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SUGAR BEET CULTURE

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SUGAR BEET

CULTURE

SUGAR BEET CULTURE

by H. A. Huston

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SUGAR BEET CULTURE

will be sent free to growers or persons interested in beet growing.

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Sugar Beet Culture

A half century of failure had well nigh convinced the American farmer that the production of sugar from the beet would not succeed here when on the site of one of the most disastrous failures there arose the first successful American Beet Sugar Factory. This was established at Alvarado, California, in 1880, and since that time we have learned that the early failures were due to selection of unsuitable locations in relation to soil, climate, water supply and labor conditions, as well as to bad business management and defective equipment.

So rapid has been the progress of the beet industry in the United States that it now produces about one-fourteenth of the world's beet sugar supply, or one-twenty-eighth of the world's total sugar supply.

In the campaign of 1908-9 there were operated 63 factories, slicing nearly 4,000,000 tons of beets and producing about 500,000 tons of sugar. These factories were located in 16 states, those having more than one factory being California 8, Colorado 16, Idaho 4, Michigan 16, Utah 5, Wisconsin 4, while Illinois, Iowa, Kansas, Minnesota, Montana, Nebraska, New York, Ohio, Oregon, Washington and Arizona have one each, the factory in the last named not being in operation.

On the average about one long ton of sugar is produced per acre.

The factories in operation have a daily slicing capacity of 49,200 tons and those under construction, or, not in operation have an additional capacity of 3,200 tons. The individual factories can slice from 350 to 3,000 tons per day. The two most common capacities are 1,200 and 600 tons. Many of the smaller factories are constructed so as to permit of doubling their capacity at a relatively small cost.

The factories may be roughly arranged in three groups—those of California, of Colorado and neighboring states where irrigation is used, and those of the humid region, of which Michigan and Wisconsin are the most important.

Climatic Conditions

Volumes have been written in regard to the climate, soil, cultural and manufacturing conditions best suited to the industry. While it is true that most of the early failures were due to neglect of these conditions, it is also true that there are a number of local conditions that have had much influence in fixing the three present centers of the industry in the United States.

In general the successful factories here, as well as abroad, are located within 100 miles on either side of a line whose average summer temperature is 70 degrees Fahrenheit.

The distribution of the rainfall in the humid region is also important, a low rainfall in October and November being desirable to permit the ripening and harvest of the beets.

Soils

It has often been stated that any soil that would raise corn would produce beets, but it would be nearer the truth to say that any soil that will raise beets will also produce corn; for there is much corn land that is quite unsuited for beets.

In general, a moderately productive, sandy loam is preferred for beets. But about the factories in the humid section beets will be found growing on every kind of soil from sandy to clay loam, and some good beets have even been grown on muck. On the lighter soils the cost of production, per acre, is less than on the heavier types.

Cultural Methods

Local conditions enter very largely into the preparation of the soil, the distance of planting, and the tillage of the crop. Since the factories usually specify the essentials in their contracts and have field superintendents to advise growers it is no unusual thing to find fields near together, but under contract to different factories, handled in quite different ways. Hence, it is not necessary to go into details upon these matters.

Varieties

Since the factories furnish the seed, the variety is not left to the discretion of the grower, but the factory manager or field superintendent furnishes seed of varieties which seem best suited to the soil conditions of the different fields under contract.

Seed Production

The production of beet seed is a business by itself and is rarely carried on by farmers who raise beets for factory purposes. The experiments on the production of seed in the United States seem to show that seed of good quality can be produced here. But at present most of the seed is imported and, perhaps, the price of seed is not high enough to encourage the outlay required for the proper equipment for producing high grade seed here. The imported seed comes mainly from Germany, smaller quantities being brought from France, Holland and Austria.

Cost of Production

When we recall the very great range in the estimates of the cost of producing a bushel of our most common crops, such as wheat or corn, it is not strange that there should be wide differences in the ideas of farmers as to the cost of producing an acre of a comparatively unknown crop like beets. And soil conditions, labor rates, and familiarity with the work do make a great difference in the cost.

As an offset to this the farmer knows in advance the price he is to secure for his crop and generally has a choice between a flat rate per ton, usually \$4.50 or \$5.00, and a rate of \$4.00 or \$4.50 per ton for beets containing 12 per cent of sugar with 33 $\frac{1}{3}$ cents for each additional per cent. As beets often run over 18 per cent sugar, there is a chance to make a substantial profit by adopting the latter form of contract, and the factories, of course, encourage the raising of

the highest grade beets since it reduces the manufacturing cost. As a rule, however, the beets with the highest sugar content do not produce the largest yield per acre. Hence, much study is given by seed growers to the matter of producing beets that will combine a high sugar content with a good tonnage per acre. Seed which will give good yields of high quality beets under proper conditions may prove disappointing under bad conditions of soil, tillage, season, or manuring.

While the factories instruct the farmers in regard to suitable soils and tillage, even to the extent of sometimes taking charge of all the tillage work from the time the beets are planted until the harvest, there has been too little attention paid to the matter of profitable manuring of the crop. Doubtless this is due in some degree to the opinion commonly held in the irrigated region that water is both food and drink to the plant, while in the humid region most of the beets are grown where the use of commercial plant foods is very little understood.

Under these circumstances, it is not strange that very few factory managers or superintendents have given any serious attention to the question of the most profitable manuring of the crop. Too often it is dismissed as being "unnecessary" instead of inquiring whether it can be made profitable. From time to time, some experiments have been made but often these took the form of testing some manufacturer's "brand" rather than an investigation of the real plant food requirements of the crop. And even when more systematic experiments were undertaken, the time and method of applica-

tion and the proportions used were not such as to give promise of results of practical commercial value to the beet grower.

What the Crop Takes from the Soil

The average yield of beets, per acre, in the United States is between 9 and 10 tons. In the irrigated region yields are, of course, better controlled. In the humid region the yield may range from 5 to 20 tons per acre according to the season and soil.

Ten tons of beets with their tops take from the soil

95 pounds of Potash

22 pounds of Phosphoric Acid

46 pounds of Nitrogen.

The proportions of these present in the roots and in the tops vary with the variety of beet, the season, the ripeness of the roots, and the character of the soil. For average conditions, there would be hauled away in the ten tons of roots

66 pounds of Potash

16 pounds of Phosphoric Acid

32 pounds of Nitrogen,

while that in the tops would remain on the farm.

Farmers' Bulletin 52, United States Department of Agriculture, says: "As to the relation which the quantity of material returned to the soil should bear to the quantity abstracted by the beet, it may be said in general that it is desirable to return as much nitrogen, from one and one quarter to one and a half times as much potash, and two and a half

times as much phosphoric acid as have been removed by the roots. Greater additions of potash and phosphoric acid have no disadvantageous effect on the roots."

On this basis we should supply for each ten tons of roots removed

200 pounds Sulphate of Potash

300 pounds Acid Phosphate

200 pounds Nitrate of Soda (or 250 pounds blood).

On clover sod or on land where a heavy application of manure has been applied the previous year the nitrate or blood may be reduced to one half.

We must remember that the beet is a highly bred plant and as such requires corresponding care in feeding. To obtain the best results it must be supplied

with the right plant foods,
in the right amounts,
in the right form,
in the right way,
at the right time.

What the plant foods are, we already know, and the relative amounts needed have been shown. Since it is important that the beet should make a continuous growth, the plant foods should be in such forms that the beet can use them as needed. This means that they must be soluble or in such loose combination with the soil that the roots can readily take them up. A large amount of unavailable plant food in a soil is of no advantage to the beet and any attempt to increase its availability by turning under green crops or apply-

ing heaving dressings of barnyard manure the same season that the beets are raised, will result in a crop of low sugar content.

On most beet soils both potash and phosphoric acid compounds can be profitably used, and on many, nitrogen compounds are also profitable, but must be used with discretion.

The beets themselves have means of letting us know whether they are hungry for certain plant foods, and if we will carefully examine the fields through the growing season we may get some very valuable hints in regard to what is needed to so supplement the soil supply as to make a properly balanced ration for maximum sugar production.

If the leaves turn yellow before maturity, a lack of nitrogen is shown.

If phosphoric acid is deficient, the leaves do not assume the usual lighter shade at maturity, but wither while still retaining their dark green color, and reddish colored spots on the edges of the leaves are sometimes seen although these are not very conspicuous. In case of both nitrogen and phosphoric acid hunger, the size of the leaves is much reduced in the early stages of growth.

When there is a lack of available potash, the leaf growth may be quite strong up to the time that cultivation ceases and the color may be rich dark green. But development is checked rather suddenly at a time when the roots should increase rapidly in size. The leaves do not ripen normally, but bear yellow spots, which later become brown. The leaves are inclined to curl and wither quickly in the sunshine.

Experiment by Mr. S. Godbold, Charlevoix, Mich.
Right, no fertilizer, yield 7 tons; test 15.8 per cent.
Left fertilized with 500 lbs. per acre of complete fertilizer containing 10 per cent
potash, yield 10 tons; test 16 per cent.

EXPERIMENTER	Acre No.	Fertilizer used—pot	
		Sulphate of Potash	Acid Phospha
LOUIS KAIN, Owendale, Mich. Clay Soil.	1	.....	.....
	2	40	100
	3	.....	100
WM. EMORY, Caro, Mich. Sandy Loam.	1	.....	.....
	2	50	125
	3	.....	125
FRED HUTCHINSON, Owendale, Mich. Clay Loam.	1	.....	.....
	2	80	200
	3	.....	200
SAGGERS BROS., Holland, Mich. Clay Loam.	1	.....	.....
	2	66	165
	3	.....	165
AUGUST WEARSHKY, Sebewaing, Mich. Clay Loam,	1	.....	.....
	2	40	100
	3	.....	100
E. H. HUME, Lansing, Mich. Clay Loam.	1	.....	.....
	2	100	250
	3	.....	250
C. A. TAGGETT, Caro, Mich. Clay Loam.	1	.....	.....
	2	100	250
	3	.....	250
A. BEATTIE, Charlevoix, Mich. Clay Loam,	1	.....	.....
	2	100	250
	3	.....	250
E. GRAHAM, Charlevoix, Mich. Clay Loam.	1	.....	.....
	2	100	250
	3	.....	250
WM. SHAPTON,, Charlevoix, Mich. Clay Loam,	1	.....	.....
	2	90	225
	3	.....	225
S. GODBOLD, Charlevoix, Mich. Sandy Loam.	1	.....	.....
	2	100	250
	3	.....	250
CHAS. W. HESS, Sebewaing, Mich. Clay Loam.	1	.....	.....
	2	100	250
	3	.....	250

per acre	Yield net pounds per acre	Increase in pounds over unfertiliz'd	Sugar in Beet % (test)	Value of Increase \$	Cost of Fertilizer \$	Profit from Fertilizer \$	\$1 spent for Potash returned \$
Blood							
.....	26,240	.....	14.7	.....	.....	.....	.....
32	37,200	10,960	17.9	49.49	3.00	46.49	39.42
32	27,760	1,520	16.	10.07	2.00	8.07	.....
.....	6,400	.....	16.5	.....	.....	.....	.....
40	13,140	6,740	16.3	19.76	3.75	16.01	7.22
40	10,320	3,920	15.9	10.73	2.50	8.23	.....
.....	28,000	.....	14.0	.....	.....	.....	.....
64	36,000	8,000	17.8	43.36	6.00	37.36	10.67
64	32,000	4,000	16.2	22.02	4.00	18.02	.....
.....	24,560	.....	16.1	.....	.....	.....	.....
53	27,600	3,040	17.3	14.45	5.00	9.45	15.26
53	26,000	1,440	12.6	-10.98*	3.34	Loss	.....
.....	14,160	.....	16.5	.....	.....	.....	.....
32	20,820	6,660	17.1	22.06	3.00	19.06	22.16
32	14,540	380	16.	— .10*	2.00	Loss	.....
.....	31,240	.....	13.4	.....	.....	.....	.....
80	30,500	Loss	15.	6.25	7.50	Loss	3.55
80	30,800	Loss	13.1	— 2.63*	5.00	Loss	.....
.....	16,000	.....	15.2	.....	.....	.....	.....
80	22,000	6,000	15.2	16.71	7.50	9.21	2.51
80	20,000	4,000	15.	10.44	5.00	5.44	.....
.....	14,920	.....	15.	.....	.....	.....	.....
80	21,400	6,480	15.	17.82	7.50	10.32	4.14
80	17,320	2,400	15.3	7.47	5.00	2.47	.....
.....	14,200	.....	16.2	.....	.....	.....	.....
80	17,040	2,840	17.5	12.04	7.50	4.54	2.78
80	15,840	1,640	16.3	5.08	5.00	.08	.....
.....	14,400	.....	15.1	.....	.....	.....	.....
72	18,000	3,600	15.4	10.85	6.75	4.10	2.54
72	16,344	1,656	15.	5.13	4.50	.63	.....
.....	13,960	.....	15.8	.....	.....	.....	.....
80	20,200	6,240	16.	18.60	7.50	11.10	4.57
80	17,480	3,520	14.8	7.18	5.00	2.18	.....
.....	18,524	.....	15.1	.....	.....	.....	.....
80	20,632	2,108	17.4	13.77	7.50	6.27	1.45
80	19,796	1,272	17.1	10.15	5.00	5.15	.....

*Loss.

EXPERIMENT BY WM. EMORY, CARO, MICHIGAN

No Fertilizer.

Fertilized with 250 lbs. per acre of
Complete fertilizer containing 10 per
cent of potash.

Fertilized with Nitrogen and Phos-
phoric Acid.

If the deficiency of potash is very marked, the leaves become narrow and the plants are especially susceptible to the bacterial disease which manifests itself by curiously crumpled, small leaves and by dark rings in the root. This disease is quite common in American beet fields. But since most of the diseased beets have lost their tops before harvest, it is frequently overlooked. A diseased beet, which still retains its top, seldom contains over 10 per cent of sugar.

Sources of the Plant Food

If barnyard manure is to be used to supply nitrogen to the beet, experience has shown that it should be applied from six months to a year before the beets are planted.

Where manure, or, green crops are plowed under at the time the beets are planted, there is an excessive growth of leaf and the beets are so late in maturing that the sugar content is seriously reduced.

On the other hand, if nitrate of soda is used it may be applied after the beets are growing, provided the quantity be not too great.

As a source of phosphoric acid, acid phosphate, dissolved bone black, and acidulated bone are suitable and basic slag is good where it can be obtained. The excess of lime in the slag may be of benefit on some soils, for the beet contains considerable lime. If bone is used it should be as finely ground as possible, but it acts rather too slowly.

Not only is potash the most abundant plant food in the beet, but it has a special work to perform in connection with

Field of Wm. Emory. Complete fertilizer with 10 per cent potash on right. On left no fertilizer, with bad stand and unprofitable yield.

the formation of the substance that gives the root its value—the sugar. During the last four weeks of growth the beet must not only increase in size but must manufacture and store a large amount of sugar. To do this successfully there must be present, in available form, enough potash for both leaves and root.

If crude salts, like Kainit, are used, it is, perhaps, better to apply them the previous fall. But as the refined salts are mostly used for beet culture, they may be used at, or just before, planting time.

Potash (K) improves the size, yield, shape and sugar content.

The sulphate of potash is generally used in sugar beet mixtures.

On land which has been cropped for a long time without any application of potash salts, it occasionally happens that a moderate application of potash salts seems to produce no increase in the yield of beets while a much heavier application is quite effective. The explanation of this seems to be that the beet is not a vigorous forager for potash and that the soil hunger for the potash is such that it fixes a certain amount too firmly for the beet to get it, but when this amount is exceeded the remainder is available to the beet. Hence, the importance of using a liberal amount of potash for the first application, and of maintaining a suitable reserve in the soil.

Amounts to Use

Most of the plant food used in America is in the form of ready mixed fertilizers. For beet culture a suitable formula for typical loam or sandy loam soils is

Nitrogen	2 per cent
Available Phosphoric Acid..	7 per cent
Potash	10 per cent

Of this, from 500 to 1,500 pounds per acre may be used.

O. No fertilizer, yield 13.2 tons; test 14.7 per cent.

KPN. Complete fertilizer with 10 per cent potash, 200 pounds per acre, yield 18.6 tons test 17.9 per cent.

PN. Fertilized with Nitrogen and Phosphoric Acid but no potash; 16.9 tons; test 16.0 per cent.

The crates contain the yield from $2\frac{1}{2}$ square rods of each plot. In this experiment one dollar spent for potash returned thirty-nine dollars and forty-two cents.

The actual plant food in a ton of this goods would be obtained by mixing 1,000 pounds of 14 per cent acid phosphate, 400 pounds sulphate of potash, and 300 pounds of dried blood. Instead of blood, 200 pounds of sulphate of am-

monia may be used to furnish the nitrogen, or 275 pounds of nitrate of soda. If nitrate of soda is used the mixture must be distributed as soon as made, or the nitrate may be held out and applied later. One may easily increase the potash in mixed goods of too low grade. To increase the potash one per cent add two pounds of sulphate (or muriate) of potash in each one hundred pounds of the fertilizer. Thus to bring goods with only five per cent of potash up to ten per cent, add ten pounds of sulphate of potash to each ninety pounds of the fertilizer.

Method of Application

If the seeders have a fertilizer attachment, 100 to 200 pounds, per acre, may be drilled in with the seed and the remainder may be applied broadcast before harrowing. There is no danger that any of the ingredients, except nitrate of soda, will be lost by leaching so the broadcast application may be made as soon as the land is plowed, and if fall plowing is used it would be quite safe to apply the potash salts and the phosphate at that time.

Beet seed is often sown with an ordinary grain drill, only every third delivery tube being left open for the seed. In such cases the fertilizer may be applied at the same time by using a grain drill with the usual fertilizer attachment. All the delivery tubes in the fertilizer attachment are left open, thus practically combining drilling in the row with broadcasting, a method that finds much favor where it is desired to force the young beet plants ahead of the weeds and at the same time provide a wider distribution of the plant food at the time the sugar is forming most rapidly.

Any excess of mineral fertilizer not used by the beet crop will be available for the following crops. The marked increase in the yield of grain that followed the introduction of the sugar beet industry in Europe was due quite as much to the heavy fertilization as to the improved tillage.

Plant foods are used in beet culture to increase the yield, to improve the sugar content, to secure a full stand, and to make the beet outgrow the weeds and permit earlier thinning. For these purposes the fertilizer must be properly balanced for the crop, and the previous treatment as well as the composition of the soil must be taken into consideration.

American farmers when first experimenting with fertilizers are quite apt to begin with bone because it is a familiar material and readily obtained. It contains nitrogen and phosphoric acid but *no potash*.

Facts from Field Tests

Some experiments conducted in Michigan in 1907 and 1908 may illustrate the profits of a properly balanced fertilizer on the beet crop.

The plan was the simplest and plainest possible; on one acre no fertilizer was used, on the second 500 pounds of a complete fertilizer containing 2 per cent of nitrogen, 7 per cent phosphoric acid and 10 per cent potash, while on the third acre 500 pounds of a fertilizer with 2 per cent nitrogen, 7 per cent phosphoric acid, but no potash, were used.

By comparing acre one with acre two we learned whether a complete fertilizer would be profitable, and by compar-

ing acre two with acre three the effect of the potash could be learned. See table, page 12.

The experimenters used the fertilizer at the rate of from 200 to 500 pounds per acre. The seasons at most points were unfavorable, the drought during August not permitting a continuous growth or the plant food to be used to the best advantage. On this account the lighter applications of fertilizer may have made a relatively better showing than the heavier ones.

The profits are calculated on the basis of \$4.50 for 12 per cent beets and 33 1/3 cents for each additional per cent of sugar in the beet.

The profits are certainly enough to justify the continued use of fertilizers and the *improvement* in both *yield* and *sugar content* due to the potash is *very striking and shows excellent profits*.

In the case of Mr. Hume's experiment a slight loss in yield was more than compensated by the increase in sugar on the plat with the potash fertilizer, while a loss of \$2.79 on plat 3 fertilized only with nitrogen and phosphoric acid was converted into a gain of \$6.24 by adding the potash.

Throughout all the experiments, the use of potash has the effect of increasing the profits out of all proportion to its cost, and the use of a fertilizer containing 10 per cent of potash is fully justified.

The Michigan Experiment Station has conducted many systematic sugar beet experiments with fertilizers and barn yard manure and sums up the results by a statement that no single element or two element fertilizer is as profitable as a

Experiment by A. Beattie, Charlevoix, Mich. Fertilized with Nitrogen and Phosphoric Acid. (See page 12.)

complete fertilizer for beets and that the proper commercial fertilizer is better than barnyard manure, because the manure while producing in some cases somewhat better yields always produced beets of such low sugar content and purity as to make the amount of sugar per acre, and the money secured from the crop, less with the manure than with the fertilizer. In these experiments the equivalent of 500 pounds of 4-7-9 goods was compared with 20 loads of manure, the manure containing over 5 times as much plant food as the fertilizer.

The Wisconsin Experiment Station in summing up the results of fertilizer tests states—Rpt.—1905—“It will be noted that there was a marked improvement both in the yield and

Experiment by A. Beattie, Charlevoix, Mich. Fertilized with Complete fertilizer containing 10 per cent potash. (See page 12.)

the quality of the beets grown on the fertilized half of the field as compared with the results for either of the plats which received no fertilizer, the average sugar content of the beets on the unfertilized plats being 16.9 per cent and on the fertilized plats 17.3 per cent; the average purity on the unfertilized plats being 89.1 and on the fertilized plat 90.2. Through the application of fertilizers the yield of beets was increased by 41.9 per cent and the yield of sugar per acre was increased by 47.3 per cent over the corresponding figures of the unfertilized plats."

The New York (Geneva) Experiment Station, Rpt. 1898, shows that from 500 to 1,500 pounds per acre of complete

commercial fertilizer are profitable on sugar beets but that twenty tons of barnyard manure did not increase the crop enough to pay for the cost of hauling and distribution.

Potash Not Injurious to the Quality of the Beet for Sugar Making

It is sometimes claimed that potash salts impair the purity of the beet juices and, hence, tend to interfere with the separation of the sugar in the factory.

If proper amounts of potash salts of high grade are used at the right time there need be no fear from this source. Very large applications of crude potash salts at planting time might have this effect; but any soluble salts used at that time would have the same effect. As mentioned above, if crude salts, like Kainit, are used on beet fields it is better to apply them some months in advance of planting.

The continued use for 15 years of considerable quantities, from 100 to 200 pounds, per acre, each year at the time of planting, of even muriate of potash in addition to acid phosphate and sulphate of ammonia was shown by the Indiana Experiment Station to produce beets of higher purity, better form and greater yield than were produced on the plats fertilized with barnyard manure or on those receiving no fertilizer.

If the right plant foods are used at the right time, in the right proportions, there need be no fear that the increased yield will be at the expense of sugar making value.

H. A. HUSTON.

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