SUGAR BEET SEED PRODUCTION IN MICHIGAN AS INFLUENCED BY SIZE AND SPACING OF STECKLINGS

Thesis for the Degree of M. S.
MICHIGAN STATE COLLEGE

Perc Albert Reeve

1942

SUGAR BEET SEED PRODUCTION IN MICHIGAN AS INFLUENCED BY SIZE AND SPACING OF STECKLINGS

by

PERC ALBERT REEVE

A THESIS

Submitted to the Graduate School of Michigan State College of Agriculture and Applied Science in partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE

Department of Farm Crops

1942

THESIS

ACKNOWLEDGMENT

The author wishes to acknowledge his indebtedness to the Farmers and Manufacturers Beet Sugar Association for making this study possible.

The author is grateful to Mr. H. L. Kohls for his guidance and assistance throughout the experiments and preparation of this thesis and to Dr. S. T. Dexter for his constructive criticism, also to Dr. W. D. Baten for his assistance with the statistical analyses.

TABLE OF CONTENTS

SUGAR BEET SEED PRODUCTION IN MICHIGAN AS INFLUENCED BY SIZE AND SPACING OF STECKLINGS

Sugar beet growers in Michigan are dependent upon two sources for seed. In recent years, part of our seed has been grown in the Southwestern states, but traditionally the sugar beet seed has been imported from Europe. In the Southwest the sugar beet seed is produced by overwintering young plants in the field. The "European steckling method" of seed production requires the growing of mother beets, which are harvested, stored overwinter in root cellars or pit silos, and replanted the next spring for the production of the seed crop.

Previous to 1923, very few attempts had been made to grow sugar beet seed in the United States. During the first World War when the European seed supply was cut off by the continental blockade, sugar beet companies and growers of this country banded together and produced almost enough seed when combined with that already on hand, to supply the wants of the growers of the United States. However, with the return of normal trade relations the seed industry was dropped in the United States, and the sugar beet growers of this country again became dependent on European seed sources.

This lack of interest in sugar beet seed growing in the United States has been attributed to two major factors; (1) There was a supply of sugar beet seed from European seed sources at a reasonable price, and (2) it was generally assumed that labor and climatic conditions were such that it was impossible to develop the seed industry in the United States. However, experimental results from Schuyler, Nebraska 1893, and Waverly, Washington 1903 (6) showed conclusively that sugar beet crops from home

grown seed were superior to those from European seed of the same variety. Furthermore, certain farmers of those areas had found that the production of sugar beet seed might be a profitable venture.

The present experiments deal with sugar beet seed production in Michigan by modifications of the European steckling method.

During the emergency of 1914-1918, sugar beet seed was produced in the United States by the steckling method. In 1922-1923 there was discovered in the southwestern part of the United States a method of producing sugar beet seed by overwintering young plants in the field. This practice proved less expensive than the European system of digging, storing, and transplanting the mother beets. The overwintering method has developed in that area, until it now supplies all of the sugar beet seed used in the United States.

Michigan sugar beet companies and growers through their cooperative agency, the Farmers and Manfacturers Beet Sugar Association, have bought controlling interests in a Western sugar beet seed company which produces sufficient seed to meet the demands of the Eastern sugar beet growers. Although this arrangement insures a supply of sugar beet seed, better adapted and cheaper seed might be grown nearer the locality where it is to be sown.

Sugar beet growing in the United States is divided into two distinct areas when varieties and diseases are considered; namely, the area west of the Eastern slope of the Rocky Mountains, and the area east of the Rocky Mountains. The former area needs varieties resistant to the curly top disease, while the latter area requires varieties resistant to cercospera leaf spot. In each area it would be desirable to have both a separate sugar

beet breeding program and a means of producing the parent stock and commercial seed. Such a program would reduce the danger of varietal adulteration, introduction of new diseases, insects, and weeds.

Sugar beet breeding work has been carried on by the Farm Crops department of Michigan State College for the last twenty years. Promising strains have been developed which must be increased for adequate field trials. In recognition of the advantages and desirability of home grown seed, an intensive program was begun in 1933 to find a practicable means of growing sugar beet seed in Michigan.

In order to utilize the promising strains more fully, H. L. Kohls, sugar beet breeder of this station, started experiments on methods of commercial seed production. The following may be enumerated: (1) overwintering in the field without protection, (2) overwintering in the field giving the young beets protection with coverings of hay and straw, (3) seeding beet seed with oats and barley and overwintering of the beets in the stubble, (4) seeding and overwintering beets in cold frames and transplanting in the spring with tomato and cabbage planters, (5) watering the young beets heavily in the fall to increase their resistance to unfavorable weather conditions, and (6) growing stecklings the size of a lead pencil to an inch in diameter, storing overwinter and transplanting the next spring. Varying degrees of success were obtained with the different methods, but none have proven to be economically sound.

REVIEW OF LITERATURE

Various experiments have been run to determine the effects of spacing on the yield of commercial beets in the United States, but the information dealing with spacing and size of stecklings and their effects on the

production of sugar beet seed in the United States is limited. Ware (8) as early as 1898, stated that some growers in Europe were enthusiastic over small stecklings for sugar beet seed production, but that other experiments showed that there was very little advantage, if any, in using small stecklings for seed production. However, he states that the small steckling method offers certain advantages of economy not to be overlooked. Tracy (7), found in Colorado that six to ten ounce roots proved most profitable for seed production because such roots kept better in the silo and considered on an acre basis were less bulky and expensive to dig, store, and transplant and with slightly closer spacings, fully as heavy seed-producers as larger roots. Also, these sizes developed seed stalks earlier, more nearly at the same time, and matured their seed crop earlier than larger roots. Harris (3) in speaking of size of stecklings for seed production in Utah found that the use of small stecklings did not seem to reduce the amount of seed produced, and concludes that there is a very good profit in the growing of sugar beet seed. Kohls (5) transplanted stecklings the size of a lead pencil to an inch in diameter, found them much easier to transplant, and obtained a yield of 860 pounds of seed to the acre without the use of fertilizer. He found that the small stecklings deveoped seed stalks, flowered and matured earlier than did the larger roots of the same variety. The stecklings less than one inch in diameter gave significantly higher yields than stecklings over one inch in diameter, many of the larger roots failing to produce seed stalks. He attributes this peculiarity to late transplanting of the stecklings (May 8). Brown (2), in letters of instructions to his sugar beet seed growers in Canada for 1942, states that any steckling between one half and four inches in diameter is satisfactory for growing seed. The beets above three inches in diameter should be cut

lengthwise through the crown and planted as separate roots in halves or quarters. He states that the best size for pitting and planting is around one to one and one-half inches in diameter. However, that even the one half inch diameter stecklings were perfectly good for seed production, providing they were planted in rich ground and had moist earth firmed around them.

At Michigan State College, Bird (1), conducted an experiment to determine the influence of different spacings of stecklings in the row and between the rows. Treatments of plots included 18", 24", and 30" spacings between rows with 6", 12", and 18" spacings in the row. He found that the 30 inch spacing between rows gave significantly higher yields than either the 24" or 18" rows. No significant differences in seed yields were found between spacings in the row. He concluded that stecklings planted in rows 30" apart were superior in yield of seed per acre to stecklings planted in rows 18" or 24" apart. Ammonium sulphate at 200 and 400 pounds per acre gave no increase in seed yield above the unfertilized plots. (The field had been in alfalfa the previous year).

Harris (4), of Utah State Agriculture College, reporting on the results of experimental work and actual growing of sugar beet seed (1905-1917) advocates planting seed at the rate of eight pounds per acre with no thinning for growing of stecklings. This method of growing stecklings reduced labor in handling and space in storing in addition to producing a large number of stecklings per acre. He states that the cost of producing sugar beet seed varies so much with conditions that definite figures are almost useless, but gives the following as suggestive:

Estimated cost of raising one acre of sugar beet seed.

Rent of land (value $250 an acre)	$20.00
Plowing and preparing land	5.00
Hauling stecklings from silo and planting	15.00
Cultivating and irrigating	6.00
Hoeing	2.00
Cutting seed	5.00
Threshing and cleaning	15.00
Cost of mother seed and stecklings	40.00
Total	$108.00

He concludes, "A comparison of these figures for cost with the price obtained for seed (15 cents per pound with an average production of 1461 pounds per acre) shows that a good profit may be made. This profit, taken with the fact that domestic seed is better than the imported, surely justifies the establishment of a sugar beet seed industry in America."

METHODS AND MATERIALS

In the spring of 1939 three quarters of an acre of land was seeded to sugar beets for the production of stecklings. The seed was sown at the rate of twelve pounds per acre and the beets were not thinned. The beets were cultivated and weeded during the summer, and the stecklings were placed in storage that fall in a root cellar. Before storage the stecklings were graded for size into three classes; namely, small, ½" to 1" in diameter, medium, 1" to 2" in diameter; and large 2" and over in diameter. All sizes kept equally well and the stecklings were in good condition for transplanting the next spring.

In the spring of 1940, stecklings of each size were planted at four spacings; 18" by 18", 24" by 24", 30" by 30", and 36" by 36". Each treatment was replicated three times. The stecklings were transplanted on

April 26, and the seed was harvested August 6. The plots were four rows wide and forty four feet long. Seed from the two middle rows was harvested and weighed to secure comparative seed yields. The basis of the field plan and the statistical analyses was a split plot design both in 1940 and 1941.

In addition to the experimental plots, a 2.7 acre field was set out with stecklings for seed production. From this field records were kept to be used in determining the cost of production for the various treatments. The costs were then prorated for the different treatments.

In the spring of 1940 three quarters of an acre of land was again seeded to produce stecklings for the 1941 experiments. The stecklings were handled and graded into sizes much the same as in 1939, and were stored in the same root cellar. The stecklings kept equally well and were in good condition for transplanting in the spring of 1941.

In the 1941 experiment, stecklings of four sizes were used; namely, small, ½" to 1" in diameter; medium, 1" to 2" in diameter; large, 2" and over in diameter; and field run, which were stecklings unsorted as to size. Stecklings of each size were planted at five spacings; 18" by 18", 24" by 24", 30" by 30", 36" by 36", and 42" by 42". Each treatment was replicated six times in plots fifty feet long and four rows wide. The stecklings were transplanted May 2. The seed was harvested July 22 from the two center rows of each plot. The procedure followed was the same as in 1940.

To secure cost of production data for the 1941 experiment, field run stecklings were set out at 30" by 30" in a 4.56 acre field.

PRESENTATION OF DATA

From a count of the stecklings in the field which had been seeded at the rate of twelve pounds of seed per acre in 1940, it was estimated that 64,800 stecklings were grown per acre. However, an actual count the following summer showed that 58,948 stecklings were produced, overwintered, and transplanted per acre of stecklings grown. The loss in storage was slightly less than one per cent. On the basis of these figures, a twenty five per cent reduction of the field estimate (64,800 to 48,600) should be sufficient to cover losses in harvest, storage, and deviations in stand.

Table 1 indicates the number of stecklings required for the production of an acre of seed. It should be noted that the closer spacings (18" by 18" and 24" by 24") require several times as many stecklings as the 36" by 36" and 42" by 42" spacings.

Table 1. The number of stecklings required per acre for the various spacings used. Also, the number of acres of transplants possible from one acre of stecklings, assuming 48,600 usable roots.

Spacing	Number of stecklings required per acre	Acres of transplants per acre of stecklings grown
18" by 18"	19,360	2.51
24" by 24"	10,890	4.47
30" by 30"	6,970	6.97
36" by 36"	4,840	10.04
42" by 42"	3,556	13.67

Using the above outline as a basis, the different sized stecklings were set out for seed production both in 1940 and 1941. The data pertaining to seed yields and estimated costs of production under the above conditions are presented and discussed in the pages following.

1940 RESULTS

Table 2 summarizes the 1940 seed yields.

The seed yields from the various treatments indicate that the small stecklings do not produce plants large enough to use the full productivity of the soil when spaced at the wider intervals. At the closer spacings seed yields are essentially the same regardless of the size of stecklings used. These data indicate that no particular spacing can be recommended as the "best." Instead, the spacings should be judged according to the size of the stecklings that are to be transplanted. Closer spacings may be used when the average size of the stecklings are below an inch and a half in diameter. Wide spacings seem advisable if the stecklings average over two inches in diameter.

Allowing for the usual land rental, overhead, and field operations, at current rates, costs of production for each plot were calculated from the data obtained from the 2.7 acre field of sugar beet seed grown on the college experimental farm. Lack of experience and inadequate equipment increased many of the cost items. However, the costs are reasonably indicative of what can be done on the average farm in Michigan.

Table 3 gives the cost factors involved in growing an acre of sugar beet seed with the various treatments.

Table 4 summarizes the cost of growing, harvesting, and storing an acre of stecklings.

Table 5 gives the net profits from each seed plot as calculated from the data of tables 2 and 3. Twelve cents was allowed per pound of seed produced.

Table 2. Yields of sugar beet seed in pounds per acre in 1940.

Size of steckling	Spacing	Rep. 1	Rep. 2	Rep. 3	Ave.
Small	18" by 18"	1512	1037	1097	1215
	24" by 24"	980	904	937	940
	30" by 30"	802	496	672	657
	36" by 36"	858	588	436	627
Medium	18" by 18"	1205	1195	1533	1311
	24" by 24"	1142	1542	904	1196
	30" by 30"	871	893	1238	1001
	36" by 36"	584	745	895	741
Large	18" by 18"	1138	1306	1283	1242
	24" by 24"	2087	1373	1152	1537
	30" by 30"	1092	1213	1120	1142
	36" by 36"	1244	1189	1006	1146

Difference required for significance between means of treatments at 5% level = 394 lbs., at 1% level = 543 lbs.

Table 3. Costs incurred in growing an acre of sugar beet seed in 1940.

Operations[1] and charges	Small Stecklings Spacings				Medium Stecklings Spacings				Large Stecklings Spacings			
	18"	24"	30"	36"	18"	24"	30"	36"	18"	24"	30"	36"
Steckling Production												
Cost of growing[2]	$9.32	$5.25	$3.36	$2.33	$9.32	$5.25	$3.36	$2.33	$9.32	$5.25	$3.36	$2.33
Topping and lifting[3]	29.20	16.43	10.52	7.30	29.20	16.43	10.52	7.30	29.20	16.43	10.52	7.30
Hauling to storage cellar	4.88	2.75	1.75	1.22	7.32	4.12	2.62	1.83	9.75	5.49	3.51	2.44
Rental of storage cellar	5.72	3.23	2.06	1.43	17.17	9.68	6.19	4.30	51.50	29.05	18.57	12.90
Seed Production												
Land rental	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Seed bed preparation	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Fertilizer[4]	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30
Application of fertilizer	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Marking seed field	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45
Hauling stecklings to field	4.88	2.75	1.75	1.22	7.32	4.12	2.62	1.83	9.75	5.49	3.51	2.43
Planting stecklings	40.00	22.50	14.40	10.00	40.00	22.50	14.40	10.00	44.00	24.75	15.85	11.00
Hoeing seed field	4.00	3.00	2.40	2.00	4.00	3.00	2.40	2.00	4.00	3.00	2.40	2.00
Seed Harvesting												
Mowing seed	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
Piling seed	3.34	2.89	2.37	2.31	3.56	3.30	2.97	2.52	3.42	3.88	3.24	3.25
Threshing seed[5]	7.39	5.72	4.00	3.81	7.97	7.27	6.09	4.51	7.55	9.35	6.94	6.97
Total expense	$126.88	82.67	60.76	49.77	144.01	93.82	69.32	54.77	186.64	120.84	86.05	68.77

(1) Man labor computed at $0.35 per hour; horse labor at $0.15 per hour.
(2) Cost of growing an acre of stecklings was $23.40 as shown in table 4.
(3) Lifting and topping an acre of stecklings cost $73.31 in 1940. The development and use of machinery reduced this cost to $40.00 in 1941.
(4) Fertilizer of 0-14-6 analysis applied to seed plots uniformly at rate of 200 pounds per acre.
(5) The cost of threshing sugar beet seed was computed at $0.0061 per pound. This figure is based upon data furnished by Dr. H. D. Brown, Canada and Dominion Sugar Co., Ltd., Chatham, Ontario.

Table 4. Estimated costs of growing, harvesting, and storing an acre of stecklings.

I.	Growing stecklings	
	Land rental	$ 7.50
	Seed bed preparation	5.00
	Applying fertilizer	0.50
	Fertilizer	2.30
	Seed (12 pounds at 15 cents per lb.)	1.80
	Planting	0.75
	Cultivation (3 at $0.45)	1.35
	Weeding	4.20
	Sub-total	$23.40
II.	Harvest of stecklings	
	Topping and lifting (1941 results)	$ 40.00
	Hauling to storage	12.25
III.	Storage	50.00
	Total	$125.65

Table 5. Net profits per acre in 1940.

Size of stecklings	Spacing	Rep. 1	Rep. 2	Rep. 3	Ave.
Small	18" by 18"	$54.56	$-2.44	$ 4.76	$18.96
	24" by 24"	34.93	25.81	29.77	30.17
	30" by 30"	35.48	-1.24	19.88	18.04
	36" by 36"	53.19	20.79	2.55	25.51
Medium	18" by 18"	0.59	-0.61	39.95	13.31
	24" by 24"	43.22	91.22	14.66	49.70
	30" by 30"	35.20	37.84	79.24	50.76
	36" by 36"	15.31	34.63	52.63	34.19
Large	18" by 18"	-50.08	-29.92	-32.68	-37.56
	24" by 24"	129.60	43.92	17.40	63.64
	30" by 30"	44.99	59.51	48.35	50.95
	36" by 36"	77.51	70.91	48.95	65.79

Difference required for significance between means of treatments at 5% level = $54.02, at 1% level = $74.42.

Note: Net profits per acre were computed by multiplying the pounds of seed per acre by $0.12 and subtracting the corresponding production cost of table 3.

On a cost basis the data show that plots of large stecklings spaced at 18" by 18" resulted in minus net profits per acre. In general, 18" by 18" spacings seem inadvisable irrespective of size of stecklings used. Also, that more space can be allowed a large steckling than a small one.

1941 RESULTS

Table 6 summarizes the 1941 plot yields. The soil heterogeneity of the experimental area made for wide variations between replications and within blocks.

No significant differences in seed yields were obtained for large, medium, and field run stecklings when their respective spacings were compared. Again, the data indicate that the smaller stecklings do not develop sufficiently enough to use the full productivity of the soil when spaced at the wider intervals.

Data for the costs of production in 1941 were obtained from a 4.56 acre field planted for sugar beet seed production in which field run stecklings were planted at 30" by 30" spacings. The stecklings used were grown in the same steckling field and stored in the same root cellar as those stecklings used in the experimental plots. These cost items were prorated for the different treatments and are summarized in table 7.

The costs were applied to their respective plots and the net profits per acre were calculated. Twelve cents was allowed for each pound of seed produced. The results are summarized in table 8.

The data show that plots of large and small stecklings spaced at 18" by 18" resulted in minus net profits per acre. Again, 18" by 18" spacings seem inadvisable irrespective of size of stecklings. Also, that more space can be allowed a large steckling than a small one.

Table 6. Yields of sugar beet seed in pounds per acre in 1941.

Size of stecklings	Spacing	Rep. 1	Rep. 2	Rep. 3	Rep. 4	Rep. 5	Rep. 6	Ave.
Smalls	18" by 18"	1321	944	900	1060	973	1104	1050
	24" by 24"	795	1176	849	882	958	1590	1042
	30" by 30"	793	888	1054	1106	1141	1028	1002
	36" by 36"	806	675	653	646	864	922	761
	42" by 42"	342	442	604	766	803	903	643
Medium	18" by 18"	1263	1162	1423	1597	1713	1597	1459
	24" by 24"	817	1100	1437	1329	1437	1655	1296
	30" by 30"	636	984	1106	976	1032	1263	999
	36" by 36"	995	1031	632	900	864	1300	954
	42" by 42"	579	629	1027	890	778	1301	867
Field Run	18" by 18"	1336	1176	1641	1771	1379	1684	1481
	24" by 24"	904	1339	1361	523	1285	1623	1173
	30" by 30"	1063	1132	1394	1228	1202	1481	1250
	36" by 36"	682	1031	857	980	958	1445	992
	42" by 42"	641	735	623	815	984	884	780
Large	18" by 18"	1249	1133	1902	1771	1060	1539	1442
	24" by 24"	795	1165	1154	893	1231	1655	1149
	30" by 30"	1080	1272	915	1097	1254	1455	1179
	36" by 36"	1016	849	1009	900	1554	1554	1147
	42" by 42"	940	716	903	1121	1096	1276	1008

Difference required for significance between means of treatments at 5% level = 192 lbs., at 1% level = 255 lbs.

Table 7. Costs incurred in growing an acre of sugar beet seed in 1941.

Size of stecklings	18" by 18"	24" by 24"	30" by 30"	36" by 36"	42" by 42"
Small	$130.19	$ 88.08	$ 67.85	$ 55.36	$ 47.77
Medium	147.52	97.96	73.18	60.24	51.64
Field Run	147.63	97.21	74.71	60.47	51.11
Large	185.13	118.34	87.88	70.85	58.79

Note: Basis of computation same as for 1940 costs. (table 3)

Man labor computed at $0.45 per hour; horse labor at $0.15 per hour.

Table 8. Net profits per acre in 1941.

Size of stecklings	Spacing	Rep. 1	Rep. 2	Rep. 3	Rep. 4	Rep. 5	Rep. 6	Ave.
Small	18" by 18"	$ 28.33	$-16.91	$-22.19	$ -2.99	$-13.43	$ 2.29	$-4.15
	24" by 24"	7.32	53.04	13.80	17.76	26.88	102.72	36.92
	30" by 30"	27.31	38.71	58.63	64.87	69.07	55.51	52.35
	36" by 36"	41.36	25.64	23.00	22.16	48.32	55.28	35.96
	42" by 42"	-6.73	5.27	24.71	44.15	48.59	60.59	29.43
Medium	18" by 18"	4.04	-8.08	23.24	44.12	58.04	44.12	27.58
	24" by 24"	0.08	34.04	74.48	61.52	74.48	100.64	57.54
	30" by 30"	3.14	44.90	59.54	43.94	50.66	78.38	46.76
	36" by 36"	59.16	63.48	15.60	47.76	43.44	95.76	54.20
	42" by 42"	17.84	23.84	71.60	55.16	41.72	104.48	52.44
Field Run	18" by 18"	12.69	-6.51	49.29	64.89	17.85	54.45	32.11
	24" by 24"	11.27	63.47	66.11	-34.45	56.99	97.55	43.49
	30" by 30"	52.85	61.13	92.57	72.65	69.53	103.01	75.29
	36" by 36"	21.37	63.25	42.37	57.13	54.49	112.93	58.59
	42" by 42"	25.81	37.09	23.65	46.69	66.97	54.97	42.53
Large	18" by 18"	-35.25	-49.17	43.11	27.39	-57.93	-0.45	-12.05
	24" by 24"	-22.94	21.46	20.14	-11.18	29.38	80.26	19.52
	30" by 30"	41.72	64.76	21.92	43.76	62.60	86.72	53.58
	36" by 36"	51.07	31.03	50.23	37.15	115.63	115.63	66.79
	42" by 42"	54.01	27.13	49.57	75.73	72.73	94.33	62.25

Difference required for significance between mean of treatments at 5% level = $23.83; at 1% level = $31.64.

Note: Net profits computed by multiplying the pounds of seed per acre by $0.12 and subtracting the corresponding production costs of table 7.

Medium, large, and field run stecklings show no significant differences in net profits per acre when spaced at the wider spacings. Small, medium, and field run stecklings were not as profitable at the 42" by 42" spacing as they were at the 30" by 30" and 36" by 36" spacings. The large stecklings gave their highest net returns per acre at the 36" by 36" and 42" by 42" spacings.

It is impossible to produce stecklings all of one size. From the data it appears that the ideal would be to grow stecklings from one inch to three inches in diameter. The elimination of the stecklings less than one inch in diameter would make the use of the wider spacings most profitable. Roots three inches and over in diameter are too expensive to store. Thus, it seems advisable to leave the roots less than one inch in diameter in the field and to sell the roots three inches and over in diameter to the sugar beet factories. The use of a single seed beet drill in seeding the steckling crop, combined with the proper planting date and care of the crop, should keep these undesirable sized roots at a minimum. However, if conditions should occur that a large number of roots less than one inch in diameter are produced, it appears advisable to plant them separately at 24" by 24" or 30" by 30" spacings.

RECOMMENDED PRACTICES FOR GROWING SUGAR BEET SEED IN MICHIGAN

The following discussion will take in sequence each step involved in sugar beet seed growing by the method previously described. The suggestions and recommendations are drawn from experiments conducted by the Farm Crops department of Michigan State College, at East Lansing.

Growing Stecklings

In view of the mechanical difficulties in harvesting and storing stecklings, it seems advisable that the stecklings for any one locality be produced by a limited number of growers. Perhaps, an arrangement should be made to furnish stecklings to individual growers at the rate of $25.00 to $30.00 an acre of transplants.

To produce a large number of stecklings of good quality and uniform size per unit of ground seeded, the following recommendations are made. Select a field relatively free from weeds and of a lighter soil type. Great emphasis must be placed on this point if difficulty in harvesting is to be avoided. Prepare the seed bed the same as for a commercial sugar beet crop. Screen the seed to obtain seed balls of a uniform size. Use a single seed beet drill and sow eight pounds of high germinating seed per acre. If a single seed beet drill is not available, use an ordinary beet drill, but increase the rate of seeding to ten or twelve pounds per acre. Sow seed for stecklings between the 25th of May and the 20th of June. Do not thin the beets, but cultivate and hoe often enough to control weeds. Three or four cultivations and one hoeing has proven sufficient under our conditions.

Harvesting Stecklings

To limit excessive hand labor in harvesting the following systems have been devised and used. Begin harvest the latter part of October or as soon as the temperature becomes low enough for storage, but before there is danger of heavy frosts. To avoid excessive heating and spoilage a temperature of between 33° and 40° F. is needed for storage. Remove the tops with a hoe or a mowing machine as close to the crown as possible without injury to the crown. Injury to the crown causes misshaped seed stalks and lower seed yields from the transplants. Windrow the tops with a side delivery rake. Lift the stecklings from the soil with a modified potato digger. This machine has had the blade replaced by an ordinary sugar beet crotch lifter which lifts the stecklings onto the elevator chain where they are shaken free of dirt. The soil must be loose and friable to avoid caking and lumping. The stecklings one inch and over in diameter are picked up and hauled to storage. Throw those roots three inches and over in diameter to the front of the beet rack for delivery to the sugar beet factory. Haul to storage with a minimum of exposure to sun and wind. Spoilage losses in storage are markedly increased by frost injury to the stecklings.

Storage of Stecklings

Storage facilities should be completely prepared in advance of harvest. Store stecklings in root cellars or pit silos, keeping the temperature between 33° and 40° F. if possible. In the present experiment only the root cellar was used. Between 1000 and 1500 cubic feet are required to store each acre of stecklings grown, or 170 to 190 cubic feet for each acre of stecklings to be transplanted at 30" by 30" spacing. Place stecklings in a root cellar

in a layer not over six feet deep, four feet being better. Place a ventilating shaft in every four foot square of stecklings. Keep a careful check on the root cellar to see that the stecklings are not heating or that the temperature does not get below freezing.

Transplanting Stecklings

Transplant stecklings in rich soil as soon as the land can be prepared in the spring. Stecklings can be planted early in April if weather conditions permit, a light frost causing no apparent damage. Fertilize the field by broadcast application, the same as for a commercial crop of sugar beets. Mark the field at the desired spacings, preferably marking in both directions, making it possible to cultivate in either or both directions for weed control. Open the furrows with a furrow opener or transplant with the use of a spade or dibble.* A V-shaped furrow opener was devised and placed on an old subsoiler for opening the furrows at the station and proved very satisfactory. Similar devices could be attached to tractors or cultivators. Avoid exposing stecklings to sun and wind. Keep the stecklings covered with a moist canvas while hauling from storage. Spread the stecklings and transplant immediately. A few minutes exposure to the sun markedly reduces the vigor and resulting seed yield of the plant. Push each steckling into the furrow until the crown is even with the surface of the soil. Firm the soil about the root, but avoid completely covering the crown with dirt.

---

* For limited areas only.

Care of Seed Crop

Keep the field free of weeds. Make a special effort to keep all noxious weeds from going to seed. Watch for and control aphids (Aphis rumicis). If not controlled they will destroy the entire seed crop. Aphids were easily controlled by power spraying with nicotine sulphate (two pints to 300 gallons of water with twelve ounces of dreft added as a spreader). On isolated plants in the experimental plots, aphids were equally well controlled by hand dusting, using three quarters of one per cent rotenone dust. Lady bugs, also, helped keep the aphids under control.

Harvesting the Seed Crop

The mother plants flower the latter part of June, and are harvested about a month later when the seed balls in the center portion of the plant begin to show a brownish tinge. Any delay in harvesting after this stage of maturity markedly increases the loss of seed from shattering. The seed stalks may be cut with either a hand sickle or a mowing machine equipped with pickup guards. If cut with a mower, windrow immediately with a side delivery rake. Harvesting with a mower and side delivery rake results in a higher percentage of seed shattering than harvesting with a hand sickle. Allow the seed to cure for about two weeks and then thresh. A grain separator or a small combine are equally satisfactory for threshing. Reduce the speed of the separator, substitute lip sieves for the grain sieves, and remove part of the concaves to prevent excessive breaking of the seed stalks. Continued care and adjustment of the separator must be practiced to prevent too much seed from going into the straw or too much straw from going into the seed sack.

Seed coming from the thresher contains from 15 to 30 per cent tare. Small pieces of seed stalk are carried into the seed bag in the threshing process and must be removed with special cleaning equipment. The cleaning equipment is too expensive to be owned by individual seed growers. Therefore, the beet seed handling companies usually buy the seed in the uncleaned condition and clean it in their special seed warehouses.

SUMMARY

In this experiment sugar beet stecklings of four sizes were planted in five spacing arrangements, from 18" by 18" to 42" by 42". Yields of seed were determined in each case and costs of production estimated. Two years data are included.

The following points of particular significance may be enumerated.

1. From 45,000 to 60,000 stecklings were grown per acre by seeding in 22 inch rows with 12 pounds of seed per acre.

2. Storage in an unheated root cellar was satisfactory. Storage losses were less than one per cent.

3. One acre of stecklings furnished enough roots to plant seven acres of transplants at 30" by 30" spacing.

4. Stecklings above two inches in diameter were most profitable planted at 36" by 36" or 42" by 42" spacing; smaller stecklings, one to two inches in diameter, were most profitable at the 30" by 30" spacing.

5. The production of stecklings less than one inch in diameter should be avoided, since they were not particularly profitable at any spacing.

6. Equipment for harvesting stecklings and seed, and for transplanting the stecklings was described.

7. In general, high seed yields were obtained only when the sugar beet plant had great vegetative vigor.

8. Under the method of production proposed, it appears that sugar beet seed can be produced as a profitable enterprize in Michigan.

BIBLIOGRAPHY

1. Bird, Samuel, R. Sugar beet seed production studies. Master's Thesis, Michigan State College, 1940.

2. Brown, H. D. General instructions for growing sugar beet seed by the steckling (small beet) method. Unpublished data by Canada and Dominion Sugar Co. Ltd. Chatham, Ontario. 1942.

3. Harris, Frank S. The commercial production of sugar beet seed in Utah. Utah Agr. Exp. Sta. Bul. 136:53-58. 1915.

4. _____ The Sugar Beet in America. New York: MacMillan 1919, pp. 223-230.

5. Kohls, H. L. Small stecklings for seed production. Proc. Amer. Soc. of Sugar Beet Tech. Eastern U.S. Detroit, Mich. 1939.

6. Palmer, Truman G. Sugar Beet Seed (History and Development). New York: John Wiley and Sons, Inc. 1918, pp 48-60.

7. Tracy W. W. Jr. Sugar beet seed growing in the Rocky Mts. States, U.S.D.A. Farmers' Bul. 1152, 1920.

8. Ware, Lewis S. Sugar Beet Seed; New York: Orange Judd. 1898, p. 57.

ROOM USE ONLY