Pak. j. sci., ind. res., vol.40, nos.5-12, May-December 1997

COMBINING ABILITY ESTIMATES OF HIGHLY ADAPTED TESTER LINES CROSSED WITH POLLINATOR INBREDS OF COTTON, *GOSSYPIUM HIRSUTUM* L.

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(Received June 30, 1996; revised February 23, 1997)

Five high yielding and well adapted hirsutum tester inbreds were crossed with five advanced pollinator strains to study their General Combining Ability (GCA) and Specific Combining Ability (SCA) parameters for number of bolls, boll weight, seed cotton yield, lint% and fibre length. Of the tester lines, CIM-240 formed the highest GCA for number of bolls and seed cotton yield whereas among the pollinator parents, only CRIS-121 was good scoring general combiner for these two traits. Thus GCA results suggested that in a crossing programme, CIM-240 and CRIS-121 can be very useful parents to develop segregating population for selection. Per se hybrid performance for number of bolls and yield was not correlated with SCA with few exceptions. Tester CIM-240 and pollinator CRIS-121 performed relatively better for GCA, SCA and per se hybrid performance which indicated that these parents can better fit either for hybrid development or selection programme. Other characters such as boll weight, lint% and fibre length were less important in present studies becasue their GCA and SCA values were not so pronounced.

Key words: Combining ability, Tester and pollinator inbreds, Cotton.

Introduction

Early evidences showed that certain inbred lines were better than others in transmitting favourable genes to their offsprings. Richy and Mayer [1] emphasized that due to the lack of any definite correlation between the parent and their offspring, selection for combining ability must be based on the performance of the lines in crosses rather than the lines per se. Thus the evaluation of the parents intended to be used in hybridization programme has been advocated in respect of General Combining Ability (GCA) and Specific Combing Ability (SCA) of the parents. Sprague and Tatum [2] used the term General Combining Ability for parents and specific Combining Ability for hybrids to designate their respective performance. The essential idea was to consider a systematic set of crosses between a number of parents and determine to what extent the variation among crosses can be interpreted as statistically due additive features of the parents and what must be attributed to the residual interactions.

In a hybridization programme, making huge number of crosses and evaluating the progeny performance for F1 to subsequent generations is very tedious and expensive job. In that situation it would be more desirable to develop a method that efficiently help in selecting the parents that produce outstanding hybrid combinations and better segregating populations for selection in early generations.

A tester line method as suggested by Rawling and Thompson [3], correctly classifies the relative performance of lines and discriminate efficiently among lines under investigation. Hallauer [4] suggested that in general, a suitable tester should include simplicity in use, provide information that correctly classifies the relative merit of lines and maximize genetic gain. Either early or late generation testing, the ultimate breeding objective is the choice of tester line to evaluate combining ability. Thus when aimed at replacing a parental line on the basis of its performance in specific combination, SCA is of prime importance and the most appropriate tester would be the opposite inbred line parent for single crosses or the opposite single-cross parent of a double cross [5]. Baloch *et al.* [6] regressed observed vs expected values to ascertain relative importance of general and specific combining abilities and noted that for seed cotton yield and lint percentage specific combining ability was more important. However, when selecting for GCA, the apparent requirement is that the tester parents should transmit their better genes to a series of offsprings thus enriching the chances of selecting better segregates in the filial generation. Soomro *et al.* [7] used six cotton lines as tester parents and observed that most of them were good general combiner for seed, cotton yield and number of bolls. In the present studies, five high yielding and well adapted hirsutum lines have been crossed as female tester lines with five advanced strains developed at Cotton Research Institute, Sakrand. The purpose of the studies was to isolate the best tester female parents and the pollinator male parents on the basis of GCA for selection in filial generations and SCA for hybrid crop development.

Materials and Methods

Four well adapted and high yielding Punjab varieties viz, NH-26, CIM-240, BH-36, S-12 and one advance strain CRIS-7A, developed at Cotton Research Institute were used as fe-

male tester parents and five strains, CRIS-121, CRIS-122, CRIS-124, CRIS-127 and CRIS-129, all evolved at Cotton Research Institute, Sakrand were used as male pollinator parents in the combining ability studieds. In a crossing programme of 1992, each female tester parent was crossed with five male pollinators. In this way a total of 25 combinations were made. The crossed bolls were raised during 1993 as F1 in a randomized complete block design with four replications in a plot size of 10'x 40'. The seeds were hand dibbled, (3 seeds per hole) so as to avoid a wastage of F1 seed by excessive use if drilled. The final plant population was maintained as one plant per hole at a distance of 1.0' plant to plant and 2.5' row to row. All the inputs like fertilizer, irrigation and insecticides were applied in recommended doses whenever required. In each repeat and each combination, 15 randomly selected plants were tagged as index plants for recording the data. The observation on number of bolls per plant was taken after about 90% bolls were opened and the boll weight was recorded from the average of 5 bolls picked from 5 index plants and weighed in grams. The seed cotton yield per plant was recorded in grams, lint in percentage and fibre length in millimeter.

The General Combining Ability (GCA) and Specific Combining Ability (SCA) analysis and estimates were determined as explained by Simmonds [8]. Since GCA values were estimated from the general mean, the sum of GCAs of each group of hybrids added-up to zero. SCA estimates were calculated as the difference of observed minus expected value of particular cross combination whereas expected values were determined as the sum total of GCA of o parent and general mean [8].

Results and Discussion

Cotton breeders are well aware of the fact that in a hybridization programme, certain parents contribute more favourable genes to the progeny than the others.Thus combination of parents with ability to transfer genes in the progeny is called "The Combining Ability of the Parents" [2].

The per se hybrid performance, their GCA and SCA estimates are presented in Table 1-3 respectively. Five tester female parents that were frequently used in our routine hybridization programme were pollinated with five newly evolved, genetically pure high yielding strains for determining their GCA and SCA performance. This information was expected to provide cotton breeders guideline for selecting breeding strategy, useful in making crosses among the parents under study.

The mean squares from analysis of variance for GCA and SCA for all the traits were significant and allowed to estimate the values of each parent. In the per se hybrid performance (Table 1), hybrids NH-26 x CRIS-121 and NH-26 x CRIS-122 were the first and the second best high yielding hybrids thus expected to perform similarly for SCA. This type of interpretation was found in the reports of Srinivasan and Grurajan [9], Julka *et al.* [10], Soomro *et at.*, [11] and Khan *et al.* [12]. Similarly for number of bolls, hybrids CIM-240 x CRIS-121 and CIM-240 x CRIS-129 ranked the best by setting first and second maximum number of bolls per plant. The interpretation that hybrid performance per se could correlate with specific combining ability value of that hybrid did not hold true for number of bolls where hybrid BH-36 x CRIS-129, ranked the first followed by hybrid CIM-240 x CRIS-121.Thus numerous reports favour the present results that hybrid performance per

TABLE 1 PERFORMANCE OF F1 HYBRIDS OBTAINED FROM THE CROSSES OF TESTER X ADVANCED STRAINS, DURING 1994.

Tester and pollinator	Number of bolls	Boll weight (g)	Seedcotton yield/plant (g)	Lint %	Fibre length (mm)
NH-26					
CRIS-121	50	3.8	191.0	34.1	28.5
CRIS-122	55	3.5	208.0	38.6	27.8
CRIS-127	54	2.6	143.0	37.7	27.7
CRIS-129	52	2.7	140.0	40.5	26.8
CRIS-130	49	3.9	194.0	39.9	28.2
CIM,-240					
CRIS-121	82	3.1	253.5	35.4	27.4
CRIS-122	66	3.0	195.8	36.5	27.8
CRIS-127	69	2.9	198.5	36.7	27.8
CRIS-129	74	2.6	189.5	36.4	27.1
CRIS-130	60	2.9	172.9	37.4	28.3
BH-36					
CRIS-121	43	3.9	170.0	33.8	27.8
CRIS-122	37	3.1	115.2	36.5	26.9
CRIS-127	38	3.4	130.0	34.0	26.0
CRIS-129	58	2.8	164.5	35.0	26.5
CRIS-130	53	3.3	175.0	36.2	27.3
S-12					
CRIS-121	65	2.6	172.0	41.3	26.8
CRIS-122	52	2.7	140.0	40.8	27.0
CRIS-127	47	2.9	136.0	41.0	27.5
CRIS-129	46	3.0	138.0	39.7	27.1
CRIS-130	56	2.8	154.0	40.1	26.9
CRIS-7A					
CRIS-121	55	2.6	145.0	33.8	26.5
CRIS-122	48	2.8	135.0	33.5	26.1
CRIS-127	54	2.9	158.5	35.6	26.6
CRIS-129	46	2.4	113.0	33.5	27.3
CRIS-130	57	3.4	199.0	33.7	25.6
General Mean:	54.64	3.02	165.25	36.86	27.17

se could not necessarily be the basis of predicting their specific combining ability [6,7,13,14].

The performances of female testers and their pollinator parents regarding GCA estimates (Table 2) and SCA estimates (Table 3) were the ultimate factors in determining future usefulness of the lines either for hybrid development or better segregating populations for selection. Initially, combining ability was a general concept considered for classifying inbred lines relative to its cross performance. Later, this concept was renewed by Sprague and Tatum [2] and the expression of GCA and SCA had the significant impact on line evaluation and population improvement in any plant breeding programme. Thus they defined GCA as the average performance of a line in hybrid combination and SCA in case certain hybrids are either better or poorer than expected on the average performance of the parent inbred lines. They also emphasized that the estimates of GCA and SCA are independent of each other.

The tester lines efficiently discriminated the inbred pollinator lines under study. Of the tester lines, CIM-240 formed the highest GCA for number of bolls and yield. Whereas among the pollinators, only CRIS-121 was good scoring general combiner for both the traits. Due to high number of bolls and yield, GCA of CIM-240 and CRIS-121 suggested their greater usefulness in population development for selection. For lint%, high GCA scoring tester parent was S-12 and for the fibre length, it was NH-26. Among the male parents, CRIS-122 and CRIS-127 and the testers CRIS-7A were the poorest general combiner for almost all the traits. Similar result that showed that GCA was more important for the yield and the bolls was also reported by Baloch *et al.* [6,14].

For Specific Combining Ability, hybrids NH-26 x CRIS-122, CRIS-7A x CRIS-130 and CIM-240 x CRIS-121 ranked the first, the second and the third respectively in order of highest scoring hybrids for yield. Whereas for number of bolls, hybrids BH-36 x CRIS-129, CIM-240 x CRIS-121 and S-12 x CRIS-121 scored the first and the second highest GCA parents. Thus SCA results suggested that except hybrid CIM-240 x CRIS-121 which scored the third for yield, other hybrids were different from those that scored high for GCA. In other words, higher scoring GCA hybrids did not rank similar for SCA. The present results thus suggested that per se hybrid performance might not necessarily give positive correlation with SCA value of that hybrid for a particular character. The

TABLE 2. GENERAL COMBINING ABILITY ESTIMATES OF TESTER FEMALE PARENTS AND MALE POLLINATORS FOR FIVE QUANTITATIVE TRAITS.

Parents	Number of bolls	Boll weight (g)	Seedcotton yield (g)	Lint %	Fibre lenght (mm)
NH-26	-2.64	0.276	9.944	1.292	0.628
CIM-240	15.56	-0.124	36.784	-0.388	0.508
BH-36	-8.84	0.276	-14.316	-1.768	-0.272
S-12	-1.44	-0.224	-17.256	3.712	-0.112
CRIS-7A	-2.64	-0.204	-15.156	-2.848	-0.752
CRIS-121	4.36	0.176	21.044	-1.188	0.228
CRIS-122	-3.04	-0.004	-6.456	0.312	-0.052
CRIS-127	-2.24	-0.084	-12.056	0.132	-0.052
CRIS-129	0.56	-0.324	-16.256	0.152	-0.212
CRIS-130	0.36	0.236	13.724	0.592	0.088
General Mean	54.64	3.024	165.256	36.868	27.172
S.E. (gi)	4.5	0.18	7.51	0.40	0.12

TABLE 3. SPECIFIC COMBINING ABILITY ESTIMATES OF TESTER FEMALE PARENTS AND MALE POLLINATORS FOR FIVE QUANTITATIVE TRAITS.

Tester and pollinator Parents	Number of bolls	Boll weight (g)	Seedcotton yield/plant (g)	Lint (%)	Fibre length (mm)
NH-26					
CRIS-121	-6.36	0.324	-5.244	-2.871	0.472
CRIS-122	6.04	0.204	39.256	0.128	0.052
CRIS-127	4.24	-0.616	-20.144	-0.592	-0.048
CRIS-129	-0.56	-0.276	-18.914	2.188	-0.788
CRIS-130	-3.36	0.364	5.076	1.142	0.312
CIM-240					
CRIS-121	7.44	0.024	30.416	0.108	-0.508
CRIS-122	-1.16	0.104	0.216	-0.292	0.172
CRIS-127	1.04	0.084	8.516	0.088	0.172
CRIS-129	3.24	0.024	3.716	-0.232	-0.368
CRIS-130	-10.56	-0.236	-42.864	0.328	0.532
BH-36					
CRIS-121	-7.16	0.424	-1.984	-0.112	0.672
CRIS-122	-5.76	-0.196	-29.284	1.088	0.052
CRIS-127	5.56	0.104	-8.884	-1.232	-0.848
CRIS-129	11.64	-0.176	29.816	-0.252	-0.188
CRIS-130	6.84	-0.236	10.336	0.508	0.312
S-12					
CRIS-121	7.44	-0.376	2.956	1.908	-0.488
CRIS-122	1.84	-0.096	-1.544	-0.092	-0.008
CRIS-127	-3.96	0.184	0.056	0.288	0.492
CRIS-129	-7.76	0.524	6.256	-1.032	0.252
CRIS-130	2.44	-0.236	-7.742	-1.072	-0.248
CRIS-7A					
CRIS-121	-1.36	-0.396	-26.144	0.968	-0.148
CRIS-122	-0.96	-0.016	-8.644	-0.832	-0.268
CRIS-127	4.24	0.164	29.456	1.448	0.232
CRIS-129	-6.56	-0.096	-20.844	-0.672	1.092
CRIS-130	4.64	0.344	35.176	-0.912	-0.908
General Mean	54.64	3.024	165.256	36.868	27.172
S.E. (Si)	2.85	0.25	9.59	0.25	0.19

hybrids that manifested higher SCA values might be useful for hybrid cotton development. The parents, CIM-240 and CRIS-121, which scored the highest for GCA and also produced hybrid that ranked the third out of 25 in SCA values, suggested that for better yield these parents may be preferred for either selection programme or hybrid cotton. Boll weight was less important because GCA and SCA did not reach even a unit value. For lint % and fibre length, hybrids NH-26 x CRIS-129 and CRIS-7A x CRIS-129 respectively formed the highest SCA values. Thus lint % and fibre lenght results demonstrated that CRIS-129 was the best specific combiner parent in case these characters are considered important. Our results of SCA for lint % and fibre length are in accordance with the results of Baloch *et al.* [6], Soomro *et al.* [7] and Kalsy *et al.* [15].

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