Side-Dressing Sugar Beets with Nitrogen in Western Montana

EDWARD L. SWIFT[1]

Beets for the Missoula factory are produced largely in four small mountain valleys, at altitudes from 3,000 to 4,000 feet. These valleys are in western Montana and are within 100 to 200 miles of the Canadian border. About 20 percent of the acreage is grown east of the Continental Divide in the Missouri River Valley, and the balance on the western slope in the upper Columbia River Basin.

During recent years definite symptoms of nitrogen deficiency have been observed in many sugar beet fields in the Bitter Root Valley of western Montana. Although there is a considerable amount of livestock feeding, there is never enough manure produced to fertilize all the beet land. It has been standard practice to apply 100 pounds of treble superphosphate (0-43-0) per acre and to broadcast this fertilizer with a grain drill before beet planting.

In 1941 Ai'anasiev and Morris *(1)*[2] conducted fertilizer experiments in cooperation with several growers in the Bitter Root Valley and from these preliminary tests determined that 20 pounds of nitrogen in the form of ammonium sulphate, either side-dressed or applied before seeding, increased sugar beet yields about 10 percent.

During the 1944 and 1945 crop seasons, field tests were conducted comparing varying amounts of nitrogen applied to 16- to 20-row strips of beets after thinning was completed. The results of these tests and the method of application are herein reported.

1944 Results

Two fields were selected for side-dressing experiments in 1944. One was a sandy loam field of average fertility, unmanured, and the other was a low-fertility field manured at the rate of 10 tons of cattle manure per acre. Each field received 150 pounds of treble superphosphate before planting. The nitrogen was applied in the form of ammonium sulphate between the rows on July 7. Strips as harvested were 12 rows wide and are summarized in table 1.

These tests indicated that there was a great deficiency of nitrogen, particularly in the field which was not manured. Further, evidence was obtained that improved yield and greater profit could be obtained from applying nitrogen in amounts greater than 20 pounds per acre.

[1]Agriculturist, American Crystal Sugar Company, Missoula, Mont.
[2]Italic numbers in parentheses refer to literature cited.

Table 1.—Effect of side-dressing of varying amounts of nitrogen on yield and quality of sugar beets, 1944.

Treatment,	No manure Average fertility Tons beets per acre	Manured Low fertility Tons beets per acre	Sucrose percentage
82 pounds nitrogen	15.06	13.27	18.7
41 pounds nitrogen	33.59	12.57	18.2
Check, no nitrogen	11.33	11.63	18.7

1945 Tests

In 1945 it was found impossible to purchase side-dressing equipment for use in large-scale tests. Therefore the American Crystal Sugar Company built three machines: A three-row, a four-row, and a six-row machine. The four-wheel tractor was adjusted to straddle three beet rows. With this arrangement it was possible to use six openers and fertilize every center in the six-row plantings. To side-dress every middle with a three-wheel "Farmall" type tractor, it is necessary to straddle an even number of rows and to use an extra opener. Both outside cans feed half speed and lap back each row, the same as when cultivating.

Several growers also built machines, most of which proved satisfactory. The most practical of these units was built on the rear bar of the regular tractor cultivator and applied fertilizer as the tools on the front bar cultivated. Five openers were used on this four-row machine. The outside cans fed half as much fertilizer as the others, and the machine lapped back each round while cultivating. Several types of shoe and one disk opener were tried on these units, and the one adopted was similar to the shoe designed by Jones *(4)*. It was found, however, that even this narrow shoe, which was less than three-fourths of an inch thick, when travelling at speeds higher than 4 miles per hour moved enough dirt 1o cover small beets 10 inches away. Grinding off the two "left wings'' on the diamond point partially corrected this, but it was necessary to shield the row when side-dressing very small beets. Covering of beets was not a factor with the machines that side-dressed as the operator cultivated, as it was not possible to operate the cultivator at a high rate of speed. Less dirt was moved when the shoe was placing the fertilizer 4 inches deep than when it was adjusted for shallow operation. All fertilizer was drilled from 3 to 4 inches deep in the center between the beet rows.

To check the results obtained in 1944 and to try even higher rates of application of nitrogen, one strip test was conducted in 1945 on a field of good fertility. This field had been planted to beets in 1944, and the beet tops plowed under in the fall. An application of 200 pounds of 6-30-0 was applied before seeding in 1945.

In this test nitrogen was applied in one application on May 30, after thinning, ammonium, nitrate being the source of nitrogen. Results are given in table 2.

Table 2.—Effect of side-dressing of varying amounts of nitrogen on yield of sugar beets, 1945.

Treatment	Tons per acre
201 pounds nitrogen	22.16
134 pounds nitrogen	19.90
67 pounds nitrogen	18.48
Check, no nitrogen	16.20

At the time the strips were harvested there were three very distinct shades of green in the field, ranging from the very dark green of the heavy treatment to a light green in the strip with the light application. The check was very yellow. The appearance of the two heavily treated strips did not indicate that all of the nitrate had been used or leached through the soil.

Many of the growers who used side-dressing equipment to apply nitrogen left an unfertilized check strip through their commercial fields in 1945. In table 3 are given the acre yields of three of these fields, one being a field low in fertility, the second average, and the third high in fertility. Applications on these fields were made with ammonium nitrate (33.5-0-0).

Table 3.—Grower tests of nitrogen fertilizer, 1045.

	Yield in tons beets per acre		
	Low fertility	Average fertility	High fertility
Treatment	Unmanured	Unmanured	Manured
67 pounds nitrogen	5.48	12.81	22.46
Check, no nitrogen	4.23	11.10	21.28
Increase in tonnage	1.25	1.71	1.18
Percent increase	29%	15%	5%

Results of these trials indicate that the farmer with average fertility land made a larger increase in tonnage than the grower with very low or very high fertility fields. The percentage increase was higher in the low fertility field, but the percentage return on the fertilizer dollar invested was less.

One grower side-dressed 67 pounds of nitrogen in two applications. The first application of $33^1/_2$ pounds was applied just after thinning, and the second application of a like amount was applied in the final cultivation. Although no data from this grower test was obtained, it appears reasonable that in using very large amounts of nitrogen per acre, especially in the form of ammonium nitrate, two lighter applications should be made during the growing season rather than one heavy early application. Carlson (2) and Gardner and Rob-

ertson *(3)* both concluded that beets make their great demand for nitrate in August and September and assimilate more nutrients during those 2 months than during any other similar period. It is important to have adequate nitrate available during July and August, and this could be accomplished by spreading the side applications of nitrogen over a longer period, of time.

Discussion

The results of preliminary tests indicated increased yields could be obtained by a moderate application of nitrogen fertilizers. These tests stimulated such wide interest among growers that in 1945 about 3,000 acres of beets were side-dressed, mostly with ammonium nitrate, at an average rate of 67 pounds of nitrogen per acre. This represents a substantial portion of the Missoula factory acreage.

Although purities on individual fields were not obtained, the indications are that nitrogen applied during the 1945 season did not have a detrimental effect on the quality of the beets. Purity of juice was 88.4 in 1945 as compared to the 8-year factory average of 88.7. The average sugar percentage for the Missoula factory was the highest of the five factories in the state of Montana, and was 0.19 percent above the past 8-year factory average.

In the light of the foregoing it is of interest to note the conclusions of Ulrich (5) : "In some environments, beets high in nitrogen may also be high in sugar, and likewise in another environment beets low in nitrogen could be low in sugar. The conditions which favor the storage of sugar by beets, even when the nitrogen supply is high, would occur in localities where sunlight is intense, the days warm to hot, and the nights cool. Under these conditions, photosynthesis would be at a maximum, and respiration would be at a minimum, thus resulting in the formation of sugar faster than it can be utilized to form new tissues (leaves and roots), even when large amounts of nitrogen are available for growth. (Other nutrients are assumed to be adequate)." These qualifications all apply to western Montana, where there are cool nights and long, warm days with intense sunlight.

Looking ahead to 1946, there is a strong possibility that well over half of the beet acreage for the Missoula factory will be side-dressed with nitrogen fertilizers. In the Bitter Root Valley the percentage will be much higher. For 1946 experimental work it is planned, to conduct tests with both ammonium nitrate and ammonium sulphate as to the most efficient source of nitrogen and the timeliness and rate of application. Tests with other fertilizer combinations will also be made.

Summary and Conclusions

A nitrogen deficiency exists in many beet fields in western Montana in the lighter-textured soils. Field tests conducted in 1944 demonstrated applications of more than 20 pounds nitrogen per acre produced the most profitable increases in beet yield. In 1945 about 3,000 acres of beets were side-dressed with ammonium nitrate or ammonium sulphate, the average application being 67 pounds nitrogen per acre. With the greater availability of side-dressing equipment, nitrogen will be applied in lesser amounts in two or three applications during the early part of the growing season to reduce losses due to leaching and to make for a more balanced feeding of the plant. Nitrogen applied to fields of low, average, and high fertility levels produced largest increases in beet yields from fields of average fertility. The percentage sucrose and purity were not affected adversely because of nitrogen fertilization. A very material increase in the use of nitrogen will be made in the fertilization of the beet crop in western Montana in 1946.

Literature Cited

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