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Inheritance of leaf rust resistance in wheat

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Abstract

Six genetic population *viz.*, P_1, P_2, F_1, F_2, B_1 and B_2 of eight crosses involving nine parents were evaluated to estimate the nature and magnitude of gene action for the inheritance of resistance to leaf rust, *Puccinia recondita* Rob. Ex. Desm. f. sp. *tritici*, during *Rabi* 2004-05. The results on gene action and mean analysis showed that all the three types of gene actions *i.e.* additive, dominance and epistatic were responsible in varying proportions for all the crosses. Among the epistatic interaction, dominance x dominance was more important followed by additive x dominance effect. The magnitude of dominance component was higher than additive component. It was suggested that reciprocal recurrent selection or mass selection with recurrent random mating might be most efficient for utilization of all three types of gene effects for the development of high leaf rust resistance genotypes of wheat.

Key words : Inheritance, bread wheat, leaf rust

Introduction

Among the various diseases of wheat, rusts cause maximum damage and leaf / brown rust is the most serious disease in the Indian subcontinent. The development of wheat varieties completely resistant to brown rust does not seem to play a very important role in the long run because of the appearance of new races of the pathogen causing this rust. An understanding of the mode of inheritance of complex quantitative characters is essential for formulation of any effective selection procedure for improvement of a particular trait. The estimates of gene effects help in understanding the genetic potentiality of the population. The present investigation was undertaken to study the gene effects and devising a suitable breeding methodology for the development of rust resistant varieties.

Material and methods

Nine wheat crosses obtained by crossing each of the lines/varieties *viz.*, MACS 6158, GW 344, GW 361, GW 322, CMH 83.2578, CMH 84.3379, HW 3026, GW 353 and Agra Local (AL) comprised the basic parental material. In each of these eight crosses, the parental, F_1, B_1, B_2 and F_2 generations were grown in a compact family block design with three replications during *rabi* 2004-05. The eight crosses formed the family block, whereas, six generations of each cross represented individual plot within family. A single replication comprised two rows each of the parents, F_1, B_1 and B_2 and four rows each of the F_2 generations. These were 20 plants in a row. The experiment was sown keeping a distance of 25 cm between rows and 10 cm within rows. Each plot and complete experimental block was surrounded with infector rows of variety Lal Bahadur to provide maximum inoculum pressure on the every test varieties. The infector rows were inoculated with a mixture of races *viz.*, 1R5, 109R31-1, 121R63-1 and 21R55. These races were widely prevalent in susceptible wheat varieties.

Observations on resistant / susceptible plants were recorded as per modified Cobb's scale by Peterson *et al.* (1). On the basis of total plants observed, the per cent resistance to leaf rust of wheat was worked out as Resistance to leaf rust = No. of resistant plants/ Total no. of plants observed x 100. Statistical analysis was performed as per Panse and Sukhatme (2) and generation mean analysis suggested by

Table 1. Mean values of per cent resistance to leaf rust in six generations in eight crosses of wheat *

	Cross	P_1	P_2	F_1	F_2	B_1	B_2	S.Em.±	CD (P=0.05)	CV (%)
I	MACS 6158 x Agra Local	81.72 (97.43)	4.05 (0.00)	76.54 (94.10)	58.04 (71.25)	75.76 (92.17)	40.87 (42.30)	2.48	7.82	7.66
II	GW 344 x Agra Local	85.91 (100.00)	4.05 (0.00)	85.91 (100.00)	58.48 (71.88)	85.91 (100.00)	47.57 (53.98)	1.76	5.55	4.97
III	GW 361 x Agra Local	81.82 (97.50)	4.05 (0.00)	81.54 (97.30)	37.12 (36.40)	81.82 (97.50)	43.54 (46.99)	3.13	9.87	9.86
IV	GW 322 x Agra Local	77.60 (94.73)	4.05 (0)	81.43 (97.15)	30.11 (24.81)	67.47 (84.59)	33.21 (30.00)	2.56	8.07	9.06
V	CMH 83.2578 x Agra Local	85.91 (100.00)	4.05 (0.00)	85.91 (100.00)	62.04 (77.32)	85.91 (100.00)	47.26 (53.24)	3.16	9.95	8.84
VI	CMH 84.3379 x Agra Local	85.91 (100.00)	4.05 (0.00)	85.91 (100.00)	53.42 (63.47)	74.79 (92.50)	42.21 (45.00)	3.69	11..62	11.07
VII	HW 3026 x Agra Local	85.91 (100.00)	4.05 (0.00)	81.82 (97.50)	61.21 (76.27)	85.91 (100.00)	46.71 (52.50)	1.33	4.19	3.78
VIII	GW 353 x Agra Local	85.91 (100.00)	4.05 (0.00)	77.75 (94.41)	60.80 (75.45)	85.91 (100.00)	43.82 (47.50)	2.65	8.36	7.70

* Figures in parentheses are retransformed values (Angular transformation)

Table 2. Estimates of scaling tests and gene effects for resistance to leaf rust in eight crosses of wheat

	Cross	Gene effects												
		Scaling test				Six parameter model						Three parameter model		
		A	B	C	D	m	d	h	i	j	l	m	d	h
I	MACS 6158 x Agra	-6.74	1.14	-6.72	-0.56	–	–	–	–	–	–	41.78*	38.84**	30.26
	Local	±11.29	±9.38	±12.53	±9.49							±19.02	±1.21	±50.01
II	GW 344 x	–	5.18	-27.87*	-16.53*	58.48**	38.34**	73.99**	33.06**	-2.59	-38.24*	–	–	–
	Agra Local		±6.72	±13.64	±7.61	±3.41	±3.36	±1.52	±1.52	±3.36	±19.16			
III	GW 361 x	0.28	1.49	-100.48**	-51.12**	37.12**	38.28**	140.85**	102.24**	-0.60	104.00**	–	–	–
	Agra Local	±5.88	±3.30	±24.93	±12.41	±6.07	±2.58	±24.99	±24.82	±2.84	±26.99			
IV	GW 322 x	-24.09**	-19.06	-124.05**	-40.45**	30.12**	34.26**	121.50**	80.89**	-2.51	-37.74	–	–	–
	Agra Local	±5.90	±9.83	±9.95	±6.61	±1.98	±5.28	±13.56	±13.22	±5.36	±23.37			
V	CMH 83.2578	–	4.56	-13.62**	-9.09	62.04**	38.65**	59.11**	18.18	-2.28	-22.74	–	–	–
	x Agra Local		±15.59	±4.26	±8.08	±1.07	±7.80	±16.17	±16.17	±7.80	±31.48			
VI	CMH 84.3379 x	-22.24**	-5.55	-48.08*	-10.15	53.42**	32.58**	61.23*	20.30	-8.35	7.49			
	Agra Local	±3.30	±12.35	±24.49	±13.81	±6.12	±6.39	±27.62	±27.62	±6.39	±35.40	–	–	–
VII	HW 3026 x	4.09	7.55	-8.76	-10.20**	61.21**	39.20**	57.24**	20.40**	-1.73	-3.20	–	–	–
	Agra Local	±2.36	±5.52	±7.55	±3.86	±1.47	±2.49	±8.07	±7.72	±2.49	±12.51			
VIII	GW 353 x	8.16	5.84	-2.25	-8.12	–	–	–	–	–	–	28.72	40.93	109.29**
	Agra Local	± 4.10	±7.83	±14.71	±6.75							±13.90	± 0.00	±31.79

* and ** indicate significance at 5 and 1 per cent level, respectively

Hayman (3) and Jinks and Jones (4). Scaling test was perform as per Hayman and Mather (5).

Results and discussion

Analysis of variance revealed highly significant differences with respect to the generations indicating that sufficient genetic variability existed in the material under investigation. The mean values of different generations for leaf rust resistance are given in Table 1. The rust intensity in the F_1 was intermediate in most of the crosses than the mid parent value which indicated that the resistance was dominant over susceptibility for these diseases.

The scaling test were significant for all crosses indicates the presence of non-allelic interaction, except cross I and cross VIII which indicates absence of epistasis (Table 2). The estimates of six parameters showed that in the inheritance of resistance to leaf rust of wheat, all three kind of gene effects (additive, dominance and epistasis) were involved (Table 2). The additive gene action was highly significant in cross I (MACS 6158 x AL) and hence, pedigree method of selection could be useful. The results are in agreement with those of Yadav *et. al* (6), Shobhna *et. al* (7) and Navabi *et. al* (8). The additive, dominance and epistasis (additive x additive and dominance x dominance) effects were significant in the cross II (GW 344 x AL) and cross III (GW 361 x AL), whereas, additive, dominance and additive x additive gene action were important in the cross combination IV (GW 322 x AL) and cross VII (HW 3026 x AL). Such crosses could be handled by practicing recurrent selection for resistant plants and by inter-mating of selected individuals in early segregating generations for development of rust resistant pure lines in advanced generations. Pawar *et. al* (9), Dalal and Singh (10) and Singh *et. al* (11) also observed similar results in wheat.

Both additive and dominance types of gene action was significant in the cross combination V (CMH 83.2578 x AL) and cross VI (CMH 84.3379 x AL) with predominant role of non-additive gene action. Under such situation, genetic ability resulting from additive effects can be effectively utilized through selection and hybridization followed by inter-crossing in segregating generations. The results are in accordance with the finding of Chawla *et al* (12), Chand *et. al* (13) and Singh *et. al* (11). The genes for resistance were dominant over the genes conferring susceptibility in case of cross VIII (GW 353 x AL), hence could be theoretically useful in hybrids, although no tangible success of hybrids was achieved in wheat so far. Therefore, in such effects could be fixed through selection. Randhawa *et. al.* (14) noticed similar results in wheat.

Knowledge of genetic of resistance in the host together with information on genetic variability in the pathogen should help the plant breeder and plant pathologist to develop breeding strategies that will yield stable varieties with durable disease resistance.

On the basis of present study, when all the three types of gene action *viz.*, additive, dominance and epistatic played a vital role in the expression of quantitative characters. Biparental mating in early generation followed by reciprocal recurrent selection should be more appropriate to break the gene constitution and so released the free variability for the leaf rust resistance in wheat.

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