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RESEARCH ARTICLE

Combining ability analysis for quantitative and qualitative traits in *Rabi* season maize (*Zea mays* L.)

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SUMMARY

The experiment was conducted in 2009-10 in complete Randomized Block Design with three replications at Oil seeds Research farm C.S.A. University of Agirucultural and Technology, Kanpur. The combining ability analysis from ten parent diallel crosses in maize (*Zea mays* L.) Showed highly significant GCA and SCA effect for important yield and quality trait except number of grain row per cob in SCA effect .This signifies the important of both additive and non- additive gene effects in controlling the inheritance of traits. The GCA /SCA ratio revealed that both additive and non-additive gene effects are parent in the experimental material for the trait under study. Parent I-78, I-65, Azad Uttam-1 and Azad Uttam were identified as best general combiner for grain yields per plant. Out of 45 crosses, 20 crosses in F_1 and 17 crosses in F_2 exhibited significant and desirable SCA effects for grain yield per plant. Crosses combination I-65xAU-1 and I-65 x AU were found good specific desirable combiners in both the generation

Key Words : Maize, Combining ability, Grain yield

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Maize (*Zea mays* L.) is one of the major cereal crops providing raw material for the food industry and animal feed (Unay*e t al.*, 2004). Grain yield is the most important trait in maize, while starch content in grain is becoming very attractive because of value-added food/feed production, as well as biofuel production. Both traits are quantitative and complex in nature. It means their expression is caused, not only by genetic factors, but also by environmental and genotype x environment interaction effects, Maize is the third most important cereal crop next to rice and wheat in India and also a predominant cereal in globle agriculture economy. Being a C_4 plant is an efficient converter of absorbed nutrients into food. Maize is high in floated, a B-vitamin, four ounces provides 31 per cent of the RDA. It is a good source of several other nutrients. Selection of superior plant and mating design play impotent role in the success of any breeding programmed. In order to exploit the genetic variability and to select suitable breeding programme, it is important to have the sound knowledge about the gene action involved in the inheritance of the traits and combining ability of the parents. Although many researchers have reported the importance of non-additive gene action for grain yield and some other agronomic traits, but some investigators indicated predominance of additive genetic effects for plant height (Amer *et al.*, 2002; Singh and Roy, 2007), ear height (Amer *et al.*, 2002), number of rows per ear (Srdic *et al.,* 2007), number of kernels per row (Saeed *et al.*, 2000), days to maturity (Singh and Roy, 2007) and grain yield (Vacaro *et al.,* 2002; Ojo *et al*., 2007).

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Information of heritability of traits, combining ability of parent and relative magnitude of additive and non-additive gene effects are useful in formulating appropriate breeding programme and selection superior parents. In most of the studies on maize diallel or partial diallel, line x tester generation mean and triple test cross mating designed have been used most often is diallel analysis. The diallel analysis is a simple and convenient way collecting information on genetic components and important parameters used for selection of superior parent and breeding programme.

Diallel mating designs are used to obtain genetic information about a trait of interest from a fixed or random selected set of parental lines in a short period of time (Castilo-Gozalez and Goodman, 1989; Griffing, 1956; Hayman, 1954; Iken and Olakojo, 2002; Murray *et al.*, 2003; Novoselovic *et al.*, 2004). Diallel analysis has also been used to identify cultivars or lines as the best combiners to increase favourable alleles in hybrids. Diallel crosses have been used to determine the relative contribution of additive and non-additive gene actions in controlling the traits of interest. According to the results of diallel crosses, maize plant height is controlled by non-additive (Choudhary *et al*., 2000; Joshi *et al*., 1998; Prakash and Ganguli, 2004) or both additive and non-additive gene action (Sain *et al*., 1997, 2001; Steven *et al*., 2002). Additive effects efficiently respond to selection while non-additive effects such as dominance and epistatic components increase hybrid vigour in cross combinations of cultivars. The contribution of both additive (Herrero and Johnson, 1980) and non-additive variances (Choudhary *et al.*, 2000; Dubey *et al*.,2001) has been reported in genetic control of different agronomic traits in maize. In the parent study, partial diallel mating design was used to collect the information on general and specific combining ability of the parents and other genetic parameters for various trait related to quantitative and productivity in this important cereal.

MATERIAL AND METHODS

The study was conducted in 2009-10 in Complete Randomized Block Design with three replications at Oil Seeds Research farm C.S. Azad University of Agricultural and Technology, Kanpur. Ten homozygous and genetically diverse genotypes namely I-65, I-74, TSK-95,I-78, TSK-41-1, TSK-36-1, TSK-105, TSK-64, AU-1 and AU. They were crossed in all possible combination excluding reciprocal. Half of the F_1 seed were advanced to get F_1s. A complete set of material consisting of 10 parents, 45 F_1s, and 45F2s was shown during *Rabi* season. All recommended cultural practices were followed to raise a healthy, five plant in each of parents and F_1s and 20 plants in each of the F_2 progenies were selected randomly for recording of 14 characters. During the growth season days to tesseling, days to silking, plant height, number of leaves at 30 DAS, number of leaves at 60 DAS, cob height, cob per plant, cob length, number of grain row per cob, number of grain per row, cob yield per plant, grain yield per plant, 100-seeds weight and seed vigour index. Seed vigour index was estimated by:

$$\text{Vigour index 1} = \frac{\text{Germination (\%)}}{\text{Seedling length (cm)}}$$

(Abdul –Baki and Anderson, 1973).

Statistical analysis was carried out usual procedure while combining ability analysis was according to the method II Model I (Griffings, 1956b) as well as estimation of per cent heterosis our standerd check.

RESULTS AND DISCUSSION

The analysis of variance Table 1 for the experiment revealed highly significant variances among treatments indicating appreciable variability for the study on partitioning of treatment variances, the mean squares of parents, F_1s, F_2s, parent vs cross (F_1s + F_2s) and F_1s vs F_2s were also found highly significant for almost all the traits indicating much variability in different populations. Analysis of variance for combining ability Table 2 revealed highly significant variances for both general and specific combining ability in both the generations for all the characters, indicating the importance of both additive and non-additive gene action in the expression of this trait studied. The variance due to parents vs crosses differs significantly indicating the presence of high heterosis response in the material studied. The variance due to general and specific combining ability were highly significant for all the characters under study, indicated that the influence of both additive and non-additive effects in the expression of these characters. The influence of both types of gene effects were also observed by Singh and Kumar (2008); Verma and Narayan (2008) and Amiruzzaman *et al*. (2011) in QPM maize. Combining ability analysis revealed that estimate of specific combining ability (SCA) variances were higher than general combining ability (GCA) variances for all the characters under study, suggesting predominance of non-additive gene action for these traits. The SCA and GCA ratio favoured both GCA and SCA in both generations indicated the preponderance of both additive and non-additive gene effects in experimental material. The magnitude of SCA variance was greater than GCA variance in all character. On the basis of GCA effect of the parents, none of the parent was found good general combiner for all the traits. Parent I-78 for six characters; I-65, AU and TSK-95 for five characters; TSK-105 and AU for four characters and TSK-36-1 for three characters were good general combiners. On the basis of GCA effect and per se performance parent AU, I-78 and I-65 for seven characters; AI-1 for six characters and TSK-105, I-74 and TSK-36-1 for three character were superior. On the basis of SCA effects and per se performance crosses I-74 × AU, I-65 × AU-1, I-65 × AU, TSK-95 × TSK-36-1 and I-78 × AU in F_1 generation and I-65 × AU, I-65 × AU-1, I-65 × TSK-105, I-74×TSK-95 and I-74× TSK-36-1 in F_2 generation were found to be good specific combiners for grain yield per plant. Whereas, cross, I-74 × AU was found to be good specific combiner over generations for this trait. These crosses also exhibited good specific combining ability effects for other important traits. The present findings are in confirmation with those of Kabdal *et al*. (2003).

Table 1: Analysis of variance (combined – parent +F_1s +F_2s) for 14 characters in maize

Source of variation	d.f.	Days to tesseling	Days to silking	Plant height (cm)	Number of leaves at 30 DAS	Number of leaves at 60 DAS	Cob height (cm)	Cobs per plant
Replication	2	0.013	1.583	3.097	0.003	0.059	5.954	0.004*
Treatment	99	8.952**	12.101**	134.917**	0.319**	0.798**	67.778**	0.101**
Parent	9	10.774**	14.300**	184.800**	0.224**	0.373**	77.399**	0.073**
F_1s	44	7.672**	12.817**	137.771**	0.258**	0.670**	73.484**	0.132**
F_2s	44	10.036**	11.169**	125.667**	2.330**	0.864**	61.733**	0.067**
Parent v.F_1s	1	3.712	3.572	74.064*	2.751**	8.149**	57.116**	0.297**
Parent v.F_2s	1	9.167*	11.523**	101.967*	0.647**	5.420**	21.995**	0.013**
Error	198	1.518	1.697	15.751	0.009	0.098	2.361	0.001

Table 1: Contd…………

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Source of variation	d.f.	Cob length (cm)	Number grain row per cob	Number of grain per row	Cob yield per plant	Grain yield per plant	100- Seed weight	Seed vigour index
Replication	2	0.056	0.045	1.030	15.337	10.820	0.250	297.430
Treatment	99	5.983**	3.865**	15.738**	183.750**	3005.762**	5.116**	80716.429**
Parent	9	7.142**	7.831**	29.146**	184.188**	3801.394**	4.221**	24682.355**
F_1s	44	5.856**	3.989**	13.139**	175.491**	3264.266**	5.021**	91735.263**
F_2s	44	4.132**	2.886**	14.547**	161.438**	1907.969**	4.843**	84315.251**
Parent v.F_1s	1	30.879**	7.201**	45.377**	610.205**	16642.163**	27.855**	709.867
Parent v.F_2s	1	0.032	1.654**	5.046**	1.332	676.543**	8.073**	3993.648
Error	198	0.092	0.113	0.615	13.854	13.469	0.272	1826.672

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

Table 2: ANOVA for combining ability and related statistics of 14 characters in a 10 parent-diallel cross in F_1 and F_2 generations of maize

Source of variation	d.f.	Days to tesseling		Days to silking		Plant height		Number of leaves at 30 DAS		Number of leaves at 60 DAS		Cobs height (cm)		Cobs per plant	
		F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
GCA	9	6.391**	8.293**	10.992**	10.633**	156.801**	161.029**	0.226**	0.133**	0.628**	0.648**	60.169**	69.849**	0.078**	F_2
SCA	45	1.968**	2.399**	2.959**	2.552**	26.412**	21.828**	0.075**	0.101**	0.178**	0.217**	17.500**	11.473**	0.035**	0.038**
Error	108	0.477	0.516	0.572	0.544	4.338	6.03	0.003	0.003	0.035	0.031	0.857	0.741	0.0004	0.019**
gca/sca ratio															

Table 2: Contd…………

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Source of variation	d.f.	Cob length (cm)		Number of grain row per cob		Number of grain per row		Cobs yield per plant (g.)		Grain yield per plant (g.)		100-Seeds weight (g.)		Seed vigour index	
		F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
GCA	2	3.943**	2.178**	5.588**	4.259**	21.720**	25.252**	184.358**	95.694**	2079.626**	2199.451**	4.715**	4.190**	83186.536**	59542.884**
SCA	45	1.825**	1.388**	0.758	0.623**	2.218**	1.672**	37.125**	45.767**	1024.685**	440.404**	1.181**	1.082**	14912.342**	17247.0226**
Error	108	0.0303	0.031	4.473	0.033	0.206	0.214	4.960	4.306	5.665	3.215	0.084	0.098	541.686	667.898
gca/sca ratio															

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

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