



## Realized response to different selection criteria in maize (*Zea mays* L.)

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### Abstract

Genotypic performance in maize (*Zea mays* L.), which is a sensitive crop, is greatly affected by variation in plant stand and soil heterogeneity particularly, during monsoon season. In the present study, 229 S1 progenies of 'Composite Kesri' were evaluated and modified S1 selection among these progenies was carried out for high (HY) and low (LY) grain yield. Experimental varieties were developed by selecting among S1 progenies on the basis of analysis of covariance of grain yield for plant stand and near neighbour (NN) corrections to account for the effect of soil heterogeneity on gain yield. Further, experimental varieties were also developed on the basis of superiority of plot and plant yield of S1 progenies in comparison to the adjacent row of balanced male (BM) composite. The objective was to identify the approach that most favourably affects the response to selection. The resulting experimental varieties were evaluated in six environments. Analysis of variance showed significant differences among experimental varieties and original Kesri for all the traits studied. Selections were effective for HY as well as LY. In case of selection for HY, the experimental varieties developed by selecting on the basis of plot yield in comparison with BM composite, gave numerically, the highest yield followed by the variety developed on the basis of selection for plot yield corrected by analysis of covariance for plant stand, and these both gave significantly higher yield than Kesri. Overall consideration of direct and correlated response to selection for HY and LY indicated that selection for yield may be more effective when based on superiority in plot yield over adjacent rows of BM composite.

**Key words:** Maize, modified S1 Selection, selection criteria, experimental variety

### Introduction

In India, maize (*Zea mays* L.) is cultivated during monsoon season which is characterized by erratic rainfall, sometimes accompanied by strong winds, and high incidence of diseases and pests. These factors generally result in variable plant stand. In the Indian maize breeding programmes, the grain yield is, therefore,

adjusted for variation in plant stand by analysis of covariance [1] to minimize the nongenetic variation. However, no information is available on the utility of analysis of covariance on response to selection.

Maize, being a very sensitive crop, is greatly affected by soil heterogeneity. Many workers have advocated corrections by NN analysis [2] to reduce the effect of soil heterogeneity in research experiments. However, not much information is available on the effect of NN analysis on response to selection.

Modified S1 selection and modified ear-to-row selection schemes have built-in system to take care of soil heterogeneity [3, 4]. In these schemes, a BM composite is repeated after every two family rows to serve as a local check and as a source of pollen.

In the present study, selection was carried out for HY and LY based on different selection criteria, and realized response to selection was reported.

### Materials and methods

Composite Kesri, a high yielding cultivar of maize with medium maturity, deep orange, flint and bold kernels was used as a base population. The S1 progenies were developed in an off-season breeding nursery at Agriculture Research Station, Amerpet, Hyderabad during winter season of 1992. Sixty-four ears of Kesri were planted ear-to-row at Hyderabad, each row being 4 m in length, spaced 75 cm apart with plant-to-plant distance of 20 cm. Five plants in each row were selected and selfed and of these 3 or 4 ears were selected at maturity. Selection at both stages was based on phenotype. The S1 progenies of resulting 229 ears were planted in an evaluation-cum-recombination block [3, 5] using a randomized complete block design with two replications. Each row was 5 m long with row-to-row and plant-to-plant spacing of 60 cm and 20 cm, respectively. A BM composite, developed by bulking equal number of seeds from each

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S1 progeny, was repeated after every two S1 progenies (superimposed in randomized complete block design). The S1 progenies were detasseled and, hence, were pollinated by BM composite. In the evaluation-cum-recombination block, selection was performed both among and within the S1 progenies. The within-progeny selection was mass selection based on fresh ear weight and 2 or 3 best ears were selected. Selection among S1 progenies was carried out using different criteria as follows.

*Plot Yield - Covariance Analysis* : Analysis of covariance was carried out to adjust the grain yield of S1 progenies for plant stand [1]. On the basis of adjusted yield, 10 highest yielding and 10 lowest yielding progenies were selected to develop experimental varieties for high yield [Plot Yield-Cov (HY)] and low yield [Plot Yield-Cov (LY)], respectively.

*Plot Yield - Near Neighbour Analysis* : The adjusted plot yield of S1 progenies was obtained after removing the effect of soil heterogeneity by conducting NN analysis [2]. MSTAT-C computer programme package was used for this analysis. Ten best yielding progenies were selected to develop experimental variety for high yield [Plot Yield-NN (HY)] and 10 poorest yielding progenies to develop experimental variety for low yield [Plot Yield-NN (LY)].

*Plot Yield - Balanced Male Composite* : Selection was based on plot yield of S1 progenies in comparison with the average of the 2 nearest plots of BM composite. The grain yield of S1 progenies was computed as percentage of that of BM composite checks, and 10 best progenies were selected to constitute high yielding experimental variety [Plot Yield-BMC (HY)]. Similarly, a low yielding experimental variety [Plot Yield-BMC (LY)] was developed from 10 poorest S1 progenies.

BM composite plots. Ten best and 10 poorest progenies were selected for constituting high yielding [Plant Yield-BMC (HY)] and low yielding [Plant Yield-BMC (LY)] experimental varieties, respectively.

The 10 selected progenies, in each case, were recombined within the experimental varieties during winter 1993-1994 at Punjab Agricultural University (PAU), Ludhiana. The original (Co) and 8 experimental varieties were evaluated, during rainy season, 1994 along with 4 other reconstituted versions of Kesri [6]. The experimental design used was randomized complete block with 4 replications. The plot consisted of 2 rows of 5 m length each. The row-to-row and plant-to-plant spacings were 60 cm and 20 cm, respectively. The experiment was conducted in 6 environments, namely 2 levels of N (45 and 90 kg/ha) at 3 locations (PAU, Ludhiana; PAU Regional Research Station, Gurdaspur; and PAU Sugarcane Research Station, Jalandhar). Data were recorded on fresh ear weight, ear girth, kernel depth, 500-kernel weight, shelling percentage and kernel moisture content. Grain yield at 15 percent moisture content was obtained from fresh ear weight and shelling percentage. The analysis of variance was carried out following Panse and Sukhatme [3].

## Results and discussion

Mean squares due to different populations were highly significant in the analysis of variance (not shown) for each environment and over six environments for all the traits evaluated, namely, grain yield, ear length, ear girth, kernel depth, 500-kernel weight, and shelling. This indicated the presence of significant genotypic differences among populations.

Selection for HY as well as LY was effective in moving the grain yield of the experimental varieties in

**Table 1.** Mean performance of Composite Kesri (Co) and the reconstituted populations on the basis of different selection criteria, for grain yield and other agronomic traits

Experimental variety	Grain yield (kg/ha)		Ear length (cm)		Ear girth (cm)		Kernel depth (cm)		500-kernel weight (g)		Shelling (%)	
	HY@	LY@	HY	LY	HY	LY	HY	LY	HY	LY	HY	LY
Plot Yield-COV	5137*	4263*	13.4*	11.8*	4.18*	3.81*	0.83*	0.67*	129*	116*	84.9	83.5
Plot Yield-NN	5089	4304*	13.7*	11.7*	4.13*	3.83*	0.78	0.69*	129*	116*	85.0	84.3
Plot Yield-BMC	5280*	4158*	13.8*	11.6*	4.09*	3.74*	0.77	0.67*	127*	118*	84.4	83.9
Plant Yield-BMC	5045	4029*	13.7*	11.6*	4.16*	3.73*	0.82*	0.65*	128*	115*	84.9	81.5*
Mean	5138	4188	13.6	11.7	4.14	3.78	0.80	0.67	128	116	84.8	83.3
Kesri (Co)	4760		12.9		3.94		0.76		123		84.7	
LSD (0.05)	357		0.4		0.08		0.03		4		1.6	

\*Significantly different than Kesri (Co) at 5 per cent level of probability; @HY = high yield, LY = low yield

*Plant Yield - Balanced Male Composite* : Plant yield of S1 progenies as well as the BM composite plots was computed by dividing plot yield with plant stand. The performance of S1 progenies was expressed as percent of the average plant yield of the 2 nearest

the direction of selection pressure. The experimental varieties showed significant differences for grain yield from that of Kesri Co except for 2 HY experimental varieties, namely, Plot Yield-NN (HY) and Plant Yield-BMC (HY) (Table 1). The differences among 4

**Table 2.** Differences between reconstituted populations after selection for high yield and low yield on the basis of different selection criteria

Experimental variety	Grain yield (kg/ha)	Ear length (cm)	Ear girth (cm)	Kernel depth (cm)	500-kernel weight (g)	Shelling (%)
Plot Yield-COV	874*	1.6*	0.37*	0.16*	13*	1.4*
Plot Yield-NN	785*	2.0*	0.30*	0.09*	13*	0.7
Plot Yield-BMC	1122*	2.2*	0.35*	0.10*	9*	0.5
Plant Yield-BMC	1016*	2.1*	0.43*	0.17*	13*	3.4*
LSD (0.05)	357	0.4	0.08	0.03*	4	1.6

\*Significant at 5 per cent level of probability

experimental varieties selected for HY or LY were non-significant for grain yield. However, the HY versus LY experimental varieties showed significant differences for each selection criterion (Table 2). Among HY experimental varieties, Plot Yield-BMC was numerically the highest yielder and it was followed by Plot Yield-Cov and both had significantly higher yield than Kesri Co. With respect to LY experimental varieties, the selection was most effective for Plant Yield-BMC followed by Plot Yield-BMC. The difference between HY and LY experimental varieties was the largest in case of Plot Yield-BMC and it was followed by Plant Yield-BMC. Similar results were observed for ear length, selection based on Plot Yield-BMC resulted in the longest ears when the selection was performed in the positive direction, and this criterion led to maximum divergence between HY and LY experimental varieties. Further, experimental variety based on Plot Yield-BMC and Plant Yield-BMC had the shortest ears.

For ear girth, kernel depth and shelling, selection based on Plant Yield-BMC for LY resulted in the poorest performance and largest divergence between HY and LY experimental varieties. In case of experimental varieties constituted for HY, selection based on Plot Yield-Cov gave the thickest ears and deepest kernels, and selection based on Plot Yield-NN, the highest shelling.

The present study indicated a trend for the superiority of Plot Yield-BMC as selection criteria for HY over other criteria, whereas while selecting for LY, Plant Yield-BMC seemed to be most effective. When conducting selection for HY on per plant basis, some poor genotypes may get selected if their plant stand is poor as the plant potential is inflated upward due to lesser inter-plant competition. However, no such undesirable effect of poor plant stand on plant yield is expected when selection is for LY. The response to selection averaged over 4 HY and 4 LY experimental varieties over criteria showed greater progress towards lower yield.

The study did not show any advantage of covariance for adjusting plot yield for variation in plant stand (plant stand of 229 S1 families showed significant genotypic differences). The application of covariance in this study could not make use of the BMC checks because the BMC plots, representing one population, could not be adjusted for any differences in plant stand.

The simple built-in approach in modified S1 selection which accounts for soil heterogeneity seemed to give better results than the complicated NN analysis. It is added that modified S1 selection requires larger resources (BM composite plot is repeated after every two progenies under evaluation) but it at the same time enables simultaneous evaluation and recombination, which is an advantage. Same is true of modified ear-to-row selection.

The present study indicated that selection for HY may be more effective when based on plot yield in modified S1 selection (or other such schemes) which has built-in system for local control than selection based on plot yield adjusted for plant stand or plot yield adjusted for soil heterogeneity through NN analysis. Selection for LY, though only of theoretical importance, may be more effectively carried out on the basis of plant yield than plot yield.

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