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Evaluation of Nine *Maize* varieties for Intervarietal Hybridization

by

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The technical difficulties in the production of double cross hybrids have been a serious problem for slow coverage of the total maize area under cultivation. The evaluation of inbreds makes the procedure costly. The development of the varietal hybrids seems to be a quick approach to ensure the high yields of maize in comparatively short time and with the least expenditure. The heterosis expressed by the genetically diverse varietal crosses can be exploited and the success of which will depend on the efficiency with which the superior varietal crosses can be detected.

Materials and Methods: Nine maize varieties and complexes, J_1 complex, B_1 (II), Amarillo-de cuba, Antigua Gr. I, Puerto Rico Gr. 1, of American origin and Sathi, Jallunder, Solan and Kulu locals of Indian origin were intercrossed (excluding the reciprocals) for the present study. These varieties were maintained either by open pollination or mass sibbing for a number of generations.

During spring 1966, the crosses were made and in preceding kharif season, a trial consisting of 72 intercrosses in the F_1 and F_2 generations with 9 parents, was laid out in randomized block design at Ludhiana. Entries in paired rows were repeated four times with $30' \times 5'$ plot size and $9''$ seed placement. Observations were recorded on ten randomly selected plants for silking days, cob length, cob girth and yield per plant.

The F_1 and F_2 data were subjected to combining ability analysis vide model II, method 4 of Griffing (1956). Although the parents were grown in the experiment they were not included in the analysis so that the F_1 and F_2 data could be kept comparable. Correlation coefficient was also calculated for all the traits.

Results: Significant differences among the parents, F_1, F_2 for their traits were noted due to the genetic differences among the parents. The yield of the parents (Table 1) ranged from 21.7 to 116.1, of the F_1's from 68.9 to 132.9 with heterosis - 26.7 to 88.9% over F_2 and 19.5 to 108.4% over mid parent.

Heterosis % gained in F_1 and depression in F_2 have been presented in table 2. The magnitude of the heterotic effect was greater for yield followed by cob length, cob girth and days to silk. Similarly, the magnitude of

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TABLE 1. *Mean values of parents*

Code	Variety name	Yield/plant (grm)	Cob girth (cm)	Cob length (cm)	Days to silk
A	Sathi	21.7	8.6	8.8	43.5
B	Solan local	64.3	10.9	14.1	55.0
C	Kulu local	93.3	14.5	13.4	54.5
D	Antigua Gr. I	99.1	12.8	14.5	60.2
E	Amarillo-de cuba	99.9	13.0	15.4	61.0
F	J_1 complex	100.7	13.2	16.4	62.0
C	B_1 (II)	116.1	14.3	15.5	62.5
H	P. Rico Gr. I	79.9	11.8	12.6	59.7
I	Jallunder local	76.0	12.8	13.6	53.0
	S.E. value	3.4	0.1	0.1	0.4
	C.D. @ 5%	6.7	0.2	0.3	0.9

TABLE 2. *Average performance of parent, F_1, F_2 generations and average heterosis in F_1 and depression (decrease or increase) in F_2*

Traits	Parent	F_1	F_2	Heterosis %	Depression %
Yield (grm/plant)	83.4	98.7	91.6	18.2	7.2
Cob girth (cm)	12.4	12.7	12.4	2.4	2.4
Cob length (cm)	13.8	15.2	15.6	10.1	-2.6
Days to silk	56.8	57.0	58.6	0.4	-2.8

depression was also greater for yield followed by cob girth; days to silk and cob length. In general, those traits which evidenced the greater amount of heterosis, likewise showed more depression. For each common parent (Fig. 1) the average yield of its F_1 hybrid was substantially higher than the corresponding mid parent value. The F_2 populations gave yields intermediate between F_1 and mid parent values thereby showing a tendency for the average yield of the F_1's involving a common parent to likewise decrease in yield as the yield of the common parent decreased. The phenotypic correlation coefficient for all the pairs of traits analysed separately for the F_1 and F_2 generations (Table 3) showed that except days to silk with cob length, all the

TABLE 3. *Phenotypic correlations between traits in the F_1 and F_2 generations*

Traits correlated	F_1	F_2
Yield × Days to silk	0.5511**	0.5476**
× Cob length	0.8467**	0.7010**
× Cob girth	0.7950**	0.7313**
Days to silk × cob length	0.3612	0.3064
× cob girth	0.5432**	0.2523
Cob length × cob girth	0.7287**	0.3901

indicates significance at 1%

other traits were highly associated with each other in F_1, while in F_2 only yield alone had good association with others. The low association (r = 0.125) observed between F_1's and F_2's for yield alone showed that F_1's yield is a sufficient indicator for the selection.

The general combining ability and specific combining ability effects were found to be of high magnitude for all the traits in both generations (Table 4).

TABLE 4. *Levels of significance for general combining ability (gca) and specific combining ability (sca) components and general combining ability : specific combining ability ratios*

Trait	F_1 generation			F_2 generation		
	gca component	sca component	gca : sca ratio	gca component	sca component	gca : sca ratio
Cob girth	**	**	1.8:1	**	**	4.3:1
Cob length	**	**	1.2:1	**	**	1.7:1
Yield	**	**	0.3:1	**	**	5.1:1
Days to silk	**	**	0.2:1	**	**	5.9:1

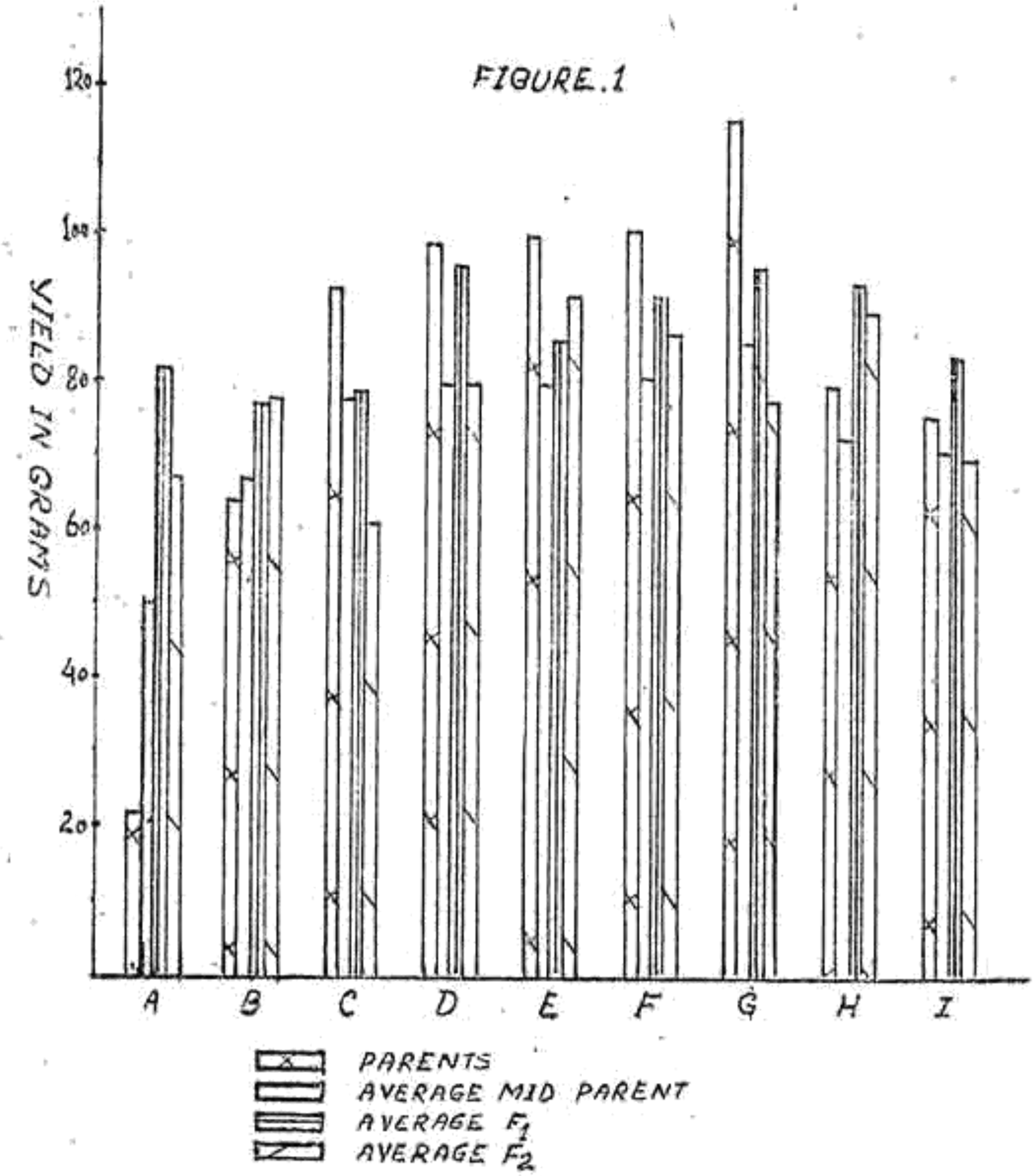
The general combining ability components were larger than specific combining ability in all the cases in F_2 and only in two cases in F_1. This indicated that there were sufficient non-additive genes in F_1, much of which lost in the F_2 generation. The parents of the American origin (Table 5) showed the

TABLE 5. *Estimates of the relative general combining ability effects of the parents for yield based on F_1 and F_2 data and the mean yield of the parents*

Code	F_1	F_2	Mean parents yield
A	-6.6	-14.3	21.7
B	-12.0	1.5	64 3
C	-10.3	23.0	93.3
D	11.1	2.8	99.1
E	0.4	17.5	99.9
F	4.6	11.5	100.7
G	10.5	0.6	116.1
H	6.3	14.6	79.9
I	- 4.9	-10.9	76.0

highest general combining ability effects in both generations followed by Indian ones. This indicated that these parents have got sufficient additive genes. Codes in table 5 represent A for Sathi, B for Solan local, C for Kulu local, D for Antigua Gr. I, E for Amarillo-de cuba, F for J_1, G for B_1 (II), [illegible] and I for Jallunder local.

FIGURE. 1



Discussion: The results for the expression of hybrid vigour in varietal crosses are in general agreement with previous reports. Of the 36 F_1 crosses, 29 or 80.6% crosses exceeded over the mid parent yield and 7 or 19.5% exceeded over the highest parent in yield. Recently Lonnquist and Gardner (1961) reported the value of 88.9% and 14.0% among 45 crosses of the U. S. Cornbelt varieties and commented that considerable genetic diversity seems to be exhibiting among the parents. In confirmity to Paterniani and Lonnquist's (1963) report about 19.84%, the range of the F_1's superiority over the highest yielding parents however, was only 0.2 to 14.5%.

The comparison of F_1 and F_2 yields for crosses indicated that superior F_1 crosses were also superior in F_2. The degree of depression in F_2 was observed to be related to the amount of heterosis in F_1. The seven crosses which have out yielded even the highest yielding parent B_1 (II), in order of superiority from highest to lowest in yield were between S...

Gr. I × B_1 (II), Puerto Rico Gr. I × Jallunder local, J_1 × P. Rico Gr. I, Amarillo-de-cuba × B_1 (II), Kulu local × B_1 (II) and Antigua Gr. I × Amarillo-de-cuba. These crosses have 3 times B_1 (II) and 2 times each of J_1, P. Rico Gr. I, Antigua Gr. I and Amarillo-de-cuba. These parents have also high general combining ability effects for all the traits thereby indicating that the additive genes were very prevalent among them. Thus, the general combining ability effects of the variety seems to be much more important than the specific combining ability effects in determining the yield in variety crosses (Lonnquist and Gardner, 1961).

The two of the highest heterotic values were gained by the two low yielding local parent Sathi and Jallunder local. Their crosses averaged first and third highest in yield for the group of parents (108.7% and 55.9% relative to mid parents and 9.9% and 5.5% to highest parents respectively). Paterniani and Lonnquist (1963) reported in same circumstances 138% and 124% values for an exotic U.S. corn variety. The lower yielding parents were exotic races rather poorly adapted to the growing conditions, indicating complimentary gene action of such nature as to provide marked increase in adaptive response to these conditions. Both the above varieties which gave the highest yielding F_1's but were poor in general combining ability and good in specifiic combining ability effects, would best be utilized in recirprocal recurrent selection programme to take advantages of their specific effects (Lonnquist and Gardner, 1961).

From the hybridization standpoint, the greatest success will likely be realised if inbred lines will be developed from populations in which the frequency of favourable genes are high and which show substantial heterosis when crossed.

Summary: The seventy-two crosses in F_1 and F_2 generations between J_1 complex, B_1 (II), Amarillo-de cuba, Antigua Gr. I, Puerto Rico Gr. I of American origin and Sathi, Jallunder, Kulu and Solan locals of Indian origin with themselves were studied in randomised block design. The greater heterosis in F_1 and depression in F_2 for grain yield followed by cob length, cob girth and silking days were observed. The degree of depression in F_2 was observed to be related to the amount of heterosis in F_1. The traits have high magnitude of general combining ability and specific combining ability effects. The American parents were superior in general combining ability effects. The comparison of F_1 and F_2 yield indicated that the general combining ability effects (additive genes) appeared to be most important in determining the yield in variety crosses. The two local varieties Sathi and Jallunder local were noticed for their superior specific effects which can well be utilized in reciprocal [illegible] selection programmes.

genes. Codes in tab[illegible]

local, D for Antigua Gr. I, E for [illegible]

[illegible] Gr. I and I for Jallunder local

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Effect of plant growth regulators on jack (*Artocarpus heterophyllus* Lamk.)

by

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Plant growth regulators are known to make effects on plant growth and development. One of such effects is to induce seed germination and to influence shoot and root growth of the plants. During the past four decades voluminous literature has accumulated on the subject. However, little attention has been paid on jack (*Artocarpus heterophyllus* Lamk.). Sonwalker (1951) had made some studies on the germination of jack seeds and reported the slow growth of the seedlings. Recently, Sinha and Sinha (1969) studied the effect of NAA on the germination of jack seeds. Investigations were undertaken to study the effect of plant growth regulators on seed germination and the root and shoot development of the jack seedlings.

Materials and Methods: Viable seeds of uniform age and weight of the local variety were selected. They were soaked in aqueous preparations of the growth regulators of potassium salt of gibberellic acid (GA 10%), indole-acetic acid (IAA), indole-butyric acid (IBA), napthalene acetic acid (NAA) and chlorophenoxy acetic acid (CPA) at 100 to 500 ppm for 48 hours. Fifty seeds were treated under each treatment and concentration and sown in raised sand beds at a spacing of 25 cm either way. Periodical observations on the germination and malformation if any, were recorded. On the 60th day after germination ten plants of the same age were pulled out carefully to examine the shoot and root development.

2. One month old seedlings of uniform vigour, shoot and root lengths were chosen for seedling treatment. The seedlings were given (a) soak treatment in which the seedlings were soaked in the growth regulator solutions from 25 to 100 ppm for 24 hours and planted ; (b) seedlings were sprayed at

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