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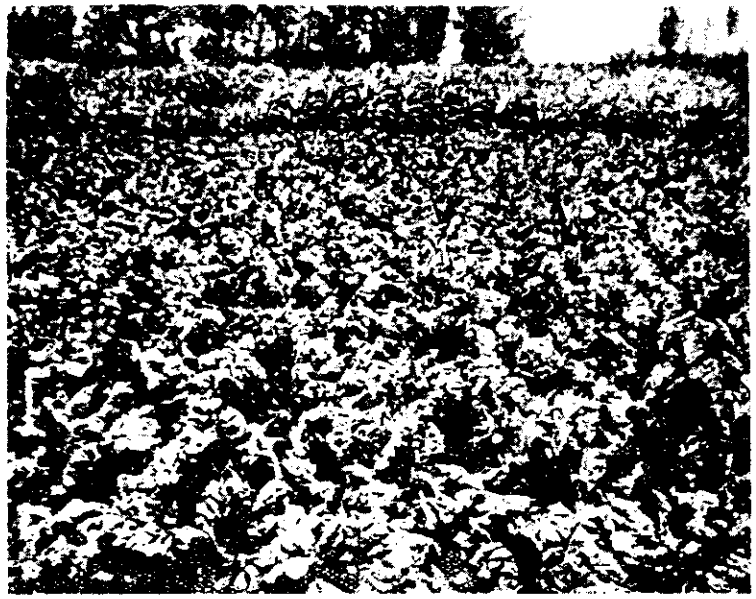
SUGAR BEET PRODUCTION STUDIES in the Beqa'a Plain, Lebanon



A field of Sugar Beets

Faculty of Agricultural Sciences
AMERICAN UNIVERSITY OF BEIRUT
Beirut, Lebanon

Publication No. 35
December 1968

République Libanaise
Bureau du Ministre d'Etat pour la Réforme Administrative
Centre des Projets et des Etudes sur le Secteur Public
(C.P.E.S.P.)

الجمهورية اللبنانية
مكتب وزير الدولة لشؤون التنمية الإدارية
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W.W. Worzella, H.D. Fuehring,
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INTRODUCTION

About one-third of the world production of sugar is produced from sugar beets and two-thirds from sugarcane. The sucrose obtained from sugar beets is, when pure, identical in all properties and for all purposes to that from sugarcane. The sugar beet is a biennial plant. For sugar production the crop is harvested near the end of the first year's growth when the roots are large and contain the maximum amount of sugar, but a seed crop is produced only in the second year after the plants have been exposed to the cold temperatures necessary for seed initiation.

The by-products from the sugar beet crop are beet tops, beet pulp, and beet molasses. The beet tops are kept on the farm and used for livestock feeding. Beet pulp and molasses, the factory by-products, also furnish desirable feed for the livestock industry.

Since 1960, beet production in Lebanon has increased from 18,000 tons to 100,000 tons in 1966. The average yield in the Beqa'a Plain has increased from 2.5 tons per dunum (1000 sq. m.) in 1960 to about 5.0 tons per dunum in 1967.

The doubling of average yields within a period of eight years was the result of extensive beet research conducted in the area and of the experience gained by the farmers in the growing of this crop. The purpose of this publication is to report the results of recent sugar beet research and deals with

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cultural studies, varietal and fertilizer trials, disease and weed control, and seed production trials. The studies were conducted at the Agricultural Research and Educational Center (AREC), in the Beqa'a Plain, Lebanon, during the 6-year period 1962 through 1967. The beet research conducted at the AREC before 1967 has been published earlier by Allos and Macksoud (1) and Worzella *et al* (7).

MATERIALS AND METHODS

The experiments were conducted under irrigated conditions at the AREC. The soil is low in organic matter and available phosphorus, high in potassium and clay content, and is calcareous with a pH of about 8.0.

Plots not involving fertilizer studies received uniform applications of 20 kg of P_2O_5 and 12 kg of N per dunum at planting time. These fertilizers were broadcast on the soil surface, then worked in with a light discing a few days before planting time. Side dressings of 4 kg of N one month after thinning and again in the middle of the growth period were made. For each experiment, a good seed bed was prepared after the land had been leveled to facilitate irrigation. All tillage operations involved in the experiments were made with regular farm equipment. Planting and thinning were done on a small plot basis using approved techniques and procedures. Except on plots involving disease, insect, or weed control studies, the beets were sprayed with fungicides and insecticides as needed and weeds were controlled by hoeing and cultivation. All plots were irrigated adequately once per week throughout the growing season.

The field experiments, laid out in randomized complete block or in split plot designs with four replicates, were conducted for periods of from two to five years. The fertilizer trials were planted in a central composite, rotatable, incomplete factorial design. Each plot consisted of four rows, five or ten meters long, and one-half meter apart. From each plot the center two rows were harvested for yield and sugar content. The beets were planted thickly and thinned, at the 4 to 6 leaf stage, to a stand of 20 cm between plants within a row. At harvest the sugar beets in the center rows were lifted, topped, weighed, and representative samples of the beets were stored in a cool room until the sugar analyses were made the following day. The statistical analyses were made according to methods described by Cochran and Cox (2), Hader *et al* (5), and Snedecor (6).

EXPERIMENTAL RETULTS

The data on the sugar beets are reported as percentage of sugar in the roots, and as weight of tops and roots in tons per dunum. The results of the various experiments are discussed under cultural practices, variety tests, fertilizer trials, irrigation, diseases, weed control, and seed production studies.

Cultural Practices

Date of Planting

Seed of the variety KWS E was planted on or near February 20, March 5 and March 20 during 1962, 1963 and 1964. The beets were harvested on October 6, October 28, and November 20 during each year. The average yields of beet roots resulting from the three planting dates are reported in Table 1.

Table 1.– Average yield of beet roots planted at different dates during 1962-1964 in the Beqa'a Plain, Lebanon.

Date of Planting	Yield of roots — tons per dunum			Average
	1962	1963	1964	1962-64
February 20	10.8	8.0	11.1	10.0
March 5	10.1	8.0	10.5	9.5
March 20	9.9	8.5	8.7	9.0
L.S.D. (5% level)	N.S.	N.S.	1.2	N.S.

The data show that the yield of roots decreased as the date of planting was delayed from February 20 to March 20. The highest yield of 10.0 tons per dunum was obtained from the earliest planting date. These data are in agreement with the studies conducted by Worzella *et al* (7) and Worzella (8) during 1959 to 1961 and which included plantings made as late as May. In the present study the early plantings, made during the cooler season of February and March, produced greater yields, but the differences were not statistically significant.

The effect of date of planting on the percentage of sugar in the beets is reported in Table 2. The results indicate that the percentage of sugar in sugar beet roots was not affected by the various dates of planting.

Table 2. Average percentage of sugar in beet roots planted at different dates during 1962-1964 in the Beqa'a Plain, Lebanon.

Date of Planting	Percent of sugar in roots			Average
	1962	1963	1964	1962-64
February 20	16.7	16.7	15.9	16.4
March 5	16.5	16.5	16.2	16.4
March 20	16.4	16.6	16.5	16.5
L.S.D. (5% level)	N.S.	N.S.	N.S.	N.S.

Date of Harvesting

Table 3 reports the average yield of roots of beets harvested on October 6, October 28, and November 20. The variety KWS E was planted on or near February 20, March 5, and March 20 during the three years 1962-1964.

Table 3. Yield of beet roots harvested at different dates during 1962-64 in the Beqa'a, Lebanon. Average of three planting dates.

Date of Harvesting	Yield of roots — tons per dunum			Average
	1962	1963	1964	1962-64
October 6	9.1	7.8	9.9	8.9
October 28	10.1	8.2	9.3	9.2
November 20	10.6	8.5	11.0	10.0
L.S.D. (5% level)	1.5	N.S.	1.2	1.1

The yield of beet roots increased as harvesting was delayed from the

first week in October to the middle of November. An average increase of 1.1 tons of roots per dunum was obtained by harvesting sugar beets on November 20 instead of October 6.

The influence of the date of harvest on the percentage of sugar in beets is shown in Table 4.

Table 4. Average percentage of sugar in beet roots harvested at different dates during 1962-1964 in the Beqa'a Plain, Lebanon. Average of three planting dates.

Date of Harvesting	Percent of sugar in roots			Average
	1962	1963	1964	1962-64
October 6	14.2	17.2	16.3	15.9
October 28	17.9	15.2	14.4	15.9
November 20	17.7	17.4	16.5	17.2
L.S.D. (5% level)	2.2	1.2	1.2	N.S.

The date of harvest influenced the percentage of sugar in the beet roots On the basis of the 3-year average the sugar analyses were 15.9% for October and 17.2% for the November harvest dates. The gross yields of sugar in tons per dunum were 1.42, 1.46, and 1.72 for the October 6, October 28, and November 20 harvests, respectively. To obtain the highest sugar yield per dunum in the Beqa'a Plain, it is clear that beets should be harvested in November.

Preliminary trials were conducted to determine the effect of December and January harvests on the yield and sugar percentage of beets. It was observed that yields and sugar percentages of the roots did not vary from those obtained at the November 20 harvests.

Within-Row Plant Spacing

Three adapted varieties of sugar beets were planted thickly in rows 50 cm apart and then thinned to stands with spacings of 15, 20, or 25 cm

between plants within the rows during the 3-year period from 1963 to 1965. The data on average yields and sugar percentages of beet roots are reported in Tables 5 and 6.

Table 5. Average yield of beet roots planted at various within-row spacings during 1963-1965 in the Beqa'a Plain, Lebanon.

Plant spacings within the row (cm)	Yield of roots — tons per dunum			Average
	1963	1964	1965	1963-65
15	8.3	9.0	9.9	9.1
20	8.6	9.6	9.5	9.2
25	9.1	8.9	9.4	9.1
L.S.D. (5% level)	N.S.	N.S.	N.S.	N.S.

Table 6. Average percentage of sugar of beets planted at various within-row spacings during 1963-1965 in the Beqa'a Plain, Lebanon.

Plant spacings within the row (cm)	Percent of sugar in roots			Average
	1963	1964	1965	1963-65
15	14.9	16.6	18.5	16.7
20	15.3	16.5	18.8	16.9
25	16.5	17.1	18.3	17.3
L.S.D. (5% level)	1.4	N.S.	N.S.	N.S.

The results show that beet yields were not affected by the plant spacings used in this experiment. A gradual but non-significant increase in sugar percentage was observed as the distance between the plants was increased from 15 to 25 cm.

Variety Trials

Yields

From 10 to 26 varieties of beets were appraised each year for yield and sugar percentage during the 6-year period from 1962 to 1967. Only four of the varieties were grown commercially in the area, while the others represented new strains.

The average yield of roots obtained for thirteen representative varieties are shown in Table 7.

Table 7. Average yield of beet varieties grown during 1962-1967 in the Beqa'a Plain, Lebanon.

Variety	Yield of roots — tons per dunum						Average
	1962	1963	1964	1965	1966	1967	1962-67
KWS E	11.0	10.3	10.5	10.0	10.9	11.6	10.7
Pedigree	11.3	9.5	9.8	9.8	10.1	10.4	10.1
Trirave	11.8	9.4	9.2	9.1	10.6	10.4	10.1
Polyrave	12.0	9.4	9.4	9.3	10.9	10.5	10.2
KWS Polybeta			9.6	9.9	10.6	10.7	
Peragis*			13.6	14.2	19.0	16.4	—
Maribo Resista-Poly				10.1	10.6	8.9	—
Maribo Continenta				8.1	—	9.8	—
Maribo Poly				8.4	9.6	9.3	—
Semarave				10.6	12.3	10.7	—
H_2					9.6	9.7	—
US 75					9.8	8.7	—
263TH2					12.1	11.4	—
L.S.D. (5% level)	N.S.	N.S.	1.3	1.5	1.0	1.2	N.S.

* Fodder beet.

The variety KWS E at 10.7 tons per dunum produced the highest average yield of roots for the 6-year period. The varieties Pedigree, Trirave and Polyrave also produced more than 10 tons per dunum. The fodder beet, Peragis, yielded an average of 15.8 tons of beets during the 4-year period 1964 to 1967. Two new varieties, Semarave and 263TH2, appear to be promising.

Sugar Percentage

The data for the sugar percentage in the roots of the above thirteen varieties of beets are reported in Table 8. The variety KWS E contained the highest percentage of sugar, with an average of 16.0% for the 6-year period, 1962 to 1967. Peragis, a fodder beet, contained only 8.4% of sugar as compared to 15.7% for KWS E over the same four year (1964 to 1967) period. Of the new varieties, Maribo Poly and US 75 contained more sugar than did KWS E. On the basis of yield of sugar, the variety KWS E performed best with an average gross sugar yield of 1.71 tons per dunum.

Table 8. Average percentage of sugar in beet varieties grown during 1962-1967 in the Beqa'a Plain, Lebanon.

Variety	Percent of sugar in roots						Average
	1962	1963	1964	1965	1966	1967	1962-67
KWS E	17.6	15.4	15.0	17.4	14.3	16.0	16.0
Pedigree	18.6	14.1	14.6	15.8	14.0	16.0	15.5
Trirave	16.8	13.9	15.1	15.2	14.6	14.9	15.1
Polyrave	17.2	14.1	14.4	15.4	16.6	15.0	15.5
KWS E Polybeta			16.5	17.8	13.5	15.6	—
Peragis*			7.0	10.4	7.2	9.0	—
Maribo Resista-Poly				16.2	12.3	15.4	—
Maribo Continenta P				17.1	—	15.5	—
Maribo Poly				18.5	15.9	16.5	—
Semarave				14.6	13.4	14.8	—
H_2					14.7	16.8	—
US 75					16.3	16.9	—
263TH2		—			12.3	20.2	—
L.S.D. (5% level)	N.S.	N.S.	1.2	2.2	1.9	1.8	N.S.

* Fodder beet.

Bolting

In the Beqa'a Plain, Lebanon, beets planted in the spring are normally brought to the factory for sugar extraction during the period from September to January. It was hoped that by planting beets in the fall it might be possible

to utilize the normal rainfall as well to produce mature roots during July and August and thus extend the processing period for the factory. Normally, most varieties planted in the fall bolt, i.e. produce flowering stems and seeds in June and July of the following year. For root production even a very low percentage of bolting is undesirable since the roots of bolted beets are small, low in sugar content, and are difficult to top.

Since amount of bolting is a varietal characteristic which is induced by winter temperatures, it should be possible to find non-bolting varieties suitable for fall planting in the Beqa'a. Therefore, 42 varieties of beets were planted on September 1 and 30 during 1965 and 1966 and the percentage of bolting was recorded during July of each succeeding year. The data for the bolting percentage of ten representative varieties are given in Table 9.

It may be noted that beet varieties planted in the fall varied greatly in their tendency to bolt. Some varieties showed a high percentage of bolting while others bolted very little. In general, plantings made on September 1 exhibited a higher percentage of bolting than did those planted on September 30. All of the varieties tested bolted to an extent unsuitable for satis-

Table 9. Average percentage of bolting of beet varieties grown during 1965-66 and 1966-67 in the Beqa'a, Lebanon.

Variety	Percentage bolting from beets planted on			
	Sept. 1, 1965	Sept. 30, 1965	Sept. 1, 1966	Sept. 30 1966
KWS E	100	80	100	100
Polyrave N	100	75	100	100
Maribo Resista	50	50	100	60
US 7	50	5	100	50
US 8	70	0	100	60
Maribo magna Poly	100	5	100	30
F64-42H2	20	5	100	90
Maribo Auto 9468	40	5	90	20
Mezzano AU/N	90	10	100	10
KW AA	30	5	50	5

factory beet production. Sugar beets planted on September 1 produced from 3 to 4 tons of roots per dunum containing from 9 to 13% of sugar, while those planted on September 30 yielded from 2.8 to 3.2 tons of roots having from 10 to 15% sugar.

Fertilizer Trials

Nitrogen Application

Fourteen irrigated field experiments with nitrogen fertilizer on beets were conducted during the years 1960 to 1965. The nitrogen fertilizer was applied at planting time or just before. It will be noted that sugar beets grown in the Beqa'a Plain responded well to the application of nitrogen fertilizer (Figure 1, a). The yield of beet tops increased to the greatest extent, approximately doubling as the rate of nitrogen application was increased from 4 to 60 kg per dunum. The yield of roots was increased to a lesser extent and the yield of sugar by a still lesser amount. Excessive levels of nitrogen reduced the percentage of sugar in the roots (Figure 1, b) and produced beets that were more difficult to process and refine because of the increased percentage of nitrogenous compounds (Figure 1, c). Under the conditions of these experiments, it was concluded that an application of 30 kg of nitrogen per dunum is justified economically when yields of 10 to 12 tons per dunum were obtained, but, where root yields are in the range of 7 to 9 tons per dunum, 20 kg of nitrogen per dunum would be adequate. If potential yields are lower due to poor stands, late planting, or inadequate watering, the level of nitrogen applied should be reduced accordingly.

Phosphorus Application

In general, soils of the Beqa'a Plain are responsive to applications of phosphorus fertilizer, although continued application over a period of years will build up the level of available phosphorus. Experiments with phosphorus fertilizers at AREC reported by Fuehring and Hashimi (3) have shown that a 10-20% increase in yield of beets can be expected as a response to applications of 15 kg of P_2O_5 per dunum.

For beet production in the Beqa'a, it is recommended that phosphorus fertilizers be applied according to a soil test. Where soil test data are not available the following guides may serve: for fields having received very

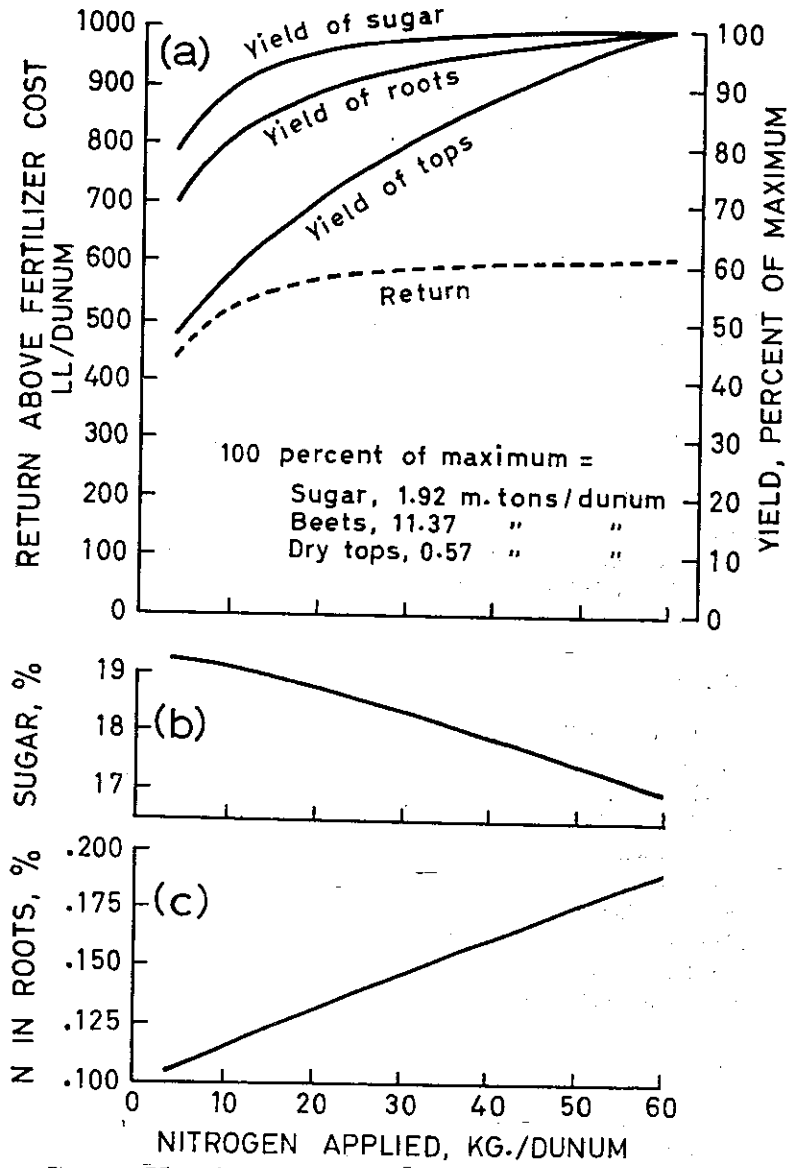

Figure 1. Effect of nitrogen fertilizer: (a) on yields of sugar, roots, and dry tops, and return above fertilizer cost; (b) on percent sugar in the roots; and (c) on percent nitrogen in the roots. Prices used were: roots at LL. 65 per ton, nitrogen at LL. 1 per kg, and P_2O_5 at LL. 0.65 per kg. The level of phosphorus applied was 60 kg of P per dunum.

little previous application of phosphorus fertilizer 30 kg P_2O_5 per dunum is recommended and, for those receiving some phosphorus fertilizer for several years, 15 kg per dunum should suffice.

Other elements

Sugar beets at AREC responded with yield increases to application of sodium up to a level of about 10 kg per dunum, Fuehring and Hashimi (3), but levels greater than 20 kg per dunum tended to reduce the yield of sugar. Sodium nitrate contains about 1.64 kg of sodium for each kg of nitrogen. Thus the application of 6 kg of nitrogen per dunum in the form of sodium nitrate would add about 10 kg of sodium. Sodium chloride (common salt) and sodium sulfate have not been satisfactory sources of sodium.

Very little or no response has been found to applications of potassium, magnesium, sulfate, chloride, zinc, boron, manganese, copper, or iron. Application of any of these is probably not justified economically unless soil tests indicate a definitely low level.

Irrigation

One or two light applications of water by a sprinkler system during germination and emergence of seedlings has been helpful in obtaining uniform and adequate stands. Results reported in 1964 by Fuehring *et al* (4), indicated the following decreases in yields of beets resulted when intervals between irrigations were extended beyond 1 week: 2 weeks, 17% decrease; 3 weeks, 31% decrease; and 4 weeks, 46% decrease. Wilting of the leaves during the hottest time of the day indicates onset of moisture stress and probable reduction in yield. For high yields of roots irrigation water should be applied at weekly intervals in the Beqa'a Plain and at rates sufficient to fill the root zone of the growing crops.

Plant Disease Control

Plant disease surveys have revealed that powdery mildew, caused by the fungus *Erysiphe betae*, is the most common and widespread disease on sugar beets in Lebanon. Field experiments were carried out to compare different

fungicides for the control of powdery mildew, and also to determine the most economical spraying schedules.

Comparative Efficacy of Fungicides

Six different fungicide treatments—sulfur (0.50%), Karathane (0.05%), Morestan (0.30%), Coprantol (0.20%), Phaltan (0.10%), Melprex (0.05%), and a non-sprayed check—were studied. Spray applications were started immediately after the first symptoms of the disease appeared and were continued at 2-week intervals.

Observations on disease development in the field revealed that early disease symptoms appeared in the latter part of June. The disease subsequently spread rapidly during the month of July resulting in a disease incidence of as high as 100% in some fields.

The disease reduced significantly the yield of roots and of sugar (Tables

Table 10. Average yield of roots of KWS N beets as affected by different fungicidal treatments for the control of powdery mildew, 1963 and 1965.

Treatment	Yield of roots — tons per dunum		Average
	1963	1965	
Sulfur	9.9	9.8	9.8
Karathane	9.8	9.3	9.5
Morestan	9.4	8.5	8.9
Coprantol	8.8	8.2	8.5
Phaltan	9.2	—	—
Melprex	—	7.7	—
Check	7.9	7.4	7.7
L.S.D. 5%	1.1	1.1	—

10 and 11). Control of the disease with sulfur, for example, increased the yield of roots by 2.1 tons per dunum and the yield of sugar by 0.37 tons per dunum. There was no significant difference in the percentage sugar content of roots from treated and untreated plots. Sulfur and Karathane proved to be the most effective fungicides followed by Morestan. Coprantol. in both experiments, showed phytotoxic effects resulting in lower yields. Melprex, in the experiment of 1965, was not significantly different from the unsprayed check.

Table 11. Average percentage content of sugar and average yield of sugar of the beet variety KWS N as affected by different fungicidal treatments for the control of powdery mildew, 1963 and 65.

Treatment	Percent sugar in roots			Average
	1963	1965	Average	tons/du
Sulfur	16.3	17.4	16.8	1.64
Karathane	16.5	18.4	17.4	1.66
Morestan	16.8	17.0	16.9	1.51
Coprantol	15.7	17.4	16.5	1.41
Phaltan	16.1	—	—	—
Melprex	—	16.9	—	—
Check	16.2	17.0	16.6	1.27
L.S.D.	N.S.	N.S.	N.S.	—

Spraying Schedules

The spraying schedule studies indicated below included ten different treatments, nine spraying schedules using sulfur (0.50%), and one non-sprayed treatment.

The experiments of 1966 and 1967 were carried out to determine the most economical spraying schedule for the control of powdery mildew on beets in the Beqa'a Plain. The data in Tables 12 and 13 show that spraying

Dates of sulfur spray applications during 1966 and 1967

Treatment No.	1966 1968	8/7 1/7	22/7 14/7	5/8 28/7	19/8 11/8	2/9 25/8	16/9 8/9	30/9 22/9
1		x	x	x	x			
2		x	x	x	x	x		
3		x	x	x	x	x	x	x
4			x	x	x	x	x	x
5				x	x	x	x	x
6					x	x	x	x
7		x		x		x		
8		x		x		x		x
9			x		x		x	
10	Check - No spray application							

schedules which started early in the season reduced the disease significantly better than schedules which started later in the season. For the two year averages, treatments 1, 2, 3, and 8, all significantly greater than the check treatment, were similar in their effects on yields of beets. Therefore, it can be concluded that four spray applications of sulfur W.P. (0.50%), the first applied immediately after the first signs of the disease appear in the field and the rest at monthly intervals thereafter, are adequate to control the disease economically.

Table 12. Yield of roots in tons per dunum of beet variety KWS E as affected by different spraying schedules using sulfur W.P. (0.50%) during 1966 and 1967.

Treatment	Yield of roots — tons per dunum		Average
	1966	1967	
1	10.9	10.5	10.7
2	10.2	10.4	10.3
3	10.6	10.9	10.8
4	9.3	9.8	9.5
5	10.0	9.0	9.5
6	9.8	9.7	9.8
7	10.5	9.5	10.0
8	10.6	10.5	10.6
9	9.8	9.2	9.5
10 (check)	9.2	9.3	9.2
L.S.D. 5%	0.8	1.1	0.9

Table 13. Average percentage content of sugar in roots of sugar beets and average sugar yield per dunum as affected by different spraying schedules using sulfur W.P. (0.50%) on the variety KWS N during 1966 and 1967.

Treatment	Percent of sugar in roots			Average Yield of sugar tons/du
	1966	1967	Average	
1	15.6	17.1	16.4	1.76
2	15.2	17.9	16.6	1.72
3	16.2	18.5	17.4	1.87
4	15.0	17.5	16.2	1.55
5	15.2	17.7	16.5	1.57
6	15.1	18.1	16.6	1.63
7	16.8	18.1	17.5	1.75
8	15.7	17.9	16.8	1.80
9	17.3	17.6	17.5	1.67
10 (check)	15.2	18.4	16.8	1.55
L.S.D.	N.S.	N.S.	N.S.	—

Weed Control

Screening trials on pre- and post-emergence applications of nine herbicides on sugar beets were conducted in 1965. The pre-emergence applications were made immediately after planting and the post-emergence sprays were applied one week after thinning. Two of the herbicides, Eptam and Tillam, were tested in an additional pre-planting treatment where the herbicides were incorporated into the soil before planting. The variety KWS E was used and unweeded check plots, sprayed with water, were included.

The eleven weed species found in the experimental plots were: *Amaranthus retroflexus, Anchusa azurea, Chenopodium opulifolium, Cirsium acarna, Euphorbia gaillardoti, Heliotropium bovi, Lactuca scariola, Lepidium chalepense, Portulacea oleracea, Saponaria vaccaria,* and *Sinapsis arvensis.*

Pre-emergence applications of Tillam and Eptam at 0.2 and 0.4 kg per dunum, respectively, gave a slight increase in the yield of roots (Table 14). The other herbicides tested, especially BV-201 and BV-207, were phytotoxic to the beets.

The percentage of sugar in the roots was influenced by the different herbicides (Table 14). The highest percentage resulted from the pre-emergence application of Tok E-25 at 0.2 kg per dunum, giving a significant increase in sugar content amounting to 5.8%. The lowest percentage was obtained from beets treated with BV-201 at 0.6 kg per dunum as a post-emergence spray. The range of the sugar content in the different treatments was 15.9 to 24.5%.

Table 14. Effect of various herbicides on the yields of roots and tops of sugar beets in tons per dunum and on the percentage of sugar in the roots of the beets.

Herbicide #	Dose (a.i.) kg per dunum	Yield of roots Pre-emergence	Yield of roots post-emergence	Yield of tops* Pre-emergence	Yield of tops* post-emergence	Percent of sugar x Pre-emergence	Percent of sugar x post-emergence
Eptam	0.2	3.3	1.5	0.5	0.1	19.5	19.1
	0.4	6.2	2.0	0.3	0.1	20.2	19.9
	0.8	4.5	2.3	0.3	0.1	19.3	18.8
Tillam	0.2	6.1	2.6	0.3	0.1	17.9	17.5
	0.4	4.7	2.3	0.3	0.1	20.0	17.9
	0.8	4.5	3.0	0.4	0.1	19.9	19.3
Amiben	0.1	4.4	1.4	0.2	0.1	20.4	20.3
	0.2	3.0	1.5	0.2	0.1	16.6	19.2
	0.3	1.5	1.7	0.3	0.1	18.1	19.8
Dowpon	0.2	4.5	2.0	0.2	0.1	19.8	17.9
	0.3	3.6	2.4	0.3	0.1	19.4	18.9
	0.7	4.1	2.3	0.0	0.1	—	17.1
BV-201	0.2	0.0	1.7	0.0	0.1	—	16.0
	0.4	0.0	1.1	0.0	0.1	—	15.9
	0.6	0.0	0.6	0.0	0.1	—	17.1
BV-207	0.2	0.0	0.4	0.0	0.0	—	—
	0.4	0.0	0.0	0.0	0.0	—	—
	0.6	0.0	0.0	0.2	0.1	19.5	19.1
Tok E-25 (Nitrofen)	0.2	1.1	1.5	0.1	0.1	24.5	17.8
	0.4	1.5	1.7	0.1	0.1	21.3	17.7
	0.6	1.8	2.4	0.1	0.1	20.9	19.8
Pyramine	0.2	5.4	1.2	0.2	0.1	19.0	20.4
	0.3	2.6	1.8	0.1	0.1	19.4	20.1
	0.5	2.1	3.6	0.1	0.2	17.4	18.0
Tok E-25 + Pyramine	0.1+0.2	4.2	3.6	0.2	0.2	19.0	18.3
	0.1+0.4	3.6	2.3	0.2	0.2	19.4	16.4
Unweeded check	0.0	5.7	3.9	0.4	0.2	18.7	18.7

Chemical names are listed in the appendix.

* Air-dried.

x L.S.D. 5%: Pre- (1.0); post- (1.1).

— Undetermined because of complete kill of beets.

An increase in yields of roots and tops of beets resulted from the pre-planting treatment of Eptam at 0.2 kg per dunum (Table 15). The percentage of sugar was also increased as a result of this treatment as well as from the application of Tillam at 0.4 kg per dunum.

Table 15. Effect of pre-planting applications of Eptam and Tillam on the yield of roots and tops of sugar beets in tons per dunum and on the percentage of sugar in the roots.

Herbicide	Dose (a.i.) kg per dunum	Yield of roots	Yield of Tops*	Percent of sugar
Eptam	0.2	5.3	0.5	20.5
	0.4	3.6	0.3	17.7
	0.8	1.4	0.2	19.7
Tillam	0.2	2.0	0.3	19.5
	0.4	0.9	0.1	21.0
	0.8	1.7	0.2	19.4
Unweeded check	0.0	4.8	0.3	18.7

* Aid-dried.

x L.S.D. 5%: (1.2).

Weed control with all herbicides was good. *Saponaria vaccaria* and *Sinapsis arvensis* were completely controlled by the herbicides tested. *Amaranthus retroflexus* was partially controlled by Dowpon, BV-207, Tok E-25 and Pyramine. *Portulaca oleracea* was tolerant to Pyramine; however, when mixed with Tok E-25, Pyramine gave good control of *Portulaca*.

Seed Production Studies

Three adapted varieties of beets were planted on September 1, 15, and 30 in rows 75 cm apart with a stand of about 6000 plants per dunum. The seed was harvested in July of the following year. The data for the seed yields of beets are shown in Table 16.

Table 16. Average seed yields of beets planted at different dates during 1963-1965 in the Beqa'a Plain, Lebanon.

Date of Planting	Kg of beet seed per dunum 1963	1964	1965	Average 1963-65
September 1	579	443	249	423.7
September 15	478	452	163	364.3
September 30	332	343	131	268.7
L.S.D. (5% level)	69	87	70	

The date of planting greatly affected the yield of sugar beet seed. Beets planted on September 1 produced an average of 155 kg of seed per dunum more than did the September 30 planting and 59.4 kg more than the September 15 planting. The favorable effect of the early date of planting may be attributed to the increased accumulation of root reserves and to the extended period of photothermal induction during the fall. The high yields that were obtained indicate that the Beqa'a Plain is an area with a high potential for commercial sugar beet seed production.

SUMMARY

Results are reported on recent sugar beet research dealing with studies of cultural practices, varieties, fertilizers, irrigation, diseases, weed control, and seet production. The studies were conducted at the Agricultural Research and Educational Center (AREC) in the Beqa'a Plain, Lebanon, during the 6-year period from 1962 to 1967.

Plantings of beets made during the cool season of February and March produced the highest yields of roots. The percentage of sugar in the roots was not affected by dates of planting.

The yields of beet roots were increased as the harvesting period was delayed from the first week in October to the middle of November. Also, the beet roots harvested in October contained 15.9% sugar, while those from the November harvests contained 17.2% sugar.

The yields of beets were not affected by within-row plant spacings of 15, 20, or 25 cm in rows planted 50 cm apart.

The variety KWS E produced the highest yield of beet roots with an average of 10.7 tons per dunum and the highest percentage of sugar of 16.0% for a 6-year period. The varieties Pedigree, Trirave, and Polyrave also produced about 10 tons of beets per dunum with sugar contents of 15%.

Sugar beet varieties planted in the fall varied greatly in their tendency to bolt. Varieties planted on September 1 developed a higher percentage of bolting than did those planted on September 30.

The yields of beet tops, roots, and sugar increased as the nitrogen application was increased from 4 to 60 kg per dunum. With a yield level of 10 to 12 tons of roots per dunum, an application level of 30 kg of nitrogen per dunum was justified economically.

Experiments with phosphorus fertilizers showed an increase of about 10 to 20% of roots with applications of 15 kg of P_2O_5 per dunum.

Sugar beets at the AREC responded favorably to applications of sodium up to a level of 10 kg per dunum when added in the form of sodium nitrate. Sodium chloride and sodium sulfate were not satisfactory sources of sodium.

Maximum root yields were obtained with irrigation applied at one week intervals and in amounts sufficient to fill the root zone.

The fungicidal control of powdery mildew of sugar beets, in the Beqa'a Plain, by the use of sulfur (0.50%), Karathane (0.50%) or Morestan (0.30%), applied at the rate of 250 liters per dunum, has increased the yield of roots by as much as 31.7% and sugar by as much as 31.8%. The most economical spraying schedule consisted of four applications of sulfur starting at the appearance of the first signs of the disease and thereafter at monthly intervals.

The pre-emergence applications of Tillam and Eptam at 0.2 and 0.4 kg per dunum, respectively, and the pre-planting application of Eptam at 0.2 kg per dunum increased the yield of sugar beets as compared to the unweeded check.

Beets from plantings made on September 1 produced 424 kg of seed per dunum while those planted on September 30 yielded 269 kg per dunum.

ARABIC SUMMARY

ملخص لنتائج الابحاث التي اجريت على الشمندر السكري في البقاع

تتضمن هذه النشرة نتائج الابحاث التي اجريت حديثا في مركز الابحاث والتعليم الزراعي (حوش سنيد ــ البقاع) التابع للجامعة الامريكية في بيروت بين سنة ١٩٦٢ و ١٩٦٧ الرامية لزيادة الانتاج وتحسين جودة الشمندر السكري .

استهدفت هذه الابحاث دراسة تأثير كل من العوامل التالية : الاصناف ومسافات الزراعة والري والتسميد ومكافحة الامراض ومبيدات الاعشاب على الانتاج وعلى نسبة السكر في الجذور ، وكذلك تأثير موعد الزراعة على الازهار وعلى انتاج البذور في الاصناف المختلفة .
وانتهت الابحاث الى النتائج التالية :

١ ــ اعطت الاصناف المزروعة خلال الطقس البارد في شهري شباط وآذار انتاجا اعلى من تلك المزروعة في الخريف (ايلول) ، بينما لم تظهر النتائج اختلافا في نسبة السكر بين المواعيد المذكورة اعلاه .

٢ ــ اعطت الاصناف التي اقتلعت في منتصف تشرين الثاني انتاجا اعلى من تلك التي اقتلعت في الاسبوع الاول من تشرين الاول ، وكذلك كانت نسبة السكر اعلى في الجذور المقتلعة في منتصف تشرين الثاني اذ بلغت ١٧،٢ ٪ بينما كانت نسبة السكر في الجذور المقتلعة في الاسبوع الاول من تشرين الاول ١٥،٩ ٪ .

٣ ــ لم يظهر اي تأثير لمسافات الزراعة المستعملة على الانتاج ، وكانت هذه المسافات على التوالي : ١٥ ، ٢٠ ، ٢٥ سم بين النباتات في التلم الواحد .

٤ ــ اعطى الصنف KWSE انتاجا اعلى من الجذور ونسبة السكر ، اذ بلغ انتاجه ١٠،٧ طنا من الجذور في الدونم الواحد ، وبلغت نسبة السكر فيه ١٦ ٪ وذلك كمعدل للسنوات الست التي اجريت فيها التجارب ؛ بينما تراوح معدل الانتاج في الاصناف Pedigree, Trirave, Polyrave عشرة اطنان للدونم الواحد .

٥ ــ تبين ان الاصناف المزروعة في الخريف تختلف من حيث قابليتها للازهار المبكر ، فالاصناف المزروعة في الاول من ايلول كان ازهارها ابكر من تلك المزروعة في نهاية ايلول .

٦ ــ اعطى الري على فترات اسبوعية وبالكمية الكافية لتغطية منطقة الجذور انتاجا عاليا في المحصول .

٧ ــ ازداد انتاج المجموع الخضري والجذري بزيادة كمية الازوت المضافة للدونم الواحد والتي تراوحت من ٤ الى ٦٠ كغم . واظهرت النتائج ان اضافة ٣٠ كغم من الازوت للدونم الواحد تعطي انتاجا ذا قيمة اقتصادية تتراوح بين ١٠ و ١٢ طنا من الجذور في الدونم ، بينما ادت اضافة ١٥ كغم من خامس اوكسيد الفسفور (P_2O_5) للدونم الواحد ، زيادة في انتاج الجذور تتراوح بين ١٠ و ٢٠ ٪ ، اما اضافة كمية ١٠ كغم من الصوديوم الى الدونم الواحد على شكل نترات الصوديوم ، (ويفضل هذا المصدر على كل من كلور الصوديوم وكبريتات الصوديوم) تحسن الانتاج .

٨ ــ اعطت مكافحة مرض البياض الدقيقي (الرمد) على الشمندر السكري زيادة مقدارها ٣١،٧ ٪ في محصول الجذور وزيادة في كمية السكر وقدرها ٣١،٨ ٪ . والمواد التي استعملت في المكافحة هي : الكبريت بنسبة ٥٠، ٪ او الكاراثان بنسبة ٠،٠٥ ٪ او الموريستان بنسبة ٠،٣ ٪ . وقد استهلك الدونم الواحد ٢٥٠ ليترا من كل من المحاليل المستعملة للتغطية الكاملة .

وقد اظهرت النتائج ان افضل طريقة لمكافحة البياض الدقيقي على الشمندر السكري هي استعمال مادة الكبريت ورشها محلولا على النبات وذلك اربع مرات ابتداء من ظهور الاعراض الاولية للمرض وعلى فترات شهرية .

٩ ــ اعطى استعمال مبيدات الاعشاب زيادة قليلة في انتاج الشمندر السكري . ومن المبيدات المفضلة استعمال كل من مادتي التيلام بنسبة ٠،٢ كغم ، والابتام بنسبة ٠،٤ كغم للدونم ، وذلك برشها قبل الانبات ، او استعمال مادة الابتام بنسبة ٠،٢ كغم للدونم الواحد وذلك قبل الزراعة .

١٠ ــ تبين ان الاصناف المزروعة في الاول من ايلول انتجت ٤٢٤ كغم من البذور للدونم الواحد ، بينما الاصناف المزروعة في الثلاثين منه انتجت ٢٦٩ كغم بالدونم الواحد .

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APPENDIX

Amiben	3-amino-2, 5-dichlorobenzoic acid
BV 201	1-(3, 4-dichlorophenyl)-3-, ethyl-2-pyrrolidinone
BV 207	1-(3-chloro-4-methylphenyl)-3-methyl-2-pyrrolidinone
Dowpon	Na-2, 2-dichloropropionic acid
Eptam	Ethyl diprophylthiol carbamate
Pyramine	5-amino-4-chloro-2-phenul-3 pyridazinone
Tillam	Propyl butyl ethylthiol carbamate
Tok E-25	2,4 dichlorophenyl ether

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