CORRELATION STUDIES OF CERTAIN CHARACTERS AND THE ESTIMATION OF GENERAL AND SPECIFIC COMBINING ABILITY IN MAIZE (*Zea mays*, L.)

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1964.

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UDAIPUR

CORRELATION STUDIES OF CERTAIN CHARACTERS AND THE ESTIMATION OF GENERAL AND SPECIFIC COMBINING ABILITY

IN

MAIZE (*Zea mays* L.)

By

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THESIS

Submitted in partial fulfilment of the requirements

for the degree of Master of Science in

Agriculture (Plant-breeding & Genetics)

to the University of

Udaipur

UDAIPUR (Rajasthan)

1964

UNIVERSITY OF UDAIPUR

UDAIPUR

RAJASTHAN COLLEGE OF AGRICULTURE, UDAIPUR

Dated: 7 June, 1964

I HEREBY RECOMMEND THAT THE THESIS PREPARED BY LAXMAN KUMAR BHATIA ENTITLED: Correlation Studies of certain characters, and the estimation of General and Specific combining ability in maize (*Zea mays* L.) BE ACCEPTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURE (Plant Breeding & Genetics).

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TABLE OF CONTENTS

APPENDIX

continued

APPENDIX (Continued) Page

INTRODUCTION

Maize, (Zea mays, L.) belongs to the family Gramineae and is cultivated all over the world. Various theories have been proposed to account for the origin of this plant. Recent discoveries of fossil maize pollen by Barghoorn and his collaborators (1954) have established the existence of this plant in Mexico, much earlier than the most primitive type of agriculture known to have existed anywhere in the western hemisphere. In India the maize has been grown since early days of 17th century.

The cytological studies have established Mexico, and Central America as the centres of origin of maize. In nature the maize plant is diploid having 2n=20 chromosomes. It is the only species of genus "Zea".

In India maize plant is known by various names as "Makai", "Maka", or "Gomdhan". Among cereals this crop occupies the 4th position from cultivation point of view. In 1962-63 the total acerage under maize was

11,316,000, with a total production of 4,449,000 tonnes. An average yield being nine mds. per acre. In Rajasthan it is grown in 1,670,690 acres of land and total production is 694,777 tonnes. Out of this 4,00,490 Acres of land is cultivated in Udaipur district alone and produces 208,444 tonnes of grain. The average yield of maize is also higher in this area being eleven mds. per acre.

Maize has been put in various usages. It is consumed by human beings, used as cattle feed and is also utilized in the industrial purposes for the preparation of starch, yarn, alchohol, paper and various plastic materials and many other commercial products.

In India maize is highly hetrozygous material. Recently a lot of work has been taken up to improve this crop. The systematic steps towards the improvements of the crop were stressed by Sir P.M. Khareghat in 1943, and I.C.A.R. Schemes were started all over India for maize breeding programmes. Some materials of hybrid maize have been released for commercial purposes which gives 26-30% higher yield over the local one and is early maturing.

The yield, which in itself is not a unitary character, is the result of interaction of a number of factors both heritable and environmental. Thus it becomes essential to study the various characters and find out their effects on the yield. This type of study is facilitated by the use of Correlation studies.

The present work has been done to study:

1) The total Coefficient of Correlation for different characters between the Parents and their F_1 generations.

2) The partial Coefficient of Correlation for different characters which make contribution on yield.

3) For the production of yield, good combiner parents have been evaluated by General and Specific combining ability, as used by Sprauge & Tatum,(1942).

4) The characters showing heterosis.

REVIEW OF LITERATURE

Voluminous literature is available on maize crop, specially regarding correlation studies, Heterosis and Combining ability. The present review have been done on quantitative characters of the plant. The knowledge âf the relationship between the various attributes of inbred line and their F_1 hybrids is considered to be useful in selection of the parent. The study of the combining ability for proper selection of the material, directly helps in rejecting the poor performers at an early stage, thus helping in saving labour and expenditure. A brief review of the study of heterosis is also reported.

Earlier methods for the improvement of maize crop were based on selection of superior ears from open pollinated material, as such, the plant characters were naturally related to the proper yield. With the help of development of hybrid maize, the importance of correlation studies has increased tremendeously.

Ewing (1910) found the negative coefficient of correlation i.e. (-0.202) between yield and days to silk, and positive correlation among the height of the plant and to yield (+0.307).

Wolfe (1924) observed negative correlation between yield and days to tasseling and days to silking. This indicated that the plant flowering late within a given variety produces less grains than the early flowering plants. He also found the high and significant values for the Coffiecient of correlation between weight of grain and length of the cob viz. (+0.877 ± 0.008). In his opinion the diameter which he measured become an important indicator towards selecting high yielding corn.

Olson (1927) stated that tasseling and silking dates were reliable basis for comparing varieties for early maturing; and suggested that counts should be made after 1/4th plants had tasseled or silked, and not after 1/2 of the population had reached that stage.

Jenkins (1929) took 142 inbreed lines of maize derived from 14 varieties and calculated 210 total Correlation Coefficient values. Out of these 65 were statistically significant. He reported positive correlation for height of the plant (+0.20), Cobs per plant (+0.31), Cob length (+0.38), and Cob diameter (+0.32) with yield.

Many of his findings were negatively significant in respect to yield and days to silking (-0.26). The correlation coefficient values between yield and days tasseling were also negative but not statistically significant (-0.2309). He further reported that the presence of deliterious characters resulted in lack of vigour and low yields.

Vesselvskaia (1930) reported that the characters such as time of flowering (Tasseling and Silking) per centage of moisture in seeds, weight of the dry seeds were correlated among themselves, but the length of the cob was not found to be correlated with any of the above characters and concluded that earlyness in corn plant could not be judged by time of flowering, per centage of moisture in seeds and dry seed weight alone.

Hays & Jhonson (1939) carried out extensive studies on correlation involving certain characters of inbred line with those of their crosses. They reported that date of silking had the correlation value of (+0.4742) with yield, whereas Plant height had (+0.2717) and Cob length (+0.2768) with yield.

Kempton (1926) using the varieties Algeria x Jala as parents made certain correlation studies in maize hybrids. He noted in F_1 hybrids that early flowering (Tasseling and silking) varieties were more productive but could not establish the same results in F_2 crosses.

Hutchison & Wolfe (1918) found little relationship between weight of grains and other characters of the plant like tasseling and silking dates.

Weihing (1935) found the height of the plant, number of green leaves per plant and vigour of the plant were correlated with lateness in the maturity of the crop.

Craige (1908) found that yield of the plant was less correlated to those characters which influenced the vigour of the plant and vegetative growth viz. height of the plant, number of nodes and inter-nodes per plant and also green leaves per plant.

Davenport (1907) reported highly positive significant correlation value for length of the cob, diameter of cob, with respect to yield, i.e. (+0.87), and (+0.47) respectively.

Jorgenson & Brewbaker (1927) studied relationship between certain ear characters of Inbreds and their Crosses. They obtained positive significant correlation value for various characters, viz. height of the plant, cob length, cob diameter with the yield.

Nilsson Leissner (1927) found that certain inbread lines were distinctly superior to others as parents as well as Crosses. He found that coefficient of correlation between yield and height of the plant was positive and significant in F_1 crosses. Similar results were reported by Hays (1926). He found significant correlation with height of the plant and ear length with yield. He also observed that Crosses with high yielding strains usually gave better results than crosses with low yielding strains.

Richey (1925) found that there was a positive correlation in length of the ear, height of the plant with yield and found a negative correlation with yield and Kernel rows numbers. He said "To judge the relation productiveness of good ears on the basis of their appearance is not warranted".

Berkner (1939) studied the height of maize plants in relation to vegetative growth and found it to be positively correlated. He also found a positive correlation value for green leaves per plant and 100 grain weight with the yield , however, he could not find any correlation between time taken for maturity, length of the cob and cob diameter with yield.

Keller (1942), in a 2 double crosses and 4 single crosses of maize observed that length, diameter and height of the plant to be strongly positive correlated with yield of the plant.

As early as 1898 Brigham's working with yellow flint type of maize, concluded that yields of the plant was associated with lesser number of leaves per plant and internodes on it. His conclusions were not based upon statistical calculations.

Montogomery (1911), Love (1912), Mc Call & Wheller (1913), Williams & Welton (1915), Love & Wentz (1917), Brunson & Willer (1929), observed that there were no significant correlation between yield and length of cob and height of the plant.

Montogomery (1911) reported that ears with greater length produces better yield, however, the size of the ear was dependent upon environmental factors.

Furwirth (1904) reported that ear with greater length was directly correlated with weight of the grain and yield. He worked out this findings with Szelker Corn.

Cunningham (1916) divided the maize varieties into various groups according to ear size. He stated that correlation between yield and cob length was not significant.

Olson, Bull and Hays (1918) indicated that there were no well marked basis for using ear characters to determine the yield. They further found that positive correlation between length of the cob and yield. The results were not significant.

Lindstrom (1935) studied relationship of ear characteristics for 2 generations in the corsses with their parents. He reported that length and diameter of the cob had positive correlation with yield.

Robinson, Comstock & Harvey (1951), had presented both phenotypic and genotypic correlation involving a series of attributes in the crosses for two generations. In few cases the two estimates of association differed appreciably. Cobs per plant, was the only character which showed high positive genetic correlation (+0.231) with yield but they obtained low values of 'r' in yield and other characters such as ear length as well as for the height of the plant.

Kopf (1953) noted and pridicted the values for 'r' for the length of the cob and diameter of cob when combined with yield in single crosses.

Murty & Roy (1957) studied 95 varieties of maize both indigenous and exotic in respect of different plant and ear characters. With a view to find out characters which were associated with yield high total correlation coefficient were observed between length of the ear and yield (r = +0.7609), 100 grain weight and yield (r = +0.6667), yield and plant height (r = 0.3296).

Partial correlation coefficient were worked out between yield and other characters as plant height, ear diameter, ear length and 100 grain weight. In yield plant height was involved and values for such correlation coefficient were very low.

Combining Ability:

Certain inbred lines of maize are much prominent in transmitting high yields and other characters to their proganies in crosses. The lines which could transmit easily are known as good combiners. The first idea regarding the combinging ability was given by Mc Clure (1892). According to Zirkle (1937) all inbred stock did not produce same amount of vigour.

Harrington (1932) suggested that analysis of a character which can be studied in F_2 population would provide a means of pridicting the values.

Richey & Mayer (1925) reported that certain inbreds were better combiners than others as was apparent from higher yielding ability studied from hybrid progaines. The problem of evaluation of maize inbreds from their combining ability point of view has been tackled from two different angles. Firstly, by establishing the correlation between characters of inbred and their F_1 crosses produced (Kiesselbach 1922, Nilsson Leissner 1927, Jorgenson & Brewbaker 1927, Jenkins 1929). They considered that correlation values were heritable characters, however the real evaluation of maize inbred line could be studied by actual hybrid progenies only.

Jenkins (1935) concluded that the combining ability of inbreds become fixed in the inbreding process and that future selection had little influence on it. The procedure for evaluating the inbred lines involves two steps:

1) General combining ability, and
2) Specific combining ability.

The term "General Combining Ability" is used to designate "the average performance of a line in hybrid combination". This was proposed by Spraugе & Tatum (1942). It is impracticable to test the line as such till their single and double crosses were not produced. Several investigators have reported data bearing the point Kiesselbach (1922) found a general relation between the yield of inbred line and of their habit hybrid combination. Richey & Coworkers (1947) advocated a series of inbred testers for determining the general combining ability of inbred line. Jenkins and Brunson (1932) grouped the inbreds and tested their performance in inbred variety cross, as well as in series of single corsses. They took 9-12 inbred lines in each group. Jones (1922) prior to Davis worked on inbred variety cmrosses, but his interest in such crosses was from the stand point of commercial utilisation of these crosses rather than as a method of evaluating inbred lines. Lindstom (1931) also carried out extensive experiments on inbred x variety cross but his aim was also to find out, if such crosses could be useful commercially. He used inbred lines (S6) as a male parent and commercial variety as a female parent. He noticed a marked prepotency of inbred series for ear type, disease resistance, lodging resistance, and uniformity a in maturity. His results showed significant interest in yield from such crosses but credit went to Jenkins & Brunson (1932) for the series study to find out if a variety could be substituted for a series of inbred testers and results had led to the wider acceptance of the top cross method for the rapid evaluation of new inbred lines. They used 202 inbred lines divided into 5 groups based on early and late types, white and yellow seeded type and inbreds from differnet localities. Trials conducted at 2 places in different years correlations were studied. They considered that inbred variety cmrosses would seem to be real promise in pridicting the performance of lines in single crosses. They suggested that this should be performed economically in an isolated plot.

Henderson (1952) stated that General combining ability as the "Average merit with respect to some trait" or "weighted combination of trait of an indefinitely large numbers of progeny of an individual" or "line when mated with a random sample from some specified population". He further stated that general combining ability had no meaning unless its value was considered in relationship to atleast one another individual or line under specific conditions.

Payne & Hays (1949) tested, selected inbred lines in F_2 & F_3 generations from the cross of A116 x L317 with 4 inbred testers. Data were analysed for yield and for moisture per centage. Statisetically significant difference in yield in F_2 & F_3 lines were obtained. The significant difference were noted in plant within families. They showed in F_3 lines produced desirable plants in combining ability. They also found that low yielding F_2 families gave lowest yields in F_3 crosses.

Hull (1947) assumed that better inbred lines already employed in commercial use were worthless as testers for General combining ability because of their tendency to observe difference among lines under test.

Green (1948), Keller (1949), Richey (1950) Metzinger (1953) have also provided the tests for General combining ability for inbred lines of maize.

Green (1948) emphasized a synthetic variety made up of line currently used would be the best tester for measuring the general combining ability of new inbred lines. Keller (1949) compared a related and an unrelated single cross as a tester parent in evaluating a group of selected F_2 plants from a single cross. He found 2 tester did not gave similar measure of combining ability.

Richey (1950) stated that combining ability of new inbred lives could be known more perfectly by their crosses and more single crosses could be used. He also considered that no one variety was likely to provide an unbiased test for all.

Metzinger (1953) compared the relative value of inbred lines, single crosses and double crosses as tester parents. He selected 8 inbred lines for hybrid production and utilized the same 8 lines to form 4 single crosses and 2 double cross testers. His data suggested that rank of General combining ability could be accomplished most economically through the use of a tester having a broad genetic base. He considered that selection of a line for replacement of an existing line in double cross combination would be a best tester.

Rojas (1951) had developed a mathematical model for estimating the variance for general and specific combining ability from groups of single crosses and observed that estimates of relative magnitude of variance of General and Specific combining ability from individual experiment was of limited value.

Sprauge & Tatum (1942) attempted to differentiate between general and specific combining ability by analysis of variance method. The data for all the possible combinations of yields within a group of inbreds were recorded. The lines which were tested previously had greater variance for general combining ability, however, those lines which were not tested previously showed a poorer variance for general combining ability and these results were based with assumption that general combining ability was dependent upon additive genetic effect while the specific combining ability was dependent upon Epistic,dominance and other effects. The large values for variance for general combining ability may arise because of line is either much better or much poorer than the remaining lines with which it is compared. Thus it provides indication that it is additive in nature. Low values for G^2s indicate that hybrids involving this particular line has performed as would be expected on the basis of General combining ability. High values for variance for specific combining ability indicate that some combination did relatively better or poorer than expected.

Lonnquist (1950) concluded that early testing of S_1 lines or S_0 plants in top cross provided a more efficient test of combining ability and provide a better basis of selection than the visual methods.

Wellhausen & Wortman (1954) carried out experiments to find, if high combining S_1 lines as determined by top cross test would gain in combining ability. For the first time in India Singh (1956) compared General Combining ability between S_1, and S_2, S_2 and S_3 and S_4 and S_5 lines in top crosses. The characters studied were yield, shelling per centage, days to tasseling, moisture per centage, plant height, ear height, number of good ears per plant, ear grain weight, 100 grain weight. There were no significant difference in all these comparisons except for days to silk, days to tassel, in S_3 and S_4 comparisons and these were at 5 per cent level.

Specific Combining Ability:

The term specific combining ability is used to designate those cases in which certain combinations do relatively better or worse than would be expected on the basis of average performance of the line involved.

As defined by Sprauge & Tatum (1942) to the "Actual yielding capacity or ability of an inbred when crossed with another inbred in specific combination".

Henderson (1952) defined specific combining ability as the deviation of the average of an indefinitely large number of progeny of two individuals or lines from the values which would be expected on the basis of known general combining abilities of these two lines or individuals and the maternal ability of the female parent.

Rojas & Sprauge (1952) observed that estimates of the relative magnitude of the variance of general and specific combining ability from individual experiments might be of limited value. The point of major interest was the constancy of such estimates when such experiments were repeated over a series of locations or years. When the estimates for General and Specific combining ability were obtained from individual experiment the results were in agreement with the results of Sprauge & Tatum (1942). However, when estimates were obtained over all years and all locations they were of essentially of equal magnitude. The interaction of General and Specific combining ability were considerably smaller than corresponding interaction involving Specific combining ability. These findings seemed to hold true for both previously tested and untested lines.

Shull (1909) advocated that after producing the reliable homozygous lines through confined inbreeding these should be tested for yield in all possible single crosses. The similar view was stressed by Hays (1926) who stated that after obtaining selfed lines the study of their performance for yield in F_1 crosses was a logical step. Sprauge & Tatum (1942) presented the work of fundamental importance on the nature of two kinds of combining ability and clearly differentiated between them on the basis of gene action involved. They made a study of relative importance in 45 single crosses of maize derived from ten inbred lines.

Cowen (1952) emphasized the importance of genotypic environmental interaction as the factor for determining the variance for General and Specific combining ability.

H E T E R O S I S:

The various aspects of heterosis or hybrid vigour have probably received more attention by plant geneticists and plant breeders than other single subject. The phenomenon of "Heterosis" hardly needs any introduction at present. Indeed the academic interest in the subject was evoked in early days of this century and high yielding hybrids were evolved in many crop plants including maize.

Heterosis or Hybrid vigour i.e. super vigour of certain hybrids over the mean of the parents or over better parents had been recognised since the days of Koelreuter (1763). Independent studies were started in 1906 by East at the connecticut Agricultural Research Station and by Shull (1908) at cold spring harbour to understand the problem in maize.

The term "Heterosis" was first proposed by Shull (1914) to avoid the implication that all the genetypic difference, which stimulate cell division, growth and other physiological causes were mendelian in inheritance and to substitute for the term "Stimulus of heterozygosity".

A true picture regarding the theoritical basis of hybrid vigour has not yet been obtained. Various theories from time to time have been forwarded to understand this phenomenon. The various theories are:

A. Genetical explanations, and

B. Physiological explanations

The genetical explanations has also been named as theory of dominance and over dominance (Jones 1910, Keeble & Pellew 1910, Bruce 1910, East & Shull 1936, Whaley 1944, and Hagberg 1953).

The mathematical studies were made by Bruce (1910), Keeble & Pellew (1910) to explain vigour in F_1 hybrids of Pea and they were the first to postulate the dominance hypothesis on the basis of additive nature of genes. All the dominant genes from the parents are contributed in the F_1 .

Davenport (1908) pointed out that dominant character is beneficial to the organisms while the recessive has the weakening effect to it. Jones (1917) upheld the dominance theory and gave the name as "dominance of linked genes hypothesis" and pointed out that a dominant gene might be linked with some determental recessive gene to prevent isolation of an individual with all the dominant genes.

Studies of Richey (1927), Richey & Spraugе (1931), and of Murphy (1941) on maize had provided evidence that atleast some of the improvements in vigour by crossing inbreds was due to a number of dominant alleles, rather than to an increased heterozygosity.

Lonnquist (1968) provided evidence in favour of dominance theory by involving crosses of High x High, High x low, Low x Low, combining lines in maize. From his studies he concluded that complementry gene action of dominant genes played the role in development of heterosis.

Jones (1946), Castle (1946), and Gusstafason (1947) had emphasised the importance of allelic interaction to heterosis. Power (1944) presented the explanation of heterosis that he considered heterosis and dominance were different degrees of expression of some "Physiological genetic phenomenon". It was apparent that dominance and partial dominance were manifestation of heterozygosity. East and Hays (1912) said if a hybrid was due to a number of dominant favourable genes obtained from two parents then why not same of the F_2 showed the vigour equal to F_1.

Hull (1945) explained the cause of heterosis to be over dominance and concluded that heterozygotes were between homozygotes.

The theory of Physiological stimulation arose from the union of unlike gametes and was reported by Ashby (1936), lindstrom (1937), Sprauge (1936), Luckwill (1937), Peddick (1944) and Stringfield (1950). This aspect of heterosis had gained importance only since 1930 when Ashby (1930) published his findings on maize. Ashby's studies showed that hybrids had the same relative growth rate. He took two inbred lines of maize and their F_1 proganies and grew them side by side. He attributed the vigour of the hybrids on the greater embryo weight of the hybrids. He considered hybrid vigour in crosses were nothing but more than the maintainence of great embryo size and stated this "Greater initial capital" hypothesis.

Lindstrom (1936) made a specific study of Ashby's hypothesis based on greater initial capital. He decapaciated the vigour F_1 seedlings to remove the initial advantage, but inspite of this reduction in capital, all the progenies in F_1 exceeded than their parental strains. Thus concluded that hybrids must have a higher growth rate than the parental inbred strains.

Sprauge (1936) observed that growth rate of hybrid was greater than that of Inbreds and during the first two phases of growth (Fertilization to maturity of seed and germination to seedling stage), but a higher growth rate was not established for 3rd stage viz. seedling stage to fertilisation. He concluded that hybrid vigour could not be attributed to the maintenance of initial difference in embryo size.

Collins (1921) noted in maize that large hybrid seeds showed a higher growth rate at initial stage but later no difference was noticed. Peddick (1944) studied two inbred lines of maize and their hybrids. He found that hybrid which grew fast made over all great growth and were composed of large plant parts. He noticed that inhibitary effects of tassel and silk formation were rapid in F_1 hybrid than their parents. He concluded that "Hybrid vigour appears as a factor accelerating the growth activities of the plant and carry them to the point beyond which is common in less vigrous inbreds".

Whaley (1950) reported that results of his study on growth rate of inbreds, single and double crosses of maize, in terms of fresh and dry weight increased during the germination and at maturity period. No relationship was found between the size of the embryo and ultimate size of the plant. Hybrids were better than parents phenotypically as he concluded.

The manifestation of heterosis had also been reported in various self and cross pollinated crop plants viz. Sugarbeets, Sorghum, Cotton, grasses, Tomato, Cucumber, Eggplant, Onions, and many forage plants besides maize.

Conner & Karper (1927) studied heterosis in Sorghum. F_1 generation gave 66 per cent taller plants than their tallest parents and in F_2 generations 40% of the plant showed taller plants than the tallest parents.

Hutchinnson (1947) indicated that good yields and wide adaptability of many commercial varieties of cotton were due to their appriciable heterozygosity maintained by cross pollination.

Power (1946) obtained in tomatoes a very good relationship between parent yield of ten varieties and their possible F_1 crosses. Tysdal etal (1942) utilized the phenomenon of hybrid vigour in double and single crosses in alfalfa.

In India the study on the various crop plants have been done for heterosis. The studies made at I.A.R.I. by Pal etal (1950) on crops like maize, gram, seasemum, chillies, etc. showed that most suitable plant utilization of heterosis was maize alone in the characters studied, were plant height, number of green leaves, number of days taken for emergence of tassels and silks. They noted that hybrids were taller than their parents and bore more leaves, Tasseled and silked earlier than their parents. They did not consider the gram plant suitable for this study due to difficulty in making the crosses on large scale and because of suspatability of plant to wilt disease.

Ramiah and Ramaswamy (1962) reported the manifestation of hybrid vigour in rice and had developed some of hybrid varieties. Soleman & Solanki etal (1969) studied morphological character of plant, like plant height, stem girth, 100 grain weight, and yield. Hybrids gave 25.87% to 201.13% higher yield over the superior parent. This was due to the more population of number of seeds per panicle and increased seed weight in the hybrids.

In case of cash crops the hybrid vigour has been noted in respect of yield in Gossypium hirsutum and Gossypium barbadens by Choudhary (1947) and Santhanam (1951). They noted the growth in lint length, Ginning per centage and plant height. etc.

Rao & Menon (1951) have studied the heterosis on Bajra. Sikka and Swaminathan (1956) worked in wheat crosses. The heterosis was shown by the crosses involving in Indian varieties and south American like Rio, Negro, etc.

MATERIALS & METHODS

Seeds of 16 inbred lines, and their 45 single crosses produced at the Botanical Garden of Rajasthan College of Agriculture, Udaipur were taken.

Based upon the availability of F_1 seeds the 16 inbreds were grouped into three groups as given below. Each group had six inbreds and fifteen single crosses:

Group I : U Mf9, U201, U202, U212, U301, U310

Group II : U203, U205, U207, U208, U215, U302

Group III : U Mf9, U201, U208, U209, U304, U307

The material was sown in randomised block with three replications. The twenty plants from each having plant to plant 2' distance and row to row 3' distance were kept.

By dibbling method all the material was sown on 2nd July, 1963 in Botanical Garden of the College. 3-4 seeds per hill were sown after germination these were thinned to two plants per hill. Two border rows around the layout were sown, of the local material.

Characters studied were grouped into (i) Maturity Group, (ii) Vegetative characters Group, (iii) Cob and grain characters Group, and (iv) Yield.

Details of the procedure adopted for taking the observations were as follows:

1) Days to mid Tasseling:

The mid-tasseling of the crop is considered when 50% or more of the plants are in tassel. The first tassel was recorded when it came out from the booth. Thereafter daily counting of tasseled plants were made till 50% plants tasseled.

2) Days to mid Silking:

The same procedure was adopted in taking down the observations as in the case of tasseling.

3) Days to Maturity:

The cobs completely dried and ready for shelling were considered to be mature. The crop was taken to be mature when 50% of the cobs were dry.

4) Height of the Plant:

Many methods have been adopted to measure the height of the maize plant. In the present study plants were measured from the crown to the tip of the tassel in centimeters. All plants of Inbreds and F_1's were measured separately and then the mean was calculated.

5) Number of Green Leaves per Plant:

Leaves were counted starting with the flag leaf appeared and mean value of Inbred and F_1 crosses were calculated respectively.

6) Number of Cobs per Plant:

The total ears formed on the plant were counted, and then harvested separately for each inbred and F_1 hybrid. Many of the ears did not bear any seed and such cabs were not considered as good cabs. A separate record was maintained for good and bad cobs respectively, however, both were considered while calculating the mean.

7) Ear Length:

The cobs, when harvested were dried completely, husked and then measured in centimeters from the butt end to the tip of apical end. All cobs from individual lines were measured.

8) Diameter of the Cob:

The diameter of the cob was measured with the help of vernier calliper and meter scale leaving 1/3rd portion from the butt end in the husked cobs.

9) The weight of the 100 grain seeds:

The weight of the 100 grain seeds were taken when the cobs were shelled out. Ten samples of 100 seeds each from every line and F_1 cross were weighed and then mean value was obtained.

10) Grain yield per plant:

Total seeds per plot divided by total number of plants in each plot gave the grain yield per plant in inbreds and F_1 hybrids.

The coefficient of correlation for the characters by true mean method were calculated in addition to that partial correlation coefficient have been worked out for the characters like Plant height, number of green leaves per plant, days to maturity of crop and finally yield per plant.

To study the hybrid vigour by comparison the mean value of F_1 hybrids with the mean value of their parents and in the mean value of the superior parent have been calculated for six characters of the plants were used:

(1) Plant height, (2) Cob Length, (3) Cob diameter, (4) Days to maturity of the crop, (5) 100 grain weight and finally (6) Yield per plant respectively.

Sprauge & Tatum (1942) method was used to find out the relative importance of variance of General and Specific combining ability for yield of inbred lines of the various groups separately by the formula proposed by them as under:

$$G^2a = \frac{n-1}{n(n-2)} \quad \frac{(\frac{n}{2}Ta-T)^2}{\frac{n(n-1)(n-2)}{4}} - \frac{E}{r}$$

n = Total number of Inbred lines in experiment

E = Mean Square Error

r = Number of Replications

Ta = Total of yield of inbred lines in the column

T = Grand total of the yield.

All the yield data are kept into two way table and then multiplied by (n-2).

$$Sa = (n-2)\ (ab) - Ta - Tb + \frac{2}{n-1}\ T$$

$$Sa = \frac{E}{r} + \frac{(n-3)}{(n-2)}\ s = \frac{\text{Square of yield}}{(n-3)\quad (n-2)\quad (n-3)}$$

Thus variance for all inbred lines are to be find out by this method.

EXPERIMENTAL RESULTS

The mean value of the various characters studied are given in table No. 1 and 2.

The Correlations among the various characters of Inbreds have been worked out (table No.3) and the results are summarised as follows:

Days to Tasseling:

It is positively correlated with days to Silking (+0.621), days to maturity (0.473), Cob length (0.080), Plant height (0.064), however, the value of 'r' for days to silking is significant at 5% level. The days to tasseling showed negatively correlated with yield per plant (-0.334), green leaves per plant (-0.213), cob diameter (-0.142), 100 grain weight (-0.120). The highest value of 'r' have been obtained for days to silking, days to maturity and yield per plant only.

Days to Silking:

This character is positively correlated with days to tasseling (+0.521), days to maturity of crop (0.251), and cob diameter (0.024). Negatively correlated with yield per plant (-0.603), 100 grain weight (-0.391), green leaves per plant (-0.344), plant height (-0.231) number of cobs per plant (-0.031) and finally with cob length (-0.001). The 'r' value for yield was negatively correlated and found to be significant at 5% level. Days to tasseling shows the maximum positive correlation.

Plant Height:

The plant height is positively correlated with number of cobs per plant (0.631), weight of 100 seeds grain/weight (0.382), yield per plant (0.256), green leaves per plant (0.251), days to maturity (0.221), cob diameter (0.200), days to tasseling (0.064) and cob length (0.001). The characters cobs per plant is significant at 5% level. The plant height is also negatively correlated with days to silking (-0.231). Number of cobs per plant shows the highest 'r' value.

Number of Green Leaves per Plant:

This character has positive and significant value of 'r' for the weight of the 100 grains (+0.568), and number of cobs per plant (0.564). It is positively

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correlated with plant height (0.261), yield per plant (0.262), and cob length (0.092). This is also negatively correlated with days to silking of the crop (-0.344) days to maturity of the crop (-0.244), days to tasseling of the crop (-0.213), and cob diameter (-0.041).

Number of Cobs per plant:

This is positively and significantly correlated with cob length (0.608), green leaves per plant (0.564), Plant height (0.480), and positively correlated with yield per plant (0.384), days to maturity of crop (0.141), weight of the 100 grain seeds (0.071) and finally with days to tasseling (0.850). Number of cobs per plant are also negatively correlated with cob diameter (-0.170) and days to silking of the crop (-0.081) In this character cob length, plant height and green leaves per plant are showing high values of coefficient of correlations.

Cob Length:

This is positively correlated with number of cobs per plant (0.608), days to maturity of the crop (0.200), yield per plant (0.150), leaves per plant(0.092) days to tasseling of the crop (0.080), cob diameter (0.668), and with plant height (0.001). Cobs per plant is however is a significant character. Cob length is negatively correlated with 100 grain weight (-0.713) and days to silking (-0.001). The 100 grain weight is significant at 5% level.

Cob diameter:

This is positively correlated with days to maturity of crop (0.460), 100 grain weight (0.414), plant height (0.200), cob length (0.058), yield per plant (0.039), and days to silking (0.034). This character is also negatively correlated with number cobs per plant (-0.170) days to tasseling (-0.142), and number of green leaves per plant (-0.041). However, the days to maturity has a slight higher value of 'r'.

Weight of 100 grain seeds:

This character is positively and significantly correlated with green leaves per plant (0.568), and positively correlated with cob diameter (0.414), plant height (0.332), yield per plant (0.113), days to maturity (0.072), and cobs per plant (0.071).

The weight of the 100 grain seeds is negatively significantly correlated with cob length (-0.713) and only negatively correlated with days to silking (-0.391) days to tasseling (-0.120). The character shows maximum positive correlation with leaves of the plant whereas the cob length is negatively correlated.

Days to maturity of Crop:

This character is positively correlated with days to tasseling (0.473), cob diameter (0.460), days to silking (0.252), Plant height (0.221), cob length (0.200), weight of 100 grain seeds (0.072), and yield per plant (0.001). This character is also negatively correlated with green leaves per plant (-0.244) and cobs per plant (-0.141). Cob diameter and days to tasseling shows high values of 'r' with days to maturity.

Yield per plant:

This character is positively correlated with cobs per plant (0.384), plant height (0.256), number of green leaves per plant (0.242), cob length (0.150), weight of 100 grain seeds (0.113), cob diameter (0.039), and days to maturity (0.001). Few of the characters are negatively correlated with yield viz. days to silking ((-0.608), and days to tasseling (-0.234). The 'r' value for days to silking is significant at 5% level.

The results for the correlation of coefficient studied among the various characters in F_1 crosses have also been worked out (Table No.4) and these results have also been summarised as under:

Days to Tasseling:

This character is positively significant with days to silking (+0.621), days to maturity (0.450) and only positively correlated with green leaves per plant (0.100). This character is also negatively significant with the weight of 100 grain seeds (-0.460), yield per plant (-0.386), and plant height (-0.326), however, only negative correlation with cob diameter (-0.129), number of cobs per plant (-0.119) and cob length (-0.024) is reported. The days to silking is showing the maximum value of 'r' with days to tasseling.

Days to Silking:

This character is positively significantly correlated with days to tasseling (0.621), days to maturity (0.366) and only positively correlated with green leaves per plant (0.066), also negatively significantly correlated with cob diameter (-0.724), weight of 100 grain seeds (-0.393) and negatively correlated with plant height (-0.279), yield per plant (-0.233), cobs per plant (-0.164), cob length (-0.080). However, in this case the days to tasseling, cob diameter, shows a very high degree of coefficient of correlation.

Height of the Plant:

This is found to be positively correlated with 100 grain weight (0.406) , leaves per plant (0.280), cob diameter (0.182), cob length (0.178), yield per plant (0.169) and number of cobs per plant (0.156). The 'r' value for 100 grain weight is significant at 5% level. The few of the characters are also negatively significantly correlated with above characters like days to tasseling (-0.386) and negatively correlated with days to silking (-0.279) and days to maturity (-0.058).

Number of Green Leaves per Plant:

This character is positively correlated with Plant height (0.280), number of cobs per plant (0.280) and 100 grain weight (0.280), cob length (0.269), yield per plant (0.206), days to tasseling (0.100), days to silking (0.066), and days to maturity (0.034). Only one character cob diameter has negative value of 'r' (-0.010) with leaves per plant. No character is showing good correlation with number of green leaves per plant.

Days to maturity of Crop:

This character is the positively significantly correlated with days to tasseling (0.460), days to silking (0.366) and has only positive value of 'r' with green leaves per plant (0.034), number of cobs per plant (0.025) and cob length (0.008). This character found to be negatively correlated with 100 grain weight (-0.217), yield per plant (-0.185), plant height (-0.068) and cob diameter (-0.016). However the days to tasseling silking have a fair value of 'r' with days to maturity of the crop.

Number of Cobs per Plant:

This is positively correlated with yield per plant (0.299), 100 grain weight (0.291), number of leaves per plant (0.280), cob length (0.246), plant height (0.155), and days to maturity (0.025). The first two characters are significant at 5% level. Cob diameter (-0.353), days to silking (-0.164), days to tasseling (-0.112), showed negative correlation value. Yield of the plant is showing high degree of association with cobs per plant.

Cob Length:

This character is positively correlated with yield per plant (0.421), leaves per plant (0.269), 100 grain weight (0.265), cobs per plant (0.246), plant height (0.173) and days to maturity (0.008). This character is also negatively correlated with days to silking (-0.080), days to silking (-0.024) and cob diameter (-0.013). Cob length has got a significant effect on yield per plant.

Cob Diameter:

This character is positively correlated with 100 grain weight (0.261), yield per plant (0.208). and plant height (0.182). Other characters are negatively correlated as days to silking (-0.724), number of cobs per plant (-0.353) days to tasseling (-0.129), days to maturity (-0.016), cob length (-0.013), and leaves per plant (-0.010). The characters days to silking and number of cobs per plant are significant at 5% level.

Weight of 100 grain seeds:

This is positively correlated with yield of the plant (0.489), plant height (0.405), number of cobs per plant(0.291), leaves per plant (0.280), cob length (0.265) and cob diameter (0.261). The yield per plant and plant height are significant at 5% level. Some of the characters are negatively correlated as days to tasseling (-0.450), days to silking (-0.393) days to maturity of crop (-0.217). The days to tasseling and silking are significant at 5% level. The character 100 grain weight has got significant positive correlation value with yield.

Yield Per Plant:

This character shows positive significant value of 'r' with 100 grain weight (0.489) cob length (0.431), number of cobs per plant (0.399), and only positively correlated with cob diameter (0.208), leaves per plant (0.205) and plant height (0.189),. Yield per plant is negatively correlated with days to tasseling (-0.286), days to silking (-0.233) and days to maturity (-0.185). The days to tasseling of crop has signficant value of 'r' at 5% level. Yield per plant is showing a high correlation with cobs per plant, cob length, weight of 100 grain seeds and days to tasseling and silking are negatively correlated.

Correlation Studies of Various Characters in Inbred Lines and their F_1 Crosses are shown in table No. 6:

The number of green leaves per plant is positively correlated and significant with each other (0.332), while other character like days to tasseling (0.228), days to maturity (0.218), cob length (0.200), days to silking (0.142), 100 grain weight (0.126), and cob diameter (0.102), are positively correlated among each other. Surprisingly the yield (-0.007), number of cobs (-0.036) and plant height (-0.133) were negatively correlated.

PARTIAL CORRELATION:

Four characters, yield per plant (A), Plant height (B), Number of green leaves per plant(C) and days to maturity (D), have been used to study the partial coefficient of correlation. In the case of Inbreds (Table No.5) have been given.

The maximum effect of yield has been shown by plant height ('r' = 0.641) followed by green leaves per plant ('r' = 0.351), and days to maturity ('r'= 0.010). The results with plant height are significant at 5% level.

In the case of F_1 hybrids (Table No.5) on the other hand yield is being effected by green leaves per plant ('r' = 0.623), followed by days to maturity (0.414) and plant height ('r' = 0.305). In each case the remaining two factors affect were held constant.

The Heterotic Effect of six characters on 45 single Crosses and their results (Table No.12):

The maximum effect of heterosis have been noticed in the case of yield per plant, followed by Plant height, 100 grain weight, cob length, cob diameter, and days to maturity.

In the case of the plant height, the cross U201 x U202 is showing an increase of 39.9% on the mean of the parents and 38.6% over the superior parent followed by the cross U304 x U209 which is showing an increase of 33.1% and 39% respectively. There is no heterotic effect in some of the crosses like U207 x U203.

In the case of 100 grain weight of seeds, the maximum effect of heterosis was 38.0% and 36.4% in cross U9 x U307 followed by a cross of U9 x U304 as 37.8 and 37.2% respectively. The three crosses as U9 x U202 U202 x U212, U209 x U201 are not showing any effect of heterosis while the crosses like U302 x U206 is showing the negative value as 14.7 and 13.0% respectively.

Cob length is showing the maximum value for heterotic effect as 64.4 and 60.0% respectively in crosses like U304 x U209, and U209 x U307 respectively.

Cob diameter has maximum value for heterotic effect as 21.2% and 20.4% respectively in cross U207 x U216, followed by 20.6% in U9 x U304. No effect was seen in crosses like U301 x U210, U201 x U212 and U208 x U201.

Days to maturity did not show much effect.

As regards yield per plant is concerned cross U206 x U203 is showing 236.1% effect followed by the cross U201 x U212 as 207.6%. Many of the crosses are not showing any effect of heterosis.

GENERAL AND SPECIFIC COMBINING ABILITY:

The general and specific combining ability have been calculated for 3 groups consisting of 6 inbred lines each by Sprauge & Tatum's method (1942), Table No. 9, 10 and 11.

Group I:

The variance for general combining ability is largest for inbred U202 (89.3), followed by U212(26.2) and U201 (0.50). For rest of the inbreds used, wf9, U310 U301, shows practically no variance.

The variance for specific combining ability have been found practically in all inbred lines, the maximum variance being 336.0 shown by U310, followed by wf9 (270.06), U301 (230.68), U212 (144.1), U202 (113.70), and U201 (70,66).

Group II:

The variance for general and specific ability is maximum in U202 (321.4) and for U203 (608.10) respectively.

Group III:

The variance for general combining ability has been obtained maximum in inbred U307 (182.3) followed by U304 (101.0), U208 (74.3), U209 (61.8) Uwf9 (4.44), and finally for U201 (4.0) respectively whereas in specific combining ability the maximum variance have been obtained in U201 (289.51), followed by U209 (254.0), U208 (193.8), U307 (180.62) Uwf9 (30.78) and for U304 (15.76) respectively.

D I S C U S S I O N S

The present study was taken to find out the association between yield and certain plant characters in maize. The ten plant characters studied could easily be grouped into three, maturity group, vegetative group and ear group.

In order to find out how different characters were interrelated and their association with yield the coefficient of correlations were found between these ten characters of Inbred lines, their hybrids and the Inbreds Vs crosses respectively.

The most important plant characters directly related to yield were ear characters. The statistical analysis showed that the inbreds and crosses differed significantically in days to silking, Plant height, cobs per plant and yield per plant. These differences could easily be explained on gene action, physiological conditions and the effects of environments.

In Inbred lines the maturity characters, viz. days to tasseling and days to maturity showed high positive correlation between each other as well as with yield. The days to silking, showed positive correlation with days to tasseling and negative correlation with yield of the plant. The days to tasseling and days to silking were taken as indicators of the actual maturity period of the crop and thereby determining the yield.

Ewing (1910) as well as Wolfe (1924) observed a negative correlation between days to silking and yield in maize. Similar results were observed by Jenkins (1929) also. He later pointed out that late maturity in inbreds was an indication of lower yield which he explained was due to the presence of delitrious characters in them. The results regarding the maturity characters were in agreement with that of Ewing (1910), Wolfe (1924) and Jenkins (1929).

Maturity characters studied in F_1 crosses were found to be positively correlated with days to tasseling, days to silking, while days to maturity of crop were negatively correlated with yield working with days to tasseling that the character was positively correlated with days to silking and days to maturity on the other hand days to silking were found to be negatively correlated with days to maturity of Crop.

Jenkins (1929) reported that if significant negative correlation was found between days to tasseling and days to silking with yield the hybrid must be an early maturity. Kempton (1926) made certain correlation studies with maize hybrids and reported that early flowering varieties were more productive. Murthy and Roy (1957) found negative correlation between yield and days to silking, and a positive correlation between days to tasseling and yield in some open pollinated varieties of Indian maize. However, Berkner's (1930) findings were completely opposite to Jenkin's (1929) findings and others. He concluded that there would be no correlation between days to maturity and yield.

In Inbred lines Ewing (1910), Jorgenson and Brewbaker (1927), Jenkins (1929), Hays and Jhonson (1939), reported that height of the plant and total leaf area were positively correlated with yield of the plant.

While studying the correlations among the plant height and yield in hybrids, Jenkins (1929) reported that yield was positively correlated with plant height. This indicated that vigour of the plant determined the yield. Murthy & Roy (1957) also found a positive correlation with plant height and yield. Similar results were obtained by Jorgenson & Brewbaker (1927), Hays & Jhonson (1939).

In the present material the ear characters comprising of cobs per plant, cob length, cob diameter, and 100 grain weight showed positive correlation with yield in Inbred lines. Love (1912), Biggar (1919), Richey (1926), Jenkins (1929) had also reported the positive correlation between cobs per plant and yield, cob length and yield Similar results were showed by Davenport (1897) and Wolfe (1924). Montogomery (1911), Mc Call & Wheeler (1913), Love & Wentz (1917), Robinson Comstock and Harvey (1951), found positive correlation between cob diameter and yield. For 100 grain weight a positive value of correlation with yield was obtained by Granthium (1957).

In F_1 crosses cobs per plant, cob length and 100 grain weight showed positive correlation with yield and similar results were reported by Mc Call and Wheeler ((1913), Love & Wentz (1917), Howard (1919), Nilsson Leissner (1927), Jenkins (1929) and Murthy & Roy (1957).

Yield of inbred lines were found to be negatively correlated with their yields of hybrid progenies. Similar results had been reported by Richey (1924), Hays (1926), Mangelsdorf (1926), Kiesselbach (1922) reported that a general relationship exist between yielding ability of inbred parent and their progeny, however there was a few exception to it. Richey & Mayor (1924) were just opposite to the findings of Nilsson Leissner (1927) and

Jorgenson & Brewbaker (1927). They reported correlation between various attributes of inbreds and hybrids which could be used for selection. A positive value of correlation was also obtained between yield of inbred line and their F_1 crosses.

The most comprehensive correlation studied were worked by Jenkins (1929). He calculated the 'r' values between various characters in inbreds and in their hybrid progenies. He obtained positive correlation in days to tasseling, days to silking, ears per plant, ear length, ear diameter, and negative correlation in plant height and yield. The results obtained in present study agree to with that of Richey (1924) and Jenkins (1929).

Partial correlations were computed between yield and each of 3 characters viz. Plant height, number of green leaves per plant and days to maturity. These characters were selected as each of them was correlated with yield, whereas among themselves they showed a little or no correlation.

In case of Inbred lines the partial correlation was uniform with each of the independent variables viz., plant height, leaves per plant and days to maturity. however, the maximum relation was with plant height. This indicated that plant height had direct effect on yield. Similar results were obtained by Jenkins (1929).

In F_1 crosses the yield had directly effected by green leaves per plant, followed by days to maturity and plant height, when other factors in each comparison were kept constant.

On the other hand Murthy & Roy (1957) studying partial correlation between yield and five other characters found plant height to have the minimum effect on yield.

In the 45 crosses of maize (*Zea mays* L.), studied marked heterotic effect was observed in number of morphological characters such as plant height, cob length, cob diameter, 100 grain weight and finally the yield. In some of the cases the increase in yield incre varied from 20.1 to 236.1 per cent over the mean of the parents as well as over the superior parent followed by plant height and cob length.

Pal (1956) studied the heterotic effect on plant height, leaves per plant, days to silking and days to tasseling in maize and concluded that maximum result of heterosis could be obtained in the crop.

COMBINING ABILITY

Modern corn breeding depends upon the isolation of commercially acceptable inbred lines as reported by Spraugo & Tatum (1942) and these inbred lines should be good combiners.

Spraugo & Tatum (1942) considered General and Specific combining ability on the basis of gene action involved and they said that predominantly general combining ability was due to additive gene action, while the Specific combining ability might be the result of only type of non additive gene action i.e. Dominance, Epistic or the interaction between gene and environment.

In the present study the variance for Specific combining ability was found greater than the variance for general combining ability indicating that non additive gene action taking place. In two of the inbred lines U302 and U304 the variance for general combining ability was greater than the specific combining ability. This indicated that here additive gene effect was more important. The results reported by this study were more or less contrary to the results reported by Sprauge & Tatum (1942). They found that variance for general combining ability was higher than variance for specific combining ability in their inbred lines used.

They further said that variance for General combining ability for previously untested lines was higher, than those of Specific combining ability for previously tested lines. The difference might be also due to the genetic constituents of the Inbred lines used. Thus they had emphasized more on specific combination of the lines.

Two limitations involved in present experiment can be stated as : (1) The results were based on a single experiment which might not be considered reliable, as Rojas & Sprauge (1952) clearly stated that estimates of relative magnitude of general and specific combining ability from individual experiment might be of limited value and (2) the number of Inbred lines included in our study were less.

SUMMARY & CONCLUSIONS

The 15 inbred lines and their 45 single crosses produced by the standard methods at Botanical Garden of Rajasthan College of Agriculture, Udaipur, were studied in respect of different plant characters with the view to find out their association with the yield of the plant.

2. The interrelationships between various characters including yield were studied by means of total as well as partial correlation coefficient.

3. The maturity characters were found to be correlated with plant height and leaves per plant and with some of the ear characters like cob length, cob diameter and 100 grain weight in inbreds and hybrid progenies.

4. Negative correlations were observed between yield and days to silking (-.235), days to tasseling (-0.326) and days to maturity (-0.135).

5. Positive correlation between Inbreds and their hybrids with regard to green leaves per plant (0.332), days to tasseling (0.228), days to maturity (0.218), cob length (0.200), and 100 grain weight (0.126) was observed. However the yield, (-0.007), plant height (-0.133) and cobs per plant (-0.036) were negatively correlated with each other.

6. Partial correlations were worked out between yield and each of the three characters separately in inbreds and hybrids viz. Plant height, number of green leaves per plant and days to maturity of crop. In Inbreds yield was found to be correlated more with plant height followed by leaves per plant and days to maturity, while in hybrid yield was correlated with Leaves, days to maturity and plant height.

7. Variance for specific combining ability was greater than variance of general combining ability in all the three groups. This indicates that selection for specific combining ability could be more effective than the selection for general combining ability in these groups.

8. Marked effects of heterosis was observed in respect of yield, plant height, cob length, cob diameter and 100 grain weight.

9. Low or no effect of heterosis was noticed in days to maturity of the plant.

ACKNOWLEDGEMENTS

The writer takes a great pleasure in acknowledging his sincere gratitudes towards his guide, teacher and professor Dr. H.N. Mehrotra, Head of the Department of Agricultural Botany and Plant Pathology, Rajasthan College of Agriculture, Udaipur, who took extra ordinary interest and pains in providing him with his indispensable guidance and it under his worthy guidance that the present work could take this shape.

The sincere regards are also due towards Associate Professors Shri B.K. Vig and Shri S.N. Chaturvedi Shri B.K. Kaul and Lecturer Dr. D. Sharma who helped a lot in proper presentation of the material.

Finally, writer owes a special debt of gratitude to Dr. A. Rathore, Dean, Rajasthan College of Agriculture, Udaipur and Mrs. Rathore, Head of the Department of Agricultural Economics & Statistics for providing him with all the required facilities in connection with the statistical calculation work.

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LAY OUT OF FIELD EXPERIMENTOF ZEA MAYS. L
AT BOTANICAL GARDEN R.C.A UDAIPUR.

135'

78'

10'

3'

3'

3'

PASSAGE

REPLICATION 1.

307	209 x 307
302	205 X 215
212	202 X 212
201	9 x 208
310	201 X 212
203	302 X 203
304	207 X 203
wt. 9	212 X 9
205	302 x 215
207	301 X 212
208	205 X 207
202	202 X 310
209	215 X 208
215	208 x 209
301	9 x 209
304 x 208	205 X 203
310 x 9	207 x 215
9 x 304	201 X 9
9 x 307	302 x 207
205 X 208	310 x 212
201 X 301	304 x 209
201 x 310	301 x 310
215 X 203	302 x 205
9X 202	201 X 202
304 X 307	203 x 208
307 X 201	208 x 302

REPLICATION 2.

207 X 208	208 X 201
301 X 202	209 x 201
208 x 307	301 x 9
304 x 201	304 x 201
301 X 9	208 X 307
209 X 201	301 X 202
208 X 201	207 X 208
203 X 208	209 X 307
304 X 208	205 X 215
310 X 9	202 X 212
9 X 304	9 X 208
9 X 307	201 X 212
205 X 208	302 X 203
201 X 301	207 X 203
201 X 310	212 X 9
215 x 203	302 X 215
9 X 202	301 X 212
304 x 307	205 x 207
307 X 201	202 X 310
208 X 302	215 X 208
203 X 208	208 X 209
201 X 202	9 X 209
302 X 205	205 X 203
301 X 310	207 X 215
304 x 209	201 X 9
310 x 212	309 x 207

REPLICATION 3

203 X 208	205 X 215	209 x 307
307	202 X 212	207 x 208
302	9 x 208	301 X 202
212	201 X 212	208 x 307
201	302 x 203	304 X 201
310	207 X 203	301 X Wt. 9
203	212 X 9	209 X 201
304	302 X 215	208 X 201
Wt. 9	301 x 212	203 X 208
205	205 X 207	307
207	202 X 310	302
208	215 X 208	212
202	208 x 209	201
209	9 X 209	310
215	205 X 203	203
301	207 X 215	304
304 X 208	201 X 9	W.t. 9
310 X Wt.9	302 X 207	205
9 X 304	310 X 212	207
9 X 307	304 X 209	208
205 X 208	301 X 310	202
201 X 301	302 X 205	209
201 X 310	201 X 202	215
215 x 203	203 X 208	301
9 X 202	208 X 302	▨
304 X 307	307 X 201	▨

TABLE I : The Mean Value of the various characters studied in Inbred lines of *Zea Mays* L.

S.No.	Inbred	Maturity Characters			Vegetative Characters	
		Days to Mid Tasseling	Days to mid Silking	Days to matu-rity of Crop	Average Plant Height in cm.	Number of Green leaves per plant
1	U201	52	58	87	168.8	14.8
2	U301	54	57	90	186.6	14.6
3	Ua69	52	57	84	169.8	13.1
4	U202	53	61	84	156.6	12.8
5	U203	53	59	86	181.3	12.8
6	U302	55	57	88	160.7	13.4
7	U304	52	65	81	157.6	14.0
8	U205	53	57	87	166.0	12.0
9.	U207	54	57	88	165.5	13.0
10	U208	54	57	86	172.0	12.3
11	U307	52	57	89	163.7	11.0
12.	U209	54	62	87	157.7	11.0
13.	U212	56	65	88	159.9	12.8
14	U215	54	61	88	152.7	12.0
15	U310	58	65	87	156.0	12.0

(Continued)

TABLE I (Contd.)

S.No.	Inbred	Ear Characters				
		Number of Cobs per plant	Cob Length in cms.	Cob diameter in cms.	100 Grain Wt. in Grams	Yield per plant in Grams
1	U201	1.0	13.7	3.8	23.4	60.0
2	U301	0.9	10.1	3.7	21.9	34.4
3	U409	1.3	12.0	3.4	15.8	61.4
4	U202	1.0	12.5	3.5	25.2	29.0
5	U203	1.0	15.2	3.5	20.1	33.0
6	U302	1.2	15.6	3.6	20.0	37.7
7	U304	1.0	10.4	3.3	18.3	25.5
8	U206	0.8	12.2	4.0	26.3	27.8
9	U207	1.2	14.4	3.4	21.9	35.2
10	U208	1.2	13.4	3.5	20.3	43.7
11	U307	1.2	11.1	3.7	20.3	32.4
12	U209	0.7	10.3	3.7	18.4	15.0
13.	U212	1.2	14.2	3.6	18.3	27.6
14	U215	1.1	12.4	3.3.	16.8	27.7
15	U210	1.0	15.6	3.6	19.4	29.5

TABLE II : THE MEAN VALUES OF THE VARIOUS CHARACTERS STUDIED IN F_1 PROCESS OF *Zea mays* L.

S.No.	Crosses	Maturity Characters: Days to Mid Tasseling	Maturity Characters: Days to Mid Silking	Maturity Characters: Days to maturity of Crop	Vegetative Characters: Average Plant Height in cms.	Vegetative Characters: Number of Green leaves per plant
1	U304x208	50	56	86	196.0	13.0
2	U310x9	50	54	77	183.6	13.4
3	U9x204	50	54	85	200.8	12.6
4	U9x207	50	54	81	214.6	14.2
5	U206x208	55	65	88	195.7	14.5
6	U201x201	52	57	83	196.0	15.2
7	U201x210	52	56	88	164.6	13.0
8	U216x208	50	57	86	213.0	13.4
9	U9x208	50	57	77	203.0	13.4
10	U304x207	52	56	85	192.0	13.3
11	U307x201	52	57	87	196.6	14.2
12	U208x302	52	56	81	196.2	12.3
13	U208x208	50	55	89	210.2	13.0
14	U201x202	52	57	87	227.7	13.0
15	U302x205	54	57	87	198.3	13.4
16	U301x210	52	55	86	198.4	13.1
17.	U304x209	51	54	81	209.8	13.1
18	U310x212	50	54	89	196.8	13.0
19	U302x207	53	57	86	207.8	13.6
20	U201x9	53	57	85	196.6	13.1
21	U207x215	54	57	86	189.3	14.5
22	U205x203	55	57	86	176.9	14.0

(Continued)

TABLE II (Continued):

23	U9x209	53	57	87	195.6	13.4
24	U208x209	54	57	87	192.3	13.0
25	U215x208	54	57	85	192.3	12.3
26	U202x310	53	57	86	170.0	12.3
27	U205x207	54	57	85	186.5	13.2
28	U201x212	53	57	85	195.8	12.8
29	U202x215	54	57	87	183.6	12.6
30	U212x9	53	58	87	182.2	11.1
31	U207x203	53	57	77	177.0	11.0
32	U302x203	54	57	87	207.0	13.5
33	U201x212	53	58	87	192.3	13.5
34	U9x208	51	57	86	196.0	13.2
35	U202x212	47	55	81	192.3	12.3
36	U215x205	54	57	85	196.0	14.4
37	U209x307	50	57	85	212.1	13.5
38	U207x208	54	57	88	187.0	11.0
39	U201x202	52	56	81	185.3	13.1
40	U208x307	52	57	85	195.8	13.1
41	U304x201	52	57	85	183.4	14.4
42	U201x9	54	57	87	191.4	12.5
43	U208x201	54	57	87	182.2	12.0
44	U208x201	56	62	87	164.5	13.4
45	U203x208	50	58	87	177.7	11.0

(Continued)

TABLE II (Continued)

S.No.	Crosses	Ear Characters				
		Number of cobs per plant	Cob length in cms.	Cob diameter in cms.	100 Grain wt. in Grams	Yield per plant in Grams
1	U304x208	1.0	16.6	4.0	24.7	69.4
2	U310x9	1.0	16.2	4.0	21.7	77.6
3	U9x204	0.9	16.1	4.1	25.5	77.8
4	U9x207	1.1	17.4	3.9	26.9	69.9
5	U208x208	0.9	16.9	3.0	21.4	66.8
6	U201x201	1.3	16.4	3.1	25.1	~~22x~~ 61.7
7	U201x310	1.1	16.7	3.5	19.8	48.6
8	U215x203	1.2	16.6	3.9	23.3	66.1
9	U209x202	0.7	16.6	4.1	22.1	63.6
10	U304x207	1.0	14.8	4.0	21.0	82.9
11	U307x201	1.1	12.1	4.0	26.6	91.6
12	U208x208	1.1	13.4	4.0	22.6	63.4
13	U208x209	1.1	19.0	3.8	24.8	79.9
14	U201x208	1.0	17.0	3.5	21.3	74.9
15	U302x205	0.9	16.8	3.6	19.7	47.6
16	U201x210	1.2	14.7	3.6	21.2	39.4
17	U304x209	1.1	17.1	4.1	22.6	55.8
18	U310x212	1.0	16.7	4.2	26.1	63.1
19	U302x207	1.0	12.4	4.0	24.3	61.1
20	U201x9	1.1	14.6	3.8	24.6	61.8
21	U307x215	0.8	16.7	4.0	21.6	60.3
22	206x209	0.6	16.8	4.1	12.4	114.3

(continued)

TABLE II (Continued)

23	U[illegible]209	0.9	16.9	3.8	16.7	49.7
24	U208x209	0.8	16.8	3.7	18.4	54.6
25	U216x208	1.0	16.2	3.9	21.5	75.4
26	U2[illegible]x310	0.8	18.0	4.1	21.6	77.3
27	U206x207	1.0	16.7	3.8	21.5	60.5
28	U201x212	1.0	15.3	4.0	23.0	66.3
29	U302x215	1.2	18.6	3.8	21.6	51.8
30	U212x9	0.8	12.3	3.7	19.9	30.4
31	U207x203	0.9	15.0	3.8	19.8	52.0
32	U303x203	1.0	14.0	3.7	23.1	29.4
33	U201x212	0.9	15.6	3.8	21.9	50.2
34	U9x208	1.1	15.4	3.8	22.8	46.0
35	U202x212	1.0	9.9	4.0	21.4	62.8
36	U205x215	1.1	15.3	3.8	24.3	51.5
37	U209.307	1.1	16.9	4.0	20.6	49.2
38	U207x203	0.9	15.0	3.8	20.1	38.0
39	U201x202	1.3	17.1	3.9	22.1	65.5
40	U202x307	0.8	16.1	4.0	20.3	69.8
41	U304x201	1.1	17.6	4.1	24.0	75.4
42	U301x9	1.0	14.0	3.9	22.1	67.5
43	U209x201	1.1	13.5	3.4	20.4	24.9
44	U205x201	1.2	13.5	3.7	18.7	37.8
45	U203x208	1.2	19.8	3.1	22.5	79.9

TABLE III : COEFFICIENT OF CORRELATIONS AMONG TEN CHARACTERS STUDIED IN INBRED LINES OF *Zea mays* L.

S.No.	Characters	Days to mid-Tasseling	Days to mid-Silking	Plant Height	Number of Green leaves per plant	Days to Maturity	No. of cobs per plant	Cob length	Cob Diameter	100 Grain weight	Yield per plant
1.	Days to mid Tasseling	-	0.521*	0.064	- 0.213	0.473	0.050	0.080	- 0.142	- 0.120	- 0.234
2.	Days to mid Silking	-	-	- 0.281	- 0.344	0.252	- 0.031	- 0.001	0.024	- 0.291	- 0.608*
3.	Plant Height	-	-	-	0.251	0.221	0.580*	0.001	0.200	0.323	0.256
4.	Number of Green leaves per plant	-	-	-	-	- 0.244	0.564*	0.092	- 0.041	0.568*	0.242
5.	Days to Maturity	-	-	-	-	-	0.141	0.200	0.460	0.072	0.001
6.	No. of cobs per plant	-	-	-	-	-	-	0.608*	- 0.170	0.071	0.304
7.	Cob Length	-	-	-	-	-	-	-	0.058	- 0.713*	0.150
8.	Cob Diameter	-	-	-	-	-	-	-	-	0.414	0.029
9.	100 Grain Weight	-	-	-	-	-	-	-	-	-	0.113
10.	Yield per plant	-	-	-	-	-	-	-	-	-	-

Sig. Value for 5% level for d.f. = 0.5135.

* indicates Sig. Value at 5% level.

TABLE IV : COEFFICIENT OF CORRELATIONS AMONG TEN CHARACTERS STUDIED IN F_1 HYBRIDS OF *Zea mays*, L.

S.No.	Characters	Days to mid-Tasseling	Days to mid-Silking	Plant Height	Number of Green leaves per plant	Days to Maturity	No. of cobs per plant	cob length	cob diameter	100 Grain weight	yield per plant
1.	Days to mid Tasseling	-	0.621*	0.325*	0.100	0.450*	-0.119	0.094	0.189	0.450*	-0.386*
2.	Days to mid Silking	-	-	-0.279	0.085	0.355*	-0.164	-0.080	-0.794	-0.398*	-0.333*
3.	Plant Height	-	-	-	0.280	-0.058	0.155	0.178	0.188	0.406	0.169
4.	Number of green leaves per plant	-	-	-	-	0.034	0.280	0.269	-0.010	0.280	0.206
5.	Days to maturity	-	-	-	-	-	0.025	0.008	-0.016	-0.217	-0.186
6.	Number of cobs per plant	-	-	-	-	-	-	0.346	-0.353*	0.281	0.399*
7.	Cob length	-	-	-	-	-	-	-	-0.013	0.266	0.431*
8.	Cob diameter	-	-	-	-	-	-	-	-	0.261	0.308
9.	100 Grain Weight	-	-	-	-	-	-	-	-	-	0.489*
10.	Yield per plant	-	-	-	-	-	-	-	-	-	-

Sig. value at 5% level for 43 d.f. = 0.2942

* indicates sig. value at 5% level of significance.

TABLE V : COEFFICIENT OF PARTIAL CORRELATION BETWEEN YIELD PER PLANT (A) PLANT HEIGHT IN CMS (B) NUMBER OF GREEN LEAVES PER PLANT (C) & DAYS TO MATURITY OF THE CROP (D) IN INBRED LINES & F_1 HYBRIDS OF *Zea mays* L.

		Partial correlation (Designation)	Value of 'r'
1.	INBREDS	r AB.CD	0.641*
		r AC.BD	0.361
		r AD.BD	0.010
2.	F_1 HYBRIDS	r AB.CD	0.306*
		r AC.BD	0.623*
		r AD.BC	0.414*

Sig. value at 5% level for 13 d.f. = 0.513

43 d.f. = 0.2942

* indicates sig. value at 5% level

TABLE VI : COEFFICIENTS OF CORRELATIONS BETWEEN TEN CHARACTERS OF INBRED LINES AND F_1 HYBRIDS

S.No.	Character	Value of 'r'
1.	Days to mid Tasseling	0.228
2.	Days to mid Silking	0.142
3.	Plant Height	-0.133
4.	Days to Maturity	0.218
5.	Number of leaves per plant	0.332*
6.	Cobs per plant	-0.036
7.	Cob length	0.200
8.	Cob diameter	0.102
9.	100 Grain weight	0.126
10.	Yield per plant	-0.007

Sig. value for 5% = 0.304

TABLE VII : ANALYSIS OF VARIANCE FOR THE YIELD PER PLANT IN INBRED LINES OF *Zea mays* L.

S.No.	Inbred	R_1	R_2	R_3	Total
1	U307	55.1	54.0	58.7	167.8
2	U302	38.7	39.0	37.0	114.7
3	U212	47.0	47.3	47.4	141.7
4	U201	30.3	24.1	32.4	86.8
5	U310	30.6	32.2	35.3	98.1
6	U203	32.3	28.0	34.0	94.3
7	U304	25.8	25.0	25.6	76.4
8	Uwf9	46.8	48.0	40.0	134.8
9	U205	30.4	28.0	29.4	87.8
10	U207	39.0	32.0	38.2	109.3
11	U206	34.0	32.5	29.5	96.0
12	U202	24.7	29.6	28.4	82.7
13	U209	24.7	29.6	28.4	82.7
14	U215	25.2	25.7	24.6	75.5
15	U301	31.5	27.3	29.6	88.4
	Total	513.4	490.1	515.2	1518.7

ANALYSIS TABLE

S.No.	Source of Variation	D.F.	S.S.	M.S.	F.	Table value of F
1.	Replications	2	34.14	17.07	2.55	Non Sig.
2.	Inbred Lines	14	3686.55	263.32	39.42	Significant
3.	Error	28	187.07	6.68	-	-
	Total	44	3907.76	-	-	-

TABLE VIII : ANALYSIS OF VARIANCE FOR THE YIELD PER PLANT IN F_1 HYBRID LINES OF <u>Zea mays</u> L.

S.No.	Crosses	R_1	R_2	R_3	Total
1	U304x208	74.6	64.1	70.1	208.8
2	Uvf9x210	83.0	70.1	81.7	234.8
3	U9x304	71.2	80.0	84.0	235.2
4	U9x307	74.0	70.0	76.0	220.0
5	U206x208	49.0	48.6	55.0	152.6
6	U201x301	61.6	63.0	60.0	184.6
7	U201x310	49.2	47.1	49.1	145.4
8	U215x208	62.0	69.7	67.5	199.2
9	U202x209	55.7	56.3	50.3	162.3
10	U304x307	79.6	72.8	90.2	242.6
11	U207x201	73.7	74.1	71.4	219.2
12	U208x202	56.6	51.3	49.0	156.9
13	U206x203	74.0	83.0	82.5	239.5
14	U201x209	71.7	84.3	60.7	216.7
15	U302x206	36.0	41.7	51.0	128.7
16	U301x310	45.3	30.4	36.2	111.9
17	U304x209	47.1	57.7	54.1	158.9
18	U310x212	67.1	63.2	58.2	188.5
19	U308x207	53.4	50.2	49.0	152.6
20	U201x9	65.0	60.0	61.3	186.3
21	U207x215	64.6	73.1	69.5	207.2
22	U206x203	90.6	60.0	94.4	245.0
23	U9x200	54.2	49.0	45.0	148.2
24	U208x209	63.8	61.5	41.8	167.1
25	U215x206	80.2	75.0	78.0	233.2

TABLE VIII (Continued)

26	U202x310	76.2	73.5	82.3	232.0
27	U206x207	67.1	81.0	62.6	210.7
28	U201x212	66.8	68.4	63.0	198.4
29	U302x215	56.5	49.2	49.0	154.7
30	U9x212	44.4	38.0	36.5	118.9
31	U207x203	54.0	48.0	53.2	155.2
32	U302x203	30.5	42.7	35.0	108.2
33	U201x212	50.8	53.0	46.4	150.2
34	U9x208	54.4	40.4	42.0	136.8
35	U208x212	69.5	57.4	57.2	184.1
36	U206x215	46.7	49.6	60,0	156.3
37	U209x307	64.0	57.4	53.0	174.4
38	U207x208	36.7	30.1	45.5	112.3
39.	U301x208	70.0	66.4	61.1	197.5
40	U208x307	59.4	58.0	61.7	179.1
41	U304x201	90.0	56.4	80.0	226.4
42	U301x9	64.7	66.4	71.2	202.3
43	U209x201	22.6	22.3	29.3	74.2
44	U208x201	21.1	47.6	45.2	113.9
45	U208x203	42.2	77.0	76.3	195.5
	Total	2601.0	2639.0	2690.5	8020.5

ANALYSIS OF VARIANCE

S.No.	Source of variation	D.F.	S.S.	M.S.	F.	Table F
1	Replications	2	39.6	19.8	0.348	Non-sig.
2	Hybrids	44	26611.93	604.81	10.39	Significant
3	Error	88	5124.00	58.22	-	-
	Total	134	31775.63	-	-	-

TABLE IX : YIELD IN GRAMS PER PLANT FOR 15 SINGLE CROSSES AMONG THE 6 INBRED LINES OF *Zea mays* L. IN GROUP NO.1 WITH THE ESTIMATION OF THEIR VARIANCE FOR GENERAL AND SPECIFIC COMBINING ABILITY FOR EACH OF THE LINES INVOLVED

S. No.	Inbred	U201	U301	U202	Uwf9	U212	U310	Total	Mean	$\sigma^2 a$	$\sigma^2 s$	Remarks
1	U201	-	61.7	74.9	61.8	50.2	48.6	297.2	59.44	0.6	70.66	-
2	U301	61.7	-	65.5	67.5	66.3	38.4	299.4	59.88	-	239.58	
3	U202	74.9	65.5	-	53.6	62.8	77.3	334.1	66.82	59.3	113.70	
4	Uwf9	61.8	67.5	53.6	-	39.4	77.6	299.9	59.98	-	270.06	
5	U212	50.2	66.3	62.8	39.4	-	63.1	281.8	56.36	26.2	144.10	
6	U310	48.6	38.4	77.3	77.6	63.1	-	305.0	61.00	-	339.00	
	Total	297.2	299.4	334.1	299.9	281.8	306.0	1817.4 / 2	359.48	-	-	-
							Mean	= 908.7	59.9			

Mean Square Error per plot = 22.3

Note : $\sigma^2 a$ = General Combining ability

$\sigma^2 s$ = Specific combining ability

TABLE X : YIELD IN GRAMS PER PLANT FOR 15 SINGLE CROSSES AMONG THE 6 INBRED LINES OF *Zea mays* L. IN GROUP NO. 2 WITH THE ESTIMATION OF THEIR VARIANCE FOR GENERAL AND SPECIFIC COMBINING ABILITY FOR EACH OF THE LINES INVOLVED

S. No.	Inbreds	U302	U205	U207	U215	U203	U208	Total	Mean	σ^2_g	σ^2_s
1	U302	-	47.5	51.1	51.8	29.4	53.4	233.2	46.64	321.4	309.4
2	U205	47.5	-	69.5	51.5	114.3	66.8	349.6	69.92	118.7	586.6
3	U207	51.1	69.5	-	69.3	52.0	38.0	279.9	55.98	36.6	204.0
4	U215	51.8	51.5	69.3	-	66.1	75.4	314.1	62.82	1.0	283.0
5	U203	29.4	114.3	52.0	66.1	-	79.9	341.7	68.34	78.8	606.1
6	U208	53.4	66.8	38.0	75.4	79.9	-	313.5	62.70	0.4	211.0
	Total	233.3	349.6	279.9	314.1	341.7	313.5	1832.0 / 2	366.40 / 6	-	-
							Mean =	916.0	61.7		

Mean square Error per plot = 54.0

TABLE XII : RESULTS SHOWING THE PER CENTAGE INCREASE OR DECREASE IN THE F_1 CROSSES FROM THE MEAN OF THE 2 PARENT AND FROM THE MEAN OF THE HIGHER PARENT IN Zea Mays L.

S. No.	Crosses	Plant height in cms.		Cob Length		Cob diameter	
		Mean of the 2 parents	Mean of the Higher parent	Mean of the 2 parents	Higher Parent	Mean of the 2 parents	Higher Parents
1	U204x208	20.3	19.1	14.5	13.4	17.6	17.0
2	Uwf9x210	12.7	12.1	17.4	15.8	14.3	13.9
3	U9x204	22.6	21.8	43.7	40.8	20.6	20.6
4	U9x207	28.6	28.1	50.0	48.4	8.2	8.1
5	U205x208	16.8	15.5	24.2	23.1	-21.0	-20.0
6	U201x201	9.8	9.3	37.8	32.8	-18.6	-18.6
7	U201x210	1.3	1.3	6.7	6.4	- 5.4	- 5.2
8	U216x208	24.9	22.5	19.5	17.7	+14.7	+14.3
9	U202x209	24.5	23.6	26.0	25.6	17.1	17.1
10	U304x207	19.5	19.1	33.3	32.4	17.1	16.2
11	U307x201	17.6	17.3	46.0	41.6	8.1	8.0
12	U208x202	15.5	15.0	- 7.8	- 7.0	11.1	11.1
13	U208x203	16.6	15.8	22.8	20.8	9.0	9.0
14	U201x202	39.9	38.6	30.0	28.5	- 5.0	- 5.0
15	U302x205	21.9	21.6	20.8	18.5	- 7.8	7.0
16	U301x210	10.5	9.7	14.0	11.5	-	-
17	U304x209	33.1	33.0	64.4	64.4	17.1	16.0
18	U310x212	24.0	23.6	12.0	11.5	16.8	10.8
19	U302x207	27.4	27.0	22.6	21.8	14.3	13.9
20	U201xwf9	10.2	10.1	13.1	12.4	5.9	5.2
21	U207x215	19.6	18.2	24.6	22.8	21.2	20.4
22	U205x203	- 0.2	0.1	22.6	20.3	10.8	10.0

TABLE XII : Continued

23	Uwf9x209	19.4	18.7	50.8	47.5	6.0	5.8
24	U208x209	16.6	16.0	40.0	35.0	3.0	3.0
25	U215x208	18.4	17.3	25.6	24.6	14.4	14.2
26	U208x210	8.8	8.6	28.4	25.2	14.0	13.8
27	U205x207	12.4	12.4	25.6	23.8	3.0	3.0
28	U201x212	12.9	12.0	26.4	22.0	11.1	10.8
29	U208x215	17.1	16.6	22.2	29.3	11.8	10.6
30	U9x212	11.1	10.8	- 6.1	- 5.8	6.0	5.6
31	U207x208	-	-	1.4	1.2	11.8	11.4
32	U208x203	18.6	17.2	- 9.1	- 9.0	6.0	5.8
33	U201x212	16.3	16.5	11.4	11.2	-	-
34	Uwf9x208	14.7	14.0	21.2	21.2	11.8	11.8
35	U208x212	21.1	21.0	-26.1	-26.1	14.3	13.8
36	U215x205	23.6	22.6	20.3	20.0	5.8	5.8
37	U209x207	31.9	31.4	60.0	60.0	8.1	8.1
38	U207x208	10.8	10.7	9.5	9.0	11.8	11.4
39	U301x202	13.8	7.2	61.3	46.4	8.3	8.1
40	U208x207	16.0	16.2	30.8	27.9	11.1	10.6
41	U304x201	12.3	11.9	41.3	40.1	17.1	16.2
42	U301xwf9	7.4	7.0	27.2	27.0	11.6	10.6
43	U209x201	14.7	14.2	12.5	11.0	- 8.1	- 8.1
44	U208x201	- 3.4	-3.4	-	-	-	-
45	U203x208	- 1.3	-1.3	38.4	36.1	-11.4	-11.4

Continued...

TABLE XII : Continued.

S.no.	Crosses	100 Grain Weight		Days to maturity of Crop		Yield per plant	
		Mean of the 2 parent	Higher parent	Mean of the 2 parent	Higher parent	Mean of the 2 parent	Higher parent
1	U304x208	28.0	26.6	1.8	1.7	142.6	122.0
2	Uwf9x210	13.6	13.3	-10.0	- 9.7	100.0	86.6
3	U9x204	37.8	37.2	3.0	2.9	121.6	95.3
4	U9x207	38.0	36.4	- 6.6	- 6.2	89.5	90.4
5	U206x208	- 8.1	- 7.2	1.7	1.7	117.6	113.6
6	U201x201	11.0	10.7	- 6.2	- 5.1	125.1	114.3
7	U201x210	- 7.6	- 7.1	1.0	1.0	68.6	87.7
8	U215x203	26.6	24.3	- 2.3	- 2.2	86.5	85.1
9	U202x9	-	-	- 8.3	- 8.3	60.4	46.0
10	U304x207	8.8	8.1	-	-	106.2	76.7
11	U307x201	14.7	14.1	1.0	1.0	128.1	94.6
12	U206x202	17.4	17.1	-	-	88.5	48.1
13	U208x208	22.2	22.2	- 5.8	- 5.8	127.0	116.1
14	U201x202	-12.2	11.7	4.0	4.0	220.0	207.6
15	U202x205	-14.7	13.0	-	-	40.6	35.6
16	U301x210	3.0	2.8	1.6	1.6	22.3	21.4
17	U304x203	24.8	29.8	1.0	1.0	134.4	120.7
18	U210x212	33.8	32.4	- 7.4	- 7.3	56.2	48.6
19	U302x207	16.2	15.4	1.0	1.0	37.3	36.3
20	U201xwf9	16.6	14.2	-	-	77.5	60.2
21	U207x215	11.8	10.2	- 3.4	- 3.4	115.9	102.6
22	U206x203	26.1	20.6	- 1.6	- 1.6	236.1	206.7

Continued.

TABLE XII : Continued

23	Uwf9x209	-10.2	-10.1	-	-	38.4	30.8
24	U208x209	- 4.6	- 4.4	-	-	85.7	79.2
25	U215x208	•16.2	14.2	-	-	152.1	143.0
26	U202x310	- 3.0	- 2.9	-	-	182.1	152.6
27	U206x207	-10.7	- 9.3	1.7	1.7	111.2	101.1
28	U301x212	14.4	13.2	4.5	4.4	71.7	65.0
29	U302x215	15.2	14.0	3.4	3.4	56.5	49.0
30	Uwf9x212	8.0	7.4	1.1	1.0	- 14.3	- 14.0
31	U207x209	- 5.8	- 5.8	-11.5	-11.3	39.0	37.6
32	U302x203	15.5	15.3	-	-	- 23.4	- 23.4
33	U201x212	5.3	4.8	-	-	30.4	30.1
34	U9x208	16.7	16.2	-	-	20.1	17.1
35	U202x212	-	-	5.2	5.1	81.5	59.7
36	U206x215	12.5	10.8	- 2.8	- 2.8	73.8	76.6
37	U203x307	6.7	6.4	- 3.4	- 3.1	19.4	14.4
38	U207x208	4.2	4.2	1.1	1.0	11.7	11.0
39	U301x202	- 6.0	- 5.8	- 7.0	- 6.6	131.6	151.6
40	U208x307	- 4.0	- 4.0	2.6	2.6	37.1	29.2
41	U304x201	15.4	13.7	1.2	1.1	200.0	198.6
42	U301x9	8.8	8.2	-	-	80.5	67.1
43	U209x201	-	-	-	-	- 3.9	- 3.7
44	U208x201	-14.2	-13.2	-	-	83.4	30.0
45	U203x208	11.3	11.2	1.1	1.1	82.1	75.6

TABLE XIII : FREQUENCY OF TASSELING FROM 43 DAYS AFTER THE DATE OF SOWING FOR INBRED LINES IN *Zea mays* L.

S. No.	Inbreds	14 Aug.	15	16	17	18	19	20	21	22	23	24	25	26	Actual days taken for mid tasseling (Range)
1	U201	-	-	2	-	3	1	1	4	4	9	-	-	-	45-52
2	U301	-	-	-	-	1	2	2	2	3	6	6	8	-	47-54
3	Uw29	-	-	-	-	2	3	-	-	2	17	1	-	-	47-52
4	U202	-	-	-	-	1	-	-	1	2	5	13	-	-	47-53
5	U203	-	-	1	-	3	1	1	1	8	6	9	-	-	45-53
6	U302	2	8	2	-	-	3	2	1	1	1	1	8	1	43-55
7	U204	2	-	1	1	-	3	-	-	9	5	-	-	-	43-52
8	U205	8	-	3	-	7	-	4	1	5	3	-	-	-	43-53
9	U207	1	-	-	-	-	1	3	1	6	2	4	8	-	43-54
10	U208	-	-	1	-	-	-	1	1	4	2	7	2	-	45-54
11	U307	3	-	1	1	4	3	1	1	1	3	-	-	-	43-52
12	U209	-	-	-	-	2	1	-	3	-	5	7	7	-	47-54
13	U212	-	1	1	-	-	2	2	2	3	2	9	3	3	44-55
14	U215	-	1	-	-	-	1	2	4	2	1	7	7	-	44-54
15	U310	-	3	5	-	1	1	1	4	4	4	-	-	-	44-52

TABLE XIV : FREQUENCY OF THE TASSELLING FROM 43 DAYS AFTER THE DATE OF SOWING FOR F_1 crosses in *Zea mays* L.

S. No.	[illegible] Crosses	14	15	16	17	18	19	20	21	22	23	24	25	26	27	Actual days taken for mid-tasseling
1	U304x208	6	1	1	-	7	6	-	4	4*	6*	-	-	-	-	50
2	U9x210	8	-	6	-	7	3	-	4	5*	8*	-	-	-	-	50
3	U9x304	3	2	6	-	10	3	-	5	4*	6*	-	-	-	-	50
4	U9x207	8	-	1	-	10	5	5	2	5*	6*	-	-	-	-	60
5	U205x208	-	-	-	-	2	1	2	2	1	4	1	5	2	-	55
6	U201x301	2	3	-	1	-	4	-	4	4	8	-	-	-	-	52
7	U201x210	4	-	-	-	5	6	1	3	1	3	-	-	-	-	52
8	U216x203	11	1	1	-	5	6	-	4	8	5	-	-	-	-	50
9	U9x202	9	-	4	3	8	3	1	2	6	4	-	-	-	-	50
10	U304x207	12	-	-	-	3	1	1	1	2	2	-	-	-	-	52
11	U307x201	4	-	-	-	63	3	-	3	11	5	-	-	-	-	52
12	U208x202	2	-	-	1	4	4	1	3	4	6	-	-	-	-	52
13	U203x208	12	2	3	-	8	-	1	1	9	9	-	-	-	-	50
14	U201x202	-	-	3	-	10	4	2	3	4	7	-	-	-	-	52
15	U302x205	-	-	-	-	4	-	2	2	2	2	8	9	-	-	54
16	U301x210	-	-	-	-	3	2	5	3	5	6	-	-	-	-	52
17	U304x209	7	1	4	-	10	-	1	3	5	3	-	-	-	-	51
18	U310x212	14	-	1	-	7	1	3	2	2	5	-	-	-	-	50
19	U302x207	4	-	2	-	2	3	2	2	6	3	8	-	-	-	53
20	U201x209	3	1	3	-	3	-	1	-	5	4	13	-	3	-	53
21	U207x216	-	-	1	-	5	3	-	3	3	7	13	-	-	-	54
22	U205x203	-	-	2	4	11	-	-	2	1	6	2	-	-	-	55
23	U9x202	-	11	2	1	5	-	1	2	2	6	10	-	-	-	53
24	U208x209	-	-	2	-	2	3	2	1	3	1	7	14	-	-	54
26	U215x208	-	-	-	1	4	1	1	-	5	5	8	13	-	-	54

Continued

TABLE XIV : Continued.

26	U208x210	-	-	3	-	9	1	1	3	2	3	6	-	-	-	53
27	U205x207	-	-	4	-	8	-	-	2	2	2	3	9	-	-	54
28	U201x212	2	1	1	0	5	1	-	3	4	6	10	-	-	-	58
29	U202x215	3	1	-	-	1	1	-	-	8	1	6	9	-	-	54
30	U212x9	-	-	-	1	3	-	-	-	3	2	16	-	-	-	53
31	U207x203	2	-	-	1	5	-	-	1	1	3	10	-	-	-	53
32	U208x203	3	1	2	-	-	-	1	-	3	3	7	-	-	-	54
33	U201x212	2	-	-	-	3	6	-	1	7	4	10	12	-	-	53
34	Uwf9x208	8	-	-	-	9	7	4	1	3	6	-	-	-	-	51
35	U202x212	8	2	-	6	14	9	-	-	2	8	-	-	-	-	47
36	U206x215	3	-	-	-	1	1	1	1	2	6	11	9	-	-	54
37	U209x307	5	1	8	6	3	-	1	3	3	14	-	-	4	-	50
38	U207x208	2	1	2	-	3	2	-	2	4	7	2	5	*	-	54
39	U201x208	-	-	3	-	6	2	-	4	-	15	-	-	-	-	52
40	U208x307	-	-	-	-	8	4	1	2	5	12	-	-	-	-	52
41	U304x201	6	1	-	-	-	3	3	4	3	4	-	-	-	-	52
42	U201x9	-	-	-	1	-	3	-	1	1	4	-	12	-	-	54
43	U209x201	-	-	-	-	-	1	-	3	2	4	1	10	-	-	54
44	U208x201	1	-	-	-	2	1	2	3	3	2	3	6	2	5	56
45	U208x208	7	-	6	-	7	5	3	2	-	3	-	-	-	-	50

* has no effect on days for tasseling

TABLE XV : FREQUENCY OF SILKING FROM THE 48TH DAY OF THE SOWING FOR INBRED LINES OF *Zea mays*

S.No.	Inbreds	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	8	Actual days taken for Silking
1	U201	-	-	-	-	4	-	2	6	-	11	6	-	-	-	-	-	58
2	U301	-	-	-	-	2	-	2	5	1	14	-	-	-	-	-	-	57
3	Uaf9	-	-	-	-	1	4	2	4	-	14	-	-	-	-	-	-	57
4	U202	-	-	-	-	2	1	2	3	2	1	-	-	2	3	-	-	61
5	U209	-	-	-	-	3	2	3	3	4	5	-	4	-	-	-	-	59
6	U290	-	-	1	1	4	3	2	4	5	4	-	-	-	-	-	-	57
7	U204	-	-	1	-	-	4	2	4	-	-	-	-	-	-	-	-	56
8	U205	1	1	-	-	4	2	2	9	2	16	-	-	-	-	-	-	57
9	U207	-	-	-	-	-	2	1	5	5	11	-	-	-	-	-	-	57
10	U208	-	-	-	-	4	2	-	7	3	8	-	-	-	-	-	-	57
11	U207	-	-	-	-	-	2	2	5	4	3	-	-	-	-	-	-	57
12	U209	-	-	-	-	-	1	-	3	2	5	2	-	6	3	3	-	62
13	U212	-	-	-	-	4	-	2	4	-	1	3	-	-	3	5	5	66
14	U215	-	-	-	-	2	-	4	3	1	7	-	-	3	1	-	-	61
15	U210	-	1	3	1	7	8	-	4	-	-	-	-	-	-	-	-	56
16																		

Total

TABLE XVI : FREQUENCY OF SILKING FROM THE 48TH DAY OF THE SOWING FOR F_1 CROSSES OF <u>Zea mays</u> L.

S. No.	Crosses	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	4	Actual days taken for Silking
1	U304x208	-	-	-	3	11	-	8	4	-	-	-	-	-	-	-	-	55
2	U9x210	-	1	1	1	12	1	10	-	-	-	-	-	-	-	-	-	54
3	U9x204	-	2	-	-	9	3	13	-	-	-	-	-	-	-	-	-	54
4	U9x207	1	1	2	1	14	-	7	-	-	-	-	-	-	-	-	-	54
5	U205x208	-	-	-	-	3	2	-	6	3	1	-	-	1	-	-	4	64
6	U201x201	-	-	-	-	5	1	3	4	2	16	-	-	-	-	-	-	57
7	U201x210	-	-	-	-	9	2	8	3	1	-	-	-	-	-	-	-	56
8	U216x202	-	-	2	1	11	-	7	4	1	10	-	-	-	-	-	-	57
9	U9x202	-	-	4	-	6	1	7	3	-	11	-	-	-	-	-	-	57
10	U207x204	-	-	4	7	6	-	2	4	1	2	-	-	-	-	-	-	55
11	U207x201	-	3	-	-	1	1	7	2	1	22	-	-	-	-	-	-	57
12	U208x202	-	-	1	-	3	2	2	12	6	-	-	-	-	-	-	-	56
13	U203x208	1	2	3	1	12	1	5	7	-	-	-	-	-	-	-	-	55
14	U201x202	-	-	-	-	10	-	8	8	1	17	-	-	-	-	-	-	57
15	U302x205	-	4	-	-	3	3	6	3	4	18	-	-	-	-	-	-	57
16	U301x310	-	-	5	3	12	-	7	-	-	-	-	-	-	-	-	-	55
17	U304x202	-	4	-	-	6	1	16	-	-	-	-	-	-	-	-	-	54
18	U310x212	-	3	7	3	4	3	12	-	-	1	-	-	-	-	-	-	54
19	U302x207	1	1	-	-	2	3	4	10	2	20	-	-	-	-	-	-	57
20	U201x9	-	-	-	-	-	3	2	8	3	15	-	-	+	-	-	-	57
21	U207x215	-	-	-	-	3	3	6	9	7	3	-	-	-	-	-	-	57
22	U205x203	-	-	-	-	2	3	8	7	2	16	-	-	-	-	-	-	57

(continued)

TABLE XVI : Continued

23	U9x209	-	-	-	-	2	5	5	6	6	9	-	-	-	-	-	-	57
24	U208x209	-	-	-	-	3	-	3	5	1	18	-	-	-	-	-	-	57
25	U216x208	-	-	-	-	4	3	3	3	1	17	-	-	-	-	-	-	57
26	U208x210	-	-	-	-	5	1	6	6	1	15	-	-	-	-	-	-	57
27	U206x207	-	-	-	-	3	2	3	3	2	15	-	-	-	-	-	-	57
28	U301x212	-	-	-	-	2	2	6	5	4	23	-	-	-	-	-	-	57
29	U302x215	-	-	-	-	-	1	5	7	1	19	-	-	-	-	-	-	57
30	U212x9	1	-	-	-	-	1	4	3	1	15	2	-	-	-	-	-	58
31	U207x209	-	-	2	-	1	1	2	5	-	23	-	-	-	-	-	-	57
32	U302x203	-	-	-	-	4	2	3	3	3	17	[illegible]	-	-	-	-	-	57
33	U201x212	-	-	-	1	1	-	2	6	2	12	[illegible]	-	-	-	-	-	58
34	U9x208	1	-	-	2	10	2	4	2	6	17	-	-	-	-	-	-	57
35	U202x212	1	-	1	-	12	1	8	6	-	-	-	-	-	-	-	-	55
36	U205x215	-	-	-	-	2	2	2	1	6	20	-	-	-	-	-	-	57
37	U209x207	-	-	-	-	13	1	9	2	5	-	-	-	-	-	-	-	57
38	U207x208	-	-	-	-	3	1	2	4	3	16	-	-	-	-	-	-	57
39	U301x208	-	-	-	-	11	1	6	5	6	-	-	-	-	-	-	-	56
40	U208x207	-	-	-	-	3	1	4	11	2	16	-	-	-	-	-	-	57
41	U304x201	-	-	-	-	7	2	-	6	4	20	-	-	-	-	-	-	57
42	U301x9	-	-	-	-	2	7	-	-	1	17	-	-	-	-	-	-	57
43	U209x201	-	-	-	-	-	4	2	4	2	11	-	-	-	-	-	-	57
44	U208x201	-	-	-	1	2	2	-	4	1	6	[illegible]	-	1	1	6	-	62
45	U203x206	-	-	-	-	5	1	2	5	1	11	5	-	-	-	-	-	58