Soil Management Practices for Sugar Beets Grown on Organic Soils

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In 1949 the estimated acreage of sugar beets grown on muck[3] soils in Michigan totaled 7,650 acres[4], representing approximately ten per cent of the total beet acreage. It has been demonstrated repeatedly that high yields of beets can be produced on muck soils with average yields generally higher than those obtained on mineral soils.

The acreage of muck soils in Michigan is estimated at 5,000,000 acres (one acre in eight)[5]. Probably less than two percent of this area is being utilized in the production of cultivated crops at the present time, thus allowing for a considerable expansion of sugar beet production in muck.

A number of factors are associated with the production of high yields of sugar beets on muck soils. Included in this list of factors are soil testing, water control, fertilizer usage, micro-nutrient elements, cultural methods, frost, control of wind damage, the relationship of maturity to sugar content, rotation and variety.

Soil Testing

Sugar beets will grow on muck soils with a wide range in pH. Soil tests for pH should be made on both the surface (0-6 inches) layer and at a twenty-four inch depth. For example, if the subsoil is extremely acid (pH 4.8 or below) the beets become very sprangling and rooty when they reach this acid layer. Generally speaking, when the pH is below 4.8, the addition of lime is advisable, ranging from two to six tons per acre depending on the degree of acidity. It is difficult to get this lime into the lower layers of muck, and the only practical way at present to do this is to spread one-half of the lime on the surface and plow fifteen to eighteen inches deep. Then, apply the other half of the lime after plowing and mix well with the soil by thorough disking. In acid areas burning-off muck is not generally recommended even though the burning will raise the pH of the soil. When muck is burned, there is the loss of the depth of the muck which can further add to the drainage problem.

Water Control

Water control includes both the problem of drainage and also the maintenance of a suitable water level for the crop concerned. The ideal situation is to have water control so that a water table of approximately twenty-four inches can be maintained during the early part of the growing season and then lowered to approximately thirty to thirty-six inches during the latter

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[3] "Muck" includes all organic soils.

[4] Courtesy of P. A. Reeve, Farmers and Manufacturers Beet Sugar Association, and M. G. Frakes, Michigan Sugar Company.

[5] Muck soils are widely distributed over the state and are found in every county. As much as one-third of the total area in some counties is muck.

Table I.—The effect of fertilizer ratios on the yield of sugar beets, Michigan State College Muck Experimental Farm, 1949[1]

Fertilizer	Tons per acre[2]
0-20-10	6.7
0-10-10	6.9
0-10-20	10.3
0-10-30	11.4
0-20-0	1.2

[1] Fertilizer applied at the rate of 500 pounds per acre. Low yields due to late planting date, June 12. Variety 215x216.

[2] Average of 5 replications except 0-20-0 plot not replicated, unfertilized treatment two replications.

part of the growing season. Factors entering into this problem are the use of dams, pumps, tile, and drainage ditches. Sugar beets should not be grown on poorly-drained muck, since poor drainage is one of the more important causes of low yields of poorly-shaped roots. The maintenance of a relatively high water table early in the growing season acts as a frost preventative measure *in* that a wet muck is less frosty than a dry surface. Excessive drainage should be avoided.

Table 2.—The effect of fertilizer placement on the yield and stand of sugar beets, Michigan State College Muck Experimental Farm[1]

Treatment		Tons/acre		Plants/200 ft. of row	
0-10-30 Lbs./acre	Placement	1947	1948	1947	1948
200	2" below seed	16.2	19.4	228	205
200	1" to side of and 2" below seed	.....	20.1	.....	201
200	1" to side of and 1½" below seed	16.8	.....	228	.....
300	2" below seed	16.7	21.1	243	227
300	7" drills, 3½" deep	15.7	19.7	221	190
400	7" drills, 3½" deep	.....	19.1	.....	206
400	1" to side of and 2" below seed	.....	20.2	.....	199
400	2" below seed	15.7	18.2	226	202
400	2" to side and 1½" below seed	16.4	.....	230	.....
600	7" drills, 3½" deep	17.5	19.6	234	208

[1] Cooperative experiment with Mr. G. A. Cumings and staff, Division of Farm Machinery, B.P.I.S.A.E., U.S.D.A., and Professor C. M. Hansen, Agricultural Engineering Department, Michigan State College. Data averages of 4 replications.

Fertilization[6]

Fertilization includes the proper selection of the fertilizer grade, placement of this fertilizer and rate of application. The data in Table 1[7] show the need for a ratio high in postash (0-1-3) .

Because muck soil is high in nitrogen, unless the soil is just fairly well drained, this element is usually not recommended in the fertilizer mixture. In case that the drainage is not the best for beets, a 3-9-18 fertilizer should be used instead of either the 0-10-20 or the 0-10-30.

[6] The data presented in this report for the years 1946-47-48 were obtained jointly by P. M. Harmer, Professor of Soils, Soil Science Department, Michigan State College, and the author.

[7] For practical purposes a difference of 7 percent between "means" of treatment can be considered as statistically significant.

Placement of fertilizer refers to the position of the fertilizer with respect to the seed. When fertilizer is applied at the rate of 1,000 pounds per acre with a grain drill in seven-inch drills and placed three and one-half inches deep, the time of application either before or after plowing is not important since the average yields over a four-year period regardless of treatment were within one-half ton per acre.

Applying fertilizer broadcast on the surface and disking in thoroughly is not as good a method as applying the same amount of fertilizer with a grain drill, three and one-half inches deep and not disturbing the fertilizer bands, with subsequent cultural treatment before planting. This average increase over a three year period was one ton per acre.

Table 3.—The effect of salt on the yield and percent sucrose of sugar beets. Michigan State College Muck Experimental Farm[1]

Treatment No.	Lbs./acre Salt	1947 Tons/acre	1947 Percent Sucrose	1948 Tons/acre	1948 Percent Sucrose	1949 Tons/acre	1949 Percent Sucrose
1	250 annually	13.3	13.1	19.4	15.1	15.5	16.8
2	500 annually	13.7	14.0	19.6	15.6	15.6	16.3
3	500 every 2 years.	13.8	13.5	19.1	15.1	15.8	16.7
4	1,000 annually	13.1	13.7	18.8	16.1	17.1	16.9
5	1,000 every 2 years.	13.1	15.0	19.9	15.6	16.6	16.4
6	750 annually	12.8	15.1	18.1	16.0	16.5	16.8
7	No salt (K2O from mine-run potash)	14.1	14.4	19.3	14.8	16.5	16.7
8	No salt (0-10-50)	12.5	12.9	20.4	15.3	16.0	16.5
9	No salt	12.4	15.3	17.5	15.1	15.0	16.7

[x]A uniform application of 1,000 pounds of 0-10-30 applied on all plots with muriate of potash the source of potash except with treatment 7.

The effect of fertilizer placement and rate of application is demonstrated by the results in Table 2. From these data it would appear that neither band placement of the fertilizer nor rate of application affected significantly the yield of beets. However, a question should be raised regarding these data. These experiments were located on land which had received for the past five or six years an annual application of one thousand pounds of fertilizer per acre. Possibly, the residual effect of this fertilizer is responsible for the failure of fertilizer placement and rate of application to influence yields.

Micro-Nutrient Elements

In addition to the regular fertilizer application, four micro-nutrient elements may be needed. These elements are copper, boron, manganese and sodium.

Copper is supplied in the form of copper sulfate and is recommended on mucks with a pH of 6.5 or less. Generally speaking, the more acid the muck, the more likelihood of obtaining a response to the copper application. If the muck is new, an initial application of fifty pounds per acre of copper sulphate is advisable. If beets are to be grown on muck which has had copper applied previously, possibly no further addition of copper will be

Table 4.—The effect of date of planting on the yield and sucrose content of sugar beets. Michigan State College Muck Experimental Farm[1]

1947			1948		
Planting date	Tons/acre (Ave. of 4 replications)	Percent Sucrose	Planting date	Tons/acre (Ave. of 4 replications)	Percent Sucrose
May 6	19.5	14.8	May 17	19.7	16.7
May 16	17.7	15.4	May 25	17.1	16.0
May 26	18.0	14.4	June 3	15.8	16.5
June 4	16.7	15.1	June 12	13.6	16.7
Ave. decrease per day	0.1		Ave. decrease per day	0.24	

[1] A uniform application of 1,000 pounds of 0-10-30 and 500 pounds of salt per acre applied on each plot. Data averages of 4 replications.

required. A rule of the thumb method to follow in determining whether copper would be necessary in this case is—if a total of three-hundred pounds of copper sulfate has been added to the muck prior to planting the sugar beets, then no copper would be needed in the fertilizer. Oftentimes, sugar beets follow crops in the rotation to which copper has been applied previously.

Boron in the form of borax is recommended for beets. Boron deficiency is more likely to occur on an alkaline muck although it may occur on an acid area. Borax should be added to the fertilizer mixture so that twenty-five pounds of borax per acre are applied on an alkaline muck and ten to fifteen pounds per acre on an acid muck.

Manganese is supplied in the form of manganese sulfate for a number of crops. However, this application of manganese sulfate mixed with the fertilizer has not increased yields of sugar beets even though the beets may show manganese deficiency symptoms. Spraying manganese on the foliage may give results. However, very few sugar beet growers have the spraying equipment available for this purpose. Because of the failure of sugar beets to respond to manganese sulfate mixed with the fertilizer, this practice is not recommended.

The use of salt is recommended for sugar beets grown on muck soils. The data in Table 3 show in general that beets respond to salt. However, the seasonal effect should be pointed out. Greater increases in yield from salt applications were obtained in 1948 than in the other two years. The

Table 5.—The effect of maturity on the percent sucrose and apparent purity of sugar beets. Michigan State College Muck Experimental Farm, 1949[1] [2]

Date	Percent Sucrose	Apparent Purity	Mean Weekly Temperatures		
			Maximum	Minimum	Average
Sept. 6	9.8	80.1	77	49	63
12	11.5	90.4	69	46	57.5
19	10.6	82.2	70	44	57
27	11.9	77.6	65	43	54
Oct. 3	13.5	82.4	71	40	55.5
10	13.8	85.1	73	54	63.5
17	14.0	85.6	68	39	53.5
24	15.4	88.4	67	41	54

[1] Variety 215x216—Planted May 16—Harvested October 28.
[2] Samples analyzed through the courtesy of M. J. Buechlen, Michigan Sugar Company, Lansing, Michigan. Plot yield 18.5 tons per acre at time of harvest. Frost occurred on Sept. 9 and 29; Oct. 1, 13, 15, 16, 19 and 23.

results reported in this table agree very closely with those obtained in 1942 when the experiment was begun. However, all mucks do not respond in the same degree to salt applications. Salt apparently had no significant effect on the percent of sugar in the beets.

Cultural Factors

A good seed bed is essential so that an even stand of beets may be obtained. If the muck is of a loose nature and is newly broken, possibly a heavy roller (six hundred to seven hundred pounds per running foot) will aid in maintaining better moisture relations by compacting the muck. This roller should not be used on mucks which have been under cultivation for a few years.

Table 6.—Results of sugar beet variety trials. Michigan State College Muck Experimental Farm[1]

Variety	1947 Tons	1947 Percent Sucrose	1947 Apparent Purity	1948 Tons	1948 Percent Sucrose
H15	12.5	11.9	80.4		
H18	14.0	11.5	80.0		
H27	11.3	11.8	78.1		
H29	13.3	12.0	80.8		
H69	11.8	12.1	80.8		
215 x 216	12.9	11.1	78.8	20.1	14.4
Muck	12.7	14.4	81.5	16.9	17.3
H125	....	....		22.0	14.9

[1] 1,000 pounds 0-10-30 and 500 pounds salt applied per acre on all plots in 1947 and 400 pounds 0-10-30 (2" below seed) and 500 pounds salt applied per acre on all plots in 1948. Averages of 3 replications in 1947 and 4 replications in 1948. Cooperative trials with Professor H. Kohls, Farm Crops Department, Michigan State College.

One of the most important factors is early planting. A good illustration of the effect of date of planting can be found in Table 4. In 1947, for each day's delay in planting, one-tenth ton fewer beets were produced. In 1948 this average daily tonnage differential amounted to .24 tons. While no apparent effect on sugar content was noted during these two years, in 1946 the sugar content followed very closely the yield changes. Higher sugar content of beets was obtained from the early planting. It is a good practice to plant the beets early and, if frost appears, to replant immediately. The chance of securing higher yields is well worth the chance of having to replant. A recommended range in planting dates for Michigan conditions is between May 5th and May 25th.

A twenty-eight inch row spacing with beets spaced nine to ten inches in the row is recommended. It might be possible to get higher yields with a narrower row spacing but usually the grower does not have his cultivation equipment set for narrow row spacing.

Observations made at the Michigan State College muck experimental farm in 1949 indicate that either the processed seed or the pelleted seed was equal in producing a stand of beets as the whole seed.

One of the big factors in the successful production of sugar beets is weed control. Unfortunately, cultivation of beets during the early part of the growing period may increase the frost hazard. The question arises then

as to whether one should take a chance and cultivate and thus increase the danger of frost injury.

The necessity of wind control measures has been demonstrated many times by the loss of plantings of sugar beets grown on muck. Inter-plantings of either spring rye or barley between every two or three rows of sugar beets may aid in the prevention of damage to stand through wind action. It is also desirable for a muck farmer to consider the use of windbreaks either of willow or possibly Austrian, Scots or White pines. If inter-plantings of small grain are used, care should be taken not to let this grain get too high before cultivating because of the increased amount of labor which would be required to remove the tall grain plants.

Table 7.—Results of sugar beet variety trials. Michigan State College Muck Experimental Farm, 1949[1]

Variety	Leaf Spot	Tons/acre	Percent Sucrose	Apparent Purity
225X226	Trace	14.0	14.5	81.7
471803-00	Trace	16.5	13.4	78.5
471802-00	Trace	14.6	14.1	19.2
11125	Medium	15.9	13.9	79.9
Muck	Very severe	12.5	17.0	86.4
488-00	Slight	15.5	15.3	87.3
U. S. 226	Slight	15.4	13.1	76.4
486-0	Severe	15.7	14.5	78.7

[1] 500 pounds 0-10-30 and 500 pounds salt per acre applied on all plots. Planted May 17. Severe frost injury occurred June 8. Cooperative variety trial with P. A. Reeve, Agricultural Supervisor, Farmers and Manufacturers Beet Sugar Association.

Maturity in Relation to Sugar Content

The data in Table 5 indicate that the percentage of sugar and apparent purity increase as the crop matures during the fall. These data would indicate that a good sugar content of beets can be obtained when grown on muck soils and that this content increases as the fall season progresses.

Variety

The ideal sugar beet variety would be high in sugar, high yielding, resistant to black root and to leaf-spot, well shaped, early maturing, frost resistant and produce a good type root. Obviously, no variety today has all of these characteristics. The data in Tables 6 and 7 summarize the results of our cooperative trials with sugar beet varieties for the past three years. One of the outstanding results in the performance of the various varieties is the high sugar content of the "Muck" beet, a selection of a Polish variety. However, this variety is very susceptible to leaf-spot. It is hoped that this variety might be used as a parent in producing a variety with high sugar and resistance to leaf-spot.

Labor and Harvesting

In the production of sugar beets on any type of soil, hand labor is required. If sugar beets are included in the rotation more efficient utilization of labor required in mint and onion production can result by providing additional hours of work on the farm during periods in which labor requirements for these crops are small. Attention should be called to the advisability of close supervision of the labor during blocking and subsequent

hoeing operations. Beet fields should not be allowed to become excessively weedy before blocking and thinning. This condition can result in loss of otherwise profitable fields.

Fortunately beets grown on muck soils can be harvested successfully by mechanical means. This factor further demonstrates the adaptability of sugar beets for muck soil production.

Rotation

Sugar beets fit well into the rotation in both special crop and general crop types of muck farming. The best place for the crop in a particular rotation is now under investigation with replicated trials at the Michigan

Table 8.—General cultural recommendations for sugar beets on muck.

Spacing:	28" rows—9-10" between plants in the row
Planting Date:	May 5—May 25
Water table:	30-36 inches
Rate of seeding:	10-15 pounds of whole seed or equivalent amounts of either processed or pelleted seed.
Fertilizer Recommendations:	On well drained muck, 400 to 700 pounds per acre of 0-10-30. Apply in 7" drills, 3VI>" deep. If equipment is available to place the fertilizer in a band, 400-600 pounds 2-3 inches below the seed or 1" to the side and 2" below the seed. Do not apply more than 150 pounds of fertilizer per acre in contact with seed. If the muck is only fairly well drained, use a 3-9-18 mixture. —500 to 1,000 povinds of salt annually —10 to 15 pounds of borax per acre on acid mucks and 25 pounds on alkaline mucks —25 to 50 pounds of copper sulfate per acre on acid mucks until a total of 300 pounds per acre has been used —lime—required only with a pH below 4.8; 2-6 tons per acre depending on the acidity and position of the acid layers.

State College muck experimental farm. Data obtained in 1949 showed that beets following potatoes yielded one ton per acre more than when beets followed mint. Possibly this difference could be ascribed to the poorer stand on the plots following mint. These data should not be considered conclusive since only one year's results are available. Likewise in 1949 no significant differences in yields of beets were obtained on plots following either potatoes or onions.

Summary

1. The production of sugar beets on muck soils offers the possibility of profitably increasing substantially the beet acreage in the state of Michigan.

2. A fertilizer high in potash is required for good yields of beets.

3. Micro-nutrient elements are sometimes necessary. Copper, boron and sodium are recommended based on the pH of the soil and previous fertilizer history of the field.

4. Beets should be planted early on muck and for each day's delay in

planting a reduction of as much as one-quarter ton in yield may result.

5. Close spacing is associated with high yields. With a twenty-eight inch row spacing, the beets should be blocked from nine to ten inches in the row.

6. Inter-plantings of small grains and windbreaks aid in reducing losses from wind damage.

7. It is hoped that the plant breeder will produce a variety better adapted to muck soils than those now available.