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LINE x TESTER ANALYSIS FOR FIELD TOLERANCE AGAINST FOLIAR BLIGHT (*H. SATIVUM*) IN BREADWHEAT

K. M. P. SINGH, M. P. JHA AND B. N. SINGH

Indian Agricultural Research Institute, Regional Station, Pusa
District Samastipur, Bihar

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ABSTRACT

Line x tester analysis of sixty crosses was done with a view to identify the gca and sca effects of five female and twelve male parents in wheat. Percentage of F_2 plants was taken into consideration in all these crosses. RL 6010/5* Ska, a backcross derivative of Sonalika with Lr 9 and Shanghai 4 of Chinese origin were found to be the best general and specific combiners for breeding for resistance to *H. sativum* isolates. The degree of dominance showed dominant genes action and narrow sense heritability to be low.

Key words: Line x tester analysis, foliar blight, combining ability, wheat.

To start with the breeding programme for foliar blight resistance, particularly due to *Helminthosporium*, selection of low-infection type (low percentage of area covered by the disease) can be used in the early generation. Addition of genes for resistance by intercrossing the low-infection types could improve the resistance level over the present level of resistance or tolerance in wheat varieties.

The genetic analysis and combining ability for adult plant resistance becomes relevant particularly because in a number of genetic stocks from CIMMYT, resistance to *H. sativum* appears to be controlled by several genes and the overall behaviour seems to be under multigenic or polygenic control in addition to major genes evident in other genetic stocks of Chinese and Yugoslavian origin. Therefore, line x tester analysis as proposed by Kempthorne [1] was used to know the type of gene action in the materials taken for the present study, in which moderately susceptible to susceptible elite and released wheat varieties were crossed with moderately resistant to resistant lines. Additive and dominance variances were calculated by covariance of half-sib and full-sib methods [2].

MATERIALS AND METHODS

During 1987–88, seventeen wheat strains selected on the basis of previous screening for resistance to *Helminthosporium sativum* were hybridized. Five susceptible to moderately susceptible wheat lines, viz Agra Local, HP 1209, UP 115, NP 852 and RL 6010/5* Sonalika, were each crossed with 12 resistant to moderately resistant wheat stocks used as testers. These were HSN 36, HSN 45, HSN 63, HSN 68, HSN 69, HSN 71, BH 1146/Ald'S', NS 51, Bezostaya, Ning 8201, Shanghai 4 and Suzhoe #8. The F_2 generation was grown in three replications in 1989–90 in field and disease symptoms were recorded at adult stage. The data obtained in these 60 crosses at adult stage were analysed to study the genetics of field tolerance to foliar blight (*H. sativum*) using line x tester analysis.

RESULTS AND DISCUSSION

The number of F_2 plants scored in the 60 crosses, percentages of resistant segregates over three replications and gca effects are given in Table 1. The ANOVA for line x tester (Table 2) shows that although differences amongst them were nonsignificant, their interactions were highly significant.

Among the 5 lines, NP 852 had the highest percentage of resistant plants (57.4%) averaged over the crosses with the twelve tolerant stocks, followed by RL 6010/5*Ska (54.1%). HP 1209 had 53.7% resistant plants (Table 1).

Among the 12 testers, HSN 36 showed maximum number of resistant segregates in F_2 (67.5%), followed by NS 51 and Shanghai 4 with 65.9 and 64.0% resistant plants, respectively (Table 1).

More than 90% resistant plants were found in the cross Agra Local x HSN 36. More than 80% resistant plants were observed in six crosses, viz RL 6010/5* Ska x Shanghai 4 (88.9%), NP 852 x NS 51 (88.5%), Agra Local x NS 51 (87.0%), NP 852 x HSN 36 (86.3%), UP 115 x Shanghai 4 (84.5%), and NP 852 x HSN 63 (80.5%) (Table 1).

A perusal of the data for the lines (Table 1) shows that Agra Local had highest gca effect of 6.47, followed by NP 852 (4.79) and Rl 6010/5*Ska (1.31). Agra Local and NP 852 are tall varieties, while RL 6010/5*Ska (a Sonalika backcross derivative) is semidwarf. HP 1209, a cultivated variety, shows gca effect of only 1.09.

Among the 12 testers, HSN 36 was the best combiner with highest gca effect (14.74), followed by NS 51, HSN 69 and Shanghai 4. HSN 36 has medium height and medium late

Table 1. Mean percentage of resistant plants in F_2 and gca effects of parents in wheat crosses

Line	Testers												Mean	Gca
	NS 51	HSN 36	HSN 45	HSN 63	HSN 68	HSN 69	HSN 71	Bezos-taya	BH 1146/ Ald 'S'	Ning 8201	Shan-ghai 4	Suzhee #8	%	
Agra Local	87.0 (392)	98.5 (382)	50.4 (405)	56.0 (414)	2.3 (430)	5.1 (409)	55.5 (396)	39.3 (414)	27.8 (416)	77.1 (400)	64.9 (411)	54.4 (369)	51.5 (4838)	6.47
HP 1209	71.6 (384)	73.4 (385)	56.7 (395)	38.4 (395)	71.7 (358)	48.7 (379)	53.9 (391)	38.3 (399)	61.8 (346)	55.4 (365)	55.1 (399)	20.0 (380)	53.7 (4576)	1.09
UP 115	54.3 (355)	13.1 (357)	25.3 (411)	23.2 (365)	3.7 (403)	57.4 (373)	64.2 (400)	59.0 (387)	14.6 (383)	51.2 (388)	84.5 (374)	18.2 (405)	39.1 (4601)	– 13.67
NP 852	88.5 (380)	86.3 (414)	53.8 (419)	80.5 (406)	78.8 (323)	55.2 (398)	51.9 (404)	44.8 (328)	15.7 (414)	45.1 (396)	26.5 (391)	61.8 (399)	57.4 (4672)	4.79
RL 6010/5* Sonalika	28.4 (411)	66.1 (356)	65.6 (384)	64.7 (377)	70.3 (372)	61.0 (371)	41.7 (338)	47.5 (341)	37.8 (343)	62.7 (347)	88.9 (353)	14.2 (393)	54.1 (4386)	1.31
Mean %	65.9 (1922)	67.5 (1894)	50.4 (2014)	52.6 (1957)	45.4 (1886)	45.5 (1930)	53.4 (1929)	45.8 (1869)	31.5 (1902)	58.3 (1896)	64.0 (1928)	33.7 (1946)	51.2 (23,073)	
Gca	13.27	14.74	– 2.66	0.03	– 7.28	11.30	0.79	– 6.97	– 21.09	5.36	11.25	– 18.74		

Values in parentheses show the number of F_2 plants scored.

maturity with good tillering. NS 51 and HSN 69 are semidwarf and medium early. The Chinese line Shanghai 4 is also semidwarf and medium early with better grain weight.

The sca effects of the 60 crosses was also computed (Table 3). The top six crosses had positive sca effect more than 25, viz. UP 115 x Shanghai 4 (33.9), HP 1209 x BH 1146/Ald'S' (29.6), NP 852 x HSN 68 (28.3), Agra Local x HSN 69 (27.4), UP 115 x Bezostaya (27.0), and HP 1209 x HSN 68 (25.7).

Table 2. ANOVA for line x tester

Source	d.f.	M.S.	F
Replications	2	59.0	1.26
Treatments	59	1653.6	35.39**
Lines	4	1823.2	1.18
Testers	11	2014.7	1.30
Line x tester	44	1547.9	33.12
Error	118	46.7	

Standard errors for combining ability effects:
Gca for lines = 1.13; gca for tester = 1.77; sca effects = 3.95; (gi-gj) line = 1.61; (gi-gj) tester = 2.50; and (sij-skl) = 5.58.

Treatments:
CD 5% = 10.9, 1% = 14.4.
CV = 13.3%
CD 5% for lines = 3.16, for testers = 4.89.

The gca and sca variances (Table 4) show that the degree of dominance was 18.4, indicating that resistance to *H. sativum* was mainly due to dominant and epistatic interactions. Since the proportion of dominance variance was high and the additive variance

Table 3. Sca effects of the 60 crosses of wheat involving five lines and twelve testers

Tester	Lines				
	Agra Local	HP 1209	UP 115	NP 852	RL 6010/5*Ska
NS 51	14.2	4.5	2.7	17.8	- 39.2
HSN 36	24.6	4.6	- 40.7	14.2	- 2.7
HSN 45	- 6.5	6.0	- 12.3	- 0.8	13.7
HSN 63	- 3.2	- 15.0	- 15.5	23.0	10.7
HSN 68	- 49.7	25.7*	- 28.0	28.3*	23.6
HSN 69	27.4*	- 17.0	7.0	- 13.0	- 4.3
HSN 71	- 4.5	- 0.6	24.3	- 6.3	- 13.0
Bezostaya	- 12.9	- 8.6	27.0*	- 5.9	0.3
BH 1146/Ald'S'	- 10.4	29.6*	- 3.3	- 20.7	4.8
Ning 8201	12.6	- 4.9	6.8	- 17.9	3.4
Shanghai 4	- 5.7	- 10.0	33.9*	- 41.9	23.6
Suzhoe # 8	14.1	- 14.4	- 2.0	23.1	- 20.8

*Positive sca effects more than 25.

was low, obviously narrow sense heritability is expected to be low. Among the proportional contribution of lines to the total variance, the lines x tester crosses accounted for 69.8% of the total variance, followed by testers (22.7%) and lines (7.5%).

Table 4. Gca and sca variances in wheat

Parameter	Value	Parameter	value
Cov. H.S. (lines)	7.6	Degree of dominance	18.39*
Cov H.S. (testers)	31.1	Narrow sense heritability	12.6%
Cov H.S. (average)	0.7	**Proportional contributions of:**	
Cov F.S.	580.1	lines	7.5%
s^2gca with F = 1	0.74	testers	22.7%
σ^2 A	2.96	lines x testers	69.8%
σ^2sca	500.38		

*Dominant gene, epistatic interaction.

It is thus evident that out of the 12 donors Shanghai 4 was the best general and specific combiner, being highly resistant to the *H. sativum*. UP 115 is a released cultivar for late sown irrigated condition. The back-cross derivative of Sonalika (RL 6010/5*Ska) is also a rust resistant released variety. Since percentage of resistant segregates in the two crosses, UP 115 x Shangai 4 and RL 6010/5*Ska x Shanghai 4, was 84.5 and 88.9, respectively, these two crosses should be used for further work to achieve maximum gains in resistance breeding.

REFERENCES

1. O. Kempthorne. 1957. An Introduction to Genetical Statistics. John Wiley and Sons, Inc., New York, USA.

2. R. K. Singh and B. D. Chaudhary. 1977. Biometrical Methods in Quantitative Genetic Analysis. Kalyani Publishers, New Delhi.