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Combining ability studies for yield and yield components over environ ments in American cotton (*G. hirsutum* L.)

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Abstract : A 10 x 10 diallel analysis was made to assess the combining ability for yield and yield contributing characters involving divergent varieties of American cotton (*Gossypium hirsutum* L.) at Regl. Agrl. Research Station, Lam in four environments. The pooled analysis of variance revealed that GCA x E (except for monopodia per plant and sympodia per plant) and SCA x E (except for number of monopodia per plant) was important for all the characters. Though the magnitude of *gca* variance was considerably higher than the *sca* variance, both additive and non additive genetic variances were important for number of bolls per plant, boll weight and seed cotton yield per plant. Non additive genetic variance was found important for days to 50% flowering, number of monopodia per plant, number of sympodia per plant and number of seeds per boll. The parents NA 1325, NDLH 1678 and CWROK 165 were the best general combiners for number of sympodia per plant, number of bolls per plant, boll weight and seed cotton yield per plant. NA 1325 and NDLH 1678 also exhibited good general combining ability for days to 50% flowering in desired direction. The crosses NDLH 1678 x CWROK 165, L 604 X NDLH 1678 and MCU 5 x NA 1325 were identified as the best crosses on the basis of *per se* performance and combining ability.

Key words : Combining ability, Cotton, Additive, Non-additive.

Introduction

Cotton is one of the most important commercial crops and forms the back bone of Indian textile industry. Choice of suitable parents for hybridization and adoption of proper breeding procedure are very important in any crop improvement programme. Combining ability is a powerful tool to discriminate between good and poor general combiners and for choosing appropriate parental lines to produce superior hybrids. The present study therefore was undertaken to obtain information on general and specific combining ability effects and their interaction with environmental variation with respect to yield and yield component characters and the results discussed.

Materials and Methods

The experimental material for the,present investigation consisted of 45 F_1 crosses obtained by involving 10 diverse parents *viz.* MCU 5, BN 1, L 389, NA 1325, AC 738, L 604, NDLH 1678, ARB 8824, CWROK 165 and ICMF 82 obtained from different cotton research stations, in a diallel fashion (excluding reciprocals). The 45 F_1's along with 10 parents were grown in a Randomized Block Design with 3 replications in 4 environments *viz.* E_1 - Normal sowing - Irrigated; E_2 - Normal sowing - Rainfed; E_3 Delayed sowing - Irrigated and E_4 - Delayed sowing - Rainfed during 1999-2000 season at Regional Agricultural Research Station, Lam. Recommended package of practices for the region were followed. Each genotype was grown in a 2 row plot of 6 meters length adopting a spacing of 120 cm between rows and 60 cm within a row. Five competitive plants were randomly selected for recording data on days to 50 per cent flowering, number of monopodia per plant, number of sympodia per plant, number of bolls per plant, boll weight (g) and number of seeds per boll and seed cotton yield plant^{-1} (g). The data pooled over environments were subjected to statistical analysis following Griffing (1956)

Table 1. Analysis of variance for combining ability for yield and fibre quality

Source	d.f.	Days to 50% flowering	No. of monopodia plant^{-1}	No. of sympodia plant^{-1}	No. of bolls plant^{-1}	Boll weight (g)	No. of seeds boll^{-1}	Seed cotton yield plant^{-1} (g)
GCA	9	10.725**	0.583**	6.188**	176.359**	1.178**	10.735**	6825.117**
SCA	45	5.785**	0.165**	3.168**	29.927**	0.273**	4.179**	834.428**
ENVIRONMENTS	3	378.818**	0.317**	347.122**	1158.669**	12.885**	0.875	27819.234**
GCA x E	27	0.678**	0.013	0.267	5.032**	0.046**	1.280**	390.499**
SCA x E	135	0.733**	0.007	0.265*	3.421**	0.040**	1.536**	102.358**
Error	432	0.446	0.012	0.204	1.985	0.018	0.594	30.969
σ^2 gca	0.10	0.01	0.06	3.03	0.02	0.14	119.22	
σ^2 sca		1.26	0.04	0.73	6.63	0.06	0.66	183.02
$2\sigma^2$gca / $2\sigma^2$ gca + σ^2 sca		0.14	0.30	0.15	0.48	0.40	0.30	0.57

*, ** Significant at 5 and 1% levels, respectively

Table 2. Estimates of general combining ability effects (pooled) for yield and yield components in cotton

Parents	Days to 50% flowering	No. of monopodia plant^{-1}	No. of sympodia plant^{-1}	No. of bolls plant^{-1}	Boll weight (g)	No. of seeds boll^{-1}	Seed cotton yield plant^{-1} (g)
MCU 5	0.33**	0.17**	0.25**	0.08	-0.04**	-0.11	-1.89**
BN I	-0.18**	-0.19**	-0.25**	0.27	-0.29**	0.95**	-6.14**
L 389	0.30**	-0.07**	-0.26**	-1.88**	0.04*	0.07	-7.50**
NA 1325	-0.98**	0.04**	0.39**	2.73**	0.06**	-0.36**	16.08**
AC 738	0.67**	0.04**	-0.07	-2.44**	-0.03	-0.58**	-13.96**
L 604	0.16	-0.04**	-0.12*	1.11**	-0.15**	0.65**	0.59
NDLH 1678	-0.39**	0.03**	0.26**	1.45**	0.22**	-0.02	16.04**
ARB 8824	-0.12	-0.04**	0.14*	0.04	-0.03	-0.39**	-1.64**
CWROK 165	-0.18**	-0.10**	0.39**	1.74**	0.24**	-0.22**	14.49**
ICMF 82	0.38**	0.15**	-0.75**	-3.11**	-0.02	0.01	-16.07**
SE (gi)	0.09	0.01	0.06	0.19	0.02	0.11	0.76
SE (gi-gj)	0.14	0.02	0.09	0.29	0.03	0.16	1.14

*, ** Significant at 5 and 1% levels, respectively

Table 3. Crosses having high mean performance and significant positive specific combining ability effects

Character	Mean Performance	SCA effects
1. Days to 50 flowering	NA 1325 X L 604 AC 738 X CWROK 165 L 389 X NA 1325	AC 738 X CWROK 165 NA 1325 X L 604 MCU 5 X NDLH 1678
2. No. of monopodia plant^{-1}	MCU 5 X ICMF 82 MCU 5 X L 604 NA 1325 X ICMF 82	BN 1 X ICMF 82 MCU 5 X L 604 L 604 X ARB 8824
3. No. of sympodia plant^{-1}	NDLH 1678 X CWROK 165 NA 1325 X L 604 NA 1325 X AC 738	NA 1325 X L 604 NDLH 1678 X CWROK 165 NA 1325 X AC 738
4. No. of bolls plant^{-1}	MCU 5 X NA 1325 BN 1 X AC 738 NDLH 1678 X CWROK 165	BN 1 X AC 738 L 389 X NDLH 1678 MCU 5 X NA 1325
5. Boll weight (g)	AC 738 X NDLH 1678 NDLH 1678 X CWROK 165 AC 738 X CWROK 165	AC 738 X NDLH 1678 BN 1 X ARB 8824 MCU 5 X ARB 8824
6. No. of seeds boll^{-1}	BN 1 X NDLH 1678 MCU 5 X CWROK 165 L 604 X ICMF 82	MCU 5 X CWROK 165 BN 1 X NDLH 1678 ARB 8824 X CWROK 165
7. Seed cotton yield plant^{-1} (g)	NDLH 1678 X CWROK 165 L 604 X NDLH 1678 MCU 5 X NA 1325	BN 1 X AC 738 MCU 5 X NA 1325 L 604 X NDLH 1678

and as extended by Singh (1973, 1979) using Method - 2, Model - 1.

Results and Discussion

The analysis of variance for combining ability over environments (Table 1) revealed highly significant differences among the genotypes for all the traits. The pooled analysis also reveled that environments were found to be significant for all the characters and had highly significant interaction variance involving *gca* x environments (except for No. of monopodia and no. of sympodia) and *sca* x environments (No. of monopoda), which revealed that both *gca* effects of parents and *sca* effects of the hybrids were influenced by the sampled environments. The magnitude of the former was greater than the latter for majority of the traits suggesting greater influence of environment on *gca* than *sca* variance. Similar results for number of bolls plant^{-1}, boll weight and seed cotton yield per plant were earlier reporte by Pavasia *et al.* (1998).

The combining ability analysis is frequentl used for testing the performance of parent and hybrid combinations and also for understandin the nature and magnitude of gene action involve in the expression of different traits beside isolating good general combiners for use i breeding programmes. Gupta and Singh (1974 Singh *et al.* (1988) and Pavasia *et al.* (199ε reported significant relationship between th *per se* performance and *gca* effects of th parents in upland cotton. Similar relationshi was also found in the present study betwee *per se* performance and *gca* effects of th parents for days to 50 per cent flowerin number of monopodia plant^{-1}, number of seec per boll and seed cotton yield per plant. Wherea such relationship was not observed for numb of sympodia per plant; number of bol ınt^{-1} and boll weight. Therefore, it can be ıted for these characters that the ability of : parents to nick well can only be judged ›m combining ability studies.

The relative importance of *gca* and *sca* riance was assessed by the ratio $2\sigma^2 gca/$ $\sigma^2 gca+2\sigma^2 sca$ as suggested by Baker (1978). ıe estimates of this ratio indicated that the ative magnitude of non-additive gene effects er additive gene effects for days to 50% ›wering, number of monopodia plant^{-1}, number sympodia plant^{-1} and number of seeds lls^{-1}. Both additive and non-additive gene tions were observed for number of boll per ınt, boll weight and seed cotton yield per ınt. So far as earlier findings regarding nature gene action is concerned, Shanti and Selvaraj 995), Surana *et al.* (1997), Murthy and Ranga-thacharyulu (1998), Valarmathi and Jehangir 998) have reported the predominance of non ditive gene action for number of sympodia/ ınt. Murthy and Ranganathacharyulu (1998) d Pavasia *et al.* (1998) reported the importance both additive and non additive gene action ur number of bolls plant^{-1}, boll weight and ;eed cotton yield per plant.

The estimates of gca effects of the parents ıre presented in Table 2. The parents NA 1325, NDLH 1678 and CWROK 165 showed significant *gca* effects for seed cotton yield. These parents ılso showed significant *gca* effects for days .o 50% flowering, number of monopodia plant^{-1}, number of sympodia plant^{-1}, number of bolls plant^{-1} and boll weight. The parent NDLH 1678 also recorded significant *gca* effects for number of monopodia plant^{-1}, number of bolls plant^{-1} and boll weight besides seed cotton yield. The parents NA 1325, NDLH 1678 and CWROK 165 were adjudged as good general combiners for and yield component traits. The *gca* of yield was influenced by *gca* of yield contributing characters.

The estimates of *sca* effects of top performing crosses for different traits are presented in Table 3. The cross NDLH 1678 X CWROK 165 recorded high *sca* effects for seed cotton yield, number of sympodia plant^{-1}, number of bolls plant^{-1} and boll weight. The cross MCU 5 X NA 1325 showed significant *sca* effects for number of sympodia plant^{-1}, number of bolls plant^{-1} and seed cotton yield. The crosses L 389 X NA 1325 and MCU 5 X NA 1325 also showed significant *sca* effects for days to 50% flowering in the desired direction. The cross NDLH 167 X CWROK 165, which had high *sca* effects for seed cotton yield and various yield components *viz.* number of sympodia plant^{-1}, number of bolls plant^{-1} and boll weight also possessed significant and high *gca* effects indicating *gca* is an indicator for specific cross effects. This close relationship may be due to predominance of additive and non additive gene action for number of bolls plant^{-1} and boll weight and seed cotton yield.

In the case of crosses, which exhibited significant *sca* effects in the pooled data, the grading of the parents based upon their *gca* effects indicated that for number of monopodia/ plant, number of seeds boll^{-1} and seed cotton yield, some of the crosses involved both the parents with poor combining ability. The superiority of the poor x poor combiners may be attributed to the genetic diversity of the parents. The cross NDLH 1678 X. CWROK 165, which involved H X H general combiners is expected to release desirable segregants in the subsequent generations, since these involve additive and additive x additive interactions. The crosses L 604 X NDLH 1678 and MCU 5 X NA 1325, which involve high x low or low x high general combiners are likely to produce desirable transgressive segregants. El-Adl and Miller (1971) obtained transgressive segregants that were better than the original F_1. Kalsy and Garg (1980) and Gururajan and Basu (1992) also stressed the importance of H x L crosses in obtaining superior combinations.

The present study indicated that the parents NA 1325, NDLH 1678 and CWROK 165, which had high *gca* effects for different economic characters can be utilized in conventional breeding programme and the crosses NDLH 1678 X CWROK 165, L 604 X NDLH 1678 and MCU 5 X NA 1325 with high sca can be exploited for hybrid vigour. Both additive and non-additive components of variance was found important for number of bolls plant^{-1}, boll weight and seed cotton yield. Under such situation, recurrent selection methods would be appropriate for rapid improvement of yield. The relatively high interaction of non additive genetic variance with the environments suggested that specific hybrids may be identified for specific situations.

References

Baker, R.J. (1978). Issues in diallel analysis. *Crop Sci.* **18**: 533-536.

El-Adl, A.M. and Miller, P.A. (1971). Transgressive segregation and nature of gene action for yield in an intervarietal cross of upland cotton. *Crop Sci.* **11**: 381-384

Griffing, B. (1956). Concepts of general and specific combining ability in relation to diallel crossing systems. *Aust. J. Biol. Sci.* **9**: 463-493.

Gupta, M.P. and Singh, R.B. (1974). Combining ability in upland cotton- ginning and fibre characters. *Indian J. Genet.* **34**: 422-426.

Gururajan, K.N. and Basu, A.K. (1992). Heterosis and combining ability in medium staple cotton. *J. Indian Soc. Cot. Improv.* **17**: 17-22.

Kalsy, H.S. and Garg, H.R. (1980). Combining ability analysis in cotton. *J. Indian Soc. Cot. Improv.* **7**: 113-118.

Murthy, J.S.V.S. and Ranganathacharyulu, N. (1998). Studies on combining ability in bollworm tolerant lines of upland cotton (*Gossypium hirsutum* L.). *Ann. Agric. Res.* **19**: 227-228.

Pavasia, M.J. Shukla, P.T. and Patel, U.G. (1998). Combining ability studies for yield and its components over environments in upland cotton. *J. Indian Soc. Cot. Improv.* **23**: 140-143.

Shanti. N. and Selvaraj, U. (1995). Combining ability studies for quantitative characters in cotton (*Gossypium hirsulum* L.). *Madras Agric. J.* **82**: 162-164.

Singh, D. (1973). Diallel analysis over different environments. *Indian J. Genet.* **33**: 127-136.

Singh, D. (1979). Diallel analysis for combining ability over environments. *Indian J. Genet.* **39**: 383-386.

Singh, T.H. Randhawa, L.S. and Singh, M. (1988 Combining ability studies for lint yield an its components over environments in uplan cotton. *J. Indian Soc. Cot. Improv.* **13**: 11-1[illegible]

Surana, P.P., Mehetre, S.S., Borle, U.M. and Dahat. D.V. (1997). Combining ability on *Gossypium hirsutum* L. for fibre quality parameters. *J. Cot. Res. Dev.* **11**: 9-15.

Valarmathi, M. and Jehangir, K.S. (1998). Line x Test analysis for combining ability in *Gossypium hirsutum* L. cotton. *Madras Agric. J.* **85**: 103-105.

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