मैहतान्सिस

Mehtaensis

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(Six-monthly newsletter named after Prof. K.C. Mehta : Founder Dr. S. Nagarajan)

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Stripe rust evaluation in green house

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Prof. K.C. MEHTA
1892-1950

Founder of the Flowerdale station

इस प्रकाशन में प्रकाशित की गई कोई भी जानकारी बिना अध्यक्ष, क्षेत्रीय केन्द्र की अनुमति के जारी न करें। *The information may not be reproduced without the prior consent of the Head, DWR Regional Station, Flowerdale, Shimla.*

सारांश / Executive Summary

इस वर्ष गेहूँ एवं जौ के रतुआ रोगों का कोई विशेष प्रकोप नहीं देखा गया। लेकिन उत्तरी भारत में कुछ स्थानों पर पीले रतुए का आक्रमण पाया गया। प्रतिरोधी किस्मों एवं गेहूँ अनुसंधान निदेशालय, कृषि विश्वविद्यालयों तथा प्रदेश के कृषि विभागों के प्रयत्न से पीले रतुए का नुकसान नाम मात्र ही हुआ। Sr31 उग्र प्रभेद (Ug99 प्रभेद) भारत, बांग्लादेश, भूटान और नेपाल में कहीं भी नहीं पाया गया। काले रतुए का संक्रमण उत्तराखंड में कुछ परीक्षण हेतु लगाई देसी किस्मों तथा कर्नाटक में जौ पर देखा गया। कुल मिलाकर रतुआ रोगो से प्रत्याशित नुकसान नहीं हुआ। इस वर्ष 1209 से अधिक रतुआ नमूनों का विश्लेषण किया गया। पीले रतुए का प्रभेद 46एस119, काले रतुए का 11 तथा भुरे रतुए का 77-5 अधिक मात्रा में पाया गया। विभिन्न रतुओं के नए प्रभेद भी पहचाने गए लेकिन ये अधिकतर कम उग्र पाए गए। गेहूँ एवं जौ के 3552 पंक्तियों को रतुआ प्रतिरोधी क्षमता के लिए परीक्षण किया गया। पीबीडब्ल्यू703 सब रतुओं से प्रतिरोधी पाई गई तथा छः पंक्तियां दो रतुओं को प्रतिरोधी तथा 30 एक रतुआ प्रतिरोधी क्षमतायुक्त पाई गई। रतुआ प्रतिरोधी जीन एवीटी– I,II में देखे गए। इसके अतिरिक्त 126 रतुआ प्रभेदों का रख–रखाव किया गया तथा जिवाणु खेप 56 वैज्ञानिकों को भेजी गई। गेहूँ के प्रतिरोधी किस्में तैयार करने तथा कुछ किस्मों को प्रजननिक क्षमता देखने हेतु 30 नए क्रोस बनाए गए। रतुआ प्रभेदों का मालीक्युलर विश्लेषण किया गया तथा गेहूँ रोग परीक्षण पौध देश में 70 स्थानों तथा सार्क नर्सरी छः देशों में 28 स्थानों पर लगाई गई तथा इसका आंकलन किया गया।

There was no major outbreak of wheat rusts in India during 2013-14. However, sporadic incidence of yellow rust of wheat was observed at some locations in Northern India. Yellow rust remained under threshold level as area and diversity of yellow rust resistant varieties has increased. Moreover joint efforts of DWR (ICAR), SAUs and State Dept. of Agriculture led to the successful management of yellow rust. Black rust of wheat was reported on indigenous experimental wheat material planted in Uttarakhand and barley material in Karnataka. During the year 1625 samples of different rusts of wheat and barley were received/ collected for pathotype analyses. Analyses of more than 1209 samples revealed that the wheat rust population analyzed is avirulent to *Yr*5, *Yr*10, *Yr*11, *Yr*12, *Yr*13, *Yr*14, *Yr*15, *Yr*24, *Yr*26, *Yr*Sp and *Yr*Sk (yellow rust); to *Sr* 26, *Sr* 27, Sr 31, *Sr* 32, *Sr* 35, *Sr*39, *Sr* 40, *Sr* 43, *Sr*Tt3 and *Sr* Tmp (black rust); to *Lr*24, *Lr*25, *Lr*29, *Lr*32, *Lr*39, *Lr*42 and *Lr*45 (brown rust). The proportion of 46S119 has increased to 74% whereas that of 78S84 has reduced to 18.5 % in *Puccinia striiformis* (yellow/stripe rust of wheat). In *Puccinia triticina* (brown/leaf rust of wheat) pathotype 77-5 (121R63-1=THTTM) was the most predominant followed by pathotype 104-2 (21R55=PHTTL). In *Puccinia graminis tritici* (black/stem rust of wheat) pathotype 11 (79G31=RRRTSF) was most predominant followed by pt 40A (62G29=PTHSC). One new pathotype each of three wheat rusts were identified, however, these are less virulent than the already described. Virulence on *Sr*31 (Ug99 type of pathotypes) were not identified anywhere in India, Bangladesh, Bhutan and Nepal. This year, 3552 lines of wheat and barley which includes AVT, NBDSN, EBDSN and breeder's material were evaluated for rust resistance. PBW703 of AVT Ist was resistant to all the wheat rusts. Ten other lines were resistant to two of the rusts whereas 31 lines were resistant to one or other rust. Rust resistance genes were characterized in AVT I and II wheat material. Proportion of lines with *Yr*9/*Lr*26/*Sr*31 has reduced drastically. Five *Yr* genes were characterized in 71 lines of AVTII and 4 in 76 lines of AVTI. Eleven *Sr* genes were inferred in 83 lines of AVTII whereas 12 *Sr* genes were postulated in AVTI lines. Nine, 10 *Lr* genes were characterized in 77 and 87 lines of AVTII and I, respectively. More than 126 pathotypes were maintained as live cultures as well as cryo-preserved. Nucleus and bulk inocula were supplied to 56 Scientists. To develop rust resistant genetic stocks and study genetics of rust resistance, thirty F1 cross combinations were generated and advancement of

generation for others was undertaken. Basic molecular studies on wheat rust pathotypes were undertaken. Wheat disease monitoring nursery and SAARC nursery were organized.

1. Incidence of wheat rusts in India

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 2014, however, due to the resistance in cultivated varieties as well as pro active steps for the management, it could be managed well. Black (stem) rust of wheat was observed on indigenous wheat material planted at Bhowali, Hawalbagh and Pantnagar (Uttarakhand) and barley material in Karnataka. Brown (leaf) rust was widely distributed in different wheat growing areas of India. In nutshell there was no major incidence of wheat rusts in India during 2013-14. Role of grasses in wheat rust epidemiology is also being studied. Rust was also reported on the species of *Panicum*, *Melinis*, *Digitaria*, *Eragostis* and *Themeda* from Wellington in the month of June and July, 2014 from Wellington (Nilgiri hills), however, so far these samples could not infect wheat.

2. Sample receipt

More than 1625 samples of three rusts of wheat and yellow rust of barley were collected from fifteen states of India, Bhutan, Nepal, and Bangladesh (Table 1).

Table1: Details of wheat rust sample receipt/collected during 2013-14

S. No.	State	Wheat Rust			Barley rust
		Black	**Yellow**	**Brown**	**Yellow / Black**
1	Tamil Nadu	66	5	64	-
2	Karnataka	37	-	170	0/31
3	Maharashtra	13	-	47	-
4	Madhya Pradesh	14	-	76	-
5	Gujarat	8	-	15	-
6	Uttar Pradesh	3	61	56	-
7	Uttarakhand	52	54	27	3/0
8	Punjab	-	71	1	-
9	Haryana	-	55	2	-
10	Himachal Pradesh	8	297	22	5/0
11	West Bengal	-	-	10	-
12	Jammu & Kashmir	1	77	-	2/0
13	Rajasthan	6	7	25	-
14	Bihar	-	1	12	-
15	Chhattisgarh	-	-	3	-
	Other countries				
16	Bhutan	-	4	9	-
17	Nepal	6	36	34	1/0
18	Bangladesh	21	-	117	-
	Total	235	668	690	11/31

3. Sample analysis and pathotype distribution of wheat and barley rusts

More than 1209 samples of three rusts of wheat and yellow rust of barley have been analyzed for pathotype distribution.

i. Yellow rust of wheat & Barley (*Puccinia striiformis*)

During this crop year, 312 samples of yellow rust of wheat and barley were analyzed from six North Indian states and Nepal. Population observed is avirulent to *Yr*5, *Yr*10, *Yr*11, *Yr*12, *Yr*13, *Yr*14, *Yr*15, *Yr*24, *Yr*26, *Yr*Sp and *Yr*Sk. Owing to the

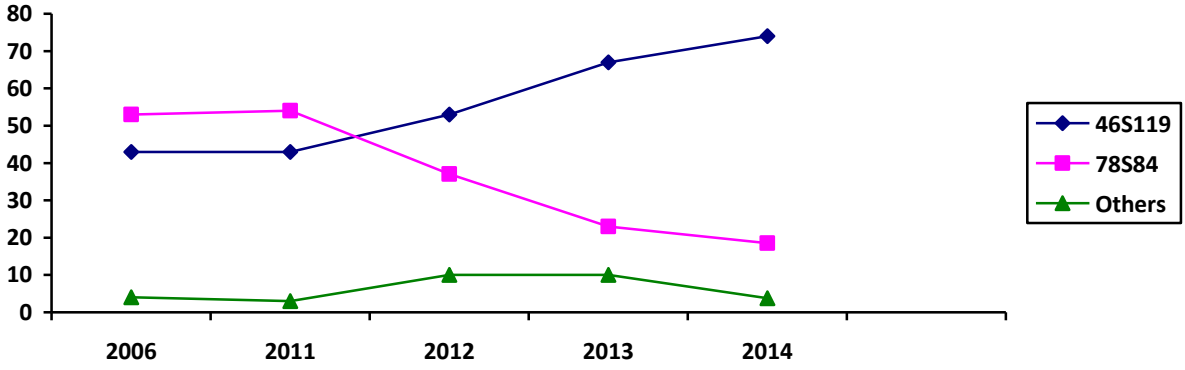


Fig.1: Predominance of *P. striiformis* pathotypes over the years

cool and humid weather, the population of pathotype 46S119, which is virulent to *Yr*2, *Yr*3, *Yr*4, *Yr*6, *Yr*7, *Yr*8, *Yr*9, *Yr*17, *Yr*18, *Yr*19, *Yr*21, *Yr*22, *Yr*23, *Yr*25 and *Yr*A has increased in proportion and was observed in more than 74 % of the samples analyzed so far. Since

Table 2: Pathotype distribution of Yellow rust (*Puccinia striiformis*) up to 30-06-2014

S. No.	State /country	No. of Samples	Pathotypes observed							
			46S119	78S84	47S103T	46S103P	46S102N	NP*	1S0(M)	0S0(57)
1	Himachal Pradesh	171	132	20	5	2	1	7	3	1
2	Jammu & Kashmir	27	17	7	1		-	-	1	1
3	Punjab	55	32	20	-	2	-	1	-	-
4	Haryana	30	25	5	-	-	-	-	-	-
5	Uttarakhand	21	16	3	-	-	-	-	-	2
6	Uttar Pradesh	7	2	2	-	-	-	3	-	-
7	Nepal	1	1	-	-	-	-	-	-	-
	Total	**312**	**225**	**57**	**6**	**4**	**1**	**11**	**4**	**4**

* Probable new pathotype.

2011, there is a drastic shift of pathotypes in favor of pt.46S119 (Fig.1). Partly it is due to the cold climate over the years as well as decrease in the area under PBW343. Many of the wheat lines/varieties which were resistant to yellow rust in farmers' field prior to 2011, became susceptible due to this shift in virulence. The proportion of PBW343 virulent pathotype 78S84 which is virulent to *Yr*2, *Yr*6, *Yr*7, *Yr*8, *Yr*9, *Yr*17, *Yr*18, *Yr*19, *Yr*21, *Yr*22, *Yr*23, *Yr*25 and *Yr*27 has reduced to 18.5%. Three other pathotype were found in about 4% of the samples only (Table2). Barley yellow rust prevalence was negligible during the year. In barley yellow rust pathotype M and 57 were observed in four samples each from Himachal Pradesh and Jammu and Kashmir.

New pathotype

In eleven samples a new pathotype has been identified which is not very virulent but is very competitive. During repeated tests, new pathotype has shown virulence to *Yr1*, *Yr* 6 and *Yr* 7 but is avirulent to *Yr*9. Further studies are under way.

ii. Black rust of wheat (*Puccinia graminis tritici*)

Black rust of wheat was observed in 9 states of India, Nepal and Bangladesh in Peninsular India. Population analyzed during the year has avirulence to *Sr* 26, *Sr* 27, Sr 31, *Sr* 32, *Sr* 35, *Sr*39, *Sr* 40, *Sr* 43, *Sr*Tt3 and *Sr* Tmp .**Virulence on *Sr*31 (Ug99 type of pathotypes) were not identified anywhere in India, Bangladesh, Bhutan and Nepal.** Pathotype 40A**(PTHSC),**which has virulence to *Sr* 5, *Sr* 7b, Sr 8,

Table 3: Pathotype distribution of black rust (*Puccinia graminis tritici*) up to 30-6-2014

S. No.	State/ country	Samples	Pathotypes observed*									
			79G31 (11)	123G15 (15-1)	9G5 (21)	24G5 (21-1)	75G5 (21A-2)	62G29-1 (40-1)	58G13-3 (40-2)	127G29 (40-3)	62G29 (40A)	NP **
1	Tamil Nadu	56	-	-	-	-	-	3	-	8	43	2
2	Karnataka	70	69	-	-	-	-	-	1	-	-	
3	Maharashtra	14	8	-	-	-	-	-	-	1	5	
4	Gujarat	8	1	-	-	-	-	1	-	1	5	
5	Madhya Pradesh	15	2	1	-	-	2	1	2	3	4	
6	Uttar Pradesh	2	2	-	-	-	-	-	-	-	-	
7	Uttarakhand	36	8	-	3	21	4	-	-	-	-	
8	Rajasthan	6	-	-	-	5		-	-	-	1	
9	Himachal Pradesh	5	-	-	-	2	2	-	1	-	-	
10	Nepal	6	2	-	1	1	1	-	-	-	1	
11	Bangladesh	4	-	-	-	1	3	-	-	-		
	Total	224	92	1	4	30	12	5	4	13	59	2

***North American equivalents of pathotypes:11(79G31)=RRTSF,15-1(123G15)=TKTSF, 21(9G5)=CHMSC, 21-1(24G5)=CKMSC, 21A-1(75G5)=CHTSC, 40-1(62G29-1) =PTHSM, 40-2(58G13-3)=PKRSC, 40-3(127G29)=PTTSF, 40A(62G29)=PTHSC** based on Jin Y , Szabo L J , Pretorius Z A , Singh R P , Ward R and Fetch T Jr .2008 . *Plant Dis.* 92: 923-6.

** Probable new pathotype

Sr 9b, *Sr* 9e, *Sr*11 and *Sr* 28, was frequent in Tamil Nadu.Among the 224 samples analyzed, pathotype 11**(RRTSF)** which has virulence to *Sr*5, *Sr* 7b, *Sr* 9b11, *Sr* 13, *Sr* 21, *Sr* 28 and *Sr*30, was widely observed in Karnataka, Maharashtra and some areas in Northern India but not in the Nilgiri hills. In Gujarat pathotype 40A was identified in maximum number of samples whereas three other pathotype were observed in one sample each. Diversity of pathotype was maximum in Madhya Pradesh where seven pathotypes were identified in 15 samples with predominance of pathotype 40A. In Uttar Pradesh, pathotype 11 was identified in two samples whereas in Uttarakhand, Rajasthan and Himachal Pradesh pathotype 21-1 which was identified in 1985 was identified in maximum numbers of samples. In north Indian states other pathotypes of 21 group were identified in few samples whereas pathotype 11 was observed in Uttarakhand (Table3).

New pathotype

Preliminary studies have shown the occurrence of two new pathotypes in one sample each from Tamil Nadu .These were designated as 40-4 and 40-5. Both the pathotypes seem to be an off-shoot of pathotype 40A.While 40-4 is virulent to *Sr*21, 40-5 has additional virulence to *Sr*7a. These new pathotypes appear to be virulence selection in 40A on diploid and tetraploid wheat.

iii. Brown rust of wheat (*Puccinia triticina*)

Thirty pathotypes were identified in 673 samples of brown rust of wheat analyzed from 15 states of India, Nepal, Bhutan and Bangladesh. Population observed during the year is resistant on *Lr*24, *Lr*25, *Lr*29, *Lr*32, *Lr*39, *Lr*42 and *Lr*45. Pathotype 77-5**(THTTM)** virulent to *Lr*1, *Lr*2, *Lr*3, *Lr*10, *Lr*13, *Lr*15, *Lr*20, *Lr*23 and *Lr*26 was predominant in 14 states and 3 neighboring countries. Pathotype 104-2**(PHTTL)** ,virulent to *Lr*1, *Lr*2, *Lr*3, *Lr*10, *Lr*13, *Lr*23 and *Lr*26 succeeded 77-5 and was observed in 12 states and two adjoining countries Nepal and Bangladesh.In Nilgiri hills, the proportion of pathotype 77-9 has increased in comparison to the previous years and was identified in 56% of the samples analyzed from that area. Frequency of predominant pathotype 77-5 for the last more than 18 years has reduced considerably. Likewise, in Karnataka, pathotype 77-9, 12 and 77-11 were the three most frequent pathotypes. In addition pathotype 77-5, 12-2 and 104-2 were also frequent. Fifteen other pathotypes were identified in the remaining samples.In Maharashtra pathotype 12 was most frequent followed by pathotype 77-5 whereas other pathotype were identified in few samples only. Contrarily pathotype 104-2 was predominant in Gujarat, Rajasthan and Madhya Pradesh. Based on the analysis of 17 samples from North eastern states of Bihar and West Bengal pt 77-5 was the most predominant. In Uttar Pradesh, pts. 77-5 and 104-2 were identified in 31% of the samples each. Eleven other pathotypes were detected in few samples only. In Uttarakhand, pathotype 104-2 was most frequent whereas in Himachal Pradesh pt 77-5 and 104-2 were more predominant with equal frequency.In Punjab, pt. 77-3 was found in maximum number of samples whereas in Jammu &Kashmir, pt. 12-9 occurred in the only two samples analyzed. In Nepal Bhutan and Bangladesh pt. 77-5 and 104-2 were identified in maximum numbers of samples whereas thirteen other pathotype were identified in few samples only (Table4).

Table 4 : Pathotype distribution of brown rust (*Puccinia triticina*) up to 30-06-2014

S. No	State/ country	No. of Samples	Pathotypes observed*																														
			12(5R5)	12-1 (5R37)	12-2 (1R5)	12-3 (49R37)	12-4 (69R13)	12-5 (29R45)	12-6 (5R45)	12-9 (93R37)	12A (5R13)	77-1 (109R63)	77-2 (109R31-1)	77-3 (125R55)	77-4 (125R23-1)	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)	77A-1 (109R23)	104-2 (21R55)	104-3 (21R63)	104-4 (93R57)	104A (21R31)	104B (29R23)	162 (93R07)	162-1(93R47)	162-2(93R39)	162A (93R15)
1	Tamil Nadu	71										1				12	8	40			9									1		
2	Karnataka	169	36	1	14	2	2				1	1		1	1	18	2	36		28	2	2	2	12	2		1		3		2	
3	Maharashtra	51	27				1				1			1		7	1	3	1	4				3			1				1	
4	Gujarat	19											2			5								10					1		1	
5	Madhya Pradesh	63	1									1				1		1						45	9		1	2	2			
6	Bihar	6							1				1			2								1	1							
7	West Bengal	12														8	3															1
8	Chhattisgarh	3											1			1																
9	Rajasthan	25														6	1	2						9	2					4	1	
10	Uttar Pradesh	70	1	2				1				3		1		22	1	8						22	4				1	3	1	
11	Haryana	10												1		2				1				2	1	2						1
12	Uttrakhand	20		2								1				3								8	3		1				2	
13	Punjab	7				1						1		2		1		1						1								
14	Himachal Pradesh	34										1		1		10	5							10	5	1						1
15	Jammu&Kashmir	3								2														1								
16	Nepal	48	1			1								1		34		1						9			1					
17	Bhutan	13		1												11	1															
18	Bangladesh	49		3		1	1					1		2		25								4	5	1	1			3		2
	Total	673	66	9	14	5	4	1	1	2	2	10	4	10	1	168	22	92	1	33	11	3	2	137	32	4	6	2	7	11	8	5

*12(5R5)=FGTTL,12-1(5R37)=FHPNM, 12-2 (1R5)=FGTTL,12-3(49R37)=FHTRL, 12-4(69R13)=FGTRM,12-5(29R45)=FHTPM, 12-6(5R45)=FHRPM, 12-9(93R37-1)=FHTTM,12[a](5R13)=FGTTL,77-1(109R63)=THTTB,77-2(109R31-1)=TGTTL,77-3(125R55)=THTTB,77-4(125R23-1)=TGTTL,77-5(121R63-1)=THTTM,77-6(121R55-1)=THTTL, 77-9(121R60-1)=MHTKP,77-10(377R60-1)=MHTKQ,77-11(125R28)=MGTTL,77-12(121R52-1=MGTNL ,77[a](109R31)=TGTTB, 77[a]-1(109R23)=TGTTL, 104-2(21R55)=PHTTL,104-3(21R63)=PHTTL,104-4(93R57)=NHKTL,104[a](21R31)=MGTDC,104B(29R23)=MGTDL,162(93R7)=KGTSC,, 162-1(93R47)=KHTTM, 162-2(93R39)=KHTTL,162[a](93R15)=KGTSB; Figures in parentheses are the Indian binomial names and those in letters are North American equivalents based on **Kolmer J A, Ordonez, M E, Manisterski J and Anikster Y. 2011. *Phytopathology* 101:870-877.**

New pathotype

In a sample from the Maharashtra, a new pathotype, designated as 77-13 was identified. This pathotype appears to be the result of a loss of virulence on *Lr*26 in the pathotype 77-10, which has virulence to *Lr*28.. Further studies are being undertaken.

4. Evaluation for rust resistance in wheat and barley

To identify rust resistant lines of wheat, barley and characterized rust resistance genes in wheat lines, 3552 lines were screened against rust pathotypes at seedling stage. It included 93 lines of AVT-II and 107 lines of AVT-I of wheat. A wide spectrum of pathotypes of black rust (*Puccinia graminis tritici*), Brown rust (*Puccinia triticina*) and Yellow rust (*Puccinia striiformis*) of wheat, having different avirulence/virulence structure were used in the studies. Likewise 278 lines of NBDSN, EBDSN and 383 other barley lines were also evaluated against barley rusts (Table 5).In addition, evaluated wheat material being developed for Near Isogenic Lines by R.S., I.A.R.I., Indore. Collaborated

Table 5: Details of material for seedling resistance test against wheat and barley rusts/Pathotype used

Name	Place	No. of. Lines	Brown	Black	Yellow
AVT I, II	DWR, Karnal	200	Predominant	Predominant	Predominant
NBDSN & EBDSN	DWR Karnal	278	Mix	11, 40A, 42	24, M, 57, G, MIX,Q
BHU	Varanasi	47	Predominant	Predominant	Predominant
PAU Wild wheat	Ludhiana	156	Predominant	-	Predominant
IARI	New Delhi, Indore	1000	Selected	-	-
NBPGR	New Delhi	659	Predominant	Predominant	Predominant
DWR	Karnal	742	Predominant	Predominant	Predominant
CSSRI	Karnal	115	Predominant	-	Predominant
VPKAS	Almora	108	Predominant	-	Predominant
ARI	Pune	202	One	-	-
BARC	Bombay	15	Selected	-	-
GB Pant UA&T	Pantnagar	30	Selected	-	-
Total		3552			

with nine other institutions for rust research work.

i. Rust resistant lines of wheat

Resistance to all the rusts was observed in PBW703 of AVTI. Ten other lines were resistant to two of the rusts whereas 31 lines were resistant to one or other rust All the wheat lines possessing *Sr*31 resistant to black rust, whereas those possessing *Lr*24 and some with *Lr*26 were resistant to brown rust. Some of the lines with *Yr*9 were resistant to yellow rust pathotypes.

AVT II Year

i. **Resistant to brown and black rusts :** HI1544,HI1563

ii. **Resistant to brown and yellow rusts :** PBW681

iii. **Resistant to yellow rust only :** PBW660(I)(C)

iv. **Resistant to brown rust only :** HD2864

AVT I Year

Resistance to all the rusts was observed in PBW703.

i. **Resistant to brown and black rusts :** UP2891,HUW677

ii. **Resistant to yellow and brown rusts** : PBW697,PBW698, PBW722, PBW723

iii. **Resistant to yellow rust only :** HD3128, HD4728, HPW411, HS592, HS593, HS594, HUW675, HUW693, HW1099, K1204, MACS3927(D), PBW692, PBW701, PBW702, VL1003,VL1004,VL3002

iv. **Resistant to black rust only:** All the lines possessing Sr31, HPW401, HPW410, HS547, TL2942, TL2969, TL2998, TL2999 and TL3000 were resistant to black rust.

v. **Resistant to brown rust only :** HD3133, CG1010, GW451, GW455

ii. Rust resistance genes in AVT lines

Rust resistance genes (*Lr, Sr, Yr*) were characterized using gene matching technique. Rust resistance genes could be characterized only in the lines where differential host-pathogen interaction was present. However, linked characters, Morphological markers, characteristic infection types and pedigree also formed the basis for postulating rust resistance genes in absence of host pathogen differential reactions.

***Yr* genes**

AVT II

In AVT II material, 5 *Yr* genes/patterns were characterized in 71 lines (Table 6). *Yr*2 was found to confer resistance in maximum number of lines (46). However, this gene is susceptible to many of the virulent pathotypes. *Yr*9 which is linked to *Lr*26 and *Sr*31 was postulated in 21 lines. Other resistance genes like *Yr*A, *Yr*18, *Yr*27, were postulated in few lines only.

AVT I

Four *Yr* genes were postulated in 76 lines of AVT I material (Table7). Among these, *Yr*2 was inferred in 47 lines. *Yr*9 which is linked to *Lr*26 and *Sr*31 was identified in 17 lines. *Yr*A was characterized in 15 lines whereas *Yr*27 was identified in 2 lines only.

***Sr* genes**

AVT II

Eleven *Sr* genes (*Sr*2,5,7b,8a,9b,9e,11,12,13,24,31) were characterized in 83 lines (Table 8). *Sr*11 was postulated in 33 lines followed by *Sr*2 and *Sr*31 in 27 and 21 lines, respectively. Postulation of *Sr*2 is based on characteristic micro-flecking. Postulation of *Sr*31 is based on its linkage to *Lr*26 and *Yr*9. *Sr*9b was identified in 12 lines, *Sr*7b in 9, *Sr*5 in 7, *Sr*8a and *Sr*9e in 6 lines each. *Sr* 24 was inferred in 5 lines whereas *Sr*12 and *Sr*13 in one line each. Most of the durum wheat varieties had resistance based on *Sr*7b, *Sr9e*, *Sr*11, *Sr* 12 and *Sr*13.

AVT I

Twelve *Sr* genes (*Sr*2,5,7b,8a,9b,9e,11,13, 25, 26,30,31) were characterized in 99 lines (Table 9). *Sr*11 was postulated in 50 lines followed by *Sr*2 and *Sr*9b in 42, 19 lines, respectively. Postulation of *Sr*31 is based on its linkage to *Lr*26 and *Yr*9 was identified in 17 lines whereas *Sr*7b in 17 lines. *Sr*13, *Sr*8a were postulated in 13 and 3 lines, respectively. Other resistance genes *Sr*9e, *Sr*25, *Sr*26 and *Sr*30 were postulated in one line each. Most of the durum wheat varieties had resistance based on *Sr*7b and *Sr*11.

***Lr* genes**

AVT II

Nine *Lr* genes (*Lr*1, 3, 10, 13, 18, 23, 24, 26, 34) were characterized in 77 lines (Table 10). Most of the lines possessed more than two resistance genes. *Lr*23 was the most common resistance gene and was characterized in 37% of the lines followed by *Lr*13 (28 lines). The proportion of lines with *Lr*26 has reduced and was identified in 21 lines only. Likewise *Lr*10 was inferred in 17 lines,*Lr*3 in 3 lines, whereas *Lr*24 and *Lr*34 were postulated in 5 lines each. *Lr*18 was inferred in one line only.

AVT I

Ten *Lr* genes (*Lr*1, 2a, 10, 13, 14a, 18, 19, 20, 23, 26) were characterized in 87 lines (Table 11). Many of the lines possessed combination of resistance genes. *Lr*13 was the most common resistance gene and was characterized in about 39% of the lines followed by *Lr*23 (28 lines), *Lr*10 was postulated in 20 lines, whereas *Lr*26 was characterized in 17 lines. The proportion of lines with *Lr*26 has reduced. *Lr*1, *Lr*18 were postulated in 12 and 4 lines, respectively. *Lr*2a, *Lr*14a, *Lr*19 and *Lr*20 were inferred in one line each.

Table 6: Postulation of *Yr genes* in AVT IInd material during 2013-14

S. No.	*Yr* genes	No. of Lines	Details of Lines
1	2+	46	BRW3723, DBW110, DBW90, GW322, HD2864, HD2888, HD2967, HD2985, HD3043, HD3086, HD3118, HI1500, HI1544, HI1563, HI8498, HI8736, HI8737, HPW349, HPW376, HS542, HW2044, K0307, K1006, K1114, K8027, MACS2971, MACS5022, MACS6478, MP3288, MP3336, MP4011, NI5439, NIAW1885, NW5054, PBW314, PBW644, PBW689 RAJ4083, UAS347, UAS446, VL967, WH1080, WH1105, WH1124, WH1129, WH1138
2	9+	14	CoW (w) 1, DBW39, DBW107, HD3090, HPW251, HS507, HW5216, MACS2496, NIAW1415, NW2036, PBW590, PBW660, WH1121, WH1142
3	9+18+	05	HD2733, HS277, HS375, VL804, VL829
4	9+27+	02	MACS6222, VL907
5	A+	04	HUW666, MP3382, NIAW1994, VL892
Total		**71**	

Table 7: Postulation of *Yr genes* in AVT Ist material during 2013-14

S. No.	*Yr* genes	No. of Lines	Details of Lines
1	2+	46	CG1010, DBW95, DBW128, DBW155, DDK1046, DDW27, DDW30, GW451, GW455, HD2932+*Lr*19+*Sr*26, HD2932+*Sr*26, HD3127, HD3139, HD4730, HI8754, HI8755, HPW400, HPW401, HPW410, HS547, HS558, HS577, HS595, HUW234, HUW661, HUW677, K1213, K1215, KB2012-03, MACS3916, MACS5040, MACS6507, MACS6604, MBBL283, MP1279, MP1277, NIAW2030, PBW677, PBW695, UAS356, UP2890, VL3006, WH1132, WH1154, WH1157, WH1164
2	9+	13	DBW154, HD3128, HD3133, HD3146, HUW579, K1217, PBW693, PBW701, UP2855, UP2864, VL976, VL977, VL1003
3	9+27+	01	PBW343
4	9+A+	03	HPW412, UAS358, VL3004
5	2+27+	01	PBW704
6	A+	12	DBW98, DBW126, DBW129, HD3132, HPW373, HS562, HS590, TL2995, UAS451, UP2891, VL3005, WH1156
Total		**76**	

Table 10: Postulation of *Lr genes* in AVT IInd material during 2013-14

S. No.	*Lr* genes	No. of Lines	Detail of Lines
1	13+	11	BRW3723, GW322(C), HD2932(C), HD3118, HI8627(d)(C), HPW349(C), K1114*, K8027(C), VL 967, WH1080(C), WH1105(C)
2	13+1+	1	PBW644(C)
3	13+3+	1	MP3382
4	13+10+	11	DBW88(I)(C), DBW110, DPBW621-50(C), HD2985(C), HD3043(C), HS542(I)(C), HUW666, KRL210(C), PBW689, WH1124(C), WH1129
5	13+10+3+	2	DBW90(I)(C), HD3086(I)(C)
6	18+	1	NIDW295(d)(C)
7	23+	18	A-9-30-1(d)(C), DBW14(C), HD2967(C), HI8736(d), HI8498(d)(C), HI8737(d), HS490(C), MACS6478(C), MP1215(d)(C), NW5054(I)(C), PDW233(d)(C), PDW291(d)(C), PDW314(d), Raj4083(C), UAS347, UAS428(d)(C), UAS446(d), WH1138
8	23+1+	2	KO307(C), NIAW1994
9	23+10	2	K1006(I)(C), NIAW1885
10	23+13+10+	2	HPW376, VL892(C)
11	24+	5	HD2888(C), HI1500(C), HW2044(C), MP3288(C), MP4010(C)
12	26+	3	COW(W)(I)(C), HW5216(C), NIAW1415(C)
13	26+1+	5	HD3090(I)(C), HS507(C), MACS6222(C), VL907(C), WH1081(C),
14	26+3+	2	DBW107*, PBW660(I)(C)
15	26+3+1+	1	WH1142
16	26+23+	3	HPW251(C), MACS2496(C), NW2036(C)
17	26+23+1+	2	DBW39(C), PBW590(C)
18	26+34+	5	HD2733(C), HS277(C), HS375(C), VL804(C), VL829(C)
TOTAL		77	

Table 11: Postulation of *Lr genes* in AVT Ist material during 2013-14

S. No.	*Lr* genes	No. of Lines	Detail of Lines
1	13	22	DBW95, DBW126, DBW128, HD2932+*Sr*26 HD3127, HPW400, HPW401, HPW410, HS558, HS590, HS593, HS594, MACS6507, PBW692, PBW706, TL2997, TL2998, UP2890, VL3002, WH1154, WH1156, WH1164
2	13+1	1	HPW411
3	13+10	8	DBW98, DBW129, HD3132, HS596, HW1099, VL3006, WH1132, WH1157
4	13+10+1	3	HS547, HS592, HS595
5	14a+	1	HUW234(C)
6	18	3	HI8750(d), HI8755(d), MACS3927(d)
7	19	1	HD2932-*Lr*19/*Sr*25
8	20	3	DDK1046, DDW30(d), MACS5040
9	23+	19	DBW155, HD3139, HD4720(d), HD4730(d), HI8751(d), HI8754(d), HS562,K1215, KB2012-03, MACS3196(d), MACS6604, MMBL283, MP1279, NIAW2030, PBW677, PBW695, TL2967(C), UAS356, VL3005
10	23+1	1	K1204
11	23+3+	1	HS577
12	23+10+	4	HUW675, MP1277, PBW702, VL1004
13	23+10+1+	1	HPW373
14	23+10+2a+1+	1	HUW661
15	23+18+	1	DDW27(d)
16	26+	4	DBW154, HD3128, HD3133, PBW343(C)
17	26+1	2	HPW412, VL3004
18	26+10+	2	PBW693, UAS358
19	26+10+1+	1	HUW679
20	26+23+	6	HD3146, K1214, PBW701, UP2864, VL977, VL1003
21	26+23+1+	2	UP2855, VL976
TOTAL		87	

Table 8: Postulation of *Sr* genes in AVT IInd material during 2013-14

S. No.	*Sr* genes	No. of Lines	Details of Lines
1.	2+	07	DBW14(C), HI1544, HI1563(C), K0307(C), HPW349(C), PBW644(C), VL892(C)
2.	5+	01	HPW376
3.	7b+2+	01	HD3086(I)(C)
4.	7b+11+2+	01	UAS347
5.	9b+2+	01	HS490(C)
6.	9e+2+	02	PBW233(C), WH1080(C)
7.	9e+12+2+	01	NIDW295(d)(C)
8.	11+2+	06	GW322(C), K1114, K8027(C), HI8498(D)(C), PBW681, UAS446(D)
9.	5+8a+9b+11+	01	HS542(I)(C)
10.	7b+	07	AKDW2997-16(d)(C), HD2985(I)(C), KRL210(C), NIAW1885, NW 5054(I)(C), WH1124(I)(C), WH1138
11.	8a+9b+11+	02	K1006(I)(C), VL967
12.	8a+11+	02	HD2864(C), HD2967(C)
13.	8b+9b+11+	01	KRL19(C)
14.	9b+11+	07	BRW3723, HD3118, HUW666, MP3382, NIAW1994, PBW689, WH1129
15.	9e+	03	HI8737(d), PDW291(C), PDW314(C)
16.	11+	13	A-9-30-1(D)(C), DBW88(I)(C), DDK1029(C), DDK1042, HD1098 (C)(C), HI8736(d), MACS2971(C), MACS5022, MPO1215(d)(C), NI5439(C), Raj4083(d), UAS428, WH1105(C)
17.	13+	01	DBW90(I)(C)
18.	24+	03	HD2888(C), HI1500(C), MP3288(C)
19.	24+2+	02	HW2044(C), MP4010(C)
20.	31+	11	Cow (W)(C), DBW39(C), DBW107, HD2733(C), HS277(C), HS507(C), HW5216(C), MACS6222(C), NIAW1415(C), NW2036(C), VL 907(C)
21.	31+2+	05	HD3090(I)(C), HPW251(C), MACS2496(C), WH1021(C), WH1142
22.	31+5+	04	HS375(C), PBW590(C), PBW660(I)(C), VL804(C)
23.	31+5+2+	01	VL829(C)
	Total	**83**	

Table 9: Postulation of *Sr* genes in AVT Ist material during 2013-14

S.No.	*Sr* genes	No. of Lines	Details of Lines
1.	2+	08	CG1010, HUW677, PBW723, TL2942 (C), TL2969 (C), TL2999, TL3000, UP2891
2.	7b+2+	05	DBW129, GW451 (D), HD3139, HS594, VL3006
3.	7b+11+2+	02	HS577, HS591
4.	8a+13+2+	01	WH1164
5.	9b+11+2+	09	DBW95, HS595, PBW672, PBW695, PBW697, PBW698, VL1004, VL3005, WH1157
6.	11+2+	06	DDW27 (D), DDW30 (D), HD4730, HI8751 (D), HI8754 (D), K1204
7.	11+13+2+	02	PBW722, WH1154
8.	13+2+	03	HI8755 (D), HPW411, VL3002
9.	7b+5+	01	DBW126
10.	5+9b+11+	01	HS562
11.	5+13+	01	MACS6604
12.	7b+	08	DBW98, GW455, HD3127, HD3132, HS590, HS593, UP2890, WH1132
13.	7b+11+	01	MP1277
14.	8a+11	01	MACS6507
15.	8a+11+13+	01	K1213
16.	9b+11+	09	DBW128, HPW400, HS558, HS592, PBW677, PBW702, PBW706, UAS356, WH1156
17.	9e+	01	DDK1044
18.	11+	15	DBW155, DDK1046, HD4728 (D), HI8750 (D), HPW373, HUW234 (C), HW1099, MACS3916 (D), MACS3927 (D), MACS5031, MACS5040, MMBL283, NIAW2030, TL2996, UAS451 (D)
19.	11+13+	03	HUW675, KB 2012-03, MP1279,
20.	13+	01	K1215
21.	25+2+	01	HD2932-*Lr*19/*Sr*25
22.	26+	01	HD2932+*Sr*26
23.	30+	01	HUW661
24.	31+	11	DBW154, HD3146, HPW412,HUW679, PBW693, PBW701, UAS358, UP2855, VL977, VL1003, VL3004
25.	31+2+	04	HD2138, HD3133, PBW343 (C), VL976
26.	31+5+	01	K1217
27.	31+5+2+	01	UP2864
Total		**99**	

iii. Adult plant resistance to brown and yellow rusts

Lines of AVT IInd year were evaluated for identifying adult plant resistance. Pathotype 46S119 and 78S84 of yellow rust and 77-5 and 104-2 of leaf rust were used in the study. Optimum conditions for infection of rust and growth of wheat material were provided. HPW376, HPW349 (C), HS490 (C), HS507 (C), WH1080 (C), Raj4083 (C) and KRL210 (C) conferred considerable adult plant resistance to both yellow and brown rusts.

iv. Evaluation for seedling rust resistance against rusts of barley

Ninety one lines of EBDSN and 187 lines NBDSN were evaluated at seedling stage against five pathotypes of barley yellow rust viz. (0S0-1) 24, (0S0)57, 4S0(G),1S0(M), 5S0 (Q) and mixture of *Puccinia striiformis hordei* (Yellow /stripe rust), three pathotypes 79G31(11),62G29(40A) and 19G35(42) of *P. graminis tritici* Black/stem rust) and mixture of five isolates of *P. hordei* (Brown/leaf rust) under controlled conditions of greenhouse. One week old seedlings were inoculated and incubated in saturated humidity chambers for 48 hours. Subsequently these plants were transferred on to the greenhouse benches where sufficient day light (more than 10,000 Lux) and temperature of 16±2^{o}C (for yellow rust), 22±2^{o}C (for brown rust) 24±2^{0}C (for black rust) and relative humidity of 40-60% were maintained. Observations recorded are summarized below:-

Rust resistant lines in EBDSN

Two lines viz. VLB132 and RD2786 were resistant to all the rusts. There were no accession showing resistance to both brown and black rusts or black and yellow rusts only. Sixteen lines were resistant to both brown and yellow rusts (**Table 12**).

Table 12: Details of rust resistant barley lines in EBDSN

Resistant to	No. of Lines	Details of Lines
All the rusts	02	VLB132, RD2786
Brown and yellow rusts	16	HUB113, KB1222, VLB130, RD2832, RD2833, RD2852, RD2853, RD2854, RD2859, RD2860, RD2861, RD2862, RD2865, RD2867, RD2869, BH979

Rust resistant lines in NBDSN

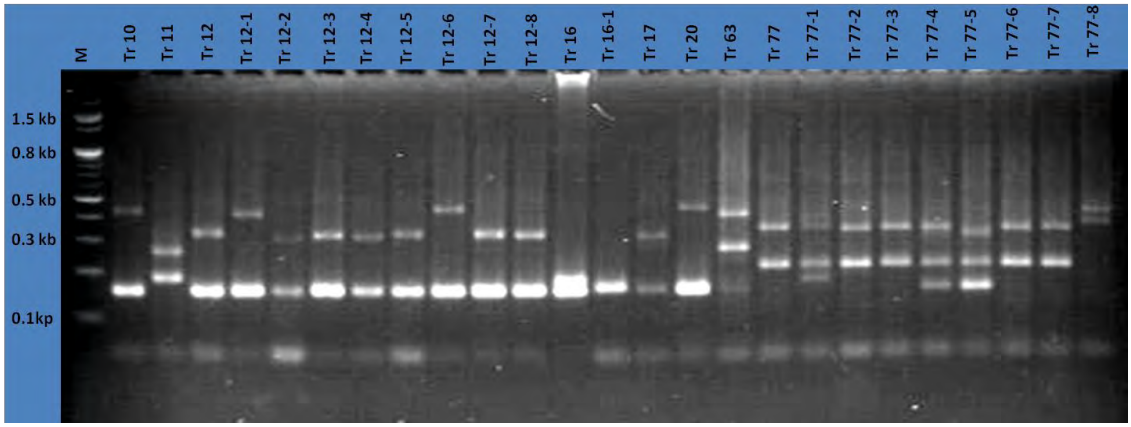
None of the lines were resistant to all three rusts of barley or brown and black rusts or black and yellow rusts only. Sixteen lines were resistant to all brown and yellow rusts (**Table 13**). PL880, BH992 and AZAD (C) were resistant to all the pathotypes of black rust. Lines RD2552, BH902, DWRUB64 (C), KB1369, RD2874, RD2881 and RD2715 (C) were resistant to all the pathotypes of yellow rust of barley.

Table 13: Details of rust resistant barley lines in NBDSN

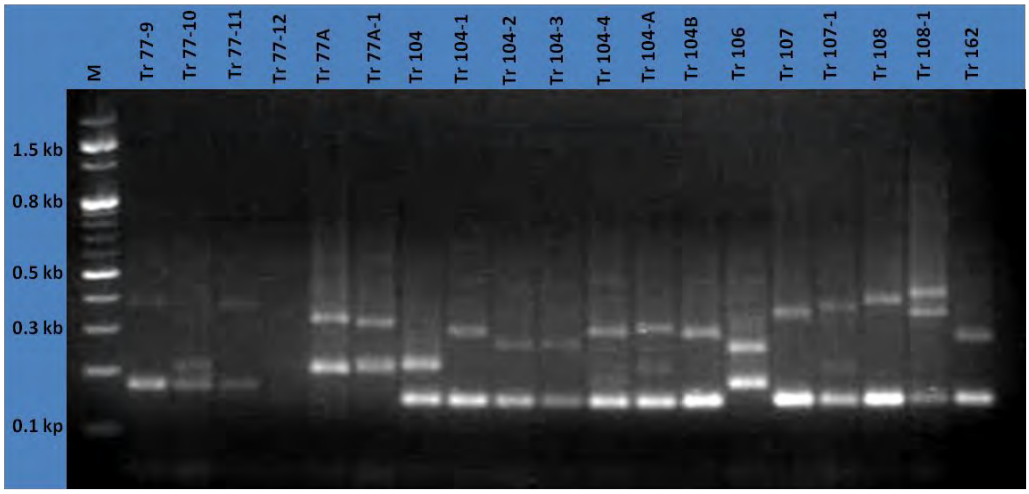
Resistant to	No. of Lines	Details of Lines
All the rusts	0	None
Brown and yellow rusts	16	VLB140, UPB1038, BH902, RD2833, BH902, RD2860, RD2889, RD2890, RD2887, DWRB127, RD2875, RD2552 (C), RD2786 (C), KB1369, RD2883, RD2882

5. Studies on DNA polymorphism in wheat rust pathotypes

Molecular variability among yellow and brown rust pathotypes was studied using specific simple sequence repeat (SSR) primer pairs. Twenty five primers were used to



'A'



'B'

Fig. 2. Variability among leaf rust races. Polymerase chain reaction (PCR) amplification was performed using the Brown rust Specific SSR Primer (TRSSR-16). PCR products were separated by 3 % Super MT4 Agarose horizontal gel electrophoresis.

study variability among brown rust pathotypes. Initially, out of 25 SSR (TR-SSR) primer pairs, 06 were found to be polymorphic to selected brown rust pathotypes. These six primer pairs were further tested against all the brown rust pathotypes. The PCR product was resolved in 3% Super MT4 Agarose (Life Technologies) instead of normal agarose, which in earlier attempts was not able to resolve the DNA bands properly. Some of the primers clearly differentiate among the brown rust pathotypes. Interestingly, the banding pattern with some primers in a group of pathotypes with similar pathogenicity/virulence was more or less similar with some exceptions (**Figure 2A, B**). Out of twenty six SSR (ST-SSR) primer pairs tested against selected yellow rust pathotypes, very few were polymorphic. These polymorphic primers are under further testing against all the yellow rust pathotypes.

In addition, total DNA was isolated from more than 100 different grasses, showing rust (yellow, brown, black) like infection. Attempts were made to amplify the DNA from these grasses using *Puccinia striiformis* and *Puccinia triticina* specific SSR primers. But there was no amplification in any of the samples, ruling out the probable association of *Puccinia striiformis* and *Puccinia triticina* with rusts of these grasses.

6. Genetic studies and development of rust resistant genetics stocks

To develop genetic stocks with diverse rust resistance and study the genetics of rust resistance, thirty F1 cross combinations involving Access, DBW110, DPW621-50, FLW14, FLW21, FLW22, Grisby, HD2189, HD3076, HD3123, HI8725, HI8727, HI8735, HI8739, HPW349, HS295, HS596, HUW668,NIAW1951, MACS3828, NW5051, NW5054, PBW644, PBW683, PDW314, RNB1001, Timber, UAS 347, UAS349, UP2848, UP2871,VL892, VL907,VL974, VL3002 were developed.

Fourteen segregating populations viz. HI1500 x Eagle (F5), HI1500 x *Sr*43 (F5), NI5439 x Eagle (F5), Lok-1 x *Sr*39 (F3), Lok-1 x *Sr*32 (F3), Lok-45 x *Sr*32 (F3), HI1500 x *Sr*32 (F6), Raj 3765/ Eagle (BC2F4), *Yr*24 x Kalyansona (F2), *Yr*26 x Kalyansona (F2), Lok-1 x Kite (F2), HI1077 x Kite (F2), Raj 3765 x Kite (F2) and NI5439 x Kite (F2) were advanced and selected. Six segregating populations Viz. Agra local x Sonalika (F2), LWHx Lok-1 (F3), Sonalika x Kalyansona (F3), LWH x FLW-14(F3), NI 5439x Sr32, (F5) and NI5439 x Lok-1 (F3) were also advanced. Forty four F2 populations of spring x winter wheat crosses (obtained from PI crop improvement DWR) were also advanced and selected.

7. Supply of nucleus inoculum of wheat and barley rusts

To enable wheat and barley researchers conduct their research elsewhere in India , Flowerdale is credited with the supply of uredosporic inoculm. Nucleus inocula of various pathotypes of different rust pathogens were supplied to 56 centres/ Scientists through speed post. List of the recipients is presented in Table 14.

Table 14 : Details of rust inoculum supplied during 2013-14

S.No.	Name	Place	Pathotypes supplied
1.	A. Kumar	New Delhi	Black rust
2.	A.N. Mishra	Indore	Black and brown rusts
3.	A.P. Agarwal	Bilaspur	Mix of brown and black rusts
4.	B.C. Game	Nasik	Mix of black and brown rusts
5.	Annu Khajuria	Jammu	Mix of yellow rust
6.	Ashish Kumar	Pusa Bihar	Mix of brown rust
7.	B.K. Das	Trombay	Black and brown rusts
8.	B.K. Hanrao	Pune	Brown rust
9.	B.R. Raghu	Almora	Yellow and brown rusts
10.	C. Manjunath	New Delhi	Black, brown and yellow rusts
11.	C.N. Mishra	Karnal	Mix of yellow and brown rusts
12.	D.P. Walia	Shimla	Mix of brown and black rusts
13.	Deepshikha	Pantnagar	Mix of brown and yellow rusts
14.	Dhanbir Singh	Dhaulakuan	Mix of brown and yellow rusts
15.	Dharminder Singh	Baru Sahib	Brown rust
16.	Gautam, V	Trombay	Black rust
17.	Gurdev Singh	Ludhiana	Brown and yellow rusts
18.	I.K. Kalpanawar	Dharwad	Mix of black and of brown rusts
19.	J.B. Khan	Kanpur	Mix of black, brown and yellow rust (wheat& barley)
20.	J.Kumar	Pantnagar	Mix of Yellow and brown rusts
21.	J.P. Jaiswal	Pantnagar	Mix of yellow and brown rusts
22.	J.B. Sharma	New Delhi	Black and brown rusts
23.	K.K. Mishra	Hoshangabad	Mix of black and brown rusts
24.	K.V. Jivani	Junagarh	Black and brown rusts
25.	Kamini Kaushal	Indore	Brown rust
26.	Kishore Panchbhai	Indore	Mix of black, brown and yellow rusts
27.	Kuldeep Singh	Ludhiana	Yellow rust
28.	M.K. Pandey	Jammu	Mix of brown and yellow rusts
29.	M.S. Saharan	Karnal	Yellow & brown rusts
30.	Madhumeeta, J.	Ludhiana	Brown and yellow rusts
31.	N.V. Savant	Mahableshwar	Black and brown rusts
32.	Navtej Singh Bains	Ludhiana	Yellow rust
33.	Neelu Jain	New Delhi	Brown rust
34.	P Nalathumbi	Wellington	Mix of black, brown and yellow rusts
35.	P.S. Shekhawat	Jaipur	-do-(barley)
36.	Parveen Chhuneja	Ludhiana	Brown and yellow rusts
37.	Rashmi Aggarwal	New Delhi	All rusts
38.	R. Devlash	Kullu	Mix. of barley yellow and brown rusts
39.	R.K. Bansal	Jaipur	Brown and yellow rusts
40.	R.K. Jaiman	Vijapur	Black and brown rusts
41.	Rajbir Singh	Karnal	Mix of brown, black and yellow rusts
42.	Rajendra Prasad	Kanpur	Brown rust
43.	Reetu Bala	Ludhiana	Yellow rust
44.	S.K. Jain	Almora	Mix of yellow and brown rusts
45.	S.K. Rana	Malan Kangra	Mix of brown and yellow rusts
46.	S.N. Sharma	Jaipur	Mix of yellow and brown rusts
47.	S.P. Singh	Faizabad	Mix of black, brown and yellow rusts
48.	S.S. Karawasara	Hisar	Mix of brown and yellow rusts of wheat and barley
49.	S.S. Vaish	Varanasi	Mix of yellow & brown rusts

50.	Satinder Kaur	Ludhiana	Brown rust
51.	R.Selva Kumar	Karnal	Mix of brown and yellow rusts of wheat and barley
52.	T.R. Sharma	Delhi	Brown and black rusts
53.	Vaibhav Singh	New Delhi	All rusts
54.	Vimal Prakash	New Delhi	Mix of yellow and brown rusts
55.	Vinod Kumar	New Delhi	Brown rust
56.	Vishnu Goyal	Karnal	Mix of Brown and yellow rusts of barley

8. Monitoring of wheat and barley rusts

To monitor pathotype situation of wheat and barley rusts effectively, many Researchers have surveyed their areas efficiently and sent a large number of rust collections to Flowerdale. Notably 57 Scientists have contributed in this national endeavour to combat wheat and barley rusts. Our esteemed co-operators are listed in Table15.

Table 15: Details of co-operators for rust collections

S.No.	Name	Place
1.	A.P Agarwal	Raipur
2.	Anand Singh	Hamirpur, H.P.
3.	Arun Kumar	Dharwad
4.	Ashish Kumar	Pusa Bihar
5.	B.C. Game	Nasik
6.	B.K. Das	Trombay
7.	B.K. Honrao	Pune
8.	B.K. Sharma	Una
9.	B.N. Mahto	Nepal
10.	B.N. Singh	Faizabad
11.	D.P. Walia	Shimla
12.	Deep Shikha	Pantnagar
13.	Dhanvir Singh	Sirmaur
14.	Dharmendra Singh	Baru Sahib
15.	Gyanendra Singh	Karnal
16.	H.S. Dhaliwal	Baru Shib
17.	I.K. Kalappanwar	Dharwad
18.	I.S Solanki	Pusa,Bihar
19.	Indu Sharma	Karnal
20.	J. Kumar	Wellington
21.	J.B. Khan	Kanpur
22.	J.P. Tandan	Dharwad
23.	K.K. Mishra	Powarkheda
24.	M. Prashar	Indore
25.	M.A. Khan	Srinagar
26.	M.K. Pandey	Jammu
27.	Madhumitta Jindal	Ludhiana
28.	N. Kulshrestha	Karnal
29.	Nitin chawala	Jaipur
30.	P.K. Malakar	Bangladesh
31.	P.S. Shekhawat	Jaipur
32.	Pankaj Sood	Mandi
33.	Pradeep Shekhwat	Jaipur
34.	R. Davlash	Kullu
35.	R.K. Bansal	Jaipur
36.	R.S. Shukla	Jabalpur
37.	S. Pradhan	Nepal
38.	S. Saharan	Yamunanagar
39.	S.A. Desai	Dharwad
40.	S.C. Mishra	Pune
41.	S.K. Jain	Almora
42.	S.K. Rana	Kangra
43.	S.K. Singh	Karnal
44.	S.P. Singh	Faizabad
45.	S.S. Karwasra	Hisar
46.	S.S. Vaish	Varanasi
47.	S.V. Kulkarni	Dharwad
48.	Sarala Sharma	Nepal
49.	Sonam	Bhutan
50.	Subhashish Sarkhel	Sabour
51.	Sunita	Cooch Bihar
52.	T.L Prakasha	Indore
53.	T.R. Sharma	Mandi
54.	V.M. Khade	Pune
55.	Vaibhav Singh	Delhi
56.	Vishal Gupta	Jammu
57.	Zahoor Ahmed Bhatt	Anantnag

9. Wheat disease monitoring nurseries

To monitor the occurrence of different diseases of wheat in SAARC countries during 2013-14, wheat disease monitoring nursery was planted at 28 locations across the six SAARC countries viz. Afghanistan, Bangladesh, Bhutan, India, Nepal and Pakistan. Data from Pakistan, Bhutan and Afghanistan are awaited. Wheat disease monitoring nursery was also planted at 70 locations in strategic areas in India. The areas bordering to neighboring countries, hotspot locations and main wheat belt areas have been taken care of. Except that wheat rusts appeared almost one month late, there was not much change in wheat disease situation Vis a Vis preceding year.

To study the survival of wheat rusts in off season, staggered sowing of different entries of wheat disease nursery is being done at Bajaura, Malan, Shimla and Kangra.

10. Visitors and news

i. Visitors

1. Dr. Indu Sharma, Project Director, D.W.R., Karnal visited this centre on January 2 and May 17, 2014.
2. Sh. Arun Khajuria, pursuing post graduate in plant pathology at J&K University of Agriculture Science and Technology was at station from Feb.10-14, 2014 to get hands on experience on wheat rust research.
3. Dr. B. Pokhrael, NARC, Kathmandu, Nepal, Dr. Reshma Sultana, Bangladesh Agriculture Research Institute, Gazipur, Bangladesh and Dr. Yadunath Bajgai, Research and Development Centre, Bajo Wangdue Phodrang Bhutan were at station on 21.5.2014.
4. Dr. H.S. Bariana, PBI, Cobbitty, Australia was at Flowerdale on May 30,2014.
5. Dr.Y.S. Ahlawat, Principal Scientist (Retd.) IARI, New Delhi, visited this centre on 27.6.2014.

ii. Award:

Dr. Hanif Khan, Scientist has been awarded Endeavour Fellowship by Govt., of Australia for six months. He was relieved on June,13, 2014 to join Plant Breeding Institute, Cobbitty, Australia.

iii. News

a. Two Research Fellows, Ms Hemlata Verma and Kiran Sharma joined as J.R.F. under DBT projects from January, 2014.
b. Sh. Roop Ram, has been promoted as P.A. w.e.f. 23.1.2014.
c. Dr. Subodh Kumar, has been promoted as Sr. Technical Officer w.e.f. 22.07.2011.
d. Sh. Baldev Singh, and Sh. Udey Singh have been promoted as Sr. Technical Assistants w.e.f. 11.11.2013 and 18.11.2013, respectively.

11. Annexure I: Constitution of differential sets 0, A and B for the binomial designation of pathotypes of brown, black and yellow rusts

Brown rust (*Puccinia triticina*)

Set-0	Set-A	Set- B
IWP 94	*Lr*14a	Loros (*Lr*2c)
Kharchia Mutant	*Lr*24	Webster (*Lr*2a)
Raj 3765	*Lr*18	Democrat (*Lr*3)
PBW 343	*Lr*13	Thew (*Lr*20)
UP 2338	*Lr*17	Malakoff(*Lr*1)
K 8804	*Lr*15	Benno (*Lr*26)
Raj 1555	*Lr*10	HP 1633 (*Lr*9+)
HD 2189	*Lr*19	
Agra Local	*Lr*28	
Black rust (*Puccinia graminis tritici*)		
*Sr*24	*Sr*13	Marquis (*Sr*7b+)
NI 5439	*Sr*9b	Einkorn (*Sr*21)
Sr25	*Sr*11	Kota (*Sr*28+)
DWR 195	*Sr*28	Reliance (*Sr*5+)
HD 2189	*Sr*8b	Charter (*Sr*11+)
Lok 1	*Sr*9e	Khapli (*Sr*7a,*Sr*13, *Sr*14)
HI 1077	*Sr*30	Tc*6/*Sr31*/*Lr26* (*Yr*9)
Barley Local	*Sr*37	
Agra Local		
Yellow rust (*Puccinia striiformis*)		
WH147	Chinese 166 (*Yr*1)	Hybrid 46 (*Yr*4)
Bilara	Lee (*Yr*7)	Heines VII (*Yr*2+)
WH416	Heines Kolben(*Yr*6)	Compair (*Yr*8)
HD2329	Vilmorin 23(*Yr*3)	*T.spelta album* (*Yr*5)
HD2667	Moro (*Yr*10)	Tc*6/*Lr*26 (*Yr*9)
PBW343	Strubes Dickkopf	Sonalika (*Yr*2+)
HS240	Suwon92 X Omar	Kalyansona *Yr*2(KS)
Anza	Riebesel47/51(*Yr*9+)	
A-9-30-1		

Binomial designations are based on the binomial values arrived at on Set A and B whereas - indicates the number of susceptible line in O set. Some of the genes show temperature sensitivity like those on *Lr*2 locus, *Lr*10, *Lr*17, *Lr*18 ; *Sr*13 etc.