatments. Among the insecticidal treatments, it was significantly less in broadcasting of fipronil 5 SC @ 80 g a.i./ha followed by broadcasting of fipronil 5 SC @ 125 g a.i./ha , imidacloprid 17.8 % SL @ 120 g a.i./ha, higher dose of fipronil 0.3 G @ 67.5 g a.i./ha, imidacloprid 17.8 % SL @ 80 g a.i./ha and imidacloprid 600 FS @ 480 g a.i./ha. The grain yield in g/m row as well as q/ha revealed non-significant differences among the treatments. Amongst the insecticidal treatment, broadcasting treatment of fipronil 5 SC @ 125 g a.i./ha had the highest grain yield as compared to rest of treatments (Table 10.12).

Centre: Kanpur

The experiment was conducted at Research Farm, Nawabganj, Kanpur, under irrigated condition in 23 rows of 4 x 5m in treated check sown on 20.11.2014 and each was replicated thrice (Table 10.13). The initial plant population counts indicated had no significant difference among all the treatments. The incidence of termite after three weeks of sowing ranged from 0.33 to 0.60 while in untreated plot it was 2.52. However, the incidence of termite after four weeks of sowing ranged 0.36 to 0.61

while in untreated plot 2.72 per cent. The incidence of termite after five weeks of sowing ranged from 0.38 to 0.71 per cent while in untreated plot 2.63 per cent. Significantly less damaged shoot were recorded in treated plot fipronil 5 SC @ 2.5 liter/ha, imidacloprid 600 FS @ 1.5 liter/ha, which was at par imidacloprid 17.8 per cent @ 500ml/ha and imidacloprid 600FS @ 1.0 liter/ha. It did not differ significantly imidacloprid 17.8 per cent @ 400ml/ha and chlorpyriphos 20 EC @ 4.5 liter/ha. All the insecticidal treatments showed superiority over untreated check in minimizing the per cent damage effective tillers. The number of effective tillers/ha in different treatments ranged from 3416.66 to 8766.66 while it was 14250.00 in untreated plots. The minimum damaged of effective tillers/ha were recorded fipronil 5 SC @ 2.5 liter/ha and imidacloprid 600 FS @ 1.5 litre/ha treated plot followed by imidacloprid 17.8 per cent @ 500ml/ha and imidacloprid 600 FS @1.0 liter/ha. All the treatments showed minimum damaged number of effective tillers /ha as grain yield g/m row and q/ha was significantly higher in treated plot with fipronil 5 SC @ 2.5 liter/ha and imicloprid 600 FS @ 1.5 liter/ha followed by imidacloprid 17.8 per cent @ 500ml/ha and imidacloprid 600 FS @ 1.0 liter/ha. It was concluded that the insecticide fipronil 5SC @ 2.5 liter/ha and imicloprid 600 FS @ 1.5 liter/ha were superior to imidacloprid 17.8 per cent @ 500ml, imidacloprid 600 FS @ 1.0 liter/ha, fipronil 5 SC @ 3 liter, imidaclorpid 17.8 per cent SL @ 400ml and chlorpyriphos 4.5 liter/ha treated plots.

Table 10.10: Management of termite damage through broadcasting of newer insecticides in standing wheat crop during 2014-15 (Centre: Ludhiana)

S.No.	Treatments	Dosage a.i./Kg seed	Dosage (L)/ha	Plant population/m row	Per cent damaged shoots/m row			Per cent damaged tillers/m row at earhead stage	No. of damaged effective tillers/ha	Grain yield	
					3 weeks	4 weeks	5 weeks			g/m row	q/ha
1	Fipronil 0.3 G	45	17.5	50.40	2.34 (9.69)	0.40 (5.44)	0.46 (5.63)	0.68 (6.22)	7416 (86.05)	71.33	47.80
2	Fipronil 0.3 G	90	35	50.16	2.29 (9.60)	0.30 (5.15)	0.36 (5.33)	0.60 (6.00)	7000 (83.60)	70.66	47.28
3	Imidacloprid 17.8 SL	80	0.4	49.80	2.32 (9.66)	0.48 (5.67)	0.44 (5.57)	0.60 (6.03)	7333 (85.50)	70.00	46.88
4	Fipronil 5 SC	125	2.5	49.46	2.32 (9.67)	0.31 (5.16)	0.45 (5.60)	1.05 (5.88)	6500 (80.61)	71.33	46.51
5	Imidacloprid 600 FS	480	1.0	50.59	2.22 (9.48)	0.32 (5.21)	0.47 (5.65)	1.09 (5.99)	6416 (80.10)	68.00	47.51
6	Imidacloprid 600 FS	720	1.5	49.83	2.27 (9.57)	0.29 (5.10)	0.44 (5.55)	1.03 (5.81)	6500 (80.56)	68.66	47.23
7	Fipronil 5SC (Seed treatment)	0.3 g a.i./kg seed	6 g/kg seed	49.66	0.41 (5.47)	0.34 (5.25)	0.36 (5.33)	0.44 (5.55)	6416 (80. 06)	66.66	48.03
8	Untreated check			50.60	2.33 (9.68)	2.24 (9.53)	2.20 (9.45)	1.66 (8.44)	9583 (97.87)	70.66	45.50
CD (p=0.05)				NS	(0.42)	(0.43)	(0.33)	(0.66)	(6.64)	NS	1.31

* Figures in parentheses are transformed means

Date of sowing	:	25.11.2014	Plot size	:	40 m^2
Date of insecticidal application	:	22.12.2014	Variety	:	PBW 660
Date of harvest	:	25.04.2015	Replications	:	Three

Table10.11: Management of termite damage through broadcasting of newer insecticides in standing wheat crop during 2014-15 (Location: Durgapura)

S. No	Treatments & Dose g a. i./ ha or L/ha	Per cent damaged effective shoot/m row at broadcasting	Per cent damaged effective tillers/m row at ear head stage	No. of damaged effective tillers/ha	Grain yield	
					q/ha	Increased Yield (q/ha) Over untreated
1	Fipronil 5% SC@ 125 g a. i./ ha or 2.5 L/ha (Regent)	3.30 (10.46)b*	5.00 (12.87)b	8281 (91.00)b	31.66b	10.33
2	Imidacloprid 600 FS @ 480 g a. i./ ha or 1.0 l/ha (Gauchau)	3.16 (10.30)b	7.43 (15.81)c	15625 (125.00)c	26.99d	5.66
3	Imidacloprid 600 FS @ 720 g a. i./ ha or 1.5 l/ha (Gauchau)	3.33 (10.51)b	5.50 (14.34)b	12100 (110.00)c	28.88c	7.55
4	Fipronil 0.3 G @ 45 g a. i./ha or 17.5 Kg/ha Broadcasted with Ist irrigation	3.33 (10.51)b	9.33 (17.78)c	24042 (155.00)c	23.99d	2.66
5	Fipronil 0.3 G @ 52.5 g a. i./ha or 20 Kg/ha Broadcasted with first irrigation	3.23 (10.56)b	8.60 (17.05)c	13242 (115.00)d	27.33c	6.00
6	Fipronil 0.3 G @ 60 g a. i./ha or 22.5 Kg/ha Broadcasted with first irrigation	3.46 (10.73)b	5.05 (12.96)b	9383 (96.66)c	30.33b	9.00
7	Imidacloprid 17.8 SL @ 80 g a.i./ha or 400 ml/ha	3.16 (10.78)b	5.02 (12.91)b	9042 (95.00)b	30.99b	9.66
8	Chlorpyriphos 20 EC @ 1000 g a. i./ ha or 5 L /ha (Lethal)	3.50 (10.25)b	11.00 (19.34)d	18242 (135.00)d	26.11d	4.78
9	Fipronil 5 Sc (Seed treatment) @ 0.3 g a.i./kg seed or 6ml /kg seed	0.13 (2.06)a	0.50 (4.04)a	4483 (66.66)a	33.33a	12.00
10	Untreated check	4.73 (12.46)b	14.30 (22.21)e	28917 (170.00)e	21.33e	-
	S.Em ±	0.40	0.50	3.67	0.51	-
	CD at 5%	1.20	1.48	10.90	1.52	-

* Transformed values, Figures within parenthesis represent actual mean values; Figures with same alphabets are statistically at par

Date of sowing	: 02.12.2014	Plot size Gross	: 8 x 3	No. of rows/plot	: 10
Date of insecticidal application	: 25.12.2014	Net	: 7.5 x2.5 m	Design	: RBD
Date of plant population counts	: 24.12.2014	Variety	: Raj - 4229	Replication	: 3
Date of harvest	: 15.04.2015	Condition	: Irrigated		

Table 10.12: Management of termite damage through broadcasting of insecticides in standing wheat crop during 2014-15 (Location: Vijapur)

Sr. No.	Treatment	Dose g a.i./ ha	Per cent damaged shoots/ m row after sowing			% Damaged effective tillers/ m row	No. of damage. EffeC.tillers/ha	Grain yield	
			3week	4 week	5 week			G/m	q/ha
1.	Fipronil 5 SC (Regent)	125	0.00* (0.00)	0.00* (0.00)	0.00* (0.00)	0.00*a (0.00)	2144**a (9615)	80	38.51
2.	Fipronil 5 SC (Regent)	80	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00a (0.00)	2140a (9615)	76	36.10
3.	Imidacloprid 48 % (Gaucho 600 FS)	480	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	4.36bc (0.60)	2386abcd (11859)	69	34.80
4.	Imidacloprid 17.8 % SL (Confidor)	120	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	3.58b (0.40)	2149ab (9776)	74	35.92
5.	Fipronil 0.3 G Broadcast with first irri.	52.5	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	4.65bc (0.66)	2519cd (13301)	66	32.23
6.	Fipronil 0.3 G Broadcast with first irri.	60	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	4.49bc (0.63)	2462bcd (12660)	69	32.77
7.	Fipronil 0.3 G Broadcast with first irri.	67.5	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	3.61b (0.40)	2216abc (10256)	73	35.58
8.	Imidacloprid 17.8 SL (Confidor)	80	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	3.84b (0.46)	2337abcd (11378)	71	35.26
9.	Chlorpyriphos 20 EC(Lethal) Check	1000	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	5.48c (0.93)	2541d (13462)	63	31.51
10.	Untreated check	-	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	7.39d (1.68)	3126e (20353)	61	31.28
	S.Em.±		-	-	-	0.42	106	5	2.16
	C.D. at 5%		-	-	-	1.25	316	NS	NS

* Figures followed within same column are Arcsin percentage transformation ** Figures followed within same column are square root transformation
Figures given in parenthesis are actual mean value, Figures followed with same letter(s) are not differed statistically
Date of sowing : 23/11/2014 Date of insecticide application : 15/12/2014, Date of harvesting : 14/03/2015 Design : R.B.D Replications : Three, Spacing: 20 cms between row No. of rows/plot : 12 Plot size : Gross : 14.0m x 2.40m Net: 13.0m x 1.60m Variety : GW 496 Condition : Irrigated

Table 10.13: Management of termite damage through broadcasting of insecticides in standing wheat crop during 2014-15 (Centre: Kanpur)

S. No	Treatments	Dose g a.i./ kg/ ha.	Plant population/m row	Per cent damaged shoots/m row			Per cent damaged effective tillers/m row at crop maturity	No. of damaged effective tillers/ha at harvest	Grain yield	
				3 weeks	4 weeks	5 weeks			g/m row	q/ha
1.	Fipronil 5 SC (Regent)	125	40.73	0.33 (3.380)	0.36 (3.452)	0.38 (3.559)	0.41 (3.669)	3416.66 (58.447)	78.49	39.75
2.	Fipronil 5 SC (Regent)	150	47.60	0.37 (3.513)	0.41 (3.669)	0.45 (3.859)	0.46 (3.882)	4450.00 (66.614)	77.26	38.16
3.	Imidacloprid 17.8% SL	80	41.00	0.57 (4.349)	0.58 (4.367)	0.69 (4.773)	0.71 (4.835)	7766.00 (88.115)	72.23	37.50
4.	Imidacloprid 17.8% SL	100	40.30	0.37 (3.513)	0.47 (3.976)	0.46 (3.876)	0.59 (4.410)	4291.66 (79.290)	77.23	38.91
5.	Imidacloprid 600 FS	480	45.66	0.50 (6.063)	0.52 (4.144)	0.61 (4.507)	0.67 (4.695)	7050.00 (83.953)	73.82	38.41
6.	Imidacloprid 600 FS	720	43.53	0.36 (3.379)	0.40 (3.619)	0.42 (3.710)	0.44 (3.799)	4386.66 (66.151)	77.76	39.25
7.	Chlorpyriphos 20EC	900	42.83	0.60 (4.453)	0.61 (4.472)	0.71 (4.831)	0.78 (5.062)	8766.66 (93.627)	73.16	36.25
8.	Untreated check	-	40.43	2.52 (9.140)	2.72 (9.318)	2.63 (9.341)	2.82 (9.673)	14250.00 (119.348)	67.44	30.02
	S. Em ±	-	-	0.136	0.164	0.140	0.089	1.614	1.015	0.628
	CD at 5%	-	-	0.408	0.509	0.416	0.280	4.894	3.078	2.406

* Transformed values, Figures within parenthesis represent actual mean values; Figures with same alphabets are statistically at par

Date of sowing	: 20.11.2014	Plot size Gross	: 4 x 5m = 20 Sqm.
Date of insecticidal application	: Broadcasting 1st Irri.	Design	: R.B.D.
Date of plant population counts	: 20.12.2014	Variety	: K0402
Date of harvest	: 20.04.2015	No. of rows/plot	: 23
Irrigated/ Unirrigated	: Irrigated	Replication	: Three

IV: Chemical control of foliage feeding wheat aphids.

Objectives:

The main purpose of conducting this experiment was to find out molecules belonging to new chemistry, which are more efficient, at lower doses and are less hazardous to environment than presently recommended molecules.

Methodology:

The experiment consisted of eight treatments was conducted at four locations viz. Ludhiana, Niphad, Pantnagar and Kanpur. The details of the treatments and their doses are given below:

S.No	Treatment	Dosage a.i. / ha
1	Confidor (Imidacloprid 200 SL)	20
2	Dantotsu (Clothianidin 50 WDS)	15
3	Fame (Flubendamide 480 SC)	20
4	Pride (Acetamiprid 20SP)	20
5	Actara (Thiamethoxam 25 WG)	12.5
6	Coragen (Chlorantranilipride 18.5 SC)	20
7	Crusier (Thiamethoxam 35 FS)	20
8	Rogor (Dimethoate 30 EC)	300
9	Control	-

Five tillers were tagged from each plot and the experiment was replicated three times. The aphids were counted from these tagged plants before spray and after spray to know the efficacy of each treatment. The grain yield was recorded to know the amount preventable losses by these treatments.

The findings of experiment from each location are as below:

Centre: Ludhiana

This trial was conducted under irrigated conditions at Plant Breeding Research Farm, PAU, Ludhiana. The wheat variety WH 1105 was sown on 6th Nov.2014 in the plots of 6 rows of 6m length in a replicated trial. Eight insecticides were sprayed when the aphid population reached at 4-5 aphids/earhead. There were total of nine treatments including untreated check and each was replicated three times. For recording observations, five shoots were ear marked in each plot and from these plants observations were recorded one day before spray and then 1, 2, 7 and 15 days after spray.

Aphid population did not differ significantly among all treatments one day before spray except seed treated plots where it was significantly lower than all other treatments (Table 10.14). When observed one day after spray, chlorantranilipride recorded minimum (1.60 aphids/earhead) and was at par with all other insecticidal treatments except untreated check (17.15 aphids/earhead). Two days after treatment, acetamiprid (0.79 aphids/earhead) recorded minimum aphid population and was at par with all other insecticidal treatments except dimethoate (1.37 aphids/earhead) and untreated check (17.44 aphids/earhead). Seven and fifteen days after spray, flubendamide was the best treatment, however it was at par with all other insecticidal treatment and better than untreated check.

Grain yield (q/ha) obtained was maximum from acetamiprid (57.51) treated plots followed by flubendamide (56.62) treated plots. However, all the insecticidal treatments recorded higher than grain yield than untreated check (52.08).

Centre: Niphad

All the insecticidal treatments were effective against aphids as they showed significantly lower aphids population than untreated control. At 1 day after spray, the plots treated with thiamethoxam 25 WG @ 12.5 g a.i./ha registered significantly minimum (1.83) number of aphids/shoot/plant as compared to rest of the treatments. It was followed by acetamiprid 20 SP @ 50g a.i./ha (2.16), imidacloprid 17.8 SL @ 20g a.i./ha (2.77) and clothianidin 50 WDG @ 15 g.a.i./ha (2.80). At 2 and 7 days after spray the treatment with imidacloprid 17.8 SL @ 20g a.i./ha, clothianidin 50 WDG @ 15 g.a.i./ha, acetamiprid 20 SP@ 50g a.i./ha and thiamethoxam 25 WG @ 12.5g a.i./ha and thiamethoxam 35 FS @ 70 g a.i./ha recorded cent per cent control of aphids. At 15 DAS, thiamethoxam 25 WG @ 12.5g a.i./ha recorded minimum number of 2.83 aphids/shoot/plant (Table 10.15).

In case of natural enemies the population of Chrysopa was recorded at the time of flowering. The maximum (1.93) number of Chrysopa was recorded in treatment with imidacloprid 17.8 SL @ 20g a.i./ha. The minimum 0.33 number of natural enemies was recorded in Chlorantraniliprole 18.5 SC @ 20 g.a.i/ha. Maximum yield of 64.78 q/ha was obtained in plots treated with clothianidin 50 WDG @ 15 g.a.i./ha which was at par with thiamethoxam 35 FS @ 70 g a.i./ha (64.23), acetamiprid 20 SP@ 20 g a.i./ha (62.35 q/ha), thiamethoxam 25 WG @ 12.5g a.i./ha (62.40) and imidacloprid 17.8 SL @ 20g a.i./ha (61.26) as against lowest in control plot (36.54 q/ha).

Centre: Pantnagar

The data on the mean aphid population demonstrated the efficacy of different chemicals against foliage aphids on wheat with non-significant differences in aphid population before Ist spray which ranged from 20.33 /shoot to 27.33/shoot. After first day of Ist spraying significantly less aphid population (9.73/shoot) was counted followed by Dantatsu (9.80/shoot), Acetamiprid 20 SP (10.40/shoot) Flubendamide 480SG (10.93/shoot) and whereas among the all treatments, the highest mean aphid population was counted on Dimethoate 30EC (13.33/shoot) followed by Thiamethoxam 25 WG (11.67/shoot), Coragen @20g (10.93/shoot), Imidacloprid 17.8 SL (11.13/shoot), in comparison to untreated control (22.06/shoot). On second day after spray, the significantly lowest mean aphid population was observed in Clothianidin 50 WDG (6.53 /shoot) followed by Imidacloprid 17.8 SL (07.47/shoot) in comparison to highest mean aphid population in Thiamethoxam 25 WG (16.80/shoot) and untreated control (26.67/shoot). After 7 days of spraying, significant difference in population of foliage aphid was observed in Clothianidin 50 WDG (1.67/shoot) followed by Imidacloprid 17.8 SL (3.73/shoot), Flubendamide 480 SG (3.47/shoot), Acetamiprid 20 SP (6.00/shoot) and Coragen 18.5 SC 40g (8.47/shoot) with significantly highest aphid population in Coragen 18.5 SC @ 20g (17.47/shoot) Dimethoate 30EC (17.33/shoot) and Untreated control (29.40/shoot). After fifteen days of spraying, significantly lowest mean aphid population was recorded on Clothianidin 50WDG (4.13/shoot) followed by Imidacloprid 17.8 SL (4.80/shoot), Thiamethoxam 25 WG (6.67/shoot) and Acetamiprid 20 SP (08.67/shoot) whereas among the other treatments the mean aphid population was ranged from 13.40/shoot to 16.67/shoot with significantly highest aphid population in untreated control (27.33/shoot) (Table 10.16).

The population of natural enemies were also observed after 7 days of spraying, nut no population of natural enemies was observed in plots sprayed with Imidacloprid 17.8 SL, Clothianidin 50 WDG, Flubendamide 480 SG, Acetamiprid 20 SP, Thiamethoxam 25 WG and Chlorantranilipride (Coragen) 18.5 SC @ 40g whereas very less population of natural enemies was observed in Chlorantranilipride (Coragen) 18.5 SC @ 2 (0.13/m2) and Dimethoate 30EC (0.27/ m2) with significantly highest population of natural enemies in untreated control (1.13/ m2). Fifteen days after spraying, the population of natural enemies was found highest in Dimethoate

30EC (0.40/ m2) whereas on the other insecticides population ranged from (0.13 to 0.33/ m2) with the highest natural enemy population in untreated control (1.47/ m2) The highest grain yield was obtained in Coragen 18.5 SC@ 20g (32.47 q/ha), Thiamethoxam 25 WG and Imidacloprid 17.8 SL (31.40 q/ha) followed by Acetamiprid 20 SP (31.40 q/ha), Flubendamide 480 SG (29.61 q/ha), Clothianidin 50 WDG (29.23 q/ha), Dimethoate 30 EC (25.71 q/ha), in comparison to untreated control (24.38 q/ha).

Centre: Karnal

Aphid population did not differ significantly among all treatments one day before spray. When observed one day after spray, Confidor (Imidacloprid 17.8 SL) recorded minimum (4.60 aphids/shoot/earhead/plant) number of aphids and it was significantly superior over all other treatments and untreated check (35.27 aphids/shoot/earhead/plant). Two days after treatment, Confidor (Imidacloprid 17.8 SL) (1.40 aphids/shoot/earhead/plant) again recorded minimum aphid population and it was significantly superior over other treatments except Rogar (Dimethoate 30 EC) and Chlorantranilipride 18.5 SC(Coragen) in comparision to untreated check(40.00 aphids/shoot/earhead/plant). Seven days after spray, Flubendamide (Fame 480 SC) recorded minimum aphid population (1.00 aphids/shoot/earhead/plant) followed by Confidor (Imidacloprid 17.8 SL), Actara (Thiamethoxam 25 WG) and Dantotsu (Clothianidin 50 WDG) and was at par with rest of the insecticidal treatments. Fifteen days after spray, again flubendamide(Fame 480 SC) , Confidor (Imidacloprid 17.8 SL), Dantotsu (Clothianidin 50 WDG) and Actara (Thiamethoxam 25 WG) recorded 0.00 aphids/shoot/earhead/plant and proved significantly superior to all other treatments in comparison to untreated check (34.00 aphids/shoot/earhead/plant) (Table-10.17). Grain yield (q/ha) obtained was maximum in flubendamide (Fame 480 SC) (49.26 q/ha) treated plots followed by Dantotsu (Clothianidin 50 WDG)(48.80 q/ha) treated plots. All the insecticidal treatments recorded higher yields as compared to untreated check (36.93 q/ha).

Centre: Kharibari

This trial was conducted under irrigated conditions at Regional Research sub-station (Terai Zone) UBKV, Kharibari, Darjeeling. The wheat variety Sonalika was sown on 1st December'2014 in the plots of 6 rows of 6m length in a replicated trial. Eight insecticides were sprayed at two times when the aphid population reached at 9-10 aphids/earhead. There were total of nine treatments including untreated check and each treatment was replicated three times. For recording observations, five shoots were ear marked in each plot and from these plants observations were recorded one day before spray and then 1, 2, 7 and 15 days after spray.

Aphid population did not differ significantly among all treatments 15 days before spray except seed treated plots where it was significantly lower than all other treatments. When observed one day after spray, Clothianidin 50 WDG recorded minimum (0.70 and 0.00 aphids/earhead) and was at par with all other insecticidal treatments except Chlorantraniliprid 18.5 SC (20.67 and 14.78 aphids/earhead) and untreated check (100.50 and 155.45 aphids/earhead). Grain yield (q/ha) obtained was maximum from Clothianidin 50 WDG (35.93) treated plots followed by flubendamide (35.73) treated plots. However, all the insecticidal treatments recorded higher than grain yield than untreated check (28.44) (Table-10.18).

Table 10.14: Chemical control of foliage feeding aphid on wheat during 2014-15 (Location: Ludhiana)

S. No.	Treatments	Dose ml or g / ha	Dosages (g a.i./ha)	Aphid population per earhead					Grain Yield (q/ha)
				Before spray	After spray				
				1 day	1 day	2 days	7 days	15 days	
1	Confidor (Imidacloprid 200 SL)	100 ml	20	21.13 (4.70)	1.82 (1.67)	1.04 (1.42)	0.68 (1.29)	0.46 (1.20)	55.64
2	Dantotsu (Clothianidin 50 WDS)	30 gm	15	18.93 (4.46)	1.76 (1.66)	0.90 (1.37)	0.58 (1.25)	0.38 (1.17)	55.82
3	Fame (Flubendamide 480 SC)	250 ml	20	19.70 (5.54)	1.62 (1.61)	0.87 (1.36)	0.49 (1.22)	0.29 (1.13)	56.62
4	Pride (Acetamiprid 20SP)	100 gm	20	18.90 (4.44)	1.62 (1.61)	0.79 (1.33)	0.47 (1.21)	0.27 (1.12)	57.51
5	Actara (Thiamethoxam 25 WG)	50 gm	12.5	19.53 (4.52)	1.71 (1.64)	0.91 (1.38)	0.64 (1.27)	0.41 (1.18)	56.00
6	Coragen (Chlorantranilipride 18.5 SC)	100 ml	20	20.06 (4.58)	1.60 (1.61)	0.87 (1.36)	0.46 (1.21)	0.32 (1.15)	56.00
7	Rogor (Dimethoate 30 EC)	375 ml	300	19.13 (4.48)	1.96 (1.72)	1.37 (1.53)	0.82 (1.34)	0.53 (1.23)	55.02
8	Control	-	-	19.76 (4.55)	17.15 (4.25)	17.44 (4.29)	16.51 (4.17)	11.49 (3.53)	52.08
	CD (p=0.05)			(NS)	(NS)	(0.15)	(0.13)	(0.18)	(0.17)

* Figures within parentheses are transformed means

Date of sowing	:	06.11.2014	Plot size	:	7.5 m^2
Date of insecticidal application	:	03.03.2014	Variety	:	WH 1105
Date of harvest	:	25. 04.2015	Replications	:	Three

Table 10.15: Chemical control of foliage feeding aphid on wheat during 2014-15 (Location: Niphad)

SN	Treatment details	Dose g a.i./ha	Av. Population of survived foliage feeding wheat aphids per shoot.					Yield q/ha	Population of N. Enemies/ m^2 at 15 DAS
			Pre count	1DAS	2DAS	7DAS	15DAS		
1	Imidacloprid 200 SL	20	49.87 (7.13)	2.77 (1.94)	0.0 (1.00)	0.0 (1.00)	4.26 (2.29)	61.26	1.93 (1.71)
2	Clothianidin 50 WDG	15	49.67 (7.12)	2.80 (1.95)	0.0 (1.00)	0.0 (1.00)	3.63 (2.15)	64.78	1.97 (1.72)
3	Flubendamide 480 SC	20	49.20 (7.08)	18.23 (4.38)	6.73 (2.78)	8.16 (3.03)	20.43 (4.63)	52.75	0.93 (1.39)
4	Acetamiprid 20 P	20	49.60 (7.11)	2.16 (1.78)	0.0 (1.00)	0.0 (1.00)	3.70 (2.17)	62.35	1.67 (1.63)
5	Thiamethoxam 25 WG	12.5	49.47 (7.10)	1.83 (1.68)	0.0 (1.00)	0.0 (1.00)	2.83 (1.96)	62.40	1.80 (1.67)
6	Chlorantranilipride 18.5 SC	20	51.00 (7.21)	20.36 (4.62)	10.90 (3.45)	11.80 (3.58)	31.29 (5.68)	50.61	0.33 (1.15)
7	Thiamethoxam 35 FS	70	50.07 (7.15)	4.90 (2.43)	0.0 (1.00)	0.0 (1.00)	4.76 (2.40)	64.23	1.53 (1.59)
8	Dimethoate 30 EC	300	50.60 (7.18)	21.43 (4.74)	6.66 (2.77)	10.60 (3.40)	29.93 (5.56)	52.02	1.63 (1.62)
9	Untreated control	-	50.13 (7.15)	104.33 (10.26)	128.93 (11.40)	160.53 (12.71)	154.66 (12.48)	36.54	0.93 (1.39)
	SE ±		**0.05**	**0.03**	**0.01**	**0.03**	**0.06**	**3.06**	**0.03**
	CD at 5%		**NS**	**0.10**	**0.04**	**0.09**	**0.17**	**9.18**	**0.09**

DAS- Days After spray, figures in parentheses indicate V_{n+1} transformed value,
Date(s) of Insecticidal application : (i) 24/12/2014 (ii) 08/01/2015 Date of Harvest : 24/03/2015

Table 10.16: Chemical control of foliage feeding aphid on wheat during 2014-15 (Location: Pantnagar)

S.No.	Treatments	Dosage g a.i./ha	Mean Population of survived foliage feeding wheat aphids/ shoot/plant					Population of natural enemies/m^2		1000 grain weight (gm)	Grain Yield (q/ha)
			Pre Spray	I st spray				7 DAS	15 DAS		
				I DAS	2 DAS	7 DAS	15 DAS				
1.	Confidor (Imidacloprid 17.8 SL)	20ml	21.13 (4.70)	10.73 (3.42)	07.47 (2.91)	03.73 (2.17)	04.80 (2.41)	0.00 (1.0)	0.20 (1.10)	42.17 (6.57)	31.42 (5.69)
2.	Dantatsu (Clothianidin 50 WDG)	15g	22.07 (4.80)	09.80 (3.29)	06.53 (2.74)	01.67 (1.63)	04.13 (2.26)	0.00 (1.00)	0.27 (1.13)	41.57 (6.52)	29.23 (5.50)
3.	Flubendamide (Fame 480 SG)	20g	21.20 (4.71)	10.93 (3.45)	11.13 (3.48)	03.47 (2.11)	15.60 (4.07)	0.00 (1.00)	0.20 (1.10)	42.26 (6.58)	29.61 (5.53)
4.	Pride (Acetamiprid 20SP)	20ml	21.00 (4.69)	10.40 (3.38)	11.67 (3.56)	06.00 (2.65)	08.67 (3.11)	0.00 (1.00)	0.13 (1.10)	41.90 (6.55)	31.40 (5.70)
5.	Actara (Thiamethoxam 25 WG)	12g.5	20.33 (4.62)	11.67 (3.56)	16.80 (4.22)	09.00 (3.16)	06.67 (2.77)	0.00 (1.00)	0.00 (1.00)	41.36 (6.51)	31.42 (5.70)
6.	Chlorantranilipride 18.5 SC (Coragen)	20g	21.47 (4.74)	10.93 (3.45)	16.60 (4.19)	17.60 (4.31)	13.40 (3.80)	0.13 (1.06)	0.33 (1.15)	42.80 (6.62)	32.47 (5.78)
7.	Chlorantranilipride 18.5 SC (Coragen)	40g	20.53 (4.64)	09.73 (3.28)	07.80 (2.97)	08.47 (3.08)	15.27 (4.03)	0.00 (1.00)	0 .13 (1.06)	41.61 (6.53)	24.95 (5.09)
8.	Rogor (Dimethoate 30 EC	300ml	21.60 (4.75)	13.33 (3.79)	14.20 (3.90)	17.33 (4.28)	16.67 (4.20)	0.27 (1.13)	0.40 (1.18)	41.45 (6.52)	25.71 (5.17)
9.	Untreated Control	-	27.33 (5.32)	22.06 (4.80)	26.67 (5.26)	29.40 (5.51)	27.33 (5.32)	1.13 (1.46)	1.47 (1.57)	41.40 (6.51)	24.38 (5.04)
	SEm		0.60 (0.36)	0.35 (0.02)	0.33 (0.03)	0.25 (0.03)	0.23 (0.03)	0.07 (0.003)	0.10 (0.002)	0.54 (0.05)	0.46 (0.04)
	CD 5%		NS	1.04 (0.07)	1.00 (0.09)	0.74 (0.08)	0.68 (0.09)	0.19 (0.009)	0.30 (0.007)	1.63 (0.16)	1.38 (0.12)

*Figures in parenthesis are angular transformed values

Date of sowing : 03/12/2014 Plot size : 10.5 sq. m Date of Harvest : 25/04/2015

Date of I[st] Insecticidal application: 10/02/2015 Variety sown : PBW 343 Replications : Three

Table 10.17: Chemical control of foliage feeding aphid on wheat during 2014-15(Location: Karnal)

S. No.	Treatments	Dosage (g a.i./ha.)	Aphid population per shoot					Grain yield (q/ha)
			Before spray	After Spray				
				1 Day	2 Day	7 Day	15 Day	
1	Confidor (Imidacloprid 17.8 SL)	20 ml	32.13 (5.76)	4.60 (2.36)	1.40 (1.55)	1.13 (1.46)	0.00 (1.00)	45.88
2	Dantotsu (Clothianidin 50 WDG)	15 g	29.67 (5.53)	7.80 (2.96)	1.93 (1.69)	1.80 (1.67)	0.00 (1.00)	48.80
3	Flubendamide (Fame 480 SC)	20 g	28.00 (5.38)	7.00 (2.83)	2.40 (1.84)	1.00 (1.41)	0.00 (1.00)	49.26
4	Pride (Acetamiprid 20SP)	20	28.87 (5.46)	6.80 (2.79)	2.60 (1.89)	2.00 (1.72)	2.73 (1.93)	43.84
5	Actara (Thiamethoxam 25 WG)	12.5	31.07 (5.66)	7.27 (2.87)	1.53 (1.59)	1.40 (1.55)	0.00 (1.00)	44.59
6	Chlorantranilipride 18.5 SC(Coragen)	20 g	30.20 (5.58)	8.60 (3.10)	6.73 (2.77)	5.60 (2.57)	7.20 (2.86)	40.43
7	Rogar (Dimethoate 30 EC)	300	28.53 (5.43)	6.80 (2.79)	5.20 (2.46)	2.60 (1.90)	5.60 (2.56)	41.97
8	Untreated check	-	30.93 (5.65)	35.27 (6.02)	40.00 (6.39)	37.67 (6.21)	34.00 (5.91)	36.93
S.Em±			0.17	0.09	0.17	0.09	0.08	2.39
CD at 5%			NS	0.27	0.52	0.29	0.23	7.23

Figures in parentheses indicate V_{n-1} transformed value

Date of sowing : 16-11-2014
Date of insecticide application : 22-02-2015
Date of harvest : 18-04-2015

Plot size : Six row of six meter length at 25 cm spacing
Variety : H D 2967
Replication: Three

Table 10.18 : Chemical Control of foliage feeding aphids on wheat during 2014-15 (Location: Kharibari, West Bengal)

	Name of Treatment	Dose gm/ml/lt.	Before spray Population	Mean no. population of survived foliage feeding wheat aphids/shoot/plant									Grain Yield (qt/ha)
				I st Spray				Before spray Population	II nd Spray				
				1 DAT	2 DAT	7 DAT	15 DAT		1 DAT	2 DAT	7 DAT	15 DAT*	
1.	Confidor (Imidacloprid 17.8 SL)	100	88.67 (9.44)	75.37 (8.71)	5.67 (2.48)	0.00 (0.71)	0.45 (0.97)	20.26 (4.56)	10.80 (3.36)	4.60 (2.26)	0.00 (0.71)	0.50 (1.00) **	35.00
2.	Dantotsu (Clothianidin 50 WDG)	30	95.57 (9.80)	65.50 (8.12)	5.25 (2.40)	0.00 (0.71)	0.70 (1.10)	15.30 (3.97)	7.90 (2.90)	2.10 (1.61)	0.00 (0.71)	0.00 (0.71)	35.93
3.	Flubendamide (Fame 480 SC)	250	80.67 (9.01)	70.45 (8.42)	5.76 (2.50)	0.00 (0.71)	0.48 (0.99)	18.25 (4.33)	8.90 (3.07)	5.60 (2.47)	0.50 (1.00)	0.10 (0.77)	35.73
4.	Pride (Acetamiprid 20SP)	100	90.25 (9.53)	78.75 (8.90)	5.45 (2.44)	0.00 (0.71)	0.75 (1.12)	22.16 (4.76)	12.25 (3.57)	8.60 (3.02)	2.10 (1.61)	1.00 (1.22)	32.43
5.	Actara (Thiamethoxam 25 WG)	50	80.77 (9.01)	60.35 (7.80)	8.76 (3.04)	0.00 (0.71)	1.86 (1.54)	20.50 (4.58)	12.50 (3.61)	7.50 (2.83)	3.10 (1.90)	1.50 (1.41)	33.91
6.	Chlorantranilipride 18.5 SC(Coragen)	100	86.93 (9.35)	60.25 (7.79)	10.15 (3.26)	15.55 (4.01)	20.67 (4.60)	35.65 (6.01)	22.60 (4.81)	15.70 (4.02)	10.56 (3.33)	14.78 (3.91)	33.98
7.	Thiamethoxam 35 FS (Crusier)	20	80.35 (8.99)	75.89 (8.74)	5.75 (2.50)	0.00 (0.71)	1.10 (1.26)	19.10 (4.43)	10.40 (3.30)	6.56 (2.66)	2.10 (1.61)	0.45 (0.97)	30.87
8.	Rogar (Dimethoate 30 EC)	1000	90.36 (9.53)	65.86 (8.15)	25.67 (5.12)	0.00 (0.71)	3.90 (2.10)	22.90 (4.84)	15.60 (4.01)	7.90 (2.90)	1.50 (1.41)	0.20 (0.84)	31.60
9.	Untreated Control	-----	86.67 (9.34)	88.23 (9.42)	90.56 (9.54)	93.56 (9.70)	100.50 (10.05)	120.45 (11.00)	128.90 (11.38)	134.60 (11.62)	145.70 (12.09)	155.45 (12.49)	28.44
	S.Em±	____	0.75	0.65	0.38	0.30	0.42	0.45	0.33	0.34	0.22	0.26	
	C.D at 5%level	____	2.23	1.91	1.14	0.88	1.25	1.32	0.96	1.00	0.64	0.78	

*DAT- Days After Treatment, ** Figures in parenthesis are Square root transformed value,

Date of Sowing: 01.12.14

Plot size: Six rows of 6meters length at 25cm apace

Date of Insecticide Application: 02-02-15 and II[nd] 25-02-15

Variety: Sonalika

Date of harvest: 23-04-15

Replication: Three

V: Biorationals for the management of foliage feeding aphids

Objectives:

(1) To identify the promising botanicals and bio-agents for management of foliar aphids of wheat

(2) To manage aphids on wheat by eco-friendly used products.

(3) To reduce indiscriminate use of chemical insecticides.

Treatment details:

1. Neem Seed Extract (NSE)	5 %
2. *Azadirahctin* 1500 ppm	3.0 ml/l
3. Vekhand powder (*Acorus calamus*)	5 g/l
4. *Verticillium lecanni* (2 x 10^8c.f.u)	3 g/l
5. *Beauveria bassiana* (2 x 10^8c.f.u)	5 g/l
6. *Metarhizium anisopliae*	3 g/l
7. Dimethoate 30EC	0.3ml/l
8. Untreated control	

Centre: Pantnagar

After one day of first spray the significantly lowest mean aphid population was recorded in chemical treatment i.e. Dimethoate 30 EC(11.67/shoot) whereas in other treatments the data were not significantly different. The lowest mean aphid population was observed in Azadirachtin (18.33/shoot) followed by *Verticillium lecanni* (18.53/shoot), *Beauveria bassiana* (19.33/shoot) with highest mean aphid population in untreated control (23.73/shoots). After second day spraying, the significant difference in mean aphid population was observed in Dimethoate 30 EC (8.60/shoot) whereas no significant difference was found among the other botanicals and bioagent treatments where mean aphid population ranged from 16.27/shoot to 20.53/shoot. After seven days of spraying, again lowest aphid population was observed in Dimethoate 30EC (8.00/shoot) whereas among the biorationals sprays the lowest mean aphid population was counted in *Beauveria bassiana* (13.27/shoot) followed by *Metarhizium anisopliae* (14.87/shoot). After fifteen days of spraying, the mean population of aphids ranged from 13.27/shoot to 23.60/shoot among the biorationals with again lowest aphid population in Dimethoate 30 EC (14.27/shoot in comparison to untreated control (21.27/shoot).

The population of natural enemies ranged from 0.33 to 0.87/m^2 and 1.07-1.73/m^2 among the biorationals after seven and fifteen days of spraying in comparison to untreated control where population of natural enemies was (1.20 and 2.40/m^2) (Table-10.19).

The grain yield clearly revealed the efficacy of biorationals with highest grain yield in NSE @ 5 % (30.85q/ha) followed by Azadirachtin @ 1500 ppm (30.57q/ha), M. anisopliae (29.14q/ha), V. lecanni (28.95q/ha), *B. bassiana* (26.95 q/ha) and Vekhand powder (25.53 q/ha) in comparison to chemical Dimethoate @ 30EC (25.80 q/ha) and untreated control (23.51 q/ha).

Centre: Karnal

The data from (Table 10.20) revealed that the treatment of *Metarhizium anisopliae* @ 3 g/l recorded significantly lowest (19.73) population of aphids/shoot/plant followed by spraying of *Beauveria bassiana* (2 x 108c.f.u) @5 g/l (22.40) at 1 day after spraying. At 2 DAS, treatment with *Metarhizium anisopliae* (2 x 108 cfu) @ 3g/l again recorded lowest (14.13) population of aphid/shoot/plant followed by *Verticillium lecanni* (2 x 108c.f.u) @ 3g/l (15.20). At 7 and 15 DAS, the same trend of efficacy was observed.

The untreated control plots recorded maximum number of 34.00, 34.67, 26.13 and 25.40 aphids/shoot/earhead/plant at 1, 2, 7 and 15 days after first spray, respectively. The plots treated with dimethoate 30 EC 0.3 ml/l registered significantly minimum number of aphids as compared to rest of the treatments at 1, 2, 7 and 15 days after spray.

The significant yield differences were observed in treated plots. Among the treated plots, *Metarhizium anisopliae* (2 x 108cfu) @ 3g/l recorded highest yield of 46.82 q/ha which was at par with all other tested botanicals. Lowest yield was observed from untreated control plot (35.15 q/ha).

Centre: Kharibari

This trial was conducted under irrigated conditions at conditions at Regional Research sub-station (Terai Zone) UBKV, Kharibari, Darjeeling. The wheat variety Sonalika was sown on 10th December'2014 in the plots of 6 rows of 6m length in a replicated trial. Seven treatments were sprayed at two times when the aphid population reached at 8-9 aphids/earhead. There were total of eight treatments including untreated check and each was replicated three times. For recording observations, fifteen shoots were ear marked in each plot and from these plants observations were recorded one day before spray and then 1, 2, 7 and 15 days after spray.

Aphid population did not differ significantly among all treatments one day before spray. When observed on 1st and 15th days after spray, *Metarhizium anisopliae* recorded minimum (22.16 & 4.50) aphids/earhead and it was significantly lower as compared to other insecticidal treatments.

Grain yield (q/ha) obtained was maximum (31.84) from *Beaveria bassiana* (2 x 108c.f.u) treated plots and was significantly better than all biorational methods of management of wheat aphids (Table 10.21).

Table 10.19: Eco-friendly management of foliage feeding aphids on wheat 2014-15 (Centre: Pantnagar)

S.No.	Treatments	Dosage g a.i./ha	Aphid population per shoot					Population of natural enemies/m²		Grain Yield (q/ha)
			Before Spray	After I st spray						
			1 day	1day	2days	7days	15 days	7DAS	15DAS	
1.	Neem seed Extract (NSE)	5%	24.87 (5.09)	20.60 (4.65)	16.27 (4.16)	18.73 (4.44)	15.40 (4.05)	0.87 (1.37)	1.20 (1.48)	30.85 (5.64)
2.	Azadirachtin 1500 ppm	3.0 ml/l	24.07 (5.01)	18.33 (4.40)	17.53 (4.30)	16.40 (4.17)	16.80 (4.22)	0.82 (1.35)	1.07 (1.44)	30.57 (5.62)
3.	Vekhand Powder (*Acorus calamus*)	5g/l	21.67 (4.76)	22.33 (4.83)	20.53 (4.64)	20.60 (4.65)	23.60 (4.96)	0.47 (1.21)	1.40 (1.55)	25.33 (5.13)
4.	*Verticillium lecanni* ($2x10^8$ c.f.u.)	3g/l	20.53 (4.64)	18.53 (4.42)	17.80 (4.34)	16.40 (4.17)	13.27 (3.78)	0.33 (1.15)	1.20 (1.48)	28.95 (5.47)
5.	*Beauveria bassiana* (2x108 c.f.u.)	5g/l	23.17 (4.92)	19.33 (4.51)	16.80 (4.22)	13.27 (3.78)	17.87 (4.34)	0.40 (1.18)	1.07 (1.44)	26.95 (5.29)
6.	*Metarhizium anisopliae*	3g/l	22.67 (4.86)	20.40 (4.61)	17.47 (4.30)	14.87 (3.98)	14.80 (3.97)	0.60 (1.26)	1.73 (1.65)	29.14 (5.49)
7.	Dimethoate 30 EC	0.3ml/l	23.53 (4.95)	11.67 (3.56)	08.60 (3.10)	08.00 (3.00)	11.00 (3.46)	0.53 (1.24)	0.60 (1.26)	25.80 (5.18)
8.	Untreated control	-	21.77 (4.77)	23.73 (4.97)	25.47 (5.14)	26.13 (5.21)	21.27 (4.72)	1.20 (1.48)	2.40 (1.84)	23.51 (4.95)
SEm			1.47 (0.04)	0.39 (0.03)	0.51 (0.03)	0.29 (0.04)	3.45 (0.02)	0.15 (0.003)	0.22 (0.007)	0.49 (0.03)
Cd 5%			NS	1.09 (0.11)	1.55 (0.09)	0.88 (0.11)	0.47 (0.07)	0.45 (0.01)	0.67 (0.02)	1.49 (0.09)

*Figures in parenthesis are angular transformed values

Date of sowing :03/12/2014 Plot size : 10.5 sq. m Date of Harvest : 25/04/2015

Dates of insecticidal applications : 10/02/2015 Variety sown : PBW 343 Replications : Three

Table 10.20: Eco-friendly management of foliage feeding aphids on wheat during 2014-15 (Centre: Karnal)

S. No.	Treatments	Dose ml or g/ ha	Aphid population per shoot					Grain yield (q/ha)
			Before spray	After Spray				
				1 Day	2 Day	7 Day	15 Day	
1.	*Azadirahctin* 1500 ppm	3.0 ml/l	34.93 (5.99)	26.00 (5.19)	20.80 (4.66)	13.40 (3.79)	16.00 (4.12)	43.12
2.	Vekhand powder (*Acorus calamus*)	5 g/l	33.93 (5.91)	31.73 (5.72)	25.00 (5.10)	21.60 (4.74)	22.67 (4.86)	43.44
3.	*Verticillium lecanni* (2 x 10^8c.f.u)	3 g/l	33.27 (5.85)	24.40 (5.04)	15.20 (4.02)	9.67 (3.26)	12.33 (3.65)	45.55
4.	*Beaveria bassiana* (2 x 10^8c.f.u)	5 g/l	32.93 (5.82)	22.40 (4.84)	20.60 (4.64)	10.60 (3.40)	14.67 (3.96)	40.99
5.	*Metarhizium anisopliae*	3 g/l	37.27 (6.18)	19.73 (4.55)	14.13 (3.89)	6.93 (2.81)	12.00 (3.60)	46.82
6.	Dimethoate 30 EC	0.3ml/l	33.27 (5.85)	13.40 (3.79)	7.40 (2.89)	10.40 (3.37)	22.80 (4.87)	41.40
7.	Untreated control	-	34.60 (5.97)	34.00 (5.91)	30.67 (5.63)	26.13 (5.21)	25.40 (5.14)	35.15
S.Em±			0.12	0.10	0.14	0.13	0.14	1.90
CD at 5%			NS	0.31	0.44	0.40	0.43	5.83

Figures in parentheses indicate V_{n+1} transformed value

Date of sowing : 16-11-2014
Date of bio-agent application : 18-02-2015
Date of harvest : 18-04-2015

Plot size : Six row of six meter length at 25 cm spacing
Variety : H D 2967
Replication :Three

Table 10.21: Eco-friendly management of foliage feeding aphids on wheat during 2014-15 (Centre: Kharibari)

	Name of Treatment	Dose gm/ml/lt.	Before spray Population	Mean no. population of survived foliage feeding wheat aphids/shoot/plant									Grain Yield (qt/ha)
				I st Spray				Before spray Population	II nd Spray				
				1 DAT	2 DAT	7 DAT	15 DAT		1 DAT	2 DAT	7 DAT	15 DAT*	
1.	Neem Seed Extract (NSE)	5 %	65.67 (8.13)	55.57 (7.49)	45.45 (6.78)	30.60 (5.58)	40.67 (6.42)	50.20 (7.12)	40.67 (6.42)	34.75 (5.94)	25.90 (5.14)	20.50 (4.58) **	27.22
2.	*Azadirahctin* 1500 ppm	3.0 ml	45.25 (6.76)	30.67 (5.58)	25.70 (5.12)	20.00 (4.53)	30.25 (5.55)	42.15 (6.53)	30.25 (5.55)	24.16 (4.97)	18.30 (4.34)	8.90 (3.07)	26.61
3.	Vekhand powder (*Acorus calamus*)	5 g	55.76 (7.50)	45.96 (6.82)	38.48 (6.24)	30.56 (5.57)	40.76 (6.42)	50.50 (7.14)	40.10 (6.37)	30.15 (5.54)	25.12 (5.06)	18.16 (4.32)	28.55
4.	*Verticillium lecanni* (2 x 108c.f.u)	3 g	65.45 (8.12)	55.35 (7.47)	42.15 (6.53)	32.47 (5.74)	40.45 (6.40)	46.70 (6.87)	36.15 (6.05)	30.10 (5.53)	22.76 (4.82)	18.20 (4.32)	26.99
5.	*Beaveria bassiana* (2 x 108c.f.u)	5 g	48.76 (7.02)	30.57 (5.57)	22.86 (4.83)	18.15 (4.32)	25.76 (5.12)	35.56 (6.00)	25.25 (5.07)	18.15 (4.32)	12.30 (3.58)	7.90 (2.90)	31.84
6.	*Metarhizium anisopliae*	3 g	45.15 (6.76)	35.55 (6.00)	22.67 (4.81)	15.78 (4.03)	22.15 (4.76)	30.15 (5.54)	20.16 (4.55)	16.35 (4.10)	10.10 (3.26)	4.50 (2.24)	26.26
7.	Dimethoate 30 EC	0.3ml	55.75 (7.50)	32.25 (5.72)	22.10 (4.75)	14.56 (3.88)	25.75 (5.12)	32.50 (5.74)	20.20 (4.55)	15.54 (4.00)	10.56 (3.33)	5.20 (2.39)	31.23
8.	Untreated Control	-----	56.67 (7.56)	68.23 (8.29)	70.56 (8.43)	73.56 (8.61)	100.50 (10.05)	115.30 (10.76)	125.10 (11.21)	135.56 (11.66)	150.10 (12.27)	160.70 (12.70)	26.69
	S.Em±		0.42	0.57	0.65	0.59	0.72	0.72	0.69	0.59	0.52	0.51	
	C.D at 5% level		1.25	1.67	1.91	1.73	2.12	2.14	2.04	1.73	1.55	1.51	

*DAT- Days After Treatment, ** Figures in parenthesis are Square root transformed value,

Date of Sowing: 10.12.14 — Plot size: Six rows of 6meters length at 25cm apace

Date of Insecticide Application: 09-02-15 and II^nd 27-02-15 — Variety: Sonalika

Date of harvest: 23-04-15 — Replication: Three

VI: Additional Experiment.

AE 1: Compatibility of different insecticides used for aphid control with fungicide (Tilt).

Centre: Ludhiana

This trial was conducted under irrigated conditions at Plant Breeding Research Farm, PAU, Ludhiana. The wheat variety PBW 621 was sown on 25th Nov. 2014 in the plots of 6 rows of 6 metre length in a replicated trial. Seven treatments were sprayed when the aphid population reached at 4-5 aphids/earhead. There were total of eight treatments including untreated check and each was replicated three times. For recording observations, five shoots were ear marked in each plot and from these plants observations were recorded one day before spray and then one, two, seven and fifteen days after spray.

Aphid population did not differ significantly among all treatments one day before spray (Table 10.22). When observed one day after spray, imidacloprid sprayed plots recorded minimum (1.18) aphids/earhead and was significantly lower than only tilt sprayed plots and untreated control. Similarly two, seven and fifteen days after treatments, aphid population was significantly lower in all treatments except foliar application of tilt only and untreated control.

The incidence of yellow rust varies from 5-10 S in treatments where tilt was applied alone or in combination with imidacloprid/thiamethoxam whereas it was 40-60S in those treatments where only imidacloprid/thiamethoxam was applied. The incidence of yellow rust was 60 S in untreated control.

Grain yield (q/ha) obtained was maximum (63.11) from tilt + imidacloprid @ 40 ml/ac in 200 litres of water treated plots and it was at par with all the mixed application of tilt and insecticides as well as application of tilt alone. The other treatment where only insecticide were applied recorded significantly lower grain yield than mixed application of tilt and insecticides, however yield in these treatments were still significantly better than untreated control.

Centre: Karnal

This trial was carried out at Research Farm, DWR, Karnal. The wheat variety HD2967 was sown on 25th November, 2014 in the plots of 6 rows of 6 metre length in a replicated trial. There were total of seven treatments including untreated check and each treatment was replicated three times. The treatments were sprayed when the aphid population was 4-5 aphids/earhead. The observations were recorded on five shoots in each plot which were ear marked and from these shoots, aphid population was recorded one day before spray and then one, two, seven and fifteen days after spray.

There was no significant difference in aphid population recorded in all treatments one day before spray (Table 10.23). However, after one day of spraying, imidacloprid sprayed plots recorded minimum (6.33) aphids/earhead and was significantly lower than other treated plots and untreated control. Similar trend was observed after two, seven and fifteen days after treatments. The next effective treatment after imidacloprid was combination of imidacloprid with tilt @ 0.1%. After fifteen days of spraying, imidacloprid, thiamethoxam and their combination with tilt @ 0.1% were equally effective in reducing aphid population.

The incidence of yellow rust ACI (%) was 2.9 in treatments where tilt was applied alone either once and two times. The combination of tilt with imidacloprid and thiamethoxam, recorded yellow rust ACI (%) as 6.3 and 5.3 respectively. The ACI (%) was 15.3 and 14.6 where only imidacloprid and thiamethoxam was applied. The incidence of yellow rust ACI (%) was 44 in untreated control.

Grain yield (q/ha) obtained was maximum (45.88) from tilt + imidacloprid @ 0.1% treated plots and it was at par with treatment of thiamethoxam (44.14) and its combination with tilt @ 0.1% (45.34). The lowest yield of 36.40 q/ha was recorded in untreated check.

AE 2: Eco-friendly management of foliage aphid on wheat through animal origin product cow urine based treatments.

Centre: Pantnagar

The data presented in (Table-10.24) showed that before one day of I[st] spraying the mean aphid population was not significantly different among the treatments (19.53-25.40/shoot). After one day of spraying mean aphid population was significantly different in Dimethoate 30 EC (16.07/shoot) whereas among the other treatments no significant difference in aphid population was noticed i.e. ranged from Neem Leaf Cow Urine Extract (NLCUE) @ 2% (18.93/shoot) to Cow urine @20 % (21.73/shoot). After second day, a significant less mean aphid population was observed in Dimethoate 30 EC (07.60/shoot) followed by NSCUE (12.600/shoot) and Neem Leaf Cow Urine Extract (NLCUE) @2%, (13.33/shoot) in comparison to untreated control (25.00/shoot). After seven days of spraying, again mean aphid population was lowest in Dimethoate 30 EC (7.670/shoot) followed by NSCUE @ 2% (11.47/shoot) and NLCUE) @2%, (12.13/shoot). After 15 days of Ist spray, Dimethoate 30 EC spray showed the least mean aphid population (06.13/shoot)but among the eco-friendly cow urine treatments significant less aphid population was observed in NSCUE @2% (10.13/shoot) and NLCUE) @2%, (11.67/shoot)ccomparison to untreated control (25.00/shoot).

After seven and 15 days of spraying, the population of natural enemies were observed the highest in cow urine and cow urine based formulations ranged from (0.93-2.20/m2) and 1.53- 2.47/m^2) with significantly very less population in Dimethoate 30 EC (0.33 and 0.66/m^2) with untreated control (1.60 and 2.60/m2), respectively

The grain yield in eco-friendly cow urine and cow urine based plant extract treatments was found significantly highest in NSCUE @2% (27.60 q/ha), NLCUE @ 2% (27.41 q/ha), Cow urine @ 20 % (26.76 q/ha) followed by Cow urine @ 50 % (26.09 q/ha), Cow urine @ 10% (25.71q/ha),Cow urine @ 100% (25.32 q/ha), in comparison to chemical treatment, Dimethoate 30 EC (25.80 q/ha) and untreated control (25.33 q/ha).

The high population of natural enemies (natural control) was observed in the plots of eco-friendly management approaches such as application of biorationals and cow urine based treatments. The natural enemies such as predators: nymphs and adults of Coccinella beetle, larvae of chrysopa and maggots of syrphid fly as well as braconid parasitoid, *Diaeretiella rapae* was also found laying eggs inside the bodies of aphid which later turned dead and mummified on the wheat foliage. Predatory bugs and spiders were also found in the plots of eco-friendly management approaches in wheat crop. The cocoons of *Cotesia* (larval parasitoid), *Campoletus chloredae*, and pradators i.e. rove beetle, *Euconthocona*, *Andrellus* were also observed feeding on pupating larvae of *H. armigera* during March and April 2015. A very less larval population of *H. armigera* was seen in wheat foliage at Pantnagar. Further studies are surely required to come to the final conclusions regarding the role of cow urine and its combination with plant extracts and use of biorationals for management of foliar aphids in wheat crop.

AE3: Management of wheat root aphid (*Rhopalosiphum rufiabdominalis*) with seed treatment of different insecticides.

Centre: Ludhiana

Management by seed treatment: This experiment was conducted in the rainfed fields at Plant Breeding Research Farm PAU Ludhiana. The wheat variety PBW 660 was sown on 25th Nov 2014. Before sowing, the seed was treated with seven different insecticides separately by spraying on the spreaded layer of equal quantity of seed on polyethene sheet. The treated seed was dried overnight before sowing. There were eight treatments including untreated check and each was replicated thrice.

The data on root aphid incidence indicated that 21 days after seed treatment, minimum root aphid population was observed in imidacloprid 600 FS @ 2 ml/kg of seed (5.56) treated plots and it was significantly lower than untreated control but at par with all other insecticidal treatments (Table 10.25). Similarly 28 days, minimum root aphid population (6.10) was observed in imidacloprid 600 FS @ 2 ml/kg of seed treated plots followed by clothianidin treated plots (6.13). Similarly 35 days after seed treatment, root aphid population/tiller was significantly lesser in imidacloprid 600 FS @ 2 ml/kg of seed treated plots which were at par with all other insecticidal treatment and better than untreated check. Thus, it was concluded that seed treatment with imidacloprid 600 FS @ 2.0 ml/kg seed followed by clothianidin 50 WDG @ 1.5 g/kg seed can be used for the management of root aphid.

Table 10.22: Compatibility of different insecticides used for aphid control with fungicide (Tilt) during 2014-15 (Centre: Ludhiana)

S. No.	Treatments	Aphid population per earhead					Yellow rust (% damage)	Grain Yield (q/ha)
		Before spray	After spray					
		1 day	1 day	2 days	7 days	15 days		
1	Tilt @ 200ml/ac in 200 litres of water	21.60 (4.74)	20.70 (4.58)	20.65 (4.65)	18.04 (4.35)	12.55 (3.67)	5	57.33
2	Imidacloprid @ 40 ml/ac in 100 litres of water	21.80 (4.74)	1.18 (1.47)	1.13 (1.45)	1.06 (1.42)	0.40 (1.18)	40-60	52.22
3	Thiamethoxam @ 20ml/ac in 100 litres of water	20.40 (4.55)	1.22 (1.49)	1.19 (1.48)	0.95 (1.39)	0.29 (1.13)	60	52.53
4	Tilt + Imidacloprid @ 40 ml/ac in 100 litres of water	20.80 (4.63)	1.55 (1.59)	1.35 (1.53)	1.28 (1.50)	0.25 (1.11)	5-10	58.22
5	Tilt + Thiamethoxam @ 20 ml/ac in 100 litres of water	19.46 (4.51)	1.51 (1.58)	1.33 (1.52)	1.19 (1.47)	0.31 (1.14)	5-10	58.62
6	Tilt + Imidacloprid @ 40 ml/ac in 200 litres of water	23.06 (4.89)	1.77 (1.66)	1.40 (1.54)	1.26 (1.50)	0.29 (1.13)	5	63.11
7	Tilt + Thiamethoxam @ 20 ml/ac in 200 litres of water	21.26 (4.71)	1.89 (1.69)	1.44 (1.56)	1.16 (1.47)	0.36 (1.15)	5-10	62.08
8	Control	21.73 (4.76)	21.76 (4.76)	17.94 (4.34)	16.06 (4.12)	11.40 (3.51)	60	45.95
	CD (p=0.05)	NS	(0.20)	(0.21)	(0.26)	(0.31)	-	5.75

* Figures within parentheses are transformed means

Date of sowing	:	25.11.2014	Plot size	:	7.5 m^2
Date of application	:	05.03.2015	Variety	:	PBW 621
Date of harvest	:	25. 04.2015	Replications	:	Three

Table 10.23: Compatibility of different insecticides used for aphid control with fungicide (Tilt) during 2014-15 (Centre: Karnal)

S. No.	Treatments	Aphid population per earhead					ACI (%)	Grain Yield (q/ha)
		Before spray	After spray					
		1 day	1 day	2 days	7 days	15 days		
1	Tilt@ 0.1% (One spray)	36.73 (6.14)	33.73 (5.89)	28.27 (5.41)	21.27 (4.72)	15.53 (4.06)	2.9	37.21
2	Tilt@ 0.1% (Two spray)	34.33 (5.93)	29.67 (5.53)	25.67 (5.15)	19.67 (4.53)	14.80 (3.97)	2.9	39.38
3	Imidacloprid 17.8 SL	34.40 (5.94)	6.33 (2.70)	2.13 (1.77)	1.67 (1.63)	0.00 (1.00)	15.3	43.08
4	Tilt@ 0.1%+ Imidacloprid 17.8 SL	32.07 (5.74)	6.67 (2.77)	2.80 (1.95)	2.33 (1.82)	0.00 (1.00)	6.3	45.88
5	Thiamethoxam 25% WDG	36.80 (6.15)	7.93 (2.99)	3.20 (2.05)	3.13 (2.03)	0.00 (1.00)	14.6	44.14
6	Tilt@ 0.1%+ Thiamethoxam 25% WDG	34.00 (5.91)	6.87 (2.80)	5.00 (2.44)	3.80 (2.19)	0.00 (1.00)	5.3	45.34
7	Untreated Control	34.80 (5.97)	32.60 (5.78)	27.40 (5.31)	21.40 (4.71)	16.80 (4.22)	44	36.40
S.Em.		0.16	0.15	0.16	0.18	0.34		2.11
CD (p=0.05)		NS	0.46	0.48	0.54	1.05	-	6.51

* Figures within parentheses are transformed means

Date of sowing : 22.11.2014 Plot size : Six row of six meter length at 25
cm spacing Date of application : 22.02.2015 Variety : HD2967
Date of harvest : 20. 04.2015 Replications : Three

Table 10.24: Eco-friendly management of aphids on wheat during 2014-15 (Centre: Local trial at NBCRC, Pantnagar)

S.No.	Treatments	Dosage g a.i./ha	Mean Population of survived foliage feeding wheat aphids/ shoot/plant					Population of natural enemies/m²		Grain Yield (q/ha)
			1 day before Spray	I st spray				7 DAS	15 DAS	
				1 DAS	2 DAS	7 DAS	15 DAS			
1.	Cow Urine	10%	22.87 (24.01)*	21.87 (24.34)	20.27 (26.56)	22.47 (25.05)	22.53 (26.40)	1.27 (6.39)	1.53 (7.09)	25.71
2.	Cow urine	20%	22.87 (23.91)	21.73 (22.84)	19.03 (23.67)	21.13 (23.85)	19.00 (22.89)	1.53 (7.09)	2.00 (8.12)	26.76
3.	Cow urine	50%	20.93 (24.75)	20.53 (24.59)	17.53 (24.45)	16.87 (22.84)	17.60 (20.24)	2.20 (8.48)	2.33 (8.76)	26.09
4.	Cow Urine	100%	23.40 (25.91)	21.73 (23.63)	16.40 (24.15)	16.20 (22.09)	16.33 (21.39)	2.13 (8.32)	2.47 (9.01)	25.32
5.	Neem Leaf Cow urine Extract (NLCUE)	2% (in cow urine 10%)	19.53 (24.83)	18.93 (24.23)	13.33 (21.65)	12.13 (20.59)	11.67 (18.83)	1.07 (5.89)	2.00 (8.12)	27.41
6.	Neem Seed Cow urine Extract (NSCUE)	2% (in cow urine 10%)	21.47 (22.77)	19.53 (22.87)	12.60 (24.17)	11.47 (22.37)	10.13 (21.35)	0 .93 (5.49)	1.73 (7.56)	27.60
7.	Dimethoate	0.3ml/1/1	25.40 (24.29)	16.07 (19.15)	7.60 (16.37)	7.67 (15.37)	6.134 (14.23)	0.33 (3.19)	0.60 (4.28)	25.80
8.	Untreated Control	-	22.20 (25.77)	24.87 (26.91)	25.00 (26.97)	26.40 (30.12)	25.00 (29.85)	1.60 (7.23)	2.60 (9.25)	25.33
	SEm		1.20 (1.27)	1.01 (1.23)	0.30 (0.92)	0.84 (1.16)	0.63 (1.03)	0.28 (0.64)	0.21 (0.48)	0.35
	CD 5%		NS	3.05 (3.57)	0.90 (2.66)	2.55 (3.35)	1.92 (2.98)	0.83 (1.93)	0.64 (1.46)	1.02

*Figures in parenthesis are angular transformed values

Date of sowing :03/12/2014 Plot size : 10.5 sq. m Replications : Three

Date of I[st] spray applic ation :10/02/2015 Variety sown : PBW343 Date of Harvest : 25/04/2015

Table 10.25: Effect of different seed treatments on the population dynamics root aphid during 2014-15 (Centre: Ludhiana)

S.No.	Treatments	Dosage a.i./Kg seed	Dose ml or g / kg of seed	Number of root aphid/tiller		
				21 days after sowing	28 days after sowing	35 days after sowing
1	Imidacloprid 600 FS (Gaucho)	480	1.0 ml	7.86 (2.97)	7.46 (2.90)	6.23 (2.68)
2	Imidacloprid 600 FS (Gaucho)	720	1.5 ml	7.30 (2.87)	7.20 (2.85)	4.73 (2.38)
3	Imidacloprid 600 FS (Gaucho)	960	2.0 ml	5.56 (2.74)	6.10 (2.64)	4.60 (2.35)
4	Clothianidin 50 WDG (Dantotsu)	0.75	1.5 g	6.60 (2.75)	6.13 (2.66)	4.80 (2.40)
5	Chlorantranilipride 18.5 SC(Coragen)	0.185	1.0 ml	7.60 (2.92)	7.13 (2.83)	6.10 (2.65)
6	Chlorantranilipride 18.5 SC(Coragen)	0.370	2.0 ml	6.26 (2.68)	6.33 (2.69)	6.10 (2.66)
7	Fipronil 5 SC (Regent)	0.3	6.0 ml	7.80 (2.96)	7.60 (2.91)	5.16 (2.48)
8	Untreated check	-	-	14.93 (3.97)	15.06 (3.99)	10.03 (3.31)
CD (p=0.05)				(0.47)	(0.56)	(0.40)

* Figures in parentheses are transformed means

Date of sowing	: 25.11.2014	Plot size	:	40 m^2
Date of insecticidal application	: 24.11.2014	Variety	:	PBW 660
Date of harvest	: 24. 04.2015	Replications	:	Three

Experiment No.7. Chemical control of foliage feeding brown wheat mites (*Petrobia latens*) on wheat crop

Centre: Durgapura

For the management of brown wheat mites (*Petrobia latens*) on the wheat crop through foliar application of acaricides and conventional insecticides, a trial was laid out at RARI, Durgapura, Jaipur. There were eight treatments including untreated check and each treatment was replicated thrice .The wheat variety Raj-4229 was sown on 02.12.2014 in plots of 16 sq m size. The mites/10 cm^2 area on three tagged plants from each plot separately was recorded from different replications at 3, 5, 7 and 15 days after spray whereas, yield was recorded at harvest. The infested plants were tapped over 4 glycerine-smeared slides held in a thermo Cole sampler at ground level for recording the mite population. The observations were recorded from 3 spots per plot. The average of the data was computed to number of mites/10 cm^2 area. The percent reduction was calculated by the Abort's formula. The data presented in (Table 10.26) revealed that all the treatments reduced the mite population significantly and increased the grain yield as compared to untreated check. At initially stage or before the spray mites population was statically non significant. On 3rd day of spray the minimum mites population was minimum with higher reduction percent in spiromesifen at 1.0 ml/L (7.66:62.32) at par with propargite at 1.5 ml/L(8.33:59.02), fenazquine 2.0 ml/L (8.88:56.27) and profenofos at 1.0 ml/L (8.99:55.73) all these treatments were at par with dicofol at 2.0 ml/L (9.33:54.10) treated plots followed by bifenthrin (9.88:51.35) and ethion (11.44:43.72), when compared to untreated check (20.33). Observations taken at 5rd day of spray indicated that the minimum mite population was observed in spiromesifen (6.33:73.12) which was at par with all treatments except propargite (7.88:65.53) and dicofol (8.32:64.67) all these treatments were significantly better than untreated check (23.55). On 7th day of spray the mite population was recorded minimum in spiromesifen (4.55:82.03) at par with all treatments except ethion (7.88:68.85). The mite populations in all these treatments were significantly lower than untreated check (25.33).

The mite population count was decreased at 15th day of spray observed minimum mites population in the spiromesifen (4.44:59.63) which was again at par with all treatments except ethion (5.55:49.54), due to continue rainfall and natural storm during the experimentation after 7th day of insecticidal application reduce the pest population as compare to mite population in untreated check (10.99). The maximum grain yield (q/ha) was observed in plots treated with spiromesifen (31.00) at par with propargite (30.88) and other treatments except ethion (26.43) as compared to minimum in the untreated check (20.22).

Table 10.26: Chemical control of foliage feeding brown wheat mites (*Petrobia latens*) on wheat crop during 2014-15 (Centre: Durgapura)

S. No	Treatments	Dose ml./L	Average number of mites population/10 cm2 after spray					Grain yield q/ha
			Before spray	3	5	7	15	
1	Dicofol 18.5 EC (Colonel)	2.0 ml	17.99a	9.33a (54.10)*	8.32b (64.67)	5.66a (77.65)	4.99a (54.54)	30.77a
2	Propargite 57 SC (Omite)	1.5 ml	17.88a	8.33a (59.02)	7.88b (66.53)	5.10a (79.82)	4.22a (67.72)	30.88a
3	Spiromesifen 240 SC (Oberon)	1.0 ml	17.66a	7.66a (62.32)	6.33a (73.12)	4.55a (82.03)	4.44a (59.63)	31.00a
4	Bifenthrin 10EC (Talstar)	0.8 ml	17.44a	9.88b (51.35)	7.55a (67.94)	4.55a (82.03)	3.21a (70.72)	30.21a
5	Profenofos 50EC (Karina)	1.0 ml	17.11a	8.99a (55.73)	7.44a (68.40)	5.10a (79.82)	4.33a (60.09)	30.10a
6	Fenazquine10 EC (Majester)	2.0 ml	17.33a	8.88a (56.27)	6.99a (70.27)	4.88a (80.69)	2.88a (73.72)	30.77a
7	Ethion 50 E C	1.0 ml	17.44a	11.44c (43.72)	7.66c (67.47)	7.88b (68.85)	5.55b (49.54)	26.43b
8	Control	-	17.21a	20.33d	23.55d	25.32c	10.99c	20.22c
	S. Em ±		0.32	0.38	0.49	0.47	0.47	0.36
	CD 5%		NS	1.17	1.51	1.43	1.42	1.11

Figures followed by same alphabets are statistically at par, **Figures in parenthesis are reduction percent based on Henderson-Tilton's formula,

Date of sowing : 2.12.2014
Date of insecticidal spray : 10.03.2015
Date of harvesting : 15.4.2015

Plot size : 4.0 x 3.0 sq.m.
Variety : Raj-4229
Replications : Three

Experiment No.8. Chemical control of shootfly on wheat crop

Centre: Dharwad

Dead heart (%): ST with Clothianidin 50 WDG @ 2.5 g/ kg seeds followed by foliar spray of fibronil 5 SC 500 ml /ha at 12 DAE recorded least dead hearts (30.33%) and it was on par with foliar spray of Azadirachtin 10,000 ppm @ 2 ml / litre at 8 DAE and 15 DAE (31.73%) and Profinophos 50EC @ 2.00 ml/litre at 8 DAE (33.45%).
Seed yield (%): Highest seed yield of 20.64 q/ ha was recorded in T5 (ST with Clothianidin 50WDG @ 2.5 g/ kg of seeds+ Foliar spray of Fipronil 5 SC @ 500ml/ha at 12 DAE) and it was on par with all the treatments in the experiment except T9 (Foliar spray of Chlorpyriphos 20EC @ 2 ml/ litre at 8 DAE) and unsprayed control (T12).

TGW (g): Non significant among the treatments indicating no reduction in seed weight due to infestation of shootfly.

Biomass (t/ha): Non significant difference among the treatments. However numerically T5 recorded highest biomass of 8.93 t/ha and unsprayed control (T12) recorded lowest biomass of 6.80 t/ha (Table 10.27).

Table 10.27: Chemical control of shootfly on wheat crop during 2014-15 (Centre: Dharwad)

Sl.No.	Treatments	Plant height(cm)	Dead Hearts (%)	Seed yield (q/ha)	TGW (g)	Biomass (t/ ha)
1	T1-ST with Clothianidin 50WDG @ 2.5 g/ kg of seeds	79.67	38.67*(39.02)**	17.91	34.58	7.69
2	T2- ST with Imidaclorpid 500 FS @ 6 ml/ kg of seeds	78.47	41.60 (42.93)	17.44	33.38	7.81
3	T3-Foliar spray of Fipronil 5 SC @ 500ml/ha at 8DAE	82.40	35.78 (35.34)	18.52	31.34	8.15
4	T4- Foliar spray of Proclaim @ 225 g/ha at 8DAE	80.60	40.46 (42.12)	17.83	35.43	7.57
5	T5- ST with Clothianidin 50WDG @ 2.5 g/ kg of seeds+ Foliar spray of Fipronil 5 SC @ 500ml/ha at 12 DAE	78.60	30.33 (25.49)	20.64	32.73	8.93
6	T6- ST with Imidaclorpid 600 FS @ 6 ml/ kg of seeds+ Foliar spray of Fipronil 5 SC @ 500ml/ha at 12 DAE	81.07	33.78 (30.94)	20.39	32.65	7.11
7	T7-Phorate 10 G @ 10kg/ha	80.80	35.50 (33.85)	17.80	32.89	7.32
8	T8-Azadirachtin 10,000 ppm @ 2 ml/L at 8 DAE and 15 DAE	82.33	31.73 (27.72)	19.80	34.43	8.10
9	T9- Foliar spray of Chlorpyriphos 20EC @ 2 ml/ litre at 8 DAE	81.47	37.83 (37.63)	16.67	32.93	7.41
10	T10- Foliar spray of Profinophos 50 EC @ 2 ml / litre at 8 DAE	83.87	33.45 (30.44)	20.07	34.04	8.80
11	T11- Foliar spray of Dimethoate 30 EC @ 1.7ml / litre at 8DAE	81.00	39.12 (39.83)	19.48	33.85	7.87
12	T12- Control	85.33	49.57 (54.91)	13.20	34.43	6.80
	SEm±	2.76	1.12	1.22	1.68	1.41
	CD (p=0.05)	8.10	3.30	3.57	4.91	3.13
	CV %	5.88	5.22	11.53	8.65	33.41

Date of sowing: 03.12.2014
Number of treatments:12
Date of data recording: 15 DAE(26.12.2014) and 30 DAE (13.1.2015)

Date of harvest:30.03.2015

Variety: UAS 304
Number of replications:3
Plot size- Gross plot: 1.60m X 3 m
Net plot: 1.20m X 3 m

Date of first appearance of shoot fly in the field: 19.12.2014

10.3 INTEGRATED PEST MANAGEMENT

Experiment No. 9: Survey of pests infesting wheat and their natural enemies

Centre: Durgapura

The survey of pests infesting wheat and barley and their natural enemies was carried out during the crop season 2014-2015 as followed: In the village Kajroli nearby Chomu (Jaipur dist.), in the third week of December, 2014, the wheat crop at early stage was heavily damaged by Wheat wireworms in certain areas of a field, 20-25% percent losses was noticed and wheat crop was also damaged by thirth instars larvae of white grub species of *Holotrichia* and another two species of *Meladera* and (*Anomola* sp.) it may be due to favorable condition or slightly high temperature during these days, the larvae unable to pupate in soil. Area of Dausa and Lalsot was surveyed on 15th January, 2015 for insect pest infesting wheat and their enemies in different places of zone III A. Most of the farmers grow Raj 3077 and 3765 wheat and RD 2035 and RD 2552 of Barley verities. Overall the wheat and Barley crop was healthy nearby Bassi and Dausa area of (Tunga) Jaipur. The shootfly infestation was observed in wheat crop at few places of area surveyed, whereas few farmers wheat field was infested by termites at Tunga and Lalsot area but termite's infestation was low to medium. At most of the location the crop was healthy. Crop stage was at ear head formation. The attack of termites from 5-10% was also observed at Shyampura. On 16th January,2015: Kotputli and Paota (Das kala) area was surveyed for insect pest infesting wheat and their enemies in different places of zone III A. PBW 343, 502, Raj 3077 and 3765 wheat verities were sown nearby Manoharpur and Viratnagar area of (Shahpura) Jaipur. The wheat and Barley crops were healthy in the zone area surveyed. The shootfly infestation was observed low at few places in wheat crop at few places of area surveyed, whereas few farmers wheat field was heavily infested by wheat termites at Jodhpua-Viratnagar) area but other places the termite's infestation was low to medium. The attack of termites from 5-20% was also observed at Viratnagar area. Few plants were damaged by shoot fly and pink stem borer. No mite incidence was seen during survey (Table 10.28).

In area of Bassi and Dausa are (Tunga, and Madhopur). The wheat crop was healthy in the zone area surveyed on 27.02.2015. The shootfly and pink stem borer infestation was observed in wheat crop at few places of area surveyed, whereas few farmers wheat field was infested by wheat and Barley aphids, termites and brown wheat mite was noticed at Tunga and Madhopur area but termite's infestation was low to medium. The attack of termites from 2-5 % was also observed in area surveyed. The *Rhopalsiphum maidis* was observed as the predominant species of aphid in almost all the surveyed of barley crop locations in the zone. The termite infestation in barley crop was remained 7-15 per cent. The incidence of *Spodoptera litura* and *Helicoverpa armigera* was very low but widespread. To explore the bio-diversity of insect pests and their natural enemies in barley during the crop season, the aphid population was moderate to high and predators like Coccinellid beetles Coccinella septempunctata was also observed as predating on barley aphids. On 28.02.2015: Nearby Bagru, Dudu and Ajmer area of zone. The few wheat plants was damaged by pink stem borer infestation at few places , The termite infestation, brown wheat mite and aphids population on both crops were noticed in the zone of area surveyed. The termite infestation was also observed in wheat crop at few places of area surveyed nearby Bagru and Dudu, whereas few farmers wheat field was infested by wheat aphids, termites and brown wheat mite at Ajmer area but termite's infestation was low to medium. The attack of termites from 2-5% was observed in nearby area of Ajmer. Some places aphid's predator cocinellids beetles were observed on wheat &

Barley crops. Overall the termite damage in wheat fields remained moderately throughout the crop season. Population of brown wheat mite was medium and noticed on the later or ear head stage of the crop. However, the attack of pink stem borer in wheat was also observed during survey of wheat crop. Occasionally reports of *Spodoptera litura* and *Helicoverpa armigera* infesting barley fields were also received from some locations during surveyed.

Centre: Niphad

Survey was carried out in the villages of Nashik district at different crop stages. Heavy incidence of aphids was recorded in Nasik district. The Coccinellid predatory grubs, beetles and Chrysopa feeding on the aphid infested fields were also observed. The incidence of Jassids and earhead caterpillar were recorded in medium intensity (Table 10.29).

Centre: Ludhiana

In order to monitor the insect pest of wheat, survey of Punjab state were undertaken during 2014-15 crop season. Sporadic incidence of termites was observed in village Bargari, District Faridkot. Severe incidence of foliar aphid was observed in some village viz. Jagmeenpur and Balowal Saunkhari etc. in Ropar district. Mild incidence of pink stem borer, termite etc. was observed in some places viz. Ladhowal, Rasolpur, Longroya, Rahon, Phillaur, Nawanshahr, Garshankar and adjoining areas. Incidence of root aphid was also recorded in village Rasolpur. Termite damage (1-2 %) was recorded in some fields near Rahon village. The grubs and adults of coccinellid beetles were observed frequently in fields infested with aphids. In most parts of Punjab, farmers practiced 1-2 sprays to control wheat aphid in their field.

Centre: Vijapur

Survey of wheat & barley fields were carried out in the state during the crop season. The termite damage in wheat fields remained low to moderate through the crop season. The population of *H. armigera*, pink stem borer, aphid , surface grasshopper, spodoptera , thrips, shoot fly, brown mite, jassids and cut worm were negligible. In barley fields, the aphid population was low to moderate. Among natural enemies, *Campoletis chlorideae* a larval parasite of *H. armigera* was observed. Predators like coccinellid beetles, chrysoperla and syrphid fly were frequently noticed predating wheat and barley aphids.

Centre: Kanpur

Survey was made at Khurdh, Pali and Sawali dated 28.01.2015. The incidence of shootfly was observed 10 per cent and rainfed termite infestation in 18 per cent, in varieties PBW343, K0307 and Halna. The incidence of termite was observed in irrigated crop 10 per cent, pink stem borer infestation 2.0 per cent.

During the the survey of pest infesting wheat crop in IInd week of Feb. 2015 at Village Malasa, Sahapur and Sengaranpurwa was observed at booting stage of termite infestation 15 per cent in irrigated wheat crop, Aphid infestation was observed in barley crop highly susceptible and in different wheat cultivar on varieties K502, Halna, HD 2733, DBW 39, K 0307 and K551 (Barley). Survey of 2nd week of Feb. 2015 pest infestation fields wheat & barley in village Uttripura was observed in mainly infestation termite 15 per cent in irrigated fields namely varieties RD2794, K0307, HD 2733 & Unnat Halna, in Barley Var. K 551. The infestation of shootfly 13.0 per cent in wheat crop. The minor incidence of pink stemborer 2.0 per cent (Table-10.30).

Centre: Karnal

The survey of wheat in Punjab and Haryana state was undertaken during 2014-15 crop season. Moderate to severe incidence of wheat aphid and minor incidence of root aphid and pink stemborer was observed in some villages of Karnal (HR) and Punjab, Mundiala Kalan (LDH), Bakhada (Main Sarandh), Basant Pura (Fatehgarh) and near Karnal (Pir Ki Mazar). Moderate termite damage was recorded in some parts of Karnal. Minor incidence of pink stem borer was observed in village- Nising and adjoining areas of district Karnal. The grubs and adults of coccinellid beetles were seen frequently in fields infested with aphids.

Centre: Pantnagar

To observe the occurrence of insect pests on wheat crop and their natural enemies, survey of wheat fields was carried out in villages of districts, Udham Singh nagar and Nainital during 2014-15 crop season (Table 10.31). To explore the biodiversity of insect pests and their natural enemies, areas such as Dineshpur, Danpur, JaafarPur, Sitarganj, Kichha, Shantipuri, Tanda, Devalchaur, Halduchaur, Mota haldu, Jainagar were surveyed and two species of aphids, *Rhopalosiphum maidis and Macrosiphum miscanthi* were observed in every wheat field with severity of damage graded as 3-5 during vegetative, boot and grain filling stage of wheat crop. Predators such as coccinella and syrphid fly were observed in every wheat field. In Jaafarpur and Dhaulpur areas of Distt U S nagar, adults of dragon and damsel flies and Tipulids were found feeding on wheat foliage aphids. Parasitoid, *Diaeretiella rapae* was also observed laying eggs inside the bodies of aphids and several mummified aphids were also seen on wheat foliage. A negligible population of *Helicoverpa armigera* was observed on wheat foliage at Pantnagar during end of March 2015 with incidence of *Parasitoids* - cocoons of *Cotesia, Campoletes chlorideae,* and Predation by *Eoucanthocona* , Carabid beetles, *Andrella, and Rove beetle* in wheat fields.

During survey of wheat fields, the other insects such as thrips, armyworm, spodopterta, wheat mite, termite, grasshopper, jassids, shoot fly armyworm, stem borers, cutworm, leaf miners, wireworm were not observed in any of the wheat fields during the survey programme. It has been observed that to control aphid, farmers sprayed their filed 6-7 times but aphid population was increased to 500-600 aphids/plant after every spray showed development of resistance in aphids against insecticides whereas on the other hand , in some fields farmers were not spraying chemicals and the population of natural enemies was more in those wheat fields.

Table 10.28: Survey of wheat and barley pests and their natural enemies during 2014-15 (Centre: Durgapura)

Locality and date of visit	Area surveyed (Rainfed) / Irrigated	No. of samples observed	Variety and stages of growth	Crop Pests			Natural enemy	
				Name	Status Major/ minor	Intensity Attack (%damage Or population	Na me	Stage Parasitisatio n/ predation
23.12.2014: in the village Kajroli nearby Chomu (Jaipur dist.), adjoined area	Irrigated	20	Raj-3077 Raj-3765 Raj-4037 Barley-RD-2035 Barley-RD-2552	Whitegrub Termite Wheat wireworms	Minor Major Minor	20-25% 1-2% 20-25%	-	-
15.01.2015: Area of Dausa and Lalsot & adjoined area	Iirrigated	15	Raj-3077 Raj-3765 Raj-4037 Barley 2552 Barley-RD-2035	Termite Aphids	Major Major	2-5 % 10-15 aphids/shoots	- *Coccinella*	- Predatory
16.01.2015: Kotputli and Paota (Das kala) & adjoined area	Irrigated	20	PBW- 343 PBW- 502 Raj -3077 Raj- 3765 RD-2035	Aphids Termite Mites *Heliothis* *Spodoptera*	Major Major Minor Minor	10-15 aphids/shoot 5-10% 1-2% 0-1%	*Coccinella*	Predatory
27.02.2015: In area of Bassi and Dausa & adjoined area	Irrigated	20	Raj-3077 Raj-3765 Barley-RD-2035 Barley 2552	Aphids Termite *Heliothis* *Spodoptera*	Major Major Minor Major	15-20 aphids/shoot 10-15% 1-2%0.5 1 %	*Coccinella*	Predatory
28.02.2015: Nearby Bagru, Dudu and Ajmer	Irrigated	15	Raj-3077 Raj-3765 Raj-4037 Barley-RD-2552	Aphids Termite Mites *Heliothis* *Spodoptera*	Major Major Minor Minor	20-30 aphids/shoot 8-10% 1-2% 0-1%	*Coccinella*	Predatory

Table 10.29: Survey and surveillance of wheat growing areas during 2014-15 (Centre: Niphad)

Locality and date of visit	Area surveyed (Rainfed/ Irrigated)	No. of samples observed	Variety and Stage of growth	Crop pest			Natural enemy
				Name	Type of damage	Intensity	
Kundewadi, Deopur, Panchkeshwar 24.12.2014	Irrigated	40	NIAW 34, DBW 343, HD 2189, NIAW 301, Ajit 102, Mohan wander Vegetative, Booting	Aphids Jassids	Major Minor	Heavy Medium	*Coccinella septumpunctata* Beetles
Raulas, Bhausaheb Nagar, Konkangaon 12.01.2015	Irrigated	40	NIAW 301, LOK-1, Ajit 102, Ajit 72, Private companies Vegetative, Booting	Aphids	Major	Heavy	*Coccinella septumpunctata* Beetles
Pimpalgaon(B), Vadali bui, Deola, 17.01.2015	Irrigated	35	NIAW 34, LOK-1, HD 2189, NIAW 301, Ajit 102, Mohan wander, Private companies Flowering, grain filling	Aphids	Major	Heavy	*Coccinella septumpunctata* Beetles
Niphad, Jalgaon, Kothure, Naitale, Lasalgaong 21.01.2015	Irrigated	50	LOK-1, Private companies, NIAW 301, HD 2189, NIAW 34, Ajit 72 Flowering, grain filling	Aphids	Major	Heavy	*Coccinella septumpunctata* Beetles
Nandgaon, Yeola, Jalgaon 29.01.2015	Irrigated	35	LOK-1, Private companies, NIAW 301, HD 2189, Mohan wander Booting, Flowering,	Aphids	Major	Heavy	*Coccinella septumpunctata* Beetles
Dawachwadi, Lonwadi, Ranmala 04.02.2015	Irrigated	30	HD 2189, Private companies, NIAW 301, LOK-1 Booting, Flowering	Aphids Earhead caterpiller	Major Minor	Heavy Medium	*Coccinella septumpunctata* Beetles, *Chrysopa*
Wadali Bhui, Chandwad, Ranwad, Sogras 10.03.2015	Irrigated	50	LOK-1, Private companies, NIAW 301, HD 2189 Booting, Flowering	Aphids Earhead caterpiller	Major Minor	Heavy Medium	*Coccinella septumpunctata* Beetles, *Chrysopa*

Table 10.30: Survey of pests infesting wheat and their natural enemies during 2014-15 (Centre: Kanpur)

Locality and date of visit	Rainfed / Irrigated	No. of samples	Variety and stage of growth	Crop pest			Natural enemies	
				Name	Status	Intensity (Attack % damage or population)	Name	Stage Parastization / Predation
28.01.2015 Kurdh Pali Savali	Irrigated	10	PBW343, K0307 and Halna (full growing stage) Barley Var.- K551	Shootfly Termite Pink stem borer Aphid	Minor Major Minor Major	10 18 2 Susceptible index 4.0	- - - *Coccinella septumpunctata*	- - - Adult and grubs
15.02.2015 Malasa Shahapur Sengaranpurwa	Irrigated	10	DBW39, PBW343, K0402 and Unnat Halna Barl. Var. – K551	Shootfly Termite Aphid	Minor Major Major	12 15 HS 5.0	- - *Coccinella septumpunctata*	- - Adult and grubs
17.02.2015 Uttaripura	Irrigated and rainfed	12	HD2733, RD2794, Unnat Halna, K0307, K0402 Barl. Var.-K551	Shootfly Termite Aphid Pink stem borer	Minor Major Major Minor	13 15 HS 5.0 2	- - - Chrysoperla	-. - - Predator

Table 10.31: Survey of wheat and barley pests and their natural enemies during 2014-15 (Centre: Pantnagar)

Locality and date of visit	Area surveyed (Rainfed/ Irrigated)	No. of samples observed	Variety and Stage of growth	Crop pest			Natural enemy Name stage parasitization or Predation
				Name	Type of damage	Intensity (% Damage)	
Tanda Range, Distt. U S Nagar 14/02/2015	Irrigated	25	UP 2425 Vegetative	Aphids	Patches and streaks due to sucking	Grade 5	Predator- Coccinella Grubs and adults Syrphid flies- maggots and adults
Deval chaur, Haldwani 14/02/2014	Irrigated	25	Desi variety Grain filling	Aphids	Patches and streaks due to sucking	Grade 3	Predator- Coccinella Grubs and adults
Village Bacchipur, Mota haldu 4/02/2014	Irrigated	25	Grain filling	Aphids	Patches and streaks due to sucking	Grade 3	Predator -*Coccinella* Parasitoids-adults of *Diaeretiella rapae* Syrphid fly- maggots and adults
Village Halduchaur 14/02/2015	Irrigated	25	PBW-117 Vegetative	Aphids	Patches and streaks due to sucking	Grade 4	Predators- Coccinella- grubs and beetles Syrphid fly- maggots and adults
Village Jai nagar Distt U. S .nagar 20/02/2015	Irrigated	25	Pusa 2967 Grain filling	Aphids	Patches and streaks due to sucking	Grade 5	Predator- Coccinella- grubs and beetles Syrphid fly- maggots and adults
Durgapur, Dineshpur Distt U. S .nagar 20/02/2015	Irrigated	25	PBW 343 Grain filling	Aphids	Patches and streaks due to sucking	Grade 5	Syrphid maggots, coccinella grubs and beetles, Spiders
Village Danpur Distt U. S .nagar 20/02/2015	Irrigated	25	PBW 502 Vegetative	Aphids	Patches and streaks due to sucking	Grade 4	Parasitoids- *D. rapae,* coccinella grubs and beetles, Syrphid fly maggots and adults
Village Jaafar Pur and Dhaulpur Distt U. S .nagar 20/02/2015	Irrigated	25	PBW 552 Booting	Aphids	Patches and streaks due to sucking	Grade 4	*Coccinella- grubs and adults* Parasitoids-*Diaeretiella rapae* Syrphid fly- maggots and adults Predation by Adults of Dragon, damsel fly and Tipulids on aphids
Shantipuri,Village- Bari, Kichha 21/02/2015	Irrigated	25	PBW 2967 Booting	Aphids	Patches and streaks due to sucking	Grade 5	Coccinella grub and beetle, Syrphid maggots
Village: Naya Gaaonv Village:	Irrigated	25	PBW 343 Booting	Aphids	Patches and streaks due to sucking	Grade 5	Parasitoid *Diaeretiella rapae,* Syrphid maggots and Coccinella grubs and

Locality and date of visit	Area surveyed (Rainfed/ Irrigated)	No. of samples observed	Variety and Stage of growth	Crop pest			Natural enemy Name stage parasitization or Predation
				Name	Type of damage	Intensity (% Damage)	
Sisayya Sitarganj 21/02/2015							beetle
At (NBCRC)Pant nagar Experimental field Jan-Feb 2015	Irrigated	5 /plot	PBW-343 Vegetative, booting and grain filling	Aphids	Patches and streaks due to sucking	Grade 5	Coccinella- grubs and adults Parasitoids-*Diaeretiella rapae* Syrphid fly- maggots and adults
At Pantnagar on trials March 2015	Irrigated	30	PBW 343 Grain filled	*Helicoverpa armigera*	Biting and cutting of leaves	Negligible	*Parasitoids* -*Cotessia* cocoons, Campoletes chloridae, Predators -Eoucantocona , Carabid beetles
At (NBCRC) Pant nagar Experimental field of Plant breeding March 2015	Irrigated	30	Varieties		Biting and cutting of leaves and chaffy grains	Negligible	*Parasitoids* – cocoons of *Cotessia, Campoletes chloridae,* Predators -*Eoucanthocona* , Carabid beetles, *Andrella, rove beetle*

During survey of nearby areas of Pantnagar , thrips were not seen on wheat foliage

Experiment No.10. Incidence and population build of major insect-pest in wheat sown at different dates of sowing. (Second Year)

Objective:

1) To test the response of various wheat varieties/lines of wheat to aphid attack on different sowing dates under field condition.
2) To determine the effect of sowing dates on population built up of aphids on wheat.

The experiment conducted for Incidence and population build of major insect pest indifferent dates of sowing at 15 days interval under irrigated conditions 2013-14 at Niphad, Ludhiana and Karnal centre (New trial).

Methodology and observations to be recorded

The crop was sown at three different dates of sowing at 15 days interval and no insecticide was applied to control any pest in this trial. However, all other agronomic practices were followed for crop raising. The data on all major pests viz. foliage feeding aphids, root aphid, BWM, termites, pink stem borer etc. were recorded at fortnightly interval starting from 21 days after sowing until maturity of crop. The first incidence and population build of different pests were recorded and documented in Tabular form.

Centre: Niphad

Results:

Aphids:

Date of sowing:

From the data presented in Table 10.32a indicated that the aphid infestation started in end of November and gradually increased during vegetative growth of wheat crop. The population reached to its peak in the month of Jan. since first to last week. The decline in population of aphids was recorded at the end of Jan. when the maximum and minimum temperature raised. The population of aphids was not recorded on crop sown at 16th Dec. (D4) at 26 days after sowing. The crop sown at 1st Dec. (D3) recorded the maximum (40.10) number of aphids. The crop sown at 1st Dec. (D3) recorded the maximum (203.18) number of aphid at 33 days after sowing. The minimum (1.05) number of population of aphids was recorded on the crop which sown at 16th Dec. (D4).

At 40 and 47days after sowing, the maximum number of aphids of 140.88 and 91.39 per shoot/plant were recorded on 16th Nov. (D2) sown crop. The increase in population of aphids in D1 was noticed since 26 days after sowing to 75 days.

At 54, 61, 68 and 75 days after sowing the population of aphids on crop sown at 16th Nov. (D2), 1st Dec. (D3), 16th Dec. (D4) and 1st Jan. (D5) was not observed. They were free from attack of aphids.

The almost all varieties recorded more or less number of aphids from 26 days after sowing to 75 days after sowing when crop sown at 1st Nov. (D1). Among various crop varieties sown at 1st Nov. (D1), the variety NIAW 917 recorded minimum (0.53, 0.60, 0.60, 0.73, 6.27, 25.20, 38.80 and 58.73) number of aphids/shoot/plant at 26, 33, 40, 47, 54, 61, 68 and 75 days after sowing, respectively. It was followed by the varieties NIAW 34 and NIAW 301 sown at 1st Nov.

Varieties:
The data presented in table 10.31b revealed that the varieties showed significant differences among each other. The variety NIAW 917 (V1) showed significantly less (5.47, 22.87, 16.03, 5.59, 1.25, 5.04, 9.09 and 11.75) number of aphids/shoot/plant at 26, 33, 40, 47, 54, 61, 68 and 75 days after sowing. The maximum number of aphids population of 34.22, 97.94, 80.48, 48.07, 9.12, 32.91, 64.25 and 67.39/shoot/plant were recorded on susceptible check variety A-9-30-1 (V5) at 26, 33, 40, 47, 54, 61, 68 and 75 days after sowing.

Sowing date x variety interaction:
Sowing date x variety interaction was significant. Among interaction of 1st Nov. (D1), 16th Nov. (D2) and 1st Dec. (D3) the lowest (0.00) number of aphids at 40 days after sowing was found in variety NIAW- 917, NIAW 34, NIAW 1415, NIAW 301 and LOK-1 which sown on 1st Dec. (D3). The population of aphids was not recorded at 47 days after sowing in same variety sown at similar date.

Shoot fly:
Infestation of shoot fly was not recorded on crop sown at 1st Nov. (D1), 16th Nov. (D2) and 1st Dec. (D3). Maximum (29.09) per cent infested shoot by shoot fly was recorded on crop sown at 1st Jan. (D5). Among the various varieties, the lowest (6.03) per cent infested shoot by shoot fly was recorded in NIDW 295. Due to the interaction effect of sowing date x variety the crop sown at 1st Jan. (D5) and variety LOK-1 (V8) recorded maximum (50.89) per cent infested shoot. Among the crop sown at 16th Dec. (D4) and 1st Jan. (D5) the variety NIAW-1415 recorded minimum number of 2.00% infested shoot by shoot fly and it was followed by NIDW 295 (V6) (5.11%) (Table 10.32b).

Yield:
Among the sowing dates, varieties and sowing dates X varieties, the grain yield differences were significant (Table 4). The highest average (43.80 q/ha) yield of wheat was found in crop sown at 1st Dec. (D3). It was at par with D2 i.e. crop sown at 16th Nov. (40.71 q/ha).
In case of varieties, the highest grain yield of 47.46 q/ha was recorded in variety NIAW 917 (V1). It was at par with variety NIAW 34 (V2) (45.51 q/ha). Among sowing date X variety interaction the highest (55.41 q/ha) grain yield of wheat was obtained in the combination viz. D3V1 sowing dates 1st Dec. X variety NIAW-917 (V1). It was at par with D2V1 (52.50), D3V2 (50.24), D3V7 (50.20) and D3V3 (49.96).
In the present study, the decline in aphid population was observed from end of Jan. This may be due to the increasing maximum and minimum temperature during onwards period. The crop sown at 16th Dec. and 1st Jan. was found very less number of aphid population but it was heavily affected by shoot fly and resulted to yield losses, addition to this environmental condition was not sufficiently favourable for wheat crop growth during that period. Delayed sowing adversely affects the physiological metabolic activity of the crop and resulted in stunted growth reduced number of tillers and consequent reduction in grain yield.

Morphological plant characters:
Due to the effect of sowing date and variety the plant height, earhead length (spike length), leaf area, number of spikelet/spike, number of grains per ear head and 1000 grain weight were significantly affected (table 4). The highest (8.66, 41.00, 17.68 and 41.79) ear head length, leaf area, number of spikelet/spike and 1000 grain weight

were found in crop sown at 1st Dec. (D3). The result shows that the plant height, ear head length, leaf area, number of grains per head and 1000 grain weight were increased with each successive delay in sowing after 1st Nov. (D1) up to 1st Dec. (D3) and further delay in sowing after 1st Dec. all the plant characters, number of grains per ear head and 1000 grain height again started to decreased.

The highest (73.53 and 44.19) number of grains per ear head and 1000 grain weight were found in NIAW 1415 (V3) and NIDW 295 (V6), respectively. Due to interaction effect of sowing dates and variety number of grains per ear head and 1000 grain weight were significantly affected (Table 10.29b). The highest (80.07 and 46.08) number of grains and 1000 grain weight were found in D3V3 and D3V6, respectively.

Centre: Ludhiana

This experiment was conducted in the irrigated fields at Plant Breeding Research Farm, PAU Ludhiana. The wheat variety WH 1105 was sown at four different dates of sowing at 15 days interval and no insecticide was applied to control any pest in this trial. However, all other agronomic practices were followed as per recommendations of PAU package of practices. The data on major pests viz. foliage feeding aphids, root aphid, pink stem borer, termites etc. were recorded throughout crop growing season at fortnightly intervals (Table 10.33).

1. **Termite damage:** The termite damage recorded at different dates of sowing indicated that early sown crop (2 Nov. 2014) suffered significantly more termite damage as compared to timely, late and very late sown crop. No termite damage was observed in any date of sowing between 6 week old crop and starting of ear emergence. At earing stage, again termite damage was maximum in early sown crop followed by timely and late sown crop.
2. **Aphid incidence:** The aphids first appeared in end of January in some dates of sowing. The aphid incidence was significantly more in early and timely sown on 19.02.2015 and 3.3.2015 as compared to late and very late sown crop. Qn 16.03.2015 and 31.03.2015, aphids incidence was significantly less in early and timely sown crop as compared to late and very late sown crop.
3. **Root aphid incidence:** The root aphids first appeared in early sown crop followed by timely and late sown. The root aphid incidence was significantly more in early sown at 3 WAS as compared to timely and late sown crop. At 4 WAS and 5 WAS, significant differences in root aphids incidence was observed among different dates of sowing.
4. **Pink stem borer Damage:** The pink stem borer damage was significantly more in early and timely sown crop as compared to late and very late sown crop at 3 WAS. Similar trend was observed at 5 WAS. At 7 was, there was no significant difference in pink stem borer damage among different dates of sowing.

Centre: Karnal

1. **Aphid incidence:** The aphid infestation started in last week of January and gradually increased during vegetative and reproductive growth phase of wheat crop. The population reached its peak in the month of February. The population of aphids was not observed on crop sown at 1st Nov. (D1), 16th Nov. (D2) at 60 and 67 days after sowing. The crop sown at 16th Dec. (D4) recorded the maximum (97.80) number of aphids at 67 days after sowing. The crop sown on 1st Dec. (D3) recorded the maximum (95.60) number of aphids at 81 days after sowing. The minimum (3.08) number of aphids was recorded on the crop which was sown on 1st Dec. (D3) (Table 10.34a).

2. **Pink stem borer Damage:** The per cent dead heart was maximum (0.47) was recorded on crop sown 16th Dec. (D4) and minimum (0.28) on crop sown on 1st Dec. (D1). There was no significant difference in pink stem borer damage among different dates of sowing (Table 10.31b).

3. **Termite damage:** The termite damage recorded at maturity stage indicated that crop sown on 16th Dec.(D4) suffered significantly more termite damage(7.77 % damage effective tillers / m row) as compared to crop sown on 1st Nov.(D1), 16th Nov.(D2) and 1st Dec.(D3) sown crop. There was no termite damage recorded seedling stage (Table 10.34b).

Centre: Kharibari

An experiment was conducted at Regional Research sub-station (Terai Zone) UBKV, Kharibari, Darjeeling. The wheat variety Sonalika was sown on 15th December'2014, 30th December'2014 and 15th January'2015. The experiment was laid out in Randomized Block Design with four replication and the plots of 5m X 4m length.

The mean number of aphid population was recorded from randomly selected fifteen tagged plants per plot taking their 10 cm twigs. The observations were taken at weekly intervals starting from 46th standard week and continuing upto 16th standard week. These recorded data were correlated with various abiotic parameters like temperature (Maximum and Minimum), Relative Humidity (Maximum and Minimum) and rainfall for determining the relationship of prevailing environmental factors with population fluctuation of aphid.

Table 10.32a: Effect of sowing dates and varieties on wheat aphids during 2014-15 (Centre-Niphad)

Sr. No	Treatments	Av. population of aphids/shoot/plant							
		26 DAS	33 DAS	40 DAS	47 DAS	54 DAS	61DAS	68 DAS	75 DAS
1	D1	1.31	1.37	1.46	1.04	23.21	71.72	131.55	152.13
2	D2	22.89	31.67	140.88	91.39	0.00	0.00	0.00	0.00
3	D3	40.10	203.18	1.64	0.00	0.00	0.00	0.00	0.00
4	D4	0.00	1.05	45.89	8.23	0.00	0.00	0.00	0.00
5	D5	5.19	21.47	0.00	0.00	0.00	0.00	0.00	0.00
SE ±		**0.09**	**0.03**	**0.01**	**0.01**	**0.004**	**0.01**	**0.01**	**0.03**
CD at 5%		**0.28**	**0.10**	**0.05**	**0.05**	**0.014**	**0.05**	**0.03**	**0.10**
9	V1	5.47	22.87	16.03	5.59	1.25	5.04	9.09	11.75
10	V2	5.64	30.11	16.40	9.65	2.73	7.45	10.96	16.27
11	V3	10.57	53.01	37.71	16.31	4.83	14.99	20.45	21.24
12	V4	22.07	89.99	55.80	31.47	7.69	17.55	32.63	37.48
13	V5	34.22	97.94	80.48	48.07	9.12	32.91	64.25	67.39
14	V6	18.70	62.32	63.01	34.51	6.60	22.88	49.45	53.63
15	V7	8.28	34.04	20.59	8.43	2.45	7.89	10.60	14.56
16	V8	6.24	23.71	13.77	7.04	2.45	6.04	13.04	21.11
SE ±		**0.11**	**0.03**	**0.03**	**0.02**	**0.02**	**0.03**	**0.03**	**0.03**
CD at 5%		**0.30**	**0.08**	**0.07**	**0.05**	**0.06**	**0.08**	**0.07**	**0.08**
17	D1V1	0.53 (1.23)	0.60 (1.25)	0.60 (1.26)	0.73 (1.31)	6.27 (2.69)	25.20 (5.12)	38.80 (6.31)	58.73 (7.73)
18	D1V2	1.40 (1.55)	1.53 (1.59)	0.73 (1.30)	0.67 (1.29)	13.67 (3.83)	37.27 (6.18)	54.80 (7.47)	81.33 (9.07)
19	D1V3	1.53	0.80	2.13	0.53	24.13	74.93	102.27	106.20

Sr. No	Treatments	Av. population of aphids/shoot/plant							
		26 DAS	33 DAS	40 DAS	47 DAS	54 DAS	61DAS	68 DAS	75 DAS
		(1.60)	(1.33)	(1.76)	(1.23)	(5.01)	(8.71)	(10.16)	(10.35)
20	D1V4	1.87 (1.70)	2.27 (1.80)	2.47 (1.86)	1.47 (1.57)	38.47 (6.28)	87.73 (9.42)	163.13 (12.81)	187.40 (13.72)
21	D1V5	2.53 (1.87)	2.20 (1.78)	2.53 (1.88)	2.07 (1.75)	45.60 (6.83)	164.53 (12.87)	321.27 (17.95)	336.93 (18.38)
22	D1V6	1.47 (1.56)	1.27 (1.50)	1.07 (1.43)	1.33 (1.53)	33.00 (5.83)	114.40 (10.73)	247.27 (15.76)	268.13 (16.40)
23	D1V7	0.47 (1.21)	0.93 (1.38)	0.80 (1.34)	0.67 (1.29)	12.27 (3.64)	39.47 (6.36)	53.00 (7.35)	72.80 (8.59)
24	D1V8	0.67 (1.29)	1.33 (1.52)	1.33 (1.52)	0.87 (1.36)	12.27 (3.64)	30.20 (5.59)	65.20 (8.13)	105.53 (10.32)
25	D2V1	15.93 (4.11)	22.00 (4.79)	55.67 (7.53)	26.47 (5.24)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
26	D2V2	10.67 (3.41)	16.40 (4.17)	45.07 (6.79)	41.07 (6.49)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
27	D2V3	26.87 (6.61)	35.73 (6.06)	141.00 (11.92)	69.27 (8.38)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
28	D2V4	37.73 (6.22)	51.13 (7.22)	221.13 (14.90)	141.80 (11.95)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
29	D2V5	42.33 (6.58)	58.53 (7.72)	313.20 (17.72)	221.07 (14.90)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
30	D2V6	29.47 (5.52)	39.53 (6.36)	244.20 (15.65)	163.07 (12.81)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
31	D2V7	9.73 (3.27)	17.33 (4.28)	67.60 (8.28)	38.60 (6.29)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
32	D2V8	10.40 (3.37)	12.73 (3.70)	39.13 (6.33)	29.73 (5.54)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
33	D3V1	9.20 (3.19)	87.00 (9.38)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
34	D3V2	10.53 (3.39)	114.93 (10.76)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
35	D3V3	22.33 (4.82)	197.40 (14.08)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
36	D3V4	63.53 (8.03)	355.67 (18.89)	6.47 (2.73)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
37	D3V5	117.33 (10.88)	390.80 (19.79)	5.20 (2.49)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
38	D3V6	55.47 (7.51)	242.40 (15.60)	1.47 (1.57)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
39	D3V7	25.20 (5.11)	143.20 12.01	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
40	D3V8	17.20 (4.26)	94.00 9.75	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
41	D4V1	0.00 (1.00)	0.00 (1.00)	23.87 (4.99)	0.73 (1.31)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
42	D4V2	0.00 (1.00)	0.00 (1.00)	36.20 (6.10)	6.53 (2.74)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
43	D4V3	0.00 (1.00)	0.00 (1.00)	45.40 (6.81)	11.73 (3.57)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
44	D4V4	0.00 (1.00)	2.60 1.89)	48.93 (7.07)	14.07 (3.88)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)

Sr. No	Treatments	Av. population of aphids/shoot/plant							
		26 DAS	33 DAS	40 DAS	47 DAS	54 DAS	61DAS	68 DAS	75 DAS
45	D4V5	0.00 (1.00)	4.23 2.29)	81.47 (9.08)	17.20 (4.26)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
46	D4V6	0.00 (1.00)	1.60 1.43)	68.33 (8.32)	8.13 (3.02)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
47	D4V7	0.00 (1.00)	0.00 (1.00)	34.53 (5.96)	2.87 (1.97)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
48	D4V8	0.00 (1.00)	0.00 (1.00)	28.40 (5.42)	4.60 (2.37)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
49	D5V1	1.67 (1.64)	4.73 (2.39)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
50	D5V2	5.60 (2.57)	17.67 (4.32)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
51	D5V3	2.13 (1.77)	31.13 (5.67)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
52	D5V4	7.20 (2.86)	38.27 (6.27)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
53	D5V5	8.93 (3.15)	33.93 (5.91)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
54	D5V6	7.07 (2.84)	26.80 (5.27)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
55	D5V7	6.00 (2.65)	8.73 (3.12)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
56	D5V8	2.93 (1.98)	10.47 (3.39)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
SE $\pm$ Interaction)		**0.24**	**0.08**	**0.04**	**0.04**	**0.01**	**0.04**	**0.03**	**0.08**
CD at 5% (Interaction)		**0.68**	**0.18**	**0.17**	**0.11**	**0.13**	**0.17**	**0.16**	**0.18**

Figures in parentheses indicate V_{n+1} transformed value DAS= days after sowing

D1= 1st Nov., D2:16th Nov., D3=1st Dec., D4= 16th Dec., D5= 1st Jan.

** V1= NIAW 917, V2= NIAW 34, V3= NIAW 1415, V4= GW-496, V5= A-9-30-1, V6= NIDW 295, V7=NIAW 301,V8=LOK

Table 10.32b: Effect of sowing dates and varieties on shoot fly, plant characters and yield of wheat during 2014-15 (Centre-Niphad)

SN	Treat ments	Av. no.of Natural enemies/m²	(%)infested shoot by shoot fly	Plant height (cm)	Spike Length (cm)	Leaf area (cm²)	No. of spikelet/spike	No. of grain/ ear head	1000 grain weight(g)	Yield (q/ha)
1	D1	1.96	0.00 (0.00)	77.94	8.51	33.37	15.02	48.85	39.94	37.30
2	D2	1.95	0.00 (0.00)	92.74	8.61	39.62	15.85	50.59	41.51	40.71
3	D3	1.93	0.00 (0.00)	84.49	8.66	41.00	17.68	49.08	41.79	43.80
4	D4	1.00	18.96 (25.77)	81.98	7.82	36.45	15.87	48.31	38.05	38.32
5	D5	1.00	29.09 (32.65)	75.26	7.51	30.60	15.04	35.14	36.07	28.26
SE ±		**0.01**	**0.21**	**0.14**	**0.01**	**0.13**	**0.06**	**0.20**	**0.05**	**0.97**
CD at 5%		**0.04**	**0.72**	**0.46**	**0.03**	**0.43**	**0.21**	**0.64**	**0.16**	**3.20**
9	V1	1.64	7.16 (15.56)	79.55	8.86	36.58	16.69	48.53	38.33	47.46
10	V2	1.62	10.00 (18.44)	78.49	8.44	39.67	16.23	38.67	39.29	45.51
11	V3	1.64	6.82 (15.12)	74.97	9.33	39.08	18.79	73.53	38.86	43.64
12	V4	1.46	12.49 (20.70)	79.92	8.58	35.47	14.11	43.71	38.27	29.86
13	V5	1.45	7.10 (15.45)	101.13	6.66	32.78	15.00	40.33	38.35	25.75
14	V6	1.45	6.03 (14.18)	79.36	6.33	30.86	15.61	39.59	44.19	33.46
15	V7	1.65	11.30 (19.64)	86.47	9.24	37.71	17.36	46.95	40.31	43.40
16	V8	1.64	15.98 (23.50)	79.97	8.32	37.52	13.35	39.84	30.34	32.34
SE ±		**0.01**	**0.16**	**0.13**	**0.01**	**0.12**	**0.08**	**0.24**	**0.06**	**0.99**
CD at 5%		**0.03**	**0.45**	**0.38**	**0.03**	**0.34**	**0.23**	**0.66**	**0.18**	**2.82**
17	D1V1	3.28	0.00 (0.00)	74.80	10.01	34.16	18.53	49.17	40.14	49.44
18	D1V2	2.81	0.00 (0.00)	82.13	8.71	40.29	15.73	39.03	42.69	46.73
19	D1V3	3.32	0.00 (0.00)	65.73	9.39	35.84	20.07	78.43	40.91	43.86
20	D1V4	2.31	0.00 (0.00)	85.20	9.89	31.01	11.73	45.30	38.11	29.20
21	D1V5	2.21	0.00 (0.00)	94.07	5.85	29.70	8.93	40.10	39.14	22.67
22	D1V6	2.09	0.00 (0.00)	60.00	5.63	26.98	13.53	40.30	42.17	31.18
23	D1V7	3.62	0.00 (0.00)	79.07	9.48	34.64	18.00	54.50	41.21	44.62
24	D1V8	3.28	0.00 (0.00)	82.67	9.14	34.32	13.60	44.00	35.11	30.69
25	D2V1	3.45	0.00 (0.00)	95.33	9.94	38.44	17.20	49.37	41.15	52.50
26	D2V2	3.39	0.00 (0.00)	91.47	8.03	40.86	15.47	40.13	43.30	48.95
27	D2V3	3.31	0.00 (0.00)	83.00	10.21	44.19	17.87	79.07	43.14	47.77
28	D2V4	2.02	0.00 (0.00)	91.40	9.38	39.06	16.20	47.00	39.10	31.94
29	D2V5	1.96	0.00 (0.00)	106.40	6.82	35.76	13.87	48.00	40.19	28.22
30	D2V6	2.10	0.00 (0.00)	88.40	6.32	34.18	15.33	42.07	45.51	36.38
31	D2V7	3.34	0.00 (0.00)	99.53	9.84	41.13	16.80	56.07	41.29	46.21
32	D2V8	3.28	0.00 (0.00)	86.40	8.32	43.34	14.07	43.00	38.39	33.68

SN	Treat ments	Av. no.of Natural enemies/m²	(%)infested shoot by shoot fly	Plant height (cm)	Spike Length (cm)	Leaf area (cm²)	No. of spikelet/spike	No. of grain/ ear head	1000 grain weight(g)	Yield (q/ha)
33	D3V1	3.10	0.00 (0.00)	84.93	8.19	42.66	15.67	52.07	41.15	55.41
34	D3V2	3.19	0.00 (0.00)	73.00	9.84	45.78	18.60	42.10	43.26	50.24
35	D3V3	3.30	0.00 (0.00)	77.00	10.25	44.45	21.07	80.07	43.18	49.96
36	D3V4	2.00	0.00 (0.00)	74.73	8.20	39.42	16.73	48.13	40.14	35.31
37	D3V5	1.93	0.00 (0.00)	108.53	7.23	37.32	18.60	43.17	40.24	31.80
38	D3V6	2.06	0.00 (0.00)	82.00	6.83	34.79	17.13	43.07	46.08	39.02
39	D3V7	3.08	0.00 (0.00)	91.40	9.66	41.70	18.07	44.00	41.18	50.20
40	D3V8	3.36	0.00 (0.00)	84.33	9.07	41.88	15.60	40.03	39.12	38.43
41	D4V1	0.00	6.66 (15.00)	75.87	8.17	36.47	16.20	52.07	36.04	47.50
42	D4V2	0.00	8.66 (17.16)	81.40	7.93	37.84	14.80	42.07	35.93	47.53
43	D4V3	0.00	2.00 (8.13)	76.13	8.65	39.04	17.07	74.97	35.01	44.86
44	D4V4	0.00	17.11 (21.43)	73.33	7.84	37.44	13.87	47.03	39.05	29.20
45	D4V5	0.00	8.22 (16.64)	103.53	6.85	34.59	18.27	43.10	36.08	26.07
46	D4V6	0.00	5.11 (13.05)	85.13	6.55	30.93	16.73	43.03	44.05	33.29
47	D4V7	0.00	15.33 (2303)	78.80	8.79	38.61	17.87	44.10	39.13	44.23
48	D4V8	0.00	31.99 (34.39)	81.67	7.79	36.72	12.13	40.10	39.07	33.89
49	D5V1	0.00	12.66 (20.88)	66.80	7.99	31.16	15.87	39.97	33.19	32.43
50	D5V2	0.00	29.55 (32.90)	64.47	7.71	33.55	16.53	30.03	31.29	34.09
51	D5V3	0.00	19.33 (26.86)	73.00	8.15	31.87	17.87	55.10	32.06	31.77
52	D5V4	0.00	37.99 (38.00)	74.93	7.60	30.43	12.00	31.10	34.95	23.64
53	D5V5	0.00	10.44 (18.81)	93.13	6.55	26.52	15.33	27.27	36.09	20.00
54	D5V6	0.00	8.66 (17.16)	81.40	6.35	27.42	15.33	29.50	43.12	27.43
55	D5V7	0.00	30.44 (33.45)	83.53	8.45	32.47	16.07	36.07	38.74	31.77
56	D5V8	0.00	50.89 (45.52)	64.80	7.27	31.67	11.33	32.07	39.09	25.00
SE ± (Interaction)		**0.03**	**0.61**	**0.39**	**0.03**	**0.37**	**0.18**	**0.52**	**0.16**	**2.73**
CD at 5% (Interaction)		**0.06**	**1.07**	**0.87**	**0.08**	**0.78**	**0.53**	**1.60**	**0.39**	**5.80**

Figures in parentheses indicate arc sin value;

D1= 1st Nov., D2:16th Nov., D3=1st Dec., D4= 16th Dec., D5= 1st Jan.

** V1= NIAW 917, V2= NIAW 34, V3= NIAW 1415, V4= GW-496, V5= A-9-30-1, V6= NIDW 295, V7=NIAW 301,V8=LOK-1

Table 10.33: Effect of sowing dates on population build of major insect pests in wheat during 2014-15 (Centre-Ludhiana)

Termite Damage (%)					
Date of Sowing	3 WAS	4 WAS	5 WAS	Milky grain stage	Grain maturity stage
2 Nov., 2014 (Early sown)	2.39 (9.77)	2.34 (9.70)	2.11 (9.29)	1.63 (8.38)	1.50(8.11)
16 Nov., 2014 (timely sown)	1.67 (8.46)	1.55 (8.23)	1.42 (7.96)	1.36 (7.84)	1.43(7.98)
2 Dec., 2014 (late sown)	1.04 (7.12)	1.11 (7.27)	0.79 (6.52)	0.99 (7.00)	1.16(7.40)
17 Dec., 2014 (V. late sown)	0.74 (6.34)	0.65 (6.14)	0.52 (5.80)	0.54 (5.84)	0.50 (5.72)
CD (p= 0.05)	(1.13)	(0.75)	(0.67)	(0.49)	(0.71)
Aphid incidence (aphids/tiller)					
Date of Sowing	**19.02.2015**	**03.03.2015**	**16.03.2015**	**31.03.2015**	
2 Nov., 2014 (Early sown)	9.41 (3.21)	20.85 (4.66)	6.58 (2.74)	1.30 (1.51)	
16 Nov., 2014 (timely sown)	8.80 (3.12)	20.11 (4.59)	9.08 (3.17)	2.52 (1.86)	
2 Dec., 2014 (late sown)	7.62 (2.93)	17.19 (4.26)	13.23 (3.77)	3.73 (2.17)	
17 Dec., 2014 (V. late sown)	5.84 (2.61)	12.07 (3.61)	17.05 (4.24)	7.19 (2.85)	
CD (p= 0.05)	(0.30)	(0.39)	(0.25)	(0.28)	
Root aphid incidence (aphids/tiller)					
Date of Sowing	**3 WAS**	**4 WAS**	**5 WAS**		
2 Nov., 2014 (Early sown)	5.73 (2.59)	5.09 (2.46)	3.31 (2.07)		
16 Nov., 2014 (timely sown)	4.16 (2.27)	3.80 (2.19)	2.74 (1.93)		
2 Dec., 2014 (late sown)	3.27 (2.06)	3.02 (2.00)	2.01(1.73)		
17 Dec., 2014 (V. late sown)	2.76 (1.94)	2.33 (1.82)	1.84 (1.68)		
CD (p= 0.05)	(0.17)	(0.16)	(0.09)		
Pink stem borer Damage (%)					
Date of Sowing	**3 WAS**	**5 WAS**	**7 WAS**		
2 Nov., 2014 (Early sown)	1.58 (8.28)	1.80 (8.72)	0.81 (6.57)		
16 Nov., 2014 (timely sown)	1.33 (7.76)	1.53 (8.19)	0.48 (5.67)		
2 Dec., 2014 (late sown)	0.98 (6.98)	1.17 (7.43)	0.43 (5.54)		
17 Dec., 2014 (V. late sown)	0.65 (6.14)	0.82 (6.57)	0.36 (5.26)		
CD (p= 0.05)	(0.54)	(0.75)	NS		

* Figures in parentheses are transformed val

Table 10.34a: Effect of sowing dates on population build of major insect pests in wheat during 2014-15 (Centre-Karnal)

	Aphid incidence (aphids/tiller)							
Treatments	**60DAS**	**67DAS**	**74DAS**	**81DAS**	**88DAS**	**95DAS**	**102DAS**	**Yield (qt./ha.)**
D1 (01-11-2014)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	20.80 (4.66)	33.80 (5.89)	37.00 (6.15)	90.40 (9.56)
D2 (16-11-	0.00 (1.00)	0.00 (1.00)	7.92 (2.98)	31.40 (5.68)	45.00 (6.77)	92.72 (9.66)	33.60 (5.88)	21.00 (4.69)

2014)								
D3 (01-12-2014)	6.12 (2.65)	30.60 (5.61)	46.40 (6.88)	95.60 (9.82)	35.40 (6.03)	23.80 (4.97)	9.00 (3.15)	3.08 (2.02)
D4 (16-12-2014)	31.40 (5.68)	97.80 (9.93)	47.00 (6.92)	29.40 (5.50)	6.80 (2.79)	5.04 (2.46)	0.00 (1.00)	0.00 (1.00)
SE ±	0.13	0.11	0.13	0.16	0.11	0.20	0.13	0.07
CD at 5%	0.41	0.34	0.40	0.49	0.34	0.61	0.41	0.22

Table 10.34b: Effect of sowing dates on Pink stem borer and Termite Damage in Wheat. during 2014-15 (Centre-Karnal)

Treatments	Plant pop / m row	Pink Stem borer damage	Termite Damage (%)	Grain yield (q /ha)
		% Dead hearts	% damage effective tillers / m row at maturity	
D1(01-11-2014)	69.20	0.28	6.96	35.40
D2(16-11-2014)	70.00	0.31	6.85	41.40
D3(01-12-2014)	71.00	0.40	5.86	43.80
D4(16-12-2014)	69.20	0.47	7.77	36.80
SE ±	0.91	0.05	0.22	1.75
CD at 5%	NS	NS	0.67	5.41

Table 10.35: Effect of sowing dates on aphid incidence in wheat during 2014-15 (Centre-Kharibari)

Standard Weeks	Rainfall (mm)	Relative humidity (%)		Temperature ^0C		Aphid incidence (Aphids/tiller)		
		Max	Min	Max	Min	Date of sowing 15.12.14	Date of sowing 30.12.14	Date of sowing 15.01.15
51	0.00	96.14	51.14	24.71	12.14	0.00	0	0
52	0.00	96.29	48.00	24.86	9.86	0.00	0	0
1	0.80	93.29	40.00	27.40	10.34	1.71	0	0
2	0.49	90.71	59.57	24.91	10.47	35.43	0	0
3	0.00	89.86	38.00	26.00	8.66	105.14	2.15	0
4	0.00	91.57	47.29	24.50	7.96	176.43	45.26	0
5	0.00	92.71	61.57	22.63	9.60	253.00	75.86	3.5
6	0.00	90.43	47.86	26.03	9.23	314.14	102.65	25.56
7	0.00	89.57	51.57	25.66	11.11	344.14	125.9	65.52
8	1.07	88.29	41.71	27.04	12.07	228.86	148.85	104.3
9	2.14	91.00	47.43	29.11	14.91	72.43	205.26	186.64
10	0.31	89.29	55.43	27.54	13.74	66.57	175.68	152.2
11	0.00	87.00	40.43	30.39	14.70	50.76	140.25	120.45
12	0.00	86.29	42.71	30.47	14.79	25.89	80.5	80.87
13	0.00	88.43	52.00	32.21	18.33	2.90	56.6	40.36
14	7.11	92.29	64.00	30.03	18.46	0.70	25.1	20.26
15	5.80	89.57	62.00	30.77	19.00	0.00	0.3	0.5

*Yield (q/ha): 15.12.14=24.15; 30.12.14=26.85; 15.01.15=22.35

r-value (Coefficient of correlation)

	Date				15.12.14	30.12.14	15.01.15
1	Temperature Maximum	X	Aphid No.	=	-0.48735	0.190291	0.39928*
2	Temperature Minimum	X	Aphid No.	=	-0.51389	0.122065	0.314061
3	Relative humidity Maxi	X	Aphid No.	=	-0.17172	-0.50009	-0.51048
4	Relative Humidity Mini	X	Aphid No.	=	-0.06893	-0.17664	-0.22903
5	Rain fall	X	Aphid No.	=	-0.32375	-0.16963	-0.06171

*= SIGNIFICANT AT 5% LEVEL OF SIGNIFICANCE

Experiment No. 11: Basic studies for development of IPM (Experiment No. 11)
11 a: Pest modelling for foliage aphids.
Centre: Ludhiana

The data was recorded by randomly selecting ten individual tillers from 500 m^2 area while moving, in a diagonal path in the field. The population of *Coccinella septempunctata* was recorded in 1m^2 area around the individual plant. Weekly observations were recorded to study the first incidence and population build up of aphid and Coccinellid beetle.

Population dynamics of Wheat aphid: The aphid first appeared on 19.1.2015 on wheat crop and it started rising and reached it's peak on 27.02.2015 (Table 10.36a). Thereafter population of wheat aphid started declining and it drastically decreased on 31.04.2015. The population of Coccinellid beetle remained low up to 02.03.2015 (one week after the peak period of activity of wheat aphid) and thereafter it started rising and reach it's peak on 16.03.2015.

Population dynamics of barley aphid: The aphid population on barley was high as compared to wheat during the whole crop season (Table 10.36b). It first appeared on 12.01.2015 on barley crop and it started rising and reached its peak on 27.02.2015. Thereafter its population started declining and become almost negligible on 31.03.2015. The population of coccinellid beetles remained low up to 02.03.2015 (the peak period of activity of barley aphid) and thereafter it stated rising and reached its peak on 16.03.2015.

Thus, it can be concluded from the data that comparatively high population of aphid appeared on barley as compared to wheat crop. The data also indicated that coccinellid beetle appeared after the peak period of aphid infestation on wheat and barley crop.

Table 10.36a: Forecasting of wheat aphid trial (population dynamics of wheat aphid and Coccinellid beetle (Centre: Ludhiana)

Date of observation	Plant No.(No. of aphids/tiller)											Collateral host (Barley)			
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	Avg.	P1	P2	P3	Avg.
19.01.2015	1	0	1	0	0	0	0	0	2	0	0.4	0	0	0	0.00
27.01.2015	0	2	1	1	0	0	0	0	1	3	0.8	1	0	0	0.33
06.02.2015	5	0	1	1	4	1	2	2	1	3	2	5	0	8	4.33
13.02.2015	15	7	9	10	8	12	10	7	10	13	10.1	10	8	12	10.00
20.02.2015	14	11	14	18	15	23	8	18	20	14	15.5	14	18	22	18.00
27.02.2015	50	40	35	35	30	22	40	20	30	15	31.7	100	50	50	66.67
02.03.2015	25	10	30	25	20	22	10	28	35	8	21.3	102	50	70	74.00
09.03.2015	14	19	20	25	11	12	31	14	16	22	18.4	44	54	32	43.33
16.03.2015	12	16	15	18	10	17	22	25	18	10	16.3	25	35	25	28.33
24.03.2015	8	4	5	8	11	0	5	8	11	14	7.4	24	21	10	18.33
31.04.2015	1	5	0	0	0	2	0	0	0	0	0.8	1	4	0	1.67
19.01.2015	0	0	0	0	0	0	0	0	0	0	0.00	1	0	0	0.33

Date of observation	Plant No.(No. of aphids/tiller)											Collateral host (Barley)			
27.01.2015	0	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0.00
06.02.2015	0	0	1	0	0	2	0	0	0	0	0.30	0	0	0	0.00
13.02.2015	0	0	0	0	0	2	0	3	0	0	0.50	1	0	0	0.33
20.02.2015	0	0	7	0	5	0	0	1	1	0	1.40	3	2	0	1.67
27.02.2015	0	5	4	0	0	0	7	0	0	7	2.30	7	4	5	5.33
02.03.2015	9	4	0	4	11	11	4	5	4	8	6.00	16	8	9	11.00
09.03.2015	16	0	12	14	7	17	7	0	14	0	8.70	14	14	19	15.67
16.03.2015	12	15	9	17	20	4	8	10	10	9	11.40	14	17	22	17.67
24.03.2015	5	10	9	18	14	8	7	5	7	4	8.70	14	5	8	9.00
31.04.2015	4	4	5	5	0	7	0	4	1	2	3.20	1	9	2	4.00

Table 10.36b: Forecasting of barley aphid trial (population dynamics of barley aphid and Coccinellid beetle) (Centre: Ludhiana)

Date of observation	Avg.
12.01.2015	0.1
19.01.2015	0.8
27.01.2015	1.1
06.02.2015	2.5
13.02.2015	10.5
20.02.2015	18.2
27.02.2015	68.2
02.03.2015	56.2
09.03.2015	37.9
16.03.2015	36.1
24.03.2015	18.9
31.04.2015	1.5

Date of observation	Avg.
12.01.2015	0
19.01.2015	0.1
27.01.2015	0
06.02.2015	0.2
13.02.2015	0.4
20.02.2015	1.6
27.02.2015	4.7
02.03.2015	5.1
09.03.2015	12.2
16.03.2015	17.7
24.03.2015	4.6
31.04.2015	1.9

Centre: Niphad

The data presented in Table 10.37 in respect of the weekly observations on wheat aphids were recorded along with different weather parameters. It is revealed that the maximum number of aphids/shoot/plant (364.10) was observed in 4th Meteorological week when the maximum and minimum temperatures were 27.10 and 9.5°C, respectively and average relative humidity was 60.0 per cent. The incidence of jassids on wheat was also recorded. The maximum population of the Jassids/plant (12.7) was recorded in 51st Meteorological week when the maximum and minimum temperatures were 25.0 and 6.1 °C respectively. The maximum (11.70) natural enemies/m2 was recorded in 7th MW when maximum and minimum temperature were 31.8 and 11.0°C respectively and average humidity was 40 per cent

Table 10.37: Seasonal incidence of the aphids and lady bird beetle on wheat at Niphad

Meteo. Weeks	No. of Aphids /Shoot/plant	Population of natural enemies/m^2	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
			Max.	Min.	Morn.	Even.	
45	0.0	0.0	0.0	31.7	13.8	74	43
46	0.0	0.0	0.0	29.8	19.3	80	66
47	0.0	0.0	0.0	30.4	13.5	74	54
48	0.0	0.0	3.10	30.0	12.8	72	42
49	1.70	0.0	8.20	29.2	12.0	75	36
50	4.30	0.0	10.00	28.0	11.7	84	30
51	4.60	0.0	12.70	25.0	6.1	79	31

Meteo. Weeks	No. of Aphids /Shoot/plant	Population of natural enemies/m^2	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
			Max.	Min.	Morn.	Even.	
52	36.50	0.0	6.50	26.2	7.5	75	31
1	124.80	0.0	3.70	24.9	11.4	79	61
2	249.20	0.0	0.70	27.4	5.5	68	27
3	282.80	0.0	0.0	27.2	7.7	79	36
4	364.10	0.0	0.0	27.1	9.5	80	40
5	30.10	2.00	0.0	28.9	10.4	75	37
6	0.0	6.70	0.0	29.2	11.3	68	34
7	0.0	11.70	0.0	31.8	11.0	64	26
8	0.0	1.50	0.0	33.0	11.1	68	31
9	0.0	0.0	0.0	28.1	10.7	85	52

11 b: Basic studies on seasonal incidence and parasitism of *Helicoverpa*

Centre: Vijapur

a. Seasonal incidence of H. armigera

Study on seasonal incidence of *H. armigera* was undertaken at Centre of Excellence for Research on Wheat, Vijapur. For this, wheat crop was observed at weekly interval for the presence of larval population right from germination to harvest of the crop. Data presented in Table-10.38a revealed that the first appearance of the pests was noticed in the third week of February and it was continued till the fourth week of February.

b. Studies on parasites of wheat crop pests

With a view to know the parasites of wheat pests present in nature, periodical collection of larvae of *H. armigera* from the wheat crop was made and brought to the laboratory for rearing and further study. Data on parasitism given in Table-10.38b indicated 9.52 per cent parasitism by *Campolatis chlorideae* on *H. armigera* larvae.

Table 10.38a: Seasonal activity of *H .armigera* (Location: Vijapur)

Sr. No.	Date of observation	No. of larval / 50 plant
1.	12/1/15	0
2.	19/1/15	0
3.	27/1/15	0
4.	2/2/15	0
5.	9//2/15	0
6.	16//2/15	1
7.	23/2/15	1
8.	2/3/15	0

Table 10.38b: Studies on natural parasitism of *H. armigera* (Location: Vijapur)

Sr. No.	Life stage observed	Date of collection	No. of larvae observed	No. of larvae parasitized	Percent parasitism	Name of parasite
1.	Larval	18/2/15 25/2/15	10 11	1 1	9.52%	*Campolatis chlorideae*

Centre: Pantnagar

To study the incidence of *Helicoverpa armigera* on wheat, experiment has been conducted by sowing wheat and chickpea in alternate lines in 500 m^2 area and observations were taken on the occurrence of *H armigera* on wheat as well as on its preferred host crop chickpea.

Seasonal incidence of *H. armigera* on different wheat varieties at Pantnagar

To study incidence of *H armigera* on different wheat varieties *i.e.* PBW-343, UP 2748, UP-2883, UP 2901, UP 2902, UP 2526 observations were made on the basis of survey conducted for incidence of *Helicoverpa armigera* at NBCRC Pantnagar in comparison to preferred host crop chickpea.

According to the data presented in Table -38 the incidence of *H armigera* started in 2nd week of March except PBW 343 on which it started in last week of March. The larval population was more on Wheat varieties i.e. UP 2748, UP 2883, UP 2901, UP 2902, UP2526 except PBW 343 in comparison to Chickpea (*var.* kabuli) (Table 10.39).

Incidence of Natural enemies of *H. armigera* in wheat crop at Pantnagar

During survey programme of incidence of *H armigera* larvae on different wheat varieties at Pantnagar, different natural enemies of *H armigera* were found such as cocoons of *Cotesia, Campoletis chloriedae,* predators like Carabid beetle, Rove beetle, *Euconthacona, Andrellus* bug feeding on larvae of *H armigera* on foliage of wheat or on pupating larvae on ground surface in the wheat field.

Table-39: Incidence of *H. armigera* on different varieties of Wheat and chickpea during crop season 2015 at Pantnagar, Uttarakhand

S. No.	Date of Observation	Larval population *of H. armigera* /30plants/500 m²						
		Wheat varieties						Chickpea *var.* Kabuli
		PBW 343	UP 2748	UP 2883	UP 2901	UP 2902	UP 2526	
1	14/03/2015	00	25	64	34	35	69	65
2	21/03/2015	00	34	68	49	48	53	80
3	28/03/2015	04	56	47	51	67	48	195
4	03/04/2015	44	79	38	26	58	34	619
5	10/04/2015	34	63	23	10	37	19	710
6	17/04/2015	06	07	00	00	03	03	636
7.	24/04/2015	00	00	00	00	00	00	305

11c. Seasonal incidence of brown wheat mites *Petrobia lateens*

Centre: Durgapura:

The data of brown wheat mite *Petrobia latens* on wheat crop were recorded randomly on ten individual selected plants from 1000 sq. m area while moving in a diagonal path in the field. Weekly observations were recorded to study the first incidence and population build up of brown wheat mite.

Population dynamics of brown wheat mite: The brown wheat mite first appeared on 15.2.2015 on wheat crop and it started rising and reached it's peak on 20.3.2015.Thereafter population of brown wheat mite started declining and drastically decreased up to 30.3.2015 (Table 10.40).

Table.10.40: Seasonal incidence of brown wheat mites at Durgapura

S. No.	Date	Plant No.(Numbers of mites/10 sq cm area)										Avg.
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	
1	15.02.2015	0	0	0	0	2	2	0	0	0	0	0.40
2	25.02.2015	3	2	2	4	2	4	2	4	2	2	2.7
3	10.03.2015	10	6	8	10	12	10	8	10	10	12	16.1
4	20.03.2015	15	18	22	20	20	15	18	20	15	20	18.3
5	30.03.2015	3	0	3	4	3	2	4	2	0	0	2.1

S. No.	Date	Plant No.(Numbers of mites/10 sq cm area)										Avg.
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	
6	04.04.2015	0	0	0	0	0	0	0	0	0	0	0.00
1	15.02.2015	0	0	0	0	2	2	0	0	0	0	0.40

Centre: Karnal

The data was recorded by randomly selecting ten individual tillers from 500 m^2 area while moving in a diagonal path in the field. The population of *Coccinella septempunctata* was recorded in 1 m^2 area around the individual plant. Weekly observations were recorded to study the first incidence and population build up of aphid and Coccinellid beetle.

Population dynamics of Wheat aphid: The aphid first appeared on 26.1.2015 on wheat crop and then it started increasing and reached its peak on 23.02.2015 (Table 10.41a). Thereafter, population of wheat aphid started declining and it drastically decreased on 16.03.2015. The population of Coccinellid beetle started from 02-02-2015 and reached it's peak on 16.03.2015.

Population dynamics of barley aphid: It first appeared on 19.01.2015 on barley crop and it started rising and reached its first peak on 23.02.2015. Thereafter its population started declining. The population of coccinellid beetles remained low up to 16.02.2015 (the peak period of activity of barley aphid) and thereafter it started to increase and reached its peak on 09.03.2015 (Table 10.41b).

The data indicated that comparatively high population of aphid appeared on barley as compared to wheat crop. The data also indicated that coccinellid beetle appeared after the peak period of aphid infestation on wheat and barley crops.

Table 10.41a: Forecasting of wheat aphid trial (population dynamics of wheat aphid and Coccinellid beetle at Karnal

Date of observation	Avg.
26.01.2015	0.30
02.02.2015	22.10
09.02.2015	31.20
16.02.2015	62.50
23.02.2015	63.60
02.03.2015	40.00
09.03.2015	20.20
16.03.2015	3.80

Date of observation	Avg.
26.01.2015	0.00
02.02.2015	0.40
09.02.2015	0.50
16.02.2015	0.50
23.02.2015	0.80
02.03.2015	1.00
09.03.2015	1.10
16.03.2015	1.60

Table 10.401b: Forecasting of barley aphid trial (population dynamics of barley aphid and Coccinellid beetle) at Karnal

Date of observation	Avg.
19.01-2015	2.50
26.01.2015	20.70
02.02.2015	45.70
09.02.2015	96.00
16.02.2015	112.00
23.02.2015	139.50
02.03.2015	79.00
09.03.2015	44.50
16.03.2015	31.00

Date of observation	Avg.
19.01-2015	0.00
26.01.2015	0.30
02.02.2015	1.10
09.02.2015	1.60
16.02.2015	1.80
23.02.2015	2.50
02.03.2015	2.90
09.03.2015	3.70
16.03.2015	2.30

10.4. Stored Grain pests

Experiemnt No. 12 Studies on the insecticidal treatment on viability of store grain pests under ambient condition

Centre: Ludhiana

The experiment was conducted at Wheat Entomological Laboratories, PAU, Ludhiana during 2014-15. Freshly harvested seed with high percentage of germination and low moisture content (>10 %) was taken for experimental purpose. Seven insecticidal treatments were done with required quantity of insecticides diluted in 5 ml water to treat the 1 kg of seed for proper coating. After drying in shade, out of 1 kg seed, only 200 gms of seeds were placed in battery jars covered with muslin cloth and kept under ambient condition in B.O.D. and each treatment was replicated thrice.

The data recorded (one month after insecticidal application) revealed that emamectin benzoate (2.42 % damage) was the most effective treatment and it was at par with all treatments except lower dosage of Novaluron (3.98 % damage) i.e. 0.05 ml/kg of seed and deltamethrin (4.54 % damage) (Table 10.42). Overall, all other treatments were significant better than untreated control (8.56 % damage). Two months after treatment, emamectin benzoate (4.13 % damage) was again the best treatment and significantly better than all other treatment. After four month, spinosad recorded minimum damage (5.70 %) by *Rhizopertha dominica* and it was on par with other treatments except deltamethrin and untreated control.

Centre: Durgapura

The experiment was conducted in the Wheat Storage Laboratory, Division of Entomology at RARI, Durgapura, Jaipur during 2014-15. Freshly harvested seed with high percentage of germination and low moisture content (>10 %) was taken for experimental purpose. For the Insecticidal seed treatment required quantity of insecticides diluted in 5 ml water to treat the 1kg of seed for proper coating. After drying in shade, seeds was packed in gunny bags and replicated thrice for each treatment. After that these bags were kept in storage under ambient conditions. Crop: Wheat, Variety: Raj-3765, Storage period: 9 months.

Newer seed dressers viz., Spinosad, Profenofos and Novaluron seed treatments were gave complete protection to wheat seed against storage insect's upto storage period of 9 months and at par with Emamectin benzoate and Deltametrhin treatment. Rest of the treatments was least effective and gave higher side of insect incidence. Seed germination was maintained in all the treatments except control (untreated) in which 41.33% seed was damaged up to storage period of 9 months (Table 10.43).

Table 10.42: Studies on the effect of insecticidal seed treatment on seed viability during storage under ambient conditions against store grain pests during 2014-15 (Centre-Ludhiana)

S. No.	Treatments	Dosage	Damage (%)		
			1 month	2 month	4 months
1	Emamectin benzoate (Proclaim)	40.0 mg/kg	2.42 (1.84)	4.13 (2.26)	5.73 (2.59)
2	Spinosad (Tracer)	4.4. mg/kg	2.88 (1.96)	4.52 (2.35)	5.70 (2.58)
3	Indoxacarb (Avaut)	13.8 mg/kg	2.50 (1.86)	4.85 (2.41)	6.41 (2.72)
4	Rynaxypyr (Coragen)	99 mg/kg	3.18 (2.03)	4.92 (2.42)	6.36 (2.71)
5	Novaluron (Rimon)	0.02ml/kg	3.98 (2.22)	5.34 (2.51)	6.74 (2.78)
6	Novaluron (Rimon)	0.05 ml/kg	3.54 (2.12)	5.00 (2.44)	6.68 (2.76)

S. No.	Treatments	Dosage	Damage (%)		
			1 month	2 month	4 months
7	Deltamethrin 2.8 EC	0.04 ml/kg	4.54 (2.35)	5.88 (2.62)	11.02 (3.46)
8	Untreated check	-	8.56 (3.09)	12.18 (3.62)	23.12 (4.91)
	CD (p =0.05)		(0.29)	(0.21)	(0.24)

Table 10.43: Effect of insecticidal seed treatment on seed germination and damage during 2014-15 (Centre-Durgapura)

S.No	Treatment	Germination (%)			Damage (%)		
		3 Month	6 Month	9 Month	3 Month	6 Month	9 Month
T1	Emamectin benzoate (Proclaim 40.0 mg/kg)	97.33 (80.73)*	96.00 (79.13)	95.66 (78.00)	0.00 (0.00)	0.00 (0.00)	1.33 (6.55)
T2	Spinosad (Tracer 4.4 mg/kg)	96.00 (78.71	95.66 (78.33)	94.00 (75.85)	0.00 (0.00)	0.00 (0.00)	2.33 (8.74)
T3	Indoxacarb (Avaut 13.8 mg/kg)	94.00 (75.85)	90.33 (71.98)	85.66 (66.74)	2.33 (8.74)	9.00 (14.04)	9.66 (17.91)
T4	Chlorantaniliprid (Coragen 99 mg/kg)	93.66 (75.49)	88.00 (69.77)	82.00 (64.98)	3.00 (9.88)	7.66 (16.02)	13.33 (21.26)
T5	Chlorfenapyr (Intrepid 0.02ml/kg)	94.66 (76.73)	90.66 (72.37)	83.66 (66.22)	2.00 (7.94)	5.00 (12.74)	12.00 (19.65)
T6	Profenofos 50 EC (0.004 ml/kg)	95.00 (77.12)	96.66 (79.59)	82.33 (65.20)	0.00 (0.00)	0.00 (0.00)	13.33 (21.79)
T7	Novaluron (Rimon 0.05 ml/kg)	96.66 (79.59)	96.00 (78.52)	87.33 (69.21)	0.00 (0.00)	0.00 (0.00)	7.00 (15.31)
T8	Deltamethrin 2.8 EC (0.04 ml/kg)	97.66 (81.53)	96.66 (79.93)	94.66 (76.70)	0.00 (0.00)	0.00 (0.00)	2.00 (7.94)
T9	Control	92.33 (73.97)	83.66 (66.22)	55.00 (47.48)	4.00 (11.47)	12.33 (20.53)	41.33 (41.73)
	S.Em±	1.191	1.548	1.21	0.630	0.811	1.23
	C.D.	3.539	4.600	3.42	1.872	2.411	3.46

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PROGRAMME 11. WHEAT NEMATOLOGY

Authors: (Daman Jeet Kaur, Indra Rajvanshi, R.S. Kanwar, Pankaj, K.N. Pathak, M.S. Saharan and Indu Sharma).

Wheat Nematology sub programme under crop protection programme of AICW&BIP action plan for the year 2014-15 considered the aspects like evaluation of host resistance against Cereal Cyst Nematode (*Heterodera avenae* & *H. filipjevi*) and root knot nematode (RKN); survey and surveillance for CCN, ECN and other plant parasitic nematodes found in wheat; population dynamics studies on major parasitic nematodes in wheat based different cropping systems and integrated and eco friendly approaches in management of CCN. The activities dealt in details with resultant outcomes are written hereunder.

11.1: HOST RESISTANCE

i) Response of CCNSN (AVT entries) against CCN, *Heterodera avenae* and *H. filipjevi* at multilocations

Hisar

Screening of wheat genotypes was done in nematode - infested soil in 1 kg pots under screen house conditions. Four seeds of each wheat var. were sown in three pots, and thinned to two plants after one week of germination. Numbers of white females/cysts were recorded in each pot after 110-120 days of sowing. Varieties/ lines were categorized as resistant (1-4 cysts), moderately resistant (5-9 cysts), susceptible (9 -20 cysts) and highly susceptible (>20cysts).

AVT-1: Under AVT-I, 100 entries, including durum, dicoccum and triticale, were screened against *H. avenae*, under screen house conditions. Of these two entries (HS 596, K 1313) were found moderately resistant, one susceptible and remaining were highly susceptible. None of the entry showed resistance.

AVT-I1: Out of the 73 entries tested, two (HW 1098, NIAW 1415) were resistant, one moderately resistant (HD 2932), one susceptible and remaining were highly susceptible.

Durgapura

One hundred wheat germplasms (AVT-I) were received from DWR, Karnal and nursery was planted in naturally infested field condition against cereal cyst nematode, *Heterodera avenae* of RARI, Durgapura, Jaipur. The inoculums level was 10 L/gm of soil. Out of 100 germplasm none was found the resistant reaction, whereas, only one showed moderately resistant reaction i.e. DBW185, rest were found susceptible (86) and highly susceptible (12) (Table- 11.1). Seventy three wheat germplasms (AVT-II) were received from DWR, Karnal and nursery was planted in naturally infested field condition against cereal cyst nematode, *Heterodera avenae* of RARI, Durgapura, Jaipur. The inoculums level was 13-15 L/gm of soil. Out of 73 germplasm none was found the resistant reaction, whereas, only one showed moderately resistant reaction i.e. HS 562, rest were found susceptible (54) and highly susceptible (18) (Table-11.2).

Ludhiana

One hundred entries under AVT I and seventy three entries under AVT II were screened for resistance against *H. avenae* CCN sick plot conditions. PBW 550, PBW 502 and PBW 343 were used as susceptible checks. Out of these none of the entry was found resistant. Only two entries HUW (C), HW 1098 (C) in AVT II and six in AVT I namely; VL 3008, PBW 719, MACS 3970 (D), MACS 3973 (D), DDK 1049 and HPBW

69 have shown moderately resistant reaction. Rest of the entries were either susceptible or highly susceptible to CCN

Delhi Only one variety HPW 393 under AVT I showed moderately resistant reaction. All the other varieties screened under AVT I and AVT II were susceptible to highly susceptible.

Table 11.1. Screening of AVT-I against CCN in wheat (Durgapura)

No. of lines	Reaction	Name of line
0	Resistant	NIL
1	Moderately resistant	DBW 185
86	Susceptible	HPW 393, HPW394, HPW421, HS 580, HS 583, HS 590, HS 596,HS 597, HS 598, HS 599, HS 600,UP 2917, UP 2918, VL 1006, VL 1007, VL 3002, VL 3007, VL 3008, VL 3009, VL4001, DBW 148, DBW 150, DDW 31, DDW 32, HD 3159, HD 3165, HD 3174, HI 1604, HI 1605, K1312, K 1313, K 1314, MACS 3949, PBW 707, PBW 709, PBW 718, PBW 719, UP 2883, K1317, CG 1015, GW 463, HI 8759 (d), GW 1315 (d) HD 3164, HI 8765 (d), JWS 712, K 1315, MACS 3970(d), MACS 3972 (d), MACS 4020 (d), PBW 721, UAS 360, UAS 361, UAS 453 (d), UAS 455 (d), DBW 181, DBW 182, DBW 183, DBW 184, DDK 1048, DDK 1049, KRL 350, KRL 351, MACS 5041, MACS 5043, WH 1309, TL 3001, TL 3003,TL 3004, TL 3005, DWR-NIL-01, DWR-NIL-02, HD 3209, KB 2912-13, HPBW 01,HPBW 02, HPBW 07, HPBW 08, HPBW 09, HUW 695, HUW 711, HUW 712, MACS 6507, WB 1, WB 2, WB 5
12	Highly Susceptible	HPW413, HPW422, HS 601, VL 1005, DBW 147, HUW 688, MACS 4024, PBW716, WH 1179, HD3171, TL 3002, HPBW 05

Table 11.2. Screening of AVT-II against CCN in wheat (Durgapura)

No. of lines	**Reaction**	**Name of line**
0	Resistant	NIL
1	Moderately resistant	HS 562
54	Susceptible	HPW 251 (c), HPW 349 (c), HS 375 (c), HS 490 (c), HS 507 (c), HS 542 ©, VL 804 (c), VL 829 (c), VL 892 (c), VL 907 (c), HD 4730, MP 1277, WH 1164, DBW 88 (c), DBW 90 (c), DPW 621-50 (c), HD 3059 (c), HD 3086 (c), PBW 644 (c), PDW 233 (c), PDW 291 (c), WH 1105 (c), C 306 (c), HD 2888 (c), K8027 (c), HD 4728 (d), HI 4730 (d), GW 322 (c), HD 2864 (c), HD 2932 (c), HI 1544 (c), HI 8498 (D) (c), MP 3336 (c), MP 4010 (c), MPO 1215 (d) (c), MACS 3927 (d), NIAW 2030, AKDW 2997-16 (d) (c), DBW 93 (I) (c), MACS 6478(C), NI 5439 (c), NIAW 1415 (c), (HD 2932+ Lr 19/Sr 25) DBW 14 (c), DDK 1029 (C), HUW 234 (c), HW 1098 (c), K0307(c), Kharchia 65 (C), KRL 19 (c), KRL 210 (c), PBW 343 (c), Raj 4083 (c), TL 2942 (c)
18	Highly Susceptible	HD 2967(c), HD 3043 (c), PDW 314 (c), WH 1021 (c), WH 1080 (c) WH 1124 (c), WH 1142 (1) (c), HI 8737 (D) (1) (c), MACS 6222 (c), UAS 347(I) (c), UAS 428 (d) (c),UAS 446 (d) (I) (c), MMBL 283, PBW 723, HD 2985 (c), HI 1563 (c), TL 2969 (c), WH 542 (c)

ii) MULTIPLE DISEASE/ PEST SCREENING NURSERIS : NEMATODES (CCN) MDSN

Hisar

Forty one entries (*Triticum aestivum* = 28, durum = 11, dicoccum = 2) were screened against *Heterodera avenae*, under screen house conditions. All the entries gave highly susceptible reaction.

Ludhiana

Out of forty one entries evaluated for resistance to cereal cyst nematode, *H. avenae*, none was found resistant. Only six entries namely DDW 23 (D), HI 8735 (D), DDK 1044 (Dic), DDK 1045 (Dic) and HI 8738(D) were moderately resistant. Rest of the entries were susceptible or highly susceptible. Screening against cereal cyst nematode was done under pot culture conditions in the nematode infested soil.

Durgapura

Forty one germplasm of wheat were screened against cereal cyst nematode, *Heterodera avenae* under infested field condition. The inoculums level was 11.0 -16.0 L/gm of soil. Out of forty one none was found resistant and moderately resistant reaction rest were found susceptible (36) and highly susceptible (4). Only one germplasm was not germinated (Table 11.3).

Table 11.3. Screening of multiple disease screening nursery of wheat against cereal cyst nematode, *Heterodera avenae* (Durgapura)

No. of lines	Reaction	Name of line
0	Resistant	NIL
0	Moderately resistant	NIL
36	Susceptible	HI 8724 (d), HI 8725 (d), HI 8728 (d), PBW 660, HI 8735 (d), HI 8739 (d), HI 8742 (d), HPW 381, HS 578 ,KRL 348, VL 3001, DDK 1044 (dic.), DDK 1045 (dic.), HI 1588 Q, HUW 668, HW 1099, HW 1900, HW 4013, HW 4042, HW 5235, HW 5237, JAUW 598, MACS 5031, Raj 4324, UP 2843, UP 2847, UP 2871, UP 2872, HW 5224, WH 1098, HD 3121, HI 8738 (d), NIDW 706 (d), WH 1129, WH 1137, NIDW 699 (d)
4	Highly Susceptible	DDW 23 (d), GW 432, HD 3095, Raj 4250

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iii) Screening against *M. graminicola*

Ludhiana

One hundred entries under AVT I and seventy three entries under AVT II were screened for resistance against root knot nematode, *Meloidogyne graminicola* in the nematode infested soil under pot culture conditions. PBW 550 and PBW 343 were used as susceptible checks. All the entries showed susceptible to highly susceptible reaction.

Pusa, Bihar

AVT 1st year wheat entries were tested against *M.graminicola*. Galling was seen in the entry no. 7,8,20,23,25,60 and 65 only with root-knot index of 2 to 2.33 revealing resistant reaction. Rest entries did not revealed any gall and appeared to be highly resistant. However no egg mass or mature female was seen even in galled plants.

A total of 77 AVT 2nd year wheat entries were screened against *M.graminicola* and none of them showed even a single galling in case of the tested entries, indicating them to be highly resistant to the nematode. None of the top ten entries of AVT 2nd year showed susceptible response to the parasite *M.graminicola*

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(iv) Studies of biotypes of *Heterodera avenae* at Durgapura

The biotypes studies of cereal cyst nematode was carried out during the crop season 2014-15 i.e Jaipur population of cereal cyst nematode, *Heterodera avenae* . Out of 26 differentials of wheat and barley eleven showed resistant reaction i..e. AUS-15854, AUS-7869,KVL-191, Harlan, Dalmitsche, Morocco, P-313221, Martin, La-estanzuella ,L-62, Nidar-2 and only AUS-15895 was found moderately resistance while rest showed susceptible reaction (Table-11.4).

Table 11.4. Reaction of *Heterodera avenae* of Jaipur population on International differentials

S.No.	International Differentials	Reaction	S.No.	International Differentials	Reaction
1	AUS-15854	R	14	Ogrlitsche	S
2	AUS-15807	S	15	Dalmitsche	R
3	AUS-7869	R	16	Harta	S
4	AUS-15895	MR	17	Emir	S
5	AUS-4930	S	18	Morocco	R
6	AUS-498	S	19	Gelliune	S
7	Loros	S	20	P-313221	R
8	IK2 Light	S	21	Martin	R
9	Psathia	S	22	Varda	S
10	Capa	S	23	Siri	S
11	Ortalan	S	24	La-estanzuella	R
12	KVL-191	R	26	L-62	R
13	Harlan	R	26	Nidar-2	R

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11.2: SURVEY AND SURVEILLANCE

Crop health monitoring survey for nematodes

Ear Cockle nematode (*Anguina tritici*)

Ludhiana

A total of 1662 wheat grain samples were collected from one hundred and ten different grain markets of twenty two districts of Punjab State in the months of April and May, 2015 and were analyzed for ear cockle nematode. None of the samples showed incidence of ear cockle nematode.

Pusa Bihar

During 2014-15 a total 140 samples of wheet grains were collected from 7 villages of Muzaffarpur, 5 villages of Samastipur and two villages of vaishali. None of the sample were found contaminated with Ear Cockle. Also in print media no report of ECN infestation were seen from Bihar.

Durgapura

Survey was undertaken in the different cultivator's fields of eight district of Rajasthan for studying the incidence of Cereal Cyst Nematode (CCN) . Diseased fields were randomly selected on the basis of above ground symptoms of the crops. Symptoms of stunting, yellowing and patchy growth were recorded during survey of each field. Roots samples were randomly collected from the rhizosphere of wheat and barley crops looking above ground symptoms like stunting growth , yellowing of leaves and patchy growth. It was further confirmed by seeing the bushy roots.

Cereal cyst infestation was recorded in Ajmer, Alwar, Dausa, Jaipur, Tonk, Sikar, Sawaimadhopur and Hanumangarh districts. Diseased fields were randomly selected on the basis of above ground symptoms of the crops. A large number of infested fields were observed in Amber, Bassi Chomu Jamwa Ramgarh, Kotputli, Sahapura, Sanganer (Shikarpura), Viratnagar, and tehsil of Jaipur district. About 350 hector field of wheat infested with CCN in Nohar and Bhadra Tehsil of Hanuman garh district. Higher population densities were recorded in Bassi and Sanganer (Shikarpura) Tehsil in both crops (wheat & barley). To find out the incidence of Ear cockle disease, *Anguina tritici* grain samples were collected from various grain Mandies of eight districts *ex.* Ajmer, Alwar, Dausa, Jaipur, Kota, Karoli, Sikar and Tonk. A total of four hundred seventy eight samples were collected of various local grown cultivars. Out of which 30 were found infected with ear cockle disease. Highest percentages of infestation were recorded form Mandawri (Dausa) (16.66) followed by Beawar (Ajmer) (15.00) and Devli (Tonk) (12.50). Sample collected from Jaipur, Kota and Palsana (Sikar) area free from disease. Highest percentages of infestation were recorded from Lok -1 of cultivars (40.00) followed by mixture cultivar (15.38). (Table 11.5-11.8).

Table 11.5. Incidence of Ear cockle disease, *Anguina tritici*

S.N.	Districts	Places	cultivars	No. of samples collected	No. of samples infested	No. of galls/1000 seed	% grain infestation
1.	Ajmer	Ajmer	Raj 1482	8	1.0	2.0	0.2
			Raj 3765	12	0.0	0.0	0.0
			Raj 3077	11	2.0	1.0	0.1
			Raj 4037	13	0.0	0.0	0.0
			Local	2	1.0	2.0	0.2
		Beawar	Raj 3765	5	1.0	1.0	0.1
			Raj 3077	6	0.0	0.0	0.0
			Raj 4037	2	0.0	0.0	0.0
			Local	2	1.0	2.0	0.2
			Mixture	5	1.0	2.0	0.2
2.	Alwar	Alwar	Raj 3765	3	0.0	0.0	0.0
			Raj 4037	3	0.0	0.0	0.0
			Raj 3077	5	0.0	0.0	0.0
			Raj 1482	6	1.0	1.0	0.1
			local	2	1.0	1.0	0.1
3.	Dausa	Dausa	Raj 3077	11	0.0	0.0	0.0
			Raj 3765	12	0.0	0.0	0.0
			Raj 1482	6	1.0	1.0	0.1

S.N.	Districts	Places	cultivars	No. of samples collected	No. of samples infested	No. of galls/1000 seed	% grain infestation
			Raj 4037	8	0.0	0.0	0.0
			Lok 1	2	1.0	1.0	0.1
			Local	2	0.0	0.0	0.0
		Lalsot	Raj3077	13	1.0	1.0	0.1
			Raj 3765	9	0.0	0.0	0.0
			Raj 4037	16	0.0	0.0	0.0
			Raj1482	3	1.0	1.0	0.1
			Local	2	0.0	0.0	0.0
		Mandawri	Raj3077	2	0.0	0.0	0.0
			Raj 3765	2	0.0	0.0	0.0
			Raj1482	1	0.0	0.0	0.0
			Lok 1	1	1.0	3.0	0.3
4.	Karoli	Hindon	Raj 3765	7	1.0	2.0	0.2
			Raj 3077	16	0.0	0.0	0.0
			Raj 1482	7	0.0	0.0	0.0
			Lok 1	2	0.0	0.0	0.0
			PBW - 343	2	0.0	0.0	0.0
			Local	2	0.0	0.0	0.0
5.	Jaipur	Jaipur	Raj 4037	3	0.0	0.0	0.0
			Raj 3077	14	0.0	0.0	0.0
			Raj 3765	8	0.0	0.0	0.0
			Local	2	0.0	0.0	0.0
			Mixture	3	0.0	0.0	0.0
		Bassi	Raj 3765	3	0.0	0.0	0.0
			Raj 3077	5	1.0	1.0	0.1
			Raj 4037	2	0.0	0.0	0.0
			Local	2	0.0	0.0	0.0
		Bagru	Raj 3765	11	1.0	1.0	0.1
			Raj 3077	16	0.0	0.0	0.0
			Raj 1482	3	0.0	0.0	0.0
			Raj 4037	13	0.0	0.0	0.0
		Chomu	Raj 3765	12	0.0	0.0	0.0
			Raj 3077	13	0.0	0.0	0.0
			PBW343	4	0.0	0.0	0.0
			Raj 1482	2	0.0	0.0	0.0
			Raj 4037	5	0.0	0.0	0.0
			C-306	2	0.0	0.0	0.0
			Local	2	0.0	0.0	0.0
			Mixture	6	1.0	1.0	0.1
6.	Kota	Kota	Raj 3765	3	0.0	0.0	0.0
			Raj 3077	6	0.0	0.0	0.0
			Raj 1482	2	0.0	0.0	0.0
			Raj 4037	2	0.0	0.0	0.0
			Local	6	0.0	0.0	0.0
7.	Sikar	Palsana	Raj 3765	6	0.0	0.0	0.0
			Raj 3077	8	0.0	0.0	0.0
			Raj 1482	4	0.0	0.0	0.0
			Lok 1	1	0.0	0.0	0.0
8	Tonk	Tonk	Raj 3765	13	1.0	1.0	0.1
			Raj 3077	18	2.0	3.0	0.3
			Raj 1482	6	1.0	1.0	0.1
			Raj 4037	3	0.0	0.0	0.0
			Local	2	1.0	1.0	0.1
		Devli	Raj 3765	5	2.0	2.0	0.2
			Raj 3077	10	1.0	1.0	0.1

S.N.	Districts	Places	cultivars	No. of samples collected	No. of samples infested	No. of galls/1000 seed	% grain infestation
			Raj 1482	12	2.0	1.0	0.1
			Raj 4037	11	0.0	0.0	0.0
			Local	18	2.0	1.0	0.1
	Total			**478**	**30**		

Table 11.6. Tehsil wise prevalence of Ear cockle disease, *Anguina tritici*

S.NO.	Districts	Tehsil	No. of samples collected	No. of samples infested	% sample infestation
1	Ajmer	Ajmer	46	4	8.69
		Beawar	**20**	**3**	**15.00**
2	Alwar	Alwar	19	2	10.52
3.	Dausa	Dausa	41	2	4.87
		Lalsot	43	2	4.65
		Mandawri	**6**	**1**	**16.66**
4.	Karoli	Hindon	36	1	2.77
4.	Jaipur	Jaipur	30	0.0	0.00
		Bassi	12	1	8.33
		Bagru	43	1	2.32
		Chomu	46	1	2.17
6.	Kota	Kota	19	0.0	0.00
7.	Sikar	Palsana	19	0.0	0.00
8.	Tonk	Tonk	42	5	11.92
		Devli	**56**	**7**	**12.50**
Total			**478**	**30**	**6.27**

Table 11.7. Cultivar wise prevalence of Ear cockle disease, *Anguina tritici*

S.No.	Cultivar	No. of samples collected	No. of samples infested	% infestation
1	Raj 3765	113	6	5.30
2	Raj 1482	60	7	11.62
3	Raj 3077	154	7	4.54
4	Raj 4037	81	0.0	0.00
5	PBW 343	6	0.0	0.00
6	**Lok 1**	**5**	**2**	**40.00**
7	C-306	2	0.0	0.00
8	**Mixture**	**13**	**2**	**15.38**
9	Local	44	6	13.63
Total		**478**	**30**	**6.27**

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c) Other important Plant Parasitic Nematodes:

Cereal Cyst Nematode and Other Soil Borne Nematodes

Hisar

Crop health monitoring survey for nematodes was done in Sirsa, Hisar and Fatehabad and Bhiwani districts. Cereal cyst nematode was reported in 40 % (28/70) samples. It was reported in samples of Rawat khera , Tokas, Shyamsukh, Sundawas, Sadalpur, Bhana , Mohabatpur , Behbalpur, Ludas of Hisar ; Bighar, Dharnia , Dhangar, Dhand, Pilimandori of Fatehabad; Odhan, Rohedawali, Nehrana, Phagu, Anandgarh, Daulatpur khera, Kalanwali, Lakkarwali of Sirsa; and Sai, Kasni, Hariyawas, and Devsar of Bhiwani districts . Other ecto-parasitic nematodes present in the samples were *Hoplolaimus* sp, *Tylenchorhynchus* sp., and *Pratylenchus* sp. The population of *Tylenchorhynchus* sp. was high in some samples (200-250/ 200 cc soil). Apart from dorylaimids and rhabditids, some other non plant parasitic nematodes such as *Aphelenchus* sp., *Ditylenchus* sp., *Nygolaimus harishi* (predator of nematodes) and *Tylencholaimus* sp. were also recorded in these soil samples.

Ludhiana

Eighty eight soil and root samples were collected from eighteen localities for the plant parasitic nematode infestation on wheat crop the state (Table 11.9). Nematodes recorded were *H. avenae*, species of *Meloidogyne, Tylenchorhynchus, Hirschmanniella, Helicotylenchus and Hoploloaimus. H. avenae* cysts were recorded from Dhola (District Barnala), Kotkapoora (District Faridkot), Ghubaia (District Muktsar), Mustfabad, Rampur and Rasulpur villages. The number of cysts recorded was 1-10 cysts/250 cc soil and highest number i.e 8- 10 cysts was recorded from Rampur. Root knot nematode was also recorded up to 160 larvae/250cc soil and *Tylenchorhynchus* was recorded from all the samples collected.

Table 11.9. Plant parasitic nematodes associated with wheat crop in Punjab (2014-2015)

Village/ Locality	No. of samples collected	Number of nematodes / 250 ml soil; Range (Frequency of occurrence, %)					
		H. avenae (cysts)	*Meloidogyne* Larvae)	*Tylenchorhynchus*	*Hirschmanniella*	*Helicotylenchus*	*Hoploloaimus*
Rukna Beg	6	-	40 (33.33)	50-250 (100.00)	50-100 (50.00)	-	-
Ralla	6	-	40 -80 (33.33)	40-360 (100.00)	40-80 (66.67)	-	80 (33.33)
Dhola	6	2-4 (50.00)	40 (50.00)	40-240 (100.00)	40-80 (16.67)	-	-
Kotkapoora	6	6-10 (66.67)	40-80 (100.00)	80-240 (100.00)	40-240 (100.00)		
Beganwali	6	-	40-80 (50.00)	160-520 (100.00)	80-160 (100.00)	40-80 (33.33)	40 (50.00)
Ghubaia	6	2-3 (66.67)	-	40-240 (100.00)	40-160 (66.67)	40 (16.66)	-
Ferozeshah	6	-	40-80 (50.00)	120-360 (100.00)	40-160 (100.00)	-	-
Mustfabad	6	2 (33.33)	-	80 (50.00)	120-160 (100.00)	80-120 (100.00)	-
Sarai	6	-	-	40 -80 (33.33)	40-240 (100.00)	40-160 (100.00)	40 (50.00)
Uchchi	6	-	40-160	240-480	80	-	

Bassi			(50.00)	(100.00)	(33.33)		
Rampur	8	8-10 (75.00)	-	120-360 (100.00)	40-120 (50.00)	-	-
Tiberi	6	-	-	80-240 (100.00)	40-120 (50.00)	40 (33.33)	-
Kalanor	6	-	-	80-240 (100.00)	40-120 (50.00)	40 (50.00)	80 (25.00)
Rasulpur	8	2 (25.00)	40 (25.00)	120-240 (100.00)	80-120 (50.00)	-	-
Total	88	2-10	40-160	40-480	40-240	40-160	40-80

Pusa Bihar

A total of 30 samples from wheat field of places of three districs namely Samastipur, Muzaffarpur and Vaishali were analysed for soil nematode populations.

The data indicated that stunt nematode (Tylenchorchynchus nudus + T. Mashoodi.) were in predominant population comprising of 46.38 % population density. This was followed by lance, spiral and root-knot nematode with population density of 17.74, 15.69, 5.68 and 2.27% respecively.

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11.3. Integrated and ecofriendly management of *Heterodera avenae*

i) Evaluation of ecofriendly approaches for the management of cereal cyst nematode, *H. avenae*

Hisar

This experiment was done in screen house in earthen pots. Nematode – infested soil was filled after diluting the soil with dune sand to make the initial inoculum 15 cysts/ 1 kg pot. Four seeds of wheat var. WH 1105 were sown on 5-12-2014 in each pot, except pots of resistant varieties, where Raj MR 1 and AUS 15854 were sown. There were eight treatments; each replicated four times (Table 11.10). Neem seed kernel water extract (5 % @ 50 ml /pot) and its residue @ 5g per pot and carbofuran @ 1.5 kg a.i. /ha were applied at sowing time. Ten days after sowing, germination was recorded and two plants were maintained in each pot, except in Triazophos, where no germination took place. Recommended dose of fertilizers and controlled amount of water were applied in pots. Observation on number of cysts (soil + roots) was recorded, 110 days after sowing.

Results revealed that seed treatment with Triazophos severely hampered the germination as only one out of 20 seeds germinated in three weeks. This tratment was, therefore, excluded from the Table. On resistant varieties, negligible cysts were formed, and application of carbofuran significantly reduced cyst population as compared to control (Table 11.10). Other treatments were not found effective in reducing the number of cysts in comparison to control.

Table 11.10. Effect of various treatments on cereal cyst nematode (Mean of four replications)

Treatment	No. of cysts per pot
T1 . Untreated Control	61.5 (7.9)
T2. Raj MR1 (CCN resistant variety)	1.0 (1.7)
T3. AUS 15854 (CCN resistant variety)	0.0 (1.0)
T4. Neem seed kernel water extract (5 %) @ 50 ml per pot	58.0 (7.7)
T5. Neem seed kernel residue from T4 @ 5g per pot	64.0 (8.1)
T6. Nimbicidine seed treatment @ 4% v/w	60.0 (7.8)
T7. Carbofuran3G @ 1.5 kg a.i. /ha	46.5 (6.9)
C D at 5 %	(0.77)

Figures in parentheses are sq. root transformations; Date of sowing : 5-12-2014; var. WH 1105

COOPERATORS:

NAME	CENTRE
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Evaluation of Ecofriendly approaches in management of CCN, *Heterodera avenae* in wheat

An experiment was conducted from 2011-12 to 2014-15 at Rajasthan Agricultural Research Institute, Durgapura, Jaipur in naturally infested soil. Inoculum level was 11.6 larvae/g soil of cereal cyst nematode. The experiment consisted of eight treatments *viz* Neem cake 10q/ha (soil application), Neem oil (10 ml/Kg) (seed treatment), Neem gold (Azadirachtin) (10 ml/kg), Nimicidine (10 ml/kg), Carbosulfan 2% 25 EC (Seed soaking), Raj MR1 (Resistant variety) along with treated check (Carbofuran@ 1.5 kg ai/ha) and untreated check (Raj 1482) in a completely randomized block design and replicated. The crop after attaining the age of 75-90 days was examined the development of white cyst/plant in each treatment. The grain yield was taken at the time of harvesting of the crop in each treatment separately. The results revealed that all the treatments gave significantly higher grain yield and reduced number of cysts/plant over control. The maximum grain yield (37.72 q/ha) was recorded in Raj MR-1 (CCN counts- 1.09 cyst/ plant) followed by carbofuran (Grain yield - 34.87q/ha; CCN counts-2.51 cysts/plant) , Carbosulfan 25 EC (Grain yield - 31.99 q/ha; CCN counts-3.16 cysts/plant) and Neem gold (Grain yield - 30.84 q/ha; CCN counts-3.31 cysts/plant) over untreated control (Grain yield-13.71q/ha; CCN counts- 4.91 cysts/plant). Carbosulfan was also increased grain yield (Grain yield - 31.99 q/ha; CCN counts-3.16 cysts/plant) as compared to other treatments. Carbosulfan 2% EC was effective in reducing the cyst population of nematode and increased grain yield over control. Neem gold 10 ml/kg seed was also effective in reducing the population of nematodes and increased grain yield over control (Table- 11.11).

Carbosulfan 2% 25 EC (Seed Treatment) was effective in reducing the cyst population of nematode and increased grain yield over control. **Neem gold (Azadirachtin)** 10 ml/ kg seed (Seed treatment) also its overall superiority and better plant growth response may be due to the fact that besides having nematicidal potential and might have increased the tolerance level of plant and develop potential to resist the nematode attack.

Table 11.11. Effect of different treatments on grain yield of wheat against cereal cyst nematode, *Heterodera avenae*

S.NO	Treatments	Grain yield Q/ha				Pooled Data Four years	B:C Ratio	Cysts/Plant (SQR)				Pooled Data Four years
		2011-12	**2012-13**	**2013-14**	**2014-15**			**2011-12**	**2012-13**	**2013-14**	**2014-15**	
1	Neem cake 10q/ha	24.00	23.56	23.56	23.89	23.75	1.92	4.10	4.01	3.80	4.41	4.08
2	Neem oil 10ml/kg seed	28.00	27.77	27.24	27.11	27.53	3.86	3.84	3.84	3.38	3.93	3.74
3	**Neem gold (Azadirachtin) 10 ml/ kg seed**	31.44	32.11	30.44	29.44	**30.84**	4.36	3.38	3.48	3.23	3.18	**3.31**
4	Nimicidine 10 ml/ kg seed	22.56	22.55	21.11	22.78	22.26	3.08	4.33	4.25	4.17	4.37	4.28
5	**Carbosulfan 25 EC 2%(8 ml/l water)**	32.22	33.44	31.77	30.56	**31.99**	4.56	3.28	3.28	2.97	3.13	**3.16**
6	Carbofuran 1.5 kg ai/ha	37.22	35.00	34.17	33.11	34.87	4.31	2.33	2.91	2.33	2.48	2.51
7	Raj MR-1	39.33	38.44	38.04	35.11	37.72	5.55	0.87	0.87	0.87	1.77	1.09
8	Untreated Check	13.22	14.33	14.00	13.33	13.71	-	4.88	4.91	4.77	5.08	4.91
	CD 5%	**1.46**	**1.93**	**2.30**	**1.46**	**1.33**		**0.37**	**0.43**	**0.32**	**0.37**	**0.29**
	CV %	**2.92**	**3.89**	**4.78**	**2.93**	**3.25**		**6.32**	**7.12**	**5.81**	**6.32**	**6.01**

Table-11.12. Diversification of existing wheat based systems for cereal cyst nematode, *Heterodera avenae* management

S, No	Treatments	2011-12		2012-13		2013-14		2014-15		Pooled data Four Yrs.		Difference	%age
		Pi (100 ml soil)	Pf (100 ml soil	Pi (100 ml soil)	Pf(100 ml soil	Pi (100 ml soil)	Pf (100 ml soil	Pi (100 ml soil)	Pf (100 ml soil	Pi (100 ml soil)	Pf(100 ml soil		
1	**Mustard**	4.22	2.41	3.29	2.73	3.08	2.73	3.88	2.79	3.62	2.66	0.96	**26.51**
2	Pea	3.71	3.13	3.38	3.08	3.24	3.47	4.09	3.28	3.61	3.24	0.37	
3	Gram	4.01	3.29	3.13	2.84	3.18	3.02	3.84	2.79	3.54	2.99	0.55	10.24
4	Fenugreek	4.35	2.79	3.33	2.94	3.02	3.29	3.74	2.84	3.56	2.96	0.60	15.53
5	**Cabbage**	3.97	1.89	3.93	2.54	3.97	2.19	4.09	2.19	3.99	2.28	1.71	
6	Raj MR-1	4.09	2.54	3.81	2.91	3.80	3.01	4.33	2.54	4.01	2.75	1.26	16.85
7	Carbofuran@ 1.0 ai/ha	4.17	2.48	4.06	2.33	4.13	2.11	4.41	2.11	4.19	2.27	1.92	**42.85**
8	Untreated check	3.89	6.12	3.62	4.44	3.75	4.73	4.30	5.01	3.89	5.08	1.19 (Increased Population)	31.42 45.82 -
	CD 5%	0.44	0.29	0.27	0.34	0.39	0.29	0.57	0.45	0.34	0.49		
	CV%	6.24	5.35	4.29	6.55	6.41	5.45	8.08	8.72	5.80			

Pi - Initial population of Soil
Pf - Final population of soil

Diversification in existing wheat based systems for CCN management

An experiment was conducted from 2011-12 to 2014-15 at Rajasthan Agricultural Research Institute, Durgapura, Jaipur in naturally infested soil. Inoculum level was 11.0 to 12.0 larvae/g soil of cereal cyst nematode. The experiment consisted of eight treatments viz Mustard, Pea, Gram, Fenugreek, Cabbage, Raj MR 1 (Resistant variety) along with treated check (Carbofuran @ 1.5 kg ai/ha) and untreated check (Raj 1482) in a completely randomized block design. Soil samples were taken from each treatment before the sowing and recorded population of cyst. Each treatment was replicated thrice. Soil samples were taken from each treatment and recorded the number of cyst after the harvest of each treatment. The results revealed that all the treatments gave significantly reduced the cyst in the soil as compared the control (Higher cyst). Carbofuran @ 1.5 kg ai/ha reduces the cereal cyst nematode population followed by cabbage, resistant variety, mustard, fenugreek, gram and Pea as compared to the control. Population were recorded in Carbofuran (Initial 4.19cyst in 100ml soil and final 2.27 cyst in 100ml soil) followed by cabbage (Initial 3.99 cyst in 100ml soil and final 2.28 cyst in 100ml soil) and mustard (Initial 3.62 cyst in 100ml soil and final 2.66 cyst in 100ml soil), fenugreek (Initial 3.56 cyst in 100ml soil and final 2.96 cyst in 100ml soil). Final population was recorded in control (Initial 3.89 cyst in 100ml soil and final 5.08 cysts in 100ml soil) (Table- 11.12). **Cabbage** is effective control to reduce the cyst population of *Heterodera avenae* after carbofuran treatment while carbofuran is costly treatment and also caused health and environment hazards. After **Cabbage mustard** also reduces significantly cyst population, it is second alternate crop for farmers for management of cereal cyst nematode. Mustard contain allyl isothiocyanate which is toxic to nematodes.

11.4 SYSTEM BASED RESEARCH

Population dynamics of major plant parasitic nematodes in cotton -wheat system

Hisar

Four fields were selected for this study in Fatehabad and Hisar districts. Soil samples from cotton and wheat crops were collected in Sept. 2014 and March, 2015, respectively. These samples were examined for the population of major plant parasitic nematodes the data on which are presented in Table 11.13. It is revealed from the data that cyst nematode was present in all the four fields and its population increased from 2.5 to 5 times on wheat depending on initial population. Population of lance nematode was higher on cotton and it decreased on wheat; in one field its number was low on cotton which was not detected on wheat. Population of stunt nematode (*Tylenchorynchus* sp.) was found higher on wheat in all the fields. Root lesion nematode was present in two fields and in wheat season its population decreased in both fields probably because wheat was not its preferred host.

Table 11.13. Population dynamics of major plant parasitic nematodes in cotton - wheat system (Nematode population / 200 cc soil)

Field no.	Crop / Rotation	HA cysts	HL	TR	PL	FL
1	Cotton	8	88	70	60	200
	Wheat	40	60	125	50	120
2	Cotton	12	16	100	-	60
	Wheat	37	10	160	-	40
3	Cotton	20	2	200	20	330
	Wheat	50	-	240	12	280
4	Cotton	6	30	80	-	140
	Wheat	28	20	110	-	100

HA = *Heterodera avenae*; HL = *Hoplolaimus* sp., TR = *Tylenchorynchus* sp., PL = *Pratylenchus* sp., FL= free living (Non plant parasitic forms) - = not detected

Ludhiana:

Two cropping systems, rice - wheat and cotton - wheat were studied for population dynamics of nematodes. Ten soil and root samples were collected during the mid season of the crop from the same field and the data recorded is presented in Table 11.14.

Table 11.14. Plant parasitic Nematodes in different cropping systems

Nematode	Nematode Pop./ 250 cc soil & Roots (Frequency of occurrence %)	
	Rice	**Wheat**
Heterodera avenae cysts	2-4 (30.00)	2-6 (60.00)
Meloidogyne sp. Larvae	20-200 (50.00)	40-160 (40.00)
Hirschmanniella oryzae	40-280 (100.00)	40 (40.00)
Tylenchorhynchus sp.	40 - 80 (50.00)	40-360 (100.00)
Hoploloaimus sp.	40 (10.00)	-
	Cotton	**Wheat**
Heterodera cysts	1-4 (40.00)	2-10 (60.00)
Meloidogyne sp. Larvae	40-280 (60.00)	40-120 (50.00)
Tylenchorhynchus sp.	40-120 (100.00)	80-520 (100.00)
Helicotylenchus sp.	40 (20.00)	-
Hoplolaimus sp.	40 (10.00)	40-80 (20.00)

Rice-Wheat: *Heterodera avenae and Meloidogyne sp. Hirschmanniella oryzae, Hoploloaimus* and *Tylenchorhynchus* sp. were recorded in rice - wheat cropping system. The highest population was recorded of *Tylenchorhynchus* sp in wheat crop. In rice *H. oryzae* was higher as compared to wheat crop. The frequency of occurrence was 100 per cent of *Tylenchorhynchus* sp in wheat and number was 360 nematodes / 250 cc soil. During wheat season the cysts of *H. avenae* were extracted from the roots. Besides larvae of root knot nematodes, galling was also observed on wheat roots of some samples.

Cotton-Wheat: In cotton- wheat cropping system *Heterodera avenae,* species of *Meloidogyne, Tylenchorhynchus. Helicotylenchus,* and *Hoplolaimus* were important plant parasitic nematodes recorded. During cotton season the highest number of nematodes recorded was of *Meloidogyne sp.* (280 nematodes/250cc soil) and *Tylenchorhynchus sp* in wheat season (520 /250cc soil) with highest (100%) frequency of occurrence.

Pusa, Bihar

Rice-wheat: Population fluctuation of nematodes occurred in Rice-Wheat System. It indicated 210% increase in initial nematode population. When rice was grown. This nematode population further increased to 12.55% over paddy when wheat was cultivated after paddy harvest in the same field. Maximum increase in nemic population in paddy was of Rice - root nematode followed by lance and stunt nematode. However in wheat the population of Rice-Root was suppressed to 37.03 per cent followed by suppression of root-knot and *Tylenchus* population. Other nematodes further multiplied in wheat after paddy.

Durgapura

An experiment was planned to find out the impact of various cropping pattern (Millet-wheat, Groundnut- wheat, Cowpea-wheat and Moong -wheat) on population dynamics of various plant parasitic nematode inhibit in soil. Population of *Hoplolaimus spp, Helechorhynchus spp., Tylenchorhynchus spp. Xiphenema,* and

Hoplolaimus spp, Helechorhynchus spp., Tylenchorhynchus spp. Xiphenema, and *Helicotylenchus* was declined in groundnut-wheat pattern and millet -wheat pattern whereas the population of *H. avenae, Meloidogyne spp , Pratylenchus spp.* were increased when was millet preceded with wheat. Population of *Hoplolaimus spp, Helechorhynchus spp., Tylenchorhynchus spp.*were declined in cowpea and moong but *H. avenae, Pratylenchus spp.* were also increased in wheat season (Table- 11.15 & 11.16).

Table 11.15 Impact of different cropping system on Nematode populations

Millet - wheat Patterns					
S.No	**Nematode**	**Initial Population(J2/100ml soil)**	**Final Population (J2/100ml soil)**	**Increase/ decrease (Percent)**	
1	*H .avenae*	127	453	356.69	Increase
2	*Meloidogyne graminicola*	35	69	197.14	Increase
3	*Pratylenchus spp.*	27	112	414.81	Increase
4	*Hoplolaimus indicus*	90	70	77.77	decrease
5	*Helechorhynchus spp.*	74	43	58.10	decrease
6	*Tylenchorhynchus spp.*	27	19	70.37	decrease
7	Other nematodes*	57	35	61.40	decrease

Other nematodes* ***Xiphenema, Helicotylenchus ,Helicotylenchus***

Groundnut -Wheat Pattern					
S.No.	**Nematode**	**Initial Population (J2/ 100ml soil)**	**Final Population (J2/ 100ml soil)**	**Increase/ decrease (Percent)**	
1	*H .avenae*	187	435	232.62	Increase
2	*Meloidogyne spp.*	124	47	37.90	decrease
3	*Pratylenchus penetrans*	27	46	170.37	Increase
4	*Hoplolaimus spp.*	56	32	57.14	decrease
5	*Helechorhynchus spp.*	87	47	54.02	decrease
6	*Tylenchorhynchus spp.*	57	28	49.12	decrease
7	Other nematodes*	102	67	65.68	decrease

Other nematodes* ***Xiphenema & Helicotylenchus***

Table 11.16. Impact of different cropping system on Nematode populations

Cowpea - wheat Patterns					
S.No.	Nematode	Initial Population (J2/ 100ml soil)	Final Population (J2/ 100ml soil)	Increase/ decrease (Percent)	
1	*H .avenae*	176	432	247.15	Increase
2	*Meloidogyne graminicola*	67	134	200.00	Increase
3	*Pratylenchus spp.*	134	253	188.80	Increase
4	*Hoplolaimus indicus*	118	68	57.62	decrease
5	*Helechorhynchus spp.*	87	34	39.08	decrease
6	*Tylenchorhynchus spp.*	59	25	42.37	decrease
7	Other nematodes*	143	57	39.86	decrease

Other nematodes * *Xiphenema , Helicotylenchus*

Moong -Wheat Patterns					
S.N.	Nematode	Initial Population (J2/ 100ml soil)	Final Population (J2/ 100ml soil)	Increase/ decrease (Percent)	
1	*H .avenae*	78	345	442.30	Increase
2	*Meloidogyne spp.*	129	55	42.63	decrease
3	*Pratylenchus penetrans*	48	96	200.00	Increase
4	*Hoplolaimus spp.*	67	36	53.73	decrease
5	*Helechorhynchus spp.*	96	49	51.04	decrease
6	*Tylenchorhynchus spp.*	69	43	62.31	decrease
7	Other nematodes*	145	87	60.00	decrease

Other nematodes* *Xiphenema* & *Helicotylenchus*

COOPERATORS:

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Biofumigation as management tool for cereal cyst nematodes, *H.avenae* in wheat

An experiment was conducted at Rajasthan Agricultural Research Institute, Durgapura, Jaipur in naturally infested soil. Inoculum level was 13.6 larvae/g soil of cereal cyst nematode. The experiment consisted of seven treatments *viz* Nicoderma (10gm/kg seed), *P. fluorescence* (10gm/kg seed), Nemata, Samrat, Dantotsu along

(10gm/kg seed), *P. fluorescence* (10gm/kg seed), Nemata, Samrat, Dantotsu along with treated (Carbofuran 1.5 kg ai/ha) and untreated check (Raj 1482). The crop was examined after attaining the age of 75-90 days for the development of white cyst/plant in each treatment. The grain yield was taken at the time of harvesting of the crop in each treatment separately. The results revealed that all the treatments gave significantly higher grain yield and reduced number of cysts/plant over control. The maximum grain yield (40.8 q/ha) was recorded in carbofuran (CCN counts- 2.79 SQR) followed by Nemata (Grain yield - 35.0q/ha; CCN counts-3.30 SQR) followed by Samrat (Grain yield - 27.8 q/ha; CCN counts-3.80 SQR) over untreated control (Grain yield-12.5q/ha; CCN counts- 4.91 SQR). Nemata was effective in reducing the population of nematodes and increased grain yield over control and other treatments (Table 11.17).

COOPERATOR

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Table 11.17. Biofumigation as management tool for cereal cyst nematodes, *Heterodera avenae* in wheat

S.NO.	Treatments	Grain Yield of Wheat		Cysts/ Plant (SQR)
		Yield q/ha	% Increase Over control	
1	Nicoderma (10gm/kg seed)	21.67	39.29	4.52
2	*P. fluorescence* (10gm/kg seed)	16.94	8.93	4.78
3	Nemata 5 kg/ha	35.00	125.08	3.72
4	Samrat (10gm/1000ml) (seed soaking)	33.05	112.54	4.22
5	Dantotsu (2gm/kg seed)	28.05	80.38	4.33
6	Carbofuran 1.5 kg ai/ha	41.11	164.37	2.54
7	Untreated check (Raj 1482)	15.55	--	5.01
	CD5%	3.57		0.33
	CV%	7.35		4.51

ANNEXURES

Annexure 1: Seedling Resistance Test of AVT II against pathotypes of brown rust (*Puccinia triticina*) at Shimla during 2014-2015

S. No.	VARIETY	PATHOTYPES																											Gene postulation
		11	12	12-2	12-3	12-5	12-7	12-9	16-1	77	77-1	77-2	77-5	77-7	77-8	77-9	77-10	77-12	77A-1	104-2	104-3	104-4	104B	106	107-1	108-1	162-1	162-3	162A	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
Northern Hills Zone																														
1	HS562	R	R	S	R	R	S	R	R	R	R	S	S	S	R	R	S	R	R	S	S	S	R	R	R	R	R	R	R	Lr23+
2	HPW251 (C)	R	R	R	R	R	S	R	R	R	R	R	S	S	R	S	S	S	R	R	R	R	R	R	R	R	R	R	R	Lr23+26+
3	HPW349 (C)	R	R	R	R	MS	S	R	R	R	R	R	S	S	R	R	S	R	R	S	MS	R	S	R	R	R	R	R	R	Lr10+13+
4	HS375 (C)	R	R	R	R	R	R	R	R	R	S	R	MS	S	R	R	S	R	R	R	R	R	R	R	R	R	R	R	R	Lr1+26+34+
5	HS490 (C)	R	R	R	R	S	S	S	R	R	R	S	R	R	S	S	S	R	R	S	S	S	R	R	R	S	R	R	R	Lr23+
6	HS507 (C)	R	R	R	R	R	R	R	R	R	R	R	R	S	R	S	R	R	R	R	R	S	R	R	R	R	R	R	R	Lr1+26++
7	HS542 (C)	R	R	S	R	R	R	MS	R	R	S	R	M	MS	R	R	S	-	-	S	R	R	S	R	R	R	R	R	R	Lr10+13+
8	VL804 (C)	R	R	R	R	R	MS	S	R	R	R	R	S	S	R	S	S	R	R	S	S	R	R	R	R	R	R	R	R	Lr26+34+
9	VL829 (C)	R	R	R	R	R	R	S	R	R	R	R	S	S	R	R	S	R	R	S	S	R	R	R	R	R	R	R	R	Lr26+34+
10	VL892 (C)	R	MS	R	R	R	R	S	R	R	R	MS	R	S	R	S	S	R	R	S	R	MS	R	R	R	R	R	R	R	Lr10+13+
11	VL907 (C)	R	R	R	R	R	MS	R	R	R	R	R	R	R	R	R	MS	R	R	R	R	MS	S	R	R	R	R	R	R	Lr26+
North Western Plain Zone																														
12	HD4730	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
13	MP1277	R	R	S	R	R	S	S	R	S	R	S	R	S	R	R	S	S	R	S	S	S	S	R	R	R	R	R	R	Lr13+
14	WH1164	R	R	R	R	R	MX	R	R	R	S	S	M	S	MS	R	S	R	R	S	R	S	S	R	R	-	R	R	R	Lr10+13+
15	DBW88 (C)	R	R	R	R	R	R	S	R	R	S	S	S	R	R	R	S	R	R	R	R	R	R	R	R	R	R	R	R	Lr3+10+13+
16	DBW90 (C)	R	R	S	R	R	S	S	R	R	S	S	S	S	R	R	S	MS	R	S	S	R	R	R	R	R	R	R	S	Lr3+10+13+
17	PBW621-50 (C)	R	R	R	R	R	S	S	R	R	S	S	R	S	S	R	S	M	R	R	R	R	R	R	R	R	R	R	R	Lr10+13+
18	HD2967 (C)	R	R	R	R	R	R	S	R	R	-	R	S	R	R	R	S	R	R	R	R	R	R	R	R	R	R	R	R	Lr23+
19	HD3043	R	R	R	R	R	R	S	R	R	S	R	S	S	R	S	S	R	R	S	S	S	R	R	R	R	R	R	R	Lr23+
20	HD3059 (C)	R	R	R	R	R	R	R	R	R	MS	R	MS	S	S	S	S	R	R	R	R	R	R	R	R	R	S	R	R	Lr13+*
21	HD3086 (C)	R	R	S	R	R	S	S	R	R	S	S	S	S	R	M	S	S	R	S	S	S	S	R	R	R	R	R	S	Lr3+10+13+
22	PBW 644 (C)	R	R	R	R	R	R	R	R	R	R	S	MS	S	R	R	S	R	R	S	S	S	R	R	R	MS	R	R	R	Lr1+13+
23	PDW233 (C)	R	R	R	R	S	S	R	S	R	MS	R	S	R	R	S	R	S	R	S	S	S	MS	R	R	R	R	R	R	Lr23+
24	PDW291 (C)	-	R	R	R	R	R	R	S	R	R	MS	R	R	R	R	R	R	R	R	R	R	M	R	-	R	R	R	R	Lr23+
25	PDW314 (C)	R	R	R	R	R	S	R	R	R	R	R	S	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	Lr23+
26	WH1021 (C)	R	R	R	R	R	R	R	R	R	S	R	MS	S	R	R	M	R	R	R	R	S	R	R	R	R	R	R	R	Lr1+26+
27	WH1080 (C)	R	MS	S	R	S	S	R	R	R	S	S	S	S	R	S	S	S	S	S	S	S	R	R	R	R	R	R	S	Lr13+
28	WH1105 (C)	R	R	R	R	R	R	S	R	R	MS	R	R	S	R	R	S	S	S	R	R	R	R	R	R	R	R	R	R	Lr13+
29	WH1124 (C)	R	R	S	R	R	R	S	R	R	S	S	S	S	R	S	S	S	R	S	S	R	S	R	R	R	R	R	S	Lr10+13+

S. No.	VARIETY	PATHOTYPES																												Gene postulation
		11	12	12-2	12-3	12-5	12-7	12-9	16-1	77	77-1	77-2	77-5	77-7	77-8	77-9	77-10	77-12	77A-1	104-2	104-3	104-4	104B	106	107-1	108-1	162-1	162-3	162A	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
30	WH1142 (C)	R	R	R	R	R	S	R	R	R	R	R	S	S	R	R	S	R	R	S	S	S	R	R	R	R	R	R	R	*Lr*26+26+
North Eastern Plain Zone																														
31	C306 (C)	R	R	S	R	S	S	R	-	R	R	R	R	R	R	R	R	R	R	S	S	S	S	R	R	R	R	R	S	*Lr*34+
32	HD2888 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	S	R	R	R	R	R	R	R	*Lr*24+
33	K8027 (C)	R	S	S	R	S	S	S	S	R	-	S	S	S	R	R	S	S	S	S	S	S	S	S	S	R	S	S	S	*Lr*13+
Central Zone																														
34	HD4728 (D)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
35	HD4730 (D)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	MS	R	R	R
36	GW322 (C)	R	R	R	R	R	R	R	R	R	MS	S	M	S	R	R	S	R	S	R	R	S	R	R	R	R	R	R	R	*Lr*13+
37	HD2864 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
38	HD2932 (C)	R	S	S	R	S	S	R	R	S	S	S	S	S	R	S	S	R	S	S	S	S	S	R	S	MS	S	S	R	*Lr*13+
39	HI1544 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	MS	R	R	R	R	R	R	*Lr*24+
40	HI8498 (D) (C)	R	R	R	MS	R	MS	R	S	R	R	R	MS	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Lr*23+
41	HI8737 (D) (C)	R	R	MS	R	MS	R	R	S	R	R	R	S	R	R	R	R	R	R	S	R	S	R	R	R	R	R	R	R	*Lr*23+
42	MP3336 (C)	R	S	S	R	S	S	R	R	R	R	S	S	S	R	S	S	S	S	S	S	S	S	R	R	R	R	S	MS	*Lr*13+
43	MP4010 (C)	R	R	R	R	R	R	R	R	R	R	R	S	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Lr*24+
44	MPO1215 (D) (C)	R	R	-	R	S	R	-	S	R	-	R	MS	R	R	R	S	-	R	-	R	R	S	R	R	-	R	R	-	*Lr*23+
Peninsular Zone																														
45	MACS3927 (D)	R	S	S	R	S	S	S	S	R	R	R	S	R	R	S	S	R	R	S	S	S	S	S	R	R	R	S	S	-
46	NIAW2030	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	S	R	R	R	R	R	R	*Lr*24+
47	AKDW2997 -16 (D) (C)	R	R	R	R	R	R	R	R	R	R	M	MS	R	R	R	R	R	R	R	S	MS	R	R	R	R	R	S	R	-
48	DBW93 (D) (C)	R	R	R	R	R	R	R	R	R	R	R	MS	R	R	R	R	R	R	S	MS	S	R	R	R	R	R	R	R	*Lr*123+26 +
49	MACS6222 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Lr*1+26+
50	MACS6478 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	S	R	R	MS	R	R	R	R	R	R	R	R	R	*Lr*1+23+
51	NI5439 (C)	R	S	S	S	R	S	MS	R	R	MS	R	R	R	R	R	MX	S	R	S	S	S	S	R	R	R	R	R	S	*Lr*34+
52	NIAW1415(C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Lr*26+
53	UAS347 (I) (C)	R	R	S	R	MS	R	S	R	R	S	R	S	R	R	R	S	R	R	S	S	S	S	R	R	R	S	R	R	*Lr*10+13+
54	UAS428 (D) (C)	R	R	S	R	S	R	R	S	R	R	R	S	R	R	R	R	R	R	S	S	S	S	R	R	R	R	R	R	*Lr*23+
55	UAS446 (D) (I) (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Special trial																														
56	HD2932+*Lr*19/*Sr* 25	R	R	R	R	R	R	R	R	R	R	R	R	R	S	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Lr*19+
57	MMBL283	R	S	S	R	S	S	R	R	S	S	S	S	S	S	S	S	S	S	S	S	S	S	R	R	MS	R	S	R	-
58	PBW723	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

S. No.	VARIETY	PATHOTYPES																												Gene postulation
		11	12	12-2	12-3	12-5	12-7	12-9	16-1	77	77-1	77-2	77-5	77-7	77-8	77-9	77-10	77-12	77A-1	104-2	104-3	104-4	104B	106	107-1	108-1	162-1	162-3	162A	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
59	DBW14 (C)	R	R	S	R	R	R	R	R	R	R	R	S	R	R	R	S	R	R	R	R	S	S	R	R	R	R	R	R	*Lr*23+
60	DDK1029 (C)	R	R	R	R	R	R	R	S	R	R	R	R	R	R	S	R	R	R	S	R	R	R	S	R	R	S	R	R	*Lr*13+
61	HD2985 (C)	R	R	S	R	R	S	R	R	R	S	S	S	S	R	M	S	R	R	S	S	S	R	S	R	R	R	R	R	*Lr*23+
62	HI1563 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
63	HUW234 (C)	R	R	S	R	MS	R	S	R	R	R	S	S	S	S	M	S	S	S	S	S	R	S	R	M	R	R	S	S	*Lr*14a+
64	HW1098 (C)	S	R	R	R	R	R	MS	S	R	R	R	S	S	R	S	R	R	R	S	R	S	M	S	R	R	S	R	R	-
65	K0307 (C)	R	R	R	R	R	R	R	R	R	R	S	S	S	R	R	S	R	R	R	R	S	R	R	R	R	R	R	R	*Lr*1+23+
66	KARCHIA65 (C)	S	S	S	R	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	-
67	KRL19 (C)	R	R	S	R	S	R	R	R	R	S	S	S	S	R	R	S	S	S	R	R	S	R	R	R	R	R	R	S	*Lr*13+
68	KRL210 (C)	R	R	S	R	R	R	S	R	R	S	S	S	S	R	R	S	S	R	S	S	R	S	R	R	R	R	R	S	*Lr*10+13+
69	PBW343 (C)	R	R	R	R	R	R	R	R	R	R	R	MS	S	R	R	R	R	R	S	S	R	R	R	R	R	R	R	R	*Lr*26+
70	RAJ4083 (C)	R	R	R	R	R	S	S	R	R	R	S	S	S	S	R	S	S	R	S	S	R	S	R	R	R	R	R	R	*Lr*23+
71	TL2942 (C)	R	R	R	R	R	R	R	R	R	R	R	S	S	R	S	R	R	S	S	R	R	R	R	R	R	R	R	R	*Lr*10+13+
72	TL2969 (C)	R	R	R	R	R	R	R	R	R	R	R	S	R	R	R	R	R	R	MS	R	R	R	R	R	R	R	R	R	*Lr*23+
73	WH542 (C)	-	-	R	-	R	S	S	R	R	S	R	S	S	R	M	MS	R	R	S	R	S	R	R	R	R	R	R	R	*Lr*23+26+ 34+

Annexure 2: Seedling Resistance Test of AVT II against pathotypes of black rust (*Puccinia graminis tritici*) at Shimla during 2014-2015

S. No.	VARIETY	PATHOTYPES																			Gene postulation
		11	11A	15-1	21	21A-2	24A	34-1	40A	40-2	40-3	122	117-1	117-3	117-4	117-5	117-6	184	184-1	295	
		1	2	3	20	4	5	6	7	8	9	10	12	13	14	15	16	17	18	19	
Northern Hills Zone																					
1	HS562	MS	R	S	R	R	R	R	S	R	S	R	R	R	R	R	R	R	R	R	Sr8a+9b+
2	HPW251 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	Sr2+31+
3	HPW349 (C)	R	R	S	R	R	R	R	S	R	R	R	MR	R	R	R	R	R	R	R	Sr2+
4	HS375 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	Sr2+5+31+
5	HS490 (C)	S	S	MS	R	R	R	R	MR	R	R	R	R	R	R	R	R	R	R	R	Sr2+9b+
6	HS507 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	Sr31+
7	HS542 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	Sr2+5+8a+9b+11+
8	VL804 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	Sr2+5+31+
9	VL829 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	Sr5+31+
10	VL892 (C)	R	R	R	R	R	R	R	MS	R	MS	R	S	R	R	R	R	R	R	R	Sr2+
11	VL907 (C)	R	R	R	R	R	R	R	R	R	R	R	S	R	R	R	R	R	R	R	Sr2+31+
North Western Plain Zone																					
12	HD4730	R	R	R	R	R	S	R	R	R	MS	R	R	S	S	R	S	S	MR	R	Sr2+11+
13	MP1277	S	R	R	R	R	MS	R	MS	R	MR	R	R	R	S	MR	MR	R	R	MS	Sr2+7b+11+
14	WH1164	MR	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	MR	R	Sr2+
15	DBW88 (C)	MS	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	Sr2+11+
16	DBW90 (C)	S	S	S	R	R	MR	R	MR	S	R	R	MS	R	MR	R	S	R	S	S	Sr2+13+
17	PBW621-50 (C)	S	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	Sr2+
18	HD2967 (C)	MS	S	R	R	R	S	R	MR	R	R	R	R	R	R	R	R	R	R	R	Sr2+8a+11+
19	HD3043	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	-
20	HD3059 (C)	S	R	R	R	R	MS	R	MS	R	R	MS	MR	R	MR	R	R	R	S	MS	Sr2+11+*
21	HD3086 (C)	S	S	S	R	R	S	S	R	S	MS	S	MS	R	R	R	R	MR	S	MS	Sr2+7b+
22	PBW1644 (C)	MR	R	R	R	R	R	R	S	R	R	R	R	R	R	R	R	R	R	R	Sr2+11+
23	PDW233 (C)	R	R	R	R	R	S	R	R	R	R	R	MS	R	S	R	S	S	S	R	Sr2+9e+
24	PDW291 (C)	R	R	R	R	R	MR	MR	R	R	MR	MR	R	MS	MS	R	S	R	MR	S	Sr2+9e+
25	PDW314 (C)	R	R	S	R	R	S	R	MR	S	S	R	S	S	S	R	S	MR	S	R	Sr2+9e+
26	WH1021 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	Sr2+31+
27	WH1080 (C)	R	R	MS	R	R	R	R	R	MR	MR	R	R	R	R	R	R	R	R	R	Sr2+9e+

S. No.	VARIETY	PATHOTYPES																			Gene postulation
		11	11A	15-1	21	21A-2	24A	34-1	40A	40-2	40-3	122	117-1	117-3	117-4	117-5	117-6	184	184-1	295	
		1	2	3	20	4	5	6	7	8	9	10	12	13	14	15	16	17	18	19	
28	WH1105 (C)	R	R	R	R	R	R	R	MR	R	R	R	S	R	R	R	R	R	S	R	*Sr*2+11+
29	WH1124 (C)	S	S	S	R	R	MS	R	R	S	MR	MS	MS	MR	R	R	R	R	R	S	*Sr*2+7b+
30	WH1142 (C)	R	R	S	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+31+
North Eastern Plain Zone																					
31	C306 (C)	S	R	R	S	R	S	S	R	S	R	R	S	R	S	R	R	R	MR	R	-
32	HD2888 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+24+
33	K8027 (C)	S	R	R	R	R	S	R	MS	R	R	S	S	S	S	MS	S	S	S	S	*Sr*2+11+
Central Zone																					
34	HD4728 (D)	MS	R	R	R	R	S	MS	R	R	R	R	R	S	S	MR	S	S	MR	R	*Sr*2+11+
35	HD4730 (D)	R	R	R	R	R	S	MR	MS	R	R	R	S	S	S	MR	S	S	MR	R	*Sr*2+11+
36	GW322 (C)	MS	R	R	R	R	R	R	R	R	R	R	R	MR	R	R	R	R	R	S	*Sr*2+11+
37	HD2864 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	-*
38	HD2932 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	-
39	HI1544 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+24+R+
40	HI8498 (D) (C)	MR	R	R	MS	R	S	R	R	R	S	S	R	S	MR	MR	MS	S	MS	S	*Sr*2+11+
41	HI8737 (D) (C)	MR	R	MS	R	R	MS	R	MS	R	S	S	R	S	R	S	MS	R	MS	S	*Sr*2+9e+
42	MP3336 (C)	S	MS	MS	R	R	R	R	MR	R	R	R	R	MR	R	R	R	R	S	MR	*Sr*2+
43	MP4010 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+24+
44	MPO1215 (D) (C)	R	R	R	R	R	R	R	R	R	S	S	MR	R	-	R	S	R	R	R	*Sr*11+
Peninsular Zone																					
45	MACS3927 (D)	MS	R	R	R	R	MR	R	R	R	S	S	MS	S	R	R	MS	S	S	MR	*Sr*2+11+
46	NAW2030	R	R	R	R	R	R	S	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+24+
47	AKDW2997-16 (D) (C)	R	MR	S	S	S	MR	R	R	S	MS	S	MR	S	S	R	S	S	S	S	*Sr*2+7b+
48	DBW93 (I) (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+31+
49	MACS6222 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+31+
50	MACS6478 (C)	S	R	S	R	R	R	R	R	R	R	R	S	R	R	R	R	R	R	MS	-
51	NI5439 (C)	MS	R	R	R	R	S	R	R	R	R	R	S	R	R	R	R	R	R	R	*Sr*11+
52	NIAW1415(C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+31+
53	UAS347 (I) (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	S	R	*Sr*2+7b+11+
54	UAS428 (D) (C)	R	R	R	R	R	S	R	R	R	S	R	R	S	R	MR	S	S	R	R	*Sr*2+11+

S. No.	VARIETY	PATHOTYPES																			Gene postulation
		11	11A	15-1	21	21A-2	24A	34-1	40A	40-2	40-3	122	117-1	117-3	117-4	117-5	117-6	184	184-1	295	
		1	2	3	20	4	5	6	7	8	9	10	12	13	14	15	16	17	18	19	
55	UAS446 (D) (I) (C)	S	R	R	R	R	S	R	R	R	R	R	MR	S	S	R	S	S	R	R	*Sr*2+11+
Special trial																					
56	HD2932+*Lr*19/*Sr*25	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+25+
57	MMBL283	S	R	S	R	R	MS	R	R	R	R	R	MS	MS	MR	R	S	R	R	R	-
58	PBW723	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+R
59	DBW14 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	S	R	*Sr*2+
60	DDK1029 (C)	R	R	R	R	R	S	R	MS	R	R	R	R	R	R	R	S	MR	R	MR	*Sr*2+11+
61	HD2985 (C)	MR	R	R	R	R	R	R	R	R	R	R	MR	R	R	R	R	R	S	MS	*Sr*7b+
62	HI1563 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+R
63	HUW234 (C)	S	R	R	R	R	S	R	MR	R	S	MS	MS	R	S	R	R	S	S	S	*Sr*9b+11+
64	HW1098 (C)	R	R	R	R	R	R	R	R	R	MR	MR	R	R	R	R	MR	S	R	MS	*Sr*2+11+
65	K0307 (C)	R	R	R	R	R	R	R	R	R	R	R	MR	R	R	R	R	R	R	R	*Sr*2+
66	KARCHIA65 (C)	S	R	R	R	MR	MR	S	MR	S	MS	S	S	S	S	MS	S	S	S	S	-
67	KRL19 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+8b+9b+11+
68	KRL210 (C)	S	S	S	R	R	MS	R	R	S	MR	MR	R	R	R	R	R	S	S	S	*Sr*7b+
69	PBW343 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+31+
70	RAJ4083 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+11+
71	TL2942 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+R
72	TL2969 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	S	R	*Sr*2+R
73	WH542 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*31+

Annexure 3: Seedling Resistance Test of AVT II against pathotypes of yellow rust (*Puccinia striiformis tritici*) at Shimla during 2014-2015.

S. No.	VARIETY	PATHOTYPES												Gene postulation
		78 S 84	P	46 S 119	K	T	I	38A	L	14A	20A	N	A	
		1	2	3	4	5	6	7	8	9	10	11	12	
Northern Hills Zone														
1	HS562	R	S	S	R	S	R	R	R	R	R	R	R	*Yr*A+
2	HPW251 (C)	MS	R	MS	R	R	R	R	R	R	R	R	R	*Yr*9+
3	HPW349 (C)	MS	S	S	R	S	R	R	-	-	R	R	R	*Yr*2+
4	HS375 (C)	S	R	S	R	R	R	R	R	R	R	R	R	*Yr*9+18+
5	HS490 (C)	R	MS	MX	R	R	R	R	R	R	R	R	R	-
6	HS507 (C)	MS	R	MS	R	R	R	R	R	R	R	R	R	*Yr*9+
7	HS542 (C)	MS	S	MS	R	MS	R	R	R	R	R	R	R	*Yr*2+
8	VL804 (C)	S	R	MS	R	R	R	R	R	R	R	R	R	*Yr*9+18+
9	VL829 (C)	S	R	MS	R	R	R	R	R	R	R	R	R	*Yr*9+18+
10	VL892 (C)	R	S	MS	MR	MS	R	R	R	R	R	R	R	*Yr*A+
11	VL907 (C)	MS	R	MS	R	R	R	R	R	R	R	R	R	*Yr*9+18+
North Western Plain Zone														
12	HD4730	S	R	MS	R	MS	R	R	R	R	R	R		*Yr*2+
13	MP1277	S	S	R	R	S	R	MS	R	R	R	R	MX	-
14	WH1164	MS	S	R	R	S	R	R	R	R	R	-	R	-
15	DBW88 (C)	R	R	MS	R	R	R	R	R	R	R	-	R	-
16	DBW90 (C)	MS	S	MX	R	MX	MS	R	R	MS	R	R	R	-
17	PBW621-50 (C)	MS	R	MS	R	R	R	R	R	R	R	R	R	-
18	HD2967 (C)	MS	S	S	R	S	R	R	R	R	R	R	R	*Yr*2+
19	HD3043	R	R	R	R	R	R	R	R	R	R	R	R	R
20	HD3059 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R
21	HD3086 (C)	MS	MX	S	R	MS	MR	R	R	R	R	R	MR	*Yr*2+
22	PBW1644 (C)	S	R	MS	R	MS	R	R	R	R	R	R	MX	*Yr*2+
23	PDW233 (C)	S	MS	S	R	MS	MS	MS	S	R	R	MX	R	-
24	PDW291 (C)	S	S	S	MS	S	S	R	S	R	R	S		-
25	PDW314 (C)	S	MS	MX	MS	S	S	R	MS	R	R	R	R	*Yr*2+
26	WH1021 (C)	MS	R	S	R	R	R	R	R	R	R	R	R	*Yr*9+
27	WH1080 (C)	MS	S	MS	MX	S	S	R	S	R	R	R	R	*Yr*2+

S. No.	VARIETY	PATHOTYPES												Gene postulation
		78 S 84	P	46 S 119	K	T	I	38A	L	14A	20A	N	A	
		1	2	3	4	5	6	7	8	9	10	11	12	
28	WH1105 (C)	MS	R	MS	R	MS	R	R	R	R	R	R	R	Yr2+
29	WH1124 (C)	MS	R	S	MS	S	R	MX	R	R	R	R	R	Yr2+
30	WH1142 (C)	MS	R	S	R	R	R	R	R	R	R	R	R	Yr9+
North Eastern Plain Zone														
31	C306 (C)	R	S	R	R	MS	R	R	R	R	R	R	R	Yr18+
32	HD2888 (C)	S	S	S	R	S	R	R	R	R	R	R	R	Yr2+
33	K8027 (C)	MS	MS	S	R	MS	R	MX	R	R	R	MX	R	Yr2+
Central Zone														
34	HD47278 (D)	MS	R	MS	R	MS	R	R	R	R	R	R	R	Yr2+
35	HD4730 (D)	S	R	S	R	MX	R	R	R	R	R	R	R	-
36	GW322 (C)	S	S	S	MS	S	S	S	R	R	R	R	MX	-
37	HD2864 (C)	S	MS	S	MS	R	R	R	R	R	R	R	R	Yr2+
38	HD2932 (C)	S	S	S	MS	S	R	R	MS	R	R	R	MS	-
39	HI1544 (C)	MS	MS	R	R	MS	R	S	MX	R	R	MX	MX	Yr2+
40	HI8498 (D) (C)	MS	MS	R	S	S	MX	S	S	R	R	R	S	Yr2+
41	HI8737 (D) (C)	S	MS	MS	MS	MX	S	S	S	R	R	R	S	Yr2+
42	MP3336 (C)	MX	MS	S	MR	MS	R	S	MS	R	R	R	MS	Yr2+
43	MP4010 (C)	S	S	S	R	R	R	R	R	R	R	MS	R	Yr2+
44	MPO1215 (D) (C)	S	S	R	R	R	MX	-	MX	R	R	-	S	-
Peninsular Zone														
45	MACS392 7(D)	R	R	R	R	R	R	R	R	R	R	R	R	R
46	NAW2030	S	S	S	R	S	R	R	R	R	R	R	R	Yr2+
47	AKDW2997-16 (D) (C)	S	S	MR	MS	S	R	S	MX	R	R	MS	R	-
48	DBW93 (I) (C)	S	R	MS	R	R	R	R	R	R	R	R	R	Yr9+
49	MACS6222 (C)	S	R	S	R	R	R	R	R	R	R	R	R	Yr9+27+
50	MACS6478 (C)	MS	MS	MS	R	MS	R	R	R	R	R	R	R	Yr2+
51	NI5439 (C)	S	S	MX	R	S	R	R	R	R	R	S	R	Yr2+18+
52	NIAW1415(C)	MS	R	S	R	R	R	R	R	R	R	R	R	Yr9+
53	UAS347 (I) (C)	S	S	S	R	S	R	R	R	R	R	MX	S	Yr2+
54	UAS428 (D) (C)	MS	R	S	S	S	R	R	S	R	R	S	R	-

S. No.	VARIETY	PATHOTYPES												Gene postulation
		78 S 84	P	46 S 119	K	T	I	38A	L	14A	20A	N	A	
		1	2	3	4	5	6	7	8	9	10	11	12	
55	UAS446 (D) (I) (C)	S	R	R	MS	S	R	R	MS	S	R	R	R	*Yr*2+
Special trial														
56	HD2932+*Lr*19/*Sr*25	S	MS	MS	MS	S	R	R	R	MR	R	R	R	*Yr*2+
57	MMBL283	S	MX	MS	MX	MS	MS	S	MS	MS	R	R	MS	-
58	PBW723	R	R	R	MS	R	R	R	MS	R	R	R	R	-
59	DBW14 (C)	S	R	MS	MS	MS	R	R	R	MS	R	MR	R	-
60	DDK1029 (C)	S	MS	MR	MS	MS	MS	R	MS	MS	R	S	R	-
61	HD2985 (C)	S	MS	S	MS	MS	R	R	MS	R	RMR	R0MR	R	*Yr*2+
62	HI1563 (C)	MS	MS	MS	R	MS	R	R	R	R	R	R	R	*Yr*2+
63	HUW234 (C)	S	MS	MS	R	MS	MS	R	MR	MS	R	MS	R	*Yr*2+
64	HW1098 (C)	S	MS	MS	R	MX	R	MX	MS	S	R	MS	R	-
65	K0307 (C)	S	MS	MS	MS	S		R	MS	R	R	R	S	*Yr*2+
66	KARCHIA65 (C)	S	S	S	S	S	S	R	S	S	R	S	S	-
67	KRL19 (C)	S	MR	MS	S	MS	S	R	MS	R	R	MS	MS	-
68	KRL210 (C)	MX	MS	MS	MR	S	R	R	R	MS	R	R	R	-
69	PBW343 (C)	S	R	S	R	R	R	R	R	R	R	R	R	*Yr*9+
70	RAJ4083 (C)	S	MS	MS	R	MS	R	R	R	R	R	R	R	*Yr*2+
71	TL2942 (C)	S	R	S	MS	S	MS	R	MS	MS	R	R	MS	-
72	TL2969 (C)	S	R	MS	R	R	R	R	MS	R	R	R	R	-
73	WH542 (C)	MS	R	MR	R	R	R	R	R	R	R	R	R	*Yr*9+

Annexure 4: Seedling Resistance Test of AVT I against pathotypes of brown rust (*Puccinia triticina*) at Shimla during 2014-2015

S. No.	VARIETY	PATHOTYPES																												Gene postulation
		11	12	12-2	12-3	12-5	12-7	12-9	16-1	77	77-1	77-2	77-5	77-7	77-8	77-9	77-10	77-12	77A-1	104-2	104-3	104-4	104B	106	107-1	108-1	162-1	162-3	162A	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
Northern Hills Zone																														
1	HPW393	R	R	R	R	R	R	R	R	R	R	R	S	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Lr*1+10+23+
2	HPW394	R	R	R	R	R	R	R	R	R	S	S	S	S	R	S	S	R	R	S	R	S	R	R	R	R	MX	R	R	*Lr*1+13+10+
3	HPW413	R	R	S	R	R	S	MS	R	R	R	S	S	S	R	M	S	R	R	S	S	R	R	R	R	R	R	R	R	*Lr*10+23+
4	HPW421	R	R	R	S	S	S	MS	R	R	-	S	M	R	R	M	S	R	R	S	R	S	MX	R	R	R	R	R	R	*Lr*23+
5	HPW422	R	R	R	R	R	R	R	R	R	S	MS	S	R	R	S	S	R	R	S	R	S	R	R	R	R	R	R	R	*Lr*23+
6	HS580	R	R	R	R	R	R	R	R	R	S	R	S	S	R	R	S	R	R	R	S	S	R	R	R	R	R	R	R	*Lr*1+26+
7	HS583	R	R	S	R	R	S	S	R	R	R	S	R	S	R	S	S	R	-	S	S	S	S	R	R	R	R	R	S	*Lr*10+13+
8	HS590	R	R	R	R	S	R	R	R	M	S	S	R	S	S	R	MX	R	S	R	R	R	R	R	R	R	R	R	R	*Lr*13+
9	HS596	R	R	R	R	R	R	R	R	R	R	S	R	S	R	R	S	R	R	R	R	R	R	R	R	R	R	R	R	*Lr*23+
10	HS597	R	R	S	R	S	S	R	R	S	S	S	S	S	S	S	S	R	S	S	S	S	S	R	S	R	S	R	S	*Lr*13+
11	HS598	R	S	S	R	S	S	S	R	S	S	S	S	S	R	S	S	S	S	S	S	R	S	R	R	R	S	R	S	*Lr*2a+13+
12	HS599	R	R	R	R	R	R	S	R	R	S	S	R	S	R	R	S	R	R	R	R	S	R	R	R	R	R	R	R	*Lr*10+26+
13	HS600	R	R	R	R	R	R	R	R	R	R	R	R	S	R	M	S	R	S	R	R	R	R	R	R	R	R	R	R	*Lr*1+13+23+
14	HS601	R	R	S	R	S	S	MS	R	R	R	S	R	S	S	S	S	R	S	S	S	S	S	R	R	R	R	R	R	*Lr*13+
15	UP2917	R	R	R	R	R	R	R	R	R	S	R	S	S	R	R	S	R	R	R	R	S	R	R	R	R	R	R	R	*Lr*10+26+
16	UP2918	R	R	R	R	R	R	R	R	R	R	R	S	R	R	R	S	R	R	R	R	S	R	R	R	R	R	R	R	*Lr*1+23+26+
17	VL1005	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	S	R	R	R	R	S	R	R	R	R	R	R	R	*Lr*1+23+26+
18	VL1006	R	R	S	R	R	R	R	R	R	R	S	S	S	R	R	R	R	R	R	R	S	R	R	R	R	R	R	R	*Lr*10+13+23+
19	VL1007	R	R	R	S	S	S	R	R	R	R	R	S	S	R	S	R	R	R	S	S	R	R	R	R	R	S	R	R	*Lr*26+
20	VL3002	R	R	R	R	R	R	R	R	R	R	S	R	R	MS	R	S	R	S	S	MX	S	R	R	R	S	S	R	R	*Lr*10+13+
21	VL3007	R	R	R	R	R	R	R	R	R	S	R	R	S	R	R	S	R	R	R	R	R	R	R	-	R	R	R	R	*Lr*1+26+
22	VL3008	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Lr*26+
23	VL3009	S	S	S	R	S	S	S	R	R	S	R	R	R	R	S	S	S	S	S	S	R	S	R	R	R	S	R	S	*Lr*2b+13+
24	VL4001	R	R	R	R	R	R	MS	R	R	-	R	R	S	R	S	R	S	-	R	R	R	R	R	R	R	S	R	R	*Lr*10+26+
North Western Plain Zone																														
25	DBW147	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	-
26	DBW148	R	R	MS	R	R	S	MS	R	R	R	S	S	S	R	S	S	R	R	S	R	R	S	R	R	R	R	R	R	*Lr*10+23+
27	DBW150	R	R	R	R	R	R	R	R	R	R	S	R	R	R	S	S	R	R	R	R	S	R	R	R	R	R	R	R	*Lr*1+10+23+
28	DDW31	R	R	R	R	S	S	R	R	R	R	R	S	R	R	R	MR	R	R	R	MS	R	R	R	R	R	R	R	R	*Lr*13+23+
29	DDW32	R	R	R	R	S	R	R	R	R	R	R	S	R	R	R	R	R	R	R	R	S	S	R	R	R	R	R	R	*Lr*23+

S. No.	VARIETY	PATHOTYPES																												Gene postulation
		11	12	12-2	12-3	12-5	12-7	12-9	16-1	77	77-1	77-2	77-5	77-7	77-8	77-9	77-10	77-12	77A-1	104-2	104-3	104-4	104B	106	107-1	108-1	162-1	162-3	162A	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
30	HD3159	R	MX	S	MS	MS	S	R	R	R	MX	S	S	S	S	S	S	S	S	S	S	S	S	R	R	R	R	R	S	*Lr*13+
31	HD3165	R	R	S	R	R	S	R	R	R	MS	S	S	S	MX	S	S	S	R	S	S	R	S	R	R	R	R	R	S	*Lr*13+
32	HD3174	R	R	S	R	R	S	R	R	R	S	S	S	S	R	S	S	S	R	S	S	R	S	R	R	R	R	R	S	*Lr*13+
33	HI1604	R	R	R	R	R	R	R	R	R	S	S	S	S	S	S	S	R	R	R	S	R	R	R	R	R	R	R	R	*Lr*1+23+
34	HI1605	R	S	R	S	MS	R	S	R	M	R	R	S	R	R	S	S	R	S	S	M	S	S	R	R	R	MS	R	S	*Lr*13+
35	HUW688	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	S	R	R	R	R	R	R	R	R	R	R	R	R	-
36	K1312	R	R	R	R	R	R	R	R	R	R	S	R	S	R	R	S	R	R	R	R	R	R	R	R	R	R	R	S	*Lr*10+13+
37	K1313	R	R	R	R	R	R	S	R	R	S	R	M	S	R	S	S	R	R	R	R	S	R	R	R	R	S	R	S	*Lr*13+
38	K1314	R	S	S	R	R	S	S	R	MX	S	S	M	S	MS	S	S	S	R	S	S	R	S	R	R	R	S	R	S	*Lr*13+
39	MACS3949	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
40	MACS4024	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
41	NW6024	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
42	PBW707	R	S	S	R	S	S	S	R	S	S	S	S	S	S	S	S	S	S	S	S	S	S	R	S	R	R	S	R	*Lr*13+
43	PBW709	R	R	R	R	R	R	S	R	R	R	S	MX	S	R	S	S	R	R	S	R	R	R	R	R	R	R	R	R	*Lr*10+13+23+
44	PBW716	R	R	R	R	R	R	R	R	R	R	S	R	S	R	R	S	R	R	R	R	R	R	R	R	R	R	R	R	*Lr*10+13+23+
45	PBW718	R	MS	S	R	R	S	S	R	R	MS	S	S	S	R	R	S	R	R	S	S	R	R	R	R	R	R	R	R	*Lr*13+
46	PBW719	R	R	R	R	R	R	R	R	R	R	R	S	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Lr*23+26+
47	UP2883	R	R	S	R	R	S	R	-	R	S	S	S	S	R	R	S	R	S	S	R	S	R	R	R	R	R	S	S	*Lr*13+
48	WH1179	R	R	S	R	R	R	R	R	R	R	S	S	R	S	R	S	R	R	S	S	R	S	R	R	R	R	R	R	*Lr*10+13+
North Eastern Plain Zone																														
49	HD3171	R	R	R	R	R	S	S	R	R	R	S	R	S	R	S	S	S	R	S	S	S	R	R	R	R	S	R	S	*Lr*10+13+
50	K1317	R	R	R	R	R	R	R	R	R	S	R	S	S	R	R	S	R	R	R	R	S	R	R	R	R	R	R	R	*Lr*1+26+
Central Zone																														
51	CG1015	R	R	R	R	R	R	R	R	R	R	S	S	S	R	R	S	M	R	R	R	S	R	R	R	R	R	-	R	*Lr*13+23+
52	GW463	R	R	R	R	R	R	R	R	R	R	R	S	R	R	R	R	R	R	R	R	S	R	R	R	R	R	R	R	*Lr*1+23+
53	HI8759 (D)	R	R	S	R	S	S	S	S	R	R	R	S	R	R	R	S	R	R	S	S	S	S	R	R	R	S	R	R	*Lr*23+
Peninsular Zone																														
54	GW1315 (D)	R	R	S	R	S	S	S	S	S	R	R	S	R	R	M	S	S	R	S	S	S	S	R	R	R	S	R	R	*Lr*13+
55	HD3164	R	R	R	R	S	R	S	R	R	R	R	R	R	R	M	S	R	R	S	S	R	MS	R	R	R	R	S	R	*Lr*13+

S. No.	VARIETY	PATHOTYPES																												Gene postulation
		11	12	12-2	12-3	12-5	12-7	12-9	16-1	77	77-1	77-2	77-5	77-7	77-8	77-9	77-10	77-12	77A-1	104-2	104-3	104-4	104B	106	107-1	108-1	162-1	162-3	162A	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
56	HI8765 (D)	R	R	R	R	R	R	R	MS	R	R	R	R	R	R	R	R	R	R	R	R	S	R	R	R	R	MS	S	R	*Lr*23+
57	JWS712	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Lr*24+
58	K1315	R	R	R	R	R	R	R	R	R	R	R	S	R	R	R	MS	R	R	R	R	MS	R	R	R	R	R	R	R	*Lr*1+23+
59	MACS397 0(D)	R	S	R	R	R	R	R	MS	R	R	R	R	R	R	R	S	-	R	R	R	R	R	R	R	R	R	S	R	*Lr*13+
60	MACS397 2(D)	R	MS	S	R	S	S	R	S	R	S	R	S	R	R	R	R	R	R	S	S	S	S	R	R	R	S	S	S	*Lr*13+
61	MACS402 0 (D)	S	R	S	R	S	S	R	S	R	R	S	R	R	R	S	S	R	S	S	S	S	S	R	R	R	S	MS	R	-
62	PBW721	R	R	R	R	S	R	S	R	S	R	S	R	S	MS	R	S	R	S	R	R	S	R	R	R	R	R	R	R	*Lr*13+
63	UAS360	R	S	S	R	R	R	R	R	S	MS	MS	R	R	R	R	S	S	S	S	R	S	S	R	R	R	R	R	S	*Lr*2a+13+
64	UAS361	R	R	R	-	R	R	MS	R	R	S	R	R	S	R	R	S	R	R	R	R	S	R	R	R	R	R	R	R	*Lr*1+23+26+
65	UAS453 (D)	MS	R	R	R	R	R	R	R	R	R	R	R	R	R	R	S	R	R	R	S	S	R	R	R	R	S	R	R	*Lr*13+
66	UAS455 (D)	R	S	S	R	R	MS	R	R	R	R	R	S	R	R	M	S	MS	R	S	S	S	S	R	R	R	S	R	R	*Lr*13+
Special Trial (Dicoccum, Salinity and Alkalinity)																														
67	DBW181	R	S	S	R	S	MS	R	R	S	MS	S	S	S	R	R	S	S	S	S	S	S	S	R	S	S	S	S	S	*Lr*13+
68	DBW182	R	R	R	R	R	R	S	R	R	S	S	S	S	R	R	S	R	R	R	R	S	R	R	R	R	S	R	R	*Lr*10+13+
69	DBW183	R	S	R	S	S	R	R	R	S	S	S	S	S	R	M	S	MS	S	S	S	S	S	R	R	R	R	R	R	*Lr*13+
70	DBW184	R	S	S	R	R	S	S	R	R	S	S	S	S	S	R	S	MS	R	S	S	S	S	R	R	R	R	R	S	-
71	DBW185	R	R	R	R	R	R	R	R	R	S	S	R	S	S	R	S	R	R	S	S	S	R	R	R	R	R	R	S	*Lr*10+13+
72	DDK1048	S	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	S	S	S	R	R	R	R	S	R	R	-
73	DDK1049	S	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	S	R	MS	S	S	R	R	S	R	R	-
74	KRL350	R	R	R	R	R	R	R	R	R	R	R	MS	S	R	R	S	R	R	R	R	R	R	R	R	R	R	R	R	*Lr*1+23+
75	KRL351	R	R	S	R	R	MS	MS	R	R	S	S	S	S	R	R	S	R	S	S	S	S	S	R	R	R	R	R	R	*Lr*10+13+
76	MACS504 1	S	R	R	R	R	R	MS	R	R	R	R	R	R	R	R	S	R	R	S	R	S	R	S	R	R	S	R	R	*Lr*20+
77	MACS504 3	S	R	S	R	S	R	MS	R	R	R	R	R	R	R	R	S	R	R	S	S	S	R	S	R	R	S	R	S	-
78	WH1309	R	R	S	R	R	S	MS	R	R	R	S	S	S	R	R	S	R	S	S	S	MS	R	R	R	R	R	R	S	*Lr*10+13+
Special Trial (Triticale)																														

S. No.	VARIETY	PATHOTYPES																											Gene postulation
		11	12	12-2	12-3	12-5	12-7	12-9	16-1	77	77-1	77-2	77-5	77-7	77-8	77-9	77-10	77-12	77A-1	104-2	104-3	104-4	104B	106	107-1	108-1	162-1	162-3	162A	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
79	TL3001	R	R	S	R	S	R	S	R	R	R	R	R	R	R	R	R	R	R	S	S	R	MS	R	R	R	R	-	R	*Lr*13+
80	TL3002	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Lr*1+26+
81	TL3003	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Lr*1+26+
82	TL3004	R	MS	S	R	R	S	S	R	S	-	S	S	R	S	R	S	R	MS	S	R	S	R	-	S	R	M	S	S	*Lr*13+
83	TL3005	R	MS	R	R	R	R	R	R	MS	R	S	S	MS	R	R	R	R	S	S	S	R	S	R	S	R	R	S	-	*Lr*13+
Special Trial (MABB/NIL (KB) entries)																													
84	DWR-NIL-01	R	R	R	R	R	MS	R	R	R	R	R	R	R	R	R	R	R	R	S	S	S	R	R	R	R	R	R	R	*Lr*23+26+
85	DWR-NIL-02	R	R	R	R	R	R	R	R	R	S	R	S	S	R	S	S	R	R	S	S	S	R	R	R	R	R	R	R	*Lr*26+
86	HD3209	R	R	R	R	R	R	R	R	R	R	R	R	R	S	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Lr*19+
87	KB2012-03	R	R	R	R	R	R	MS	R	R	R	R	S	R	R	R	S	R	R	R	R	S	R	R	R	R	R	R	R	*Lr*10+23+
Special Trial (Wheat Bifortification)																													
88	HPBW01	R	R	R	R	R	R	R	R	R	R	R	MS	S	R	R	S	R	S	S	R	R	R	R	R	R	R	R	R	*Lr*10+23+26+
89	HPBW02	R	R	R	R	R	R	R	R	R	R	S	R	S	R	R	S	R	R	R	R	R	R	R	R	R	R	R	R	*Lr*10+23+26+
90	HPBW05	R	R	R	R	R	R	R	R	S	M	R	S	S	R	S	S	R	S	R	R	R	R	R	R	R	R	R	R	*Lr*13+
91	HPBW07	R	R	S	S	R	S	S	R	R	S	S	R	S	R	S	S	S	R	S	S	S	R	R	R	R	S	R	R	*Lr*13+
92	HPBW08	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
93	HPBW09	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
94	HUW695	R	R	R	R	R	R	S	R	R	S	R	R	S	S	R	S	R	R	R	R	R	R	R	R	R	R	R	R	*Lr*10+23+
95	HUW711	R	R	R	R	S	R	MS	R	R	MS	S	MS	S	R	R	S	R	MS	R	R	R	R	R	R	R	R	R	R	*Lr*23+
96	HUW712	R	R	R	R	R	R	S	R	S	-	S	S	S	R	R	S	R	R	R	R	R	R	R	R	R	R	R	R	*Lr*13+
97	MACS6507	R	S	S	R	R	S	S	R	S	MS	S	S	S	R	R	S	S	S	S	S	S	S	R	R	R	S	R	S	*Lr*13+
98	WB1	R	R	R	R	R	R	S	R	S	R	R	R	S	R	R	S	S	R	R	R	R	R	R	R	R	R	R	R	*Lr*13+
99	WB2	R	R	R	R	R	R	R	R	S	R	S	R	R	R	R	S	R	S	R	R	S	R	R	R	R	R	R	R	*Lr*13+
100	WB5	R	R	R	R	R	R	R	R	R	R	R	R	S	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Lr*1+26+

Annexure 5: Seedling Resistance Test of AVT 1st against pathotypes of black rust (*Puccinia graminis tritici*) at Shimla during 2014-2015

S. No.	VARIETY	PATHOTYPES																			Gene postulation
		11	11A	15-1	21	21A-2	24A	34-1	40A	40-2	40-3	122	117-1	117-3	117-4	117-5	117-6	184	184-1	295	
		1	2	3	20	4	5	6	7	8	9	10	12	13	14	15	16	17	18	19	
Northern Hills Zone																					
1	HPW393	MS	R	R	R	R	R	R	MS	R	MS	R	R	R	R	R	R	R	R	R	*Sr*11+
2	HPW394	MR	R	R	R	R	R	R	MS	R	R	R	R	R	MS	R	R	R	R	MS	*Sr*11+
3	HPW413	MS	S	S	R	R	R	MR	MS	R	S	R	R	R	R	R	R	S	R	S	*Sr*7b+
4	HPW421	R	R	MS	R	R	R	R	R	R	MS	R	R	R	R	R	R	R	S	R	*Sr*5+8a+11+
5	HPW422	R	R	R	R	R	MR	R	R	R	R	R	R	R	R	R	R	R	MS	R	*Sr*11+
6	HS580	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*5+31+
7	HS583	S	R	R	R	R	MR	R	MS	R	S	MR	S	R	MS	MS	MS	R	S	MS	*Sr*2+9b+11+
8	HS590	S	MR	R	R	R	R	R	MR	R	S	S	MR	R	R		MR	R	S	MS	*Sr*2+7b+
9	HS596	R	R	R	R	R	R	R	R	R	MS	R	MS	R	MS	R	R	R	R	R	*Sr*11+
10	HS597	S	R	R	R	R	R	R	R	R	S	R	MR	R	MR	R	S	R	R	MR	*Sr*2+11+
11	HS598	R	R	S	R	R	R	R	R	R	S	R	MR	R	R	R	R	R	R	R	*Sr*2+30+
12	HS599	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+31+
13	HS600	MR	R	S	R	R	R	R	MS	R	S	R	MS	R	R	R	R	R	R	R	*Sr*2+7b+
14	HS601	R	R	S	R	R	R	R	MR	MS	R	R	MR	R	R	R	R	R	R	R	*Sr*5+7b+
15	UP2917	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+31+
16	UP2918	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+31+
17	VL1005	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+31+
18	VL1006	R	R	R	R	R	R	R	MS	R	MR	MR	MS	R	R	R	R	R	MS	MS	*Sr*2+11+
19	VL1007	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+31+
20	VL3002	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+R+
21	VL3007	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+31+
22	VL3008	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*31+
23	VL3009	R	R	S	R	R	R	MS	MR	R	R	R	R	R	R	R	R	R	R	R	*Sr*30+
24	VL4001	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+31+
North Western Plain Zone																					
25	DBW147	R	R	MR	R	MS	R	R	R	S	R	R	R	R	R	R	R	R	R	R	*Sr*2+30+
26	DBW148	S	S	S	MS	S	R	S	S	S	S	S	MS	MS	MR	R	MS	S	S	MS	*Sr*2+7b+
27	DBW150	MR	R	S	R	R	R	R	S	R	S	R	S	R	R	MS	R	R	MS	R	*Sr*2+7b+
28	DDW31	R	R	R	R	R	S	R	R	R	R	R	S	S	S		S	R	MS	R	*Sr*2+11+

S. No.	VARIETY	PATHOTYPES																			Gene postulation
		11	11A	15-1	21	21A-2	24A	34-1	40A	40-2	40-3	122	117-1	117-3	117-4	117-5	117-6	184	184-1	295	
		1	2	3	20	4	5	6	7	8	9	10	12	13	14	15	16	17	18	19	
29	DDW32	R	R	S	R	R	MS		S	S	S	R	S	S	MS	R	S	MS	S	R	*Sr*2+7b+
30	HD3159	R	R	R	R	R	R	R	R	R	MR	R	R	R	R	R	R	R	R	R	*Sr*5+11+13+
31	HD3165	S	S	S	R	S	R	R	MR	S	MS	MS	S	R	R	R	MS	MS	R	MS	*Sr*2+7b+
32	HD3174	S	S	S	R	R	MS	R	MR		MR	S	R	R	R	R	R	MR	R	S	*Sr*2+7b+
33	HI1604	R	R	R	R	R	R	R	R	R	R	R	MR	MR	R	R	R	R	R	R	*Sr*11+
34	HI1605	MS	R	R	R	R	R	R	R	R	R	R	MS	R	R	R	R	R	R	R	*Sr*5+11+
35	HUW688	MS	R	R	R	R	R	R	MS	R	R	MR	R	R	R	MR	R	R	S	R	*Sr*5+11+
36	K1312	R	R	R	R	R	R	R	MS	R	R	R	R	R	R	R	R	R	S	R	*Sr*5+11+
37	K1313	R	R	R	R	R	R	R	R	R	S	R	R	R	R	R	R	R	R	R	*Sr*2+5+30+
38	K1314	R	R	S	R	R	R	R	MR	R	MS	R	R	R	R	R	R	R	R	R	*Sr*2+5+7b+
39	MACS3949	R	R	MR	R	R	MS	R	R	R	MS	R	R	MS	MR	R	S	S	R	R	*Sr*2+7b+
40	MACS4024	MR	R	R	R	R	S	R	R	R	MR	R	MR	S	S	S	S	S	R	R	*Sr*2+11+
41	NW6024																				-
42	PBW707	MS	R	R	R	R	R	R	R	R	MR	R	MR	R	R	R	R	R	R	R	*Sr*9b+11+
43	PBW709	MS	MS	R	R	R	R	R	R	R	MR	MR	R	R	R	R	R	R	R	R	*Sr*9b+11+
44	PBW716	R	R	S	R	R	MS	R	S	R	S	R	MR	R	R	R	R	R	MS	R	*Sr*2+7b+
45	PBW718	R	R	R	R	R	R	R	R	R	R	R	S	R	R	R	R	R	S	R	*Sr*9e+
46	PBW719	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*31+
47	UP2883	MS	R	R	R	R	R	R	R	R	R	R	MS	R	R	R	R	R	R	R	*Sr*11+
48	WH1179	R	R	S	R	R	R	R	R	S	S	MS	MR	R	R	R	R	R	R	S	*Sr*7b+
North Eastern Plain Zone																					
49	HD3171	R	R	MS	R	R	MR	R	MS	R	R	R	MS	R	R	MR	R	R	R	MR	*Sr*7b+
50	K1317	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+31+
Central Zone																					
51	CG1015	MS	MS	R	R	R	R	R	MS	R	MR	R	MR	R	R	R	R	R	R	R	*Sr*2+5+7b+
52	GW463	MS	R	R	R	R	MR	R	R	R	MR	R	R	R	R	R	R	R	R	R	*Sr*2+11+
53	HI8759 (D)	MS	R	R	R	R	S	R	R	R	R	MS	MS	R	R	R	S	MS	MS	MR	*Sr*2+11+
Peninsular Zone																					
54	GW1315(D)	R	R	R	R	R	MS	R	MR	R	R	R	S	R	R	R	S	R	R	R	*Sr*7b+11+
55	HD3164	S	R	S	R	R	R	R	R	S	S	R	MR	R	R	R	R	R	S	MS	*Sr*7b+
56	HI8765 (D)	R	R	R	R	R	MS	R	R	R	R	R	MR	MR	R	R	MS	S	R	MS	*Sr*9b+11+

S. No.	VARIETY	PATHOTYPES																			Gene postulation
		11	11A	15-1	21	21A-2	24A	34-1	40A	40-2	40-3	122	117-1	117-3	117-4	117-5	117-6	184	184-1	295	
		1	2	3	20	4	5	6	7	8	9	10	12	13	14	15	16	17	18	19	
57	JWS712	R	R	R	R	R	R	R	R	MS	R	R	R	R	R	R	R	R	R	R	*Sr*2+24+
58	K1315	R	R	S	R	R	R	R	MR	R	MS	R	R	R	R	R	R	R	R	R	*Sr*2+7b+13+
59	MACS3970(D)	R	R	S	R	R	S	R	R	R	R	R	MS	S	S	S	S	S	S	R	*Sr*7b+
60	MACS3972(D)	R	R	R	R	MR	S	R	R	R	MR	R	MR	S	MR	MR	R	S	R	R	*Sr*2+11+12+
61	MACS4020(D)	R	R	R	R	R	S	R	MR	R	R	R	MS	S	S	MR	S	S	R	R	*Sr*2+11+12+
62	PBW721	R	R	R	R	R	R	R	R	R	MS	R	R	R	R	R	R	R	R	R	*Sr*5+9e+11+
63	UAS360	S	S	R	R	R	R	R	MS	MS	R	R	R	R	R	R	R	R	R	R	*Sr*30+
64	UAS361	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	MS	R	R	*Sr*2+31+
65	UAS453(D)	R	R	MR	R	MR	R	R	MR	R	MR	R	R	MR	MS	R	MS	S	R	R	*Sr*2+7b+9e+
66	UAS455(D)	R	R	MS	R	R	S	R	S	R	R	R	S	MS	R	MR	MS	S	MR	R	*Sr*2+7b+9e+
Special Trial (Dicoccum, Salinity and Alkalinity)																					
67	DBW181	R	R	S	R	R	R	R	S	S	S	R	MS	R	R	R	R	R	S	R	*Sr*2+7b+9e+
68	DBW182	S	R	R	R	R	R	R	R	R	R	MR	R	R	R	R	R	R	R	R	*Sr*2+5+11+13+
69	DBW183	R	R	R	R	R	R	R	S	S	MR	R	R	R	R	R	R	R	R	R	*Sr*2+8a+
70	DBW184	R	R	R	R	R	R	R	MR	R	R	R	MS	R	R	MR	R	R	R	R	*Sr*2+7b+11+
71	DBW185	R	R	MS	R	R	R	R	MR	R	R	S	R	R	R	R	R	R	R	MS	*Sr*2+5+7b+
72	DDK1048	R	R	MR	R	MR	MS	R	MR	R	MR	MS	R	R	R	R	S	R	R	R	*Sr*7b+
73	DDK1049	R	R	MR	MR	R	S	R	R	R	MR	MR	MR	R	MR	R	S	S	MR	S	*Sr*7b+
74	KRL350	R	R	R	R	R	R	R	R	R	MR	R	MR	R	R	R	R	R	R	R	*Sr*2+7b+11+
75	KRL351	R	R	MR	R	R	R	R	S	R	R	R	R	R	R	R	R	R	R	R	*Sr*5+9e+
76	MACS5041	MS	R	R	R	S	S	R	R	R	MR	MR	R	R	R	R	S	S	R	R	*Sr*2+7b+15+
77	MACS5043	MR	R	R	R	MS	S	R	R	R	R	MR	MS	R	R	MR	S	S	MR	S	*Sr*7b+11+
78	WH1309	R	R	MR	R	R	R	R	MS	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+5+7b+9b+
Special Trial (Triticale)																					
79	TL3001	R	R	R	R	R	R	R	MR	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+
80	TL3002	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+31+
81	TL3003	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+31+
82	TL3004	R	R	R	R	R	R	R	MR	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+5+
83	TL3005	R	R	R	R	R	R	MR	R	R	MS	R	R	R	R	R	R	R	R	R	*Sr*2+5+7b+
Special Trial (MABB/NIL (KB) entries)																					
84	DWR-NIL-01	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*31+

S. No.	VARIETY	PATHOTYPES																			Gene postulation
		11	11A	15-1	21	21A-2	24A	34-1	40A	40-2	40-3	122	117-1	117-3	117-4	117-5	117-6	184	184-1	295	
		1	2	3	20	4	5	6	7	8	9	10	12	13	14	15	16	17	18	19	
85	DWR-NIL-02	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*31+
86	HD3209	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+11+25+
87	KB2012-03	MS	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+5+11+
Special Trial (Wheat Bifortification)																					
88	HPBW01	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	MR	R	*Sr*2+31+
89	HPBW02	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+31+
90	HPBW05	R	R	S	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+5+8a+
91	HPBW07	S	R	R	R	R	R	R	R	R	R	R	R	R	MR	R	R	R	R	R	*Sr*7b+11+
92	HPBW08	R	R	R	R	R	R	R	R	R	MR	R	MR	R	R	R	R	R	MS	R	*Sr*2+9e+11+
93	HPBW09	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+5+
94	HUW695	MR	R	R	R	R	R	R	R	R	MR	R	R	R	R	R	R	R	R	R	*Sr*2+5+11+13+
95	HUW711	MS	R	R	R	R	R	R	MS	R	MR	R	R	R	R	R	R	R	R	R	*Sr*2+5+11+13+
96	HUW712	MR	R	R	R	R	R	R	S	R	MS	R	R	R	R	R	R	R	R	R	*Sr*2+11+13+
97	MACS6507	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+5+11+
98	WB1	R	R	S	R	R	MR	R	MR	R	S	R	R	R	R	R	R	R	R	MS	*Sr*2+7b+
99	WB2	R	R	R	R	R	R	R	MS	R	S	R	MR	R	R	R	R	R	R	R	*Sr*2+7b+
100	WB5	R	R	R	R	R	R	R	MR	R	R	R	R	R	R	R	R	R	R	R	*Sr*2+31+

Annexure 6 : Seedling Resistance Test of AVT I against pathotypes of yellow rust (*Puccinia striiformis tritici*) at Shimla during 2014-2015

S. No.	VARIETY	PATHOTYPES												Gene postulation
		78 S 84	P	46 S 119	K	T	I	38A	L	14A	20A	N	A	
		1	2	3	4	5	6	7	8	9	10	11	12	
Northern Hills Zone														
1	HPW393	S	S	S	MS	S	MS	R	MS	R	R	S	MS	*Yr*2+
2	HPW394	R	R	R	R	MS	R	R	R	R	R	R	R	-
3	HPW413	S	S	S	R	S	R	R	R	R	R	R	R	*Yr* 2+
4	HPW421	MS	MS	S	R	S	R	R	R	R	R	R	R	*Yr* 2+
5	HPW422	MS	S	MS	S	S	R	R	R	R	R	R	R	*Yr* 2+
6	HS580	R	R	S	S	S	R	R	R	R	R	R	R	*Yr* 9+A+
7	HS583	S	S	S	R	MS	S	MX	R	R	R	R	R	*Yr* 2+
8	HS590	R	R	R	R	R	R	R	R	R	R	R	R	-
9	HS596	R	R	R	R	R	R	R	R	R	R	R	R	R
10	HS597	R	R	R	R	MS	R	R	R	R	R	R	R	-
11	HS598	R	S	S	R	S	R	R	R	R	R	R	R	*Yr* A+
12	HS599	R	S	S	MS	S	R	R	R	R	R	R	R	*Yr*9+A+
13	HS600	R	R	MS	MS	R	R	R	R	R	R	R	R	*Yr*A+
14	HS601	S	S	S	R	S	R	R	R	R	R	R	R	*Yr*2+
15	UP2917	R	R	S	R	MS	R	R	R	R	R	R	R	*Yr*9+A+
16	UP2918	S	R	MS	R	R	R	R	R	R	R	R	R	*Yr*9+
17	VL1005	R	R	MS	R	MS	R	R	R	R	R	R	R	*Yr*9+A+
18	VL1006	S	S	S	S	S	S	S	S	S	S	S	MX	-
19	VL1007	R	R	S	R	MS	R	R	R	R	R	R	R	*Yr*9+A+
20	VL3002	R	R	R	R	R	R	R	R	R	R	R	R	R
21	VL3007	R	R	MS	R	MS	R	R	R	R	R	R	R	*Yr*9+A+
22	VL3008	R	R	S	R	MS	MS	R	R	R	R	R	R	*Yr*9+A+
23	VL3009	R	S	S	MX	MS	R	R	R	R	R	R	R	*Yr*A+
24	VL4001	S	R	MS	R	R	R	-	R	R	R	-	R	*Yr*9+
North Western Plain Zone														
25	DBW147	R	S	S	R	MS	R	R	R	R	R	R	R	*Yr*A+
26	DBW148	MS	S	S	R	S	R	R	R	R	R	R	R	*Yr*2+
27	DBW150	R	S	MS	MR	MS	MX	R	R	R	R	R	R	*Yr*2+

S. No.	VARIETY	PATHOTYPES												Gene postulation
		78 S 84	P	46 S 119	K	T	I	38A	L	14A	20A	N	A	
		1	2	3	4	5	6	7	8	9	10	11	12	
28	DDW31	S	S	S	S	S	MX	R	R	S	R	R	R	-
29	DDW32	R	R	R	R	R	R	R	R	R	R	R	R	R
30	HD3159	S	S	S	R	S	R	R	R	R	R	R	R	*Yr*2+
31	HD3165	MS	S	S	R	MS	MR	R	R	MX	R	R	R	*Yr*2+
32	HD3174	MS	S	S	R	MS	R	R	R	R	R	R	MS	*Yr*2+
33	HI1604	MS	S	S	R	MS	R	R	R	R	R	R	R	*Yr*2+
34	HI1605	S	MS	S	R	MS	R	R	R	R	R	R	R	*Yr*2+
35	HUW688	R	R	R	R	R	R	R	R	R	R	R	R	R
36	K1312	MS	MS	S	R	MS	R	R	R	R	R	R	R	*Yr*2+
37	K1313	R	S	MS	R	MS	R	R	R	R	R	R	R	*Yr*A+
38	K1314	R	S	S	MS	S	MS	R	R	R	R	R	R	*Yr*A+
39	MACS3949	R	MS	MS	MS	MS	S	R	S	R	R	R	R	*Yr*2+
40	MACS4024	R	R	R	R	R	R	R	R	R	R	R	R	-
41	NW6024													-
42	PBW707	MS	S	S	R	S	R	R	R	R	R	R	R	*Yr*2+
43	PBW709	R	R	R	R	R	R	R	R	R	R	R	R	R
44	PBW716	R	S	MS	R	S	R	R	R	R	R	R	R	*Yr*A+
45	PBW718	MS	S	S	R	MS	R	R	R	R	R	-	MR	*Yr*2+
46	PBW719	R	R	S	R	MS	R	R	R	R	R	R	R	*Yr*9+A+
47	UP2883	R	R	R	R	R	R	R	R	R	R	R	R	R
48	WH1179	MS	S	S	R	S	R	R	R	R	R	R	R	*Yr*2+
North Eastern Plain Zone														
49	HD3171	R	R	R	R	R	R	R	R	R	R	R	R	R
50	K1317	R	R	MS	R	S	R	R	MS	R	R	R	R	*Yr*9+A+
Central Zone														
51	CG1015	MS	R	MR	R	MS	MR	R	MR	MX	R	S	R	-
52	GW463	S	S	S	S	MS	MS	S	MS	R	R	R	S	-
53	HI8759 (D)	MS	MS	MR	MR	S	S	S	MS	MS	R	R	MX	-
Peninsular Zone														
54	GW1315(D)	S	S	S	S	S	S	S	S	S	R	S	S	-

S. No.	VARIETY	PATHOTYPES												Gene postulation
		78 S 84	P	46 S 119	K	T	I	38A	L	14A	20A	N	A	
		1	2	3	4	5	6	7	8	9	10	11	12	
55	HD3164	R	R	S	R	MS	R	R	R	R	R	R	R	*Yr*A+
56	HI8765 (D)	S	S	S	S	MS	S	R	MS	R	R	R	R	*Yr*2+
57	JWS712	MS	S	S	R	S	R	R	R	R	R	R	R	*Yr*2+
58	K1315	MS	MS	S	R	S	R	R	R	R	R	R	R	*Yr*2+
59	MACS3970(D)	MS	R	MS	R	S	MS	R	R	MS	R	R	MX	-
60	MACS3972(D)	R	R	R	R	R	R	R	R	R	R	R	R	R
61	MACS4020(D)	S	S	S	S	S	S	S	S	S	R	MX	MX	-
62	PBW721	S	S	S	MR	S	MS	R	MS	MX	R	R	R	-
63	UAS360	S	S	S	R	MS	R	R	R	R	R	R	R	*Yr*2+
64	UAS361	R	R	S	R	MS	R	R	R	R	R	R	R	*Yr*9+A+
65	UAS453(D)	S	S	MX	MS	S	S	S	R	R	R	R	R	*Yr*2+
66	UAS455(D)	MS	R	R	MR	MR	MR	R	R	MX	R	R	R	-
Special Trial (Dicoccum, Salinity and Alkalinity)														
67	DBW181	S	S	S	R	MS	R	R	R	R	R	R	R	*Yr*2+
68	DBW182	R	R	R	R	R	R	R	R	R	R	R	R	R
69	DBW183	MX	S	S	MX	S	S	R	MS	S	R	R	R	-
70	DBW184	MS	R	MS	R	MS	R	R	R	R	R	R	R	*Yr*2+
71	DBW185	MS	R	S	R	MS	R	R	R	R	R	R	R	*Yr*2+
72	DDK1048	R	MS	MR	R	MS	R	MS	R	R	R	R	R	-
73	DDK1049	MR	MS	R	R	MX	R	MS	MS	R	R	MS		-
74	KRL350	S	S	S	MS	MS	MR	R	R	R	R	R	R	*Yr*2+
75	KRL351	S	S	S	S	S	MS	R	S	R	R	R	R	-
76	MACS5041	MS	MR	MR	MR	MS	R	MS	MS	R	R	MS	MX	-
77	MACS5043	S	MX	MX	R	MS	R	R	R	R	R	MS	MX	*Yr*2+
78	WH1309	S	S	S	R	S	R	R	R	R	R	R	R	*Yr*2+
Special Trial (Triticale)														
79	TL3001	MS	R	S	R	MS	MS	MS	R	R	R	-	R	*Yr*2+
80	TL3002	S	R	S	R	R	R	-	R	R	R	-	R	*Yr*9+
81	TL3003	S	R	MS	R	R	R	-	R	R	R	MX	R	*Yr*9+
82	TL3004	S	R	S	MR	MS	R	R	R	R	R	R	R	*Yr*2+

S. No.	VARIETY	PATHOTYPES												Gene postulation
		78 S 84	P	46 S 119	K	T	I	38A	L	14A	20A	N	A	
		1	2	3	4	5	6	7	8	9	10	11	12	
83	TL3005	S	R	S	R	MS	R	R	R	R	R	R	R	*Yr*2+
Special Trial (MABB/NIL (KB) entries)														
84	DWR-NIL-01	S	R	MS	R	R	R	R	R	R	R	R	R	*Yr*9+
85	DWR-NIL-02	MS	R	S	R	R	R	R	R	R	R	R	R	*Yr*9+
86	HD3209	S	S	S	MS	MS	R	R	MR	R	R	MX	R	*Yr*2+
87	KB2012-03	S	MS	S	R	MS	R	R	R	R	R	R	R	*Yr*2+
Special Trial (Wheat Bifortification)														
88	HPBW01	MS	R	S	R	R	R	R	R	R	R	R	R	*Yr*9+
89	HPBW02	MS	R	MS	R	R	R	R	R	R	R	R	R	*Yr*9+
90	HPBW05	MS	R	MS	R	MS	R	R	R	R	R	R	R	*Yr*2+
91	HPBW07	R	R	R	R	R	R	R	R	R	R	R	R	R
92	HPBW08	S	S	S	MS	S	S	MX	S	R	R	R	S	-
93	HPBW09	R	R	R	R	R	R	R	R	R	R	R	R	R
94	HUW695	R	R	R	R	R	R	R	R	R	R	R	R	R
95	HUW711	MS	R	S	R	MS	R	R	R	R	R	R	R	*Yr*2+
96	HUW712	MS	R	S	R	MS	MS	R	R	R	R	R	R	*Yr*2+
97	MACS6507	MS	MS	S	R	MS	R	R	R	R	R	R	R	*Yr*2+
98	WB1	MS	R	MS	R	MS	R	R	R	R	R	R	R	*Yr*2+
99	WB2	MS	R	MS	R	MS	R	R	R	R	R	R	R	*Yr*2+
100	WB5	S	R	S	R	R	R	R	R	R	R	R	R	*Yr*9+

Annexure 7: Seedling Resistance Test of AVT IInd year against pathotypes of brown rust (*Puccinia triticina*) at Mahabaleshwar during 2014-15

Sr. No.	AVT II Genotypes	Reaction against pathotypes of leaf rust													
		77A-1	77-2	77-3	77-5	77-6	104A	104B	104-1	104-2	12-A	12-2	12-5	162-1	17
CENTRAL ZONE															
1	HD 4728 (d)	R	R	R	R	R	R	R	R	R	R	R	R	R	R
2	HD 4730 (d)	R	S	S	S	R	S	S	R	S	R	S	R	R	R
3	GW 322 (C)	S	S	S	S	R	R	S	R	S	R	S	R	S	R
4	HD 2864 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R
5	HD 2932 (C)	S	S	S	S	R	R	S	R	S	R	S	R	S	R
6	HI 1544 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R
7	HI 8498 (D) (C)	R	S	S	S	R	R	R	R	R	R	S	R	R	R
8	HI 8737 (D) (I) (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R
9	MP 3336 (C)	S	S	S	S	R	R	R	R	S	R	S	R	S	R
10	MP 4010 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R
11	MPO 1215 (d) (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R
PENINSULAR ZONE															
12	MACS 3927(d)	R	R	R	R	R	R	S	R	R	R	R	R	R	R
13	NIAW 2030	R	R	R	R	R	R	S	R	R	R	R	R	R	S
14	AKDW 2997 -16(d)	S	S	S	S	R	R	R	R	S	S	S	S	R	R
15	DBW 93 (I) (C)	S	S	S	S	S	R	R	S	S	S	S	S	R	R
16	MACS 6222(C)	S	S	S	S	R	R	S	R	R	R	R	R	R	R
17	MACS 6478 (C)	S	S	S	S	R	R	S	R	R	R	R	R	R	R
18	NI 5439(C)	S	S	S	S	R	R	S	R	S	R	S	R	S	R
19	NIAW 1415 (C)	S	S	S	R	R	R	S	R	S	R	R	R	R	S
20	UAS 347 (I) (C)	S	S	S	R	R	R	S	R	S	R	S	R	S	R
21	UAS 428 (d) (C)	S	S	S	R	R	R	S	R	S	R	S	R	S	S
22	UAS 446 (d) (I) (C)	R	R	R	R	R	R	R	R	R	R	R	R	R	R

Annexure 8: Seedling Resistance Test of AVT Ist against pathotypes of brown rust (*Puccinia triticina*) at Mahabaleshwar during 2014-15

Sr. No.	AVT I Genotypes	Reaction against pathotypes of brown rust													
		77A-1	77-2	77-3	77-4	77-5	77-6	104A	104-1	104-2	104-3	104	12-A	12-2	17
CENTRAL ZONE															
1	CG 1015	R	S	S	NG	S	S	R	S	S	R	R	R	NG	R
2	GW 463	R	R	S	R	S	R	R	R	S	R	R	R	S	R
3	HI 8759(D)	R	R	R	R	R	R	R	R	R	R	R	R	R	R
PENINSULAR ZONE															
4	GW 1315 (d)	R	R	R	R	R	R	R	R	S	R	R	R	R	R
5	HD 3164	R	R	S	R	S	R	R	R	S	R	R	R	R	R
6	HI 8765(d)	R	S	R	R	S	R	R	R	R	R	R	R	R	R
7	JWS 712	R	R	S	R	S	R	R	R	R	R	R	R	R	R
8	K 1315	R	R	R	R	R	R	R	R	R	R	R	R	R	R
9	MACS 3970(d)	R	R	R	R	R	R	R	R	R	R	R	R	R	R
10	MACS 3972(d)	R	S	S	R	S	R	R	R	S	R	R	R	R	R
11	MACS 4020(d)	R	S	S	R	S	R	R	R	S	R	R	R	R	R
12	PBW 721	R	R	R	R	R	S	R	R	R	R	R	R	R	R
13	UAS 360	R	S	S	R	S	R	R	S	S	R	S	S	R	S
14	UAS 361	S	R	S	R	R	R	S	R	S	R	R	R	R	R
15	UAS 453(d)	R	R	R	R	R	R	R	R	S	R	R	R	R	R
16	UAS 455(d)	R	R	R	R	R	R	R	R	R	R	R	R	R	R

All genotypes showed resistance to 77-1, 104-3, 77-7, 77-8, 104-B, 12-3, 12-4, 12-5, 162-1, 108

Annexure 9: Seedling Resistance Test of AVT IInd year against pathotypes of black rust (*Puccinia graminis tritici*) at Mahabaleshwar during 2014-15

Sr. No.	AVT II Genotypes	Reaction against pathotypes of stem rust												
		R 11	R 11A	R 21-1	R 40-1	R 40A	R 42	R 117A	R 117-3	R 117-4	R 117-5	R 117-6	R 122	R 295
CENTRAL ZONE														
1.	HD 4728 (d)	R	R	R	R	R	R	R	R	R	NG	R	R	NG
2.	HD 4730 (d)	R	R	NG	R	S	R	R	R	R	R	R	R	R
3.	GW 322 (C)	R	S	NG	S	R	S	S	NG	R	R	R	S	R
4.	HD 2864 (C)	R	R	R	R	S	R	R	R	R	NG	R	R	R
5.	HD 2932 (C)	R	R	R	R	S	R	R	R	R	R	R	R	S
6.	HI 1544 (C)	R	R	R	R	R	R	R	R	R	R	R	R	R
7.	HI 8498 (D) (C)	S	S	S	S	R	S	S	R	R	R	R	R	R
8.	HI 8737 (D) (I) (C)	R	S	R	S	R	S	S	R	S	NG	R	S	R
9.	MP 3336 (C)	R	S	R	S	S	S	S	R	R	R	R	S	R
10.	MP 4010 (C)	NG	NG	NG	R	S	NG	R	R	R	NG	NG	NG	NG
11.	MPO 1215 (d) (C)	NG	NG	NG	R	S	NG	NG	R	NG	NG	NG	NG	NG
PENINSULAR ZONE														
12.	MACS 3927(d)	R	S	R	R	S	R	S	R	S	R	R	R	R
13.	NIAW 2030	R	R	R	R	S	R	R	R	R	R	NG	R	R
14.	AKDW 2997 -16(d)	R	S	S	R	S	S	S	R	R	R	R	R	R
15.	DBW 93 (I) (C)	NG	R	R	R	S	NG	R	R	R	R	R	R	R
16.	MACS 6222(C)	R	R	R	R	R	R	R	R	R	R	R	R	R
17.	MACS 6478 (C)	R	R	S	R	S	NG	R	NG	R	NG	R	S	R
18.	NI 5439(C)	R	R	S	R	S	R	R	S	R	R	R	R	NG
19.	NIAW 1415 (C)	R	R	R	R	R	R	NG	R	R	R	R	R	R
20.	UAS 347 (I) (C)	R	R	R	R	S	R	R	R	R	R	R	R	R
21.	UAS 428 (d) (C)	R	R	NG	R	S	R	R	R	R	R	S	R	R
22.	UAS 446 (d) (I) (C)	R	R	R	R	S	R	R	S	R	R	R	R	R

Annexure 10 : Seedling Resistance Test of AVT Ist year against pathotypes of black rust (*Puccinia graminis tritici*) at Mahabaleshwar during 2014-15

Sr. No.	AVT I Genotypes	Reaction against pathotypes of stem rust												
		R 11	R 11A	R 21-1	R 40-1	R 40A	R 42	R 117A	R 117-3	R 117-4	R 117-5	R 117-6	R 122	R 295
CENTRAL ZONE														
1	CG 1015	R	R	NG	R	R	R	R	NG	R	R	R	NG	R
2	GW 463	R	S	S	R	R	R	R	R	NG	R	R	R	R
3	HI 8759(D)	R	S	R	R	R	R	R	R	R	S	R	R	R
PENINSULAR ZONE														
4	GW 1315 (d)	R	R	R	NG	R	R	R	R	R	R	R	R	R
5	HD 3164	R	R	R	R	R	R	R	R	R	R	R	R	R
6	HI 8765(d)	R	S	R	R	R	S	R	NG	R	S	R	R	S
7	JWS 712	R	R	NG	R	R	NG	R	R	R	NG	R	R	R
8	K 1315	R	R	R	R	R	R	R	R	R	R	R	R	R
9	MACS 3970(d)	R	R	R	R	S	R	R	R	R	R	R	R	R
10	MACS 3972(d)	R	R	R	R	S	R	R	R	NG	R	NG	R	R
11	MACS 4020(d)	R	R	R	R	R	R	R	R	R	R	R	R	R
12	PBW 721	R	R	R	R	R	NG	NG	R	R	R	R	R	R
13	UAS 360	R	R	NG	R	R	R	NG	R	R	R	R	S	R
14	UAS 361	R	R	R	R	R	R	R	R	R	R	R	R	R
15	UAS 453(d)	R	R	NG	R	S	R	R	R	NG	R	R	R	R
16	UAS 455(d)	R	R	R	R	S	R	R	NG	R	R	R	R	S

All genotypes showed resistance to 77-1, 77-4, 104-3, 104, 12-3, 12-4, 108)

WHEAT CROP HEALTH NEWSLETTER

Directorate of Wheat Research
P.B. 158, Karnal-132 001

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The first issue of Vol. 20 (2014-15) is being brought out in the month of November. Wheat crop health was monitored during off season in high hills of Himachal Pradesh (Lahaul and Kullu). The Crop Protection Technologies for different wheat growing zones finalized in the 53rd All India Wheat Workers' Meet held at Jabalpur during August 22-25, 2014 are also being presented in this issue. Karnal bunt situation in the country during 2013-14 crop season is also presented in this issue. During off season, survey for stripe rust was conducted in Lahaul valley and Kullu valley of Himachal Pradesh. Foot hills areas of Haryana (Yamunanagar) adjoining Himachal Pradesh were surveyed for rusts observation on grasses on October 7-8, 2014 by Dr. M. S. Saharan (DWR, Karnal) and O. P. Gangwar (DWR, Flowerdale, Shimla).

Dr. S. C. Bhardwaj, Head, DWR Regional Station, Flowerdale, Shimla observed stripe rust on Sept.12,2014 in the form of a mild flecking on Agra Local bordering the off-season in Wheat Disease Monitoring Nursery (WDMN) sown at Flowerdale, Shimla on August 1, 2014. During 1st week of October, it had been observed on few more lines and samples were picked up for pathotype analyses. It is for the first time that the stripe rust was observed on off- season WDMN. Telia formation in yellow rust since Oct. 6, 2014 and simultaneous appearance of brown rust with two distinct types of pustules were observed by 2nd week of October in WDMN at Flowerdale, Shimla.

Awareness for Stripe Rust Management

Stripe rust awareness among farmers was created by organizing Farmers' Day at DWR, Karnal on October 30, 2014. Lectures related to seed borne diseases and stripe rust management were delivered by Dr. R. C. Sharma (Ex Dean, College of Horticulture, UHF, Solan) and Dr. Indu Sharma, Project Director, DWR, Karnal. Dr. M. S. Saharan (Principal Scientist-Plant Pathology, DWR, Karnal) replied the farmers questions in Kishan Goshti. Posters were also displayed to make farmers aware of the stripe rust diagnosis and management. More than 500 farmers attended the fair. Stripe rust management cards were also distributed among the farmers.

Strategy Planning Meeting

A meeting on evolving strategies for enhancing wheat production with special reference to management of wheat rusts and Karnal bunt was organized by DAC on Oct. 16, 2014 in Lucknow under the Chairmanship of Dr. J. S. Sandhu, Agriculture Commissioner, Govt. of India. From DWR, Karnal, Drs. R. Chatrath, S. C. Tripathi and M. S. Saharan participated in the meeting. Dr. M. S. Saharan presented a talk on involving strategies for enhancing wheat crop production with special emphasis on stripe rust and Karnal bunt management.

Improved varieties of wheat for different zones and production conditions

The wheat varieties recommended for different zones are given hereunder:

Zone	Production condition	Varieties
Northern Hills Zone (Western Himalayan regions of J&K (except Jammu and Kathua distt.); H.P. (except Una and Paonta Valley); Uttarakhand (except Tarai area); Sikkim and hills of West Bengal and N.E. States	TS-IR-high fertility	HPW 349, HS 507, VL 907, VL 804*, VL 738*
	TS-RF-low fertility	HPW 349, HS 507, VL 907, SKW 196*, VL 804*, VL 738*, TL 2969 (trit), TL 2942 (trit)
	ES-RF-low fertility	VL 829, HPW 251, VL 616
	LS-RI-medium fertility	VL 892, HS 420*, HS 295*, HS 490
	High altitude areas Summer sowing	HS 365, VL 832, SKW 196*, HS 375
North Western Plains Zone (Punjab, Haryana, Delhi, Rajasthan (except Kota and Udaipur divisions), Western UP (except Jhansi division), parts of J&K (Jammu and Kathua districts), HP (Una dist. and Paonta valley) and Uttarakhand (Tarai region)	TS-IR-high fertility	Bread Wheat: DBW 88, HD 3086, WH 1105, DPW 621-50, HD 2967, DBW 17*, PBW 550*, PBW 502*. Durum Wheat: PDW 314 (d), WHD 943, PDW 291(d)
	LS-IR-medium fertility	DBW 90, DBW 71, HD 3059, WH 1124, PBW 590*, WH 1021, DBW 16, WR 544 (VLS), RAJ 3765*
	TS-RF-low fertility/RI	PBW 644 (RI), WH 1080, HD 3043(RI), PBW 396,
North Eastern Plains Zone (Eastern UP, Bihar, Jharkhand, Orissa, West Bengal, Assam and plains of NE States)	TS-IR-high fertility	NW 5054, K 1006, DBW 39, CBW 38, Raj 4120, K 307, HD 2824, HD 2733, PBW 443, HUW 468, NW 1012
	LS-IR-medium fertility	DBW 107, HD 3118, HD 2985, HI 1563, NW 2036, HW 2045, DBW 14, NW 1014, HD 2643
	TS-RF-low fertility	HD 2888, MACS 6145
	LS-RF-low fertility	K 9465, K 8962
Central Zone (MP, Chhattisgarh, Gujarat, Rajasthan(Kota and Udaipur divisions) and UP (Jhansi division)	TS-IR-high fertility	MP 3288, HI 1544, GW 366, GW 322, GW 273 HI 8713 (d), MPO 1215 (d), HI 8498(d)
	LS-IR-medium fertility	MP 3336, Raj 4238, MP 1203, HD 2932, HD 2864, MP 4010
	TS-RF-low fertility	*DBW 110, *MP 3288, *MP 3173, *HI 1531, HI 1500, HW 2004 (Amar), *HI 8627(d), , HD 4672(d),

Peninsular Zone (Maharashtra, Karnataka, Andhra Pradesh, Goa, plains of Tamil Nadu)	TS-IR-high fertility	UAS 347, UAS 304, NIAW 917, MACS 6478, MACS 6222, Raj 4037, GW 322, HUW 510 UAS 446(d), UAS 428 (d), UAS 415 (d), MACS 2971(dic), HI 8663(d), DDK 1029 (dic), , DDK 1025(dic),
	LS-IR-medium fertility	HD 3090, AKAW 4627, HD 2932, Raj 4083, PBW 533, HD 2833
	TS-RF-low fertility/RI	NIAW 1415, HD 2987, PBW 596, HD 2781, K 9644, AKDW 2997-16(d)
Southern Hills Zones (Hilly areas of Tamil Nadu and Kerala comprising the Nilgiri and Palni hills of southern plateau)	TS-RI-medium fertility	HW 2044, HW 1085, COW (W) -1
	Salinity-alkalinity condition	KRL 210, KRL 213, KRL 19, KRL 1-4
	IR-Medium fertility	Raj 3765, WR 544

NIAW 1415, HD 2987, PBW 596 also suitable for restricted irrigation in PZ, (d)=durum wheat, (Dic)= dicoccum wheat, TS=Timely Sown, LS=Late Sown, ES=Early Sown, IR=Irrigated, RF=Rainfed, RI=Restricted irrigation
*Varieties underlined should not be sown in stripe rust prone areas as these are stripe rust susceptible.

Crop Protection Technologies
The host resistance is the cheapest, effective and environmental friendly means management of disease and pests. The disease scenario of different zones varies but the problem of yellow rust disease which is prevalent in northern and southern hills, north western and north eastern plains of the country is a major cause of concern.

Rust management: In NWPZ and NHZ, stripe rust (yellow rust) is very important. Usually, it is observed that the early infection of stripe rust starts in wheat fields under the poplar trees wherever these are grown having early sown crop (i.e. October). Hence, strict watch is needed by the farmers in such fields. More over for avoiding the losses due to stripe rust of wheat in NWPZ, varieties given in table be sown. Since most of the varieties recommended for NWPZ and NHZ do not carry high level of resistance, chemical sprays are needed. Spray the crop with Propiconazole (Tilt 25 EC @ 0.1 per cent), or Tebuconazole (Folicur 250EC @ 0.1%) or Triademefon (Bayleton 25WP @ 0.1%) at stripe rust initiation using 200 litre of water/ha. Usually, it is required in the first half of February. Stem and leaf rusts are the major diseases of wheat in CZ, PZ and SHZ. From rust epidemiology point of view, for disrupting the *Puccinia* path, rust resistant varieties given table are required to be grown in respective zone.

Loose smut: Loose smut is a seed borne disease. In view of the horizontal distribution of the seed material among the farmers and the use of the carry over seed effective control measures for lose smut should be undertaken. For this, seed treatment with Carboxin (75 WP @ 2.5 gm/kg seed) or Carbendazim (50 WP @ 2.5 gm/kg seed) or Tebuconazole (2DS @ 1.25 gm/kg seed) or a combination of a reduced dosage of Carboxin (75 WP @ 1.25 gm/kg seed) and a bioagent fungus *Trichoderma viride* (@ 4 gm/kg seed) is recommended.

Integrated management of loose smut involving reduced dosage of chemical fungicide and bioagent fungus is more eco-friendly and equally effective as the chemical control measures and thus should be preferred. Use of bioagents also helps in improving the initial vigour of the crop. Seed treatment with fungicide should be done one or two days before sowing. In case of integrated management, the treatment with *T.viride* should be done 72 hrs before sowing, followed by the fungicide, 24 hours before sowing.

Karnal bunt: Karnal bunt (KB) control is required for seed crop and the produce grown for export purposes. For producing KB free wheat, farmers are advised to grow KB resistant varieties recommended for the respective area.

- ✓ In areas where Karnal bunt incidence is low, by growing durum wheat for 2-3 years, fields can become free from Karnal bunt pathogen, *Tilletia indica*
- ✓ Zero tillage helps in reducing Karnal bunt incidence.
- ✓ Avoid irrigation at heading time
- ✓ One spray of Propiconazole 25EC (Tilt 25 EC) @ 0.1 per cent or Tebuconazole 250 EC (Folicur 250 EC) @ 0.1 per cent using 200 litre of spray solution be given in mid February to control the disease.
- ✓ In KB prone areas, the seed crop can be given one spray of Propiconazole or two sprays of *T.viride* at tillering and ear head emergence stage.

Powdery mildew: For the control of powdery mildew in disease prone areas, one need-based spray of Propiconazole (Tilt 25 EC @ 0.1%) can be given at ear head emergence or appearance of disease on flag leaf, whichever is earlier.

Foliar blight: Foliar blight is the main crop health problem in NEPZ. For effective management of the diseases, cultivation of recommended (resistant) varieties, like HD 2985, HI 1563, DBW 39, CBW 38, NW 1014, NW 2036, K 9107, HD 2733 (resistant to LB), DBW 14, HD 2888, K0307, DBW39 and HUW 468 should be encouraged.

Flag smut: Flag smut disease also poses problems in isolated fields in Punjab, Haryana, Rajasthan and some other parts of NWPZ. Disease management measures taken for the control of loose smut disease (as discussed above), prove to be effective against flag smut too. Hence, seed treatment with Carboxin or Tebuconazole may be followed in fields with flag smut history.

Termite: In the termite prone areas, seed treatment with chlorpyriphos @ 0.9g a.i /kg seed (4.5 ml product dose / kg seed), be taken up for their management. Seed treatment with thiamethoxam 70WS (Cruiser 70WS) @ 0.7 g a.i./kg seed (4.5 ml product dose / kg seed) or Fipronil (Regent 5FS @ 0.3 g a.i./kg seed or 4.5 ml product dose / kg seed) is also very effective. In the standing crop, the broadcasting of the insecticide treated soil 15 DAS be practiced. For this, chloropyriphos 20EC @ 3 Litre mixed in 50 Kg soil be used for one hectare field. Crop planted under FIRBS is more prone to termite attack in the termite-prone areas, while zero tillage shows less termite damage. Hence, proper attention should be given in crop planted under FIRBS.

Aphids: For the management of aphids, foliar spray of imidacloprid 200SL @20g a.i./ha on border rows at the start of the aphid colonization be given. This will help in protection of the bioagent insect, the lady bird beetle inside the field which feeds on aphids.

Pink stem borer: The incidence of pink stem borer is observed more in fields of rice-wheat cropping system where wheat is sown in zero tillage fields. For its management, foliar spray of quinalphos (Ecalux) 800 ml /acre as soon as pink stem borer is seen. Irrigation also helps in reducing the pink stem borer damage.

Ear cockle: Ear cockle is an important disease in eastern parts of India, hence proper precautions be taken, especially in eastern U.P., Bihar and Jharkhand. Wider publicity should be given by extension agencies on the use of gall-free seed, well before the sowings. Farmers should adopt floatation technique for the separation of galls from the infested seed lots. The infested seed lot should be floated in 2 percent brine solution for this purpose. The galls will float on the surface. These should be separated and destroyed away from the field by burning. The seed should be thoroughly washed to remove the salt solution before sowing.

KARNAL BUNT STATUS DURING 2013-14

A total of 8900 grain samples collected from various mandies in different zones, were analyzed by DWR as well as other cooperating centers (Table 1). The number of samples analyzed by various centres were: DWR-1766, Ludhiana-1919, Hisar-960, Pantnagar-2763, Dhaulakuan-381, Vijapur-490 and Durgapura-621. From Central and Peninsular zones, 694 and 222 samples, respectively, were analyzed to know the distribution and disease situation in these zones. The Karnal bunt situation in the country has been depicted in the Table 1. The highest incidence (83.98%) was recorded from UP. In Haryana, out of 1769 samples analyzed, 47.99 per cent were found infected with KB. A total of 1919 samples were collected by Ludhiana centre from different grain markets of Punjab. The disease prevalence was higher during the current year and 39.13 per cent samples were found infected. From Rajasthan, out of 720 samples analyzed, 30.13 per cent were found infected with KB with infection range upto 2.15 per cent. In Uttarakhand, out of 2845 samples analyzed, 24.67 % were infected. In MP, out of 294 samples, 6.12 per cent samples were KB infected. Based on the overall KB occurrence, it emerged that the KB incidence this year was less than the previous year. No sample from West Bengal, Gujarat (Vijapur), Maharashtra (Pune) and Karnataka (Dharwad) was found infected with KB (Table 1).

Table 1. Karnal bunt situation in the country during 2013-14 crop season

State	Total samples	Infected samples	% infected samples	Range of infection
Punjab	1919	751	39.13	0.07-2.56
Haryana	1769	849	47.99	0-5.25
Rajasthan	720	217	30.13	0-2.15
Uttarakhand	2845	702	24.67	0-10.00
gHimachal Pradesh	381	114	29.90	0.1.8
West Bengal	14	0	0	-
U.P.	256	215	83.98	0-9.3
M.P.	294	18	6.12	0-2.40
Gujarat	490	0	0	-
Maharashtra	112	0	0	-
Karnataka	100	0	0	-
Total	**8900**	**2866**	**32.20**	**0-10.00**

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The second issue of Vol. 20 (2014-15) is being brought out in the month of January.

Punjab and Haryana: On 20.12.14, Dr. S. C. Bhardwaj (Head, IIWBR Regional Station, Flowerdale, Shimla), Dr. M. S. Saharan (PI, Crop Protection, IIWBR, Karnal), Dr. O. P. Gangwar (Scientist, Flowerdale, Shimla) and Dr. Parmod Parsad (Scientist, Flowerdale, Shimla) surveyed wheat and grass rusts in Yamuna Nagar, Ambala and Panchkula districts of Haryana. Wheat crop was rust free at all the locations. Rust was observed on some of the grasses in villages, Padlu, Jatarpur, Barara, Saravan and the samples were collected and taken to Shimla for further analysis. On 24-12-2014, Dr. P.P.S Pannu, Senior Plant Pathologist, Department of Plant Pathology and Dr. (Mrs.) Jaspal Kaur, Plant Pathologist, PAU, Ludhiana visited the field area enroute Ludhiana-Samrala-Chamkaur Sahib-Ropar-Kiratpur Sahib-Anandpur Sahib-Noorpur Bedi-Nangal-Garhshankar-Pozewal-SBS, Nagar-Rahon-Macchiwara. In most of the areas, the crop condition was good, however yellow rust was reported in one field in the village Daroli Upper near Anandpur Sahib on unrecommended wheat variety Berbet. There was only one patch in an area of about 2 Kanal field. The concerned farmer Mr. Bahadur Singh was adviced to spary the fungicide. He immediately sparyed Propiconazole (Tilt) on 24-12-2014. The farmer noticed this patcth of infection 5 days back (Probably on 19.12.2014).

Dr. R. Selvakumar, Sr. Scientist (Plant Pathology), IIWBR and Dr. (Mrs.) Jaspal Kaur, Plant Pathologist, PAU, Ludhiana conducted survey on December 28, 2014 in Nawan -Shahr, Harshankar, Balachur, Rahon, Machiiwara and Prata Garh areas for observation of any plants / grasses showing stripe rust. The rust was not observed on any of the grasses / wheat fields. Dr. S. S. Karwasra, Head, Plant Pathology, CCS HAU, Hisar surveyed the wheat crop from Hisar to Kurukshetra on January 3, 2015. Most of the crop has been sown on normal date of sowing. However, about 10% farmers had sown wheat in 2nd week of December in areas where *basmati* rice was harvested late. Nearly about 20% farmers are still growing PBW 343. No rust was observed in any field. However, in some fields there was yellowing of the crop, that may be due to cold weather. Overall the crop stand was good. Dr. R. S. Taya, Pathologist, KVK, Damla (Yamunanagar) survey the farmers fields in Yamunanagar area during 1st week of January, 2015. No rust was observed.

Dr. Subhash Katare (Sr. Scientist, Entomology, IIWBR, Karnal) visited wheat crop in Nissing area on December 4, 2014. Incidence of pink stem (*Sesemia inference*) borer was observed in some wheat fields in Nising area under rice-wheat cropping system. The farmers were advised to follow the recommended insecticide for insect management. On December 8, 2014, Dr. Subash Katare conducted insect pest survey in villages, Mundiala Kalan(Ludhiana), Bakhada (Main Sirhand), Basant Pura (Fatehgarh) and in Karnal (Haryana). No insect pest was found in any wheat field. A team of scientist comprising of Dr Beant Singh (Assistant Entomologist) Wheat Section, and Dr Jaspal Kaur, Plant Pathologist, Department of Plant Breeding and

Genetics, PAU, Ludhiana surveyed the wheat crop on 6 January, 2015 in different districts of Punjab enrouting Ladhowal, Rahon, Phillaur, Langroya, Nawanshahr Garshankar and adjoining areas. Mild incidence of pink stem borer was observed in some villages *viz.*, Ladhowal, Rasolpur and Longroya. Incidence of root aphid was also recorded in village Rasolpur. Termite damage (1-2 %) was recorded in some fields near Rahon village. In general, the wheat crop was healthy and free from all major diseases of wheat.

Karnataka: Dr. P. V. Patil Principal Scientist (Plant Pathology), Dr. Arunkumar G. S. Research Associate and Dr. Sudhakar V. Kulkarni Technical Assistant, UAS., Dharwad conducted survey on January 2, 2014 in Lokur area of Dharwad. At the field of Shri. arasinganavar, leaf rust (40S) and spot blotch (46) were observed in Local bread wheat variety (parrot green colour ear head). The farmer planted the variety in four acres in rainfed condition.

Monitoring of rusts in Wheat Disease Monitoring Nurseries

To monitor the occurrence of wheat and barley rusts off season (2013-14) wheat disease monitoring nurseries (WDMNs) were conducted at Dalang Maidan (H.P.), Sangla (H.P.), Kukumseri (H.P.) and Leh (J. & K.). For main crop season (2014-15), WDMN have been planted at more than 50 locations in the areas bordering to neighboring countries, hotspot locations and main wheat belt areas of the country. To monitor the occurrence of different diseases of wheat in SAARC countries, SAARC-WDMN has been planted at 28 locations across the six SAARC countries viz. Afghanistan, Bangladesh, Bhutan, India, Nepal and Pakistan. **So far rusts have not been reported on any of the entry of these nurseries.**

Workshop organized

The interactive workshop on wheat and barley aphids and their management was organized by CIMMYT South Asia Office, Nepal and IIWBR at Karnal on 24.11.2014. Dr. Indu Sharma, Director, IIWBR, Dr A.K. Joshi, Regional Co-ordinator, CIMMYT-South Asia Office-Nepal, Dr C.P. Srivastava, Head, Dept of Entomology, BHU and Prof. Dr Urs Wyss, University of Kiel, Germany interacted with the Entomologists of AICW&BIP centres.

Awareness for stripe rust management

Dr. Indu Sharma, Director, IIWBR, Karnal delivered talk on stripe rust management in Farmers' Day organized by Gyan Vigyan Manch and State Department of Agriculture in village Faizal Mazra (Karnal) on December 10, 2014. Dr. Randhir Singh, PI-Social Science, IIWBR, Karnal interacted with farmers for stripe rust management in village Kalwehri, Karnal on December 8, 2014.

Advisory for stripe rust management

Advisory for stripe rust management was issued on December 5, 2014. Stripe rust advisory issued on January 3, 2015 is again circulated:

- Keeping in view the recent rains in 2nd fortnight of December, 2014 and in 1st week of January, 2015 and favorable temperature / humidity for stripe rust development, farmers are advised to visit their crop regularly for observing stripe rust incidence.
- Farmers should give special emphasis in the early sown crop and the crop planted under trees. Farmers are advised to inform or consult the wheat scientists/experts/extension workers for confirmation of yellow rust disease symptoms as sometimes yellowing of leaves may be due to other factors than disease.

If farmers observe yellow rust in patches in their wheat fields, following measures are recommended:

One spray of Propiconazole 25EC (Tilt 25 EC) @ 0.1 per cent be given at the foci of infection to avoid its further spread. One ml of chemical should be mixed in one litre water and thus 200 ml of fungicide mixed with 200 L of water should be sprayed in one acre wheat crop. If need, farmers are advised to repeat the spray. Farmers should spray the crop when weather is clear i. e. no rain, no fog / dew etc.

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Wheat crop health was monitored during January-February, 2015 by scientists of Indian Institute of Wheat and Barley Research (IIWBR), State Agricultural Universities and State Department of Agriculture (Haryana, Punjab, HP, Uttarakhand, J & K). The detailed status of different diseases and insect-pest is given below:

Punjab

- In 2nd week of January, Dr. P. P. S. Pannu, Dr.(Mrs.) Jaspal Kaur, Dr. Beant Singh, Mr. Gurinder Singh (PAU, Ludhiana), Mrs.Anju Bala (KVK Langroya, SBS Nagar), Dr. Ravinder Ghuman and Dr. Ashok Kumar (FASS & KVK, Ropar) observed one foci of infection of yellow rust each in villages of Chhidauri (on var. DBW-17) and Kharod (on var. HD-2967) in SBS Nagar and in Mohan Mazra (on var. HD 2967) in Ropar.
- During January 8-9, Dr. Sudheer Kumar (IIWBR, Karnal) and Dr. O. P. Gangwar (IIWBR Regional Station, Shimla) did not observe any rust in Ropar, Mohali and Ludhiana areas.
- Deputy Director (Training) KVK, Ropar reported appearance of yellow rust in the fields of Sh. Bhagvant Singh, Sh. Ajit Singh and Sh. Sarabjeet Singh of village Dakal, Ropar in variety HD 2967 on 29.1.2015.
- A team of scientists comprising of Dr Jaspal Kaur, Plant Pathologist, Dr Achla Sharma, Assistant Breeder, Dr Beant Singh, Assistant Entomologist, Wheat Section, Department of Plant Breeding and Genetics, PAU, Ludhiana surveyed the wheat crop on 13th February, 2015 in villages enrouting Ladhowal, Phillaur, Langroya, Balachour, Ropar and adjoining areas. In most of the areas the crop condition was good; however minor incidence of yellow rust was observed in few fields namely Langroya, Jagmeenpur, Rattewal etc. Minor incidence of aphid was also observed in all the places visited but it was severe in village Jagmeenpur (Ropar). In general, the wheat crop was healthy and free from all other diseases and insect pests.
- On February 18, 2015, Dr. Sudheer Kumar, IIWBR and Dr. Sujay Dutta, ISRO, Ahemdabad observed yellow rust at farmers fields in villages Pasredi Jatta Chamkaur Sahib, Morinda and Ropar. Disease foci were of 2 m^2 but one foci was of 80S in100 m^2.
- Survey of wheat crop for incidence of diseases was conducted by Dr P. P. S. Pannu, Sr. Plant Pathologist, Deptt. of Plant Pathology and Dr Jaspal Kaur, Plant Pathologist, Deptt of Plant Breeding and Genetics on 19.2.2015 on the route Ludhiana-Machhiwara-Rahon-Langroya-Saroa-Balachour-Ropar and adjoining areas. There was incidence of yellow rust in few villages on the route but from Langroya to Saroa, almost all the fields were infected with yellow rust but severity was very low (upto 10S) except for the village Diyall where one field (var. HD 2967) around one acre was severely infected with yellow rust (60S). In

addition in the TRAP plot nurseries (TPN) sown at KVK Lngroya and KVK Ropar, symptoms of yellow rust were also observed. Brown rust upto 10S was also observed in entries in TPN planted at Gurdaspur.

Haryana

- Dr. R. Selvakumar and Mr Ishwar Singh of IIWBR, Karnal visited the fields in Jagadhri on January 16, 2015. Stripe rust was observed (10 MS-S) in one field.
- Survey was carried out by Dr. R. Selvakumar, Mr. Ishwar Singh along with Dr. R. S. Taya, KVK, Damla in Yamunanagar area. In Munda khera village, Chhachhurali, stripe rust was severe (40-60S) in 10m x 7 m area in the early sown crop (var. Barbat). The late sown crop is having few plants infected with yellow rust. In another field of Mr. Joneykumar, Pahadipur village, Sadhaura, Super 172 was infected with stripe rust (trace-10MS). The other fields were free from any rust.
- On 27th Jan. 2015, Mr. Vipin Panwar, SRF, IIWBR, Karnal visited the TPN nursery planted at KVK, Saharanpur and no rust was observed.
- On 28th Jan. 2015 Dr R. S. Taya informed about the appearance of yellow rust on variety HD 2851 at one farmers field in village Mahua Kheri, Babbain (Kurukshetra).
- Dr. Girish Naybal, DDA, Ambala informed on 31.1.2015 for appearance of yellow rust on the field of Sh. Sunder, village chhapra, Ambala.
- Dr Indu Sharma, Director, IIWBR and Dr. M.S. Saharan observed yellow rust (10S) in variety HD 2967 at Jaloda, Yamunanagar on 9.2.2015.
- Dr. Mangal Singh, IIWBR, surveyed Yamunanagar area on 12th Feb. 2015. Yellow rust was observed only at Bharwabgarh, Budhia (5S) and Fatehgarh (20 - 40S) villages.
- Dr. R. S. Beniwal surveyed the districts Hisar, Fatehabad and Sirsa on 5.2.2015. In Hisar district, there was no yellow rust. Yellow rust was noticed in village Ding on HD 2851 in Sirsa district in traces. There was no yellow rust incidence in Panniwala Mota and Bhagsar. No rust was observed in villages Matana, Dharnia, badopal and Kharakheri (Fatehabad).
- On the way from Delhi to Chandigarh on Feb. 17, 2015, Dr S C Bhardwaj, Head, DWR Regional Station, Flowerdale, Shimla and Dr Sujay Dutta surveyed the wheat fields. On the way from Chandigarh to Karnal via Yamunanagar, yellow rust was observed in five fields. These were only 1-2 sq m foci on susceptible varieties.
- Dr. Sudheer Kumar, IIWBR and Dr. Sujay Dutta, ISRO, Ahemdabad observed some patches of yellow rust at village Khukhari Near Bilaspur (Yamunanagar) on Feb., 18, 2015.
- Mr. Surendra Singh, ADO and his team reported yellow rust in the village Shargarh (Karnal) on 19.2.2015.
- The detailed report received from Dr. Madan Mohan Singh, Project Director ATMA-cum-Deputy Director of Agriculture, Yamuna Nagar is depicted below:

S.N	Name/Father	Village/Block	Variety	Date of rust Incidence observed
1.	Jasmer Singh/ Raghubir Singh	Rampur Majra/ Jagadhri	HD-2967	10-01-15
2.	Jitender Singh/ Devender Singh	Maheswari/ Mustafabad	Puskar-67	19-01-15

S.N	Name/Father	Village/Block	Variety	Date of rust Incidence observed
3.	Raj Kumar/ Kapoor Chand	Jai Rampur Jagir / Jagadhri	HD-2967	19-01-15
4.	Joney Kumar/ Kuda Ram	Pahadipur/ Sadhaura	Super-172	20-01-15
5.	Ajit Singh/ Jagmal	Munda Khera/ Chhachhrauli	Barbat	21-01-15
6.	Satpal /Krishan Lal	Bakala/Sadhoura	HD-2894	21-01-15
7.	Gurpreet Singh/ Narender Singh	Sultanpur/ Sadhoura	HD-2894	23-01-15
8.	Devender/Gopi Chand	Kaptan Majri/ Sadhoura	HD-2894	02-02-15
9.	Amarjeet/Mam Chand	Sarawan/ Sadhoura	Puskar-67	02-02-15
10.	Jagir Singh/ Jhandu Singh	Sabapur/ Sadhoura	621-50	02-02-15
11.	Alim/Niaz Mom	Ratli/Sadhoura	Super-172,	04-02-15
12.	Aslam/Moh. Sadik	Sarawan/ Sadhoura	HD-2967, HD-2894	04-02-15
13.	Karanpal/Balbir	Kot Mukarmpur/ Chhachhrauli	HD-2967	04-02-15
14.	Luxman Singh/ Ram Singh	Topra Kalan/ Sadhoura	HD-2967	04-02-15
15.	Gian Singh/ Banarsi Dass	Topra Kalan/ Sadhoura	HD-2967	04-02-15
16.	Satpal/Parsa Ram	Topra Kalan/ Sadhoura	HD-2967	04-02-15
17.	Raj Kumar/ Sunder Lal	Topra Kalan/ Sadhoura	25+2	04-02-15

Himachal Pradesh

- On Jan.10-11, Dr. S. C. Bhardwaj surveyed different areas in Shimla, Solan and Bilaspur districts of HP. The wheat crop was in good condition and free from rusts.
- Dr. S. K. Rana, Malan, Palampur conducted surveys in parts of Bhavarna, Nagrota Bagwan, Kangra, Dehra, Rait, Nagrota Surian and Fatehpur blocks of district Kangra during the last week of January. Yellow rust was recorded with minor incidence and severity less than 10S on PBW 550 at Nagrota Suria Dam area (Nagrota Surian block) and HD 2967 at Lunj Kahlian (Kangra block) and Bhanth (Fatehpur block). However, the disease was observed in severe form touching severity 60S on varietal mixture (Raj 3765 main) in a large patch (Focus) at Bhanth-Sthana (Fatehpur block). Wheat Disease Monitoring Nursery/ Trap Plot Nursery of wheat planted at SAREC Kangra, was found free from rust in the last week of January. Powdery mildew was recorded in severe form (5-6 on 0-9 scale) on varietal mixture (Raj 3765 main) at Bhanth-Sthana in Fatehpur block. Flag smut was also recorded at some locations in Nagrota Surian, Kangra and Fatehpur blocks with incidence varying from 2-7%. Yellowing of wheat crop due to water stagnation and low temperatures was observed at few locations

especially under Rice- wheat system. The grasses in vicinity of fields were critically examined/ observed for rusts, especially yellow rust but no rust was found.

- Survey was conducted by Dr Dhanbir Singh, Principal Scientist (Plant Pathology), CSKHPKV HAREC, DhaulaKuan during the last week of January in Nahan and Paonta blocks of Sirmoor. No yellow rust appearance was noticed in the farmers field. However, yellowing of crop was recorded due to water stagnation in some fields near Kodhanwala. Severe attack of cut worms was recorded in one field in Khadar near Kolar village. Good rains were received during Jan. and low temperature was recorded with foggy weather. The crop condition was excellent in all the areas under survey. In hilly areas, crop condition was poor due to delayed sowing in rainfed areas. No rust and other diseases were recorded in Trap and SAARC nurseries.
- Dr. Dhanbir Singh, conducted survey in Nahan and Paonta Blocks of Sirmour district on 4.2.2015 for recording the appearance of wheat diseases. Yellow rust was noticed in Barotiwala (Paonta) on wheat variety HD 2967 at 3-4 locations in traces. Yellow rust was also recorded in traces on local variety in village Shivpur. High severity of yellow rust up to 60S was recorded on HD 2967 and HD 2380 in village Bharapur on 16.2.2015. Similarly, high severity of yellow rust up to 40S noticed in village Kolar at three locations. However, mild incidence/infestation of powdery mildew and aphids were recorded in both the blocks under survey. Yellow rust in Trap and SAARC nurseries was recorded on 10.2.2015 on wheat varieties WL-711 (10S), HD-2329 (5S), Agra local (10S), HW2021 (10S), Lal Bhadur (10S), Kharchia mutant (10S), HP-1633 (5S), WH-147 (10S), Anna Purna (5S), HD 2189 (10S), Pak 81 (5S) and susceptible check (30S). Good rains were received on 18 &19th February.
- Director Agriculture, Himachal Pradesh informed the status of yellow rust regularly during January-February. Yellow rust was reported from same places of district Bilaspur, Hamirpur, Kangra, Mandi, Sirmour and Una was in traces during 1st week of February. During 2nd week of February, yellow rust was observed in traces in Bilaspur (villages, Nanawan and Bhatoli), in Mandi (villages, Mehar, Surahi, Tandu), in Una (villages, Adarsh Nagar, Amb, Athwan, Krishna Nagar, Busal, Dehar, Badoh, Jalgran) and in Sirmour (villages, Dhaun, Bhangani, Nagal, Phoolpur, Shivpur, Subhkhera, Surajpur).

Jammu & Kashmir

- On 8th January, 2015, Dr. M. K. Pandey surveyed the areas in the route starting from Anand Nagar to Udhywalla via Puni chak, Sari Rakhawllan, Gao Manahansa, Gajansoo and Marh. The presence of any yellow rust was not observed in any of the field of the farmers in the surveyed areas except two small pustules of brown rust and one pustules of yellow rust was observed in SAARC and TPN nursery (Village- Saharan) on Agra Local.
- An extensive survey was carried out on 25th & 26th January, 2015 by Dr. M. K. Pandey, SKUAS&T, Jammu. On 25th January, 2015, fields were surveyed the areas in the route starting from Anand Nagar to Udhywalla via Puni chak, Sari Rakhawallan, Gao Manahansa, Gajansoo, Jiri and Mishriwalla (Jammu). During survey, stripe rust was observed on PBW-175 with some pustules with 5S severity at Lalyal Camp (Jammu) at the field of Yash Paul Sharma. One field of Oats was also severely affected with stripe rust and blight with 80S and 40% severity respectively. On 26th January, 2015, fields were surveyed in Jammu,

Kathua and Samba areas via Raipur, Khandwal, Chatha, R S Pura, Saikalan Ramgarh, Chadwal Rajbag and Khanpur. The field of Taj Ram (Chak Gogal) of wheat variety HD-2967, stripe rust was observed in 2-3 patches with 20MS severity. One field of Bal Dev Singh (Nagari, Kathua) many foci of stripe rust with severity of 10-20MS were observed. One field in Arnia of unknown wheat varieties was also infected with stripe rust (0.05 ha) with 10-20S severity. Stripe rust was also observed on wheat varieties HD-2967 and RSP-561 with 10-20MS severity in 4-5 patches (1 meter) in experimental field of Chatha, SKUAST - Jammu on 20th January.

- On February 10, 2015, The farmer's fields were surveyed by Dr. Sudheer Kumar along with Dr. Vaibhav Kumar Singh, Scientist (Plant Pathology), Division of Plant Pathology, IARI, New Delhi and Dr M.K. Pandey, Scientist (Plant Pathology), SKUAST-Jammu observed four farmers field patches of yellow rust in Jammu and Samba district in Jammu region. These patched were of 2 - 10 m^2 with the severity of 10-60S. In area surveyed all the fields were found free from yellow rust infection.

Uttarakhand

- Dr. Deepshikha, JRO, Plant Pathology, Dr. J.P. Jaiswal, Professor, Genetics and Plant Breeding and Dr. Kanak Srivastava, STA/Jr. Scientist, Plant Pathology surveyed Distt. Udham Singh Nagar Bazpur (Talli farm, Karbola and Doraha), Kashipur (Jaitpur, Jaganathpur and Bhogpur), Gadarpur (Mukundpur, Bagwala and Bhagwanpur), Dineshpur (Durgapur, Anandkhera and Makrandpur mauza), Rudarpur, Kichha (Shankar farm and Pulbhatta), Sitarganj (Gurunanak Farm, Manjeet farm, Kathni, Karghata and Khempur), Sara Saria, Nanakmatta and Khatima (Jhankat and Jungle Jogi kher), Kathgodam (Devlatalla, Madanpur, Golapar, Sitapur and Kuwarpur) and Gorapadao (Haripur Tularam) of Uttarakhand for yellow rust during January 21-23, 2015. No rust or any other insect pest was observed in any field. It was observed that small farmers of Sitarganj, Nanakmatta and Khatima are predominately growing rust susceptible varieties PBW 343, UP 2338 and PBW 373.
- Wheat crop was monitored for rust in the farmers' field by Dr. Deepshikha, JRO ; Dr. Kanak Srivastava, STA Plant Pathology and Dr. Anil Kumar, J.R.O., Genetics and Plant Breeding on 16 Feb 2015 enroute Rudurpur (Vill. Jafarpur, Premnagar and Narainpur), Dineshpur, Gadarpur (Mukundpur, Langra bhoj, Motipur, Abadnagar, Kundan nagar and Chunpuri), Bajpur (vill. Bajpur, Tanda Azam, Maheshpur Doraha, and Namoona), and Bajpur (Vill. Khalo farm and Dehori yadav farm). The varieties sown in the areas were WH 1105, HD 2967, PBW 550, PBW 502, PBW 226, PBW 154 and PBW 343. The crop health was good, in some places yellow rust was observed in traces. One of the farmer's field at village Chunpuri (Gadarpur) yellow rust was observed in patches showing severity of 70S in PBW 343 (1Ha). On 18 Feb., 2015, area between Pantnagar and Khatima enroute Kichha (Vill. Shankar farm (Bhanga), Chacher farm, Pipalia and Gurunanak farm (Bari), Sitarganj (Katangari, Bara, Jungle jogi ther and Nakha farm), Nanakmatta and Khatima (Vill. Sara Saria, Jhankat, and Lohiyapul) were surveyed. Varieties sown in these areas are HD 2967, PBW 550, WH 711, PBW 226, DBW 17, PBW 343, PBW 373 and PBW 154. Yellow rust was in trace and in some area powdery mildew was also noticed. Survey was conducted from Pantnagar to Haldwani on 19 Feb, 2015, places visited were Golapar (Devlatalla, Kuwarpur naya gaon, Naya gaon Mehra and Sambal), Gorapadao (Haripur tula and Haripur punanand), Teenpani, Motinagar and Motahaldu. Varieties sown in

these areas were HD 2967, PBW 154, UP 2425 and DBW 17. One of the farmer at Motinagar had sown RR- 21 in one Ha. Overall crop was good, rust was not observed but between Pantnagar to Haldwani the problem of Powdery mildew was severe in many places.Survey reports were received from the Director, Agriculture, Uttarakhandregularly. No rust was reported during January-February in Uttarakhand.

Rajasthan

- Survey was carried out on 14th and 15th January, 2015 in the area of Dausa and Jaipur districts by Dr K.K. Bhargava, Dr P.S. Shekhawat & Dr Nitin Chawla. None of the rust was observed in wheat and barley crop. However, 1-2 per cent incidence of flag smut was observed in variety Raj1482 and Raj 3077 at Lalsot area (Dausa) and in variety PBW 343 at Paota area of district Jaipur. In most of the area the wheat crop was at flag leaf stage (37-41 of Zadok's scale). Traces to 5 per cent Incidence of loose smut was noted in most of the barley fields having variety RD2035 and RD2552. Incidence of covered smut, *Drechslera* stripe and bacterial streak *in traces* were also noted in few fields of barley. The barley crop was at ear-head emergence to beginning of anthesis stage (54-60 of Zadok's scale). In some fields the early sowing crop of barley was facing infertility problem due to adverse effect of cold. Mild infestation of termite was also noted in few fields of wheat crop. Overall both wheat and barley crop were healthy in the area surveyed.

Maharashtra

- Dr. B. K. Honrao conducted survey on 23rd and 30th January covering Ahmednagar district (Shrigonda, Loni and Belwandi) and Baramatitaluka of Pune district area respectively. First natural incidence of leaf rust was found in ARI germplasm nursery on 2nd February 2015. (varieties:- Agralocal, Morocco and *T. turgidum* sp. zukovsky). No natural incidence of rust was observed on farmer's fields. Incidence of foliar blight was observed in farmer's fields in Shrigonda area. Foliar blight incidence was also found on varieties like HD 2204, HW 2021, WH 147, LalBahadur, Gulab, HD 2189 and entries in coordinated trials .Viz. N-2-14, N-2-15, N-2-17, N-2-34, N-4-26 etc. with severity ranging upto 35. Aphids were observed in majority of farmer's fields with low to high population. In TPN nursery, foliar blight was observed and leaf rust just started appearing on Agra local (traces). Dr B C Game, Jr. Wheat Pathologist, Agricultural Research Station, Niphad visited the wheat disease monitoring nursery sown at Pimpalgaon Baswant on January 15, 2015. The nursery was free from rust. Incidence of leaf blight was recorded on two entries viz., WL 1562 (03) and HW 2021 (02). Survey was undertaken by Dr. B. C. Game and Mr.V. S. Pawar, Sr. Research Asstt. (Pathology) in Dindori and Surgana tehsils of Nashik district (Maharashtra) on 29/01/2015 for monitoring rust and other diseases of wheat crop on farmers field. The villages visited were, Materewadi, Jopul, Rajapur, Varkheda, Parmori, Lakhmapur, Karanjvan, Pimperkhed, Sangpada, Pandane and Sarat. The varieties grown in the area were NIAW 917, NIAW 34, Lok-1, Ajay 72, Ajeet 102, Mohan wonder etc. Incidence of rust was not observed in any field from the area surveyed. Majority of the fields were found infested with aphids. Leaf rust was observed on January 28, 2015 at the field of Mr. Santosh Shankar Gaikwad of village Kenjal (Satara), Maharashtra on var. Lok-1. On Feb. 16, 2015 Dr.Indu Sharma, Director, ICAR-IIWBR and

Dr. R Chatrath, ICAR-IIWBR surveyed Farmers fields in Rahuri areas and observed no rusts.

Central Zone

- On January 28, 2015, Dr. M. S. Saharan and Dr. Upkar S. Sadana, National Consultant (Soil Science), National Food Security Mission, DAC, New Delhi alongwith State Department Officers of Bhopal visited the farmers fields near to Bhopal. No rust was observed. During Feb. 13-14, 2015 Dr.Indu Sharma, Director, ICAR-IIWBR surveyed Junagarh and Dantewara areas for appearance of any rust in the field. No rust was observed. During 16.2.2015 to 18.2.2015 a monitoring team comprising Dr. R. Selvakumar and Dr. Jogendra Singh from ICAR-IIWBR and Dr. Shekhawat from ARS, RAU, Durgapura visited farmers fields in SK Nagar (Gujarat), Udaipur (Rajasthan), Banswara (Rajasthan) and Kota, Rajasthan. There was no rust incidence in any of wheat and barley crop in the visited areas. Leaf blight and foliar aphids were present in few areas. On 25th Feb. 2015 a monitoring team comprising Dr. R. Selvakumar and Dr. Vishnukumar from ICAR-IIWBR visited the farmers' fields as well as field trials in Mathura, Morena districts in Uttar Pradesh. There was no rust incidence in any of wheat and barley crop. In few plants leaf blight was observed. Foliar aphid is also emerging in few fields. On the same day farmers fields and experimental farm in Gwalior (Madhya Pradesh) were visited. The fields were free from rusts. Only leaf blight and foliar aphids were observed.

Strategy Meetings: Strategy meeting for managing stripe rust and Karnal bunt was organized by DAC, New Delhi at Panchkula on January 20, 2015. Dr. J. S. Sandhu, Agriculture Commissioner, G. O. I. chaired the meeting. Dr. Indu Sharma, Director, IIWBR, Karnal made presentation on stripe rust and Karnal bunt management. A meeting for reviewing the status of Karnal bunt management was organized by DAC at Bhopal on January 28, 2015. Dr. J. S. Sandhu, Agriculture Commissioner, G. O. I. chaired the meeting. Dr. M. S. Saharan, Principal Scientist-Plant Pathology, IIWBR made presentation on Karnal bunt management.

Advisory for stripe rust management for northern states (Punjab, Haryana, Western UP, Uttarakhand, HP, J & K)

Stripe rust advisory is again circulated:

Keeping in view the recent rains in last week of February, 2015 and favorable temperature / humidity for stripe rust development, if farmers observe yellow rust in their wheat fields, one spray of Propiconazole 25EC (Tilt 25 EC) @ 0.1 per cent be given at the foci of infection to avoid its further spread. One ml of chemical should be mixed in one litre water and thus 200 ml of fungicide mixed with 200 L of water should be sprayed in one acre wheat crop. If need, farmers are advised to repeat the spray. Farmers should spray the crop when weather is clear i. e. no rain, no fog / dew etc.

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