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STRATIFIED MASS SELECTION FOR GRAIN YIELD IN THE MAIZE VARIETY, METRO.

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Ringkasan

Cara mudah bagi pemilihan umum berstrata (stratified mass selection) diterangkan. Selepas pemilihan umum pusingan keempat (fourth cycle) dijalankan hasil darinya telah dibuatkan percubaan untuk perbandingan pengeluaran yang dijalankan serentak di Tg. Karang, Serdang dan Lundang. Di dalam percubaan pengeluaran hasil ini termasuklah juga jenis Asli, Metro KS, L dan B.

Adalah didapati bahawa pengeluaran hasil biji (grain yield) dari jenis Metro KS, L dan S lebih rendah sebanyak 10-15% daripada Metro Asli. Tidak terdapat perbezaan yang berkesan di dalam pengeluaran hasil biji di antara Metro Asli dan jenis TK-4 yang telah diperbaiki (improved TK-4) sungguhpun penambahan hasil sebanyak 14.7% diperolehi di Serdang — Lundang dan 25.7% diperolehi di Tg. Karang. Walau bagaimanapun Metro TK-4 lebih mengeluarkan hasil yang berkesan daripada jenis B.L, KS dan S.

Introduction

Metro, a synthetic variety which originated in Indonesia, was introduced into Malaysia in 1964 to replace our low yielding variety, Local Flint. A selection programme to improve the grain yield of Metro under local conditions was initiated in 1968 at the Peat Research Station, Tanjong Karang (Selangor). The method used was stratified mass selection.

Mass selection has been found to be effective in changing traits like ear and plant height (Smith, 1909), oil and protein content (Woodworth et al, 1952) and date of maturity (Andrew, 1969). However, no definite conclusions could be drawn with regards to mass selection for improving grain yield. Though Montgomery (in Hayes *et al*, 1955) and William & Welton (1915) obtained increase in grain yield with mass selection, other breeders like Kiesselbach, Noll, Richey, Hayes & Alexander (reviewed in Gardner, 1961) found it to be ineffective. Hayes *et al* (1955) concluded that it was ineffective for increasing grain yield of adapted varieties.

However, in recent years the results obtained in the United States (mainly North Carolina and Nebraska) demonstrated that large amounts of additive genetic variance for yield existed in open-pollinated varieties (Robinson *et al*, 1955, and Gardner, 1961). Hence, selection on single-plant basis should be effective in improving grain yield. This has been confirmed by the findings of Lonnquist & McGill (1956), Gardner (1961) and Lonnquist *et al* (1966).

The object of this paper is to report on a study involving the mass selection and performance of Metro as evaluated in 1970.

Materials and Methods

The material used for the mass selection was a random sample of seeds drawn from the Metro variety grown in 1967 at Tanjong Karang. These seeds were labelled TK-O and some seeds were sent to Kuala Lumpur for storage in the cold room.

The stratified mass selection scheme used was that described by Gardner (1961) and Sombatsiri *et al* (1964).

The base population for the selection experiment consisted of 36 plots with each plot size of 25 ft x 15 ft (7.62 m x 4.57 m). With a planting distance of 1 ft x 3 ft (0.305 m x 0.915 m) each plot contained 125 plants arranged in five rows. At tasseling stage, prior to anthesis, all plants that were off-types, lodging and poor vigour were detasseled. At harvest 30 superior-looking cobs from plants of better vigour and least attacked by pests and diseases were selected and bagged according to plot. After dehusking and drying, all the 30 cobs, taking one at a time, were weighed and the heaviest five were retained. These selected cobs were bulked with those of the other plots, shelled and the seeds thoroughly mixed. These seeds, labelled TK-1, would form the base population for the next cycle of selection. The above procedure was repeated until TK-4 seeds were produced.

TK-0 is referred here as the Original since TK-4 was derived from it. In 1970 seeds from four different locations, as listed below, were collected to represent the existing status of Metro in the country.

Collections	Locations
Metro 'KS'	Kuala Selangor (Selangor)
Metro 'S'	Serdang (Selangor)
Metro 'B'	Butterworth (Province Wellesley)
Metro 'L'	Lundang (Kelantan)

The above collections together with TK-0 and TK-4 were incorporated into an evaluation trial conducted at Tanjong Karang (shallow peat), Lundang (clayey loam) and Serdang (sandy clay loam) simultaneously. A randomized complete block design with four replications was used. The plot size was 10 ft x 15 ft (3.05 m x 4.58 m) and with a planting distance of 30 in x 9 in (0.763 m x 0.229 m).

Results and Discussion

The Original referred here is TK-0, the base population from which TK-4 was derived. The results of yield tests conducted at Tanjong Karang, Serdang and Lundang are presented in Tables I & II. Plant height, ear height and days to 75% silking are recorded in Tables III, IV & V respectively.

Based on Bartlett's Test for homogeneity of residual variances for grain yield, it was decided to conduct a combined analysis for Serdang and Lundang and a separate analysis for Tanjong Karang. The combined analysis showed no significant interaction between the entries and locations, indicating that the entries gave quite similar yield response at Lundang and Serdang (given in appendix). However, the analysis of Tanjong Karang revealed high variation for grain yield, coefficient of variation being 42.9%. This was not unexpected as symptoms of localised stunting and yellowing of leaves were also noted. Further analysis showed significant correlation between entry means and corresponding standard deviations at 1% level ($r = + 0.894$), inferring that logarithmic transformation is appropriate, a summary of the analysis is given in the appendix.

As seen in Table I & II, TK-4 consistently gave higher yield than the Original over all the three locations tested. However, none of the difference was statistically significant although grain yield improved by 14-25.7% of the Original. This could be attributed to insufficient replications which rendered the experimental design less sensitive. The yield increase of 14-25.7% after four cycles of selection is comparable to results achieved by other researchers. Using the open pollinated maize variety Hayes Golden, Gardner (1961) obtained a gain of 22.8% after four cycles of selection and Lonnquist *et al* (1966) reported an increase of 12.7% after six cycles of selection. Sombatsiri *et al* (1961) recorded a

gain of 0-22% after three cycles of selection using the variety Guatemala, a variety related to Metro. Using the variety Chalco, Covarrubias obtained 9% gain in yield after two cycles of selection and Johnson reported an improvement of 33% after three cycles of selection with variety V520C (in Lonnquist 1966).

From the yield results, it can be seen that Metros KS, L, B and S were outyielded significantly by TK-4 at all locations. The overall average of Metros KS, L, B & S (no significant difference among them) is represented in Fig. I as barcharts together with TK-4 and the original.

There was no significant difference between the entries for plant and ear height. However, interaction between entries and location were marked. For days to 75% silking from sowing, difference between entries wer significant at Serdang and Tanjong Karang but not Lundang. At Serdang, L was significantly longer maturing than all entries. The earliest maturing entry at Serdang and Tanjong Karang was B. From table V, it appears that all the entries took longer time to reach maturity at Lundang than at the other two locations.

Thus, it can be seen that though TK-4 gave significantly higher yield than KS, L, S & B generally TK-4 was not significantly different from these entries in plant height, ear height and days to 75% silking. One can conclude that selecting for cob weight in maize does not have any marked effect on plant height, ear height and days to 75% silking. The results here indicate that controlled mass selection can be effective in improving grain yield of an open-pollinated variety of maize. Since TK-4 is significantly higher than KS, S, L and B in yield, it could replace the present Metro variety in the country.

Table I: Grain Yield (15% Moisture) at Tanjong Karang (retransformed data)

Metro Entries	Av. Plot Yield (gm)	Yield in Kg/ha.*	% of Original
TK-4	1063.0	1905 a	125.7
Original	845.9	1516 ab	100.0
KS	507.0	909 bc	60.0
L	423.6	759 bc	50.1
B	404.1	724 c	47.8
S	398.3	714 c	47.1
Mean	578.2	1036	

Coeff. Var = 7.0%

* Values followed by the same letter are not significantly different at 5% using the Duncan's Multiple Range test.

Table II: Grain Yield (15% Moisture) at Lundang and Serdang.

Metro Entries	Yield in Kg/ha		Mean Yield*	% of Original
	Serdang	Lundang		
TK-4	3506	4087	3797 a	114.7
Original	3091	3528	3310 ab	100.0
S	2940	3201	3071 bc	92.8
KS	2108	3253	2681 cd	80.1
L	2212	2831	2521 cd	76.2
B	1428	2611	2020 d	61.0
Location				
Mean	2667	3464		

Coeff. Var – 17.8%

* Values followed by the same letter are not significantly different at 5% using the Duncan's Multiple Range test.

Table III. Plant height in cm. at Serdang, Lundang and Tanjong Karang.

Metro Entries	Serdang	Lundang	Tg. Karang	Mean*
TK-4	243.7	396.4	270.2	303.4 a
Original	241.4	376.5	251.4	289.8 ab
KS	247.9	382.1	275.8	301.9 a
S	249.9	389.6	270.0	303.2 a
L	248.6	377.2	260.7	295.5 a
B	193.3	379.8	250.0	274.4 b
Mean	237.1	384.3	263.6	

* Values followed by the same letter are not significantly different at 5% using the Duncan's Multiple Range test.

Table IV: Far heights in cm. at Serdang, Lundang and Tanjong Karang.

Metro Entries	Serdang	Lundang	Tg. Karang	Mean *
TK-4	144.1	156.4	140.6	147.0 ab
Original	141.0	144.8	123.9	136.6 b
KS	146.2	139.4	143.1	142.9 ab
S	152.2	167.9	144.1	154.8 a
L	148.3	150.9	135.2	144.8 ab
B	107.9	173.4	122.7	134.7 b
Mean	139.9	155.9	133.4	

* Values followed by the same letter are not significantly different at 5% using the Duncan's Multiple Range test.

Table V: No. of days to 75% silking for all entries at Serdang, Lundang and Tanjong Karang.

Metro Entries	Serdang *	Lundang *	Tg. Karang *
TK-4	49.3 bc	78.5 a	55.3 ab
Original	48.8 bc	75.0 a	55.3 ab
KS	50.5 b	78.5 a	57.0 ab
S	50.8 b	75.0 a	58.8 a
L	53.0 a	79.3 a	57.8 a
B	47.8 c	80.3 a	51.8 b
Mean	50.0	77.3	55.4
Coeff. Var.	2.7%	4.2%	6.9%

* Values followed by the same letter are not significantly different at 5% using the Duncan's Multiple Range test.

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Summary

A simple method of stratified mass selection is described. After the fourth cycle of mass selection, the end-product was incorporated into a yield trial conducted at Tanjong Karang, Serdang and Lundang simultaneously. Also included in the yield trial were the Original, Metros KS, L, S and B.

It was found that grain yield of Metros KS, L, S and B were lower than the Original by some 10-50% of the latter. There was no significant difference in grain yields between the Original and the improved, TK-4, though increases of 14.7% and 25.7% were obtained at Serdang — Lundang and Tanjong Karang respectively. Metro TK-4, however, significantly outyielded the entries B, L, KS & S.

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APPENDIX

ANOVA 1: Combined analysis for Grain Yield (Serdang - Lundang)

Sources of Var.	*df.*	*Mean squares*
Locations	1	8888942 *
Entries	5	3953272 **
Locations x Entries	30	247297 NS
Residual	30	299512

ANOVA 2: Logarithmic transformation (base 10) analysis for grain yield at Tanjong Karang.

Sources of Var.	*df.*	*Mean squares*
Replications	3	0.52304736 **
Entries	5	0.11227811 *
Residual	15	0.03750696

$x = 2.76205$

NS = not significant
* = significant at 5%
** = significant at 1%

ANOVA 3: Combined analysis for Plant height and Ear height.

Sources of Variety	*df.*	*Mean squares*	
		Plant height	*Ear height*
Locations	2	172349.62 **	3852.58 **
Entries	5	1284.97^{NS}	574.42^{NS}
Locations x Entries	10	461.49 **	637.68 **
Residual	45	136.52	104.50

ANOVA 4: Analysis for days to 75% silking.

Sources of Var.	*df.*	*Mean squares*		
		Lundang	*Serdang*	*Tg. Karang*
Replications	3	2.333^{NS}	2.778^{NS}	42.433 *
Entries	5	22.167^{NS}	11.333 **	33.333 *
Residual	15	10.222	1.778	10.539

NS = not significant

* = signikcant at 5%

** = significant at 1%

Figure 1: Bar-chart of grain yield at Tanjong Karang, Serdang and Lundang.