Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 9 (2) : 160-163 (July-2021) Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Evaluation of Combining Ability in Upland Cotton

Sukhdeep Singh Sivia[1]*, Sunayana[2] and S.S. Siwach[1]
[1]*CCS Haryana Agricultural University, Hisar-125 004*
[2]*Punjab Agricultural University, RRS, Abohar-152116*
**E-mail : sukhdeepsinghsivia@gmail.com*

Abstract

Sixty F_1 crosses were obtained by crossing 15 lines and 4 testers during Kharif 2014 to estimate GCA and SCA. These were evaluated in randomized complete block design during Kharif 2015. GCA and SCA effects were significant for all the characters except plant height. Predominance of non-additive gene action was reported for seed cotton yield and its components. High GCA was detected for H1464 for boll weight, H1476 for seeds per boll and H1470 for seed cotton yield per plant and bolls per plant. The cross combination AC726 x H1236, H1476 x H1226, Luxmi PKV X H1226, H1470 X H 1098-I and H1470 X H1236 showed significant SCA effects for seed cotton yield. At least one parent with high or average GCA effect for a particular character was observed. Significant SCA effect was observed in the crosses involving parent H1470 and H1236 for yield contributing traits which can be used for development of hybrid.

Key words : *Gossypium hirsutum, gca and sca.*

Introduction

Cotton (*Gossypium hirsutum* L.) is known as white gold and it is an important fibre crop which requires hot and dry weather with adequate moisture. It plays an important role in commerce of many countries including India. Cotton produces 'lint' fibres to produce yarn that is knitted or woven into fabrics. There is need to emphasize on the magnitude of heterosis *per se* performance and stability of genotypes to increase the productivity of cotton in India in comparison to developed countries like USA. For the proper identification of parents used for the development of hybrids of superior performance combining ability plays an important role. Many researches revealed that the good performing genotypes might not necessarily produce desirable progenies when used in hybrid breeding. So, it is therefore, obligatory to discover high potential genotypes on the basis of combining abilities. However, lot of information is available on heterosis in cotton but still there is a want to explore for the divergent genotypes with superior combining abilities. Hybridization is the most persuasive technique for breaking undesirable linkages. Development of hybrids with desirable traits mainly depends on the parent's selection using combining ability.

To study the combining ability effects of crosses for the selection of superior parents and hybrids Line x Tester analysis is the most suitable procedure (1). GCA and SCA effects for yield components among 15 (female) and 4 (male) of *G. hirsutum* lines were estimated to find out suitable parents and crosses for desired traits.

Materials and Methods

15 diverse female lines (H1156, ISR12, HR1, Luxmi PKV, AC726, Deltapine, H1472, H1465, H1463, H1464, H1470, H1471, H1476, H1477 and CSH3075) and 4 male lines (H1226, H1098-I, H1117 and H1236) were selected during the *Kharif* 2013. Line x Tester design was used for crossing during *Kharif* 2014. The 60 hybrids, 19 parents with single check HHH223 were planted in the field during *Kharif* 2015 at cotton research area, CCS Haryana Agricultural University, Hisar (India) in randomized block design (RBD) with three replications. Each genotype was grown in a 7.2 m length row adopting a spacing of (67.5 x 60) cm. Data were recorded on five randomly selected plants per replication for Days to first flower, plant height (cm), number of monopodia per plant, number of sympodia per plant, number of bolls per plant, boll weight (g), number of seeds per boll and seed cotton yield per plant (g). It was analyzed for analysis of variance, standard error and critical difference (2) while Line x Tester analysis done as by (1).

Results and Discussion

The analysis of variance indicated that the mean squares of genotypes for all the characters were significantly different. It indicated the presence of variability among hybrids and parents. General combining ability variances for female parents were highly significant for all the eight characters enlightening vital role of additive gene effects. GCA variances for male parents were highly significant for all traits except plant height indicating the non-additive gene effects (Table-1). The ratio of ^{2} GCA/ ^{2} SCA was

Received : July-2020; Revised : July-2020; Accepted : July-2021

Table-1 : Combining ability analysis for characters in *Gossypium hirsutum* L.

Source of variation	Df	DF	PH	NM/P	NS/P	NB/P	BW	NS/B	SCY/P
Replication	2	25.27**	405.05**	0.07	9.06**	37.37*	0.05**	25.32**	83.98
Hybrid	59	42.30**	414.67**	.92**	8.69**	71.18**	.31**	3.27**	872.82**
Lines	14	90.36**	1211.96**	2.02**	20.11**	130.88**	0.88**	6.38**	2043.29**
Testers	3	71.267**	65.37	1.282**	2.391**	50.199**	0.48**	5.902**	508.978**
Lines x Testers	42	24.21**	173.86**	0.53**	5.34**	52.77**	0.11**	2.04**	508.66**
Error	118	2.14	50.99	0.04	0.30	9.15	0.01	0.56	49.65
^{2} GCA		1.99	16.31	0.04	0.21	1.33	0.02	0.14	26.93
^{2} SCA		103.95	678.47	2.21	19.06	156.06	0.69	7.17	1888.68
^{2}GCA/ ^{2}SCA		0.04	0.05	0.04	0.02	0.02	0.06	0.04	0.03

**Significant at 1% level of significance, *Significant at 5% level of significance.
DF = Days to first flower, PH = Plant height (cm), NM/P = Number of monopod/plant, NS/P = Number of sympod/plant, NB/P = Number of bolls/plant, BW = Boll weight (g), NS/B = Number of seeds/boll, SCY/P = Seed cotton yield/Plant (g).

Table-2 : Above average and poorest general combining parents for different characters.

Characters	Female parent			Male parent
	Above average combiners		Poor combiners	Above average Combiner
	1st	2nd		
Days to first flower	H1156 (-5.82**)	ISR12 (-5.07**)	H1471 (3.10**)	H1098-I (-1.48**)
Plant height	H1471 (13.75**)	H1464 (10.92**)	Deltapine (-19.58**)	H1236 (1.52)
No. of monopods	AC726 (0.56**)	H1156 (0.53**)	CSH3075 (-0.70**)	H1098-I (0.14**)
No. of sympod/plant	H1470 (2.14**)	H1476 (1.59**)	CSH3075 (-2.43**)	H1226 (0.34**)
No. of bolls/plant	H1470 (9.31**)	HR1 (3.14*)	H1477 (-5.03**)	H1226 (1.28*)
Boll weight/boll	H1464 (0.42**)	H1470 (0.30**)	Deltapine (-0.56**)	H1236 (0.13**)
No. of seed/boll	H1476 (0.97**)	H1464 (0.62*)	Deltapine (-2.13**)	H1236 (0.34*)
Seed cotton yield per plant	H1470 (34.07**)	H1464 (11.77**)	Deltapine (-20.35**)	H1236 (4.39**)

GCA value in parenthesis, **Significant at 1% level of significance, *Significant at 5% level of significance

less than unity which indicates the preponderance of non-additive gene action. Predominance of SCA variance in American cotton have been reported by (3,4) for seed cotton yield and seed germination (5).

The perusal of Table-2 revealed that among the four male parents H1236 was the best combiner for seed cotton yield, boll weight, plant height and number of seeds per boll while H1098-i was best combiner for days to first flower and number of monopods. Best combiner for number of sympodia and number of bolls per plant was H1226. Among female parents, H1470 was good general combiner for seed cotton yield, number of bolls, number of sympods and the same parent also second best combiner for boll weight. The genotype H1471 was recorded as good combiner for plant height and female parent H1464 was the best combiner for boll weight. These results were supported by (6,7,8). H1156 was the good combiner for dwarfness and AC726 for number of monopods per plant as female parent. The highest GCA effect for number of seeds per boll was reported from female parent H1476. However, on basis of GCA effects H1470, H1464, H1471, H1156 (female) while H1236 and H1098-i (male) can be used for future breeding programme.

Out of total sixty crosses, nine cross combinations had significant positive SCA effects. Most prominent crosses among the entire cross combination were AC726 x H1236 (27.76) H1476 x H1226 (26.19), Luxmi PKV x H1226 (24.02) and H1470 x H1098-i (14.64) due to their highest significant positive SCA effect. AC726 x H1236 (27.76) revealed significant SCA effects for number of boll per plant and boll weight to increase seed cotton yield and results were supported by (9,10). In table 3, the maximum SCA effect for bolls per plant was observed by cross H1463 x H1226 (8.55) (good x good GCA) followed by Luxmi PKV x H1226 (7.63) (poor x good GCA). Cross combinations, H1476 x H1226 (0.29) and AC726 x H1236 (0.28) observed highest positive significant SCA effects. There are combinations of good x poor and poor x good general combining parents, respectively. H1463 x H1226 proved to be a best specific cross combination for number of sympods involving good x good parents. Hybrid ISR12 x H1226, having high negative SCA effects for days to first flower was a combination of good x poor combining parent which indicated the importance of additive and dominance variance also supported by (10,11,12).

H1470 x H1236 (good x good GCA), H1470 x

Table-3 : Above average specific cross combination for different characters along with per se performance.

Characters	Above average cross combination			
	1st	Per se	2nd	Per se
Days to first flower	ISR12 x H1226 (-6.46**)	60.33 (days)	CSH3075 x H1117 (-4.95**)	68.33 (days)
Plant height	ISR12 x H1098-I (16.13**)	134.67 (cm)	H1465 x H1098-i (12.13)	140.67 (cm)
No. of monopods	ISR12 x H1226 (0.79**)	3.13	H1476 x H1098-i (0.75**)	2.07
No. of sympod/plant	H1463 x H1226 (2.83**)	15.87	H1472 x H1098-i (2.29**)	13.40
No. of bolls/plant	H1463 x H1226 (8.55**)	37.33	Luxmi PKV x H1226 (7.63**)	33.00
Boll weight	H1476 x H1226 (0.29**)	3.18 (g)	AC726 x H1236 (0.28**)	3.25 (g)
No. of seed/boll	H1477 x H1226 (1.74**)	27.83	CSH3075 x H1117 (1.49*)	30.13
Seed cotton yield per plant	AC726 x H1236 (27.76**)	103.91 (g)	H1476 x H1226 (26.19**)	104.12 (g)

SCA value in parenthesis
**Significant at 1% level of significance, *Significant at 5% level of significance.

Table-4 : Performance in terms of *per se,* GCA, SCA and heterosis for the ten better performing crosses based on seed cotton yield.

Crosses	*Per se* performance of crosses	GCA of parents		SCA of crosses	Heterosis for seed cotton yield
		P_1	P_2		
H1470 x H1236	122.958	G	G	G	G
H1470 x H1098-i	116.859	G	A	G	G
3 H1476 x H1226	104.122	P	A	G	G
AC726 x H1236	103.910	A	P	G	G
H1464 x H1236	95.497	G	G	A	G
H1470 x H1117	91.758	G	P	A	G
H1465 x H1098-i	86.372	G	A	A	A
H1463 x H1226	86.001	A	A	A	A
H1464 x H1226	85.501	G	A	A	A
H1464 x H1117	84.958	G	P	A	A

G = Good, A = Average and P = Poor

H1098-i (good x average GCA), AC726 x H1236 (average x poor GCA) and H1476 x H1226 (poor x average GCA) found maximum heterosis for seed cotton yield as well as good SCA effects (Table-4). These finding reported that study of SCA effects alone is not appropriate for choosing parents for hybridization programme but study of their heterotic effect are also necessary as reported by (13,14).

Conclusion

Parents having high GCA values i.e., H1156 for days to first flowering, H1471 for plant height, AC726 for monopods per plant, H1464 for boll weight, H1476 for seeds per boll and H1470 for seed cotton yield per plant, bolls per plant and sympods per plant were detected with higher GCA for developing superior genotypes. The significant SCA effects were recorded for seed cotton yield from the cross combination AC726 x H1236, H1476 x H1226, Luxmi PKV X H1226, H1470 X H 1098-I and H1470 X H1236 having at least one parent with high or average GCA effect for a scrupulous trait. The results indicate the consequence of non-additive genetic effects for attaining maximum progress in quantitative traits.

Referances

1. Kempthorne O. (1957). An Introduction to Genetic Statistics, New York, *John Wiley and Sons,* 1st Edition, pp: 456-471.
2. Panse V.G. and Sukhatme P.V. (1961). Statistical methods for agricultural workers. *Indian Council of Agricultural Research,* New Delhi. pp: 381.
3. Nidagundi J.M., Deshpande S.K., Patil B.R. and Mane R.S. (2011). Combining ability and heterosis for yield and fibre quality traits in American cotton. *Crop Improvement,* 38(2): 179-185.
4. Pushpam R., Thangaraj K. and Raveendran T.S. (2015). Heterosis and combining ability studied in upland cotton for yield characters. *Electronic Journal of Plant Breeding, 6(2):* 459-463.

5. Mohammad Arshad Nadeem, Sanket Kumar, Prashant Goel and M.S. Amarnat (2020). Validation of seed germination per cent age and its attributes for different vegetables. *Frontiers in Crop Improvement*, 8(2): 114-116.
6. Sanjay B.A., Kajjidoni S.I. and Talwal A.M. (2010). Combining abiltiy and heterosis for yield and its components in interspecific crosses of desi cotton. *Agricultural Research and Communication Center.*, 30(3): 55-59.
7. Kumar M., Nirania K.S., Sangwan R.S. and Yadav N.K. (2013). Combining ability studies for yield and quality traits in upland cotton (*Gossypium hirsutum* L.). *Journal of Cotton Research and Development,* 27(2): 171-174.
8. Kencharaddi H.G., Hanchinal R.R. and Patil S.S. (2015). Studies on combining ability in inter heterotic group derived cotton hybrids for lint yield and its components. *Research on Environment and Life Science,* 8(3): 451-456.
9. Laxman S. (2010). Diallel analysis for combining ability for seed cotton yield and its components in desi cotton (*G. arboreum* L.). *Journal of Cotton Research and Development,* 24(1): 26-28.
10. Alkuddsi Y.A., Rao M.R., Patil S.S., Gowda T.H. and Joshi M. (2013). Combining ability analysis for seed cotton yield and its components in intra hirsutum hybrids and forming heterotic boxes for exploitation in cotton. *Genomics and Applied Biology,* 4(5): 35-49.
11. Anandan A. (2010). Environmental impact on the combining ability of fiber traits and seed cotton yield in cotton. *Journal of Crop Improvement,* 24(4): 310-323.
12. Rajamani S., Gopinath M. and Reddy K.H.P. (2014). Combining ability for seed cotton yield and fibre characters in upland cotton (*Gossypium hirsutum* L.). *Journal of Cotton Research and Development,* 28(2): 207-210.
13. Karademir C., Karademir E. and Gencer O. (2009). Combining ability estimates heterosis for yield and fibre quality of cotton (*G. hirsutum* L.) in line x tester design. Notulae Botanicae Horti Agrobotanici Cluj-Napoca, 37(2): 228-233.
14. Murthy K.G.K., Pradeep T., Radha Krishna K.V., Sokka Reddy S., Saida Naik D. and Satish Chandra B. (2018). Combining ability studies in multiple cross derivatives of upland cotton (*Gossypium hirsutum*) for identifying desirable plant types suitable to High Density Planting System. *Indian Journal of Agriculture Science,* 88(6): 937-947.