EFFECT OF DATES OF PLANTING ON YIELD AND OTHER CHARACTERISTICS IN MAIZE

by

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ABSTRACT

A two-year study was conducted at the American University Farm in Lebanon to find the effect of planting dates on the yields of grain, forage and stover, protein percentage of grain, days to tasseling, plant and ear heights, percentages of suckering, barrenness and multiple ears, uniformity of ears and ear filling on three maize hybrids, S.D. 604, Ind. 620 and A.E.S. 808. Plantings were done in March, April, May and June.

Early plantings made in March resulted in the highest grain yields. Grain yields decreased significantly as the seeding was delayed until June. The protein percentage reduced with a delay in planting. Forage yields were highest from the April plantings and lowest from the March plantings. The May plantings gave the highest stover yields while the March crop produced the least. As for the hybrids, S.D. 604 exceeded in grain yields and A.E.S. 808 gave the highest percentage of protein and stover yields.

The number of days to tasseling decreased gradually with successive plantings from March to June. Plant and ear heights were lowest for the March plantings.

Hybrid A.E.S. 808 produced the taller plants with higher ears than Ind. 620 or S.D. 604.

Suckering, barrenness and multiple ears were not influenced by the four dates of planting. Ear filling was better in the earlier plantings than in the later seeded crop.

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INTRODUCTION

Maize (Zea mays L.) is a crop plant that has yielded most spectacularly to the modern scientific research. The development of high yielding adaptable hybrid varieties and improvements of cultural practices have resulted in yields per unit area, unprecedented in the crop history.

The production potential of maize crop has remarkably been exploited in the United States of America. Directly or indirectly, maize provides the United States with more food, feed and industrial products than any other grain. The research experiences of the States have beneficially been utilized in other parts of the world. As a result, the world acreage and production of the crop is on a steady increase. An F.A.O. report estimates the world area under the maize crop in 1959-60 as 105.7 million hectares compared with 91.1 million hectares in the base years of 1948-49 to 1952-53. The production for the years given is stated to be as 219.6 and 145.8 million metric tons, respectively. The same general trend is apparent in Lebanon since there has been a gradual increase from

7,000 hectares in the base years 1948-49 to 1952-53 to 10,000 hectares in 1959-60 with a corresponding increase in production from 12 to 19 thousand metric tons (33).

The major maize-producing areas of the world are located in regions having a temperate climate with a warm summer and no distinct dry periods in the growing seasons. Limits to maize production are set by the killing frosts and practically no crop can be grown at places where mean summer temperature is less than 66°F (19°C) (12, 29). The Beka'a plain, the main food grain producing area of Lebanon, is characterized by dry warm summers and cold wet winters. Temperatures as low as -5°C are frequently noted in the winter while the mean maximum temperature for the hottest month of August is approximately 33°C. The total annual rains average about 400 mm. at the University Farm, with no rainfall during the months of June, July, August and even September+ These seasonal limits, however, can be ingeniously utilized if the optimal extents for the critical period of plant establishment are known. The importance of the problem, in view of the unavailability of any previous work in Lebanon, is thus evident.

Since high yield per hectare implies that the crop is able to utilize the full growing seasons without being

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+ American University Farm Meteorological Data, Beka'a Valley, Lebanon.

hampered by adverse conditions of soil, climate and other prevailing conditions, it is imperative that the crop is sown at an optimum date. For the wide variations in the conditions under which maize crop is planted, the time of sowing varies from locality to locality.

This experiment, conducted in the Beka'a plain, reports results for the crop years of 1961 and 1962. The purpose of this study was to find the effect of dates of planting on yield and other characteristics in maize. Three hybrid varieties were used and their performance, with regards to yield, protein content and other characters evaluated when planted at four different dates.

REVIEW OF LITERATURE

Maize, because of its widely divergent types, is grown over a variety of climatic conditions. It is thus difficult to exactly define the climatic limits of maize production. General limits on major production areas have, however, been studied by a number of workers.

In an extensive review on climatic requirements for maize production Shaw (29) stated that the important production areas in the United States have a mean summer temperature of 70-80°F, a mean night temperature exceeding 58°F and a frostless season of over 140-150 days. He observed that practically no maize is grown where the mean summer temperature is less than 66°F or where the average night temperature during the three summer months falls below 55°F. Sprague (30) stated that areas producing maize in the world as a whole are limited by the 70-80°F isotherm during the period of silking and tasseling. Shaw (29) sets a lower limit of about 8 inches of rainfall in summer without irrigation, although if evaporation is not excessive an even smaller summer rainfall will suffice. Under conditions of very low rainfall, maize crop must be grown

under irrigation. Rose (27) and Visher (34) found significant correlation in parts of the corn belt between maize yields and some climatic factors notably precipitation and temperatures for May, June, July and August.

The period from planting to emergence is characterized by a dependence on soil temperature, soil moisture and food stored in the seed. Sufficient water must be available for seed to germinate and the plant to continue subsequent growth. A suitable temperature must be maintained for both germination and later growth to take place.

Wallace and Bressman (35) reported that the laboratory experiments indicate that a temperature of about 90°F is most favorable for germination and growth of maize, and that growth stops altogether at temperatures below 40°F or above 118°F. The day time temperature of the soil where the seed is to be placed should be 60°F or higher. Kincer's (20) findings indicate that at the time of planting of maize the average temperature varied from 54°F to 57°F in most of the maize growing areas of the United States.

Stringfield and Anderson (32) gave the general planting dates for maize growing areas of the United States as ten days to two weeks after the average date of the last killing frost of that area. They consider planting before this period to be early and that afterwards to be late.

The average planting time for main maize crop in the United States begins late in January in the extreme south and progresses a day for every 13 miles north and ends up with early in June in the extreme north (31)

The dates of planting for maize vary not only from locality to locality but they may also vary for the same locality. McClelland (21) stated, "The planting dates of corn in any locality vary from year to year because of varying seasonal conditions, relative urgency of various types of work, the necessity for early feed, the traditions of the farmers and also set convictions of many as to what is the proper date for planting." He observed that in many places the practice was to divide the planting, putting in some early and some late, thus distributing the labor and giving better insurance against damage by drought and insects.

Planting Date and Maize Plant Establishment

Early planting is desirable in extending the crop season, getting early harvests, distributing the labor more equitably and avoiding the later crop hazards. Satisfactory establishment of stands from early sowing, however, may become difficult due to 1) seed rots, seedling blights and other fungal troubles, 2) attacks of insect pests like cutworms, wireworms and borers, 3) an early growth of weeds, and 4) early season hazards. Late planting may be advisable to avoid exigencies of the season and to

reduce insect and disease losses (7). Early planting may be advantageous where the soil is dry enough for good coverage, weather conditions indicate temperatures above 60°F and there are no probable local hazards such as floods, or insect infestations (32).

Seedling blight of maize incited by Gibberella spp. occurs where the soil is cold while the seed is still germinating. Soil temperature is important in determining the extent of the disease. Dickson (6) showed that the most favorable range for seedling blight caused by Gibberella zeae is 8-20°C, while none occurs above 24°C. He concluded that the influence of environmental factors on the host seems to be the fundamental cause of susceptibility to the disease. When the temperature is most favorable for the host, it can withstand the pathogen most effectively.

Ekerson and Dickson (8) attributed the resistance and susceptibility of the plants as influenced by temperature, to the chemical composition of the cell-wall and nature of food reserves presented to the pathogen. Seedlings grown at low soil temperatures are low in available carbohydrates and high in available nitrogen and their cell-walls are composed mainly of pectic compounds, with little or no cellulose and lignin. At low temperatures, therefore, the cell-walls are much less resistant and the foods available much more attractive for the pathogen. Rush and Neal (28) observed that low temperatures resulted

in retarded physiological activities in germinating maize and thus predisposed the plants to attacks by various soil organisms.

Bunting (4) attributed differences in the extent and speed of emergence in varieties to their different genetic make-up and suggested breeding of hybrid varieties capable of germination and growth at low temperatures as a possible approach to extend maize production in Great Britain. He further stated that in addition to inherited varietal characteristics, conditions of seed production and methods of processing influence the ability of maize seed to tolerate cold and wet conditions at the time of sowing.

Early planting may expose the crop to late spring frosts and cause stand failures. Despite cold weather conditions early planting may sometimes be beneficial. Owens and Ensign (23) working in Idaho found that early spring planting, though it may expose the crop to later frosts, is most often justified in the ultimate increased yields of the crop. Grogan et al. (11) reported that, although planting as early as April 20 in central Missouri risks some damage from frost or cold, it was observed in 1956 that maize seed remained in the ground under very cold conditions and still germinated to produce an excellent crop.

Delayed planting may bring the crop into the

drought period and cause crop failures. Thus Helm (13) noticed that late planting is most often the cause of reduced crop yields in south-east and south-west Missouri.

Early planting of maize has long been associated with heaviest infestation of the first generation of the European corn borer, Ostrinia nubilalis. Also, the borer population build up as the planting is delayed (25). It appears, however, that a given level of infestation will cause more harm when the plants are small than when they are large. Since the seasonal history of the multiple generation strain of the insect may vary greatly, its relation to the host plant must be studied in each locality (7).

The percent borer (Chilo zonellus) infestation was significantly higher in the early sown maize than the late sown crop in an experiment conducted by Chela (5) at Jullunder, India. Similar results are reported by Gill (9) from Lyallpur, Pakistan. Though Dungan (7) also observed higher borer infestation in the early plantings than in the plantings done late he cautioned against sowing late for reduction of insect and disease damage as this had a detrimental effect on crop yield and quality.

Grogan et al. (11) in their studies from 1955-57 in Missouri found an increase in the number of borer larvae as the planting was delayed from April 1 to June 20.

Isa (17) in a study on the susceptibility of maize

to infestations with the borers: Chilo simplex, Sesamia critica and Pyrausta nubilalis at Uras Elsoda, Alexandria (Egypt), observed that if the insect host plants are absent during the period of emergence of moths, the later sown crop will escape much of the damage.

Grogan et al. (11) also noted ear-worm damage to be associated with planting dates, and found an increase in worm penetration with a delay in planting time. A distinct relation between the date of planting and the number and location of maize ear-worm eggs was observed by McColloch (22). Varietal differences were ascribable principally to the time and period of silking, the time of maturity and the morphological characters of the plants.

Rolston (26) in his study of the biology and control of south-western maize borer (Diatraea grandiosella), noticed that early planting produced less loss from 'dead heart' and enabled harvesting before girdling began. He referred to a test at Fayetteville, Arkansas, where the corn planted in mid-April, mid-May and mid-June had 1, 8 and 40 percent, respectively, of the plants affected by 'dead heart'. He concluded that girdling can largely be avoided if harvesting is completed by September 10.

An increase in lodging percentage with delayed planting was observed by Grogan et al. (11) in their studies in Missouri. An approximate increase of 15 percent in root lodging occurred for each month of delay in

planting from April 20 to June 20, averaged over three years, 1955-57. Though stalk lodging showed considerable variation over the years and locations, it was less for early planting than for the other dates. York et al. (36) also found higher, though not significant, lodging percentage with delayed planting in Arkansas, during the years 1955 to 1958.

Planting Date and Maize Plant Development

According to Alberts (1) Georgeson et al. (1895), Morrow and Hunt (1889), Foster (1891), Gardner (1895) and Morrow and Bone (1896) reported that the development of maize plant was retarded by planting too early in the season. Most of these investigators noticed seed rotting or blighting of maize and, in general, a slower growth of the plants. Planting too late was likewise noticed by other investigators like Hickman (1890), Morrow and Gardner (1892) and Williams and Welton (1915) as resulting in poor growth of the crop due to short growing period and consequent failure to come to full maturity. Alberts (1) also noticed that the leaves of the plants from the earliest planting dried first and late planted varieties retained green leaves longer in the season. Becker (3) found that the vegetative portions were increasingly tall and bulky with progressively later sowing dates.

Silking, tasseling and maturity dates have been found to be remarkably influenced by the date of planting.

Alberts (1) from his observations at Wisconsin in 1925 found that varieties silked in order of the date of planting but there was little difference in silking of varieties from early plantings.

Dungan (7) observed that three week difference in planting dates separated tasseling dates by only about a week. Stringfield and Anderson (32) stated that a delay of two days in planting will normally delay silking and maturity by about one day.

In the three-year study, 1955-57, Grogan et al. (11) reported that the dates of planting were more influential than hybrid varieties in affecting differences in the number of days from planting to tasseling and silking. They found that at Columbia, Missouri, the June 20 planting required three weeks less time than the April 20 planting to reach the tasseling stage. Similar results were obtained at Sikeston, Missouri, and tasseling was more than a month early in the June 20 planting than the April 1 planting. The silking date on an average was 2 days late than the tasseling date at the two locations.

Tests conducted by Idris (16) at the Agricultural Research Station, Tozi, Sudan, on the other hand, showed that days to silking and tasseling were not affected by delay in planting, but days to maturation were reduced by more than two weeks for both of the varieties he included in the trial.

The effect of planting date on plant height and stem thickness was studied by Chela (5), 1950-51. He found that the plants from the crop sown on August 4, the last date of planting had smaller plant height than that planted on earlier dates of July 5, July 15 and July 25. The plants of the last planting had a significantly smaller stem thickness than other plantings. He also found that the percentage of barren plants went on increasing as planting was delayed. The last planting date had significantly higher percent barren plants when compared with other dates.

Grogan et al. (11) observed that though at Columbia, Missouri, the effect of planting date on ear-height grade was not much pronounced when compared with years and maturity, it had the greatest effect at Sikeston, Missouri. At Sikeston height of the ear increased gradually as the date of planting was delayed. The reverse was the case at Columbia.

Idris (16) obtained a reduction in the number of cobs per hundred plants with a delay in planting. Cob weight also decreased with delayed planting and the number and weight both showed a more significant decrease for the late maturing hybrid.

Chela (5) obtained the highest shelling percentage for July 15, the optimum sowing date, and the least for the last date of sowing. Grogan et al. (11) found the

shelling percentage was affected by the date of sowing and it decreased gradually as the plantings were delayed. The grains, therefore, develop best at the optimum date of sowing for the locality and show a poor development as the planting is delayed.

Planting Date and Crop Yields and Quality

Maize yields are determined by the combined effect of a number of inter-related factors like adaptability of the variety, temperature, soil moisture, plant population, plant nutrients, insects, plant pathogens and cultural practices. Their sum total effect expressed at critical periods in the development of maize plant is largely responsible for limiting crop yields in many areas.

The effect of dates of plantings on yield of maize crop has been studied by a number of workers. The results have been in favour of early planting in all cases where the length of the growing season presents a serious limitation on the growth of maize.

McClelland (21) conducted dates-of-planting experiments in Arkansas from 1917 through 1926 at Fayetteville and from 1922 through 1926 at Scott. Plantings were made on the first and 15th of each month from April to July. The results from the tests at Fayetteville for the ten-year period showed that on the average the April 15 plantings gave the highest yields. The results of the tests at Scott for the five-year period showed June 1 as the

best planting date for the majority of the varieties. McClelland concluded that the results of these tests though definite, are only for the given conditions and should not be extended as such to conditions different in the State.

Stringfield (31) referred to a 20-year experiment at Wooster, Ohio, where the best yields were obtained by planting between May 7 and May 12, which is early for the area. Delayed plantings of one, two and three weeks gave reduced yields of 2, 7 and 14 bushels per acre respectively. He further stated that perhaps the planting date was less critical south of Ohio latitude and quoted Johns and Brown (1941) in Louisiana who found no significant difference in yield from planting dates ranging from February 25 to May 15, though lower yields and increased insect injury resulted by planting after May 15. Another reference is made to experiments in Texas by Manglesdorf (1929) which showed a sharp drop in yield for most varieties as planting is delayed after the earlier dates while in Georgia, Stacy (1941) obtained the best yield by medium to early plantings.

Green et al. (10) in their studies in south Florida between 1934 and 1939, planted 16 varieties of open-pollinated maize each month from November through May. They obtained satisfactory yields only from the January and February plantings. For each day's delay in planting after

February 15, an estimated loss of about one bushel per acre was recorded.

Dungan (7) carried out yield and quality tests of short-, mid- and full-season maize varieties planted at three different dates during the five-year period, 1927-31. Results showed that early planting of the full-season varieties gave the best yields both in northern and central Illinois. Though mid-season and full-season varieties produced almost the same yields in the northern Illinois, yet the results indicate that it is more important to plant full-season varieties earlier than the short-season varieties. Quality of the grain, as measured by bushel weight and percentage of water-free shelled maize, deteriorated by delayed planting in all cases. The late planting of full-season varieties showed a tendency to give lower quality than other plantings.

Becker (3) planted maize varieties at intervals of nine days from the 1st of April to mid-May, 1952-53 on sandy and clay soils. He obtained marked decline in yields after the 28th of April. On clay soils maximum yields were obtained from the plantings made on April 19.

Hume et al. (15) conducted studies on date and rate of maize planting at two locations, representing the eastern and central areas of South Dakota from 1945 to 1955. Three commercial hybrids of different maturity levels were grown at three planting rates of two, three and four

kernels per hill, 42 inches apart in either direction. They were planted on May 1, May 20 and May 30. In eastern South Dakota, the highest average yields were obtained from sowing a hybrid of medium maturity in mid-May with an average stand of 3.3 plants per hill. In central South Dakota, the best yields were obtained from an early hybrid sown on May 20 with 2.5 plants per hill. They suggest that with the availability of hybrids capable of germination in early May, it may be possible to plant earlier and get still better yields without loss of quality.

Gill (9) reported that the maize crop sown from March to the first week of July gave low grain and fodder yields at Lyallpur, Pakistan, during 1958. It had poor grain set and was damaged more by the maize borer. Delaying the planting to September, however, also resulted in lower yields by decreasing the span of the growing season. Ishag (18) also obtained low yields from early plantings in the crop sown on July 13 to September 5 in 1960, from an experiment conducted at Gezira Research Station, Wad Medani, Sudan. The crop from the last date gave the maximum grain yield for most of the varieties used. Stover yield, however, was the highest from July 26, the second date of planting. He ascribed the low grain yield from the earlier sowings to water-logged conditions during the crop season.

In another experiment conducted at Tozi, Sudan, Idris (16) planted two short and two long maturing varieties

over four planting dates from July 14 to August 31, 1960. The second date of planting, July 29 gave the highest grain and stover yields. Tall, long maturing varieties appeared to be more sensitive to late planting than dwarf short maturing varieties. The first planting date was noted to be too early due to the general late condition of the season.

Chela (5) spaced sowing dates at 10-day intervals from July 5 to August 4 during 1951 and 1952. The second date of planting, July 15, gave the highest yields and proved superior to the 3rd and 4th plantings by a significant margin but was at par with the first date of planting. The interaction value of dates and years was not significant indicating that the order of yield for different dates was the same in the two years and the seasonal effect was shared alike by all plantings. The second date also gave the highest yield of stalks while the last planting gave the lowest yield.

Grogan et al. (11) conducted dates-of-planting studies at Columbia and Sikeston, Missouri from 1955 through 1957. Hybrids representing four different maturities were grown in the tests. The tests at Columbia were started at monthly intervals from April 20 to June 20 while at Sikeston, where the growing season is longer, the dates were spread 20 days apart from April 1 to June 20. The differences between years, maturity and dates of

planting and their interactions were all highly significant at the two locations. Years and dates contributed most to the source of variation. All hybrids decreased in yield as the dates of planting were delayed. At Columbia the 3-year average production showed roughly a 12 bushel per acre decrease from each month of delay in planting. At Sikeston, the difference in yield between April 1 and June 20 planting for all hybrids was about 30 bushels to the acre. The investigators found that 115-125 day adapted hybrids yielded best at Columbia and 140-day adapted hybrids at Sikeston. The earlier maturing hybrids approached or equalled the full-season hybrids in over-all performance only when the planting was delayed until after the first of June.

York et al. (36) conducted dates-of-planting experiment over a four year period, 1955 to 1958, at the Main Experiment Station, Fayetteville and at the Cotton Branch Experiment Station, Marianna in Arkansas. Two maize hybrids representing each of the three different maturity groups were planted about April 15, May 15 and June 15 at each location. At the Main Experiment Station the mid-May and mid-April plantings gave the highest yields during the years 1955, 1956 and 1958. In 1957, when there were ample rains late in the growing season, yields from the mid-June planting approached a higher significant level than the mid-May planting. At the Cotton Branch

Station, yields were higher from the mid-April and mid-May plantings than from the mid-June planting except for 1956 when supplemental irrigations were supplied to the experiment. The hybrids of the long maturity group gave the highest yields regardless of the planting dates.

Azab (2) in 1958 carried out studies at the College of Agriculture, Gieza, Egypt, on the effect of planting date on the yield of different hybrids and the variety Early American. Early planting of July 3 had a very pronounced effect on increasing the yield. The difference between the mean yield of the early planting and that of the later plantings made on July 17, July 31 and August 14 were highly significant. The latest date resulted in a very poor yield. The investigator observed that the expression of hybrid vigour increasing the yield was more pronounced in the early plantings and had no evident effect in the plantings done as late as July 31. He concluded that each hybrid has to be planted on a certain date to bring out its highest yielding capacity.

MATERIALS AND METHODS

The experiment was conducted for two consecutive years, 1961 and 1962, on the American University Farm, 80 kilometers east of Beirut, under the irrigated conditions of the Beka'a plain. The soil was a clay type with a pH of 8.0. Three American hybrid varieties, Indiana 620, S.D. 604 and A.E.S. 808, differing in their maturity periods, were used in this trial.

Four planting dates were chosen; middle of March, middle of April, middle of May and middle of June. The middle of March represented the earliest planting and the middle of June represented the latest dates of planting.

The soil was fertilized with an initial application of 12 kg. per dunum of Nitrogen applied as ammonium nitrate and P_2O_5 at the rate of 20 kg. per dunum applied as super phosphate. The fertilizers were broadcast and then disced into the soil previous to planting. Additional application of Nitrogen fertilizer at the rate of 4 kg. per dunum were applied as side-dressings at knee-high and pre-tasseling stages of the crop. The crop was irrigated every

week by a sprinkler system in the early stages and later through furrows made adjacent to the rows. Moisture and nutrients were supplied in sufficient amounts as not to interfere with the experimental variables under study.

Insects and diseases were controlled immediately when first observed and not allowed to become a problem. Arasan treated seed was used. Endrine was sprayed at the two-leaf stage of the crop against cutworm attack. Metasystox was used later when leaf hoppers appeared.

A split plot design was used. It included four planting dates and three varieties replicated four times. The dates of planting were assigned the main plots and varieties the sub-plots. Each main plot or date of planting was bordered by two buffer rows planted on the same date as the main plot. Each variety plot consisted of two rows, five meters long and one meter wide; one of the two rows was used for forage and the other for grain and stover yield.

Planting was done with a hand planter using 20 percent excess seed. The plots were thinned to 25 plants per row when 6 - 10 inches tall to get a uniform stand of five thousand plants per dunum. Weeding was done every week with regular nursery equipment in the early stages of the crop. In the later stages the competition of the crop itself afforded most of the weed control.

Data on emergence, number of diseased plants, plant height, ear height, date of tasseling, total and barren

tillers, number of multiple ears, ear weight, uniformity in position, uniformity in filling of ears, number of ears, yield of grain on basis of 15.5 percent moisture, air-dry yield of forage and stover were taken and recorded. Out of the total of 5-meters-row only four meters were harvested for forage, grain and stover yield since one-half meter on each end was left out for border effect. Harvesting for forage was done in the late dough stage when the kernels had started to dent. Grain and fodder yields were taken after the plants had matured and the ears contained less than 25 percent moisture. All field weights were recorded to a tenth of a pound.

For calculation of air dry yield of forage and stover representative 10 pound samples were taken from each treatment and a composite sample for each variety from all four replications made at each harvest. For ear moisture determinations the central portions of each ear from a representative sample were taken at harvest. The adjusted grain yield to a standard 15.5 percent moisture basis was calculated by the use of conventional conversion table.

For protein analysis of the grain a representative sample from each treatment was taken, dried in an oven (temperature 100-103^{o}C for 48 hours), cooled, ground and kept separately. A 1-2 gram sub-sample was weighed on an analytical balance, from each of the samples. The percentage of nitrogen of the samples was then determined by the

modified Kjeldahl method, as detailed in the official methods of analysis of the Association of Official Agricultural Chemists (14). The nitrogen values obtained were multiplied by the factor 6.25 to get the protein percentage. The duplicates that differed in their results from the sample mean by 6 percent or over were discarded and analysis repeated. The range of variation was calculated by the following formula:

$$\frac{X-Xm}{Xm} \times 100 = 6\ \%$$

where X = percent total nitrogen in the sample;

Xm = mean percent total nitrogen in the sample.

Statistical analyses of the data were done by methods appropriate to the split plot design. Analysis of variance was made to find out the significance of results and the 't' test was used to find differences between the treatments and their combinations (19, 24).

RESULTS AND DISCUSSION

A two-year study was undertaken to find the effect of four dates of planting on yield and other characteristics in maize. The agronomic data obtained included grain, forage and stover yields, protein percentage in the grain, days to tasseling, plant and ear heights, suckering, barrenness, multiple ears percentages, uniformity of ears and ear filling of three maize hybrids. The data were taken for two crop seasons, 1961 and 1962. The results are summarized and reported in Tables 1 to 9. Analysis of variance tables are given in the appendix. The L.S.D. figures in the tables are given for dates, varieties and only for the interactions that were statistically significant.

Yield of Grain

A significant effect of planting dates on grain yield in maize was found in the two crop-years, 1961 and 1962 as shown in Table 10. All hybrids decreased in yield as the dates of planting were delayed. The highest average per dunum yields of 1000.5 kg. and 986.8 kg. were obtained from the March planting and the lowest yields of 600.3 kg. and 613.5 kg. were for the June planting, in 1961 and 1962,

Table I. Effect of dates of planting on grain yield, in kgs. per dunum, in maize during I961 and I962 at the University Farm

	Dates of planting								Means of hybrids	
	March		April		May		June			
	I96I	I962	I96I	I962	I96I	I962	I96I	I962	I96I	I962
S.D. 604	967.4	I009.6	945.5	97I.2	875.5	826.I	645.0	7I2.I	858.3	879.7
Ind. 620	I064.8	I039.9	792.6	826.8	795.8	7I3.9	548.8	546.6	800.5	78I.8
A.E.S. 808	969.6	9I0.8	929.8	85I.3	750.9	782.I	607.0	58I.8	8I4.3	78I.5
Mean of dates	I000.5	986.8	889.3	883.I	807.4	774.0	600.3	6I3.5		

	I96I		I962	
	L.S.D.(5%)	L.S.D.(I%)	L.S.D.(5%)	L.S.D.(I%)
Dates	I58.9	228.3	I9I.7	275.4
Hybrids	I05.I	I42.4	9I.6	I24.I

Means:

	March	April	May	June	March	April	May	June	
Dates	I000.5	889.3	807.4	600.3	986.8	883.I	774.0	6I3.5	*

	S.D.604	A.E.S. 808	Ind.620	S.D.604	A.E.S. 808	Ind.620
Hybrids	858.3	8I4.3	800.5	897.7	78I.5	78I.8

* Treatments underlined do not differ significantly at 5 percent level.

respectively (Table 1). In both years, maize planted in March and April gave significantly higher yields than the June planting at the one percent level of significance. Between the March and April plantings, no significant differences in grain yields were observed, though March plantings gave a higher average yield in both of the years. The March planting out-yielded the May and June plantings significantly in the two years. The yield differences between the planting dates were greater in the last date of planting than the earlier plantings.

The extended growing period afforded by the earlier plantings appears to be the major factor for their higher crop yields. An increase in yield from the crop planted early in the season was also obtained by other workers (7, 21, 31).

Though the hybrids gave no significant differences in the yields in the 1961 crop, S.D. 604 tended to give the highest average yield of 858.3 kg. per dunum . In 1962, however, S.D. 604 yielded 879.7 kg. per dunum and excelled Ind. 620 and A.E.S. 808 significantly. There were no significant differences in the yields of the latter two hybrids. Thus S.D. 604 appears to be better suited to the existing conditions than the other two hybrids for grain yields.

The results suggest that to obtain maximum grain yields, the hybrids should be planted as early as the soil

Table 2. Effect of dates of planting on yield of forage, in kg. per dunum, in maize during I96I and I962 at the University Farm

Hybrids	Dates of planting								Means of hybrids	
	March		April		May		June			
	I96I	I962	I96I	I962	I96I	I962	I96I	I962	I96I	I962
S.D. 604	I659	I225	I787	I558	I704	I602	I795	I300	I736	I422
Ind. 620	I538	I2I3	I79I	I4I8	I606	I658	I670	I482	I659	I458
A.E.S. 808	I370	I533	I845	I595	I7II	I342	I607	I688	I633	I539
Means of dates	I522	I324	I808	I545	I764	I534	I70I	I490		

	I96I		I962	
	L.S.D.(5%)	L.S.D.(I%)	L.S.D.(5%)	L.S.D.(I%)
Dates	68.3	98.2	232.2	337.7
Hybrids	I06.6	I44.4	286.7	388.6

Means:

Dates	April	June	May	March	April	May	June	March
	I808	I70I	I674	I522	I545	I534	I490	I324 *
Hybrids	S.D.604	Ind.620	A.E.S.808		A.E.S.808	Ind.620	S.D.604	
	I736	I659	I633		I539	I458	I422	

* Treatments underlined do not differ significantly at 5 percent level.

and weather conditions would permit. In cases where late planting is done an objective appraisal of all factors is necessary. The importance of a proper date of planting is well revealed in the present study where the differences in grain yields between the March and June plantings amounted to an average of 386.8 kg. per dunum.

Yield of Forage

During the two years of this study the maize planted in April gave the highest forage yields as revealed in Table 2. The average yields obtained from the April plantings were 1808 kg. and 1545 kg. per dunum in 1961 and 1962, respectively. The differences in forage yields between the April plantings and the other plantings were significant only in the 1961 crop. The overall forage yields were low in 1962, and the April plantings did not yield significantly higher than the other plantings (Table 11). The lowest average yields of 1522 kg. and 1324 kg. in 1961 and 1962, respectively, were recorded for the crop planted in March.

The early planting in March produced relatively smaller plants with lower ears (Table 6 and 7). This may account for the low forage yields from the March planting. The next planting made in April appears to have utilized the growing season much better to gain overall weight and gave an increased forage yield.

Table 3. Effect of dates of plantings on the yield of stover, in kg. per dunum in maize during I96I and I962 at the University Farm

Hybrids	Dates of planting								Means of hybrids	
	March		April		May		June			
	I96I	I962	I96I	I962	I96I	I962	I96I	I962	I96I	I962
S.D. 604	723	460	620	573	889	746	988	72I	807	625
Ind. 620	669	432	670	574	I040	90I	II43	70I	88I	652
A.E.S. 808	908	659	966	906	I395	923	II77	8I8	III2	827
Means of dates	770	5I7	752	684	II08	857	II02	747		

	I96I		I962	
	L.S.D.(5%)	L.S.D.(I%)	L.S.D.(5%)	L.S.D.(I%)
Dates	I86	267	I74	25I
Hybrids	90	I22	7I	96

Means:

	May	June	March	April	May	June	April	March	
Dates	II08	II02	770	752	857	747	684	5I7	*
	A.E.S. 808		Ind.620	S.D.604	A.E.S. 808		Ind.620	S.D.604	
Hybrids	III2		88I	807	82(		652	625	

* Treatment underlined do not differ significantly at 5 percent level.

There were no significant differences in the forage yields of the hybrids (Table 2). Hybrids S.D. 604 and A.E.S. 808 gave inconsistent results and changed places in the order of the forage yield in the two seasons.

Yield of Stover

The stover yields in maize were affected significantly by the dates of planting as is apparent from the data in Table 12. In both of the years May and June plantings were the best for stover yields. The differences in stover yield between these dates were not statistically significant. However, the highest yields of 1108 kg. and 857 kg. per dunum in 1961 and 1962, respectively were recorded for the May planting (Table 3).

The overall stover yields were about one-third higher in 1961 than the yields obtained in 1962. In 1961, the March and April plantings gave significantly lower yields than the plantings done in May and June. In 1962, however, only the March planting yielded significantly lower than the May and June plantings. It appears that the warmer weather during the plant development of the crop sown in May was more favourable for stover yields.

The hybrids gave consistent results in the two years. Hybrid A.E.S. 808, which is late maturing, gave significantly more stover yield than either of the two hybrids, Ind. 620 and S.D. 604. Of the latter two hybrids, the mid-maturity hybrid, Ind. 620, yielded higher than

S.D. 604 but the differences were not statistically significant.

Protein Percentage in Grain

The data presented in Table 4 show a consistent trend for protein percentage in the maize grain as effected by the planting dates during the two crop-years. A gradual reduction in the protein percentage occurred as the planting was delayed. A high percentage of protein in the grain was obtained from the March plantings relative to the June plantings. The crops planted in March and June 1961 gave an average of 10.95 and 10.08 percent protein, respectively. The corresponding figures in 1962 were 10.95 and 9.85 percent, respectively. The differences in the protein percentages were not significant in the 1961 crop-year (Table 13). In 1962, the crop planted in June gave significantly a lower percent protein in grain than at any other planting date.

Hybrid A.E.S. 808 gave the higher percentage of protein in both years when compared with that in the other hybrids, Ind. 620 and S.D. 604. The increase did not differ significantly in 1961. In 1962, however, A.E.S. 808 exceeded S.D. 604 in percent protein by a significant margin. The low grain yield and long maturity period appear to increase the percentage of protein in A.E.S. 808 in relation to S.D. 604 and Ind. 620.

Table 4. Effect of dates of planting on the protein percentage in maize grain during I96I and I962 at University Farm

Hybrids	Dates of planting								Means of hybrids	
	March		April		May		June			
	I96I	I962	I96I	I962	I96I	I962	I96I	I962	I96I	I962
S.D. 604	II.6	I0.6	I0.3	I0.2	I0.7	I0.5	9.6	9.6	I0.5	I0.2
Ind. 620	I0.4	I0.8	I0.3	I0.8	I0.2	I0.6	I0.6	9.6	I0.3	I0.5
A.E.S. 808	I0.9	II.4	I0.9	II.I	I0.9	I0.8	I0.2	I0.I	I0.7	I0.8
Means of dates	I0.9	I0.9	I0.5	I0.7	I0.6	I0.6	I0.I	9.8		

	I96I		I962	
	L.S.D.(5%)	L.S.D.(I%)	L.S.D.(5%)	L.S.D.(I%)
Dates	I.0	I.5	0.4	0.6
Hybrids	0.5	0.7	0.5	0.6

Means:

	I96I				I962			
Dates	March	April	May	June	March	April	May	June
	I0.9	I0.5	I0.6	I0.I	I0.9	I0.7	I0.6	* 9.8
Hybrids	A.E.S.808	S.D.604	Ind.620		A.E.S.808	Ind. 620	S.D. 604	
	I0.7	I0.5	I0.3		I0.8	I0.5	I0.2	

* Treatments underlined do not differ significantly at 5 percent level.

Table 5. Effect of dates of planting on the number of days from planting to tasseling in maize during I96I and I962 at the University Farm

Hybrids	Dates of planting								Means of hybrids	
	March		April		May		June			
	I96I	I962	I96I	I962	I96I	I962	I96I	I962	I96I	I962
S.D. 604	I08	I04	82	80	73	68	64	6I	82	78
Ind. 620	I08	I06	84	82	74	69	65	6I	83	79
A.E.S. 808	II2	I08	86	83	77	69	66	63	85	8I
Means of dates	I09	I06	84	82	75	69	65	62		

	I96I		I962	
	L.S.D.(5%)	L.S.D.(I%)	L.S.D.(5%)	L;S.D.(I%)
Dates	I.9	2.8	0.9	I.2
Hybrids	0.8	0.6	0.5	0.6

Means:

	March	April	May	June	March	April	May	June
Dates	I09	84	75	65	I06	82	69	62

	A.E.S.808	Ind.620	S.D.604	A.E.S.808	Ind.620	S.D.604
Hybrids	85	83	82	8I	79	78

* Treatments underlined do not differ significantly at 5 percent level.

Days from Planting to Tasseling

The number of days from planting to tasseling were found to be influenced greatly by the date of planting in maize (Tables 5 and 14).

Significant differences were found in the number of days required for maize to tassel as influenced by various planting dates in the two years of the study. A close similarity was found in the number of days from planting to tasseling for the different dates in the two years. The March plantings required the greatest number of days, with an average of 109 and 106 days for 1961 and 1962, respectively. A gradual reduction in the days to tasseling occurred with successively later dates of planting. Maize planted on the last date of planting in June tasseled on the average in 65 days and 62 days in the two years. It is of interest to note that a difference of three months in planting separated the tasseling dates by only 44 days. The difference was about twice as large between the first and second dates of planting as that for any other planting date.

The early date of planting thus apparently makes use of extended growing season by an increase in the number of days from planting to tasseling. These results are in agreement with the findings of Dungan (7) Grogan et al. (11) and Stringfield and Anderson (32).

The differences in the number of days to tasseling

Table 6. Effect of dates of planting on plant height, in cms., in maize during I96I and I962 at the University Farm

Hybrids	Dates of planting								Means of hybrids	
	March		April		May		June			
	I96I	I962	I96I	I962	I96I	I962	I96I	I962	I96I	I962
S.D. 604	228	235	258	245	255	243	256	240	249	24I
Ind. 620	223	234	249	247	259	252	263	235	250	242
A.E.S. 808	242	236	26I	255	27I	255	278	252	262	250
Means of dates	23I	235	256	249	262	250	266	242		

	I96I		I962	
	L.S.D.(5%)	L.S.D.(I%)	L.S.D.(5%)	L.S.D.(I%)
Dates	9.4	I3.6	I9.9	28.6
Hybrids	I0.4	I4.2	5.3	7.2

Means:

	June	May	April	March	May	April	June	March	
Dates	266	262	256	23I	250	249	242	235	*
	A.E.S.808		Ind.620	S.D.604	A.E.S.808		Ind.620	S.D.604	
Hybrids	262		250	249	250		242	24I	

* Treatments underlined do not differ significantly at 5 percent level.

were significant also for the hybrids. The later maturing hybrid A.E.S. 808 required significantly more days to tassel than Ind. 620 and S.D. 604. The early maturing hybrid S.D. 604 took significantly less days compared with Ind. 620 from planting to tasseling.

Plant Height

The lowest plant height was recorded for the March planting of maize during both of the years as shown in Table 6.

In 1961, the March planting resulted in an average plant height of 231 cms. which was significantly lower than all other dates of planting. The June planting had the highest plants and averaged 266 cms. The maize plants from the May and June plantings did not differ significantly in their height. There were no significant differences in the average plant height for the different planting dates in 1962 (Table 15). The average plant height ranged from 250 cms. for the May planting to 235 cms. for the March planting. Alberts(1) and others also obtained decrease in plant height by planting maize in the early cold season.

Plant height was found to be related to relative maturity of the hybrids used. The later maturing hybrid A.E.S. 808, had a significantly higher plant height than either Ind. 620 or S.D. 604, the earliest hybrid. Ind. 620, the medium maturing hybrid, tended to have taller

Table 7. Effect of dates of planting on ear height, in cms., in maize during I96I and I962 at the University Farm

Hybrids	Dates of planting								Mean of hybrids	
	March		April		May		June			
	I96I	I962	I96I	I962	I96I	I962	I96I	I962	I96I	I962
S.D. 604	96	92	I09	I0I	I09	II9	II5	99	I07	I03
Ind. 620	93	99	II5	I22	I20	I25	I22	98	II3	III
A.E.S. 808	I04	II2	I20	I28	I24	I40	I26	I2I	II8	I25
Means of dates	97	I0I	II5	II7	II8	I28	I2I	I06		

	I96I		I962	
	L.S.D.(5%)	L.S.D.(I%)	L.S.D.(5%)	L.S.D.(I%)
Dates	8.6	I2.3	9.I	I3.I
Hybrids	5.0	6.9	4.6	6.2
Dates x Hybrids			9.2	I2.5

Means:

Dates: June I2I, May II8, April II5, March 97 — May I28, April II5, June I06, March I0I *

Hybrids: A.E.S.808 II8, Ind.620 II3, S.D.604 I07 — A.E.S.808 I25, Ind. 620 III, S.D. 604 I03

Dates x Hybrids, I962:

May A.E.S. 808	April A.E.S. 808	May Ind. 620	April Ind. 620	June A.E.S. 808	May S.D. 604	March A.E.S. 808	April S.D. 604	June S.D. 604	March Ind. 620	June Ind 620	March S.D. 604
I40.5	I28.2	I25.5	I2I.8	I20.8	II9.2	II2.0	I0I	99.2	98.8	96.5	92.2

* Treatments underlined do not differ significantly at 5 percent level.

plants than S.D. 604 though the differences were not significant.

Ear Height

The data in Tables 7 and 16 show that the ear height followed the same general trend as found in plant height responses to various dates of planting. The taller plants produced the higher ears and the shorter plants had the ears lowest on the plant.

The maize planted in March 1961 had the ears at an average height of 97 cms., which is significantly shorter than that found at the other dates of planting. The highest average ear height of 121 cms. was noticed for the June planting, which did not differ significantly from the April and May plantings.

The maize planted in May had ears significantly higher (128 cms.) than all the other dates in 1962. The ear height was the lowest on the maize planted in March (101 cms.), though it did not differ significantly from the June planting.

The differences in the height of ears in hybrids were all significant. The taller hybrid A.E.S. 808 had ears higher than either Ind. 620 or S.D. 604. Hybrid Ind. 620 had ears significantly higher than S.D. 604.

The interaction dates x varieties gave significant differences for ear height only in 1962. Hybrid S.D. 604

Table 8. Effect of dates of planting on suckering percentage in maize during I96I and I962 at the University Farm

Hybrids	Dates of Planting								Means of hybrids	
	March		April		May		June			
	I96I	I962	I96I	I962	I96I	I962	I96I	I962	I96I	I962
S.D. 604	36.99	I5.70	28.47	I6.I7	I8.86	22.I2	I9.09	I8.03	25.85	I8.00
Ind. 620	24.20	I6.62	23.74	I8.5I	20.I4	23.48	23.20	25.I9	22.82	20.95
A.E.S. 808	39.66	23.09	40.06	24.28	34.25	I7.02	I6.29	I9.38	32.57	20.94
Means of dates	33.62	I8.47	30.76	I9.65	24.42	20.87	I9.53	20.86		

The figures given are the mean of $y=\sin^{-1}\sqrt{x}$ where x=ratio of suckers to total number of plants in 4 square meter plot. The original field data are given in table I9.

	I96I		I962	
	L.S.D.(5%)	L.S.D.(I%)	L.S.D.(5%)	L.S.D.(I%)
Dates	I2.8	I8.07	5.86	8.42
Hybrids	8.32	II.27	5.09	6.89

Means:

	March	April	May	June	May	June	April	March
Dates	33.62	30.76	24.42	I9.53	20.87	20.86	I9.65	I8.47*

	A.E.S.808	S.D.604	Ind. 620	Ind. 620	A.E.S.808	S.D.604
Hybrids	32.57	25.85	22.82	20.95	20.94	I8.00

* Treatments underlined do not exceed the L.S.D. at 5 percent level.

planted in March gave the lowest height of ears while the May planting of A.E.S. 808 resulted in the highest ear-height.

Suckering Percentage

Though the L.S.D. figures for the data (Table 8) reveal some significant differences in dates and varieties during 1961, the analysis of variance shown in Table 17 did not show any significant effect of dates of planting on the suckering percentages in maize. The analysis of variance is regarded as a more reliable test of the group differences. Quite opposite trends were obtained in the two years. The suckering percentage decreased with successive later dates of planting in 1961. The order changed in 1962 and the March planting gave the lowest suckering while the May planting resulted in the highest percentage of suckers.

Equally inconsistent results were obtained with the hybrids. Hybrid Ind. 620 exceeded both A.E.S. 808 and S.D. 604 on 5 percent L.S.D. basis in 1961. The accumulated differences in suckering percentages of the hybrids were, however, not significant in the two years.

Percentage of Barren Plants

There were no significant differences in the percentage of barren plants as a result of the dates of planting in the two years (Tables 9 and 18). In 1961 maize

Table 9. Effect of dates of planting on percentage of barren plants in maize during I96I and I962 at the University Farm

Hybrids	Dates of planting								Means of hybrids	
	March		April		May		June			
	I96I	I962	I96I	I962	I96I	I962	I96I	I962	I96I	I962
S.D. 604	28.72	I4.6I	22.57	I3.54	I7.80	I2.50	I6.93	I3.75	2I.50	I3.60
Ind. 620	I6.38	I0.26	23.74	I2.8I	I7.58	I5.32	23.20	20.67	20.22	I4.76
A.E.S. 808	30.75	I2.69	34.98	I5.48	32.48	I4.I7	I6.29	I5.55	28.63	I4.47
Means of dates	25.28	I5.52	27.I0	I3.94	22.60	I3.99	I8.8I	I6.66		

The figures given are the means of $y=\sin^{-1}\sqrt{x}$ where x=ratio of barren plants to total number of plants in 4 square meter plot. The original field data are given in Table 20.

	I96I		I962	
	L.S.D.(5%)	L.S.D.(I%)	L.S.D.(5%)	L.S.D.(I%)
Dates	II.38	I6.35	4.79	6.89
Hybrids	8.03	I0.88	4.I3	5.59

Means:

Dates	April	March	May	June	June	May	April	March	*
	27.I0	25.28	22.60	I8.8I	I6.66	I3.99	I3.94	I2.52	
Hybrids	A.E.S. 808	S.D. 604	Ind. 620		Ind. 620	A.E.S. 808	S.D. 604		
	28.63	2I.50	20.22		I4.76	I4.47	I3.60		

* Treatments underlined do not exceed the L.S.D. at 5 percent level.

planted in April had the highest percentage of barren plants followed by the March and May plantings. The lowest barrenness was obtained from the crop sown in June. The pattern of the barrenness percentage was quite different in 1962 and the June planting gave the highest percentage while the lowest percentage was recorded for the March planting.

The hybrids also gave quite inconsistent results. In individual comparisons hybrid Ind. 620 gave significant differences for the barrenness percentage when compared with the other two hybrids, A.E.S. 808 and S.D. 604, in 1961. The analysis of variance, however, did not give any significance for barrenness of hybrids in both the years.

Percentage of Plants with Multiple Ears

Though the raw data showed some-what more multiple ears for the later plantings than for the earlier plantings, the distribution of plants with multiple ears was not uniform in the population. More than half of the total plots did not have any multiple ears for any single treatment. The data, therefore, are not presented.

Uniformity of Ears

An examination of the data taken from the field plots showed that there was not much variation in the uniformity of ears on the plants for the various dates under study. The hybrids also had identical differences

in the uniformity of ears. No data, therefore, are reported.

Ear-filling

Grading of ears at each harvest showed that March and April plantings had better ear fillings as most of the ears were given the grade 'fair-good'. A poor filling of ears was observed in maize planted in June and most of the ears were graded as 'poor-fair'.

SUMMARY AND CONCLUSIONS

The study deals with the evaluation of the effect of four planting dates on the yields of grain, forage and stover, protein percentage of the grain, days to tasseling, plant and ear-heights, percentages of suckering, barrenness, multiple ears, uniformity of ears and ear filling of three maize hybrids. The dates of planting were about the middle of March, April, May and June during 1961 and 1962. Hybrids S.D. 604, Ind. 620 and A.E.S. 808 were used.

Maize planted in March gave the highest grain yields in the 1961 and 1962 crop-years. The grain yields decreased with delayed plantings. The June planting gave the lowest yield. There were no significant differences in the grain yield from March and April sowings. The hybrid S.D. 604 produced higher grain yields than Ind. 620 and A.E.S. 808.

Forage yields were the highest from the April plantings during both years. The lowest forage yields were obtained from the crop planted in March. The hybrids gave inconsistent results with no significant differences in their forage yields.

The best stover yields were obtained from the May and June plantings. Of the two, the May planted crop exceeded in the stover yields, but not by a significant margin. The March planted maize yielded significantly lower than the May and June sown crop. Hybrid A.E.S. 808 proved superior to either Ind. 620 or S.D. 604 in the yield of stover.

The protein percentage in the grain decreased gradually with a delay in sowing. The protein percentage was relatively high in the March planting and low in the June planting. The differences in the percentages were not significant in 1961, but in 1962, the June plantings were significantly lower than other plantings. The hybrid A.E.S. 808 had a higher percentage of protein than Ind. 620 and S.D. 604.

The time required for the plants to tassel was significantly influenced by all dates of planting. Maize planted in March required an average of 107.5 days to tassel, while that planted in June required only an average of 63.5 days. The hybrids also varied significantly in the number of days to tasseling with hybrid A.E.S. 808 requiring 83 days and S.D. 604 80 days.

The March plantings produced the smaller plants possessing the lowest ears. The ear heights were the highest in the May or the June plantings. Hybrid A.E.S. 808 was taller with higher ears than either Ind. 620 or

S.D. 604. Hybrid Ind. 620 tended to be higher in plant height and differed significantly in ear height than S.D. 604.

No significant differences were found in the percentages of suckering and barrenness of plants due to planting dates of hybrids.

The differences in the number of plants with multiple ears were not consistent in either year. The uniformity of ears also did not show much variation. The earlier plantings showed better filling of ears than the later sowings.

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APPENDIX

Table 10. - Analysis of variance for yield of grain, in maize

Source	D.F.	M.S. 1961	M.S. 1962
Replications	3	340,097.9^{++}	113,832.0
Planting dates	3	343,107.1^{++}	305,701.1^{++}
Error (a)	9	24,627.2	43,095.1
Hybrids	2	14,609.3	51,616.0^{+}
Dates x Hybrids	6	17,128.7	11,227.8
Error (b)	24	20,728.4	15,751.0

+ denotes F values significant at the 5 % level.

++ denote F values significant at the 1 % level.

Table 11. - Analysis of variance for yield of forage in maize

Source	D.F.	M.S. 1961	M.S. 1962
Replications	3	534,279.5^{++}	547,122.8^{++}
Planting dates	3	166,069.6^{+}	125,889.1
Error (a)	9	54,724.4	63,258.1
Hybrids	2	46,139.6	58,163.0
Dates x Hybrids	6	30,488.1	116,906.2
Error (b)	24	21,332.3	154,499.2

+ denotes F values significant at the 5 % level.

++ denote F values significant at the 1 % level.

Table 12. - Analysis of variance for yield of stover in maize

Source	D.F.	M.S. 1961	M.S. 1962
Replications	3	49,921.3	10,336.6
Planting dates	3	475,402.5^{++}	242,195.8^{+}
Error (a)	9	40,453.9	35,733.7
Hybrids	2	403,244.4^{++}	191,473.3^{++}
Dates x Hybrids	6	36,186.6	23,490.4
Error (b)	24	15,331.8	9,394.5

+ denotes F values significant at the 5 % level.

++ denote F values significant at the 1 % level.

Table 13. - Analysis of variance for protein percentage in grain of maize

Source	D.F.	M.S. 1961	M.S. 1962
Replications	3	5.994^{+}	2.147^{++}
Planting dates	3	1.517	2.719^{++}
Error (a)	9	1.262	0.205
Hybrids	2	0.650	1.509^{+}
Dates x Hybrids	6	0.913	0.081
Error (b)	24	0.554	0.406

+ denotes F values significant at the 5 % level.

++ denote F values significant at the 1 % level.

Table 14. - Analysis of variance for number of days planting to tasseling in maize

Source	D.F.	M.S. 1961	M.S. 1962
Replications	3	8.22	1.02
Planting dates	3	4,334.07++	4,581.24++
Error (a)	9	4.42	0.89
Hybrids	2	53.08++	30.43++
Dates x Hybrids	6	1.88	1.72
Error (b)	24	0.60	0.40

++ denote F values significant at the 1 % level.

Table 15. - Analysis of variance for plant height in maize

Source	D.F.	M.S. 1961	M.S. 1962
Replications	3	7757^{++}	626
Planting dates	3	3028	635
Error (a)	9	105	465
Hybrids	2	852^{+}	386^{+}
Dates x Hybrids	6	84	88
Error (b)	24	205	53

\+ denotes F values significant at the 5 % level.

++ denote F values significant at the 1 % level.

Table 16. - Analysis of variance for ear height in maize

Source	D.F.	M.S. 1961	M.S. 1962
Replications	3	195	625^{+}
Planting dates	3	1,317^{++}	1,816^{++}
Error (a)	9	86	98
Hybrids	2	518^{++}	2,080^{++}
Dates x Hybrids	6	36	160^{+}
Error (b)	24	50	40

+ denotes F values significant at the 5 % level.

++ denote F values significant at the 1 % level.

Table 17. - Analysis of variance for suckering percentage in maize[1]

Source	D.F.	M.S. 1961	M.S. 1962
Replications	3	205.48	38.53
Planting dates	3	481.37	15.88
Error (a)	9	185.66	40.34
Hybrids	2	398.17	46.07
Dates x Hybrids	6	165.67	64.26
Error (b)	24	130.37	19.27

1. The analysis was done for $\sin^{-1} \sqrt{x}$ values, where x = ratio of suckers to total number of plants in 4 square meter plot.

Table 18. - Analysis of variance for percentage of barren plants in maize[1]

Source	D.F.	M.S. 1961	M.S. 1962
Replications	3	181.90	97.08
Planting dates	3	155.59	35.83
Error (a)	9	152.01	26.89
Hybrids	2	328.21	5.88
Dates x Hybrids	6	150.62	26.83
Error (b)	24	121.60	32.05

1. The analysis was done for $\sin^{-1}\sqrt{x}$ values, where x = ratio of barren plants to total number of plants in 4 square meter plot.

Table I9. Field data suckering percentage in maize during I96I and I962

Hybrids	Dates of planting								Means of hybrids	
	March		April		May		June			
	I96I	I962	I96I	I962	I96I	I962	I96I	I962	I96I	I962
S.D. 604	37.7	7.7	22.9	8.2	II.4	I4.3	II.5	9.7	20.9	I0.0
Ind. 620	I6.9	8.5	I7.3	I0.5	I2.2	I6.2	20.3	I8.6	I6.7	I3.5
A.E.S. 808	4I.7	I6.9	4I.6	I7.2	34.I	8.9	7.9	II.3	3I.3	I3.6
Means of dates	32.I	II.0	27.3	I2.0	I9.2	I3.I	I3.2	I3.2		

Table 20. Field data barrenness percentage in maize during I96I and I962

Hybrids	Dates of planting								Means of hybrids	
	March		April		May		June			
	I96I	I962	I96I	I962	I96I	I962	I96I	I962	I96I	I962
S.D. 604	25.9	6.9	I6.I	5.8	I0.2	6.4	II.5	5.8	I5.9	6.2
Ind. 620	8.5	4.2	I7.3	6.5	9.6	7.2	20.3	I2.7	I3.9	7.7
A.E.S. 808	27.8	6.4	33.7	7.5	3I.5	6.3	7.9	7.8	25.2	7.0
Means of dates	20.7	5.8	22.4	6.6	I7.I	6.6	I3.2	8.8		