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Variability and Associations Among Components of Slow Rusting to Leaf Rust in Wheat

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ABSTRACT

It may never been possible to prove the effectiveness of any type of resistance to all races of the pathogen, there are reports that slow rust resistance is long lasting. Experiments were conducted for two seasons during 1998-99 and 1999-2000 with leaf rust pathotype 77-5 (*Puccinia recondita* f.sp. *tritici*) at Indian Agricultural Research Institute, New Delhi to study slow rusting of six leaf rust resistant varieties. Wheat variety Agra Local was used as susceptible check. The rust resistant varieties showed highly significant phenotypic variability for each component of slow leaf rusting (latency period, uredial size and uredial number) at adult stage of plant growth under glasshouse and area under disease progress curve in field conditions. All the varieties expressed long latent period, small uredial size and uredial number than the fast ruster, Agra Local. All the varieties also showed less AUDPC values compared to Agra Local. Positive correlation between uredial size and uredial number and negative correlations between latency period and uredial size, and latency period and uredial number suggested that the components of slow rusting resistance were either tightly linked or under pleiotropic gene control. AUDPC was negatively associated with latency period and positively with uredial size and number. So both the components of slow rusting as well as AUDPC can be used suitably as selection criteria in breeding programmes aimed at resistance to leaf rust. Kundan, Galvez-87 and Trap showed stable and high degree of slow rusting resistance as compared to the fast ruster, Agra Local in both the seasons and can serve as slow rust resistance donors in wheat breeding programmes.

Key words : AUDPC, Latency Period, Slow Leaf Rusting, Uredial Number, Uredial Size.

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Leaf rust caused by the pathogen *Puccinia recondita* Rob. ex Desm. f. sp. *tritici* (Ericks. & E. Henn) is worldwide a major problem of wheat. The vertical resistance has been extensively used to overcome the disease but the short-lived nature of race specific hypersensitive resistance has created the necessity to search for the more durable type of resistance. Some varieties have the ability to retard rust development even though they have a susceptible reaction type (Caldwell *et al*., 1970) known as the slow rusting. The special features of the slow rust resistance are depressed epiphytotic development despite the ultimate expression of a high infection type, long latency period, decreased uredial number, smaller uredial size and reduced sporulation (Kulkarni *et al*., 1981and Shaner *et al*., 1978).

The present study was undertaken to understand the variation and association among the components of slow rust resistance and with the field response as area under disease progress curve (AUDPC).

MATERIAL AND METHODS

The field experiment was conducted during the crop seasons of 1998-99 and 1999-2000 at Indian Agricultural Research Institute (IARI), New Delhi, India. Six genotypes were selected on the basis of slow rusting to wheat leaf rust. They were evaluated for components of partial resistance to leaf rust both in the glasshouse and field conditions. The pathotype used for these experiments was 77-5 of *Puccinia recondita* f. sp. *tritic*i. The avirulence/ virulence formula for this pathotype is as follows:

Lr9, Lr18, Lr19, Lr 22a,Lr24, Lr 25, Lr28, Lr29, Lr32, Lr 34, Lr 48, Lr 49 / Lr1, Lr2a, Lr3, Lr10, Lr11, Lr12, Lr13, Lr14a, Lr15, Lr16, Lr17, Lr20, Lr23, Lr26, Lr27+31, Lr33

Glasshouse studies:

The genotypes were tested in glasshouse at seedling stage during 1998-99 and 1999-2000. Seedlings of the parents were raised in 10 cm pots and 10-12 seeds were sown in each pot. Four replications of each variety were maintained. The 8-10 days old seedlings were inoculated with pathotype 77-5 of *Puccinia recondita* by spraying a suspension of freshly collected spores in one per cent Tween-20 (two drops in 100 ml distilled water) used as surfactants. The pots were then kept in humid chambers for 48 hours and then transferred to glasshouse benches. Infection types were

Table 1. Wheat entries with their seedling and adult plant reactions when tested with *Puccinia recondita* f. sp. *tritici* pathotype 77-5 during 1998-99 and 1999-2000

Variety	Reaction at seedling		Field Response	
	1998-99	1999-2000	1998-99	1999-2000
Kundan	3+	3+	30S	30S
Galvez-87	3	3+	30S	40S
Trap	3	3	30S	30S
Mango	3+	3	40S	40S
Chris	3	3+	40S	50S
PBW-438	3+	3+	40S	50S
Agra Local	4	4	90S	80S

Table 2. Mean response of the seven entries included in the present investigation during the 1998-99 and 1999-2000 for the components of slow rusting and AUDPC to *Puccinia recondita* f. sp. *tritici* pathotype 77-5

Variety	Glasshouse						Field	
	LP*		USi*		UNo*		AUDPC	
	98-99	99-00	98-99	99-00	98-99	99-00	98-99	99-00
Kundan	20.89[a]	21.70[a]	0.166[a]	0.134[a]	10.75[a]	10.25[a]	218.5[a]	217.0[a]
Galvez-87	19.68[a]	21.17[a]	0.168[a]	0.159[a]	13.75[b]	13.20[c]	380.0[b]	364.0[ab]
Trap	20.65[a]	21.44[a]	0.178[a]	0.149[a]	14.00[b]	11.75[b]	345.0[b]	349.0[ab]
Mango	16.73[b]	17.94[b]	0.213[a]	0.210[a]	18.73[c]	17.60[d]	434.4[bc]	412.0[b]
Chris	16.37[b]	16.88[b]	0.212[a]	0.195[a]	21.52[d]	18.55[d]	501.0[cd]	504.0[b]
PBW-348	16.75[b]	16.18[b]	0.213[a]	0.208[a]	25.50[e]	21.03[e]	570.5[d]	737.0[c]
Agra Local	9.85[c]	11.60[c]	0.274[b]	0.396[b]	36.40[f]	34.10[f]	1455.0[c]	1300.0[d]
CD at 5%	2.18	2.52	0.047	0.047	1.67	1.32	97.2	163.6

[+] LP: Latency period; USi: Uredial Size; UNo: Uredial Number
[a], [b], [c], [d], [e], [f] are the ranking of the entries based on DMRT

recorded after 12 days of inoculation following the scale proposed by Stakman *et al*. (1962).

The genotypes were also sown in 30 cm pots. Each genotype was sown in 4 replications in a randomized complete block design. Thinning was done to achieve four tillers per genotype per replication. When the plants were at flag leaf stage, they were inoculated with a suspension of freshly harvested urediospores in one per cent Tween-20. The suspension had 20 urediospores per microscopic field (10x X 10x) on an average. Each flag leaf was sprayed uniformly with urediospores. The plants were then transferred to moist chamber for 48 hours. At the end of incubation period, the pots were transferred to glasshouse benches.

Flag leaves were individually evaluated for latency period, uredial size and uredial number. Latency period and uredial size were calculated by using the formula given by Das *et al*. (1993) and Kochman and Brown (1975), respectively. Uredial number as the number of uredia per unit area was counted.

Field studies:

The genotypes tested in glasshouse were also planted in the field during 1998-99 and 1999-

Table 3. Analysis of variance for components of slow rusting and area under disease progress curve (AUDPC) for entries tested during 1998-99 and 1999-2000

Source of variation	df	Mean squares in glasshouse			Field
		LP*	USi*	UNo*	AUDPC
1998-99					
Replication	3	1.949	0.000	0.152	27291.631
Variety	6	315.522**	0.008**	72.732**	677007.717**
Error	18	3.317	0.000	1.271	4283.749
1999-2000					
Replication	3	5.961	0.000	0.781	11317.310
Variety	6	260.632**	0.028**	53.989**	536239.619**
Error	18	2.868	0.000	0.793	12125.643

+ LP: Latency period; USi: Uredial Size; UNo: Uredial Number

Table 4. Correlation coefficients based on means between various components of slow rusting and AUDPC for the entries in crop seasons, 1998-99 (above diagonal) and 1999-2000 (below diagonal)

	LP+	USi+	UNo+	AUDPC
LP+		-0.986	-0.967	-0.950
USi+	-0.934		0.970	0.925
UNo+	-0.981	0.980		0.939
AUDPC	-0.941	0.963	0.981	

+ LP: Latency period; USi: Uredial Size; UNo: Uredial Number

2000 *rabi* seasons in a four replicate, randomized complete block design to compare the glasshouse observations with the field response where disease increase is multicyclical. Plot consisted of two rows 3m seeded 10 cm apart with 18 cm between rows and 30 cm between the plots. Spreader composed of Agra Local, Kharchia Local and Lal Bahadur were planted all around the experimental block and between the beds. It was also planted between the plots as every 10th entry. The spreader rows were inoculated with pathotype 77-5 after 45-50 days of sowing, so that the proper disease spread could occur. Upon the appearance of the 50% symptoms on the spreader plants, the genotypes were evaluated for rust severity and reaction using the "Modified Cobb's" scale (Peterson *et al*., 1948) at weekly intervals for a total of three recordings. The area under the disease progress curve (AUDPC) was calculated from the disease observations using computer programme developed at CIMMYT.

RESULTS AND DISCUSSION

The seedlings of test entries (Table 1) showed high infection types (ITs "3" - "4") based on "0-4" scale described by Stakman *et al*. (1962). In field at adult plant stage, Agra Local (AL) showed high susceptible response but the remaining entries though susceptible but not in the same intensity as

Agra Local for two years 1998-99 and 1999-2000 which shows the slow rusting of the varieties to leaf rust.

The data on components of slow rusting over the two years suggested that the fast rusting cultivar, Agra Local has shortest latency period, larger pustule size and highest pustule number (Table 2) whereas, all other entries viz., Kundan (K), Galvez-87 (G), Trap (T), Mango (M), Chris (C) and PBW-348 (P) showed significantly lesser values in comparison to Agra Local for pustule size, pustule number and higher values for latency period. Among these entries, Kundan exhibited the smallest pustule size (0.134 and 0.166), least number of pustules (10.25 and 10.75) with longest latency period (21.70 and 20.89) during the crop seasons 1998-99 and 1999-2000.

Analysis of variance for the components of slow rusting *i.e*., pustule number, pustule size and latent period and for AUDPC showed significant variation in the entries as the mean squares due to varieties were highly significant (Table 3) for the two years.

The major components of slow rusting studied at the adult plant stage in the glasshouse and AUDPC in the field on six cultivars were subjected to correlation studies to know the extent of relationship between the components of slow rusting and the AUDPC. Correlation coefficients between the components of partial resistance and AUDPC in parents were significantly high (Table 4). Latency period was negatively correlated with the pustule size and pustule number and AUDPC, whereas, pustule size was positively associated with the pustule number and AUDPC. Pustule number was also positively correlated with the AUDPC. The highest correlation with AUDPC was recorded by latency period (-0.950) followed by uredial number (0.939) and pustule size (0.925) during 1998-99 and uredial number (0.981), uredial size (0.963) and latency period (-0.941) during 1999-2000.

The cultivars, Kundan, Galvez-87 and Trap showed significant values over the other parents for the components under study and they are very consistent over the years. The consistent expression of disease severity as AUDPC and slow rusting components over the years in all the varieties suggested that AUDPC and slow rusting components could be used as the most reliable direct parameters for measuring slow rusting resistance as also reported by Singh *et al*. (1991) and Prabhu *et al*. (1993).

As slow rusting components and AUDPC express consistently over the years, they can be used as the direct parameters in selecting slow rusting wheat varieties for leaf rust.

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