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Adult Plant Resistance in Selected Indian Wheat Cultivars and Postulation of Yellow Rust Resistance Genes

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Abstract: ***Wheat varieties were screened against different pathotypes of Puccinia striiformis for yellow rust resistance both at seedling in optimum temperature under controlled green house as well as adult plant stage under field conditions. By applying the gene matching technique, different combinations of yellow rust resistance genes, viz. Yr 2, Yr9, and Yr18 were characterized. Promising adult plant resistance was observed on the varieties during cropping season 2014 - 15 and 2015 - 16.***

Keywords: Puccinia striiformis, resistance, wheat, yellow rust

1. Introduction

Rusts in wheat are worldwide distributed and are known historically for causing rust infections in this crop. Wheat yellow rust is the most destructive rust and is caused by the fungal pathogen *Puccinia Striiformis Westend. F. sp. tritici Eriks.* & Henn. It causes serious losses in all wheat growing areas of the world. The ability of the fungus to mutate, multiply rapidly and spread over large areas has led to widespread epiphytotics in India. Among the different methods of disease control, host resistance is the most economic and environmental friendly method of reducing yield losses caused by brown rust in wheat. Resistance that contains catalogued yellow rust genes is quite useful for managing yellow rust of wheat (Bhardwaj et al., 2010).

Approximately 100 years ago, the wheat cultivars Malakoff and Webster were submitted to genetic studies of leaf rust resistance. *Yr* genes is quite useful for managing yellow rust of wheat. However, a shift in virulence and emergence of new pathotypes may render the resistance *Yr* genes susceptible, due to their race specific nature (McIntosh et al., 1998). The most important and widely used yellow rust resistance gene *Yr*9, became susceptible in India in 1996 by the emergence of new pathotypes 46S119 and in 2001 emergence of the other new yellow rust pathotype 78S84 having additional virulence on *Yr*27 rendered the most popular wheat cultivars PBW343 susceptible (Prasher et al., 2007).

2. Material and Methods

Wheat material used in the study

The seedling and adult plant of seventy - nine wheat varieties with susceptible checks were evaluated for resistance to different pathotypes of *Puccinia triticina* during 2014 - 15, 2015 - 16 at IIWBR, Regional Station, Flowerdale, Shimla.

Table 1: Wheat material used in the experiment

S. No.	Variety	S. No.	Variety	S. No.	Variety	S. No.	Variety
1.	A - 8	21.	HD1941	41.	Narmada 195	61.	Raj821
2.	A28	22.	HD1981	42.	Nephad14	62.	RATAN
3.	A90	23.	HD2177	43.	NIAW301	63.	Ridley
4.	Ajanta	24.	HP1493	44.	NP114	64.	RW346
5.	AKW1071	25.	HW1095	45.	NP404	65.	Sharbati Sonora
6.	Arpana	26.	HW2045	46.	NP770	66.	Sidhi
7.	Bivsage HUW2	27.	HW517	47.	NP771	67.	SKAML - 1
8.	Bivsage HUW3	28.	HYB65	48.	NP775	68.	SONAK
9.	C281	29.	IC296433	49.	NP799	69.	TAWA207
10.	C285	30.	J24	50.	NP830	70.	TODIA GENE POOL
11.	C286	31.	JNKUW184	51.	PBW142	71.	UAS304
12.	C518	32.	JOB984	52.	PBW51	72.	UP215
13.	Chotti lerma	33.	JW3020	53.	PBW12	73.	UP2526
14.	Durga pura65	34.	K8424	54.	PBW154	74.	UP2572
15.	DWR 137	35.	KSML3	55.	P360864	75.	UP368
16.	DWR16	36.	Kudrat09	56.	PV18	76.	Utkalika
17.	GW18	37.	MACS6273	57.	Raj114	77.	WG377
18.	GW40	38.	MP1142	58.	Raj4120	78.	WH542
19.	GW89	39.	N59	59.	Raj4125	79.	WH533
20.	HD1925	40.	Naphal	60.	Raj6560		

Pathotypes Selected

For this study, pathotypes were used for the seedling evaluation while mixture of four pathotypes i.e. was used to evaluate for adult plant resistance in the field. Pathotypes selected for the study are 78S84, 46S119, 110S119, 110S247 and K, 38.

Growing and Inoculation

The seedlings were grown in breadpans (29 cm long, 12 cm wide and 7 cm deep) or aluminum trays using loam soil containing 5g NPK (12: 32: 16) mixture. Inoculation was done using a lancet needle. Inoculated plants were sprayed with a thin mist of water and place dove rnight in dew chambers at 20±2°C temp, 100%relative humidity and 12 h daylight. The plants were then transferred to greenhouse benches and kept at 16±2°Cin relative humidity of 40 - 60%, and illuminated at about 15, 000 lux for 12 h. Infection types (resistant or susceptible) on the test lines were recorded 14 days after inoculation following modified method of Stakman et al. (1962) with modifications (Bhardwaj et al., 2010).

Infection types were characterized as 0 = no visible infection; 0; = small hypersensitive flecks, 1 = minute uredia, surrounded by necrotic areas, 2 = small to medium uredia surrounded by chlorotic area, 3 = uredia small to medium in size and chlorotic areas may be present, 3+ = uredia large with or without chlorosis, profusely sporulating and rings formed. Infection type 33+ is classified when both 3 and 3+ pustules occur together. The experiment was performed twice Characterization of *Yr* genes. The existence of brown rust resistance genes in wheat varieties can be assumed by applying the gene matching technique using multipathotype data (Browder, 1973).

Characterization of *Yr* gene's

Table 2: Gene postulation of brown rust (*Puccinia Striiformis*)

Gene's	No. of Varieties	Varieties/Cultivars
9+	3	BIVSAGE HUW 2, BIVSAGE HUW 3, DWR16
2+	32	AKAW1071, ARBA, CHHOTO LERMA, DURGAPURA65, GW18, GW40, HD1941, HD1981, HP1493, HW1095, HW517, IC296433, JOB984, K8424, KSML3, NIAW301, NP770, PBW12, PBW51, PBW142, PBW154, RATAN, RIDLEY, RW346, SARBATI SONARA, SIDHI2010, SKAML - 1, SONAK, TAWA207, TODIA GENE POOL, UP215, UP2526
A+	6	C281, HW2045, MACS6273, NARNADA195, NEPHOD14, NP114
2+A+	5	GW89, HD2177, J24, PI360864, RAJ821
Total	46	

Inoculation

Infector rows infected with a mixture of *Puccinia Striiformis* at 3 - 4 leaf stage in last week of December each year. These rust spores were mixed in water with the help of few drops of tween - 20and sprayed on infector rows through hand sprayer. Immediately, the leaf canopy was saturated with fine mist of water and maintained till evening.

Disease rating

Disease ratings were measured at weekly intervals. The observation was recorded immediately after first appearance of the symptoms of the disease in the experimental plots. Yellow rust severity was recorded as per cent of infection randomly from individual lines in all the replications according to the modified Cobb's scale given by Peterson et al. (1948). The infection types at adult plant stage were categorized as resistant (R), moderately resistant (MR), moderately susceptible (MS) and susceptible (S). For quantifying the adult plant resistance, the area under disease progress curve was calculated for the varieties by using the formula given by Wilcoxson et al. (1975) and coefficient of disease level was calculated following Loegering (1969).

3. Results and Discussion

Seedling plant resistance and *Yr* genes characterized

Seventy - nine wheat varieties and old cultivars with some isogenic yellow rust resistance gene were screened with six pathotypes (Pts.) of yellow rust pathogen. Wheat varieties HW2045, RAJ4120, RAJ4125 and SONAK were expressed resistance to all pathotypes tested. Wheat varieties JNKUW184 and Raj6560 expressed immense resistance to all pathotypes tested whereas cultivars C286 and C518 were moderately resistant. Wheat cultivars AJANTA, NAPHAL, NP404 and DWR137 showed susceptibility to all pathotypes tested while HI1925, HP1493, N59, RW346, SARBATI SONARA, TAWA207, WG377 and UTKALIKA were also susceptible to all pts. Except one or two pathotypes. Yellow rust resistant gene *Yr2*, *Yr9* and *YrA* were postulated through infection types matrices by gene matching technique using multipathotype data (Browder, 1973).

Important rust resistance gene *Yr9* was postulated through susceptibility to the pathotypes 78S84, 46S119, 110S119, 110S84, 110S247 and 238S119 which are virulent on *Yr9*, resistant to other pathotypes and also confirmed by linkage with *Lr26/Sr31*. *Yr2* is postulated through infection type matrices. It is susceptible to all except pts.31 and 38A. *YrA* gene is resistant to pts.78S84 and 110S84 while susceptible to others. Three yellow rust resistant genes *Yr2*, *Yr9* and *YrA* were postulated singly or in combination with other genes. Yellow rust resistance gene *Yr*9 was postulated in three varieties BIVSAGE HUW 2, BIVSAGE HUW 3 and DWR 16. *Yr*2 a common yellow rust resistance gene present in Indian wheat materials, was postulated in 32 varieties. *YrA*, a yellow rust resistance gene identified from Avocet variety, were postulated in six varieties namely C281, HW2045, MACS6273, NARNADA195, NEPHOD14 and NP114. The combination of two genes *Yr2* and *YrA* were postulated in five varieties namely GW89, HD2177, J24, PI360864 and RAJ821.

Adult Plant Resistance

The adult plant resistance experiment with pathotype 110S84

In the first week of disease observations on 9th February, average yellow rust severity of three replications ranged from 0.0 to 16.66 percent. The maximum yellow rust severity was observed on the varieties N59 (16.66 percent)

and UP368 (13.33 percent) followed by RAJ114 (10 percent). More than 5 percent infection also observed on the varieties IC296433, JW3020, K8424, KUDRAT09, MP1142, NAPHAL, NEPHAD4, NP404, PV18, RAJ4125, RAJ 6560, SARBATI SONARA, UTKALIKA WH912 and WL1562 whereas most of the other varieties were free from disease.

In the second week of disease observations on 16th February, average yellow rust severity of three replications ranged from 0.0 to 43.33 percent. The maximum yellow rust severity was observed on the varieties N59 (43.33 percent) and UP368 (36.66 percent) followed by JW3020 and UTKALIKA (26.66 percent). More than 15 percent infection observed on the varieties KUDRAT 09, MP1142, NEPHAD4, SIDHI2010, SARBATI SONARA and UP2572. Lower infection type o to trace observed on the varieties A8, A28, C285, C286, C218, CHHOTO LERMA, DURGAPURA65, DWR16, GW18, GW89, HD1925, HD1981, HD2177, HW1095, JNKUW184, KSML3, NARMADA195, NP770, NP771, NP775, NP799, PBW142, PBW12, RATAN and TODIA GENE POOL.

By the end of the third week of disease observations on 23rd February, average yellow rust severity of three replications ranged from 0.0 to 63.33 percent. The maximum yellow rust severity was observed on the varieties UP368 (63.33 percent), N59 and UTKALIKA (60 percent) followed by MP1142, NP404 and RAJ114 (56.66 percent). More than 40 percent infection was recorded on the varieties IC296433, JW3020, KUDRAT 09, PI360864, PV18, RAJ6560 SIDHI2010, SARBATI SONARA and UP2572 whereas varieties ARBA, DWR137, HD1941, NEPHAD4 and WL1562 were recorded more than 30 percent infection. Lower infection type zero to 5MR were observed on the varieties A28, C218, GW89, HD2177, JNKUW184, KSML3, NP770, NP771, PBW142, RAJ821, RATAN and TODIA GENE POOL.

By the end of the fourth week of disease observations on 2nd March, average yellow rust severity of three replications ranged from 0.0 to 83.33 percent. The maximum yellow rust severity was observed on the varieties UP368, N59, NP404 and UTKALIKA (83.33 percent), followed by MP1142 (80 percent) and RAJ114 (76.66 percent). More than 50 percent infection was recorded on the varieties ARBA, DWR137, IC296433, J24, NEPHAL, NEPHAD4, JW3020, KUDRAT 09, PI360864, PV18, RAJ6560 SIDHI2010, SARBATI SONARA, UP2572 and WL1562. Lower infection type zero to 10MR were observed on the varieties A28, C218, HD2177, JNKUW184, KSML3, NP770, NP771, PBW142, RAJ821 and TODIA GENE POOL.

At the end of the fifth week of disease observations on 9th March, average yellow rust severity of three replications ranged from 0.0 to 100 percent. The maximum yellow rust severity was observed on the varieties NP404 and UTKALIKA (100 percent) followed by N59 (96.66 percent) and RAJ114 (93.33 percent). Higher severities more than 80 percent infection were recorded on the varieties ARBA, IC296433, J24, JW3020, KUDRAT 09, MP1142, PI360864, PV18, SIDHI2010, SARBATI SONARA, UP368 and UP2572 WL1562. Lower severities with promising yellow rust resistance were (zero to 20MR) were recorded on the varieties A28, C218, HD2177, JNKUW184, KSML3, NP770, NP771, PBW142, RAJ821 and TODIA GENE POOL.

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