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Combining Ability Analysis in Sorghum for Yield and its Attributing Traits

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Abstract

In the present study envisaged assessing the general combining ability of the parents and specific combining ability of the hybrids, using line x tester mating design. Thirty-three hybrids (derived from mating eleven lines with three testers in L x T design) along with their parents and checks (CSV-23, CSV-17 and PC-1080) were evaluated in randomized block design with three replications during kharif-2019 and 2020 at three environments. Data on ten randomly taken plants from each genotype in each replication were recorded on different quantitative characters. The ratio of ^{2}GCA/ ^{2}SCA being lesser than unity for all the traits except no. of primaries in E2 and protein content in fodder in E1, and pool. Hence, non-additive components played greater role in the inheritance of all the traits except above excluding traits. The ratio of ^{2}GCA/ ^{2}SCA was less than unity for all the characters indicating preponderance of non-additive gene action (dominance and epistasis). As regards over the environment highest percent contribution showed by lines for protein content in fodder (72.67), by testers for days to maturity (20.61) and line x tester interaction by grain yield per plant (69.32).

Key words : *Combining ability, line x terster, quantitative traits, RBD and yield.*

Introduction

Sorghum *(Sorghum bicolor* (L.) Moench) is an important rain-fed crop. It is an often-cross-pollinating crop with a genome, about 25 per cent the size of maize or sugarcane and having diploid (2n = 2x = 20) chromosomes. It is a C_4 plant with higher photosynthetic efficiency and higher tolerance to abiotic stress and biotic stress (1). It is the third most important food grain crop in India, next to rice and wheat. Sorghum stands first among the cereal fodder because of its faster growing habit, high yield potential, suitability to cultivate throughout the year, palatable and nutritious fodder quality, higher digestibility and various forms of its utilization like green chop, stover, silage, hay, etc.It is the primary necessity for the breeder to make choice of elite parentsfor hybridization to improve yield. Combining ability analysis is the main toolfor choice of parents as well as understanding of the nature of gene action (2). So, information on relative importance of general and specific combining ability is of huge use in the development of an efficient breeding programme. The present study was therefore conducted to estimate the general and specific combining abilities of parents and hybrids, respectively.

Materials and Methods

Eleven homozygous lines and three testers of sorghum were used as parents in this hybridization programme. The crossing programme was adopted using line x tester mating design. The parental lines, testers and their resultant 33 F_1s were evaluated with three standard checks at two different location in three environments of MPAUT, Udaipur, Rajasthan. The experiment was conducted in a RBD with three replications. The recommended agricultural practices were adopted to raise a healthy crop. All the recommended cultural package of practices was followed from sowing to harvesting of the crop. Data on ten randomly taken plants from each genotype in each replication were recorded on different quantitative characters *viz.* Plant height (cm), number of primaries per panicle, no. of seeds per primaries, grain yield (g/plant), dry fodder yield (g/plant) in all the three environments. Combining ability from line x tester analysis of variance (3) was carried out for the pooled data of the four environments including pool for all traits. The hybrids (crosses) mean squares were partitioned into variances due to testers and lines and due to interaction between lines and testers. The estimates of genotypic variances of testers and lines are equivalent to variance due totheir GCA, and that of their interaction is equivalent to variance due to SCA.

Results and Discussion

The analysis of variance for combining ability for yield and its attributing traitsare presented in Table-1. The ANOVA revealed significant varietal differences for genotypes, parents and hybrids for all the characters studied which was the indication of existence of sufficient variability among genotypes. Mean sum of square due lines was found significant for panicle length, number of seeds per primaries, protein content in grain, protein content in fodder. Whereas, variance due to testers was found

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Table-1 : Analysis of variance for combining ability in over the environment for different characters in sorghum.

Source of variation	df	Mean Sum of Square											
		Days to 50 % flowering	Days to maturity	Plant height	Panicle length	No. of primaries/ panicle	No. of Seeds/ primaries	Seed index (g)	Grain yield/ plant	DFY/ plant	Harvest Index	Protein content grain	Protein content fodder
Replication	2	10.83	10.34	92.88*	17.12**	28.35	5.99	0.023	19.79	60.1686	4.94	1.17*	0.16
Rep. x Env.	4	5.2	3.78	13.31	3.36	6.01	13.25	0.002	2.52	44.08	3.38	0.12	0.12
Crosses	32	68.13**	99.58**	341.44**	95.79**	713.34**	126.25**	0.34**	1571.55**	1792.44**	207.3**	6.49**	3.41**
Line effect	10	92.91	105	409.41	195.79**	814.33	207.4*	0.45	1461.14	2817.91	261	13.95**	7.93**
Tester effect	2	51.95	328.45*	114.28	50.14	343.6	142.78	0.03	408.85	1040.47	28.46	0.96	1.09
Line x Tester effect	20	57.36**	73.99**	330.18**	50.36**	699.82**	84.02**	0.33**	1743.02**	1354.9**	198.33**	3.32**	1.38**
Env. x crosses	64	24.77**	27.57**	302.66**	12.45**	109.95**	75.83**	0.09**	163.3**	194.33**	29.04**	3.32**	2.15**
Env. x Line effect	20	39.82*	16.05	320.19	17.01	101.73	87.22	0.18**	182.12	192.82	39.76	4.06	2.99
Env. x Tester effect	4	28.19	31.65	210.53	0.78	225.14	65.3	0.04	114.92	792.25**	4.68	4.69	0.68
Env. x L x T effect	40	16.9**	32.93**	303.11**	11.33**	102.54**	71.19**	0.06**	158.73**	135.3**	26.12**	2.81**	1.88**

Table-2 : Additive, dominance variance and per cent contribution of line, testers and their interaction in pooled environment.

Parameters	Days to 50 % flowering	Days to maturity	Plant height (cm)	Panicle length (cm)	No. of primaries per panicle	No. of seeds per primaries	Seed index (g)	Grain yield per plant (g)	Dry fodder yield per plant (g)	Harvest Index (%)	Protein content in grain (%)	Protein content in fodder (%)
vargca	1.07	3.38	3.76	1.9	8.99	2.67	0	14.57	30.17	2.24	0.11	0.07
varsca	5.85	7.79	33.88	5.22	76.37	8.55	0.04	191.79	147.38	21.61	0.33	0.14
Var Ad.	2.15	6.76	7.51	3.8	17.98	5.33	0.01	29.14	60.34	4.47	0.23	0.14
Vardom	5.85	7.79	33.88	5.22	76.37	8.55	0.04	191.79	147.38	21.61	0.33	0.14
Ad/vardom	0.3675	0.8671	0.2217	0.7269	0.2355	0.6239	0.2054	0.152	0.4094	0.207	0.6795	1.0128
Contribution of lines	42.61	32.95	37.47	63.87	35.67	51.34	40.42	29.05	49.13	39.35	67.12	72.67
Contribution of testers	4.77	20.61	2.09	3.27	3.01	7.07	0.47	1.63	3.63	0.86	0.93	1.99
Contribution of L x T	52.62	46.44	60.44	32.86	61.32	41.6	59.12	69.32	47.24	59.8	31.96	25.34

significant for days to maturity. Interaction mean sum of square *i.e.* environment x line and environment x testers were significant for days to 50% flowering, seed index and dry fodder yield per plant, respectively. Variance due to line x testers interaction were also found significant for all the traits. These findings indicating characters influence by environment on the expression of characters. Similar findings had been reported by (4,5,6). The GCA variances were higher as compared to SCA variances forall the characters. These types of result suggested the preponderance of additive gene action for yield and its attributes. The estimates of general combining ability effects for plant height, two lines SU-1539 (8.98, 7.9, 4.93 and 7.21 in E1, E2, E3 and pooled respectively) and SU-1080 (7.92, 6.02 and 3.0 in E1, E3 and pooled respectively) depicted positive significant GCA effects. These lines may be used in crop breeding hybridization programme for plant height improvement. Top six crosses for plant height namely, SU-1572 x SU-1561 (7.41), SU-1594 x SU-1561 (3.72), SU-1575 x SU-1601 (9.43), SPV-2165 x SU-1601 (7.09), SU-1581 x SU-1606 (6.37), CSV-15 x SU-1606 (7.77) appeared positive significant on pooled based. The estimates of GCA effectsfor panicle length revealed that outof eleven lines, SPV-946 (2.83, 2.14, 3.04, 2.67 in E1, E2, E3 and pooled respectively) and SU-1080 (4.89, 3.99, 2.11 and 3.66 in E1, E2, E3 and pooled respectively) among lines and tester SU-1606 (0.93, 0.78, 0.73 and 0.81 in E1, E2, E3 and pooled respectively) they were observed good general combiner and two crosses namely, SU-1594 x SU-1606 and SPV-2185 x SU-1606 found to be positive significant SCA effects. While SU-1581 x SU-1606 showed negative and significant SCA effects. Three lines *viz.,* SU-1539 (9.76, 16.37, 4.33 and 5.26 in E1, E2, E3 and pooled respectively), SU-1596 (6.77, 15.57, 7.42 and 5.02 in E1, E2, E3 and pooled respectively) and SU-1080 (9.17, 25.63,14.49 and 11.51 in E1, E2, E3 and pooled respectively) and tester SU-1601 (1.45,1.54 and 1.12 in E1, E2 and pooled respectively) were identified as good general combiners. The hybrids on pooled based *viz.,* SU-1572 x SU-1561 (7.82), SU-1581 x SU-1561 (11.06), SU-1600 x SU-1561 (13.97), SU-1080 x SU-1561 (5.77), SU-1596 x SU-1601 (7.13), SPV- 2165 x SU-1601 (2.78), SPV-2185 x SU-1601 (2.8), SU-1539 x SU-1606 (8.28), SU-1575 x SU-1575 x SU-1606 (8.25), SPV-2165 x SU-1606 (5.39), SPV-946 x SU-1606 (14.14) possessed positive significant SCA effects. Based on GCA effects two lines namely, SU-1581 (2.68, 4.67 and 2.82 in E1, E2, and pooled respectively and SU-1600 (1.81, 5.22, 2.77 and 5.26 in E1, E2, and pooled respectively) and one tester SU-1601 (1.06, 2.0 and 1.35 in E1, E2, and pooled respectively) were found to be good general combiners for number of seeds per primary. Cross combinations *viz.,* SU-1539 x SU-1561 (2.68), SU-1594 x SU-1561 (5.68), SPV-2165 x SU-1606 (4.93), SU-1581 x SU-1606 (1.81), SPV-2185 x SU-1606 (4.0) and SPV-946 x SU-1606 (1.92) depicted positive significant over the environment for number of seeds per primary. Looking to the most important character *i.e.* grain yield per plant, among lines SU-1596 (21.73, 13.62, 19.33 and 18.22 in E1, E2, E3 and pooled respectively) and SPV-946 (4.3, 6.02, 5.48 and 5.27 in E1, E2, E3 and pooled respectively), while tester SU-1601 (3.03, 2.62, and 2.26 in E1, E2, and pooled respectively) displayed positive and significant GCA effects implying their good general combiners. So, these lines and testers can be used as parents for yield improving breeding programme. A perusal of data on SCA effects revealed that 7 crosses in E1, 10 in E2, 10 in E3 and 11 crosses in pool were found to be positive significant SCA effects. Top performance crosses *viz.,* SU-1080 x SU-1606 (29.68), SPV-2165 x SU-1561 (22.51), SU-1594 x SU-1594 x SU-1561 (14.38), SPV-2185 x SU-1601 (12.75), SPV-946 x SU-1561 (7.96) SU-1575 x SU-1606 (6.39), SU-1539 x SU-1601 (5.54), SU-1572 x SU-1561 (4.09), SPV-946 x SU-1601 (3.51) and SU-1581 x SU-1601 (2.97) were observed positive and significant SCA effects and were found be best specific combiners in order to merit high grain yield per plant. So, these hybrids could be subjected to evaluate for further generation for yield improving programme. Data recorded for dry fodder yield per plant, perusal of data revealed that lines SU-1572 (13.43, 6.73, 19.47 and 13.21 in E1, E2, E3 and pooled respectively), SPV-2185 (14.25, 17.31, 9.35 and 13.63 in E1, E2, E3 and pooled respectively) and SU-1080 (8.9, 7.63, 11.25 and 9.26 in E1, E2, E3 and pooled respectively) whereas, testers SU-1601 (5.18, 3.08, 1.65 and in E1, E2 and pooled respectively) and SU-1606 (1.38, 6.94 and 2.08 in E1, E2, E3 and pooled respectively) were appeared with positive and significant GCA effects. Hence, these parents (lines and testers) to be considered desirable for dry fodder yield per plant. As regards the dry fodder yield the significant and positive SCA effects were expressed in 14 crosses in E1, 6 crosses in E2, 13 crosses in E3 and 15 crosses in pooled. However, four hybrids namely, SU-1572 x SU-1561 (5.56, 8.8, 9.06 and 7.81 in E1, E2, E3 and pooled respectively), SPV-946 x SU-1601 (9.44, 15.47, 10.18, and 11.69 in E1, E2, E3 and pooled respectively), SU-1080 x SU-1601 (9.97, 9.77, 8.41 and 9.38 in E1, E2, E3 and pooled respectively), SPV-2185 x SU-1606 (17.17, 25.93, 17.02 and 20.24 in E1, E2, E3 and pooled respectively) good specific combiner across and over the environment.

Conclusions

It can be concluded that there is both general combining ability and specific combining ability variances are highly significant for the studied characters indicating their importance of additive as well as non-additive types of gene action in controlling these traits. Both general combining ability and specific combining ability variances are highly significant for the studied characters indicating the importance of additive as well as non-additive types ofgene action in controlling these traits. Moreover, variances due to SCA are higher in magnitude than GCA for the yield and quality traits.

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