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COMBINING ABILITY OF INBRED LINES AND ITS USEFULNESS IN VARIETY DEVELOPMENT OF MAIZE

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ABSTRACT

Inbred lines with good combining ability could be potentially utilized to develop high yielding maize varieties, such as top crosses and many other kinds of traditional hybrids. In comparison to traditional hybrids, top crosses are a cheaper source of seed and of greater yield potential than open pollinated varieties. During *maha* 1998/99 seasons, nine top crosses were developed combining one vigorous line with nine families developed from maize populations. They were evaluated during *yala* 1999 season at FCRDI, Maha Illuppallama. Due to high promise shown, steps were taken to develop eighteen further top crosses combining same families with two other inbred lines during *maha* 1999/2000 season. They were evaluated in a RCBD during *yala* 2000 season. From the results, one inbred line could be identified that produced better crosses than others. Thus, it was used to develop hybrids combining with other exotic inbred lines. It was also possible to identify a most outstanding OPV family for utilizing in top cross development.

KEY WORDS: Inbred Lines, Top Crosses, Yield Potential, Traditional hybrids, Combining Ability

INTRODUCTION

Cultivated maize, (*Zea mays* L.), have been first selected by American Indians during the period between 34th and 23rd century BC with continuous improvements up to 15th century. Colombus in Cuba saw corn in 1492 on his first voyage to America. It is a staple for many Africans and Americans, having possible centers of origins in Guatemala and Mexico (Martin *et al.*, 1975). Colonial rulers would have introduced the crop to Asia and its existence in Sri Lanka dates back to reign of ancient kings. Maize is also an ingredient of over 500 different products and bi-products of food, feed and industrial consumption groups. In Sri Lanka, human consumption of maize is mainly in the form of boiled green ears, harvested at roaster-stage and dry grains boiled as rice or ground into flour for preparing *roti* or *pittu*. Sri Lanka requires around 160,000 t of dry grains, of which about 80% is utilized in poultry feed production and less than 25% is being locally supplied. Sri Lanka has about 29,000 ha under maize annually with a production of around 30,000 t (Census & Statistics, 2001) of grain in which about 65,000 - 70,000 farmer families are engaged. Maize ranks as the second important cultivated cereal in Sri Lanka.

Utilization of hybrids, increased nitrogen application and heavy plant population contributed greatly to increased grain production in maize. Other important factors were favorable soil and climatic conditions, efficient mechanization, effective pest control, modern cultural practices, intelligent water management and greater crop labor productivity (Jugenheimer, 1976).

Several kinds of hybrids are possible, depending upon the number and arrangement of the parental inbred lines. Top crosses are simple to produce and often are useful hybrids for use in early stages of a breeding program. A top-cross may combine desirable traits of inbred line and an open pollinated variety. Top crosses are useful for evaluating the general combining ability of inbred lines. They also provide a means of selecting promising open-pollinated varieties for use as source materials for the development of inbred lines.

In 1950s, the Department of Agriculture attempted to develop maize hybrids (Sithamparanathan, 1958), but there was no demand for high cost seed from the subsistence farmers who preserved their own seed requirements after each crop (Hindagala, 1980) A hybrid development program was reinitiated at FCRDI, Maha Illuppallama in 1998, to cater for the new demand created for hybrid seed recently. Inbred lines received from Thailand and Mexico combined to develop hybrids and local lines were developed simultaneously to develop more adapted hybrids.

In 1998, top-cross hybrids were developed by combining three inbred lines received from Asian Regional Maize Program in Thailand with nine maize lines (open pollinated) received from Mexico. Further top-cross hybrids were developed and tested later to confirm the promising results obtained from the initial study (Research Reports, 1999).

MATERIALS AND METHODS

During 1998/99 *maha* season, nine top crosses were made between a vigorous inbred-line, Ki 31, received from Thailand and 9 open pollinated lines that were selected from International Maize and Wheat Improvement Centre (CIMMYT) maize populations. During *yala* 1999, the top crosses were compared against the parents in a randomized complete block experiment comprising three replicates to study the yield gain accrued to the hybridization. Two rows of 5 m long were planted to each treatment and whole plot was considered for yield analysis. Field performances were recorded according to CIMMYT guidelines. Grain yields were calculated at 14.5% moisture.

To get consistent results, this study was repeated during *maha* 1999/2000, for which eighteen further top-crosses were developed together with the hybrids tested in the previous season with the objective of comparing both inbreds as well as open pollinated (OPV) parents for identifying the most promising inbred line and OPV family for using in future breeding programs. They were compared in a simple lattice (6 X 6 two replicates) trial against parents during *yala* 2000 season. Two rows were planted to each treatment as in the previous season of 5 m long. Recommended cultural practices were followed in fertilizer application and spacing. Pest and weed control practices were carried out as and when necessary. Yield data were analysed to study the combining ability of the inbreds and the OPVs selected.

RESULTS AND DISCUSSION

Out of the nine top crosses evaluated in the experiment, six crosses produced mean yields greater than the yield of open pollinated check variety Bhadra in the first experiment. Vigorous inbred Ki 31, which was the male parent of the top cross hybrids, produced a little lesser grain yield than Bhadra but had out-yielded the three remaining top cross hybrids, together with Bhadra (Table 1).

Nine OPV parents produced the lowest grain yields of 0.9 t - 3.0 t. Highest grain yield of 5.8 t/ha that was recorded by the top cross KTC 2, had about 45% greater yield than the of check variety, Bhadra, and inbred parent Ki 31. Days to maturity (days to 50% flowering) of the materials indicates no relationship to differences in grain yields obtained, which was merely genetically governed.

Table 1. Grain yield of top crosses of maize tested during *yala* 1999 at FCRDI, Maha Illuppallama

Entry	*Grain Yield (t/ha)*	*50% Flowering (days)*	*Entry*	*Grain Yield (t/ha)*	*50% Flowering (days)*
KTC 2	5.80	52	KTC 7	3.06	58
KTC 5	5.63	55	Ac 9839	3.00	60
KTC 1	5.45	49	Ac 9834	2.47	55
KTC 4	4.95	53	Ac 9838	2.32	58
KTC 3	4.32	53	Ac 9842	2.22	50
KTC 6	4.18	56	Ac 9841	2.06	61
Bhadra	4.06	54	Ac 9837	2.01	58
Ki 31	4.03	55	Ac 9835	1.65	56
KTC 8	3.87	58	Ac 9840	1.54	55
KTC 9	3.79	58	Ac 9836	0.91	61

GM = 3.36, LSD (0.05) = 0.58, CV (%) = 27.03

In the experiment conducted during *yala* 2000, KTC 6 and KTC gave low grain yields confirming yields obtained in the previous experiment (Table 2). Among the parents tested, inbred Ki 42 had done better than other two lines and among the OPV lines 9837 gave the highest yield out-performing ten top crosses too. Its cross progenies KTC 4, KTC 13 and KTC 22 too performed well. OPV line 9835 did better than seven top crosses. KTC 20, the combination of Ki 42 and line 9835, gave a satisfactory yield revealing good compatibility. However, when all top cross yields were considered, OPV line 9839 gave the best average, indicating its better combining ability in top-cross combinations (Table 1).

Table 2. Grain yield of maize top-crosses tested during *yala* 2000 at FCRDI, Maha Illuppallama.

Entry	*Grain Yield (t/ha)*	*Days to 50% Flowering*	*Entry*	*Grain Yield (t/ha)*	*Days to 50% Flowering*
KTC 24	6.34	51	KTC 17	4.33	57
KTC 23	6.08	50	KTC 14	4.31	54
KTC 21	6.04	50	9835	4.27	54
KTC 5	5.84	55	KTC 10	4.19	55
KTC 26	5.81	54	KTC 2	4.12	53
KTC 19	5.62	49	KTC 9	4.05	51
KTC 16	5.42	51	KTC 12	3.91	52
KTC 20	5.27	49	KTC 18	3.88	53
KTC 25	5.19	52	KTC 7	3.79	57
KTC 13	5.14	54	Ki 42	3.77	55
KTC 15	4.99	53	KTC 6	3.51	53
KTC 22	4.91	50	9834	3.06	54
KTC 3	4.79	52	9838	2.59	57
KTC 1	4.71	48	Ki 31	2.43	51
KTC 27	4.68	52	9836	2.16	55
KTC 4	4.67	54	9841	1.99	63
9837	4.61	51	Ki 32	1.5	57
KTC 11	4.49	54	9839	1.48	57

GM = 4.28, LSD (0.05) = 1.74, CV (%) = 19.94

Except top cross KTC 5, which is a combination of Ki 31, the rest of the top crosses which gave the highest grain yields were from combination of inbred Ki 42. Table 3 reveals that the top crosses developed using inbred Ki 42 are better than top crosses developed with other two inbreds between same parents selected.

Table 3. Mean yields of top crosses developed with 3 inbred lines of the top cross evaluation conducted at FCRDI, Maha Illuppallama, during *yala* 2000[1]

Inbred line	*Mean Yield (t/ha)*
Ki 42	5.77 a
Ki 32	4.62 b
Ki 31	4.41 b

GM = 4.85, LSD (0.05) =1.01, CV (%) =12.82s

[1]mean followed by the same letter are not significantly different at 0.5% by DMRT

This study reveals that out of three inbred parents, Ki 42 had the best combining ability and it is the most suitable for hybrid development compared to two other lines tested. Out of nine OPV lines tested, line 9839 has the most promising heterotic pattern, qualifying for variety development (Table 4).

Table 4. Mean yields of top crosses developed with 9 OPV families of the top cross evaluation conducted at FCRDI, Maha Illuppallama, during *yala* 2000[1]

Open Pollinated Family	*Grain Yield (t/ha)*
9839	5.68 a
9838	5.41 ab
9837	5.13 abc
9834	5.02 abc
9841	4.95 abc
9836	4.91 abc
9840	4.89 abc
9835	4.49 bc
9842	4.20 c

GM = 4.85, LSD = 0.79, CV (%) = 16.49

[1]mean followed by the same letter are not significantly different at 0.5% by DMRT

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