Sindh Univ. Res. Jour. (Sci. Ser.) Vol.47 (1):127-130 (2015)

SINDH UNIVERSITY RESEARCH JOURNAL (SCIENCE SERIES)

Exploration of Combining Ability in Upland Cotton

M. BALOCH[++], A. W. BALOCH, S. N. MARI, N. N. MEMON*

Department of Plant Breeding and Genetics, Sindh Agriculture University, Tandojam, Pakistan

Received 10th March 2014 and Revised 21st September 2014

Abstract: Combining ability analysis for five quantitative traits was studied through 6x6 diallel cross of upland cotton. Both additive and non-additive gene effects were important in the inheritance of most of the traits. The parent SD-16 displayed high GCA effects for plant height and number of bolls per plant, whereas parent SD-12 gave high GCA effects for number of sympodial branches, parent SD-13 depicted high GCA effects for boll weight and seed cotton yield per plant. These parents may be utilized as general combiners for their respective traits. Regarding specific combining ability effects for seed cotton yield, highest SCA estimates were recorded from hybrid SD-14 x SD-15 hence this particular hybrid may be utilized for producing hybrid seed and developing new cotton varieties for high yield.

Keywords: Upland cotton, *Gossypium hirsutum*, combining ability, SCA, GCA

1. INTRODUCTION

Identification and isolation of potential genotypes on the basis of combining ability analysis is some what orthodoxically difficult as parents with highest general combining ability estimates (for any particular character under study) do not necessarily give hybrids with high specific combining ability estimates. In other words, general and specific combining abilities are not correlated or high general combining ability estimates can not be criterioned to obtain/predict hybrids with high specific combing ability. Therefore early generation testing has often been suggested to identify segregating populations that are expected to contain the greatest frequency of favourable genotypes and at the same time will eliminate inferior populations with limited promise (Darren and Smith, 2006).

Selecting potential genotypes on the basis of combining ability have been considered on the basis of high, while high estimates of specific combining ability variances indicate predominance of non-additive and dominance gene action. Combining ability analysis of cultivars and their filial generation combinations is thus important to exploit the relevant type of gene action in the particular breeding program. If specific combining ability is predominant, it can be used in hybrid breeding programs for further isolation of best performing hybrids in cultivar development. Combining ability estimates are also used to evaluate number of promising lines in F_1, F_2 and subsequent generations, which is quite helpful in selecting the potential of parents for hybridization for particular metrical character (Hennawy, 1966; Iqbal and Choudhry, 2000). The main objective of this experiment was to identify the best combiners and their crosses on the basis of their GCA and SCA.

2. MATERIALS AND METHODS

To explore the combining ability of six cotton genotypes, an experiment was conducted at Sindh Agriculture University, Tandojam. Six cotton genotypes were crossed in 6 x6 diallel mating design during 2009 and thus resultant F1 was planted during May 2010. The parental genotypes comprised of SD-12, SD-13, SD-14, SD-15, SD-16 and SD-17. The experiment was conducted in randomized block design replicated three times. Single row of three meter length served as an experimental unit. Inter row distance was 75cm. Observations were recorded on five quantitative traits (plant height, number of sympodial branches per plant, number of bolls per plant, boll weight and seed cotton yield) on ten indexed plants tagged for this purpose. Data were analyzed following the formula outlined by Griffing's, Model I, Method 2 (1956).

3. RESULTS AND DISCUSSION

This study was aimed to evaluate the general and specific ability to obtain an explanation on the genetic control of agronomic and fiber traits in the hybrid combinations obtained through half diallel cross (parents plus one way crosses) of six selected upland cotton cultivars. Accordingly, the analysis of variance for general and specific combining ability for 2007 F_1 diallel sets for five quantitative traits (plant height cm, number of sympodial branches per plant, number of bolls per plant, boll weight gm and seed cotton yield per plant gm) was performed to estimate the variances for GCAs and SCAs which will pave way to targeted

[++]Corresponding author's email: munaizabaloch@yahoo.com

*Department of Horticulture, Sindh Agriculture University ,Tandojam, Pakistan.

selection/isolation of desirable parents for further exploitation of their utility in the cotton breeding program. Mean squares for general and specific combing ability together with the estimates of GCA and SCA variances are presented in Table-1. The estimates of general combining ability effects for parents and specific combining ability effects for their one-way hybrids for 2007 F_1 diallel set are given in **(Table-2)**.

Mean squares for general combining ability for plant height (cm) were significant (P<0.05) and highly significant (P<0.01) for sympodial branches per plant, number of bolls per plant, boll weight (gm), and seed cotton yield per plant (gm). Since general combining ability reflects parental performance and is the result of additive gene effects and additive x additive type of gene effects, significance of GCAs mean squares for above mentioned quantitative characters show the importance of additive gene effects for these characters. And since the magnitude of GCA variances for all the quantitative characters was of lesser intensity, pedigree breeding method for selecting desired parental genotypes on the basis of significant additive gene effects would be more effective and fruitful. Mean squares for specific combining ability were highly significant (P<0.01) for plant height (cm), sympodial branches per plant, bolls per plant , boll weight (gm) and yield of seed cotton per plant (gm). Since the specific combining ability reflects the average performance of hybrid progenies and is outcome of dominance and dominance x dominance gene effects, significance of mean squares of SCAs for above mentioned characters reflect the importance of dominance gene effects, selection of desired hybrid progeny genotypes must be made on the basis of dominance gene effects which are pronounced and preponderant for the above significant characters under study. Pedigree record breeding would be the most appropriate selection procedure in selecting the desired hybrid progeny ideotypes on the basis of significant dominance gene effects for precise objectivity. In addition, since the magnitude of SCA variances was significantly high for plant height and seed cotton yield per plant (gm), pedigree breeding would be even more meaningful if dominant gene effects are further partitioned into dominance x dominance epistatic effects for these two characters to pin point the desired genotypes masking/epistating the effects of recessive alleles and expressing pronounced phenotypic attribute for that character.

The estimates of general combining ability of six parents for all the characters under study are given in **(Tables 1 and 2)** For plant height (cm), the highest GCA estimates of 4.23 were scored by SD-16 and the lowest of -6.99 by SD-15. In cotton breeding programs, since bushy compact and early maturing type plants are preferred in intensive cultivation of cotton-wheat-cotton rotation system, selection on the basis of negative general combining ability estimates would give the targeted results/phenotypes and must be criterion accordingly in the pedigree record breeding procedure. For number of sympodia per plant, parent SD-12 scored the highest GCA and SD-15 was the lowest. SD-16 scored highest GCA (1.19) for number of bolls per plant and SD-15 was the lowest with -1.79 GCA value. For boll weight (gm), SD-13 secured highest GCA of 0.23 while SD-14 ranked lowest (GCA = - 0.25). With respect to seed cotton yield per plant (gm), SD-13 scored maximum GCA value of 6.70 while SD-14 ranked lowest (GCA = -5.75). Except for plant height (as already explained), selection of parents on the basis of high general combining ability estimates must be correlated with the estimates of GCA variances and GCA mean squares to account for significant additive gene effects and additive x additive component of gene effects. For example, selection of high yielding parents on the basis of high GCA values and significant additive gene effects (variances of GCAs), coupled with directly and proportionately correlated yield components like sympodia per plant, number of bolls per plant and boll weight, is quite easy, less time consuming and phenotypically comprehendible on the basis of criterion parameter estimates. But selection becomes comparatively more tedious, less comprehendible and moderately effective when targeted high yielding genotypes are simultaneously programmed with fiber

Table 1. Mean squares from the analysis of variance of general and specific combining ability of 6x6 F_1 cotton diallel cross for five quantitative characters at Sindh Agriculture University Farm, Tandojam.

Source of variation	D.F	**Plant height (cm)**	**Sympodial branches per plant**	**Bolls per plant**	**Boll weight (gm)**	**Yield per plant (gm)**
Replications	2	14.06	0.07	0.69	0.02	1.51
GCA's	5	171.86*	9.38**	14.41**	0.29**	228.69**
SCA's	9	171.87**	4.49**	4.28**	0.17**	270.15**
Error	28	32.88	0.39	0.43	0.02	4.77
GCA Variances	-	14.32	0.78	1.20	0.02	19.06
SCA Variances	-	57.23	1.49	1.43	0.06	90.05

*, **= Significant at 5% and highly significant at 1% probability levels, respectively

Table 2. General and specific combining ability estimates from 6x6 F_1 cotton diallel cross for five quantitative characters at Sindh Agriculture University Farm, Tandojam.

Particulars/Traits	Plant height (cm)	Sympodial branches per plant	Bolls per plant	Boll weight (gm)	Yield per plant (gm)
General Combining Ability					
SD-12	-058	0.99	0.08	0.01	0.04
SD-13	0.55	0.35	-0.72	0.23	6.70
SD-14	1.80	0.21	0.83	-0.25	-5.75
SD-15	-6.99	-1.64	-1.79	0.06	-2.55
SD-16	4.23	0.20	1.19	0.01	2.98
SD-17	0.99	-0.10	0.41	-0.06	-1.42
Specific Combining Ability					
SD-12 x SD-13	6.78	0.77	-0.43	0.30	9.43
SD-12 x SD-14	1.10	-0.62	-0.87	0.05	-2.14
SD-12 x SD-15	-6.05	-0.98	-0.23	-0.36	-11.87
SD-12 x SD-16	4.04	1.65	1.90	-0.05	3.63
SD-12 x SD-17	-5.87	-0.82	-0.37	0.06	0.95
SD-13 x SD-14	-9.34	-0.04	-0.33	-0.06	-3.71
SD-13 x SD-15	2.32	0.46	0.52	0.18	6.40
SD-13 x SD-16	5.87	-0.18	0.83	-0.25	-1.57
SD-13 x SD-17	-5.63	-1.01	-0.58	-0.16	-10.54
SD-14 x SD-15	7.03	1.00	0.71	0.18	9.71
SD-14 x SD-16	-1.27	-0.19	0.00	0.03	2.01
SD-14 x SD-17	2.48	-0.15	0.49	-0.20	-5.87
SD-15 x SD-16	-10.48	1.87	-2.09	-0.02	-11.89
SD-15 x SD-17	7.18	1.39	1.09	0.01	7.64
SD-16 x SD-17	1.84	0.59	-0.64	0.29	7.82

quality characters like staple length, fiber strength and fiber fineness. In that particular case, the cotton breeder has to be more vigilant, knowledgeable in exercising the art of discarding troubled genotypes and religiously follower of pedigree record breeding/selection on the basis of GCA estimates coupled with GCA variances and mean squares for GCA components/variances.

The estimates of specific combining ability of 15 one-way crosses for all the five quantitative characters in 2007 F_1 diallel set are also given in Table-2. Here, since the specific combining ability of a particular cross is the deviation of hybrid mean from overall mean of the hybrids for that particular character, the sum of deviations over those hybrid arrays would be approximately zero. For plant height (cm), the maximum SCA estimates were given by the hybrid SD-15 x SD-17 (SCA = 7.18) followed by 7.03 SCA value of hybrid SD-14 x SD-15 and the lowest SCA value was given by hybrid SD-15 x SD-16 (SCA = -10.48) followed by hybrid SD-13 x SD-14 (SCA = -9.34). For sympodial branches per plant, hybrid SD-15 x SD-16 scored the highest SCA value of 1.87 followed by hybrid SD-12 x SD-16 (SCA = 1.65) and the lowest SCA estimates were given by hybrid SD-13 x SD-17 (SCA = -1.01) followed by second lowest hybrid SD-12 x SD-15 (SCA = -0.98). With respect to number of bolls per plant, hybrid SD-12 x SD-16 scored the highest value (SCA = 1.90) followed by second highest SCA value of 1.09 by hybrid SD-15 x SD-17 while the lowest SCA was recorded in hybrid SD-15 x SD-16 (value = -2.09) followed by second lowest SCA of -0.87 in hybrid SD-12 x SD-14. For boll weight (gm), highest SCA scoring hybrid was SD-12 x SD-13 (SCA = 0.30) followed by SD-16 x SD-17 with SCA value of 0.29 and the lowest SCA scoring hybrid was SD-13 x SD-16 (SCA = -2.25) followed by -0.20 SCA value of hybrid SD-14 x SD-17. For seed cotton yield per plant (gm), highest SCA estimates were given by SD-14 x SD-15 (SCA = 9.71) followed by hybrid SD-12 x SD-13 with SCA score of 9.43 and the lowest SCA estimates giving hybrid was SD-15 x SD-14 (SCA = -11.89) followed by second lowest ranking hybrid SD-12 x SD-15 (SCA = -11.87).

REFERENCES:

Darren, D.J. and C.W. Smith, (2006) Early generation testing in upland cotton. Crop Science, Vol. (46): 1-5.

Falconer, D.S. and F.C. Mackay. (1996) Introduction to Quantitative Genetics, 4th Edition. Longman, Essex, UK.

Griffing, B. (1956) Concept of general and specific combining ability in relation to diallel crossing system. Australian Journal of Biological Sciences, Vol. (9): 463-493.

Hennawy, M.A. (1996) Heterosis and combining ability in diallel crosses of eight bread wheat varieties. Bulletin, Faculty of Agri. Univ. of Cairo, Vol. (47): 379-392.

Iqbal, K. and M.S. Choudhry, (2000) Combining ability estimates of some quantitative characters in five spring wheat (*Triticum aestivum* L.) genotypes. Pakistan Journal of Biological Sciences, Vol. (3): 1126-1127.

Matzinger, D. F. (1963) Experimental estimates of genetic parameters and their application in self-fertilizing plants. In: W.D. Hanson and H. F. Robinson (Eds.), Statistical Genetics and Plant Breeding. National Academy of Science, National Research Council. Washington, D.C. USA. Publication no: 982.

Sprague, G.F and L.A. Tatum, (1942) General *versus* specific combining ability in single crosses of corn. Journal of American Social Agronomy, Vol. (34): 923-952.