PHYSIOLOGICAL GENETIC STUDIES ON MAIZE (*Zea mays* L.)

By

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DEDICATION :

To the memory

of my beloved mother

بسم الله الرحمن الرحيم

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CONTENTS

INTRODUCTION

Maize is considered one of the major cereal crops in Egypt. The annual area cultivated by maize is estimated to be about 1.8 million feddans. The average production of grain yield per feddan is about 13.90 ardabs (one ardab = 140 Kgs.). Maize is used primarily as a feed grain for human and livestock, but it is also the source of an increasing number of important industrial products. The local open pollinated cultivars occupy most of the maize area which are not high yielding cultivars. One of the outstanding approaches to increase the grain is the development of good high yielding hybrids, so the choice of parental lines in a hybrid corn programme is very important.

The present study was carried out on six inbred lines of maize crossed in a complete diallel crossing programme with the following objectives in mind.

1. To estimate heterosis, general and specific combining ability effects for 10 agronomic characters.
2. To elucidate biochemical genetic markers for the prediction of the performance of inbreds and their single crosses.
3. To study the immunoelectrophoretic basis of heterosis and combining ability in maize.

REVIEW OF LITERATURE

YIELD COMPONENTS :

HETEROSIS :

Leng (1954) used a large number of inbreds and their F1 hybrids in maize to determine heterosis for total yield, number of kernel rows per ear and 100 - kernel weight. The F1 hybrids showed marked superiority over their respective better parents in the studied characters. Robinson et al. (1956) made a diallel cross of six varieties of maize. They found that F1 hybrids exceeded their mid - parent values and their better parents in yield by approximately 20 and 11 percent, respectively.

Cabulea (1961) studied the yield of seven inbreds and their single and double crosses in direct and reciprocal combination of maize. He found that reciprocal differences were significant in single but not in double crosses. Lonnquist and Gardner (1961) found that heterosis, relative to the mid - parent, was 108.5 % and relative to the better parent was 102.8 % with respect to grain yield in maize. Paterniani and Lonnquist (1963) showed that the average heterosis over the mid - parents and higher parent for yield were 33 % and 14 %, respectively.

Rubcova (1964) carried out a dialled cross of eight inbred lines of maize. He reported significant heterosis for plant height in the F1. Wellhousen (1965) noted that the average mid - parents heterosis for yield in maize was 164.0 %. However, Khalil and Fawzy (1966) found that the average mid - parents heterosis for yield was 8.97 %.

Mureson and Sarca (1967) studied 45 pairs of reciprocal single of crosses maize, which 19 pairs showed significant differences in yield. These differences indicated that the lines used as female parents had a controlling influence which varied among lines. Pesev and Trifunovic (1968) reported that the average mid - parent and better parent heterosis for grain yield were 72 % and 43 %, respectively.

Daniel (1969) studied eleven parental inbreds, their F1's and F2's in a diallel analysis of maize in one year. He obtained marked heterosis for plant height in all studied crosses. Heichel and Musgrave (1969) reported that plant height and ear height in the hybrids were significantly greater than those of in the parental lines. Krolikowski (1969) noted that heterosis was significant in the F1 for grain yield per plant, ear length and plant height. there were reciprocal differences with respect to the degree of heterosis.

Abro and Abidi (1970) crossed six inbred lines of maize in all possible combinations. They reported that maximum increases in ear - length, ear - daimeter and number of hernel rows per ear were found in several combinations. Sayed - Galal et al. (1970) studied crosses of 118 maize lines with American Early variety. Their results showed that heterotic effects for grain yield ranged from 97 to 105 % of their better parents. Kovack and Khertseg (1971) reported that hybrids between sister lines of maize gave a dry - grain yield 50 - 100 % greater than the average yield of their parental stocks. El-Rouby and Galal (1972) found that heterosis averages from mid - parents and better parents for grain yield were 6.4 % and 0.8 %, respectively.

Krolikowski (1973) studied grain yield in a diallel of eight selfed lines. Heterotic effects reached almost 200 % of the midparental grain yield and 150 % over the better parent. Maternal effects were significant.

Dornescu (1975) reported that hybrids derived from genetically distinict parents wre superior to the original material in vegetative and reproductive characters and had a heterotic value of 222 % for grain weight per ear. Shehata and Dhawan (1975) obtained significant heterosis expression of 63 % for grain yield. Filho and Vencovskey (1976) noted that average heterosis for plant height, ear height and yield were 2.8 %, 3.2 % and 15.2 %, respectively. Yasien (1977) showed markerd heterosis over the mid - parents ranging from 76.49 % to 456.53 % for grain yield per plant, 7.89% to 37.14 % for ear - diameter and 13.25 % to 44.61 % for plant height.

Mourad (1978) studied six inbred lines crossed in all possible combinations. Results showed heterosis over the mid and better parents for grain yield per plant, ear height, plant height, ear - diamter and 100 - kernel weight. Omar et al. (1978) in a diallel cross between eight inbred lines of maize, showed marked heterosis in F1 hybrids over the mid and better parents in grain yield per plant and weight of 100 - kernel. Silva and Paterniani (1978) reported that heterosis for yield and 50 grain weight was highly significant. Vianna and Silva (1978) obtained insignificant differences between reciprocal crosses for most characters. However, some traits such as 50 grain weight, plant height, ear height and yield showed reciprocal differences.

Mohamed (1979) noted substantial heterosis measured as percentages of mid parents which ranged from 17.39 to 434.3 for plant height, ear height, grain yield per plant, ear length, ear diameter, number of kernel rows per ear and weight of 100 - kernel. Moreover, expression of heterosis as estimated from the better parents ranged from 10 % to 377.07 % for the same characters. Nawar et al. (1980) reported heterotic effects for plant height in maize ranging in F1's from 0.63 to 46.22 % of the mid parent and from - 8.27 to 33.16 % of the better parent. The average heterosis for all crosses was 17.3 % of the mid parent and 6.4 % of the high parent. The average heterotic effects related to number of ears per plant were 22.2 and 11.23 % over mid and high parent, respectively. The mean percentage heterosis of high and mid parent for rows number / ear, ear length and ear diameter were 4.0, 13.0 ; 6.0, 11.0 and 3.0 , 8.0 %, respectively.

Akhtar and Singh (1981) reported analysis of data involving five flint parents, five dent parents and 25 crosses of maize between them. They revealed that heterosis for yield over the midparental value ranged from 12.48 to 73.94 %.

Zhao and Hiu (1981) found strong heterosis effects for plant height, ear position and grain weight /ear. The plant height and ear length had the widest range of correlation with other characters.

Yasein (1982) reported highly significant heterosis for grain yield ranging from 150.3 % to 185.9 % over the mid parent and from 84.1 % to 112.6 % over the better parent, in three maize hybrids.

Gerrish (1983) studied yield heterosis in a diallel cross involving six - lines. He found that heterosis, relative to the mean parental value, ranged from 111 to

128 %. El - Nagouly et al. (1981) pointed out that average yield of maize percent heterosis relative to mid aand high parents were 16.6 and 5.1, respectively. Introzzi and Matto (1984) studied the P1, P2, F1, F2, BC1 and BC2 from crosses of 5 inbreds. They showed in all crosses that heterosis was expressed for grain yield and 100 - grain weight. Mohamed (1984) obtained highly significant heterosis based on mid and better parent for plant height, ear height, grain yield per plant, ear length, ear diameter and number of rows per ear. Raghbe (1985) found highly significant heterosis over the mid - or better - parent for plant height, ear height, grain yield per plant, ear length, ear diameter and number of rows per ear.

El - Itriby (1986) reported that the average heterotic expression for grain yield was 26.1 and 16.1 percent relative to the mid - parent and high parent, respectively. Heterosis up to 52.3 percent (mid - parent) and 36.8 percent (high parent) were obtained.

COMBINING ABILITY

Sprague and Tatum (1942) in their studies on corn, used the terms general and specific combining abilities as measures for types of gene action. Accordingly, general combining ability is due to genes which are mainly additive in their effects, while specific combining ability is due to genes with non - additive effects, i.e dominance or epistatic effects. Robinson et al. (1949) found that additive genetic variance had a more important role in the expression of plant and ear height. But the non - additive genetic variance was more important for yield, ear length and ear diameter.

Lonnquist and Gardner (1961) studied general and specific combining ability for grain yield using 12 heterozygous populations in a diallel cross. They found, in general, that additive effects (g.c.a) were more important than non - additive effects (s.c.a). Gamble (1962) reported that dominance gene effects were quite important in the inheritance of yield. Epistatic gene effects were considered to be more important than additive gene effects.

Eberhart et al. (1966) estimated genetic variance parameters in materials derived from homozygous and heterozygous populations. The results showed that the largest part of the genetic variance concerning plant height, ear height, ear length and ear diameter were due to additive effects.

Baghal (1968) tested the genetic behaviour of some growth habits and yield of maize in a diallel cross. He concluded that additive genetic variance affected ear - diameter. As for ear height and ear length, both additive and dominance genetic variances were postulated. Moreover, he reported that dominance genetic variance affected plant height and yield. Laible and Dirks (1968) studied the inheritance of prolificacy and its relationship to yield in six segregatining populations arising from four inbred lines which were selected because of their consistent differences in ear number. They stated that ear number means and genetic variance component analysis, generally, could be ascribed to an additive model with partial to complete dominance for prolificacy.

Daniel (1969) studied eleven parental inbreds, their F1's and F2's in a diallel analysis system. He found that dominance effects were important for plant height.

Krolikowski (1969) indicated that specific combining ability was more important than general combining ability for grain yield. Manoliu (1969) reported additive gene action for weight, diameter and length of ear as well as number of rows per ear, grain yield per plant and plant height. Epistasis had a greater effect than the additive gene action and smaller effect than dominance. Hajkhan (1970) indicated that specific combining ability effects were significantly larger for ear length and ear diameter as compared with general combining ability effects.

Sentz (1971) reported that additive genetic variance was more important than dominance for plant height, ear height and ear diameter. He also found that additive variance was significant for plant height and ear length.

El - Rouby and Galal (1972) observed that additive genetic variance for yield was more important than the non - additive. Moreover, significant general combining ability effects were noted in seven variaties of maize, indicating the important role of additive genetic variance for yield inheritance.

Piovarci (1973 a) in his comparison between general combining ability and specific combining ability, found that the ratios of G.C.A. / S.C.A. were 2 : 1 for grain yield and 33 : 1 for 100 Kernel weight in maize. Piovarci (1973 b) determined combining ability for grain yield in a diallel cross involving eight inbred lines. General combining ability was predominant over specific combining ability with a ratio of 16 : 1 for grain yield. It was concluded that additive gene effects were more important than non - additive effects. Vosda (1973) found that for ear height, specific combining ability was the main cause of the increased height in the F1 and F2, while general combining ability was insignificant. Additive components of variance were subordinate to non - additive components in both generations. Dominance and epistasis had the main influence among the components of the variances.