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Combining ability and gene action for Alternaria blight and powdery mildew resistance in linseed

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Abstract

A 10 x 10 diallel set excluding reciprocals was made to study the gene action for Alternaria blight and powdery mildew resistance in linseed. Combining ability analysis revealed the involvement of both additive and non-additive gene effects in both F_1 and F_2 generations with predominance of former. Close correspondence between mean performance of the parents and their gca effects was observed over generations for both diseases. GS 280 x NP29 and Neelum x Chambal were best specific combiners over generations for low incidence of Alternaria blight and powdery mildew, respectively. Therefore, crosses involving high x high general combiners in case of Alternaria blight may be utilized for obtaining transgressive segregants. For powdery mildew, population improvement followed by recurrent selection is suggested to accumulate desirable genes.

Key words : Combining ability, Alternaria blight, powdery mildew, resistance, linseed

Introduction

Linseed (*Linum usitatissimum* L.) is an important oilseed crop grown for seeds as well as fibre. India is the largest linseed growing country in the world and ranks third in production. Presently it is cultivated on about 0.59 million ha with a contribution of 0.194 million tones to the annual oilseed production. The average yield of India is very low (395 Kg/ha) as compared to world's productivity (858 kg/ha). Besides abiotic stresses, biotic stresses (Alternaria blight and powdery mildew) are the major limiting factors causing considerable economic loss (26-60%). Dey [1] from India first reported the occurrence of Alternaria blight affecting the flower buds around Kanpur. Alternaria blight is still considered to be of academic and economic importance because true and stable source of resistance is not available in cultivated species. In case of powdery mildew, there is appearance of whitish superficial colonies of the pathogens on aerial parts including floral buds which cause serious damage in North India [2]. The present investigation was, therefore, undertaken to identify the suitable parents and crosses and also to elucidate the nature and magnitude of gene action for Alternaria blight and powdery mildew resistance in linseed.

Materials and methods

The experimental material for the present investigation was generated by crossing ten elite and agronomically superior genotypes of diverse origin in all possible combinations excluding reciprocals *i.e.*, diallel method. One hundred treatments comprising 10 parents, 45 F_1s and 45 F_2s were grown at Students' Instructional Farm of C.S.A.University of Agric. and Tech., Kanpur in a randomized complete block design with three replications during *rabi,* 1999-2000. Parents and F_1s were sown in single row and F_2s in two rows each of 3 meter length. The distance between row to row and plant to plant was kept 45 cm and 15 cm, respectively. Highly susceptible cultivar Chambal was inter-planted as an infector row after every fourth test entry and all round the experimental plot. Data for Altemaria blight and powdery mildew incidence were recorded at peak infestation stage on plot basis following 0-5 scale (0 = 0%, 1 = 1-10%, 2 = 11-25%, 3 = 26-50%, 4 = 51-75%, 5 = 76-100%). Statistical analysis for combining ability was done following Griffing's Method 2, Model I [3].

Results and discussion

Highly significant differences were observed among parents, F_1s and F_2s for both characters indicating significant variability in the base material as well as in F_1 and F_2 populations. Significant MS values for both

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general (*gca*) and specific combining ability (*sca*) in both the generations indicated the importance of additive as well as non-additive gene actions in controlling Alternaria blight and powdery mildew resistance in linseed (Table 1). However, the magnitude of *gca* variance was higher than *sca*. More than unity ratio of *gca*/*sca* variance also revealed that additive gene action play a primary role in governing these traits irrespective of selfing generations. Similar results for Alternaria blight resistance were also reported earlier [4]. Less than unity value of degree of dominance [5] in both the generations revealed that Alternaria blight and powdery mildew incidence are controlled by partial dominance in the present set of linseed materials. Close correspondence between *per se* performance and their *gca* effects in F_1 and F_2 generations was observed for both diseases (Table 2). Based on *gca* effects over generations and *per se* performance, the good general combiners were LCK

Table 1. ANOVA for combining ability, their ratios for Alternaria blight and powdery mildew incidence in linseed

Source	d.f.	Alternaria blight incidence		Powdery mildew incidence	
		F_1	F_2	F_1	F_2
Gca	9	3.42**	2.87**	4.31**	0.38**
Sca	45	0.04**	0.03**	0.05**	0.04**
Error	108	0.007	0.01	0.04	0.03
$6^{\wedge 2}g$		0.28	0.23	0.35	0.02
$6^{\wedge 2}s$		0.03	0.02	0.01	0.01
$6^{\wedge 2}g/6^{\wedge 2}s$		9.33	11.50	35.00	2.00
$(6^{\wedge 2}s/6^{\wedge 2}g)^{0.5}$		0.32	0.29	0.01	0.70

** = Significant at 1 per cent level, $6^{\wedge 2}g/6^{\wedge 2}s$ = Ratio of *gca* variance to *sca* variance, $(6^{\wedge 2}s/6^{\wedge 2}g)^{0.5}$= Degree of dominance

Table 2. Ranking of desirable parents based on *per se* performance and *gca* effects over generations in linseed

Characters	Mean value		Good general combiners F_1		Good general combiners F_2		Common parents
Alternaria blight incidence	LCK 9216	(1.20)	LCK 9216	(-0.61)**	LCK 9216	(-0.60)**	LCK 9216
	SLS7	(1.80)	SLS 7	(-0.43)**	SLS 7	(-0.36)**	SLS 7
	NP 29	(2.00)	NP 29	(-0.36)**	NP 29	(-0.28)**	NP 29
	Nagarkot	(2.00)	Nagarkot	(-0.31)**	Nagarkot	(-0.30)**	
Powdery mildew incidence	LCK 9216	(1.00)	SLS 7	(-0.51)**	SLS 7	(-0.49)**	SLS 7
	Nagarkot	(1.00)	LCK 9216	(-0.48)**	LCK 9216	(-0.44)**	LCK 9216
	SLS7	(1.00)	Nagarkot	(-0.48)**	Nagarkot	(-0.45)**	Nagarkot
	NL93	(1.50)	NL 93	(-0.20)**	NL 93	(-0.21)**	

**Significant at 1 per cent level.

Table 3. Superior crosses for Alternaria blight and powdery mildew incidence with their *per se* performance in linseed

Characters		Desirable specific combinations	*Per se* performance	*Gca* effect of the parents	
				P_1	P_2
Alternaria blight incidence	F_1	- GS280/Nagarkot**	2.00	H	H
		- Chambal/Kiran**	3.31	H	L
		- GS280/SLS7**	1.90	H	H
		- Neelum/LCK9216**	2.20	L	H
		- GS 280/ NP 29 **	2.00	H	H
	F_2	- GS280/NP29**	1.60	H	H
		- EC 10457 NL 93**	2.50	H	L
		- Neelum/NL93**	3.00	H	L
		- LCK9216/Kiran**	1.40	H	H
		- Nagarkot/ SLS 7**	1.40	H	H
Powdery mildew incidence	F_1	- Neelum/ Chambal*	3.50	L	L
	F_2	- Neelum/ Chambal**	3.23	L	L

*,**Significant at 5% and 1% level, respectively.

9216, SLS 7 and NP 29 for Alternaria blight resistance; SLS 7, LCK 9216 and Nagarkot for powdery mildew resistance. Promising specific cross combinations presented in Table 3 revealed that for Alternaria blight resistance, the magnitude and direction of *sca* effects were not consistent over generations except in case of cross GS280/NP29. *Sca* effect is an estimate and *per se* performance is a realized value, hence later should be preferred during selection of superior cross combinations in early segregating generations. For Alternaria blight resistance, three crosses each in F_1 (GS280/Nagarkot, GS280/SLS 7, GS280/NP29) and F_2 generations (GS280/NP29, LCK 9216/Kiran, Nagarkot/SLS 7) having high x high parental combinations can be exploited for the isolation of pure lines. Neelum x Chambal involving parents with low x low *gca* effects was the best specific combiner over generations for low incidence of powdery mildew. It appears that high *sca* effect of any cross does not necessarily depend upon the *gca* effects of the parents involved. The superiority of this cross may be due to complementary type of gene interaction, which can be exploited in the subsequent generations. In such crosses where non-additive gene effects played a predominant role, biparental mating followed by recurrent selection is suggested to exploit simultaneously both the components.

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