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COMBINING ABILITY ANALYSIS OF GRAIN YIELD AND OIL CONTENT ALONG WITH SOME OTHER ATTRIBUTES IN MAIZE (*ZEA MAYS* L.)

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ABSTRACT

Combining ability analysis was carried out in a 6 x 6 diallele of maize for grain yield and oil content along with their component characters in kharif and rabi seasons. Results from pooled analysis over seasons revealed that nonadditive gene effects were more important for grain yield, oil content, number of rows/ear, number of grains/row and ear length, whereas for maturity, ear diameter, 100-grain weight and embryo size the additive gene effects exhibited predominant role. Gca was less influenced by environment than sca for all the characters except rows/ear, grains/row, and oil content. The line Sarhad HSRB proved to be a good general combiner for both grain yield and oil content. Five out of the 15 F_1 hybrids evaluated have been identified to be good specific combiners for grain yield, whereas three crosses gave desirable significant sca effects for oil content.

Key words: Diallel, combining ability, maize.

With the global acceptance of maize endosperm oil concentrate as a rich source of nutritive oil with least detrimental effect on human health, attention has been diverted to high oil trait of maize. In a cross-pollinated crop like maize, combining ability analysis is of special importance since it leads to the identification of potential lines that can be used to develop hybrids/synthetics/composites. Such studies also help in elucidating the nature and magnitude of different types of gene action governing the expression of quantitative characters of economic importance. The present investigation aims at identification of superior parents, cross combinations, and evaluation of the type of gene action along with the environmental effect for grain yield and oil content as well as their respective components.

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MATERIALS AND METHODS

A 6 x 6 diallel set (excluding reciprocals) was made involving six high oil maize lines: ICRISAT-742, Alexho Elite, Syn D.O., Iowa 2 Ear H.O., R 802 A, and Sarhad HSRB. The resulting 15 F_1 hybrids along with their parents were grown in randomized block design with three replications in kharif 1990 and rabi 1990–91 at Kalyani, West Bengal. Data recorded for nine quantitative characters were used for statistical analysis. Oil content was determined by the solvent extraction method through Soxhlet using 5 g ground grain sample.

Model II Method 2 of Griffing [1] was applied for combining ability analysis. The pooled analysis was carried out following Singh [2].

RESULTS AND DISCUSSION

Pooled analysis of variance showed highly significant differences due to environments, genotypes, and genotype x environment interactions for all the characters studied except ear diameter, number of rows/ear, and oil content for which mean square estimates due to genotype x environment interaction was nonsignificant. Parent x environment and hybrid x environment interactions were also significant for all the characters except these three traits. Thus, the results indicated stability in performance of the parents and hybrids over two seasons for ear diameter, No. of rows/ear, and oil content.

Analysis of variance for combining ability revealed that the mean square estimates for both general combining ability (gca) and specific combining ability (sca) for maturity, oil content and grain yield were significant. Significant estimates of gca were obtained for ear diameter, rows/ear, 100-grain weight and embryo size, whereas for ear length and grains/row the sca mean squares were significant.

A comparison of the magnitude of components of variance due to gca and sca confirmed the nature of gene action in controlling the expression of traits (Table 1). Pooled analysis revealed higher magnitude of sca component in comparison to gca component for grain yield, oil content, grains/row, rows/ear, and ear length, indicating the importance of nonadditive gene effects in controlling these traits. Earlier studies using diallele analysis also showed the preponderance of nonadditive gene effect for grain yield and ear length [3–5], whereas equal importance of both additive and nonadditive components had been reported for rows/ear and grains/row [4]. However, Misevic et al. [6] reported higher magnitude of additive gene effect in controlling oil content. These findings also suggest greater influence of additive component of gene action in the expression of maturity, ear diameter, 100-grain weight, and embryo size, which in agreement with earlier reports [7–9].

Table 1. Estimates of variances due to general combining ability (σ^2g) specific combining ability (σ^2s), and their interactions with environment for oil content, grain yield, and their components in maize

Character	σ^2g	σ^2s	$\sigma^2$1	σ^2g1	σ^2s1	σ^2e
Maturity period	1.347	0.200	849.920	0.198	0.725	0.598
Ear length	- 0.031	0.019	0.006	- 0.014	0.940	0.422
Ear diameter	0.487	- 1.220	6.519	0.418	0.950	2.704
Rows/ear	- 0.001	0.031	1.619	0.076	0.039	0.417
Grains/row	- 1.019	2.933	- 0.550	1.425	1.035	2.237
100-grain weight	0.386	- 1.012	0.349	0.468	2.588	1.820
Embryo size	1.006	- 3.966	5.534	1.490	4.876	7.626
Oil content	0.409	21.183	1.649	0.421	- 0.817	4.361
Yield	15.730	38.347	12.724	2.355	32.351	5.868

Based on the nature of gene action observed, it may be suggested that selection on the basis of specific combining ability for the most useful heterotic crosses and thereafter development of single- or double-cross hybrids would be more effective in achieving genetic amelioration of maize for grain yield and oil content.

This study also revealed that gca was less influenced by environment than sca for all the characters except No. of rows/ear, No. of grains/row, and oil content, where expression of nonadditive effect was less influenced by diverse environments.

The gca effects revealed the genetic worth of different lines (Table 2). Pooled analysis showed that the lines ICRISAT-742, Syn D.O., Alexho Elite, and R 802 A were good general combiners for oil content. Among these, ICRISAT-742 and R 802 A also had good gca effects for rows/ear, and Syn D.O. showed additional good effect for maturity. These four lines were poor combiners for grain yield, whereas Sarhad HSRB was a good combiner for grain yield, maturity and oil content, as it contributed maximum number of favourable genes for these characters. Thus, the lines Sarhad HSRB, ICRISAT-742, Syn D.O. and R 802 A may be used for production of synthetics and composites with high grain yield and oil content. In case of oil content, the lines with moderate to high mean had high gca effects, while for grain yield only the lines showing high gca effect had high mean. Thus, association between *per se* performance and gca effects was evident in the present study, indicating the effectiveness of choice of parents based on *per se* performance alone for predicting combining ability of parents.

Table 2. Mean performance and general combining ability (gca) effects of parents for oil content, grain yield and their component characters in maize

Character	ICRISAT-742		Alexho Elite		Syn D.O.		Iowa 2 Ear H.O.		R 802 A		Sarhad HSRB		S.E	S.E.
	mean	gca	mean	gca	mean	gca	mean	gca	mean	gca	mean	gca	(gi)	(gi-gj)
Maturity period (days)	73.5	1.298**	75.0	1.214**	72.7	-0.786**	74.8	1.006**	79.3	0.298	76.0	-0.411*	0.176	0.273
Ear length (cm)	12.3	-1.326**	12.8	-0.431**	12.2	-0.469**	12.8	-1.131**	13.6	0.004	12.9	-0.373*	0.148	0.229
Ear diameter (cm)	3.7	0.435	3.9	0.197	3.8	-0.328	3.5	-0.545	4.0	0.368	4.1	-0.253	0.375	0.581
Rows/ear	14.0	1.226**	13.3	-0.024	13.0	0.143	13.0	0.143	13.0	0.393**	14.0	-0.024	0.147	0.228
Grains/row	28.8	-2.375**	28.5	-1.000	26.4	-1.917**	28.8	-2.333**	27.2	-2.375**	28.0	-2.000**	0.341	0.529
100-grain wt (g)	20.5	-0.933**	20.6	0.600	21.4	0.000	20.9	-0.042	23.3	-1.171**	22.4	-1.471**	0.308	0.477
Embryo size (mm^2)	34.3	-2.044**	34.6	-0.410	32.3	-0.051	31.3	-1.621*	37.1	0.359	38.2	-2.011**	0.630	0.976
Oil content (%)	5.4	5.192**	5.3	1.163*	5.2	3.397**	5.2	0.789	5.1	1.279**	6.0	1.248*	0.477	0.738
Yield (q/ha)	26.6	-9.691**	35.2	-3.018**	21.8	-5.632**	19.2	-3.970**	32.7	-12.973**	49.5	1.386*	0.553	0.856

*,**Significant at 5% and 1% levels, respectively.

The estimates of sca effects for grain yield and oil content (Table 3) revealed that none of the three top ranking crosses for oil content figured among the five top ranking crosses for grain yield. The results showed that significant desirable sca effects were associated with *per se* performances of such crosses for oil content and grain yield. Thus, the close association of *per se* performance of the crosses with sca effects suggests that selection of crosses based on any one of these parameters would be equally effective. Further, the crosses involving parents with moderate to high gca effects had good sca effects for oil content, indicating preponderance of additive gene effects, whereas for grain yield all the crosses with high sca effects always involved low x low general combiner parents, indicating dominance x dominance gene

Table 3. Promising crosses of maize for grain yield and oil content

Cross	Mean	Sca	Gca status of parents
		Yield (q/ha)	
Alexho Elite x R 802 A	50.3	8.38**	Low x low
ICRISAT-742 x R 802 A	51.6	10.61**	Low x low
Iowa 2 Ear H.O. x R 802 A	43.9	9.41**	Low x low
ICRISAT-742 x Alexho Elite	44.5	7.26**	Low x low
Syn D.O. x R 802 A	47.2	9.41**	Low x low
SE (S_{ij})		1.52	
SE (S_{ij}–S_{ik})		2.27	
		Oil content (%)	
R 802 A x Sarhad HSRB	5.99	6.05**	High x high
Iowa 2 Ear H.O. x Sarhad HSRB	6.11	6.29**	Medium x high
Alexho Elite x syn D.O.	5.84	8.16**	High x high
SE (S_{ij})		1.31	
SE (S_{ij}–S_{ik})		1.95	

*,**Significant at 1% levels.

effects. Oil content had undesirable association or no association with grain yield on the basis of sca effects.

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