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THE EFFECT OF DATE OF PLANTING AND VARIETY ON SUGAR BEET SEED PRODUCTION IN THE BEQA'A, LEBANON

by

Syed Abdul Moquit

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Seed Production in Sugar Beets

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ABSTRACT

A two year study was carried out at the Agricultural Research and Education Center, Beqa'a, Lebanon, to evaluate the possibility of growing sugar beet seeds by the winter-annual method. Three varieties Pedigree E, Pedigree SSA and Polyrave were planted on three different dates, September 1, 15 and 30 in 1963 and 1964. Data were recorded on seed yield, seed quality and other agronomic characteristics.

Among the three varieties studied Pedigree E produced the best quality and the highest amount of seed. The size, viability and seedlings per 100 seed balls were found to be distinctly superior for Pedigree E.

Sugar beets planted in early September produced 45.5 per cent more seed than those sown at the end of the month. Bolting, earliness in maturity and root yields were found to be superior with the early plantings. The data for plant heights and number of seedlings per 100 seed balls of the beets planted on different dates varied considerably during the two years. Seed size and viability were affected very little by the three different plantings made in September.

Sucrose content of the roots was not affected by the three varieties or the three dates of plantings.

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INTRODUCTION

Sugar beets supply more than one-third of the world's sugar (1). Most of the European countries and the Middle Eastern countries depend for their sugar supply on sugar beets grown at home and on imported sugar. Successful production of sugar beets is usually limited to the farms that are located within 75 to 100 kilometers of a sugar beet factory. Lebanon established a sugar beet factory in the Beqa'a in 1958. Before 1958 the sugar beets grown in Lebanon were sent to a factory in Homs, Syria. Due to the heavy cost of transportation, sugar beet production was limited. After the establishing of the factory in Lebanon the production increased from 3,000 tons on 1,300 dunums of land in 1958 to 72,682 tons grown on 17,600 dunums in 1964[x].

The countries in the Middle East obtain their sugar beet seed from Europe. Lebanon imports sugar beet seed costing approximately 60,000 L.L. annually. Sugar beet seed requirements in Iraq and Syria are much higher than those of Lebanon.

Sugar beet seed is produced by two methods, namely 1) the biennial method and 2) the winter-annual method. The production of sugar beet seed by the biennial method is costly, laborious and requires two years. The winter-

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[x] Production figures obtained from Lebanese Sugar Factory. Dunum = 1,000 square meter.

annual method, which was evolved by the joint efforts of the United States Department of Agriculture and the New Mexico Agricultural Experimental Station, requires less money, less labour and the seed can be produced in one year. The principle behind the winter-annual method is that plants subjected to photothermal induction of $45^{0}F$ to $55^{0}F$ for 90 to 110 days, produce enough hormones in the roots which initiate bolting (38). The climatic condition of the central Beqa'a plain (Table 1, pp. 16), where most of the sugar beets are grown, seems to be suitable for the production of sugar beet seed by the winter-annual method.

The purpose of this study, therefore, was to evaluate the possible degree of success in sugar beet seed production in the Beqa'a, Lebanon, by the winter-annual method. Different varieties and different dates of planting may influence seed production. Therefore, three varieties (Polyrave, Pedigree E and Pedigree SSA) were taken. These were planted on three different dates; September 1, September 15 and September 30 in 1964 and 1965. Seed yield, seed size, germination percentage, seed shattering habit, root yield, sucrose percentage and other characters were studied.

If sugar beet seeds can be produced successfully in the Beqa'a by the winter-annual method, this would eliminate the regular importation of seed and help to stabilize the sugar beet industry. Also, farmers in Lebanon could earn an appreciable amount of money by exporting sugar beet seeds to the neighbouring countries.

REVIEW OF LITERATURE

The conventional method for producing sugar beet seed used extensively in Europe is by the biennial method which requires two years. In this method seeds are planted to grow the vegetative plants during the first season, stored over winter in pits or field trenches. The plants are reset in the field the following spring for seed production. This involves much time, labour and was found not to be feasible in many countries that desired to produce their own seed (10, 31, 38). In an observation to find out the best time of planting in New Mexico in 1923, according to Brewbaker (7), Overpeck and Elcock found that early fall planted sugar beets would live over the winter and produce seed stalks upon resumption of growth in the spring. This led to vigorous research on sugar beet seed production by the winter-annual method.

Temperature and light

The principle behind the winter-annual method of beet seed production is the response of plants to photo-thermal induction. In vegetative plants, the reproductive phase of growth, the seed stalks and flowering branches, can be induced by cool temperature which is known as thermal induction. Length of day or photoperiod also influences the reproductive phase of growth. The effect of light and temperature on reproductive development is jointly known as photothermal induction (38). Owen, Garsner and Stout (23) and Stout (39) stated that development of the seed stalk and flowering is brought out by the cumulative effect of long photoperiods following cool temperature. Photothermal induction produces one or more flower inducing substances or hormones. Owen, Garsner and Stout (23) stated that in some cases prolonged thermal induction influences reproductive tendency so strongly that the tendency for seed stalk initiation continues for some time even in distinctly unfavourable environmental conditions for seed production.

The relative importance of thermal and photoperiodic induction varies with different types of beets according to their genetic make up (23, 7). Ulrich (41) also stated that there are interactions of climate and variety on root growth and sugar production.

For the production of the sugar beet seed by the winter-annual method, the winter should be mild enough so that the seedlings survive and at the same time the cool period must be long enough so that the thermal induction is adequate which is essential for the reproductive phase of growth in the following spring. The most effective thermal temperature is in the range of 45^{o}F to 55^{o}F which must prevail for a period of 90 to 110 days.

depending on the genetic make up of the beets. The vegetative phase of growth is favoured when the temperature goes above 70^{o}F. Temperatures close to freezing are not favourable for thermal induction as the metabolic activity stops (38). Stout (39) found that there was no or very little induction at -1^{o}C to -0.5^{o}C. There was very little seed stalk development even when the plants were subjected to a 17 to 18 hour photoperiod for 50 days. The most effective thermal inductive temperature was only slightly over 6^{o}C. Hawthorn and Pollard (16) found in an experiment with the sugar beet variety Crosby Egyptian that there was 100 per cent bolting when the plants were grown at 50^{o}F to 60^{o}F but only a few plants bolted at 60^{o}F to 70^{o}F. No bolting was in evidence when the plants were grown at temperatures above 70^{o}F. Stout (39) also revealed the same result with another variety.

Adequate thermal induction is reduced or neutralized if the plants are subjected to warm temperatures following cool temperatures, and this is referred to as reversal of thermal induction. The rate of reversal was approximately twice as fast at 19.3^{o}C as at 13.2^{o}C and at about 25^{o}C it was the maximum (39). It may be considered that this induction process exists in a state of complete reversibility until the development of sufficient seed stalks which will partially prevent the reversal of reproductive development. Even warm mid-day temperatures during the favourable cooler period, may so counteract the effect of cool temperature that little thermal induction will result. The most favourable temperature for induction was found to be where the cool temperature prevailed continuously over a long period, and the transition from warm to low temperature in the fall and from low to warm temperature in the spring was gradual and long (39). Owen, Garsner and Stout (23) also stated that photothermal induction is frequently reversed either by decreasing the length of the photoperiod or by increasing the temperature. This reversal may cause the plants to turn to vegetative growth even after the plants have started the reproductive phase of growth.

Steinberg and Garner (37) stated that change in temperature may modify to some extent the effect of length of day and vice versa, although the mode of action is not the same. He found that flowering in sugar beets occurred in 65 days with an 18 hour day when kept at a continuous 60°F temperature. However, with increase of temperature the effectiveness of an 18 hour day progressively decreased. Several varieties of sugar beets flowered freely without material thickening of the roots when exposed to 16 to 17 hour days at a mean temperature of 55°F. Owen, Garsner and Stout (23) stated that sugar beets can be kept vegetative throughout the year in an eight hour day, even if they are subjected to temperatures of 33°F to 36°F.

Gaskill (14) stated that two successive generations of sugar beet seed can be grown in 12 months with 100 per cent flowering, when illuminated continuously and maintained at a temperature of 46°F to 49°F. Steinberg and Garner (37) said that with supplementing light at night and avoiding high mid-summer temperatures, as much as five generations of mature beet seed can be obtained in one year. Seeds mature at 52 to 66 days after planting.

Poehlman (31) stated that cool temperatures of 35°F and 45°F for a period of two to three months are desirable to keep the beets in a semi-vegetative condition which will insure complete reproduction. However, during this period it was necessary to have temperatures below 32°F for a few days. Pendleton (28) found that sugar beets that were badly frozen, recovered and produced normal seed stalks and the seed yields were higher than the average. He suggested that this may be due in part to the fact that the beets were in a semi-vegetative condition. Under conditions of incomplete thermal induction, new root tissues may continue to develop along with the seed stalk formation. Under the condition of complete thermal induction no further root growth took place after spring growth had resumed. Fife and Price (13) and Pendleton (26) also reported the same results.

Date of planting

The seed yield of sugar beets can be increased considerably by planting at the proper date and by following modified cultural practices. Several research workers reported that early plantings usually produce the largest yields. Mast (21) stated that the advantages of early planting are many. These include a) an extension of photoperiod, b) an early rapid development of foliage prior to the winter months which gives a good foliage cover, and hinders weed growth, and c) increased root development.

Pendleton (27) and Pack (24) stated that there was a high positive correlation between root weight and seed yield. Farrar (12) stated that early planting not only gave higher seed yields but the quality of the seed was improved. Under the Hamet (California) conditions the period for planting sugar beet seed was from August 15 to September 15. Planting before August 15 did not increase seed yield but it required additional irrigation, cultivation and care. In a four year experiment he found that on an average, August 15 plantings yielded 1,135 pounds more seed per acre than September 15 plantings. Samman (34) found that under the Beqa'a (Lebanon) conditions the September 1 planting produced higher sugar beet seed yields than did those planted later. Mast (21) stated that the effect of too high winter temperatures, which hinders thermal induction, could be minimized by early planting accompanied with high fertility which will result in early growth to provide shading in early fall. Owen, Garsner and Stout (23) found that by providing artificial shade, thus reducing the temperature from 49.16^{o}F to 43.30^{o}F, bolting increased from 88 to 100 per cent.

Irrigation and beet seed production

Sugar beet plants are especially sensitive to unfavourable moisture conditions for three to four weeks after emerging of seedlings. Frequent irrigations at an interval of 8 to 20 days are better than less frequent and heavy water applications (15, 21). From the report of Brewbaker (7) it was disclosed that Overpeck and Elcock found that unless the irrigation is done timely, the viability of the seed is affected. They found a positive and direct correlation between irrigation at one, two and three week intervals and the percentage of seed germination. Hawthorn and Pollard (16) stated that high moisture during the seed setting period may delay the maturity and lower the germination percentage of the seed.

Soil fertility

Loam soils have been reported to be the most suitable for seed production. Mast (21) stated that sugar beets for seed production should follow a truck crop, both from the stand point of freedom from weeds and improved residual fertility.

The importance of judicial application of fertilizer for sugar beet seed production has been recognized by many workers. Proper fertility of the soil not only increases seed yield but the quality of the seed also is improved. Pendleton (29) found that the seed yield was increased by 500 pounds per acre by applying an additional 300 pounds of nitrogen per acre, and the seed germination increased by eight per cent. In another experiment Pendleton (30) found that fertilization conducive to the highest yield of seed did not produce seed with the highest viability. Snyder (35) found that there was not much difference in seed yield by applying an excess of nitrogen. In order to get higher seed yield nitrogen fertilizer should be supplied in balance with other nutrients. Pultz (33) stated that the effect of nitrogenous fertilizers is more pronounced for seed production with early planting. He also stated that the supply of nitrogen should be adequate during the entire flowering period when the sucrose percentage in the roots decreases, otherwise the formation of flowers stops prematurely and a correspondingly lower seed yield results. He found a highly negative correlation between sucrose percentage found in the roots at the time of seed harvest and the seed yield. Nitrogenous fertilizers had very little effect on the size of the roots developed during the fall and winter. Steward (38) and Poehlman (31) stated that bolters reduce the yield and quality of the roots.

Beet seed quality

Under field conditions the quantity and quality of seed produced varies greatly. It was found (36) that plants which received a temperature of 75°F, starting from time of anthesis until maturation of seed, produced almost half the amount of seed as those receiving 65°F. Seeds that matured at the higher temperature germinated more rapidly than seeds that matured at the lower temperature (36).

Size of seed is an important character in seed production. In both green house and field experiments (32) it was reported that larger seed balls germinate faster and give more vigorous seedlings and produce higher yields than smaller seed balls. Bush and Brewbaker (8) and Lill (19) stated that larger seed balls have no significant effect on the yields of roots or sugar. The greatest advantage of larger seeds was their characteristic of faster germination, because seed bed conditions favourable at the time of planting may soon become unfavourable.

<u>Winter injury and stand</u>

Sugar beet plants are quite winter hardy and the tops of the beet plants have great ability to recover following a frost. Reports show that even up to 75 per cent defoliation of the leaves had little effect in reducing the beet-top yields or sucrose percentage (4, 5). On the other hand, Coons (9) and Martin and Leonard (20) stated that after the fall frost the killed foliage was replaced by a new growth at the expense of the food reserves in the roots and consequently sucrose percentage decreases. Sugar beet seedlings once established are hardy enough, but emergence of seedlings sometimes becomes a problem. McBirney (21) stated that apart from seed bed preparation, planting, seed quality, seed bed moisture, etc. there are still unknown reasons which cause poor stands or lack of uniformity of emergence. Pendleton (25) found that beets sometimes fail in the seedling stage due to shortage of sulfur.

<u>Time of harvesting seed</u>

The optimum time of harvesting is very important especially with the sugar beet seed crop. Beet seeds mature unevenly on each plant. The seed balls at the base of the stalk mature first, while those of the tip mature last. This uneven maturity results in a seed shattering problem. Delayed harvesting may result in excessive shattering, while too early harvesting results in more immature and poorer quality seeds. Usually the best time for harvesting is when the seeds of the middle portion of the branches are in the hard dough stage. In view to obtain high quality seed the immature seeds on tips of the branches are disregarded (16).

Viability test

Viability of the produced seed is very important in evaluating seed quality. Several workers (6, 11, 17, 40) reported that the best method of finding out the germination capacity of sugar beet seed in the laboratory is to soak the seed at first in running water for two to three hours; then the seeds should be placed in the germinator maintaining an alternate temperatures of 20°C and 30°C.

MATERIALS AND METHODS

The experiment on sugar beet seed production by the winter-annual method was carried out for two years, 1963-64 and 1964-65, at the Agricultural Research and Education Center of the American University of Beirut, located in the central part of the Beqa'a, Lebanon.

The soil is low in nitrogen, phosphorus and organic matter; high in clay and potassium content and is calcareous with a pH of about eight. Average temperature, rainfall, relative humidity and sunshine hours in the central Beqa'a, Hoch Sneid, Lebanon, are shown in Table 1. The six months from November through April were cooler and possessed higher humidity than did the summer months of May through September. The average monthly temperatures varied slightly during the two-year period of the study, with 1964-65 having the higher temperatures. The length of the daylight in the Beqa'a is sufficient for favourable seed production.

A good seed bed was prepared and the experimental plots received a uniform application of 20 kilograms of P_2O_5 as superphosphate and 12 kilograms of nitrogen as ammonium sulfonitrate per dunum. The fertilizers were broadcast and disked into the soil before planting. In January an application of eight kilograms of nitrogen

Table 1. Average temperature, sunshine hours, rainfall and relative humidity at the Agricultural Research and Education Center of the American University of Beirut in the Beqa'a, Lebanon[x].

	Temperature (^{o}C)		Sunshine hours		Rainfall (mm)		Rel. Humidity	
	1963-64	1964-65	1963-64	1964-65	1963-64	1964-65	1963-64	1964-65
September	21.0	20.2	10:27	10:30	00.0	0.00	58.4	58.8
October	16.5	17.7	7:03	10:15	49.6	0.00	61.4	41.9
November	11.2	12.3	8:02	6:03	16.4	167.2	68.9	54.3
December	5.3	6.8	6:33	6:31	70.6	22.1	69.3	54.3
January	1.0	4.1	5:02	4:13	60.6	114.6	73.7	59.6
February	3.6	5.5	5:36	6:45	183.8	102.2	75.6	59.1
March	9.0	8.1	6:30	7:16	52.8	46.3	71.2	60.5
April	9.6	9.2	8:05	7:31	13.9	48.7	66.6	61.3
May	12.7	14.0	11:27	11:26	23.7	3.0	61.7	53.5
June	20.4	20.7	12:16	12:15	00.0	3.0	61.5	48.2
July	23.1		12:17		00.0		55.3	
August	23.2		11:54		00.0		54.3	
Total					471.4			

x Information obtained from the AUB Agricultural Research and Education Center Meteorological Data, Hoch Sneid, Lebanon, recorded by H.G. Nasr and F.M. Malouf.

per dunum was side dressed for the 1963-64 crop and four kilograms per dunum for the 1964-65 crop.

The experiment was laid out on a split-plot design involving three dates as the major plots and three varieties as sub-plots. The three varieties used were Pedigree E, Pedigree SSA and Polyrave. Each year the sugar beet seeds were planted on September 1, September 15 and September 30. There were four replications. (Through an error in the year 1964-65 the September 1 date of planting was not randomized). The sub-plots consisted of four rows each five meters long and 0.75 meters apart.

The seeds were planted solid by the Planet Junior garden drill at the rate of 1.87 kilograms per dunum in 1963-64 and 1.50 kilograms per dunum in 1964-65. Thinning was done when the plants were four to six inches tall to a stand of 20 to 25 centimeters between the plants within the rows.

Weekly sprinkler irrigation was given during the fall. Then weekly furrow irrigation was given starting from the middle of May until a week before harvesting of the seed crop. Weeds were controlled by hand and by hoeing during the entire growing season. In 1964-65 cut-worms did considerable damage to the stand of seedlings. Transplanting was done to fill up the gaps caused by the cutworms and the weeds.

Karathane was sprayed five times during the growing season in 1963-64 to keep the plants free from powdery mildew, Erysiphe betae. In 1964-65 powdery mildew was observed in the field during the later part of June when the seeds were already formed. No curative measures were taken as recommended by plant pathologist.

In 1964, for seed yields, the plants were harvested on July 24 when most of the seed pods were brown. In the second year the plants were harvested on July 15 and 21 to reduce the shattering. Excessive care was taken at the time of harvesting to avoid shattering. Four meters from the two center rows were harvested, leaving two side rows and 50 centimeters on either end of the two central rows to eliminate the border effect. Harvesting was done by sickle, the stems bearing the seeds were put into sacks which were hung in the open air and sun to permit drying. Shattered seeds were collected from the ground from in between the rows, cleaned and calculated as kilograms per dunum. After about two weeks, the seeds were threshed by a nursery grain thresher. Chaff and other impurities were removed as far as possible by seiving. The seed was weighed and the yield calculated as kilograms per dunum. Representative samples of seeds were taken to evaluate the quality of the seed as per International Rules for Seed Testing (2).

The roots were dug, cleaned and weighed. Representative beets were taken for sucrose analysis which was determined by the A.O.A.C. method (3). Data were also obtained for plant height, seed shattering, root diameter both at bolting and harvesting time and percentage of bolting.

Statistical methods appropriate to the split-plot design were used according to LeClerg, Leonard and Clark (18).

RESULTS AND DISCUSSION

A two-year study was conducted to find out the effect of three different dates of plantings and three varieties of sugar beets on the yields of seeds, roots, sucrose content and other agronomic characteristics. The results are summarized in Tables 2 to 14. Analysis of variance tables are given in the appendix from Table 15 to 37. The L.S.D. figures are given at the bottom of the analysis of variance tables for the treatments that were statistically significant.

The data obtained for the 1964-65 crop are not as favorable as those from the 1963-64 crop. This may be due to the fact that the plants suffered considerably during their emergence, to the retardation due to transplanting and from insect attack. These factors influenced greatly the normal growth of the sugar beet plants and the results that were obtained. Climatic variation may have contributed also to the poorer results obtained in 1964-65.

Seed yield[x]

Sugar beet seed yields were affected significantly as the result of the three different dates of plantings as shown in Table 2. The lowest seed yields were obtained,

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[x] Including the shattered seed.

Table 2. Seed yield of sugar beets expressed in kilograms per dunum as affected by date of planting and variety, during 1963-64 and 1964-65.

Year	Date of planting	Variety: Pedigree E +	Pedigree SSA	Polyrave	Date mean
1963-64	Sept. 1 +	524.3	421.2	382.7	442.7
	Sept. 15	422.6	458.3	476.8	452.5
	Sept. 30	338.0	303.8	390.0	343.9 x
Variety mean		428.3	394.4	416.5	
1964-65	Sept. 1 +	276.0	239.3	231.7	249.0
	Sept. 15	193.1	171.3	125.5	163.3 x
	Sept. 30	128.8	171.3	93.3	131.1 xx
Variety mean		199.3	193.9	150.1	

x Significant at the 5% level.

xx Significant at the 1% level.

\+ Sept. 1 date of planting and variety Pedigree E used as check.

in both of the years, from the September 30 plantings. In 1963-64 the average seed yields from the September 1 and September 15 plantings were about the same. However, in 1964-65, as the planting dates were delayed from September 1 to September 30, the average yields were progressively decreased. On the average of the two years of study the September 1 plantings produced 45.5 per cent more seed than did the September 30 plantings. Samman (34) conducted similar trials in 1962-63 in the Beqa'a, and also obtained higher seed yields with the early plantings.

The data revealed a significant interaction between the varieties and the dates of plantings in 1963-64. The variety Pedigree E produced the highest seed yield of 524.3 kilograms per dunum for the September 1 planting. This yield gradually decreased with the later plantings. This variety yielded 338 kilograms per dunum when planted on September 30. Both Pedigree SSA and Polyrave gave the highest seed yields when planted on September 15 with 458.3 and 476.8 kilograms per dunum, respectively. The lowest yield was obtained by Pedigree SSA when planted on September 30. Whereas, in the case of Polyrave, the lowest seed yield was obtained from the September 1 planting.

Weight of 1000 seeds

The weights of 1000 seeds as affected by the different dates of plantings and the three varieties are

Table 3. Weight of 1000 seeds of sugar beets expressed in grams as affected by date of planting and variety, during 1963-64 and 1964-65.

Year	Date of planting	Variety: Pedigree E+	Pedigree SSA	Polyrave	Date mean
1963-64	Sept. 1+	17.7	17.2	17.2	17.4
	Sept. 15	18.2	15.0	17.0	16.7
	Sept. 30	18.5	17.3	17.6	17.8
Variety mean		18.1	16.5	17.3	
1964-65	Sept. 1+	16.3	14.1	16.0	15.5
	Sept. 15	18.2	15.2	16.6	16.7
	Sept. 30	17.8	16.1	17.2	17.0
Variety mean		17.4	15.1x	16.6	

x Significant at the 5% level.

\+ Sept. 1 date of planting and variety Pedigree E used as check.

shown in Table 3. In both of the years, 1963-64 and 1964-65, the variety Pedigree E produced the heaviest seeds followed by Polyrave and the least weight was that of Pedigree SSA.

A study of the data in Table 3 shows that, during both years, the weight of the seed was not influenced greatly by planting sugar beets on different dates in September. However, the September 30 planting produced slightly heavier sugar beet seeds than those obtained from the earlier sowings.

Seed shattering

The amount of shattered sugar beet seeds as affected by three varieties when planted on three different dates is shown in Table 4. The data show that, in both of the years, Pedigree SSA shattered the least, however, the differences were not statistically significant in 1964-65.

The 1963-64 plantings that were made on the different dates had very little effect on seed shattering. In 1964-65 the amount of seed shattering was found to be somewhat lower with the later plantings.

Germination of seed

The data on the germination of sugar beet seeds as affected by the three dates of planting and three different varieties are shown in Table 5. In both of the years,

Table 4. Shattering of sugar beet seeds expressed in kilograms per dunum as affected by date of planting and variety, during 1963-64 and 1964-65.

Year	Date of planting	Variety: Pedigree E[+]	Variety: Pedigree SSA	Variety: Polyrave	Date mean
1963-64	Sept. 1[+]	10.1	6.0	9.8	8.63
	Sept. 15	10.6	7.0	12.0	9.86
	Sept. 30	10.6	6.1	8.4	8.36
Variety mean		10.43	6.36[xx]	10.06	
1964-65	Sept. 1[+]	5.6	4.1	4.0	4.56
	Sept. 15	2.7	1.9	2.6	2.40[xx]
	Sept. 30	1.8	1.9	1.9	1.86[xx]
Variety mean		3.36	2.63	2.83	

[xx]Significant at the 1% level.

[+] Sept. 1 date of planting and variety Pedigree E used as check.

Table 5. Germination percentage of sugar beet seeds as affected by date of planting and variety, during 1963-64 and 1964-65.

Year	Date of planting	Variety: Pedigree E+	Pedigree SSA	Polyrave	Date mean
1963-64	Sept. 1+	94	92	54	80
	Sept. 15	96	89	55	80
	Sept. 30	89	87	51	76
Variety mean		93	90	54xx	
1964-65	Sept. 1+	69	81	41	64
	Sept. 15	73	79	48	67
	Sept. 30	83	80	51	71
Variety mean		75	80	47xx	

xxSignificant at the 1% level.

+ Sept. 1 date of planting and variety Pedigree E used as check.

1963-64 and 1964-65, it was found that the three different dates of plantings had little effect on the viability of the sugar beet seeds.

Among the three different varieties studied, the variety Polyrave produced seeds of very poor quality. The seeds of Polyrave germinated 54 and 47 per cent for 1963-64 and 1964-65, respectively. There was very little difference in the germinability of the seeds between the varieties Pedigree E and Pedigree SSA. Both varieties produced seeds of good germinability that could be used satisfactorily in commercial seed production. The data on the seed germination of these varieties agree with those reported by Samman (34).

Number of seedlings per 100 seed balls

Sugar beet seeds are botanically fruits. A single ball contains two (unless the seed is monogerm) to as high as seven true seeds. The average number of seedlings per 100 seed balls as affected by planting on three different dates and three different varieties is shown in Table 6.

In both of the years, 1963-64 and 1964-65, the variety Polyrave produced a very low number of seedlings per 100 seed balls. In 1963-64 the highest number of seedlings per 100 seed balls was produced by the Pedigree E. However, in 1964-65 there was no difference between Pedigree E and Pedigree SSA in the multigerm character.

Table 6. Number of sugar beet seedlings per 100 seed balls as affected by date of planting and variety, during 1963-64 and 1964-65.

Year	Date of planting	Variety: Pedigree E+	Variety: Pedigree SSA	Variety: Polyrave	Date mean
1963-64	Sept. 1+	195	173	77	148
	Sept. 15	176	152	83	137xx
	Sept. 30	166	142	81	130xx
Variety mean		179	156xx	80xx	
1964-65	Sept. 1+	143	143	66	117
	Sept. 15	134	140	80	118
	Sept. 30	151	144	107	134
Variety mean		143	142	84xx	

xx Significant at the 1% level.

+ Sept. 1 date of planting and variety Pedigree E used as check.

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It may be noted that the seeds possessing the higher germination percentage (Table 5), also contained the higher number of seedlings per 100 seed balls.

The data involving the effect of dates of planting on the seedlings per 100 seed balls was not consistant. The data obtained in 1963-64 show that as the planting dates were delayed the number of seedlings per 100 seed balls decreased. Seeds obtained from the September 15 and 30 plantings produced a significantly lower number of seedlings than the seeds from the September 1 plantings. On the other hand, the seeds obtained from the 1964-65 crop produced a higher number of seedlings from the September 30 plantings than from the earlier sowings. The data obtained in 1962-63 by Samman (34) are in agreement with the 1963-64 results of this study.

Seed purity

In this study seed purity concerned only immature small seeds and chaff. There were no weed seeds in the samples as the method of harvesting that was used eliminated the weeds. The data presented in Table 7 show the percentage of inert matter (immature small seeds and chaff) as affected by the three dates of planting and the three varieties.

In both of the years, 1963-64 and 1964-65, the seed samples of the variety Polyrave contained a higher

Table 7. Percentage of inert matter in sugar beet seeds as affected by date of planting and variety, during 1963-64 and 1964-65.

Year	Date of planting	Variety: Pedigree E[+]	Variety: Pedigree SSA	Variety: Polyrave	Date mean
1963-64	Sept. 1[+]	11.1	9.9	13.4	11.4
	Sept. 15	9.4	9.6	10.9	9.9
	Sept. 30	10.5	10.7	13.8	11.6
Variety mean		10.3	10.0	12.7[x]	
1964-65	Sept. 1[+]	9.4	9.9	11.7	10.4
	Sept. 15	11.1	9.6	11.9	10.8
	Sept. 30	8.9	10.0	11.3	10.0
Variety mean		9.8	9.8	11.6[x]	

[x] Significant at the 5% level.

[+] Sept. 1 date of planting and variety Pedigree E used as check.

percentage of inert matter than did the samples of the varieties Pedigree E and Pedigree SSA. The sugar beet seed samples of the varieties Pedigree E and Pedigree SSA contained the same amount of inert matter.

The data show that planting dates were not a factor in influencing the amount of inert matter present in the sugar beet seed samples.

Bolting percentage

In this study bolting is concerned with the initiation and development of a seed stalk. In 1963-64, bolting started on the third week of April, 1964, and the next year bolting started on the first week of May, 1965. Data on bolting percentage were recorded on June 24, 1965, when there was the least possibility of any further seed stalk initiation. The data on the percentage of bolting of the 1964-65 crop are shown in Table 8. In 1963-64 all the plants bolted irrespective of the three dates of plantings and the three varieties.

The data show that the three varieties used in the trials did not vary in the percentage of plants that bolted.

The different dates of plantings greatly affected the percentage of bolting. Plants of the September 1 sowing bolted on a greatly higher level than those from the September 15 or September 30 plantings. The average

Table 8. Percentage of bolting of sugar beets as affected by date of planting and variety, in 1964-65.

Year	Date of planting	Variety: Pedigree E[+]	Pedigree SSA	Polyrave	Date mean
1964-65	Sept. 1[+]	92.2	92.5	89.1	91.3
	Sept. 15	63.5	62.2	59.4	61.7[xx]
	Sept. 30	41.9	48.4	45.4	45.2[xx]
Variety mean		65.8	67.7	64.6	

xx Significant at the 1% level.

\+ Sept. 1 date of planting and variety Pedigree E used as check.

bolting percentage of the sugar beet plants of the September 1 planting was 91.3, whereas, the September 30 sowing had 45.2 per cent.

Plant maturity

Table 9 shows the percentage of brown seed stalks at harvest time as affected by the three varieties and the three dates of planting. In the 1963-64 crop the sugar beet plants matured uniformly at the time of harvest. The data in Table 9 show that in 1963-64 the varieties and the different dates of plantings used, influenced only slightly the maturity of the sugar beet plants.

In the 1964-65 crop, greater variations in plant maturity were observed between different plants within the same plot. Also, in some plants the seed stalks remained green even though the seed balls were completely brown. The insect injury and the set back of the seedlings in transplanting encountered in establishing a good stand, probably were responsible to some extent for the irregular maturity of this crop. From the data in Table 9 it will be noted that, in 1964-65, the early plantings produced the greater percentage of matured plants at the time of seed harvest. The September 1, September 15 and September 30 plantings produced 73.5, 54.0 and 46.7 per cent matured plants, respectively.

The three varieties under study were different in

Table 9. Percentage of brown seed stalks at harvest of sugar beets as affected by date of planting and variety, during 1963-64 and 1964-65.

Year	Date of planting	Variety: Pedigree E+	Pedigree SSA	Polyrave	Date mean
1963-64	Sept. 1+	90.1	98.3	91.2	93.2
	Sept. 15	91.9	93.4	97.1	94.1
	Sept. 30	89.3	94.9	89.3	91.2
Variety mean		90.4	95.5	92.5	
1964-65	Sept. 1+	83.0	80.0	57.5	73.5
	Sept. 15	51.6	69.0	41.4	54.0xx
	Sept. 30	60.0	55.5	24.8	46.7xx
Variety mean		64.8	68.1	41.2xx	

xx Significant at the 1% level.

\+ Sept. 1 date of planting and variety Pedigree E used as check.

plant maturity. The variety Polyrave appeared to be a late maturing variety, while Pedigree SSA was the earliest. In 1964-65, the percentage of brown seed stalks at the time of harvest was 64.8, 68.1 and 41.2 for Pedigree E, Pedigree SSA and Polyrave, respectively.

Plant height

The plant heights of the three varieties when planted on three different dates are shown in Table 10. The data of both of the years, 1963-64 and 1964-65, show that the three varieties under study were about the same in plant height. In 1964-65, the variety Pedigree SSA appeared somewhat shorter than the other two varieties but the differences were not statistically significant.

In 1963-64 the three dates of planting had very little effect on the plant heights. In 1964-65, the average height of the plants of the September 15 and the September 30 plantings were significantly lower than that of the September 1 plantings. The difference in plant height between the September 1 and the September 30 plantings was 27 centimeters.

Root diameter at bolting time

The root diameters, at the time of bolting, of three varieties of sugar beets sown on three different dates are shown in Table 11. This character was studied

Table 10. Plant height of sugar beets expressed in centimeters as affected by date of planting and variety, during 1963-64 and 1964-65.

Year	Date of planting	Variety: Pedigree E+	Variety: Pedigree SSA	Variety: Polyrave	Date mean
1963-64	Sept. 1+	134	130	144	136
	Sept. 15	143	137	149	143
	Sept. 30	138	141	141	138
Variety mean		137	136	145	
1964-65	Sept. 1+	136	129	135	133
	Sept. 15	114	106	120	113x
	Sept. 30	113	105	100	106x
Variety mean		123	113	118	

x Significant at the 5% level.

\+ Sept. 1 date of planting and variety Pedigree E used as check.

Table 11. Diameter of sugar beet roots at bolting time, expressed in centimeters as affected by date of planting and variety, in 1964-65.

Year	Date of planting	Variety: Pedigree E+	Pedigree SSA	Polyrave	Date mean
1964-65	Sept. 1+	6.94	7.12	7.19	7.08
	Sept. 15	6.33	6.68	7.08	6.69
	Sept. 30	6.18	6.72	6.43	6.44
Variety mean		6.38	6.84xx	6.47	

xx Significant at the 1% level.

\+ Sept. 1 date of planting and variety Pedigree E used as check.

only for the year 1964-65. Data were recorded only for the roots of the plants which had initiated their seed stalk development.

Among the three varieties studied the average root diameter of the variety Pedigree SSA was larger than that for Pedigree E and Polyrave. There was very little difference in the root diameters between Pedigree E and Polyrave. Pedigree E produced the smallest roots with an average diameter of 6.38 centimeters.

The diameter of the roots at the time of bolting gradually decreased from the early planted beets (7.08 centimeters) to the late plantings (6.44 centimeters). These data are in agreement with the findings of Samman (34).

Root diameter at harvesting time

Data in Table 12 show the average root diameters of sugar beets, at the time of seed harvesting, of three varieties planted on three dates during 1964-65.

The size of the beet roots, harvested in the third week of July, 1965, varied very little as compared to those harvested at the time of bolting (Table 11). Also, Pedigree SSA had the largest roots (7.01 centimeters) while Pedigree E possessed the smallest root diameters (6.50 centimeters).

The beets planted on September 30 produced roots

Table 12. Diameter of sugar beet roots at harvesting time expressed in centimeters as affected by date of planting and variety, in 1964-65.

Year	Date of planting	Variety			Date mean
		Pedigree E^+	Pedigree SSA	Polyrave	
1964-65	Sept. 1^+	6.05	6.57	6.70	6.44
	Sept. 15	6.60	6.97	6.52	6.69
	Sept. 30	6.85	7.50	7.05	7.13
Variety mean		6.50	7.01	6.76	

that were 7.13 centimeters in diameter at the time of harvest, while those planted earlier were smaller. The differences obtained, however, were small and not statistically significant.

Yield of beet roots

The average yields of sugar beet roots, at the time of seed harvest, of three varieties sown on three different dates are shown in Table 13.

In 1963-64 root yields decreased gradually as the plantings were delayed from September 1 to September 30. The difference in root yields between the September 1 and September 30 plantings was 1.21 tons per dunum. In the 1964-65 crop the dates of planting did not influence the yield of the resulting roots. It has been reported (21), that earlier plantings result in larger roots and an increased accumulation of food materials in the roots. A comparison of the data in Table 2 and Table 13 reveals that the highest seed yields were obtained from the beets with the largest roots. Several authors (27, 24, 12) reported positive correlations between the seed yields and the root yields.

In 1963-64, the variety Pedigree E produced the largest amount of beet roots with an average yield of 3.94 tons per dunum. Pedigree SSA and Polyrave produced less beet roots than Pedigree E. In 1964-65 the amount of beet

Table 13. Yields of sugar beet roots expressed in tons per dunum as affected by date of planting and variety, during 1963-64 and 1964-65.

Year	Date of planting	Variety: Pedigree E+	Variety: Pedigree SSA	Variety: Polyrave	Date mean
1963-64	Sept. 1+	4.40	3.99	3.61	4.00
	Sept. 15	4.62	3.56	3.06	3.75
	Sept. 30	2.80	2.89	2.70	2.79x
Variety mean		3.94	3.48x	3.12xx	
1964-65	Sept. 1+	2.89	3.31	3.29	3.16
	Sept. 15	3.02	3.07	3.19	3.09
	Sept. 30	3.06	2.97	3.61	3.21
Variety mean		2.99	3.12	3.36	

x Significant at the 5% level.

xx Significant at the 1% level.

\+ Sept. 1 date of planting and variety Pedigree E used as check.

roots was about the same for each of the three varieties.

Sucrose content

The percentages of sucrose in sugar beet roots of three varieties planted on three different dates are shown in Table 14.

In both of the years, 1963-64 and 1964-65, it will be noted that neither the dates of planting nor the varieties influenced greatly the sucrose content of the beet roots. The beet roots grown in 1963-64 contained about four per cent more sucrose than those harvested in 1964-65. The roots of the same varieties harvested in October were found to contain about 18 per cent of sucrose (42). The lower sugar content in the beets obtained in this experiment are the results of utilization of the sugars by the plants for the reproductive phase of growth (31, 38) and the warmer temperatures during June and July as compared to those in October (Table 1). High sugar content in the roots is preferred both as a more desirable livestock feed and for the higher yield of total sugar per dunum.

Table 14. Sucrose percentage of sugar beet roots as affected by date of planting and variety, during 1963-64 and 1964-65.

Year	Date of planting	Variety			Date mean
		Pedigree E	Pedigree SSA	Polyrave	
1963-64	Sept. 1	14.67	11.78	13.66	13.37
	Sept. 15	16.16	12.22	11.86	13.41
	Sept. 30	15.75	14.97	13.93	14.88
Variety mean		15.52	12.99	13.15	
1964-65	Sept. 1	8.85	8.75	9.12	8.90
	Sept. 15	10.70	10.67	10.52	10.63
	Sept. 30	10.30	10.27	10.00	10.19
Variety mean		9.95	9.89	9.88	

SUMMARY AND CONCLUSIONS

The study was conducted for two years, 1963-64 and 1964-65, at the Agricultural Research and Education Center of the American University of Beirut, Beqa'a, Lebanon, to evaluate the possibility of growing sugar beet seeds by the winter-annual method. Three varieties of sugar beets, Pedigree E, Pedigree SSA and Polyrave, were planted on the three different dates September 1, 15 and 30. Data were obtained for seed yield, seed size, shattering, purity, viability, seedlings per 100 seed balls, bolting, maturity, plant height, root diameter, root yield and sucrose content of the roots.

The variety Pedigree E produced the highest amount of sugar beet seeds. Sugar beet plantings made on September 1 produced on an average 45.5 per cent more seed than those planted on September 30. In both of the years the September 30 plantings produced the least amount of seeds.

The weight of 1000 seeds was the highest for Pedigree E and the lowest for Pedigree SSA. The three different dates of plantings influenced the size of the seed only slightly. The September 30 plantings produced slightly larger seeds than those obtained from the earlier plantings.

Shattering of beet seeds was found to be less than 2.5 per cent. Its amount was influenced little by the varieties used or the three different plantings made in September.

The variety Polyrave produced seed of low viability during both years of the study. The germination percentages of the seed produced by Pedigree E and Pedigree SSA were high and satisfactory as commercial seed.

The variety Polyrave produced a very low number of seedlings per 100 seed balls with a two year average of 82, whereas, Pedigree E produced an average of 161 seedlings. The three dates of planting had little, if any, effect on the number of seedlings per 100 seed balls.

The beet seed samples of the variety Polyrave contained a higher percentage of inert matter (immature small seeds and chaff) than that found in Pedigree E and Pedigree SSA. The three different dates of planting had no effect on the amount of inert matter present in the seed samples.

The plants from the September 1 planting bolted 91.3 per cent while those from the September 30 planting bolted only 45.2 per cent. The three different varieties used did not differ in their bolting habit.

In 1963-64 all of the sugar beet plants matured quite uniformly. In 1964-65, the early plantings produced the greater percentage of matured plants at the time of seed harvest. The variety Polyrave appeared to be later in maturity than Pedigree E and Pedigree SSA.

The heights of the plants were not affected by the three dates of planting made in September 1963, however, the planting made on September 1, 1964 produced the tallest sugar beet plants. The three varieties under study did not vary in plant height.

Among the three varieties studied the root diameters of the variety Pedigree SSA was the largest both at the time of bolting and at the time of harvest. The diameter of the roots, at the time of bolting, gradually decreased from the September 1 to the September 30 plantings, however, the reverse was true at the time of seed harvest.

In the 1963-64 crop the beet root yields decreased as the plantings were delayed from September 1 to September 30, however, in the 1964-65 harvest the yield of roots was not affected by the three dates of planting. During the first year of this study Pedigree E produced the highest yield of beet roots. The yields of beets were the same for the three varieties for 1964-65.

The sucrose content of the sugar beet roots was not affected either by the varieties or the three different dates of plantings. The beet roots grown in 1963-64 contained about four per cent more sucrose than those harvested in 1964-65.

It appears from this study that sugar beet seed production by the winter-annual method is feasible in the Beqa'a Plain. The two-year average seed yield obtained from the September 1 planting was 345.8 kilograms per dunum. Samman (34) obtained 579 kilograms of beet seed per dunum from the September 1 plantings in the Beqa'a in 1962-63. The ten year average (1950-60) sugar beet seed yield in the United States was 360 kilograms per dunum (38). Since varieties and dates of planting affect the amount of sugar beet seed that can be produced it seems reasonable that further study should be carried out with other varieties, and probably with earlier dates of plantings. In addition to the satisfactory beet seed yields per dunum, an appreciable amount of roots are harvested as a by-product. The roots provide a valuable livestock feed and add to the value and use of the crop.

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APPENDIX

Table 15. Analysis of variance for seed yield in sugar beets, 1963-64.

Source	D.F.	M.S.	F.
Blocks	3	2625.23	0.31
Dates	2	43319.65	5.14[x]
Error "a"	6	8432.47	
Varieties	2	3541.69	1.07
Dates x varieties	4	14231.11	4.29[x]
Error "b"	18	3316.97	

[x] Denotes F value significant at the 5% level.

L.S.D. at 5% level for date = 86.77; variety = N.S.

Table 16. Analysis of variance for seed yield in sugar beets, 1964-65.

Source	D.F.	M.S.	F.
Blocks	3	2028.87	0.59
Dates	2	44511.69	13.03[xx]
Error "a"	6	3416.09	
Varieties	2	8726.01	2.69
Dates x varieties	4	2188.79	0.67
Error "b"	18	3239.16	

[xx] Denotes F value significant at the 1% level.

L.S.D. at 1% level for date = 88.44; variety = N.S.

Table 17. Analysis of variance for 1000 seed weight in sugar beets, 1963-64.

Source	D.F.	M.S.	F.
Blocks	3	7.51	1.28
Dates	2	3.72	0.63
Error "a"	6	5.86	
Varieties	2	8.26	3.16
Dates x varieties	4	2.00	0.76
Error "b"	18	2.61	

Table 18. Analysis of variance for 1000 seed weight in sugar beets, 1964-65.

Source	D.F.	M.S.	F.
Blocks	3	0.68	0.14
Dates	2	7.94	1.60
Error "a"	6	4.96	
Varieties	2	16.27	4.93[x]
Dates x varieties	4	0.75	0.23
Error "b"	18	3.30	

[x] Denotes F value significant at the 5% level.

L.S.D. at 5% level for date = N.S.; variety = 1.65.

Table 19. Analysis of variance for the weight of shattered seeds in sugar beets, 1963-64.

Source	D.F.	M.S.	F
Blocks	3	82.71	3.89
Dates	2	5.50	0.25
Error "a"	6	21.24	
Varieties	2	67.96	11.59[xx]
Dates x varieties	4	1.25	0.21
Error "b"	18	5.86	

[xx] Denotes F value significant at the 1% level.
L.S.D. at 1% level for date = N.S.; variety = 2.84.

Table 20. Analysis of variance for the weight of shattered seeds in sugar beets, 1964-65.

Source	D.F.	M.S.	F
Blocks	3	4.33	2.62
Dates	2	25.13	15.23[xx]
Error "a"	6	1.65	
Varieties	2	1.61	1.91
Dates x varieties	4	1.01	1.20
Error "b"	18	0.84	

[xx] Denotes F value significant at the 1% level.
L.S.D. at 1% level for date = 1.94; variety = N.S.

Table 21. Analysis of variance for germination percentage in sugar beet seeds, 1963-64.

Source	D.F.	M.S.	F.
Blocks	3	13.08	0.81
Dates	2	60.99	3.77
Error "a"	6	16.17	
Varieties	2	5779.74	116.59^{xx}
Dates x varieties	4	9.96	0.20
Error "b"	18	49.57	

^{xx} Denotes F value significant at the 1% level.

L.S.D. at 1% level for date = N.S.; variety = 8.23.

Table 22. Analysis of variance for germination percentage in sugar beet seeds, 1964-65.

Source	D.F.	M.S.	F.
Blocks	3	354.11	2.21
Dates	2	186.33	1.16
Error "a"	6	160.33	
Varieties	2	3829.08	40.47^{xx}
Dates x varieties	4	63.68	0.67
Error "b"	18	94.61	

^{xx} Denotes F value significant at the 1% level.

L.S.D. at 1% level for date = N.S.; variety = 11.42.

Table 23. Analysis of variance for the number of seedlings per 100 seed balls in sugar beets, 1963-64.

Source	D.F.	M.S.	F.
Blocks	3	8.59	0.18
Dates	2	1061.33	22.72[xx]
Error "a"	6	46.70	
Varieties	2	32182.58	196.73[xx]
Dates x varieties	4	412.41	2.52
Error "b"	18	163.58	

[xx] Denotes F value significant at 1% level.

L.S.D. at 1% level for date = 10.35; variety = 15.02.

Table 24. Analysis of variance for the number os seedlings per 100 seed balls in sugar beets, 1964-65.

Source	D.F.	M.S.	F.
Blocks	3	895.88	3.71
Dates	2	1073.58	4.45
Error "a"	6	241.25	
Varieties	2	13456.00	22.84[xx]
Dates x varieties	4	484.33	0.82
Error "b"	18	589.07	

[xx] Denotes F value significant at the 1% level.

L.S.D. at 1% level for date = N.S.; variety = 28.5

Table 25. Analysis of variance for the percentage of inert matter in the threshed seeds of sugar beets, 1963-64.

Source	D.F.	M.S.	F.
Blocks	3	0.72	0.24
Dates	2	10.53	3.57
Error "a"	6	2.95	
Varieties	2	24.95	4.88[x]
Dates x varieties	4	1.76	0.34
Error "b"	18	5.11	

[x] Denotes F value significant at the 5% level.

L.S.D. at 5% level for date = N.S.; variety = 1.78.

Table 26. Analysis of variance for the percentage of inert matter in the threshed seeds of sugar beets, 1964-65.

Source	D.F.	M.S.	F.
Blocks	3	7.18	2.66
Dates	2	1.90	0.70
Error "a"	6	2.71	
Varieties	2	13.26	4.82[x]
Dates x varieties	4	2.00	0.73
Error "b"	18	2.75	

[x] Denotes F value significant at the 5% level.

L.S.D. at 5% level for date = N.S.; variety = 1.42.

Table 27. Analysis of variance for the bolting percentage in sugar beets, 1964-65.

Source	D.F.	M.S.	F.
Blocks	3	316.14	1.32
Dates	2	6526.73	27.27[xx]
Error "a"	6	239.32	
Varieties	2	29.17	0.31
Dates x varieties	4	22.76	0.24
Error "b"	18	92.09	

[xx] Denotes F value significant at the 1% level.

L.S.D. at 1% level for date = 23.41; variety = N.S.

Table 28. Analysis of variance for the percentage of plants with brown seed stalks at harvest time in sugar beets, 1963-64.

Source	D.F.	M.S.	F.
Blocks	3	37.31	0.51
Dates	2	26.95	0.37
Error "a"	6	72.12	
Varieties	2	79.53	1.94
Dates x varieties	4	36.13	0.88
Error "b"	18	40.90	

Table 29. Analysis of variance for the percentage of plants with brown seed stalks at harvest time in sugar beets, 1964-65.

Source	D.F.	M.S.	F.
Blocks	3	307.06	2.22
Dates	2	2291.41	16.60^xx
Error "a"	6	138.03	
Varieties	2	2578.87	17.35^xx
Dates x varieties	4	214.91	1.44
Error "b"	18	148.56	

xx Denotes F value significant at the 1% level.

L.S.D. at 1% level for date = 17.78; variety = 13.83.

Table 30. Analysis of variance for plant height of sugar beets, 1963-64.

Source	D.F.	M.S.	F.
Blocks	3	396.68	3.72
Dates	2	159.00	1.49
Error "a"	6	106.50	
Varieties	2	288.41	3.00
Dates and varieties	4	72.94	0.76
Error "b"	18	95.91	

Table 31. Analysis of variance for plant height of sugar beets, 1964-65.

Source	D.F.	M.S.	F.
Blocks	3	584.91	2.29
Dates	2	2455.16	9.61[x]
Error "a"	6	255.42	
Varieties	2	204.19	2.38
Dates and varieties	4	125.55	1.46
Error "b"	18	85.59	

[x] Denotes F value significant at the 5% level.

L.S.D. at 5% level for date = 16.0; variety = N.S.

Table 32. Analysis of variance for the root diameter at bolting time in sugar beets, 1964-65.

Source	D.F.	M.S.	F.
Blocks	3	0.583	0.96
Dates	2	1.280	2.11
Error "a"	6	0.606	
Varieties	2	0.620	6.45[xx]
Dates x varieties	4	0.152	1.56
Error "b"	18	0.096	

[xx]Denotes F value significant at the 1% level.

L.S.D. at 1% level for date = N.S.; variety = 0.36.

Table 33. Analysis of variance for the root diameter at seed harvesting time in sugar beets, 1964-65.

Source	D.F.	M.S.	F.
Blocks	3	0.57	0.78
Dates	2	1.46	2.00
Error "a"	6	0.73	
Varieties	2	0.80	2.58
Dates x varieties	4	0.17	0.55
Error "b"	18	0.31	

Table 34. Analysis of variance for the root yield in sugar beets, 1963-64.

Source	D.F.	M.S.	F.
Blocks	3	0.62	0.62
Dates	2	5.26	5.60[x]
Error "a"	6	0.94	
Varieties	2	2.24	9.12[xx]
Dates x varieties	4	0.517	2.10
Error "b"	18	0.246	

[x] Denotes F value significant at the 5% level.

[xx] Denotes F value significant at the 1% level.

L.S.D. at 5% level for date = 0.96; variety = 0.42.

L.S.D. at 1% level for date = N.S.; variety = 0.58.

Table 35. Analysis of variance for the root yield in sugar beets, 1964-65.

Source	D.F.	M.S.	F.
Blocks	3	0.089	0.20
Dates	2	0.009	0.02
Error "a"	6	0.441	
Varieties	2	0.412	1.681
Dates x varieties	4	0.189	0.771
Error "b"	18	0.245	

Table 36. Analysis of variance for the sucrose percentage in sugar beet roots, 1963-64.

Source	D.F.	M.S.	F.
Blocks	3	3.93	0.38
Dates	2	8.90	0.88
Error "a"	6	10.10	
Varieties	2	24.16	2.28
Dates x varieties	4	5.24	0.49
Error "b"	18	10.58	

Table 37. Analysis of variance for the sucrose percentage in sugar beet roots, 1964-65.

Source	D.F.	M.S.	F.
Blocks	3	3.86	1.05
Dates	2	9.66	2.64
Error "a"	6	3.65	
Varieties	2	0.015	0.016
Dates x varieties	4	0.132	0.141
Error "b"	18	0.931	