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YIELD POTENTIAL OF GRAIN MAIZE IN HUMID TROPICAL MALAYSIA

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RINGKASAN

Keputusan hasil bijirin jagung diperolehi berasaskan kepada percubaan kultivar dan percubaan hasil daripada petak seluas 0.4 hektar. Bergantung kepada lokasi, hasil dari percubaan kultivar dan percubaan hasil masing-masing ialah di antara 3–6 dan 3–4 t/hektar. Pengurusan yang baik dan pengairan tambahan membolehkan hasil yang diperolehi dalam percubaan hasil mencapai peringkat ladang. Hasil daripada percubaan kultivar pula boleh disifatkan sebagai paras potensi hasil yang boleh diperolehi.

INTRODUCTION

Maize yield in the tropics is far below that in the temperate zone. Maize yield in tropical areas averages 1.4 t/hectare. This is low compared with a yield of 5.8 t/ha in the developed countries of the temperate world (ANON., 1984). Management is an important factor contributing to the higher yield in developed countries. The importance of inputs for increased yield is shown by commercial yields of 5–6 t/ha achieved in the Nile Valley of Egypt (SPRAGUE and PAHLIWAL, 1984) where maize is grown under irrigation.

The other factor contributing to low yield in the tropics can be attributed to the genotype of tropical maize. Tropical maize is not grain yield efficient. The harvest index is low and the tall and leafy plant type is subjected to lodging. However, selection by FISCHER, JOHNSON and EDMEADES (1983) has shown increased grain yield with reduced plant height, tassel size and leaf area.

In Malaysia, research on breeding and selection for improved yield is being pursued. YAP and CHIOW (1974) showed bulking of superior full-sibs improved yield by 14.4% and 11.9% in the cultivars Local Flint and Metro respectively. WONG (1980) selected an open-pollinated cultivar, MARDI Composite $1C_5$, which has improved yield. In the continuing effort to improve grain yield, high-yielding cultivars Suwan I C_7 from Thailand and Across 7824 and Across 7728 from CIMMYT, Mexico were introduced (ANON., 1983).

This study documents the grain yields achieved at various locations in Malaysia and discusses prospects for achieving high grain yield.

MATERIALS AND METHODS

The yield trials were conducted over four sites. Tal Tujuh is a riverine area along the Kelantan River bank near Kota Bharu. Pasir Putih, with soil described as granite wash, is also located in Kelantan. IPRS in Pontian (Johore) is a peat soil station characterized by peat with low pH. Bertam in Seberang Perai has sandy clay loam classed as Oxic Dystropept (WONG, 1981).

Seeds were sown 75 cm between rows and 50 cm within rows with two seeds per point. Planting density at this spacing is approximated to 53 000 plants/hectare. The yield potential of maize cultivars was evaluated by two methods:

a) Replicated yield trials: Entries for yield trials were planted in 3 m x 5 m plots, replicated four times. All four

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rows were harvested for yield assessment.

b) Bulk yield assessments: Assessments were made on cultivars each planted in a 0.4-hectare block. All plants within the block were harvested.

Grain yield was derived from grain weight computed from air-dried cob weight corrected for 80% shelling percentage and 15% moisture content. Grain moisture content was measured by using a Steinlite Electronic Moisture Meter or a Burrows Digital Moisture Computer 700.

Plant height was measured from the soil surface to where the tassel begins and cob height to where the cob attaches to the plant. Twenty plants/plot were sampled in the replicated yield trials. In the bulk yield trials, heights of 100 random plants were taken. Cultural practices, fertilizers and pest control were as recommended by WONG (1980).

RESULTS

Grain yields recorded on various replicated yield trials of open-pollinated cultivars and hybrids across locations at Kelantan, Johore and Seberang Perai are presented in *Tables 1–4*. Grain yields ranged from below 3 t/ha to as high as 6 t/hectare. A consistent trend of lower yields of below 4 t/ha were recorded on peat soil at Pontian and the granite wash at Pasir Putih. Higher yields of up to 6 t/ha were recorded for the riverine areas of Kelantan and at Bertam. However, larger plot yields from bulk harvests of 0.4-hectare blocks both at Pontian and Bertam *(Table 5)* gave more realistic yield estimates. These bulk harvests consistently gave yield estimates of below 4 t/ha on peat at Pontian and above 4 t/ha at Bertam.

Genotype or cultivar differences in yield expression appear to be very small or absent. Both hybrid and open-pollinated cultivars gave equal performance at all locations. Plant and cob heights, with the exception of some entries *(Table 3)* and Across 7728 *(Table 5)* fall within the desirable 2.0 m and 1.0 m respectively.

DISCUSSION

Grain yields ranging from 3 t/ha to 6 t/ha over seasons and locations are indicative of the yield potential of modern tropical grain maize in Malaysia. The absence of any outstanding cultivar, be it open-pollinated

Table 1. Mean yield, plant and cob heights of grain maize cultivars at Tal Tujuh and Pasir Putih (Kelantan)

Cultivar	Yield (t/ha)		Plant ht. (m)		Cob ht. (m)	
	1+	2	1	2	1	2
Suwan I	4.5	3.1	2.1	1.5	1.0	0.7
Suwan II	3.9	2.3	2.0	1.5	0.9	0.6
Hycorn 9	4.4	–	2.0	–	0.9	–
Across 7824	4.5	3.4	2.1	1.6	1.0	0.8
MARDI Comp. $1C_5$	4.4	3.0	2.3	1.7	1.2	0.9
Tocumen 7936	3.7	2.5	1.8	1.4	0.8	0.6
Caripeno DMR	3.7	2.5	1.9	1.4	0.9	0.7
Across 7728	4.4	3.2	1.9	1.5	0.9	0.8
L.S.D. (P=0.05)	0.97	0.86	0.15	0.22	0.16	0.16
C.V. (%)	15.7	16.7	5.2	10.9	11.3	12.5

+1 Tal Tujuh, Kelantan – Date sown 14.6.82
2 Pasir Putih, Kelantan – Date sown 14.2.82

Table 2. Mean yield, plant and cob heights of grain maize cultivars at IPRS (Pontian) and Bertam (Seberang Perai)

Cultivar	Yield (t/ha)		Plant ht. (m)		Cob ht. (m)	
	1+	2	1	2	1	2
Suwan I(s) C_7F_3	4.80	4.62	2.11	1.94	1.00	0.96
Suwan II(s) C_4F_3	2.88	3.43	1.72	1.87	0.87	0.95
Caripeno DMR	2.91	4.18	1.87	1.96	0.91	0.99
Across 7824	3.16	4.72	1.90	1.93	1.09	1.02
Tocumen 7936	2.74	–	1.95	–	0.88	–
Across 7728	3.39	4.13	2.18	2.01	1.06	0.98
MARDI Comp. $1C_5$	4.02	–	1.96	–	1.25	–
Hycorn 9	–	4.01	–	2.07	–	1.13
L.S.D. (P=0.05)	0.90	0.49	0.42	0.71	0.19	0.12
C.V. (%)	30.3	9.0	14.0	2.7	23.0	0.2

+1 IPRS, Pontian – Date sown 9.10.82
2 Bertam, Seberang Perai – Date sown 14.3.83

Table 3. Results of hybrid maize varietal trials

Cultivar	Yield (t/ha)	Plant ht. (cm)	Cob ht. (cm)
Bertam (1.10.84)+			
2 H 106	6.6a	175.4b	89.0b
2 H 107	6.5a	182.1b	89.1b
P 6181	6.3a	179.7b	95.4ab
Suwan I (check)	5.9ab	198.9a	99.9a
XCF 34	5.4b	177.3b	82.3c
3 H 001	5.3b	179.6b	82.3c
C.V. (%)	9.5	4.6	7.1
Tal Tujuh (6.8.81)+			
IRAT 81	4.95	226	134
IRAT 82	4.96	189	99
IRAT 83	5.97	213	103
IRAT 98	6.26	238	137
IRAT 100	5.45	239	143
X 304C	5.76	214	105
H 688	5.83	210	97
MARDI Comp. $1C_5$ (check)	6.04	228	132
L.S.D. (P=0.05)	1.40	24	22
C.V. (%)	11.2	4.6	8.5

+Date sown
Values within the same column with similar letters are not significantly different from one another according to the L.S.D. test (P=0.05)

or hybrid, across locations and seasons confirmed the low yield potential of tropical maize. This genetic barrier to higher grain yield has yet to be overcome. Breeding for

Table 4. Results of IRRI grain maize varietal trial at Bertam (Seberang Perai)

Cultivar	Yield (t/ha)	Plant ht. (cm)	Days to 50% tasselling (DAP)
EDC 002	4.0	177.0	47.0
P 7930	4.1	154.2	44.5
Arun 2	4.7	173.1	46.0
T 7931	3.2	155.5	48.0
XC 001	3.8	168.8	47.5
Raijuna	4.2	168.0	46.5
Suwan I C_7 (check)	4.9	174.9	49.5
Across 7824 (check)	3.6	151.3	47.0
TCI EC4	4.7	172.0	46.5
EDC 001	4.0	167.4	46.5
TFE 139	3.4	176.9	48.5
P. Rica	3.2	155.0	43.5
C.V. (%)	34.3	8.0	9.7
L.S.D. (P=0.05)	N.S.	N.S.	N.S.

Date sown: 4.10.84
DAP = Days after planting
N.S. = Not significant

Table 5. Yield, plant and cob heights of maize from bulk harvests of 0.4- hectare blocks

Location	Date sown	Cultivar	Yield (t/ha)	Plant ht. (cm)	Cob ht. (cm)
IPRS, Pontian	15. 5.83	Suwan I C_7	3.1	195.0±25.3	91.6± 9.2
	9.12.83	Suwan I C_7	2.7	157.0±28.8	77.0±16.1
	9. 5.84	Suwan I C_7	3.8	192.7±28.2	100.1±13.9
	2. 1.85	Suwan I C_7	3.4	202.0±17.4	96.0±10.8
Bertam, Seberang Perai	28. 4.83	Across 7728	4.6	245.9±24.6	132.4±16.7
	24. 5.83	Across 7824	5.6	194.7±17.9	98.5±14.0
	18. 7.84	Suwan I C_7	4.4	197.7± 7.8	99.5± 5.7
	5. 2.85	Suwan I C_7	4.3	196.4±29.6	99.1±14.1

better harvest index, by reducing plant height is being pursued (SPRAGUE and PAHLIWAL, 1984). Furthermore, work has been initiated to breed maize for drought tolerance (FISCHER *et al.*, 1983). However, at this juncture, both crop agronomist and farmer have to accept the ceiling yield imposed by genotype until breeders make a major breakthrough to upgrade the grain yield potential. As small experimental plots have yielded no more than 6 t/ha, this yield may be regarded as the ceiling yield in the Malaysian environment. On the other hand, the grain yields of 3 t/ha and 4 t/ha recorded at Pontian and Bertam respectively, in the 0.4-hectare block trials can be takens as realisable yields under recommended agronomic inputs in the Malaysian environment.

Entrepreneurs and farmers evaluating the economics of maize production in Malaysia must therefore be well aware of this ceiling yield. While plant breeders are actively trying to break through the ceiling yield to bring tropical maize to the grain yield levels of temperate maize, maize growers can improve their crop performance by

better management. Recommended agronomic inputs of fertilizer and lime to upgrade the low pH of tropical soils must be followed. However, the most crucial factor to successful grain maize production in Malaysia is some form of supplementary irrigation. Water must be available either in the form of furrow irrigation or a powerful overhead 'rain gun'. Such supplementary irrigation is necessary to break the two to three weeks dry spell frequently encountered in a growing season which can drastically reduce yield. The need for such supplementary irrigation for annual crops was emphasized by NIEUWOLT (1981) who recommended some form of 'temporary' irrigation to overcome the 'short-term' drought.

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ABSTRACT

Grain yields of maize were estimated from replicated cultivar and 0.4 -hectare plot bulk yield trials. Depending on locations, replicated cultivar and 0.4 -hectare plot yield estimates ranged from 3–6 and 3–4 t/ha respectively. With good management and supplementary irrigation, the yield recorded in the bulk yield assessment could be duplicated at farm level while the yield achieved in the replicated yield trials may be taken as the ceiling yield potential.

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