EFFECT OF DATE OF PLANTING ON YIELD, PROTEIN CONTENT AND OTHER CHARACTERISTICS OF MAIZE

by

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ABSTRACT

A study was conducted during the year 1963 at the Agricultural Research and Education Center, in the Beqa'a plain, Lebanon to evaluate the effect of four planting dates and three hybrids on the yield, protein content, and other characteristics of maize.

The yield of grain, forage and stover were not influenced greatly by the different dates of planting. However, a tendency towards increased yield of both forage and stover were obtained with the delay in planting. The crop planted on March 15 gave significantly higher percentage of protein than that obtained with later plantings. The hybrid A.E.S. 808 gave the highest percentage of protein and forage yield.

The number of days required from planting to tasseling were decreased gradually as the plantings were delayed. Plant and ear heights were not affected by the various planting dates. Hybrid A.E.S. 808 produced the tallest plants with higher ears. Ear filling was best in the first planting and poorest in the last planting.

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INTRODUCTION

Maize (Zea mays L.) has been cultivated in America for many centuries. High yield potential, ease of cultivation, adaptability to varied environmental conditions and innumerable food and industrial uses to which the crop can be put, caused its rapid spread in Europe, Africa and many Asian countries. Because of the above reasons, maize is rightly designated as the "King of Food Grain Crops" in the more important maize growing countries, and ranks as one of the leading cereal crops of the world.

Maize is believed to have originated in America. Its cultivation probably started in the region of central and southern Mexico about the begining of the Christian Era. Early writers disagreed as to the place of origin of maize, some maintaining that it came from eastern Asia, others that it came from Africa, while still others said it was of American origin (44). The present evidence favors the American origin.

Maize has low fiber content, is high in carbohydrates and oils and is the most palatable of the cereals. It is an important source of grain in livestock feeding and is also used as a source of roughage for dairy and beef cattle. Approximately 12 percent of the corn crop is used to provide food for human consumption and production of certain industrial products like alcohol, corn starch, corn sirup, corn sugar and corn flakes (11).

Climatic conditions and soil fertility are more important with maize than in the growing of any of the other important cereals. In addition to good soil fertility, maize also requires (a) a generous well dis-

tributed rainfall, (b) a frost free growing period of sufficient length to mature grain, and (c) an abundance of warm weather and sunshine. Laboratory experiments indicate that when plenty of moisture is available, a temperature of about 90°F is most favorable both for germination and plant growth. Growth stops altogether at temperatures of below 40°F or above 118°F (44). Frosts are hazards in maize production. Although the late spring frosts can be damaging, fall frosts generally cause the greatest losses.

Lebanon is a small country on the eastern coast of the Mediterranean. In general, the climate of this country is of mediterranean type. The great bulk of the rain falls during the winter months, while the summer period of May through October is practically rainless. Because of the long dry summer only winter crops and deep rooting trees and bushes, such as olives and vines, can be grown without supplementary irrigation. On the other hand, many vegetables and field crops are grown successfully under irrigation. The Beqa'a plain, the main grain producing area of Lebanon, grows winter cereals and pulses on dry land and potatoes and vegetables in the irrigated section. Maize also grows successfully under irrigation. The average acre yields, however, are low as compared to the yields obtained in the other important maize growing countries like United States, Italy, Hungary, France, and Argentina. High yields in most of these countries are due to the use of better cultural practices and the development of more adapted maize hybrids. On the other hand, the lower yields obtained in the Middle Eastern countries are due to use of unadapted hybrid and inefficient cultural practices. The purpose of this study, therefore, was to determine the effect of dates of planting on the

yield, protein content and other characteristics of three maize hybrids when grown under the irrigated condition in the Beqa'a plain.

REVIEW OF LITERATURE

A great change in the production of maize has occured since about 1940. This change has been brought about by the introduction and wide spread use of adapted hybrids, the greater use of balanced fertilizers, heavier planting rates and mechanization of crop on the family size farm. Acre yields have been increased sharply. This increase in yield has been possible because an increasing number of farmers have applied a combination of highly effective cultural practices on their maize land.

Climate, emergence and date of planting

Maize, because of its divergent types, is grown over a wide range of climatic conditions. Some strains grow very short and others very tall. Some require 1-1.5 months to mature and others require 10 to 12 months. Therefore, the dates of planting maize vary from locality to locality and even from season to season. According to McClelland (30) the dates of planting of maize 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 farmers and convictions of many as to what is the proper date of planting. He recommended the practice of dividing the planting, putting some maize early and some late which would ultimately give better assurance against failure of the crop from drought or damage by insects.

Maize trials were carried out by Bunting and Willey (8) during 1953-55 in several locations in Britain. A southern dent variety and a

northern flint variety of maize were sown at a range of dates from late March till early May. The first year flintxdent hybrids were also sown. They showed a marked difference between early and late sowing dates in the speed of emergence. There was an increase in the final emergence with the later sowing dates. The open pollinated varieties usually emerged more slowly than the hybrids. The experiments suggest that until varieties capable of growing at low temperature are available, little advantage in time of emergence will be gained by sowing maize before April in Britain.

Effect of date of planting on diseases and insects

When the length of the growing season is limiting the growth of maize, there is an obvious advantage to be gained from early plantings. However, a satisfactory stand from early plantings is often unsuccessful because the grain rots or the seedlings wilt and die from the attack of soil borne pathogens. Therefore, even in the absence of killing frosts, the effective growing season may be much shorter than the interval between the last and first frosts (17). Helm (19) reported that lower yields from early planting may result from a) poor stands due to rotting of the seeds, attacks from wireworms and cutworms, and b) an early rank growth of weeds. But he also mentions that late planted maize is affected more by the attack of earworms than maize planted earlier.

According to Ullstrup (43) "The period during which the seed germinates and the seedling becomes established is very critical in the life cycle of the maize plant. The prevalence of seedling blight varies considerably depending, in part, on the weather conditions following planting. Seedling diseases are more prevalent in cold wet soil than in warm soil. He further stated that delay in planting until the soil has become warm

and until the danger of extended periods of cold weather has passed minimizes the hazard of poor stands due to seedling blight." He showed that the favorable temperature for seedling blight is about 50°F because at this temperature germination is very slow and soil borne pathogens can grow and invade the seed and seedlings. Sabet (40) reported that disposition to seedling rot caused by Erwinia carotovora f. sp. zeae Sabet increases with the increasing soil temperature up to 35°C and 70 percent moisture and drops sharply at higher temperature and higher moisture levels.

Dickson (12) conducted dates of planting test at Madison, Wisconsin to find the influence of soil temperature and moisture on the development of seedling blight caused by Gibberella saubinetii. Plantings were made on April 20, 30 and May 20. Results obtained by this test indicate that the first planting was severely affected by blight and 70 percent of the plants were killed during the germination and before emergence. The last planting showed only a small degree of blighting in two or three susceptible strains.

The planting of maize early is recommended for northern Arkansas for the control of Southwestern maize borer, Diatrae grandiosella (Dyar). Whitcomb and Wall (45) conducted a dates of planting experiment near Mountain Home, Arkansas in 1959 to determine the effect of date of planting on infestation of Southwestern maize borer. The four planting dates were April 15, May 1, May 15 and June 1. They concluded that early planted maize was not attractive to the parents of the second and third generations Southwestern maize borers. Leveck (27) mentioned a date of planting study in Mississippi. He reported that maize planted earlier reduced the losses caused by the Southwestern maize borer.

Rolston (39) found that early planting reduced losses from "dead heart" as harvesting may be completed before girdling begins. From a date of planting test conducted at Fayettvile, he found that when maize was planted during the middle of April, May and June; 1, 8, and 40 percent respectively, of the plants were affected by "dead heart".

The stage of development of maize at the time European corn borer moths are flying ready to deposit their eggs has a marked influence on the degree of infestation of this pest. The date of planting determines largely what stage of growth maize will be in when the borer attacks. Brindley (6) suggested that growers avoid extremely early and extremely late plantings. He cited the research work at the United States European corn borer laboratory at Ankeny, Iowa, where the infestation of first-brood borers were small on late planted maize. The author was in favor of mid-season planting to escape severe borer infestations.

Chiang et al. (10) conducted studies in six states in the north central United States during 1955-59 to determine the factors influencing the European corn borer population. Their findings indicate that in Missouri and Nebraska the earlier planted maize had the highest first generation infestation, while the maize planted later in the season received higher second generation infestation. However, the earliest planted maize still was susceptible to a limited second generation infestation.

Marton and Dibble (29) reported that in Michigan, plantings made from May 12 and 25 gave the highest yields of mature maize regardless of the borer infestations. Plantings made on June greatly reduced the borer infestations. Early planted maize was attracted more by corn borer moths due to the taller and more vigorous plants.

In a date of sowing study on the development and yield of maize in Jullunder, India, Chela (9) showed that borer attack was the highest in the early sowing (5th July) and least in the last sowing (4th August). Grogan et al. (16) found that in Missouri early planted maize had less European corn borer damage and the number of borer larvae was increased as planting was delayed from April 1 to June 20.

Hayward et al. (18) in Missouri, found an increase in the number of European corn borer larvae as the dates of planting were delayed.

The effect of date of planting on the amount of earworm injury has been studied at several locations. In trials in Virginia, Phillips and Barber (36) concluded the following: "It was found that the average number of kernels destroyed was least in the earliest planted plats and maize fields and greatest in those planted on latest dates." Blanchard and Douglas (5) noted that the time at which field maize was planted affected the severity of earworm damage. In the north central and north eastern states, the earliest planted maize was injured less and the latest planted maize was damaged most severely.

An experiment on date of sowing was carried out by Johns and Brown (24) during 1933-37. This involved nine plantings made each year at about 15 day interval from February 25 to July 3. The plants infested with maize borer, maize earworm and maize rootworm were less in the early planted maize and increased with the delay in plantings. The rust disease (Puccinia sorghi) caused serious injury to the June 15 and July 3 plantings each year and during some years to the June 1 plantings.

Work by Langford et al. (26) indicates that the Japanese beetle may seriously damage field maize in Maryland, particularly if it silks

before August 10. They found the highest damage in the early plantings and considerably reduced beetle injury in late plantings.

Effect of date of planting on plant development and other characteristics

The most favorable time for planting maize varies with different locations, season and varieties. The time of planting is primarily important from the stand point of determining the time of tasseling. Yields are materially affected by soil moisture conditions at the time, and following tasseling (32).

Hayward et al. (18) in their date of planting studies found that as the dates were delayed, the number of days from planting to tasseling decreased, while lodging, number of dropped ears and ear height increased.

Alberts (1) reported the result of a study on the effect of time of planting maize to the time of silking, denting and senescence. He found out that varieties silked in the order of planting. The early varieties required shorter period of time to reach the silk stage than late varieties. Leaves on the plants from the earliest plantings were dried up first.

In a study at Columbia, Missouri, Grogan et al. (16) found that the number of days from planting to tasseling was greatly affected by dates of planting. The June 20 planting required three weeks less time than the April 20 planting to reach the silk stage. On an average, the early maturity hybrids tasseled earlier than the late maturity hybrids. Similar results were obtained at Sikeston, Missouri. There was a difference of more than a month in the number of days from planting to tasseling between plantings made on April 1 and June 20. Also, early planted maize generally had less lodging, fewer dropped ears and showed an increase in

numbers in lodging and dropped ears as the dates of planting were delayed. Shelling percentage was also decreased gradually with the delay in date of planting.

A three year study made by Rao and Ali (38) indicated that the shortest period to tasseling and to maturity were obtained when the crops were sown in April and the longest when planted in November.

Idris (22) in Sudan found that the number of days to tasseling and silking were not affected to a great extent by late planting but the number of days to maturation were shortened by more than two weeks. He obtained a reduction in the number of cobs per 100 plants and also in cob weight with delay in planting. Reduction in cob weight and number of cobs per plant due to late planting were more significant in the late maturing hybrid.

Dungan (13) reported that late planting affected the maize plant in a number of ways. It usually caused severe lodging and shortened vegetative period. An interesting observation was noted by him that three weeks difference in planting dates separated tasseling date only about a week.

Chela (9) at Jullunder, India noted the best developed grain in the second sowing, followed by a first and third, and was poorest in the last sowing. The percentage of barren plants showed an increase with the advance in sowing time.

Stringfield and Anderson (42) observed that a delay of two days in planting will normally delay silking and maturity about one day.

In an investigation during 1955-58 York and et al. (48) found an increase in lodging percentages with delayed planting. The increase obtained in plant lodging was significant in only one year out of four.

Grogan et al. (16) also found the same trend and showed higher lodging with delay in planting. In general, both root and stalk lodging were less for the early plantings than for the other dates.

Mufti (31) planted maize at four dates at the Agricultural Research and Education Center and found that the number of days from planting to tasseling decreased gradually with successive plantings from March to June. The plant and ear heights were the lowest for the March plantings. Suckering, barrenness and multiple ears were not influenced by the dates of planting. Ear filling was better in the earlier planting than in the later seeded maize.

Effect of date of planting on yield and quality

Studies on dates of planting have shown considerable effect on the yield of crops like maize. Chela (9), reported that Latta, Latta and Anderson, and Robertson obtained higher maize yields from early planting. Late sown maize fell of rapidly in bushel weight and grain yield. Williams and Welton (46) found that extremely early or extremely late sowings gave poor yields of maize as compared with normal sowing dates.

McClelland (30) conducted dates of planting experiments in Arkansas from 1917 through 1926 at Fayettevile and from 1922 through 1926 at Scott. Plantings were made on the 1st and 15th of each month from April through July. The results from the tests at Fayettevile for the ten year period indicated April 15 as the best average planting date in northwest Arkansas. The results from the test at Scott for five year period showed June 1 to 15 as the best sowing date for the majority of the varieties.

Dungan (13), working in the northern and central Illinois during 1927-31 found that when maize was planted in early May, late May and early June, the intermediate date proved best, from the stand point of

yield for the short season varieties in northern Illinois, but that early planting proved best for full season varieties in both northern and central Illinois. The quality of grain as measured by bushel weight and percent of moisture for shelled maize, was reduced by delayed planting in all cases.

Specht (41) found May 10 as the best sowing date for the maize growing areas of Frankfurt, Germany. His results showed that when maize was sown later than June 10, no ears were formed.

Chela (9) at Jullunder, India in 1950-51 used four sowing dates in trials spaced at ten day intervals from July fifth to the fourth of August. The results showed that crops sown on July 1 and 15 gave the highest grain yield per acre. Both the first and second sowing gave higher yields of grain per acre than the third and fourth sowings. The yield of stalk in the second sowing outyielded all other sowings and the last planting gave the lowest yield.

Wofford et al. (47), from the trials conducted at the Florida Agricultural Experiment Station, reported an increase in yields obtained from sowing maize between March 15 and April 15. They noted decrease in yield as sowing was delayed.

Stringfield and Anderson (42) reported an experiment conducted over 20-year period at the Ohio Agricultural Experiment Station, where the best yields were obtained by planting maize between May 7 and 12, which is early for that area. Delayed planting of one, two and three weeks gave yield reductions of 2, 7 and 14 bushels per acre, respectively.

Planting dates are very important for production of grain or production of silage in the short season areas. Owens (33) reported the effect of planting dates on the yields of dry matter in maize silage at the Aberdeen Branch Experiment Station, Idaho. Four dates of planting

May 9, May 19, May 26 and May 30 were selected. Two maize hybrids were used. The results of this study showed an decrease in the yield of dry matter as the planting dates were delayed. The earliest planting gave the highest yields of dry matter with both of the hybrids.

Papow (35) found that the average dry matter in maize sown in mid-June and harvested early September, was approximately 50 percent higher than from those sown in mid-July and harvested in late September.

An experiment was carried out by Azab (3), at the College of Agriculture, Giza, on the effect of planting date on the yield of different maize hybrid. The early planting, July 3, had a very pronounced effect on increasing the yield. The latest planting date resulted in a very poor yield. He observed that the expression of hybrid vigor in increasing the yield was more pronounced in the early planting and had no significant effect when the planting was delayed. He concluded that each of these hybrids has to be planted at a certain planting date to bring out its highest yielding capacity.

Experiments by Mangelsdorf (28) conducted at eleven localities in Texas, from 1918 to 1927 disclosed that early planted maize usually was more productive than medium planted maize and practically always outyielded late planted maize.

In a trial at Ilonga, Tanganyka (2) maize gave the highest yield when sown on December 28. When maize was sown later than December 28, grain yields were reduced up to 80 percent and total plant weight up to 50 percent.

Using maize hybrids of three maturity group, York et al. (48) observed the following: At the Main Experiment Station during the three period of 1955, 1956 and 1958, the April 15 and May 15 plantings gave

the highest yields. In 1957, a year of ample rainfall, June 15 plantings gave the highest yields. At the Cotton Branch Experiment Station, yields were higher from the April 15 and May 15 plantings except for 1956, when supplimental irrigations were applied to the experiment. The hybrids of long maturity group gave highest yields regardless of planting date.

Grogan et al. (16) conducted dates of planting studies at Columbia and Sikeston, Missouri, from 1955 through 1957. Hybrids representing four different maturities (90, 115, 125 and 140 days) were grown in the test at both locations. The investigators found that all the hybrids decreased in yield as the dates of planting were delayed. The highest yields were obtained from 125 day adapted hybrid at Columbia and from 140 day adapted hybrid at Sikeston.

Brown (7) working at the University of Connecticut found an increase in acre yields of dry matter from early planting. When planted at May 3, three weeks before usual planting date, several maize varieties produced about ten percent more dry matter per acre than from the May 27 planting. In 1924, the very cool spring retarded the early planted maize so that no advantage was derived from the practice that year.

An experiment was carried out by Green et al. (15) at Belle Grade, South Florida during 1934-39. Sixteen varieties of open pollinated maize were planted each month from November through May. Satisfactory yields were obtained only from the January and February plantings. In another study conducted during 1951-53, the January planting also gave the highest yields. Yields dropped rapidly in plots planted from February to April. For each day's delay in planting after February 15, there was loss in yield of about one bushel per acre.

Johns and Brown (24) in Louisiana, planted maize at about 15 days

interval from February 25 to July 3 during 1933-37. Their study indicated that the yield differences were probably not significant from February 25 to May 15, but plantings in June and July consistently produced lower yields.

Becker (4) reported an experiment on the influence of sowing date on the development and yield of maize. Two maize varieties were sown in 1952-53 on sandy soils; and 1953, on clay soil, at intervals of nine days from April 1 to mid-May. On sandy soil there was a marked fall in grain yields from crops sown after 28 April. In 1953, on a clay soil, the maximum yields were obtained from the April 19 sowing.

Hume et al. (21) in South Dakota, found that the highest average yields in the eastern area were obtained by growing a hybrid of medium maturity, planted at a rate sufficient to give 3,3 plants per hill, and planted about mid-May. In the central area, the best yields were obtained by the early hybrid planted at May 20 at a rate giving 2.5 plants per hill.

A two year study was conducted by Mufti (31) at the Agricultural Research and Education Center, located 80 kilometers northeast of Beirut, Lebanon. Four planting dates; March, April, May and June and three hybrids were used. From this test he concluded the following; "Early plantings made in March resulted in the highest grain yields and this decreased significantly as the planting was delayed until June. The forage yields were highest from April planting and lowest from March planting. The May planting gave the highest stover yields while the crop planted on March produced the lowest. The protein percentage was decreased with delay in planting. As for the hybrids, S.D. 604 gave the highest grain yields whereas A.E.S. 808 gave highest percentage of protein and stover yields."

Quayle (37) reported a test made at Wyoming. Planting Falconer

maize at two weeks interval from April 15 to June 15 he showed June 1 as the best date of planting for the production of grain. However, in the hot dry season of 1936, June 15 gave slightly higher yield than planting two weeks earlier.

Ishag (23) studied the relationship between varying sowing dates and varieties on yield of maize. Four open pollinated varieties were sown on five sowing dates; July 13, July 26, August 3, August 15 and September 5. Maximum grain yield was obtained from the September 5 sowing date for most of the varieties.

Idris (22) reported a planting date experiment on maize where two varieties and four dates of plantings spaced fortnightly from July 14 to August 31 were studied. His findings indicate that there was no difference in yield between the two varieties. On the other hand, the first planting was significantly inferior to that of second. Reduction in yield due to delay in planting from second to fourth date was gradual in case of the Iowa hybrid and marked in case of Mexican June.

MATERIALS AND METHODS

The experiment was carried out during the year 1963 at the Agricultural Research and Education Center located in the Beqa'a plain, 80 km. east of Beirut, Lebanon. The trial was conducted on a clay type soil, high in potassium content, low in organic matter and phosphorous with a pH of about 8.0. Three American maize hybrids: South Dakota (Early maturity), Indiana 620 (Medium maturity), and Agricultural Experiment Station 808 (Late maturity) were used in this trial. In the last two dates of planting hybrid A.E.S. 809 was used in place of A.E.S. 808 due to shortage of seed. The two A.E.S. hybrids, in general, do not differ in maturity yield and other characteristics. In the results, the figures given for A.E.S. 808 are the average of the two A.E.S. hybrids four planting dates: March 15, March 30, April 15 and April 30, were selected.

The experimental plots were fertilized with a uniform application of 12 kgs. of nitrogen in the form of ammonium sulfo-nitrate, and 20 kgs. of P_2O_5 in the form of superphosphate per dunum. The fertilizers were broadcasted and then worked into the soil by discing before planting time. The plots also received an additional two applications of nitrogen at the rate of four kgs. per dunum as a side dressing applied by a 'Planet Junior' which placed the fertilizers adjacent to each row. One application of the side dressing was made before tasseling and the other about one month later. The crop was irrigated weekly by a sprinkler system up to June 15 and thereafter water was applied through surface furrows adjacent to each row.

A split plot design, replicated four times, was used, with dates of planting being the main plots and varieties the sub-plots. The varieties were randomly assigned to the three sub-plots in each main plot. Each main plot or date of planting was surrounded with two border rows planted at the same rate and date as the main plot. Hybrid Ind. 620 was used for all border rows. Each sub-plot was made of two rows, five meters long and 75 cms. apart. Out of two rows in each sub-plot, one was harvested for forage and the other for stover and grain yield. Out of the total of five meters row only four meters were used for all data since one-half meter on each end was discarded to avoid the border effect. The planting was made by a hand planter using 50 percent excess seed which was treated with Arasan. When the seedlings were 6-8 inches tall they were thinned down to 21 plants per row thus giving a uniform stand of 4,000 plants per dunum.

Weeding was done regularly with a push hoe and other nursery equipments. In the early stages of growth, weeds were controlled at a regular interval due to the fast growth of weeds but at the later stages of growth the maize crop itself smothered most of the weeds. Insects were controlled when first observed. Endrine was sprayed at the two leaf stage of seedling against cutworm attack. The maize seedling from the first two dates of planting, March 15 and March 30 were dusted with DDT as cutworms began to damage some of the plants. Metasystox was sprayed in the later stages of growth against leaf hopper and aphid attacks. No disease symptoms were observed throughout the study with the exception of one or two plants which were attacked with the common corn smut (Ustilago zeae).

Data on the number of days from planting to tasseling, plant height, ear height, number of tillers, number of barren plants, number of plants with multiple ears, ear weight, ear filling, yield of forage, stover and grain were taken and recorded. The yields of grain were calculated on a 15.5 percent moisture basis, and that for forage and stover on an air dry basis.

Data on the date of tasseling were recorded when 50 to 75 percent of the plants tasseled. The plant height was measured in centimeters from the base of the plant at the ground level to the top of the tassel. The ear height was measured in centimeters from the base of the plant to the point of attachment of the ear. Harvesting for fodder was done in the late dough stage when the kernels had started to dent, and for stover when the plants were mature. The yield data obtained are reported in kilograms per dunum.

For protein determination of the grain, a representative sample from all treatments was taken and dried in an oven for 48 hours at a constant temperature of 70°C. The oven dry samples were cooled, ground in a Wiley mill using 20 mesh sieve and kept separately in bottles. Analysis for nitrogen were then made according to the modified Kjeldahl method (20). The nitrogen values obtained were multiplied by the factor 6.25 to find the protein percentage (14).

Analysis of variance and the "F" test were used to find the significance of results and their interactions. The final "t" test was made to calculate the difference between treatments and their combinations (25, 34).

RESULTS AND DISCUSSION

An experiment was conducted during the year 1963 at the Agricultural Research and Education Center, Beqa'a, Lebanon, to find the effect of four planting dates and three maize hybrids on yield, protein content and other characteristics of maize. The results are summarized and reported in Tables 1 to 7. The analysis of variance are given in the appendix (Tables 8 to 14). The L.S.D. figures at the five percent and one percent levels are given in the Tables (1 to 7) only for the dates and hybrids.

Yield of grain

The yield of grain in maize showed no significant difference due to dates of planting as shown in Table 1. These results are in agreement with the data of Mufti (31) obtained at the Agricultural Research and Education Center during the years 1961 and 1962. He found that maize planted during March and April produced about the same amount of grain, but the later plantings made on May and June resulted in significantly lower grain yields. The grain yields in the March 15 planting were influenced by the poor early growth of the plants due to low temperatures in the early season.

The three hybrids used, even though varying in maturity, performed about the same as to the amount of grain produced. Though the hybrids gave no significant differences in yields, Ind. 620, produced the highest average yield of 908.0 kgs. per dunum.

Table 1. Effect of planting date and hybrid on grain yield, in kgs. per dunum, in maize grown at the Agricultural Research and Education Center, Beqa'a, Lebanon, during 1963.

Hybrids	Date of planting				Means of hybrids
	March 15	March 30	April 15	April 30	
S.D. 604	862.3	910.6	970.1	851.4	898.6
Ind. 620	828.5	899.7	1003.9	899.9	908.0
A.E.S. 808	833.4	867.2	970.1	804.4	868.8
Means of dates	841.4	892.5	981.4	851.9	

Yield of forage

The yield of forage per dunum was not influenced by dates of planting as is apparent from the data in Table 2. However, with the delay in plantings, a tendency towards increased yield was observed. The highest average yield of 1709.0 kgs. per dunum was obtained from the April 30 planting and the lowest yield of 1392.5 kgs. per dunum was obtained for the March 15 planting. Similar results on the dates of planting were obtained by Mufti (31) at the Agricultural Research and Education Center during the year 1962.

The hybrids differ significantly in the yield of forage at the five percent level. A.E.S. 808 produced 1655.2 kgs. of forage per dunum and outyielded Ind. 620 and S.D. 604 significantly. There were no significant differences in the yield between Ind. 620 and S.D. 604 hybrids.

A significant interaction between planting dates and hybrids was found as shown in Table 9. Hybrid A.E.S. 808 planted on April 30 produced the highest yield of forage, whereas the same hybrid gave the lowest yield when planted on March 15.

Yield of stover

The yields of stover in maize were not influenced significantly by the four dates of planting as shown in Table 3. Maize planted on March 15 produced 520.8 kgs. of stover per dunum and the yields increased gradually as the plantings were delayed until April 30, but the differences are not statistically significant. Mufti (31) also observed small differences in the yield of stover between the March and the April plantings and reported a general increase in the yield as the plantings dates were delayed.

Table 2. Effect of planting date and hybrid on yield of forage, in kgs. per dunum, in maize grown at the Agricultural Research and Education Center, Beqa'a, Lebanon, during 1963.

Hybrids	Date of planting				Means of hybrids
	March 15	March 30	April 15	April 30	
S.D. 604	1464.9	1389.5	1430.3	1437.5	1430.5
Ind. 620	1374.8	1397.7	1536.0	1795.1	1525.9
A.E.S. 808	1337.8	1725.7	1662.9	1894.4	1655.2
Means of dates	1392.5	1504.3	1543.1	1709.0	

	L.S.D. (5%)	L.S.D. (1%)
Dates	524.5	753.5
Hybrids	125.9	170.6

Means

	March 15	March 30	April 15	April 30
Dates	1392.5	1504.3	1543.1	1709.0+
Hybrids	A.E.S. 808		Ind. 620	S.D. 604
	1655.2		1525.9	1430.5

+ Treatment means underlined by the same line do not differ significantly from each other at the 5% level.

Table 3. Effect of planting date and hybrid on the yield of stover, in kgs. per dunum in maize grown at the Agricultural Research and Education Center, Beqa'a, Lebanon, during 1963.

Hybrids	Date of planting				Means of hybrids
	March 15	March 30	April 15	April 30	
S.D. 604	450.0	488.1	610.4	629.7	544.5
Ind. 620	507.3	547.8	671.8	570.6	574.4
A.E.S. 808	605.0	783.8	800.4	773.0	740.6
Means of dates	520.8	606.6	694.2	657.8	

The hybrids did not vary significantly in their production of stover. This does not agree with the data obtained by Mufti (31). However, hybrid A.E.S. 808, tended to give the highest average yield of 741.7 kgs. per dunum which agrees with the result obtained by Mufti (31). On the basis of the three years results hybrid A.E.S. 808 appeared to be better suited to the environmental conditions of the Beqa'a plain than the other two hybrids (Ind. 620 and S.D. 604) for stover yields.

Protein percentage in the grain

The protein percentage in the maize grain was influenced greatly by the various dates of planting as shown in Table 4. The highest percentage of protein was obtained from the March 15 planting and decreased gradually as the plantings were delayed. The grain harvested from the March 15 plantings contained 11.03 percent protein and from the April 30 plantings 9.88 percent protein. Similar effects were observed by Mufti (31) who found the highest percentage of protein in the grain obtained from the early plantings.

The hybrids differed significantly in the protein percentage of the grain as can be seen in Table 4. Hybrid A.E.S. 808 produced significantly higher percentage of protein than S.D. 604 which in turn differed significantly from the hybrid Ind. 620. Similar results were obtained by Mufti (31).

There was significant interaction between planting dates and protein content in the hybrids as shown in Table 11. Hybrid A.E.S. 808 when planted on March 15 gave the highest percentage of protein (12.10 percent) whereas the hybrid Ind. 620 produced the lowest percentage of protein when planted on April 30.

Table 4. Effect of planting date and hybrid on the protein percentage in maize grain grown at the Agricultural Research and Education Center, Beqa'a Lebanon, during 1963.

Hybrids	Date of planting				Means of hybrids
	March 15	March 30	April 15	April 30	
S.D. 604	10.72	10.41	10.03	9.49	10.16
Ind. 620	10.27	9.32	10.08	9.10	9.69
A.E.S. 808	12.10	11.74	10.37	11.05	11.31
Means of dates	11.03	10.49	10.16	9.88	

	L.S.D. (5%)	L.S.D. (1%)
Dates	0.43	0.62
Hybrids	0.35	0.47

Means

	March 15	March 30	April 15	April 30
Dates	11.03	10.49	10.16	9.88 +

	A.E.S. 808	S.D. 604	Ind. 620
Hybrids	11.31	10.16	9.69

+ Treatment means underlined by the same line do not differ significantly from each other at 5 percent level.

Days from planting to tasseling

The number of days from planting to tasseling has been greatly affected by the dates of planting in maize as is apparent in Table 5. The number of days required from planting to tasseling, as influenced by dates of plantings, were highly significant. The crop planted on March 15 required the maximum number of days (115 days) to reach the tasseling stage. This decreased gradually as the plantings were delayed from March 15 to April 30. There was a difference of more than a month in the number of days from planting to tasseling between the March 15 and April 30 plantings. Similar results were obtained by Mufti (31), Dungan (13), Grogan et al. (16) and Stringfield and Anderson (42).

The hybrids differed significantly in the number of days from planting to tasseling. These differences among hybrids are due mainly to genetic make up of the individual hybrid. The later maturing hybrid, A.E.S. 808, required 97 days to tassel, while for Ind. 620, this period was 96 days and S.D. 604, 95 days from planting to tasseling.

Plant height

The plant height in maize was not affected greatly by the various dates of planting studied as noted in Table 6. However, the crop planted on March 15, produced the shortest plants and there was a gradual increase in plant height as the dates of plantings were delayed. Similar effects were observed by Mufti (31) during 1962 at the Agricultural Research and Education Center and by Alberts (1). The smaller plants obtained from the earliest planting can be attributed to the short days and low temperature during the early development of the crop.

The hybrids differed significantly in plant height as shown in

Table 5. Effect of planting date and hybrid on the number of days from planting to tasseling in maize grown at the Agricultural Research and Education Center, Beqa'a, Lebanon, during 1963.

Hybrids	Date of planting				Means of hybrids
	March 15	March 30	April 15	April 30	
S.D. 604	114	100	88	78	95
Ind. 620	115	101	89	79	96
A.E.S. 808	116	103	90	81	97
Means of dates	115	101	89	79	

	L.S.D. (5%)	L.S.D. (1%)
Dates	0.9	1.2
Hybrids	0.4	0.5

Means

	March 15	March 30	April 15	April 30
Dates	115	101	89	79
	A.E.S. 808		Ind. 620	S.D. 604
Hybrids	97		96	95

Table 6. Effect of planting date and hybrid on plant height, in cms., in maize grown at the Agricultural Research and Education Center, Beqa'a, Lebanon, during 1963.

Hybrids	Date of planting				Means of hybrids
	March 15	March 30	April 15	April 30	
S.D. 604	207.5	221.2	231.2	227.5	221.8
Ind. 620	208.7	225.0	230.0	235.0	224.7
A.E.S. 808	218.7	234.7	237.0	247.5	234.5
Means of dates	211.6	226.9	232.7	236.6	

	L.S.D. (5%)	L.S.D. (1%)
Dates	33.5	48.2
Hybrids	5.9	8.1

Means

	March 15	March 30	April 15	April 30
Dates	211.6	226.9	232.7	236.6 +
	A.E.S. 808	Ind. 620	S.D. 604	
Hybrids	234.5	224.7	221.8	

+ Treatment means underlined by the same line do not differ significantly from each other at the 5 percent level.

Table 6. The late maturing hybrid, A.E.S. 808, produced the taller plants, whereas the shortest plants were produced by S.D. 604, the early maturing hybrid.

Ear height

The data on the effect of dates of planting on ear height of maize are shown in Table 7. Maize planted on March 15 had the lowest ear height with an average of 90.6 cms. The highest ear height of 108.3 cms. were found on plants originating from the April 30 plantings. The increases obtained in the ear height from March 15 to April 30 plantings represent merely a trend as the differences are not statistically significant. However, Mufti (31) found that ear height increased with delayed planting dates.

The hybrids differ significantly from one another in the height of ears. The taller hybrid A.E.S. 808 produced significantly higher ears than the other two hybrids. The hybrid Ind. 620 had significantly higher ears than the shorter hybrid, S.D. 604.

Ear-filling

Ear filling was better in the first planting followed by third, second, and was poorest in the last planting. Mufti (31) also observed better ear filling in the early planting.

Tillers, barren plants and plants with multiple ears

Data regarding number of tillers, barren plants and plants with multiple ears were not presented here because very few plants exhibited these characters. Mufti (31) also found insignificant differences in the percentage of suckering and barrenness of plants. He further noted that

Table 7. Effect of planting date and hybrid on ear height, in cms., in maize grown at the Agricultural Research and Education Center, Beqa'a, Lebanon, during 1963.

Hybrids	Date of planting				Means of hybrids
	March 15	March 30	April 15	April 30	
S.D. 604	83.2	93.5	98.7	96.7	93.0
Ind. 620	88.7	97.5	105.5	108.7	100.1
A.E.S. 808	100.0	109.0	114.2	119.5	110.7
Means of dates	90.6	100.0	106.1	108.3	

	L.S.D. (5%)	L.S.D. (1%)
Dates	19.3	27.8
Hybrids	3.4	4.6

Means

	March 15	March 30	April 15	April 30
Dates	90.6	100.0	106.1	108.3 +
	A.E.S. 808	Ind. 620	S.D. 604	
Hybrids	110.7	100.1	93.0	

+ Treatment means underlined by the same line do not differ significantly from each other at the 5 percent level.

the differences in the number of plants with multiple ears was not consistent in both years of his experiment.

SUMMARY AND CONCLUSIONS

The experiment was conducted during the year 1963 at the Agricultural Research and Education Center, to determine the effect of four planting dates (March 15, 30, April 15 and 30) and three hybrids (Ind. 620, S.D. 604 and A.E.S. 808) on the yield, protein content and other characteristics of maize.

There were no significant differences in the yield of grain due to dates of planting and the different hybrids.

Yields of forage were not influenced significantly by dates of planting, although with delayed plantings a tendency towards increased yield was observed. On the other hand the hybrids differed significantly in the yield of forage, A.E.S. 808 producing the higher forage yield.

Neither the dates of planting nor the hybrids were found to have much effect on the yield of stover.

The March 15 planting gave the highest percentage of protein which decreased gradually as the plantings were delayed. The A.E.S. 808 had the highest protein content among the three hybrids.

The number of days required from planting to tasseling was found to be influenced greatly by the dates of planting. The crop planted on March 15 required the longest time to reach the tasseling stage and this decreased gradually as the plantings were delayed. The later maturing hybrid A.E.S. 808 required more days to tassel than Ind. 620 and S.D. 604.

The plant and ear heights were not affected greatly by the various dates of planting. However, there were slight increases in both plant and ear heights as the dates of planting were delayed. The hybrid A.E.S. 808

produced taller plants with higher ears.

Ear filling was better in the early planting and was poorest in the late planting.

On the basis of the results of this research the following conclusions were drawn:

1. Planting in the first half of April was better for grain yields while later planting was better for forage and stover yields.

2. To obtain maximum protein in the grain, the hybrids should be planted as early as possible.

3. Among hybrids, A.E.S. 808 and/or A.E.S. 809 appeared to be better suited to the environmental conditions of the Beqa'a plain than the other two hybrids.

LITERATURE CITED

1. Alberts, H.W. Relation of time of planting corn to the time of silking, denting and senescene. J. Amer. Soc. Agron. 18: 375-380. 1926.

2. Anonymous. The effect of sowing date on the yield of maize, soya and groundnut. Rep. Dept. of Agr. Tanganyika. 1959. Cited in Field Crop Absts. 13:266. 1960.

3. Azab, Y.E. Effect of planting date in the "Neely" period of maize hybrids and early American. Alexandria J. Agr. Res. 8:125. 1960.

4. Becker, W.R. The influence of sowing date on the development and yield of maize. (German) Landbouwk. Tijdshr., Wagenigen. 66:524-528. 1954. Cited in Field Crop Absts. 8:22. 1955.

5. Blanchard, R.A. and W.A. Douglas. The corn earworm as an enemy of field corn in the eastern states. U.S.D.A. Farmer's Bul. 1651. 1953.

6. Brindley, T.A. Stop corn borers. I. Stage of development. Crops and Soils. 12(8):8. 1960.

7. Brown, B.A. The effects of early planting on the composition and yield of corn. Conn. Agr. Expt. Sta. Bul. 151. 1928. Cited in Expt. Sta. Rec. 60:534. 1929.

8. Bunting, E.S. and L.A. Willey. The emergence of maize from field sowings in Great Britain. I. The effect of date of sowing on the extent and speed of emergence of different varieties. J. Agr. Sci. 48:447-456. 1957.

9. Chela, K.S. Effect of sowing time on the development and yield of maize (Zea mays) Crop. Indian J. Agr. Sci. 30:135-141. 1960.

10. Chiang, H.C.; J.L. Larvis.; C.C. Burkhardt.; M.L. Fairchild.; G.T. Weekman and C.A. Triplehorn. Populations of European corn borer, Ostrinia nubilalis Hbn. in field corn, Zea mays L. Univ. of Missouri, Agr. Expt. Res. Bul. 776. 1961.

11. Delorit, R.J. and H.L. Ahlgren. Crop production principles and practices. Prentice Hall, Inc. New York. 1953.

12. Dickson J.G. Influence of soil temperature and moisture on the development of seedling blight of wheat and corn caused by Gibberella saubinetii. J. Agr. Res. 23:837-870. 1923.

13. Dungan, G.H. Yield and bushel weight of corn grain as influenced by time of planting. J. Amer. Soc. Agron. 36:166-170. 1944.

14. Edward, S.W. and R.T. Wilbert. Textbook of biochemistry. The Macmillan Company. New York. 1955.

15. Green, V.E. Jr., W.T. Forsee, Jr., W.H. Thames, Jr., and F.T. Boyd. Field corn production in south Florida, Univ. of Florida, Agr. Expt. Sta. Bul. 582. 1957.

16. Crogan, C.O., M.S. Zuber., N. Brown., D.C. Peters and H.E. Brown. Date of planting studies with corn. Univ. of Missouri, Agr. Expt. Sta. Res. Bul. 706. 1959.

17. Harper, J.L. Problem involved in the extention of maize cultivation into northern temperate regions. World crops 7:93-96. 1955.

18. Hayward, S.; J.H. Dogwell, Jr.; M.D. Whitehead and Maston, A. Breeding corn hybrid for Missouri. A. Develop agronomically superior hybrids. B. Develop hybrid for special purposes. C. Conduct investigations in pathological, entomological and cultural problems. Annual Report of the Missouri, Agr. Expt. Sta. Bul. 679. 1956.

19. Helm, C.A. Corn in Missouri. II. Field methods that increase the corn crop. Univ. of Missouri, Agr. Expt. Sta. Res. Bul. 185. 1921.

20. Howitz, W. (Chairman). Official methods of analysis. Assoc. Agr. Chem. Inc., 1960.

21. Hume, A.N.; V.A. Dirks and D.B. Shank. Date and rate of corn planting. Agr. Expt. Sta., S. Dakota State College, Brookings, Bul. 455. 1956.

22. Idris, H. Maize planting date experiment. Agr. Res. Sta., Agronomy Section. Tozi, Sudan. Mimeographed Annual Report, 1959-60. 1960.

23. Ishag, H.M. Maize sowing date experiment. Agr. Res. Div. Gezira Res. Sta., Agronomy Section. Mimeographed Annual Report. 1959-60. 1960.

24. Johns, D.M. and H.B. Brown. Effect of date of planting on corn yields, insect infestation and fungus diseases. Louisiana Expt. Sta. Bul. 327. 1941. Cited in Expt. Sta. Rec. 85:45-46. 1941.

25. Kempthrone, O. The design and analysis of experiments. John Wiley and Sons Inc. New York. 1952.

26. Langford, S.G.; R.G. Rothgeb and N.E. Cory. Relation of planting dates on corn and Japanese beetle injury. J. Econ. Ent. 37:253-257. 1944.

27. Leveck, H.H. Corn investigations. Mississippi Agr. Expt. Sta. 75th Annual Report. 1962.

28. Mangelsdorf, P.C. Corn varieties in Texas: Their regional and seasonal adaptation. Texas Agr. Expt. Sta. Bul. 397. 1929. Cited in Expt. Sta. Rec. 61:633. 1929.

29. Marton, A.R. and C.B. Dibble. Investigations of corn borer control at Monroe, Michigan. Mich. Agr. Expt. Sta. Spec. Bul. 204. 1930. Cited in Expt. Sta. Rec. 64:363. 1931.

30. McClelland, C.K. Effect of different dates of planting corn on yield. Univ. of Arkansas, Agr. Expt. Sta. Bul. 222. 1927.

31. Mufti, S.I. Effect of dates of planting on yield and other characteristics of maize. Unpublished M.Sc. Thesis. Faculty of Agricultural Sciences. American University of Beirut. Beirut Lebanon. 1963.

32. Mutton, C.E., H.W. Lundy and W.K. Robertson. Managing west Florida soils for high corn yields. Univ. of Florida, Agr. Expt. Sta. Circ. S-76. 1954.

33. Owens, E.W. and R.D. Ensign. Field corn production in Idaho. Idaho Agr. Expt. Sta. Bul. 310. 1959.

34. Panse, V.G. and P.V. Sukhatme. Statistical methods for agricultural workers, Indian Council of Agricultural Research. New Delhi. 1957.

35. Papow, G. The cultivation of green maize. (German) Mitt. Schweiz, Landw. 10(3):42-47. 1962. Cited in Field Crop Absts. 16:92. 1963.

36. Phillips, W.J. and G.W. Barber. Earworm injury in relation to date of planting field corn in central Virginia. Agr. Expt. Sta. Tech. Bul. 55. 1934. Cited in Expt. Sta. Rec. 71:816. 1934.

37. Quayle, W.L. Corn planting dates. Univ. of Wyoming, Agr. Expt. Bul. 219. 1937.

38. Rao, S.V. and S.M. Ali. Observation on optimum period of sowing of maize crop in Andhra Pradesh. Ind. J. Agron. 6:30-36. Cited in Field Crop Absts. 15:277. 1962.

39. Rolston, L.H. The Southwestern corn borer in Arkansas. Univ. of Arkansas, Agr. Expt. Sta. Fayettevile. Bul. 553. 1955.

40. Sabet, K.A. On the effect of certain environmental conditions on infection with bacterial root and stalk-rot disease of maize. Ind. J. of Agr. Sci. 27:467-474. 1957.

41. Specht, G. Cultivation of green and silo-maize in the district of Cottbus, Frankfurt (Oder), Potsdam, based on recent trials. (German) Dtsch. Landw. 8:168-171. Cited in Field Crop Absts. 10:230. 1957.

42. Stringfield, G.H. and M.S. Anderson. Corn production. U.S.D.A. Farmer's Bul. 2073. 1960.

43. Ullstrup, A.J. Corn diseases in the United States and their control. Agriculture Handbook. 199. Washington, D.C. 1961.

44. Wallace, H.A. and E.N. Bressman. Corn and corn growing. John Wiley and Sons. Inc. New York. 1937.

45. Whitcomb, W.H. and H.C. Wall. Southwestern corn borer infestations as influenced by dates of planting. Ark. Farm Res. 8(6):3. 1959.

46. Williams, C.G. and F.A. Welton. Corn experiments. Ohio Agr. Expt. Sta. Bul. 282. 1915. Cited in Expt. Sta. Rec. 33:35. 1915

47. Wofford, I.M. Plant populations, date of planting and nitrogen levels for field corn. Proc. Soil and Crop Sci. Soc. Fla. 16:352-359. 1956. Cited in Field Crop Absts. 12:21. 1959.

48. York, J.O.; R.L. Shepherd and C.J. Neetles. Effect of different planting dates on the performances of corn hybrids of three maturity groups. Agr. Expt. Sta. Univ. of Arkansas, Fayetteville, Rep. Series 102. 1962.

APPENDIX

Table 8. Analysis of variance for grain yield of maize.

Source	D.F.	M.S.	F
Replications	3	42982.4	1.19
Planting dates	3	48647.3	1.35
Error (a)	9	35921.9	
Hybrids	2	6721.4	0.68
Dates x Hybrids	6	2432.6	0.24
Error (b)	24	9752.6	

Table 9. Analysis of variance for yield of forage in maize.

Source	D.F.	M.S.	F
Replications	3	247158.4	1.19
Planting dates	3	206253.6	0.63
Error (a)	9	324432.4	
Hybrids	2	203466.3	6.80++
Dates X Hybrids	6	82017.6	2.74+
Error (b)	24	29897.3	

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

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

Table 10. Analysis of variance for yield of stover in maize.

Source	D.F.	M.S.	F
Replications	3	49690.6	0.97
Planting dates	3	67668.6	1.33
Error (a)	9	50808.0	
Hybrids	2	180610.9	1.07
Dates x Hybrids	6	8631.0	0.05
Error (b)	24	168330.6	

Table 11. Analysis of variance for protein percentage in grain of maize.

Source	D.F.	M.S.	F
Replications	3	0.88	4.00^{+}
Planting dates	3	2.94	13.36^{++}
Error (a)	9	0.22	
Hybrids	2	11.10	48.26^{++}
Dates x Hybrids	6	0.92	4.00
Error (b)	24	0.23	

+ denotes F values significant at the 5% level.

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

Table 12. Analysis of variance for number of days from planting to tasseling in maize.

Source	D.F.	M.S.	F
Replications	3	4.13	4.63^{+}
Planting dates	3	2851.57	3200.42^{++}
Error (a)	9	0.89	
Hybrids	2	28.31	117.00^{++}
Dates x Hybrids	6	0.04	0.14
Error (b)	24	0.24	

+ denotes F values significant at the 5% level.

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

Table 13. Analysis of variance for plant height in maize.

Source	D.F.	M.S.	F
Replications	3	2843.5	2.15
Planting dates	3	1446.8	1.09
Error (a)	9	1320.2	
Hybrids	2	673.3	10.12++
Dates x Hybrids	6	35.8	0.53
Error (b)	24	66.4	

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

Table 14. Analysis of variance for ear height in maize.

Source	D.F.	M.S.	F
Replications	3	1221.4	2.76
Planting dates	3	715.6	1.61
Error (a)	9	441.8	
Hybrids	2	1149.1	50.53++
Dates x Hybrids	6	25.4	1.11
Error (b)	24	22.7	

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