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Genetics of seedling vigour in Sesame (*Sesamum indicum* L.)

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Abstract: Ten lines, three testers and their 30 F_1 hybrids were studied in line x Tester method. The results showed that the specific combining ability variance was higher than general combining ability variance indicating the predominance of non-additive gene action for the inheritance of seedling vigour. For exploiting non-additive gene action biparental mating system followed by recurrent selection was proposed. The genotype Si. 102, Si. 1071, Si. 3214, Annamalai I and SVPR I were identified as good general combiners for seedling vigour. The cross Si. 3214 x SVPRI exhibited high heterotic effects for seedling vigour. In general, crosses with high *per se* performance yielded high *sca* crosses and crosses involving at least one of the parents with either high *gca* or high *per se* showed high heterotic effects for seedling vigour in sesame.

Key words: Seedling vigour, Combining ability, Gene action, Sesamum indicum.

Introduction

Basically seed vigour is a genetically controlled character and the charge for the vigour comes from the parental genome (Heydecker, 1973). Higher the seed or seedling vigour greater would be the plant's ability to withstand the biotic and abiotic stresses and hence the yield (Opoku *et al.* 1996). However, conflicting reports have been published about the relationship between seedling vigour and yield of the resulting crops (Johnson and Wax, 1978, Opoku *et al.* 1996) and for the genetic architecture of seedling vigour. Ye *et al.* (1981) reported the importance of non-additive gene action for seedling vigour as against the report of Verma *et al.* (1988) who reported the preponderance of additive genetic variance in barley. Verma and Singh (1991) attributed additive as well as non-additive gene action for seedling vigour in barley. The information related to genetic architecture of seedling vigour is useful for crop improvement. The present study was therefore carried out to elucidate the nature of gene action governing seedling vigour in sesame.

Materials and Methods

The experiment was conducted at the School of Genetics, Tamil Nadu Agricultural University, Coimbatore during 1997. Thirteen diverse germplasm lines (Si. 102, S. 0626 NL 4, S.0651, VRI 1, TMV 6, TMV 4, Si. 3214, Si. 1071, Si. 1671 and S. 9091) of different origin were crossed with three well-adapted males as testers (Annamalai 1, CO1 and SVPR 1) to produce 30 F_1 hybrids in "Line x Tester mating design". Field emergence potential was evaluated by sowing 3 x 100 seeds from each genotype in raised beds. Single seed per point was sown at uniform depth and irrigated immediately after sowing. The experiment was replicated thrice. Emergence counts were recorded on seventh day after sowing and 30 seedlings from the field emergence were removed carefully and utilized for assessing the shoot length (cm) and root length (cm) as per the international rules for seed testing (ISTA, 1985). The seedlings were dried in shade for one-hour followed by oven drying at 80 ± 1°C for 24 hours and the dry weight (mg) was recorded. The values, thus, obtained were used to estimate the vigour index I and 2 using the standard formulae (Abdul Baki and Anderson, 1972). Analysis of variance for combining ability was carried out as per Kempthorne (1957). Heterosis over standard check variety CO I was estimated.

Vigour Index 1 = Per cent field emergence x Mean length of seedlings
Vigour Index 2 = Dry matter weight x Mean length of seedlings

Results and Discussion

Analysis of variance for seedling vigour indices is shown in Table 1. The mean square

Table 1. ANOVA for combining ability for seedling vigour indices in sesame

Sources of variation	df	Vigour index 1	Vigour index 2
Parents	12	22561.21**	26.84**
Hybrids	29	16438.24**	24.04**
Parents Vs Hybrids	1	15948.50**	123.22**
Error	84	1663.46	4.19
Lines	9	6165.49*	2.83
Testers	2	99345.16**	36.89**
Lines x Testers	18	12362.73**	19.97**
Error	58	2245.40	5.10
		Proportional Contribution (%)	
Lines	11.64	0.81	
Testers	41.67	47.63	
Lines x Testers	46.69	51.56	
		Estimates of variance components	
^{2}*gca* / ^{2}*sca*	0.61	0.01	

*, ** Refers to significant at 5 and 1 per cent levels respectively.

due to testers and Lines x Testers was not only significant but also greater than due to lines, indicating greater variability and diversity of the testers. The proportional contribution of lines, testers and their interaction was also supportive of this observation. Testers and their interaction with lines contributed more than 85 per cent of the total variance. Significance of variances due to parent *versus* hybrids and Line x Testers showed the presence of heterotic effects for these traits. The relatively higher magnitude of specific combining ability variance over general combining ability variance, as revealed by low *gca / sca* ratio, suggested the predominance of non-additive gene action for vigour indices in sesame as reported by Verma and Singh (1991) in barley.

The data on *per se* performance, gca *and sca* effects and standard heterosis for selected parents and hybrids are presented in Table 2. Perusal of *gca* effects revealed that none of the parents except, Si. 3214 showed significant *gca* effects for vigour index 2. Among lines, Si 102 and Si 1071 and among testers Annamalai 1 and SVPR I recorded positive and significant *gca* effects for vigour index 1. The above lines and testers, which have good general combining ability for seedling vigour can be used in pedigree breeding since they are expected to give good recombinants. Association between *per se* performance and *gca* effects was not evident, therefore, suggesting non-additive gene action for these traits. In fact, many cases, the lines with high mean had low *gca* effects, indicating the ineffectiveness of choice of parents based on *per se* performance for hybridization.

Considering both direction and magnitude of *sca* effects, three crosses *viz.* VRI 1 x Annamalai 1, TMV 6 x SVPR 1, Si. 3214 x SVPR 1, Si. 1071 x CO 1 and Si. 102 x CO 1 exhibited significant positive *sca* effects for vigour index 1 as well as vigour index 2. Other crosses have recorded either negative or non significant *sca* effects. The *sca* effects along with *per se* performance gives the idea about the practical utility of hybrid combination for heterotic breeding. Si 3214 x SVPR 1, TMV 6 x SVPR 1 and Si 1071 x Annamalai 1 were the crosses exhibiting high *per se* combined with significant *sca* effects for vigour index 1. For vigour index 2, two crosses *viz.* Si 3214 x SVPR 1, TMV 6 x SVPR 1 showed high *per se* and significant *sca* effects. The crosses involving Si 3214 and TMV 6 as maternal

Table 2. *Per se* performance, *gca* and *sca* effects and heterosis for vigour indices in selected parents and hybrids

Selected lines / testers	Mean		*gca* effects	
	Vigour index-1	Vigour index-2	Vigour index-1	Vigour index-2
Lines				
Si.102	451.20	12.99	34.64**	0.28
VRI 1	308.45	14.76	18.88	0.44
TMV 6	494.61	14.10	-29.52**	0.74
Si. 3214	239.76	7.97	-24.78	3.74**
Si. 1071	415.58	13.03	32.97*	0.83
Testers				
Annamalai 1	431.89	16.34	39.51**	-0.34
SVPR 1	470.44	17.87	11.51	0.08
CO 1	285.68	8.84	66.02**	0.26
Mean of parents	370.01	12.34	gi = 12.54	gi = 0.60
			gj = 5.90	gj = 0.28

Promising Hybrids	Mean		*sca* effects		Heterosis	
	Vigour Index-1	Vigour Index-2	Vigour Index-1	Vigour Index-2	Vigour Index-1	Vigour Index-2
VRI 1 x Annamalai 1	513.31	16.89	61.04**	2.46**	9.12	-5.48
Si. 1071 x Annamalai 1	563.14	16.88	96.79**	2.03*	19.70	-5.52
Si. 102 x CO 1	482.04	17.12	27.02	2.24**	2.46	-4.22
TMV 6 x SVPR 1	572.50	17.37	74.75**	3.50**	21.69	-2.80
Si. 3214 x SVPR 1	580.32	22.39	99.25**	4.06**	23.36**	25.31**
Mean of hybrids	432.72	14.14	Sij = 17.70	Sij = 0.84	SE = 33.30	SE = 1.67

parent and SVPR 1 as paternal parent may, therefore, be considered as suitable cross-combinations for heterotic breeding. A critical analysis of the *gca* of parents and *sca* of hybrids revealed that crosses with high *sca* effects need not always have both the parents with high *gca* effects. However, it requires at least one of the parents with either high *per se* or high *gca* to yield high *sca* crosses.

The estimates of standard heterosis varied from - 33.23 to 23.36 per cent for vigour index 1 while, it ranged between – 43.48 and 25.36 per cent for vigour index 2. Many hybrids displayed significant heterosis for vigour indices but in negative direction. Only one hybrid i.e. Si 3214 x SVPR 1 revealed significant and positive standard heterosis for vigour index 1 as well as vigour index 2 indicating the close association exists between *sca* effects of crosses and heterosis. Therefore it may be inferred that crosses exhibiting high *sca* together with high *per se* can reliably be included in heterotic breeding. The parents of the high heterotic cross Si 3214 x SVPR I exhibiting low x high *gca* effects, indicated additive x dominance type of inter-allelic gene interaction. Several workers (Verma *et al.* 1988 and Nagarajan *et al*, 1993) have proposed the adoption of biparental mating system for generating population possessing higher proportion of favourable and adoptive genes in crops like wheat, barley and cotton. The same method could be effectively utilized in sesame, until the F_1 hybrids have become commercial reality.

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