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Combining Ability in Sorghum

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The nature and magnitude of combining ability effects in 36 crosses of Sorghum involving two male sterile lines with 18 pollinators were studied in respect of yield per plant and other yield contributing charecters. The estimate of variance due to g.c.a. of the male was higher in almost all the charecters, indicating thereby the involvement of additive gene action. The parent 906 was proved to be the best general combiner followed by T 8 B and T 22 for yield per plant. The combination msck 60 A × 906 had the highest s.c.a. effects for yield plant. The crosses manifesting high s.c.a. effects involved low × high, high × high and low × low general combining parents which pointed out the dominant, additive and complementary type of gene action.

The choice of suitable parents for evolving better varieties or hybrids is a matter of constant concern to the plant breeders. Some idea of usefullness of the parents may be obtained from their direct performance, particularly for components of yield (Sikka and Jain, 1958). However, the nature of gene action may vary with the genetic structure and divergence between populations involved in hybridization. Consequently a high yielding line may not necessarily be able to transmit its superiority in cross combinations and vice-versa. It is therefore, necessary to assess the genetic potential of the parent by estimating their combining ability before they are used in a hybridization programme. The line × tester analysis suggested by Kempthorne (1957) and tried by various workers in several crops is an appropriate metdho, as, a relatively large number of varieties or cultivars can be tested by it.

The present study was under taken to examine the combining ability of some lines of Sorghum in the process of screening the vast germplasm available at Kanpur.

MATERIAL AND METHODS

The material consisted 36 F1's obtained from the crosses made betwen two male sterile lines, viz., msck 60 A and ms 2219 A and 18 pollinators. These 36 F1's were sown in a randomised block design with 3 replieations at Experimental Station Block 'E' U.P. Institute of Agricultural Sciences, Kanpur (C.S.A. University of Agriculture and Technology, Kanpur)

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TABLE I Analysis of variance for combining ability and estimates of components of variance

Source	d.f.	Days to flower	Days to maturity	Plant height	Diameter of stem	Length of cob.	Yield/ plant
Blocks	2						
Males	17	66.087**	286.607**	16292.57*	0.529*	32.75**	2111.66**
Females	1	773.34*	1020.500*	2706 25**	0.170*	103.25*	12.44
Males X Females	17	162.44**	67.931	399.80*	0.019	6.95	205.62**
Error	70	19.014	53.302	194.18	0.028	4.58	22.37
Estimates of components of variance							
S.c.a (Males Females)		4.876	47.75	68.536	0.003	0.79	0.023
g.c.a (Males)		158.761	101.816	384.40	0.025	16.05	32.20
g.c.a (Females)		4.049	−1.78	294.31	0.009	0.478	35.30

* Significant at 5% level of probability.
** Significant at 1% level of probability.

TABLE II Effects of general combining ability in six characters of Sorghum

Parents	Characters					
	Days to flower	Days to maturity	Plant height	Diameter of the stem	Length of cob	Yield/ Plant
msck 6'A	8.58	9.33	15.00	0.12	−2.9	−1.02
ms 2219A	−7.48	−9.11	15.01	−0.12	2.9	−1.02
- CO	1.666	2.795	16.875	0.084	0.818	1.811
Males						
IS 3922	−21.416	−13.39	−178.1	0.14	5.5	−56.08
IS 3796	−21.916	−21.39	−195.5	−0.12	3.7	−47.30
IS 2945	−9.916	−21.39	−180.8	−0.54	12.7	−54.75
IS 464	−50.416	−32.39	−232.9	−0.71	−10.2	−95.32
Swarna	−10.916	4.61	−173.3	−0.51	−6.0	−64.85
906	18 583	20.11	180.0	0.30	3.0	113.67
T3 B	18.583	18.61	120.9	0.10	−5.1	68.15
T3	13 583	12.11	131.2	−0.05	−12.5	3.68
48/12	15.583	15.61	202.6	0.19	8.3	21.02
5242-1A	16.583	20.11	44.8	0.17	1.3	43.04
60/9	9.583	21.11	138.7	−0.04	4.5	37.50
60/24	5.083	12.11	157.8	−0.16	−10.0	1.72
T.22	29.08	25.61	162.8	0.11	0.8	58.01
B21-2	−13 916	−15.39	−121.7	0.15	2.7	−33.09
IS 6922	−4.417	−31.39	13.1	0.06	4.4	10.07
IS 9569	2.083	−24.09	−25.9	−0.06	3.2	−14.66
58/3	10.083	22.11	46.6	−0.06	−8.0	59.78
B 21-1	−5.917	−11.89	−135.3	−0.05	1.7	−50.65
	5.015	8.397	16.019	0.607	2.468	5.453

TABLE III Specific combining ability effects in six characters of Sorghum.

Crosses	Days to flower	Days to Maturity	Plant height	Diameter of the stem	Length of cob.	Yield/Pla
msck 60A×IS3922	– 5.08	– 4.33	–33.0	–0.09	–8.6	17.13
msck 60A×IS3796	12.42	31.67	–27.6	–0.11	–2.0	10.01
msck 60A×IS2945	– 7.58	–11.33	–23.6	0.12	1.8	– 0.34
msck 60A×IS464	7.92	– 9.33	–11.8	0.04	2.6	2.59
msck 60A×Swarna	3.42	–11.33	–11.4	0.08	0.0	11.48
msck 60A×906	2.92	7.17	36.9	–0.07	3.5	40.51
msck 60A×T 8 B	– 3.08	1.67	35.2	0.19	–2.4	2.27
msck 60A×T 3	– 2.08	– 3.83	8.1	–0.14	–1.4	2.90
msck 60A×48/12	0.92	– 0.33	18.5	0.08	–2.6	– 9.76
msck 60A×5742-1A	– 1.08	1.17	24.1	0.00	3.8	19.30
msck 60A×60/9	1.92	1.17	13.4	0.05	–0.6	20.16
msck 60A×60/24	– 3.58	–11.83	11.3	0.13	1.5	9.72
msck 60A×T-22	– 2.58	4.67	–18.1	0.25	3.9	–22.65
msck 60A×B 21-2	3.42	9.57	—6.0	0.07	—1.4	20.30
msck 60A×IS 6922	– 3.08	—1.33	8.6	—0.19	0.1	1.25
msck 60A×IS 9669	0.42	2.17	—5.0	0.29	4.5	25.95
msck 60A×58/3	— 1.58	—4.83	—0.5	–0.27	—0.5	–16.68
msck 60A×B 21-1	– 3.58	0.83	–19.5	–0.34	—2.8	–13.59
2219A×IS3922	3.98	4.11	33.0	0.09	8.6	17.14
2219A×IS3796	13.52	–13.89	27.6	0.11	2.0	–10.00
2219A×IS2945	6.48	11.11	23.3	–0.12	—1.8	0.35
2219A×IS464	10.94	9.11	11.8	—0.04	–2.6	2.60
2219A×Swarna	—4.52	11.11	11.4	—0.08	0.0	—11.47
2219A×906	—4.02	–7.39	—36.9	0.07	–3.5	40.52
2219A×T8B	1.98	—1.89	–35.2	–0.08	2.4	–2.26
2219A×T3	0.98	–3.61	–8.1	–0.14	7.2	–2.89
2219A×48/12	—2.02	0.11	—18.5	–0.14	2.6	9.77
2219A×5742-1A	–0.02	–1.39	–24.1	0.0	—3.8	–19.29
2219A×60/9	–3.02	—1.39	—13.4	—0.05	0.6	—20.15
2219A×60/24	2.48	11.68	—11.3	—0.13	—1.5	—9.71
2219A×T22	1.48	–4.89	18.1	–0.25	—1.9	22.66
2219A×XB 21-2	–4.52	–9.89	6.0	—0.07	1.4	–20.29
2219A×IS6922	1.98	1.98	8.6	0.19	–0.1	—1.24
2219A×IS9669	–1.52	—2.39	5.0	–0.29	—4.5	—25.94
2219A×58/3	0.48	4.61	0.5	—0.27	0.5	16.69
2219A×B 21-1	2.48	0.61	19.3	0.34	2.8	13.60
CD at 5% level	7.084	11.86	22.648	0.279	3.477	7.683

in the year 1971-72. The inter row and inter plant distence were kept at 45 cm. and 15 cm. respectively. The observations were recorded for 6 characters, viz., days to flower, days to maturity, plant height (cm) and, diameter of the stem (cm), length of cob (cm) and grain yield per plant (g) on 5 randomly selected plants in each replication. The data were analysed according to the method suggested by Kempthorne (1957). The effects of the combining ability were estimated by standard methods suggested by Gupta and Singh (1967).

RESULTS AND DISCUSSION

The analysis of variance for combining ability and the estimates of variance due to general and specific combining ability are presented in Table I. The mean squares due to males, females and males X females were significant for all characters except for girth of the stem, length of the cob and days to maturity in case of males X females and yield per plant for female parents. A perusal of the estimates of variance for combining ability showed that the variance due to general combining ability of the males was higher in almost all the characters which indicated the involvement of additive gene action.

The general combining ability (g.c.a.) effects of male and female parents presented in Table II indicated that the female parent msck 60 A was found to be the better combiner for lateness, plant height and diameter of the stem, whereas the parent ms 2219-A was observed to be the good combiner for earliness, length of cob and yield per plant.

Among all the male parents studied, the strain 906, T 8 B and T. 22 were found to be the best combiners for grain yield per plant whereas, IS 464 swarna, IS 3922, IS 2945, B 21-1 and IS 3796 have proved to be the poor combiners for this character.

For early flowering the high combiners were IS 464, IS 3796, IS 3922, B 21-2, Swarna and IS 2945. All these varieties have also offered promise for early maturity except Swarna. On the other hand T 22, 906, T 8 B, 5742-1A, 48/12 and T 3 had shown possitive (g.c a.) effect for days to flowers as well as for maturity, thereby indicating their ability to combine well for lateness.

The variety IS 2945 was observed to be the best combiner for diameter of stem and length of cob followed by the varieties 906 and 48/12.

The diversity of the g c.a. effects of the various male parents can be attributed to the genetic as well as geographic diversity in the material. High g.c.a. effects observed for different charecters may be helpful in the determination of the different components of the yield and quality.

Estimates of specific combining ability effects (s. c. a.) (Table III)

revealed that 20 out of 36 crosses studied showed high s c.a. effect for increased yield The highest s.c.a. effect was exhibited by the hybrids msck 60 A x 906 and ms 2219 AX 906 followed by the hybrids msck 60 A x IS 9669 ms 2219 A x T 22, msck 60 A x B 21-2, msck 60 A x 60/9 and msck 60 A x 5742-1 A. The two combinations, viz , msck 60 A x 906 and ms 2219 A x 906 were hybrids envolving low x high and high and high combiners. The low x high combiners pointed the involvement of dominant gene action, which is unfixable, where as in high x high combiners (ms 2219 A x 906) additive or additive X additive type of gene interaction may be involved, which is fixable in nature. All the superior combinations involved atleast one high general combining parent. However, some crosses, viz , msck 60 A x IS 966 , msck 60 A x B 21-2, msck 60 A x Swarna and msck 60 A x 3796 exhibited high s.c.a. effects for yield although both the parents involved were low combiners, indicating there-by the role of complementary type of gene action. Such results have also been reported by Singh and Dhaliwal (1971) in wheat.

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