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COMBINING ABILITY ANALYSIS FOR QUANTITATIVE CHARACTERS IN FORAGE MAIZE (*ZEA MAYS* L.)

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SUMMARY

Combining ability for various quantitative traits viz., plant height, leaf length, leaf width, number of leaves per plant, leaf : stem ratio and green fodder yield per plant was studied through (5 x 9) line x tester mating design. Highly significant gca and sca variances on pooled basis for the traits indicated that sufficient variability existed for gca effect in the parents and that for the sca effect in the crosses. Higher and significant sca variances on pooled basis suggested a higher non-additive gene action for these traits. Parents J-1006 and African Tall among females and GWC-0512, GWC-0401 and GWC-0511 among males were found to be the best general combiners. The hybrids viz., IC-130726 x GWC-0512, IC-107121 x GWC-9603 and IC-130726 x GWC-9603 were found to be the best specific crosses for green fodder yield per plant and, therefore, these can be further exploited for selection of hybrids and transgressive segregants.

Key words : Combining ability, green fodder yield, line x tester, maize

Maize (*Zea mays* L.) is one of the most important cereals of the world. It has worldwide significance as human food, animal feed and as a raw material for large number of industrial products. It is a versatile, miracle crop. It is highly cross pollinated crop. Maize being a C_4 plant has the highest potential of per day carbohydrate productivity (Singh *et al.,* 2014).

Combining ability analysis is used in crop plants for identifying the superior parents for obtaining superior hybrid combinations. Besides, it also helps in characterization of nature and magnitude of gene action for various characters of economic importance. The concept of general and specific combining ability is an especially useful testing procedure that involves the study and comparison of the performance of homozygous inbred lines in cross combinations. The knowledge of gene action for characters helps in employing suitable breeding methodology for their improvement.

MATERIALS AND METHODS

The present study was conducted at the research farm of Main Forage Research Station, Anand Agricultural University, Anand (Gujarat) during **kharif** 2012 (E_1), **rabi** 2012 (E_2) and summer 2013 (E_3) seasons with the objective of getting information on combining ability and nature of gene action for fodder yield and its component characters in forage maize. Five lines (IC-107121, IC-130726, GM-6, J-1006 and African Tall) and nine testers (IC-130643, IC-130693, GWC-0319, GWC-0320, GWC-0321, GWC-0401, GWC-0511, GWC-0512 and GWC-9603) were crossed in line x tester fashion. The experimental material with 45 F_1s and 14 parents (5 lines + 9 testers) was planted in RBD with three replications. Each experimental plot consisted of two rows of 4.5 m length each. The inter-row and intra-row spacings were 30 and 15 cm, respectively.

For recording observations, five competitive plants were randomly selected from each treatment in each replication and the average value per plant was computed for various quantitative traits viz., plant height, leaf length, leaf width, number of leaves per plant, leaf : stem ratio and green fodder yield per plant. Analysis of variance and estimation of combining ability effects were made as per Kempthorne (1957).

RESULTS AND DISCUSSION

Analysis of variance for combining ability (Table 1) revealed that the gca variances on pooled basis were

highly significant for the characters viz., plant height, leaf length and leaf width. The sca variances on pooled basis were highly significant for all the characters. This indicates that sufficient variability exists for gca effect in the parents and that for the sca effect in the crosses. This also suggests that both additive and non-additive gene actions were important for the inheritance of all the traits and all the traits used in the study could be improved by proper choice of the parents, their hybridization and by adopting suitable selection methods. The higher magnitude of sca variance was observed for all the characters. High sca variance for yield and other characters have also been reported in maize by Parmar *et al.* (2008) and Abadi *et al.* (2011). The variance ratio for general combining ability to specific combining ability (σ^2gca /σ^2sca) indicating the role of both additive and non-additive gene action in the inheritance of characters was used in present study. This suggested that improvement of these traits could be possible by simultaneous exploitation of both additive and non-additive components.

The information regarding gca effect of the

TABLE 1
Analysis of variance on pooled basis for combining ability for different characters

Sources	Plant height	Leaf length	Leaf width	No. of leaves/plant	Leaf : stem ratio	Green fodder yield/ plant
σ^2gca	24.80**	6.17**	0.01**	-0.02	-0.003	-34.40
σ^2sca	121.00**	6.22**	0.293**	0.296**	0.05**	4700.00**
Error	74.13	22.79	0.40	0.69	0.003	199.88
σ^2gca/σ^2sca	0.68	0.91**	0.16	-0.02	0.01	0.03

**Significant at P=0.01 level.

TABLE 2
General combining ability effect of parents on pooled basis for different characters

Sources	Plant height	Leaf length	Leaf width	No. of leaves/plant	Leaf : stem ratio	Green fodder yield/plant
Lines						
IC-107121	-4.93**	-2.87**	-0.02	-0.49**	0.02	-26.81**
IC-130726	-10.36**	-1.46**	-0.21**	-0.08	0.06	-4.83**
GM-6	7.38**	0.87*	-0.20**	0.00	-0.03	-4.70**
J-1006	12.08**	4.98**	0.27**	0.38**	-0.10	32.78**
African Tall	-4.16**	-1.53**	0.16**	0.19	0.06	3.57**
SE (gi)	0.75	0.41	0.05	0.11	0.00	1.23
S.E (gi-gj)	1.06	0.58	0.07	0.16	0.00	1.74
C. D. (P=0.05)	1.48	0.81	0.14	0.22	0.00	2.42
Testers						
IC-130643	-1.49	0.02	0.16*	-0.05	-0.04**	-24.80**
IC-130693	-1.56	-1.05	0.09	-0.36*	-0.01	20.65**
GWC-0319	-3.64**	1.58**	-0.10	-0.60**	-0.02*	-7.53**
GWC-0320	-6.67**	-0.37	-0.04	-0.02	0.11**	-32.75**
GWC-0321	2.62*	-3.00**	-0.10	0.35*	-0.01	0.34
GWC-0401	5.59**	1.03	-0.08	0.48**	-0.09**	10.05**
GWC-0511	6.26**	1.62*	0.00	0.54**	-0.05**	22.49**
GWC-0512	3.83**	1.05	0.42**	0.18	0.00	38.20**
GWC-9603	-4.94**	-0.87	-0.36**	-0.53**	0.13**	-26.66**
SE (gi)	1.06	0.59	0.08	0.16	0.01	1.74
SE (gi-gj)	1.50	0.83	0.11	0.23	0.01	2.46
C. D. (P=0.05)	2.08	1.16	0.16	0.32	0.02	3.43

*,**Significant at P=0.05 and P=0.01 levels, respectively.

TABLE 3
Specific combining ability effects of crosses on pooled basis for different characters

Crosses	Plant height	Leaf length	Leaf width	No. of leaves/plant	Leaf : stem ratio	Green fodder yield/plant
IC-107121 x IC-130643	-8.84**	0.11	-0.09	-0.55**	0.00	-32.79**
IC-107121 x IC-130693	3.00	2.20	0.45**	0.26	-0.01	45.66*
IC-107121 x GWC-0319	7.47**	-2.45*	-0.14	0.10	0.13**	-47.39**
IC-107121 x GWC-0320	0.25	-0.83	-0.18	0.26	0.29**	18.84 *
IC-107121 x GWC-0321	2.60	0.43	-0.02	0.14	0.10**	-4.25
IC-107121 x GWC-0401	-3.71	2.46*	-0.46**	0.38	-0.06*	-33.74**
IC-107121 x GWC-0511	1.31	1.11	-0.08	-0.35	-0.14**	11.04**
IC-107121 x GWC-0512	-7.31**	-1.15	0.15	-0.20	-0.14**	-52.56**
IC-107121 x GWC-9603	5.22*	-1.90	0.37*	-0.04	-0.18**	95.19**
IC-130726 x IC-130643	12.52**	-2.49*	-0.05	0.44*	-0.05**	23.78**
IC-130726 x IC-130693	-12.67**	-4.30**	-0.45**	-0.62**	0.05**	-63.44**
IC-130726 x GWC-0319	-28.67**	-2.90*	-0.36*	-0.67**	0.10**	-38.15**
IC-130726 x GWC-0320	-0.38	1.73	0.19	-0.20	-0.14**	-16.26**
IC-130726 x GWC-0321	1.05	-0.74	-0.18	-0.16	-0.05**	-31.68**
IC-130726 x GWC-0401	0.91	-4.36**	-0.23	-0.54**	0.11**	-56.28**
IC-130726 x GWC-0511	4.82*	1.02	-0.08	0.13	0.25**	-23.4**
IC-130726 x GWC-0512	12.80**	7.78**	0.88**	0.70**	-0.16**	126.67**
IC-130726 x GWC-9603	9.63**	4.26**	0.27	0.92**	-0.12**	78.76**
GM-6 x IC-130643	-4.12	-2.95*	-0.02	-0.13	0.04**	4.33
GM-6 x IC-130693	-1.84	-0.76	0.34*	0.14	-0.05**	44.10**
GM-6 x GWC-0319	-1.85	2.23	0.30	0.31	0.15**	-5.05
GM-6 x GWC-0320	4.63*	-1.07	-0.14	-0.20	-0.20**	4.95
GM-6 x GWC-0321	-1.32	0.99	-0.20	-0.35	0.11**	-33.81**
GM-6 x GWC-0401	1.43	-0.09	-0.25	-0.33	-0.01	4.37
GM-6 x GWC-0511	-5.64**	-2.46*	-0.16	0.46*	0.06**	-49.3**
GM-6 x GWC-0512	1.47	0.23	-0.41*	-0.12	-0.02*	19.10**
GM-6 x GWC-9603	7.24**	3.88**	0.55**	0.21	-0.09**	11.30**
J-1006 x IC-130643	-0.39	3.50**	-0.27	-0.10	-0.03**	-8.93*
J-1006 x IC-130693	8.28**	0.35	-0.14	0.40*	0.22**	-14.82**
J-1006 x GWC-0319	14.07**	2.65*	0.11	0.14	-0.16**	38.36**
J-1006 x GWC-0320	-4.87*	1.17	-0.13	-0.20	0.17**	-10.09**
J-1006 x GWC-0321	-2.26	-0.96	0.44**	0.48*	-0.05**	37.49**
J-1006 x GWC-0401	0.78	0.23	0.18	0.14	0.03**	64.00**
J-1006 x GWC-0511	-7.13**	-0.95	0.02	-0.32	-0.09**	3.67
J-1006 x GWC-0512	-5.30*	-3.81**	0.04	-0.58**	-0.13**	-26.49**
J-1006 x GWC-9603	-3.20	-2.19	-0.25	0.03	0.04**	-83.18**
African Tall x IC-130643	0.84	1.82	0.43**	0.34	0.04**	13.61**
African Tall x IC-130693	3.24	2.51*	-0.20	-0.18	-0.22**	-11.5**
African Tall x GWC-0319	8.98**	0.46	0.09	0.12	-0.23**	52.23**
African Tall x GWC-0320	0.36	-1.00	0.26	0.34	-0.12**	2.57
African Tall x GWC-0321	-0.08	0.28	-0.05	-0.12	-0.11**	32.25**
African Tall x GWC-0401	0.59	1.76	0.75**	0.34	-0.08**	21.65**
African Tall x GWC-0511	6.64**	1.27	0.30	0.08	-0.08**	57.99**
African Tall x GWC-0512	-1.66	-3.05**	-0.66**	0.20	0.45**	-66.72**
African Tall x GWC-9603	-18.90**	-4.05**	-0.93**	-1.12**	0.35**	-102.08**
SE (sij)	2.11	1.17	0.16	0.20	0.01	3.47

*,**Significant at P=0.05 and P=0.01 levels, respectively.

parents is of prime importance as this would help in identification of suitable parents. The estimates of gca effect revealed that the female parent J-1006 was found good general combiner for green fodder yield per plant as well as for plant height, leaf length and leaf width. While female parent African Tall was found good general combiner for green fodder yield per plant as well as for leaf width. Among the male parents, GWC-0512 was a good general combiner for green forage yield and was also a good general combiner for plant height and leaf width. Another male parent, GWC-0511 appeared to be a good general combiner for green fodder yield per plant, plant height, leaf length and number of leaves per plant. Other male parent, IC-130693 was also good general combiner for green fodder yield per plant (Table 2).

Among crosses, the hybrids IC-130726 x GWC-0512, IC-107121 x GWC-9603 and IC-130726 x GWC-9603 exhibited significant sca effect for green forage yield per plant over environments. The estimates of specific combining ability effects revealed that J-1006 x GWC-0319 for plant height, IC-130726 x GWC-0512 for leaf length and leaf width, IC-130726 x GWC-9603 for number of leaves per plant and African Tall x GWC-0512 for leaf : stem ratio were the best specific cross combinations (Table 3).

The results are in conformity with those obtained earlier by Sharma *et al.* (2004), Premlatha and Kalamani (2010) and Sundararajan and Kumar (2011). The knowledge of combining ability of parents and hybrids can be of much help in further breeding programmes.

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