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Diallel analysis in grain amaranth (*Amaranthus* spp.)

S.B. PRAJAPATI, Y. RAVINDRABABU* AND D.B.PRAJAPATI
AICRP on Underutilized Crops, Regional Research Station, S.D. Agricultural University, Sardarkrushinagar, BANASKANTHA (GUJARAT) INDIA

ABSTRACT

A study involving 45 hybrids using 10-parent diallel excluding reciprocal for combining ability analysis in grain amaranth revealed higher magnitude of sca variance over gca variance for all the traits which indicated preponderance of non additive gene action. The parents GA-1, GA-2 and SKNA-7-1 were good general combiners for seed yield per plant and its five or more component traits. Eight out of 45 hybrids showed significant positive sca effects seed yield per plant and component traits.

Key words : Amaranth, Combining ability, Grain amaranth diallel and Yield attributing traits

INTRODUCTION

Grain amaranth has been reported to be more nutritive than common food grains. Recently this crop has gained lot of importance in the plains of India, especially in parts of Gujarat and Maharastra, whereit is known as "Rajgirah". In Gujarat, people who observe fast on *Ekadasi* or during other festivals prefer sweets prepared from amaranth grain, sugar and ghee popularly known as *"seera"*. The information about combining ability is of immense help to the plant breeder in the choice of suitable parents for hybridization programme. The nature of gene action has a bearing on development of efficient breeding programme. Looking to the importance of crop and necessity of understanding of combining ability of parents and nature of gene effects of yield and its components, present study was undertaken on diallel analysis in grain amaranth.

MATERIALS AND METHODS

Ten diverse genotypes of grain amaranth (*Amaranthus spp.*) were crossed 10 x 10 diallel fashions excluding reciprocals. The resulting F_1s along with their ten parents were sown in three replication in randomized block design (RBD) during *rabi* 2004-05 at All India co-coordinated Research Project on Under Utilized crops, Regional Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar. Each genotype was sown in 3m long single row keeping spacing of 45cm between plants and within rows, respectively. The observations were recorded on five competitive plants selected randomly in each genotype in each replication for seed yield per plant (g) and its component traits like, days to 50 per cent flowering, days to 80 per cent maturity, plant height (cm), earhead length(cm), number of fingers per ear head, number of branches per plant, finger length(cm), straw yield per plant (g), 1000-seed weight (g), harvest index (%) and protein content (%). Data were subjected to combining ability analysis following Griffing's (1956) Method-2, Model-I (fixed model).

RESULTS AND DISCUSSION

The results of analysis of variance for different characters are presented in Table 1. It revealed that mean squares due to gca were significant for all the traits except 1000-seed weight and protein content and mean squares due to sca were significant for all the traits except for

Table 1 : Analysis of variance for combining ability estimates of components of variance and their ratios for different characters in grain amaranths

Source of variation	D.f.	Days to 50% flowering	Days to 80% maturity	Plant height (cm)	Earhead length (cm)	No. of finger per earhead	Finger length (cm)	No. of branches per plant	Seed yield per plant (g)	Straw yield per plant (g)	1000-seed weight (g)	Harvest index (%)	Protein content (%)
GCA	9	184.49**	239.69**	3426.72**	482.28**	1272.23**	87.96**	17.60**	131.07**	442.00**	0.0019	77.25**	1.356
SCA	45	13.14**	19.58**	207.74**	37.93**	86.69**	8.27**	1.23	7.17**	62.67**	0.0037	6.03**	0.208
Error	108	0.333	1.328	14.811	4.13	8.94	1.50	0.04	1.540	8.645	0.000021	1.610	0.178
σ^2gca		0.025	0.099	1.110	0.300	0.67	0.11	0.003	0.110	0.640	0.0000016	0.120	0.013
σ^2sca		0.280	1.120	12.560	3.500	7.58	0.26	0.031	1.300	7.33	0.000018	1.36	0.15
σ^2gca/ σ^2sca		0.089	0.088	0.088	0.085	0.088	0.084	0.087	0.084	0.087	0.088	0.088	0.086

* and ** indicates significance of values at P=0.05 and P=0.01, respectively.

*** Author for correspondence**

number of branches, 1000-seed weight and protein content and mean squares due to sca were significant for all the traits excepts for number of branches, 1000-seed weight (g) and protein content. This indicating the importance of both additive and non-additive gene effect in the expression of yield and its competent. Comstock *et al.* (1949) has suggested the use of reciprocal recurrent selection for effective use of both additive and non-additive gene effects. A comparison of magnitude of estimates of variance revealed that variance due to sca was higher than that of the gca for all the traits which suggested the role of non-additive gene action in the inheritance of seed yield and its component characters. These results are in accordance with the findings of Pandey (1982) for seed yield per plant, plant height, panicle length, days to maturity, days to 50 per cent flowering. Pandey and Pal (1985) and Aruna and Ponnuswami (1998) for protein content and Pandey and Nath (2003) for harvest index. Lehman *et al.* (1991) also reported non-additive gene effects for inheritance of seed yield per plant.

The close examination of general combining ability effects of the parents (Table 2) revealed that none of the parents was found to be consistently good general combiner for all the characters. The parents GA-1, SKNA-7-1 and GA-2 were found to be good general combiners for seed yield per plant and majority of its direct components. Among these, GA-1 was the best general combiner as it possessed significant positive gca effects for yield per plant, earhead length, number of fingers per earhead, finger length, 1000-seed weight, protein content, straw yield per plant and harvest index in the desired direction. The parent SKNA-7-1 recorded positive significant gca effects for seed yield, plant height, number branches per plant, finger length, protein content, harvest index and early flowering and maturity. Parent, GA-2 exhibited significant positive gca effect for yield, ear head length, number of finger per earhead, early flowering, straw yield and harvest index in desired direction. Therefore, it would be worth while to use above parental lines in hybridization programme for the improvement in seed in grain amaranth.

Specific combining ability effects of hybrids revealed that none of the hybrids was consistently good for all the traits. However, as many as eight cross combinations exhibited significant and positive sca effects for seed yield per plant. These eight best specific combiners with their mean performance, gca effects of parents and their significant response to other traits are presented in Table 3. All these crosses showed significant positive response to two or more yield components indicating its direct effect for increasing seed yield per plant. However, five crosses showed significant response to number of fingers per earhead, straw yield per plant and harvest index, four for earhead length and 1000-seed weight, two for days to 50 per cent flowering and one each for plant height, days to 80 per cent maturity finger length and number of branches per plant. This may be because of very complex nature of seed yield and its dependence on its components.

Out of eight crosses showing high mean along with significant positive sca effects for seed yield per plant, two crosses were of good x poor and two crosses of poor of poor x poor gca of parents. The good x good gca combination could be due to additive and additive x additive type of gene action which is fixable in nature. The crosses involving one parent with significant high gca effects may throw desirable transgressive segregants if additive genetic system is present in good combiner and complementary epistatic effects in other, resulting F_1 to

Table 2 : Estimates of gca effects of parents for different characters in grain amaranth

Parents	Days to 50% flowering	Days to 80% maturity	Plant height (cm)	Earhead length (cm)	No. of finger per earhead	finger length (cm)	No. of branches per plant	Seed yield per plant (g)	Straw yield per plant (g)	1000-seed weight (g)	Harvest index (%)	protein content (%)
GA-1	1.14**	3.54**	17.81**	12.24**	14.09**	1.25**	-1.80**	6.23**	14.15**	0.02**	1.61**	0.28*
GA-2	-2.47**	0.46	11.77**	7.51**	9.10**	-0.08	-1.80**	6.08**	3.74**	-0.01	6.33**	0.00
IC-120588-1	-3.28**	-2.76**	8.62**	3.28**	3.58**	-2.17**	0.09**	-0.26	2.13**	0.00	0.95**	0.64**
SKNA-7-1	8.61**	-11.07**	-44.75**	-6.36**	-25.33**	6.96**	2.55**	0.90**	-8.87**	-0.02**	1.41**	0.26*
SKNA-18-1	1.19**	-1.01**	3.57**	-8.45**	-0.73	-2.95**	0.37**	-1.57**	1.96*	0.01**	-1.77**	-0.34**
AG-114-1	3.33**	0.93**	-2.39*	-1.81**	0.44	-0.13	-0.04	-1.75**	2.30*	0.01**	-1.79**	-0.07
SKNA-21	3.53**	1.35**	3.20*	1.23*	2.77**	-1.08**	0.20**	-1.62**	0.40	0.00	-1.60**	0.12
SKNA-20	1.47**	2.02**	0.97	-1.13*	-2.71**	-1.00**	0.13*	-1.62**	-2.84**	-0.01**	-1.12**	-0.44**
IC-95307	-0.61**	1.29**	-1.32	-4.94**	-1.52	-0.54	0.08*	-1.86**	-1.87**	0.00	-1.10**	0.33**
IC-35713	4.31**	5.24**	2.52*	-1.58**	0.30	0.25	0.21**	-2.73**	-3.64**	0.00	-1.01**	-0.13
SE±	0.15	0.31	1.05	0.55	0.81	0.33	0.05	0.33	0.80	0.001	0.34	0.11
C.D. at 5%	0.29	0.61	2.07	1.08	1.60	0.65	0.09	0.65	1.58	0.001	0.67	0.21
C.D. at 1 %	0.49	0.81	2.75	1.44	2.12	0.86	0.13	0.86	2.09	0.002	0.89	0.28

* and ** indicates significance of values at P=0.05 and P=0.01, respectively

Table 3 : Eight best specific combiners for seed yield per plant and their performance for other traits in grain amaranths

Crosses	sca effects	Mean seed yield per plant (g)	gca effects of parents	Significant response in other traits for sca effects in desired direction
GA-1XIC-120588-1	6.06**	29.74	G X P	Plant height, number of fingers/earhead,straw yield/plant,1000-seed weight, harvest index
GA-1XSKNA-18-1	5.82**	28.19	G X P	Earhead length, number of fingers/earhead, finger length, harvest index
GA-2XSKNA-7-1	4.11**	27.00	G X G	Earhead length,, number of fingers/earhead, straw yield/plant
GA-2XSKNA-21	3.87**	26.03	G X P	1000-seed weight, harvest index
SKNA-21X IC-35713	3.62**	15.39	P X P	Earhead length, number of branches/plant, straw yield/plant
GA-1XSKNA-7-1	3.54**	26.58	G X G	Number of fingers/earhead,straw yield/plant,1000-seed weight
SKNA-20X IC-95307	2.62*	17.85	P X P	Days to 50 per cent flowering, days to 80 per cent maturity, earhead length, straw yield/plant, harvest index
GA-2XAG-114-1	2.35*	24.39	G X P	Days to 50 per cent flowering, number of fingers/earhead, 1000-seed weight, harvest index

* and ** indicates significant of values at P=0.05 and 0.01, respectively

act in favorable direction. Better performance of hybrids involving poor x poor combiners parents indicated dominanceXdominance (epitasis) type of gene action (Jinks, 1956). Such crosses could be utilized in the production of high yielding homozygous lines.

The crosses which expressed high *per se* performance and desirable sca effects for seed yield per plant, various characters involved either good x good, good x poor and poor x poor combination parents. Thus, crosses expressing high sca effects did not always involve parents with high gca effects. It is suggested that inter allelic interactions were also important for these traits. The presence of predominantly large amount of non additive gene action would necessitate the maintenance of heterozygosity in the population.Breeding methods such as biparental mating followed by reciprocal recurrent selection may increase frequency of genetic recombination and hasten the rate of genetic improvement.

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