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HETEROSIS, COMBINING ABILITY AND YIELD PREDICTION IN HYBRIDS FROM LOCAL MAIZE INBRED LINES

SRIANI SUJIPRIHATI

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HETEROSIS, COMBINING ABILITY AND YIELD PREDICTION IN HYBRIDS FROM LOCAL MAIZE INBRED LINES

By

SRIANI SUJIPRIHATI

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LIST OF ABBREVIATIONS

FAO	:	Food and Agriculture Organisation
CIMMYT	:	International Maize and Wheat Improvement Centre
GCA	:	general combining ability
GLM	:	ground magnesium limestone
ICS	:	interpopulation cross superiority
MT	:	Metro
OPV	:	open-pollinated variety
QPM	:	quality protein maize
RGR	:	relative growth rate
RRIM	:	Rubber Research Institute of Malaysia
SAS	:	statistical analysis system
SCA	:	specific combining ability
SM5	:	SMC 305 (San Miguel Corporation 305)
SM7	:	SMC 317 (San Miguel Corporation 317)
SW	:	Suwan
TW	:	Tanco White
UPM	:	Universiti Pertanian Malaysia

Abstract of dissertation submitted to the Senate of Universiti Pertanian Malaysia in fulfillment of the requirements for the degree of Doctor of Philosophy.

HETEROSIS, COMBINING ABILITY AND YIELD PREDICTION IN HYBRIDS FROM LOCAL MAIZE INBRED LINES

By

SRIANI SUJIPRIHATI

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Chairman : Assoc. Prof. Dr. Ghizan Saleh

Faculty : Agriculture

Studies were conducted to identify and select for superior maize inbred lines based on their performance *per se,* and to evaluate their performance and combining ability in all possible crosses. Performance and heterosis of the single crosses were evaluated at two locations, in Universiti Pertanian Malaysia, Serdang. Furthermore, some promising double cross hybrids developed from the potential single crosses were also evaluated for performance and for comparison with the predicted.

In general, most of the inbred lines exhibited poor performances due to inbreeding effects after successive generations of selfing, but some were however, found to have high potential for use in hybrid production.

Hy-58, Hy-59 and Hy-60 were identified as the best performing F_1 single-cross hybrids at both locations, with grain yields of 3703.7 kg/ha,

3940.7 kg/ha and 3451.9 kg/ha, respectively, at Field 2; 5659.3 kg/ha, 5725.9 kg/ha and 5948.1 kg/ha, respectively, at Share Farm; and 4681.5 kg/ha, 4833.3 kg/ha and 4700.0 kg/ha, respectively, in the locations combined. In general, hybrids that produced high yields were those formed between inbred parents that were themselves high yielding and from genetically diverse population sources.

High heterosis was shown by grain yield, ear weight and grain weight per ear, moderate heterosis by number of kernels per row, ear height, plant height and ear length, while low heterosis was shown by ear diameter, number of kernel rows per ear, 100-grain weight and shelling percentage. Maturity characters showed negative heterosis, indicating earliness of the hybrids.

The results of combining ability analyses showed significant GCA and SCA effects for all characters studied, except for shelling percentage, indicating the importance of both additive and non-additive gene actions in the control of these characters. However, the SCA variances for most characters were much higher than their respective GCA variances at both locations.

The varied estimates of broad-sense heritability between the two locations for all characters were due to the presence of genotype x location interactions. Estimates of broad-sense heritability were high for 100-grain weight, plant height, days to tasselling and days to silking, at Field 2; for

grain yield, ear weight, ear length, number of kernels per row, 100-grain weight, days to tasselling and days to maturity at Share Farm; and for 100-grain weight, days to tasselling, days to silking and days to maturity in the combined analysis. Narrow-sense heritability estimates obtained from the variance components were generally in agreement with those from the parent-offspring regression, although those obtained from the regression were slightly higher.

The WR-VR analysis indicated that the gene actions involved in the control of ear diameter and days to tasselling were generally over dominance, while that for number of kernel rows per ear was between partial dominance and complete dominance, and that for plant height was between complete dominance and over dominance.

Grain yield for the single-cross hybrids was highly significantly correlated with most of the other characters studied. With some exceptions, correlations among the yield components were generally positive and significant. Maturity characters were negatively correlated with most other characters.

The best performing double-cross hybrids, DC-26 and DC-34, were found to have high yield potentials. From the correlation analysis, the actual and the predicted performances of the double-cross hybrids were found to have generally a good agreement at both locations, and locations combined.

Abstrak disertasi ini dikemukakan kepada Senat Universiti Pertanian Malaysia bagi memenuhi syarat memperolehi ijazah Doktor Falsafah.

HETEROSIS, KEUPAYAAN BERGABUNG DAN JANGKAAN HASIL PADA HIBRID DARI WARISAN INBRED JAGUNG TEMPATAN

Oleh

SRIANI SUJIPRIHATI

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Pengerusi : Prof. Madya Dr. Ghizan Saleh

Fakulti : Pertanian

Kajian dijalankan untuk mengenalpasti dan memilih warisan inbred jagung bijian yang unggul berdasarkan prestasinya sendiri, dan menilai prestasi serta keupayaan bergabungnya dalam semua kombinasi kacukan di antaranya. Prestasi dan heterosis pada hibrid kacukan tunggal tersebut dinilaikan di dua lokasi di Universiti Pertanian Malaysia. Selanjutnya, beberapa hibrid terpilih dari kacukan ganda dua yang dibentuk dari kacukan tunggal yang berpotensi juga dinilai prestasinya serta dilakukan perbandingan dengan prestasi yang dijangka.

Pada amnya, kebanyakan warisan inbred menunjukkan prestasi yang rendah disebabkan kesan kemelesetan akibat dari beberapa generasi penyendirian yang dijalankan, tetapi beberapa diantaranya, walaubagaimanapun mempunyai potensi yang tinggi untuk pembentukan hibrid. Hy-58, Hy-59 dan Hy-60 dikenalpasti sebagai hibrid-hibrid kacukan-tunggal F_1 terbaik di kedua-dua lokasi, dengan hasil bijian masing-masing

3703.7 kg/ha, 3940.7 kg/ha dan 3451.9 kg/ha di Ladang 2, 5659.3 kg/ha, 5725.9 kg/ha dan 5948.1 kg/ha di Ladang Kongsi, dan 4681.5 kg/ha, 4833.3 kg/ha dan 4700.0 kg/ha di gabungan kedua lokasi. Pada amnya, hibrid-hibrid yang memberikan hasil bijian tinggi adalah hibrid-hibrid yang dibentuk dari warisan-warisan inbred yang sendirinya berprestasi tinggi dan diperolehi dari populasi-populasi sumber yang luas perbezaan genetiknya.

Heterosis yang tinggi ditunjukkan oleh hasil bijian, berat tongkol dan berat bijian setongkol, heterosis yang sederhana ditunjukkan oleh bilangan biji sebaris, tinggi tongkol, tinggi pokok dan panjang tongkol, manakala heterosis yang rendah ditunjukkan oleh garispusat tongkol, bilangan baris setongkol, berat 100-biji dan peratus peleraian. Heterosis pada ciri-ciri kematangan adalah negatif, ini menunjukkan hibrid-hibrid lebih awal matang.

Keputusan analisis keupayaan bergabung menunjukkan kesan GCA dan SCA yang bererti untuk kesemua ciri yang dikaji kecuali peratus peleraian. Ini menunjukkan pentingnya kedua-dua tindakan gen menambah dan gen tak-menambah dalam pengawalan ciri-ciri tersebut. Walaubagaimanapun, varian SCA untuk kebanyakan ciri amat melebihi varian GCA-nya di kedua-dua lokasi.

Anggaran kebolehwarisan luas yang berbeza ditunjukkan antara dua lokasi pada semua ciri adalah disebabkan kewujudan interaksi genotip x persekitaran. Nilai kebolehwarisan luas adalah tinggi untuk berat 100-biji, tinggi pokok, hari pentaselan dan hari perambutan, di Ladang 2, untuk hasil

bijian, berat tongkol, panjang tongkol, bilangan biji sebaris, berat 100-biji, hari pentaselan dan kematangan, di Ladang Kongsi, serta untuk berat 100-biji, hari pentaselan, hari perambutan dan kematangan di gabungan kedua lokasi. Anggaran kebolehwarisan sempit yang diperolehi daripada komponen varian pada amnya adalah selari dengan anggaran yang diperolehi dari regresi induk-anak, walaupun nilai yang diperolehi dari cara regresi adalah agak lebih tinggi sedikit.

Analisis Wr-Vr menunjukkan bahawa tindakan gen yang terlibat mengawal ciri-ciri garispusat tongkol dan hari pentaselan adalah pada amnya, dominan lampau, manakala untuk bilangan baris setongkol adalah antara separa dominan dan dominan lengkap, serta untuk tinggi pokok pula adalah antara dominan lengkap dan dominan lampau.

Hasil bijian pada hibrid kacukan tunggal berkorelasi secara sangat bererti dengan kebanyakan ciri-ciri yang dikaji. Korelasi diantara ciri komponen hasil secara amnya adalah positif dan bererti, kecuali dalam beberapa keadaan. Ciri-ciri kematangan berkorelasi negatif dengan kebanyakan ciri yang lain.

Hibrid kacukan dua ganda terbaik, DC-26 dan DC-34, didapati mempamerkan potensi penghasilan yang tinggi. Dari analisis korelasi, prestasi sebenar hibrid kacukan dua ganda pada amnya, didapati menunjukkan pertalian yang rapat dengan prestasi yang dijangka, di kedua-dua lokasi, dan gabungannya.

CHAPTER I

INTRODUCTION

Maize is the world's third most important cereal crop after wheat and rice, and is mainly used for human food, animal feed, and many unique industrial and commercial products in many parts of the world (Boyer and Hannah, 1994).

Maize is planted in a wide range of climatic conditions. It is known for its versatile nature and tremendous genetic variability, enabling it to grow successfully throughout the world. In Asia, maize is grown in varied environmental conditions, from tropical lowlands at sea level to high elevations in the Himalaya region, and from latitudes of 45^0 N to 20^0 S (De Leon and Paroda, 1993a).

In Malaysia, maize is presently a relatively minor crop, where the area planted with it is very small as compared to those in the other Asian countries. In 1993, the area planted with maize in Peninsular Malaysia was 21,000 ha (CIMMYT, 1994), mainly with sweet corn. The demand for grain maize, however, has increased greatly in the past ten years, due to rapid growth in the ruminant livestock industry. To meet this need, therefore, Malaysia has been very much dependent on the importation of grain maize

from other countries, particularly from China, Thailand, and the United States. In 1994, the demand for imported maize was 1.9814 million tonnes costing about RM 683.3 million (Department of Statistics, Malaysia, 1994). This demand is expected to increase in the future (Nik Fuad, 1992). This trend indicates the great need to develop the local maize growing industry, so as to reduce the dependence on imported feeds in the long term (Ahmad Badri, 1987; Saleh e*t al.*, 1994).

The unavailability of high yielding varieties suited to local conditions, and the high cost of production are the main reasons for the lack of interest among local farmers in growing grain maize. Nevertheless, Yap and Saleh (1994) suggested the use of adapted superior genotypes that can substantially reduce the cost of production. In addition, De Leon and Paroda (1993b) emphasised that area expansion and increase in productivity of maize in Malaysia would be possible only when improved production technologies using high yielding hybrid varieties in a large-scale maize industry and mechanised cultivation with appropriate inputs are made available to the farmers.

Therefore, the development of local superior genotypes or hybrid varieties, fully adaptable to the local environment, is much encouraged. The full potential of the locally-adapted inbred lines as parents of hybrid maize varieties through selection for their performance and combining ability in hybrid combinations needs to be fully exploited. Maize breeding programmes at Universiti Pertanian Malaysia were initiated in 1980, directed