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COMBINING ABILITY ESTIMATES IN 5X5 DIALLEL INTRAHIRSUTUM CROSSES

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Abstract

A study was carried out to determine general and specific combining abilities of seed cotton yield, number of bolls, sympodial branches, ginning outturn percent, seed and lint indices from 5x5 diallel intrahirsutum crosses. Qalandari was the best general combiner of the parents studied for seed cotton yield and number of bolls followed by K-68-9. Parent Acala SJI which had the poorest general combining ability for yield and number of bolls, was the top parent for ginning outturn percent and seed and lint indices. The parents that formed the best general combining ability did not always form best specific combining ability with every other parents, however, Qalandri with highest general combining ability estimate also ranked first in specific combination with NIAB-78. The regression of observed vs expected values suggested the importance of specific combining ability (control of dominant genes) for seed cotton yield and seed and lint indices, and general combining ability (control of additive genes) for number of bolls, sympodial branches and ginning outturn percentage. The consistency in estimates of combining ability for bolls and yield indicate that selection based on number of bolls will result in simultaneous improvement in cotton yield.

Introduction

Genetic improvement in any quantitative character depends on effective selection among individuals that differ in genotypic value. The genotypic value of individuals in. determined by various types of gene actions such as additive, dominance and their interactions. In quantitatibe genetics, it is the gene actions that are associated with the breeding value of individuals (Falconer, 1981). In plant breeding, effective selection relies on the breeding value of an individual and is that portion of genotypic value that determines the mean performance of its progeny. Thus, breeding value of progeny is determined by the average effect of genes, also referred to as additive effect of genes, and not the dominance. Whereas dominant genetic effect, on the otherhand, is the result of interaction of genes within the locus and is important for hybrid crop development. Determining the types of gene actions for various characters in cotton, therefore, has important implications in directing plant breeding strategies. Diallel analysis is one of the mating design being widely used in predicting combining abilities of the parents, ultimately the type gene actions involved in the expression of any trait. Sprague & Tatum (1942) further split the term combining ability into general combining Ability (GCA) and specific combining ability (SCA). The GCA effect is determined by additive genes and is used to designate the performance of the parents in general combination whereas SCA effect is determined by dominant genes and is used to designate the

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Table 1. General combining ability estimates and experimental mean of 5x5 diallel intrahirsutum crosses.

Parent	Yield/ plant	Bolls/ plant	Sympodial branches	Ginning outturn %	Seed index	Lint index
NIAB-78	-1.719	1.815	-0.535	-0.092	0.215	0.086
CRIS-18	-0.467	-0.340	1.040	0.083	0.135	-0.049
K-68-9	1.356	1.685	0.915	0.048	-0.110	-0.047
Qalandri	2.758	3.185*	0.490	-0.305**	-0.285*	-0.209**
Acala SJI	-1.922	-2.715*	-1.910	0.268**	0.315*	0.219**
SE (gl)	1.200	1.310	-0.955	0.056	0.125	0.031
Experimental-mean	54.37	26.89	21.81	33.89	8.41	4.31

*Twice as great or greater than S.E. (Si), **Thrice as great or greater than S.E. (Si)

hybrid performance in specific combinations. Diallel analysis is, therefore, of great value to plant breeders who attempt to select parents to be used in hybrid cotton and also for those whose primary objective is, to transfer specific traits as it assists them in identifying desirable parents for producing potential segregating populations for selection.

Materials and Methods

Five diallel parents, three commercial cultivars (NIAB-78 K-68-9 and Qalandri), one newly evolved strain (CRIS-18) and one exotic (Acala SJ1) were planted in 1990. The 5x5 diallel crosses in 10 cross combination without reciprocals were attempted in large number so as to produce enough hybrid seed for replicated testing. During 1991, F_1 seeds from all 10 cross combination were sown in a randomized complete block comprising of 4 replications. Two to three seeds per hill were planted, thinned to one plant per hill with a distance of 2.5' between rows and 9.0" between plants. Twenty F_1 plants in each progeny in each replicate were tagged and treated as index plants for recording the data. The data on 6 characters viz., yield per plant, bolls in each plant, sympodial branches per plant, ginning outturn calculated as % of lint, seed index as the weight of 100 seeds and lint index with the formula:

$$\text{Lint index} = \frac{\text{GOT\% x seed index}}{100 - \text{GOT\%}} \text{ were recorded.}$$

The estimates of general combining ability and specific combining ability were determined as suggested by Simmonds (1979). The GCA was calculated as the difference between the average performance of the parents and the experimental mean.

The characteristic feature of GCA is that since it is estimated from the experimental mean, the sum of GCA's of each trait adds to zero. The SCA effects were determined as the difference of observed minus expected value of a particular cross combination where expected value was considered as the sum total of GCA of female parent, GCA of male parent and experimental mean (Simmonds, 1979). Observed values were plotted against the expected values so as to determine the relative importance of additive and dominant gene actions.

Results and Discussion

Plant breeders have long observed that in a hybridization programme, certain combinations contribute more favourable genes in the progeny than other combinations. Thus the combination of parents with ability to transfer genes in the hybrid is called "The combining ability of the parents" (Sprague & Tatum, 1952).

The estimates of GCA for 6 imprtant characters with respect to all 5 parents are presented in Table 1. Qalandri and K-68-9 were first and second for GCA effects for yield of seed cotton and number of bolls per plant. The lowest general combiner parents were Acala SJI and NIAB-78, respectively, for both traits. Number of sympodial branches was of little importance in ranking the parents because the parents that were good general combiner for yield and number of bolls did not hold a similar position for sympodial branches. The parent Acala SJI which had the poorest GCA effects for yield, number of bolls and sympodial branches gave significantly maximum GCA for ginning outturn %, seed index and lint index. Our GCA results thus suggested varietal difference for combining ability effects. This means that the varieties contained different type of genes for different characters. The commercial variety, Qalandri showed better GCA than the exotic Acala SJI and new strain CRIS-18 which may be due to their highly adaptive nature and accumulation of more favourable genes during selection programme. Similar results showing that adapted varieties have better general combining ability than exotic lines were reported by Khan *et al.*, (1980) and Shahani & Chang (1985). That Qalandri manifested maximum GCA values for yield of seed cotton as well as the highest GCA value for number of bolls indicates that number of bolls, a rather less complicated trait as compared to yield, may be the best criterion for improving cotton yield and that this parent may also be chosen for developing populations for better segregates.

The highest specific combining ability estimates (Table 2) for yield and number of bolls per plant were noted from the cross NIAB-78 x Qalandri and next for yield only was CRIS-18 x K-68-9. Interestingly Qalandri and K-68-9, which had the best general combining ability for yield and number of bolls, did not form the best specific combining ability between each other or with every other parent. Such similar results have been reported by Khan *et al.*, (1980), Azhar *et al.*, (1983), Soomro (1984), Khan *et al.*, (1985). Shahani & Chang (1985) and Baloch *et al.*, (1993) in that the highest GCA scoring parent may not always produce hybrid with highest SCA for the particular character. For ginning outturn %, cross K-68-9 x Acala SJI recorded significantly maximum SCA effect suggested the importance of dominant genes in this hybrid. The highest ranked crosses for seed index were NIAB-78 x Acala SJI, CRIS-18xK-68-9 and

Table 2. The specific combining ability estimates and experimental mean of 5x5 diallel intra-hirsutum crosses.

Parent	Yield/ plant	Bolls/ plant	Sympodial branches	Ginning outturn%	Seed index	Lint index
NIAB-78 X CRIS-18	-3.18*	-4.930	1.88**	0.005	-0.49*	-0.260*
NIAB-78 X K-68-9	1.99	-1.120	-0.29	-0.180	-0.32	-0.203
NIAB-78 X Qalandri	6.59**	8.34*	0.23	-0.073	0.46*	0.249*
NIAB-78 X Acala SJI	-2.73	-4.360	-2.37**	0.010	0.56*	0.302*
CRIS-18 X K-68-9	2.75	5.165	0.73	0.165	0.54*	0.312*
CRIS-18 X Qalandri	2.00	-0.235	0.06	0.008	-0.09	-0.026
CRIS-18 X Acala SJI	-4.98**	-0.335	-1.64*	-0.095	-0.09	-0.073
K-68-9 X Qalandri	-2.48	-4.760	-0.72	-0.337*	-0.41	-0.288*
K-68-9 X Acala SJI	0.00	-0.080	-1.19	0.400**	0.08	0.134
Qalandri X Acala SJI	1.00	-0.160	0.91	-0.047	-0.24	-0.143
S.E. (Si)	1.56	3.251	0.61	0.113	0.21	0.120
Experimental mean	54.37	26.89	21.18	33.89	8.41	4.31

*Twice as great or greater than S.E. (Si), **Thrice as great or greater than S.E. (Si)

NIAB-78 x Qalandari, whereas the highest ranked crosses for lint index were CRIS-18 x K-68-9 and NIAB-78xAcala SJI. Specific combining ability results, therefore, suggested that if yield in cotton is to be improved, the cross NIAB-78 with Qalandri which gave maximum effects for yield and bolls and reasonably significant effects for seed and lint indices will form the superior combination for hybrid crop development.

To ascertain the relative importance of GCA vs SCA, the regression of observed values for all the traits was plotted against expected values calculated from GCA's of the parents (Simmonds, 1979). Deviation of points from the regression line vertically or horizontally correspond to the SCA effects. The negative effects are on the right and positive effects to the left on the regression line (Fig.1). Correlation coefficient between the observed vs expected values show closeness of the values to the regression line and r^2 which is the coefficient of determination and accounts for the portion of variability explained by any character due to SCA effects. Since there is large deviation between the observed and expected values on regression line for yield, the importance of SCA for this trait is shown in (Fig.1). Heterosis in the expression of yield due to dominant genes may also be an explanation for the greater importance of SCA for this trait. For the traits bolls per plant, sympodial branches and ginning outturn %, the larger number of hybrids show minimum deviations of points from the regression line and quite high correlations between r values (ranging from 0.894 to 0.914) demonstrates the greater importance of GCA for these traits. Rather large deviation of points from regression line and r values for seed and lint indices suggest greater importance of SCA effects and indicated that partial dominant genes were functioning for these two traits. Our results provide two options: i) since the number of bolls is the major criterion for

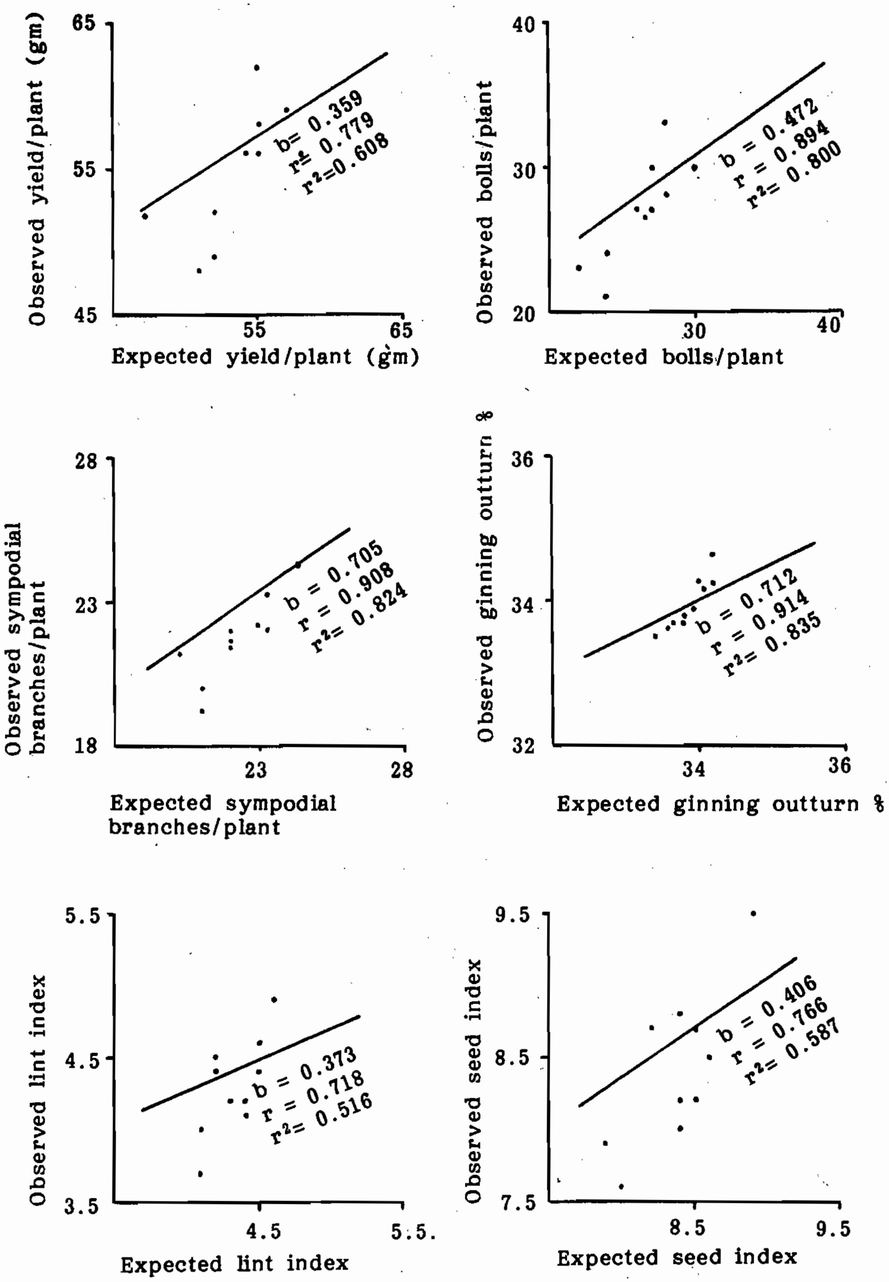

Fig. 1. Regression of observed values on expected values of hybrids to ascertain relative importance of general and specific combining ability for various traits in cotton.

improving cotton yield and is controlled by additive type of genes, selection indirectly for number of bolls will ultimately increase cotton yield, ii) since yield is controlled by dominant genes, specific combinations that give higher yield may be used for hybrid crop development. In the present study, dominant genes are found more important for yield, seed and lint indices and additive genes for number of bolls are in agreement with those of Al-Rawi & Khohel (1970), Khan *et al.*, (1980), Shahani & Chang (1985), Said *et al.*, (1989) and Baloch *et al.*, (1991).

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