J. Trop. Agric. and Fd. Sc. 29(1)(2001): 29–38

Characterisation of selected tropical maize inbred lines developed in Malaysia

(Pencirian titisan inbred jagung bijian tropika yang dibentuk di Malaysia)

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Key words: grain maize, inbred lines, characterisation

Abstrak

Banyak kajian telah dijalankan untuk mengenal pasti dan memilih titisan inbred unggul jagung (*Zea mays* L.) berdasarkan prestasinya sendiri dan juga keupayaan bergabung amnya. Dalam kajian ini, sekumpulan titisan inbred hampir homozigus yang diperoleh selepas lima generasi pendebungaan sendiri terhadap populasi sumber yang pelbagai, telah dinilaikan prestasinya. Titisan inbred ini adalah daripada lima kumpulan yang berbeza, kesemuanya dari asal usul tropika. Penilaian telah dijalankan di Ladang 2, Universiti Putra Malaysia, menggunakan reka bentuk Blok Penuh Terawak (RCB), dalam 3 replikasi, dengan amalan penanaman yang lazim. Tiga belas titisan inbred daripada setiap kumpulan dikaji. Sebilangan titisan inbred memperlihatkan potensi yang tinggi untuk digunakan dalam kerja-kerja pembiakbakaan. Antara titisan yang menunjukkan prestasi terbaik ialah UPM-TW-5, yang menghasilkan 43.5 g berat bijian/pokok, 49.9 g berat tongkol/pokok dan 24.6 bilangan bijian/baris, UPM-SM5-4 (44.9 g, 57.7 g dan 27.1), UPM-SM7-6 (82.6 g, 104.7 g dan 31.7), UPM-MT-5 (54.8 g, 68.4 g dan 21.4), dan UPM-SW-6 (40.6 g, 55.0 g dan 21.9), masing-masing untuk ketiga-tiga ciri berkenaan. Bagi korelasi antara ciri, terdapat sedikit perbezaan dalam nilai yang diperoleh apabila kumpulan yang berbeza dibandingkan, walaupun secara amnya nilai-nilainya agak seragam. Berat bijian/pokok berkorelasi positif dengan semua ciri lain yang diukur dalam semua kumpulan, kecuali hari pengeluaran bunga jantan dan hari pengeluaran bunga betina yang kedua-duanya menunjukkan korelasi negatif dengan berat bijian/pokok. Titisan inbred unggul yang dikenal pasti dalam kajian ini boleh dimajukan seterusnya untuk digunakan dalam kacukan dialel bagi pembentukan varieti hibrid jagung bijian yang berhasil tinggi dan sesuai untuk keadaan penanaman di Malaysia.

Abstract

Many studies have been conducted to identify and select superior maize (*Zea mays* L.) inbred lines based on their performance and general combining ability (GCA). In this study, a series of near-homozygous inbred lines obtained after five generations of selfing from various source populations, were evaluated for performance. These inbred lines were from five different groups, all of tropical origin. Evaluations were conducted at Field 2, Universiti Putra Malaysia, using RCB design, in 3 replications under standard cultural practices. Samples of 13

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inbred lines from each group were studied. A number of inbred lines have comparatively high potential for breeding work. Among the best performing lines were UPM-TW-5, giving 43.5 g of grain weight/plant, 49.9 g of ear weight/plant and 24.6 kernels/ row, UPM-SM5-4 (44.9 g, 57.7 g and 27.1), UPM-SM7-6 (82.6 g, 104.7 g and 31.7), UPM-MT-5 (54.8 g, 68.4 g and 21.4), and UPM-SW-6 (40.6 g, 55.0 g and 21.9), respectively. Correlations among characters measured, showed some variations when different groups were compared, although in general they were quite consistent. Grain weight/plant was positively correlated with all other characters measured in all groups, except days to tasseling and days to silking with which it was negatively correlated. The superior inbred lines identified in this study could be advanced further for use in diallel crosses to produce high yielding hybrid varieties of grain maize suitable for Malaysian conditions.

Introduction

Inbred line development is the main pre-requisite for production of hybrid varieties. This process is achieved through successive generations of inbreeding followed by repeated testing and selection. Selected plants are usually self-pollinated for several generations until homozygosity is reached. Inbred lines need 7 to 8 generations of selfing to become fully stabilized (Poehlman 1987). Extensive studies on inbreeding depression in maize (*Zea mays* L.) have indicated that selfing is important in inbred line development because it leads to rapid gene homozygosity, whereby desirable dominant genes can be accumulated while the undesirable ones are eliminated (Gallais 1989; Saleh et al. 1993).

Hallauer and Miranda (1982) reported that many undesirable recessive genes will be eliminated from families as a result of the inbreeding process, then selection will be applied within and between lines for the best individual plants. Hallauer (1990) added that maize inbred lines developed from improved source populations would have greater vigour and grain yield as compared to those developed from unimproved sources. Stoskopf et al. (1993) also cited that inbred lines are developed after 5 to 7 generations of selfing, during which selection for characters of interest is also conducted.

One of the main strategies of maize breeding research at Universiti Putra Malaysia is to develop high yielding hybrid varieties. Hence, a preliminary programme to develop inbred lines was initiated, as reported by Saleh and Yap (1988). Through this programme, more than 200 families, each from various populations, were initially developed through self-pollination and then selected for their performance *per se* along successive generations, and eventually tested for their general combining ability (Saleh and Sujiprihati 1997).

This study was a part of the above-mentioned programme to evaluate a series of maize inbred lines which were obtained from five source populations after five generations of selfing. The main objectives were to evaluate the performance *per se* of these advanced inbred lines, and to investigate correlations among the characters studied, so as to determine the potential of these lines as parental materials for the production of superior hybrid varieties.

Materials and methods

Plant materials

The materials used in this study include a series of near-homozygous inbred lines obtained after five generations of selfing from various source populations (Saleh et al. 1989). All source populations are of tropical origin. The source population groups were Tanco White (TW), SMC 305 (SM5), SMC

317 (SM7) (all from the Philippines), Metro (MT) (from Indonesia) and Suwan-1 (SW) (from Thailand). The inbred lines in each group had previously been tested and selected for their general combining ability (GCA).

The experiments were conducted at Field 2, Universiti Putra Malaysia (UPM), Serdang. The inbred lines within the different groups were evaluated simultaneously in a randomized complete block (RCB) design with three replicates. Each block was represented by 13 plots, and inbred lines were allocated randomly among the plots. Each plot comprised two rows of plants with 15 plants per row at 75 cm x 25 cm plant spacing. The experiments were conducted under standard cultural practices (Sujiprihati 1996).

Varieties Suwan-1 and Metro were grown between plots as borders to minimize the effect of unequal competitive ability of genotypes and to provide ample pollen quantities for ear development. Planting dates were adjusted to facilitate for coincidence of flowering between borders and plants within the plots.

Data collection and analysis

Data were collected for both pre- and post-harvest characters from a sample of 13 inbred lines per group. They include the following:

a. Pre-harvest characters:
   1. Plant height (cm)
   2. Ear height (cm)
   3. Days to tasselling
   4. Days to silking
b. Post-harvest characters:
   1. Grain weight/plant (g)
   2. Ear weight/plant (g)
   3. Ear length (mm)
   4. Ear diameter (mm)
   5. Number of kernel rows/ear
   6. Number of kernels/row

Data collected were analyzed using the SAS computer package (SAS Institute Inc. 1987). The analysis of variance (ANOVA) was used to determine the significance of variation among the inbred lines. Subsequently, Duncan New Multiple Range Test (DNMRT) was applied for comparison of mean performance of the inbred lines. Simple correlations among the ten characters measured were also analyzed.

Results and discussion

Results on the performance of inbred lines within each of the TW, SM5, SM7, MT and SW groups are presented in *Table 1*, as also been summarized by Sujiprihati (1996).

For the TW group, grain weight/plant was highest in UPM-TW-5 (43.5 g), followed by UPM-TW-9 (37.6 g) and UPM-TW-12 (36.8 g). With regard to the yield components, UPM-TW-5 had the highest ear weight/plant (49.9 g), followed by UPM-TW-12 (46.6 g) and UPM-TW-9 (45.9 g). In addition, UPM-TW-5 also gave the highest number of kernels/row (24.6), and had the tallest plants (141.0 cm), with the highest ear placement (59.5 cm). UPM-TW-10 had the shortest plants (95.9 cm) while UPM-TW-2 had plants with the lowest ear placement (23.4 cm). With regard to flowering characters, UPM-TW-6 was the earliest tasselling (51.6 days) and earliest silking (54.4 days).

For SM5 group, the highest grain weight/plant was obtained from UPM-SM5-4 and UPM-SM5-5 (44.9 g and 43.9 g, respectively). They also gave the highest ear weight/plant, ear length, ear diameter, number of kernel rows/ear and number of kernels/row. UPM-SM5-4 also had the tallest plants (135.5 cm) and UPM-SM5-6 had the highest ear placement on the plants (57.5 cm) while UPM-SM5-8 had the shortest plants (91.0 cm), with the lowest ear placement (36.4 cm). Earliest flowering was recorded on UPM-SM5-5, which tasseled after 56.3 days and silked after 61.3 days.

For SM7 group of inbred lines, UPM-SM7-6 gave the highest grain weight/plant (82.6 g), highest ear weight/plant (104.7 g), longest ears (127.8 mm), largest ear

Table 1. Mean values for the characters measured on TW, SM5, SM7, MT and SW inbred lines of maize

Inbred line	Grain weight/ plant (g)	Ear weight/ plant (g)	Ear length (mm)	Ear diameter (mm)	No. of kernel rows/ear	No. of kernels/ row	Plant height (cm)	Ear height (cm)	Days to tasselling	Days to silking
Tanco White (TW)										
UPM-TW-1	10.9h	15.3e	79.6e	24.0f	9.7fg	13.7f	104.2fg	41.7f	59.7a	64.4a
UPM-TW-2	12.9h	16.5e	58.8f	24.5f	9.5g	12.5f	99.6gh	23.4h	54.1e	57.4ef
UPM-TW-3	33.8cd	43.5b	84.8de	34.8a	12.5a	17.6e	133.4b	46.9de	52.6fg	58.4def
UPM-TW-4	26.3fg	33.0d	109.3b	31.4b	11.7bc	20.3cd	112.2e	53.8b	58.6ab	62.7b
UPM-TW-5	43.5a	49.9a	107.1bc	29.3cd	10.2ef	24.6a	141.0a	59.5a	56.8cd	61.0c
UPM-TW-6	27.7ef	33.0d	90.8d	29.1de	10.7de	18.0de	103.9fg	35.2g	51.6g	54.4g
UPM-TW-7	29.1ef	37.2c	114.5ab	28.6de	11.8bc	22.0bc	112.7e	49.9cde	57.4bc	61.3bc
UPM-TW-8	29.0ef	38.0c	117.9a	28.1e	10.0efg	22.2b	119.5d	50.6bcd	56.2cd	59.5d
UPM-TW-9	37.6b	45.9ab	101.5c	31.2bc	12.1ab	19.1de	132.8b	61.2a	56.1cd	58.0def
UPM-TW-10	28.4ef	35.3cd	89.3d	29.3de	11.2cd	18.1e	95.9h	34.2g	55.9d	57.2f
UPM-TW-11	30.5ed	35.5cd	83.7de	32.2b	12.2ab	18.4e	109.5ef	49.1cde	53.3ef	54.8g
UPM-TW-12	36.8bc	46.6ab	91.5d	33.9a	11.8bc	18.1e	137.1ab	52.0bc	52.3fg	57.9def
UPM-TW-13	22.7g	33.8cd	86.0de	31.2bc	11.0d	17.3e	125.9c	46.3e	56.2dc	59.1de
Mean	28.4	35.7	93.4	29.9	11.1	18.6	117.5	46.5	55.5	58.9
C.V. (%)	24.8	23.6	14.9	9.1	11.3	18.0	9.4	14.5	4.6	5.0
SMC 305 (SM5)										
UPM-SM5-1	19.5d	25.7ef	71.1h	28.6d	11.0de	15.5e	116.6bc	42.0d	60.9c	65.8a
UPM-SM5-2	27.1c	34.4d	86.3ef	30.9c	13.2ab	20.6cd	107.2de	39.0de	60.0de	66.0a
UPM-SM5-3	24.8cd	32.6de	82.5ef	29.3d	12.8b	18.5d	101.6e	41.1de	59.4d	65.4a
UPM-SM5-4	44.9a	57.7a	103.4a	34.2a	13.4ab	27.1a	135.5a	50.3b	57.9ef	63.6bc
UPM-SM5-5	43.9a	54.9ab	102.0ab	33.8a	13.7a	25.2a	115.0bcd	47.7bc	56.3g	61.3d
UPM-SM5-6	40.1ab	48.8bc	90.8cd	31.4bc	11.8c	19.8cd	132.2a	57.5a	62.2b	64.5ab
UPM-SM5-7	39.8ab	53.9ab	101.8ab	32.8ab	10.4ef	20.3cd	117.0b	56.6a	63.3ab	66.3a
UPM-SM5-8	21.2cd	27.3def	80.5f	28.2de	11.7cd	16.2e	91.0f	36.4e	56.9fg	62.6cd
UPM-SM5-9	34.7b	43.8c	94.5bc	31.7bc	12.6b	22.7b	117.4b	44.1cd	57.2fg	61.8cd
UPM-SM5-10	19.4d	23.2f	65.6h	26.8e	11.6cd	14.9e	121.2b	49.2b	60.7c	63.6bc
UPM-SM5-11	26.1c	34.5d	72.5gh	29.1d	11.6cd	16.0e	122.9b	48.5bc	64.4a	65.8a

(cont.)

Table 1. *(cont.)*

Inbred line	Grain weight/ plant (g)	Ear weight/ plant (g)	Ear length (mm)	Ear diameter (mm)	No. of kernel rows/ear	No. of kernels/ row	Plant height (cm)	Ear height (cm)	Days to tasselling	Days to silking
UPM-SM5-12	19.7d	25.5ef	79.0fg	25.1f	10.1f	15.8e	102.6e	44.0cd	59.0de	63.0cd
UPM-SM5-13	6.2b	44.5c	90.2cde	32.1bc	12.7b	21.2bc	108.1cde	43.7cd	56.4g	62.0cd
Mean	30.6	39.0	86.2	30.3	12.0	19.5	114.5	46.2	59.6	63.9
C.V. (%)	35.8	35.2	16.7	9.1	11.8	19.7	13.8	19.4	4.0	5.0
SMC 317 (SM7)										
UPM-SM7-1	26.2de	36.6de	88.1cde	26.7g	11.8ef	18.0fg	119.8cde	39.9g	55.7bc	60.6b
UPM-SM7-2	31.1cd	39.7d	93.3c	29.7cd	13.0ab	21.1de	131.3b	54.3bc	57.0ab	60.1bc
UPM-SM7-3	34.2c	42.1d	93.6c	30.8bc	11.2fg	19.6ef	99.2g	33.7h	55.3c	58.6cd
UPM-SM7-4	30.2cd	37.6de	90.5cd	28.5def	12.1de	23.0cd	120.0cde	47.1de	54.1de	57.8d
UPM-SM7-5	32.3cd	39.0de	94.0c	28.0ef	12.1de	22.8cd	116.8def	40.6g	55.6bc	59.4bc
UPM-SM7-6	82.6a	104.7a	127.8a	39.7a	12.9abc	31.7a	138.5a	55.4ab	58.1a	60.1bc
UPM-SM7-7	24.1e	29.9e	81.5e	27.6fg	12.8abcd	18.8f	138.9a	58.9a	56.2bc	59.2bcd
UPM-SM7-8	31.0cd	36.5de	86.9cde	29.1de	12.3bcde	19.0ef	112.7ef	45.3ef	55.7bc	60.2bc
UPM-SM7-9	43.0b	51.3bc	93.2c	31.3b	13.2a	23.6c	123.4cd	54.0bc	56.3bc	59.3bcd
UPM-SM7-10	33.1c	43.4cd	82.4de	31.8b	12.7abcd	17.4fg	113.5ef	46.4de	57.8a	62.5a
UPM-SM7-11	45.3b	56.2b	113.2b	29.2de	12.1cde	27.2b	141.8a	56.2ab	56.1bc	60.1bc
UPM-SM7-12	22.3e	30.1e	83.9de	24.8h	11.0g	19.6ef	126.3bc	50.4cd	56.1bc	60.7b
UPM-SM7-13	28.2cde	37.2de	79.9e	31.3b	13.3a	16.3g	111.5f	42.1fg	58.2a	63.9a
Mean	35.7	44.9	92.9	29.9	12.3	21.4	122.6	48.0	56.3	60.2
C.V. (%)	30.1	34.6	16.0	7.6	11.1	18.7	11.1	16.4	4.0	4.7
Metro (MT)										
UPM-MT-1	18.3g	23.0g	62.2e	29.4f	11.5fg	11.0fg	99.0gef	40.8e	53.7cd	58.6bcd
UPM-MT-2	29.5de	39.9de	90.5cd	38.0a	13.1bc	14.7e	93.9g	46.6cd	55.6b	58.5bcd
UPM-MT-3	36.4bc	52.6bc	112.4a	35.2c	12.8bcd	18.7b	137.9c	61.4b	55.7b	58.0cde
UPM-MT-4	29.5de	32.4f	84.2d	33.5d	12.6cd	15.3de	97.5gf	50.5c	55.0bc	59.0bcd
UPM-MT-5	54.8a	68.4a	109.1a	35.6c	14.0a	21.4a	155.6a	64.0ab	55.8b	59.9b
UPM-MT-6	31.9cd	43.3d	96.0bc	36.4bc	12.5cde	17.4bcd	102.9ef	41.7e	51.7ef	56.0fg

(cont.)

Table 1. *(cont.)*

Inbred line	Grain weight/ plant	Ear weight/ plant	Ear length (mm)	Ear diameter (mm)	No. of kernel rows/ear	No. of kernels/ row	Plant height (cm)	Ear height (cm)	Days to tasselling	Days to silking
UPM-MT-7	25.0ef	35.2ef	95.2bc	35.1c	12.7cd	11.8f	94.3g	42.9de	53.0de	56.7ef
UPM-MT-8	31.8cd	46.1cd	103.7ab	37.7ab	12.7cd	17.0bcd	102.3ef	42.0e	50.9f	54.8g
UPM-MT-9	13.5h	21.4g	64.5e	29.4f	11.1g	9.7g	104.0e	47.3c	59.4a	62.2a
UPM-MT-10	28.2de	40.6de	97.6bc	26.2g	12.1def	17.5bc	131.3d	61.8ab	58.5a	62.4a
UPM-MT-11	20.4fg	22.1g	105.0ab	31.7e	12.1def	18.4bc	70.6h	22.6f	54.7cb	57.6de
UPM-MT-12	32.6cd	42.3d	110.7a	38.0a	13.6ab	16.4cde	104.4e	48.7c	55.1bc	59.4bc
UPM-MT-13	39.7b	57.9b	109.8a	32.8de	11.8efg	21.9a	149.2b	65.9a	56.2b	59.4bc
Mean	30.1	40.4	95.5	33.8	12.6	16.3	111.0	48.9	55.0	58.7
C.V. (%)	29.7	31.7	20.4	8.2	11.0	22.8	9.8	15.9	4.7	5.1
Suwan-1 (SW)										
UPM-SW-1	24.9def	33.0fg	81.5e	32.7b	14.1a	16.6de	104.5e	44.2d	59.6bc	61.7cd
UPM-SW-2	35.8b	44.3bc	117.7ab	27.7d	10.1g	21.4a	138.7c	50.4c	58.9c	59.6ef
UPM-SW-3	21.3fg	26.6h	65.8f	31.5b	12.1d	13.9f	117.4d	38.7ef	54.9e	58.5fg
UPM-SW-4	30.3c	43.5bc	93.9d	34.9a	12.9bc	18.2cd	157.2ab	67.3ab	59.5bc	62.3bcd
UPM-SW-5	28.8cd	38.6cde	124.7a	29.9c	10.2g	19.1bc	151.6b	68.1a	62.9a	63.6ab
UPM-SW-6	40.6a	55.0a	122.6a	32.6b	12.0d	21.9a	123.5d	37.7f	55.6de	57.7g
UPM-SW-7	24.4ef	32.6fg	70.1f	31.4b	13.3b	15.3ef	105.8e	42.8de	60.4b	62.8bc
UPM-SW-8	21.1fg	28.2gh	91.5d	27.5d	11.2f	16.8de	140.1c	63.9ab	58.9c	61.3d
UPM-SW-9	29.4c	39.1cde	91.2d	31.5b	12.4cd	19.0bc	142.5c	63.2b	60.1bc	63.0bc
UPM-SW-10	35.3b	45.0b	106.9c	29.8c	11.2ef	20.3ab	160.1a	64.6ab	58.9c	59.9e
UPM-SW-11	19.9g	29.6gh	108.0c	26.7d	10.7fg	16.8de	109.1e	27.0g	59.3bc	62.3bcd
UPM-SW-12	30.1c	39.2cde	106.0c	31.5b	11.9de	18.7bc	106.7e	38.0f	56.5d	59.1ef
UPM-SW-13	27.9cde	35.6ef	112.8bc	26.6d	10.2g	19.1bc	138.2c	53.5c	63.3a	64.4a
Mean	28.4	37.7	99.5	30.3	11.7	18.2	130.4	50.7	59.1	61.2
C.V. (%)	26.6	25.6	14.0	7.5	11.5	16.4	10.4	16.7	3.6	4.0

Mean values followed by the same letter in the same column are not significantly different at $p \leq 0.05$

diameter (39.7 mm), and the highest number of kernels/row (31.7). UPM-SM7-3 had the shortest plants (99.2 cm), as well as the lowest ear placement (33.7 cm). UPM-SM7-4 had plants that were earliest tasselling (54.1 days) and earliest silking (57.8 days).

For MT group of inbred lines, UPM-MT-5 was found to be the tallest (155.6 cm) and had the highest grain weight/plant, ear weight/plant, number of kernel rows/ear and number of kernels/row (54.8 g, 68.4 g, 14.0 and 21.4, respectively). With regard to ear placement, UPM-MT-5 had the value of 64.0 cm, which was not significantly different from the highest (65.9 cm) obtained from UPM-MT-13. UPM-MT-11 gave the lowest ear placement on plants (22.6 cm) and had the shortest plants (70.6 cm). UPM-MT-8 was the earliest tasselling, after 50.9 days and earliest silking, after 54.8 days.

For SW group of inbred lines, UPM-SW-6 gave the highest grain weight/plant and ear weight/plant (40.6 g and 55.0 g, respectively). The longest ears were produced by UPM-SW-5 (124.7 mm) and UPM-SW-6 (122.6 mm), highest ear diameter by UPM-SW-4 (34.9 mm) and highest number of kernel rows/ear by UPM-SW-1 (14.1), while highest number of kernels/row was shown by UPM-SW-2 and UPM-SW-6 (21.4 and 21.9, respectively). UPM-SW-10 had the tallest plants (160.1 cm), while UPM-SW-1 had the shortest (104.5 cm). The highest ear placement was shown by UPM-SW-5 (68.1 cm) and the lowest by UPM-SW-11 (27.0 cm). UPM-SW-3 was the earliest tasselling, after 54.9 days, and UPM-SW-6 was the earliest silking, after 57.7 days.

From results presented in *Table 1*, it was realized that, within group variations between and within lines were generally small for all the characters, as the lines were already near-homozygous and had been selected after five generations of selfing. As expected, the inbred lines showed some minor within-line phenotypic variations due to minor genetic variation which might have been amplified by the environmental differences that existed. Similarly, variability among lines was also relatively low because they had been selected for grain yield in the preceding generations.

Table 2 shows correlation coefficients among characters measured on the 13 inbred lines within each group. With some exceptions, the correlation coefficients for each pair of characters were generally quite similar among groups, thus elaboration of results obtained were made together.

Grain weight/plant was positively correlated with other characters in all groups (with r values ranging from 0.19 to 0.97), except days to tasselling and days to silking with which it was negatively correlated. The same trend of correlations was also found with ear weight/plant (with r values ranging from 0.19 to 0.81), as it was highly correlated with grain weight/plant. Days to tasselling was negatively correlated with plant height in SM5 and SM7 groups (with r values of -0.14 and -0.29, respectively), positively correlated in MT group (with r = 0.15), while not correlated in TW and SW groups. In all groups, plant height was highly positively correlated with ear height, with r values ranging from 0.68 to 0.85.

Ear diameter was positively correlated with the number of kernel rows/ear in all groups reflecting that it could be taken as a good indicator of the number of kernel rows/ear. With the exception of SW group, all groups showed that ear diameter was positively correlated with ear length, which was in turn, was positively correlated with number of kernels/row. Ear length was a better indicator of the number of kernels/row, as these two traits were more highly correlated. Ear length was also significantly correlated with the number of kernel rows/ear in all groups except SM7.

The significant negative correlations between grain yield and days to tasselling, and days to silking, indicated that the earlier flowering inbred lines were higher yielding and possessed larger measurements for other related characters as compared to the late

Table 2. Correlation coefficients among characters measured within groups of maize inbred lines

Group	Character	GW/P	EW/P	EL	ED	NKR/E	NK/R	PH	EH	DTT
TW	EW/P	0.96**								
	EL	0.57**	0.62**							
	ED	0.66**	0.73**	0.35**						
	NKR/E	0.46**	0.50**	0.23**	0.58**					
	NK/R	0.71**	0.72**	0.76**	0.43**	0.29**				
	PH	0.54**	0.57**	0.33**	0.47**	0.24**	0.36**			
	EH	0.53**	0.54**	0.54**	0.40**	0.29**	0.49**	0.68**		
	DTT	–0.33**	–0.36**	–0.01	–0.41**	–0.21**	–0.15**	0.00	–0.23**	
	DTS	–0.34**	–0.36**	–0.12**	–0.39**	–0.22**	–0.18**	–0.01	–0.14**	0.87**
SM5	EW/P	0.97**								
	EL	0.80**	0.81**							
	ED	0.81**	0.79**	0.64**						
	NKR/E	0.41**	0.38**	0.25**	0.51**					
	NK/R	0.79**	0.77**	0.80**	0.71**	0.44**				
	PH	0.45**	0.42**	0.39**	0.39**	0.15**	0.34**			
	EH	0.41**	0.38**	0.30**	0.30**	0.02	0.24**	0.80**		
	DTT	–0.20**	–0.26**	–0.20**	–0.22**	–0.26**	–0.31**	–0.14**	–0.09	
	DTS	–0.34**	–0.29**	–0.23**	–0.26**	v0.15**	–0.30**	–0.47**	–0.45**	0.72**
SM7	EW/P	0.96**								
	EL	0.80**	0.77**							
	ED	0.78**	0.76**	0.51**						
	NKR/E	0.24**	0.23**	0.07	0.39**					
	NK/R	0.81**	0.77**	0.84**	0.52**	0.09				
	PH	0.43**	0.41**	0.42**	0.19**	0.20**	0.50**			
	EH	0.38**	0.37**	0.34**	0.22**	–0.19**	0.41**	0.82**		
	DTT	–0.14**	–0.13**	–0.19**	0.05	0.05	–0.22**	–0.29**	–0.22**	
	DTS	–0.31**	–0.28**	–0.38**	–0.09	–0.03	–0.38**	–0.39**	–0.39**	0.80**
SW	EW/P	0.93**								
	EL	0.54**	0.57**							
	ED	0.45**	0.51**	–0.04						
	NKR/E	0.19**	0.19**	0.26**	0.66**					

(cont.)

Table 2. *(cont.)*

Group	Character	GW/P	EW/P	EL	ED	NKR/E	NK/R	PH	EH	DTT
	NK/R	0.70**	0.66**	0.71**	0.18**	0.04				
	PH	0.39**	0.39**	0.41**	0.07	–0.14**	0.42**			
	EH	0.28**	0.27**	0.25**	0.16**	0.03	0.31**	0.85**		
	DTT	–0.25**	–0.22**	0.01	–0.28**	–0.20**	–0.16**	–0.01	–0.11*	
	DTS	–0.40**	–0.35**	–0.19**	–0.26**	–0.15**	–0.28**	–0.15**	–0.05	0.88**
MT	EW/P	0.90**								
	EL	0.61**	0.64**							
	ED	0.42**	0.40**	0.38**						
	NKR/E	0.44**	0.38**	0.37**	0.50**					
	NK/R	0.64**	0.63**	0.71**	0.21**	0.25**				
	PH	0.48**	0.52**	0.23**	–0.06	0.11*	0.38**			
	EH	0.43**	0.45**	0.18**	–0.03	0.12*	0.26**	0.84**		
	DTT	–0.16**	–0.12*	–0.11*	–0.30**	–0.16**	–0.07	0.15**	0.15**	
	DTS	–0.19**	–0.18**	–0.19**	–0.30**	–0.18**	–0.13*	–0.09	0.06	0.91**

GW/P = Grain weight/plant; EW/P = Ear weight/plant; EL = Ear length; ED = Ear diameter; NKR/E = Number of kernel rows/ear; NK/R = Number of kernels/row; PH = Plant height; EH = Ear height; DTT = Days to tasselling; DTS = Days to silking
**, *Significant at $p \leq 0.01$ and 0.05, respectively

flowering ones. Early flowering ensures a longer time for grain filling before any unfavourable environmental stress prevailed at the end of the growth period. Similar results on relationships among the above-mentioned plant characters in maize were also reported by Abrecht and Dudley (1987), Schnicker and Lamkey (1993) and Lamkey et al. (1995).

Conclusion

Many potential inbred lines from various genetic backgrounds for possible use in hybrid production were identified. However, one or two more generations of selfing and selection will be required before the top performing lines could be determined for diallel crosses, as a further step in the hybrid variety development programme.

Acknowledgement

This research work was funded by IRPA grant (IRPA Project No: 1-07-05-017).

References

Albrecht, B. and Dudley, J. W. (1987). Evaluation of four maize populations containing different proportions of exotic germplasm. *Crop Sci.* ***27:*** 480–6

Gallais, A. (1989). Lines versus hybrids. The choice of the optimum type of variety. Contribution of quantitative genetics and selection theory. *Proc. The XII Congress of Eucarpia*, Gottingen, Germany: Vortage-fur Pflanzenzuchtung

Hallauer, A. R. (1990). Methods used in developing maize inbreds. *Maydica* ***35:*** 1–16

Hallauer, A. R. and Miranda, J. B. (1982). *Quantitative Genetics in Maize Breeding.* Ames: Iowa State University Press

Lamkey, K. R., Schnicker, B. J. and Melchinger, A. E. (1995). Epistasis in an elite maizehybrid and choice of generation for inbred line development. *Crop Sci.* ***35:*** 1272–81

Poehlman, J. M. (1987). *Breeding field crops.* 3rd ed. New York: Van Nostrand Reinhold

Saleh, G., Rafii, Y. M. and Yap, T. C. (1993). Inbreeding depression and heterosis in sweet corn varieties Manis Madu and Bakti-1. *Pertanika J. Trop. Agric. Sci.****16:*** 209–14

Saleh, G. and Sujiprihati, S. (1997). Heterosis with respect to diversity among locally-developed maize inbred lines in Malaysia. In CIMMYT, 1997. *Book of Abstracts. The Genetics and Exploitation of Heterosis in Crops;* An International Symposium, Mexico City: Mexico D.F. p. 154–5

Saleh, G. and Yap, T. C. (1988). Development of inbred lines in grain maize. In *Progress Report 1988. Improvement of Food Crops: Rice, Corn and Sweet Potato.* (Yap, T. C. and Saad, M. S., ed.). Serdang: Universiti Pertanian Malaysia

Saleh, G., Yap, T. C., Kamaruhzaman, M. Z. and Wong, K. O. (1989). Inbreeding depression in corn population after two generations of selfing. In *Progress Report 1989. Improvement of Food Crops: Rice, Corn and Sweet Potato.* (Yap, T. C. and Saad, M. S., ed.). Serdang: Universiti Pertanian Malaysia

SAS (1987). *SAS/STAT™ Guide for personal computers.* Version 6th ed. Cary, North Carolina: SAS Institute Inc.

Schnicker, B. J. and Lamkey, K. R. (1993). Interpopulation genetic variance after reciprocal recurrent selection in BSSS and BSCB1 maize populations. *Crop Sci.* ***33:*** 90–5

Stoskopf, N. S., Tomes, D. T. and Christie, B. R. (1993*). Plant breeding. Theory and Practice.* San Francisco: Westview Press Inc.

Sujiprihati, S. (1996). Heterosis, combining ability and yield prediction in hybrids from local maize inbred lines. Ph.D. Thesis, Universiti Pertanian Malaysia

Accepted for publication on 16 May 2001