Time and Method of Fertilizer Application

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During the past 5 years more than 350 field tests have been conducted with farmers to investigate the soil fertility problems in areas in which the Utah-Idaho Sugar company operates. These tests have investigated kind of fertilizer, rate of fertilizer, time of applying fertilizer, and methods of making the fertilizer placement. Some of the results of these tests have been given at previous meetings of the Sugar Beet Technologists.

In these previous reports it has been pointed out that fertilizer rates and ratios which supply from 60 to 80 pounds of nitrogen per acre and 45 to 60 pounds of P_2O_5 per acre have given the greatest yield increases. Consequently, we are now recommending the general use of 400 pounds per acre of such fertilizer mixtures as 14-13-0, 15-11-0, and 22-15-0. These three mixed fertilizers provide all the elasticity that is necessary in our area to fit the fertilizer recommendations to the needs of the various farms.

The present paper is a summary report of all the tests which furnish information relative to time and method of applying fertilizer in connection with sugar beet production.

AREA IN WHICH TESTS WERE CONDUCTED

Tests reported in this paper were conducted in Utah, Idaho, Washington, Montana, and South Dakota. All sugar beets grown in the areas under consideration are grown under irrigation. In some of the areas the first irrigation is applied prior to thinning, in some other areas beets are not irrigated until from two to three weeks following thinning.

EXPERIMENTAL RESULTS

Tests in 1946

Four tests were conducted in 1946 comparing the yield response from 300 and 600 pounds of 16-20-0 applied at the following periods: Planting time, thinning time, last cultivation (July 4 to 15), and split application (one-third of the fertilizer applied at each of the other 3 periods compared). Fertilizer applied at planting time was banded in 6 inches from the press-wheel mark with the same side-dresser which was used to apply the later treatments.

The results of these four tests are shown in Table 1. The average yield increase from 300 pounds of 16-20-0 was 1.93 tons per acre, and the average yield increase from 600 pounds of 16-20-0 was 2.93 tons per acre. Time of application had no significant effect on the fertilizer response. The highest average yield, 18.99 tons, was obtained from plots receiving fertilizer at planting time. The lowest average yield, 18.56 tons per acre, was obtained on the plots w4iere the fertilizer was put on in split applications.

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Table 1.—Effect of Time of Application on the Yield Response Obtained from 300- and 600-pound applications of 16-20-0. Results are Averages of 4 Field Tests Conducted in Widely Separated Areas.**—

Amount of Fertilizer Applied	Planting Time	Thinning Time	Last Cultivation	Split Application*	Combined Average Yield
300 Pounds of 16-20-0	18.14	18.47	18.42	18.06	18.27
600 Pounds of 16-20-0	19.84	19.29	19.09	18.87	19.27
Average Result	18.99	18.88	18.74	18.56	18.77
Yield of the Check	16.34	16.34	16.34	16.34	16.34

* Split application consisted of one-third of the amount of fertilizer applied at each of the 3 other periods compared.
** Each yield figure shown is the average of 8 replicated plots. Plots were 8-row strips. Entire strip harvested for yield data.

Tests in **1947**

Following the tests in 1946, the question was raised as to whether the result would have been the same if the phosphate had been applied early in all cases and the nitrogen applied at later periods. Consequently, in the 1947 tests all phosphate was side-dressed at planting time. On one-half of the plots the nitrogen was also side-dressed at planting time; on the other half of the plots the nitrogen was side-dressed after thinning.

There was a total of 30 tests with 3 replicated plots of each treatment in each test. The various fertilizer treatments compared at each date of application are shown in Table 2.

The results of these tests confirm the results obtained in 1946. The average response of nitrogen over the checks was 2.56 tons per acre. The average yield increase from nitrogen plus phosphate was 2.93 tons per acre. Time of application had no significant effect on the response. The average yield for fertilizer banded in at planting time was 18.16, and the average yield for fertilizer side-dressed after thinning was 18.17 tons per acre.

Table 2.—Yield Response Obtained from Various Combinations of Nitrogen and Phosphate, Comparing also the Effect of Adding the Nitrogen at Planting Compared to Side-dressing after Thinning.

Fertilzer Treatments Compared	Nitrogen Banded in at Planting Time	Nitrogen Side-dressed After Thinning***	Combined Averages
1. Check (No fertilizer treatment)	1597	15.97	15.97
2. 200 pounds of 32-0-0 (ammonium nitrate)	18.16	18.42	18.29
3. 400 pounds of 16-20-0*	18.53	18.76	18.65
4. 400 pounds of 32-0-0 (ammonium nitrate)	18.84	18.72	18.78
5. 600 pounds of 22-14-0**	1929	19.00	19.15
Combined Averages	18.16	18.17	18.17

* 200 pounds of ammonium nitrate plus 200 pounds of treble superphosphate
** 400 pounds of ammonium nitrate plus 200 pounds of treble superphosphate
*** All phosphate was applied in bands 4 inches deep and 6 inches from presswheel mark at planting time. Nitrogen was side-dressed after thinning on this set of treatments.
All figures shown in the above table are averages of 30 field plots with 3 replicated plots of each treatment in each plot. Plots were 8 to 12 row strips. Entire strip harvested for yield data.)

FALL.VERSUS SPRING APPLICATIONS

The fact that all prior tests had indicated that fertilizer might be put on *in* one heavy pre-planting application raised the question as to how far ahead of planting this application might be made. In view of the fact that

it would be advantageous to lengthen out this period even to the fall before, if possible, tests were set up to measure fertilizer response from fall as compared to spring applications. The complete set of treatments compared and the results of the tests are shown in Table 3.

It is evident from the data in this table that banding fertilizer into the seedbed in the fall of the year gave just as good results as did spring applications.

In areas of low winter moisture, such as is found in the areas where these tests were conducted, there is no apparent loss of fertilizer during the winter months.

Table 3.—Comparison of the Yield Response from Fertilizer Applied to the Seedbed in the Fall as Compared to Spring. All Fertilizer was Banded into the Seedbed about 4 inches Deep.

Kind and Amount of Fertilizer Applied Per Acre	Applications Made in the Fall	Applications Made in the Spring	Combined Averages
Check (Unfertilized plots)	16.89	16.89	16.89
200 pounds of 32-0-0 (ammonium nitrate)	18.95	18.33	18.64
400 pounds of 32-0-0	19.78	19.00	19.39
400 pounds of 16-20-0*	19.21	19.01	19.11
600 pounds of 22-15-0**	20.05	19.68	19.87
Combined Averages	19.02	18.58	18.80
Number of Replicated Plots of Each Treatment	10	10	20

Note: The above results included tests in Washington, Montana and South Dakota.
* 200 pounds of ammonium nitrate plus 200 pounds of treble superphosphate
** 400 pounds of ammonium nitrate plus 200 pounds of treble superphosphate

Tests in 1948 and 1949

In 1948 and 1949 tests which were designed to give further data on the effect of time and method of fertilizer application were conducted in all areas in which the Company operates. The first group of these tests was designed to compare the effect of banding fertilizer into the seedbed before planting with broadcasting fertilizer and working it into the surface of the seedbed, and both of these methods were compared with side-dressing after thinning. The complete set of treatments and the yield results obtained are shown in Table 4.

The average results of these two years of extensive tests indicate that it is just as well to band fertilizer into the seedbed before planting as to wait and side-dress after thinning. Fertilizer broadcast and worked into the surface of the seedbed was not as good as either of the banding treatments.

In connection with the banding in of fertilizer ahead of planting, one of the questions frequently asked is, "How important is depth of application, and what can the distance between bands of fertilizer be?" Field tests were conducted in which width between fertilizer bands as well as depth of fertilizer bands were investigated. The complete set of treatments and the results obtained are shown in Table 5.

When fertilizer was banded in 4 inches deep there was no advantage to having the fertilizer in bands 10 inches apart as compared to bands 20 inches apart. There was a consistent difference in favor of banding fertilizer

4 inches deep as compared to banding at a 2-inch depth. On a few plots there was some evidence of damage to the germinating seeds from the shallow pre-banded fertilizer. No damage was noted on plots where the banding was at the 4-inch depth.

In the above test a uniform rate of mixed fertilizer (400 pounds of 14-14-0) was used on all treatments. It was felt that it would be important to determine whether or not kind of fertilizer would have influence on the importance of depth of fertilizer application. Consequently, in a second series of tests sugar beets were side-dressed at varying depths with mixed fertilizer with nitrogen alone and with phosphate alone. The treatments

Table 4.—Effect on Yield Response on Sugar Beets of Commercial Fertilizer Applied by Different Methods. Uniform Application of 14-14-0 Mixed Fertilizer Applied on all Plots Except on Checks.

Method of Application Compared	Tests in 1948	Tests in 1949	Weighted Averages
Check (Unfertilized plot)	14.52	16.18	15.83
Side-dressed after Thinning	15.81	17.83	17.40
Broadcast and Worked into Surface of Seedbed	15.06	17.34	16.85
Banded into Seedbed before Planting	15.69	17.85	17.39
Fifty Percent Broadcast plus Fifty Percent Side-dressed	15.58	17.77	17.30
Total Number of Replicated Plots of each Treatment	**16**	59	75

were compared and the results obtained are shown in Table 6.

The results of these tests indicate that kind of fertilizer had very little influence on depth of placement. Broadcasting gave the lowest response (.92 tons per acre). Side-dressing 2 inches deep was next, with an increase over the check of 1.15 tons per acre, and side-dressing 4 inches deep gave the highest yield with an increase of 1.20 tons per acre.

Table 5.—Effect of Depth of Fertilizer Placement and Distance Between Bands of Fertilizer Banded into the Seedbed Before Planting—as Shown by Yield of Sugar Beets.

Depth Fertilizer Was Placed in Seedbed	Bands 20 inches Apart	Bands 10 inches Apart	Combined Averages
Fertilizer Applied 4 inches Deep	15.93	15.94	15.93
Fertilizer Applied 2 inches Deep	15.28	15.62	15.45
Combined Averages	15.62	15.78	15.70
Check (Unfertilized Plots)	14.52	14.52	14.52

Figures in Body of Table are Averages of 16 Replicated Plots.
Combined Averages are Averages of 32 Replicated **Plots.**

The difference between side-dressing 2 inches deep and 4 inches deep is not significant. The difference between side-dressing 4 inches deep as compared to side-dressing 2 inches deep was less than one might have expected, in view of the fact that banding fertilizer into the seedbed before planting at a depth of 4 inches gave consistently higher yields than did fertilizer banded to a depth of 2 inches. The difference between these two sets of tests in regard to the importance of depth of application may be explained as follows:

1. Deep side-dressing may prune off feeder roots of the growing beet. This is not a problem where fertilizer is banded before planting.

2. Deep side-dressing on some fields dried out the soil excessively, while on the before-planting applications the fields were harrowed after the fertilizer was applied.
3. On most fields where side-dressing shallow and deep were compared, the fields were irrigated soon after the fertilizer was applied.

Table 6.—Effect of Kind of Fertilizer on Method of Placement of Commercial Fertilizer as Shown by the Yield Response of Sugar Beets in Field Tests.

Methods of Fertilizer Application	400 pounds of 14-14-0 (56 lb. N. + 56 lb. P_2O_5	270 pounds Amm. Sulf. 56 lb. N.	130 pounds Treble Super-phosphate (56 lb. P2O5)	Combined Averages
Broadcast and Worked into Soil Surface	14.58	14.28	14.04	14.30
Side-dressed 2 in. deep at Thinning Time	14.99	14.39	14.21	14.53
Side-dressed 4 in. deep at Thinning Time	14.97	14.45	14.32	14.58
Combined Averages	14.85	14.37	14.19	14.47
Check (Unfertilized Plots)	13.38	13.38	13.38	13.38

All Figures in Body of Table are Averages of 14 Replicated Plots.
All Combined Averages are Averages of 42 Replicated Plots.

DISCUSSION AND SUMMARY

The results of extensive field tests conducted over the past 5 years have shown quite conclusively that throughout the areas in which sugar beets are grown for the Utah-Idaho Sugar company mixed fertilizer supplying both nitrogen and phosphorus may be applied any time from the start of land preparation to after thinning. This makes the application of fertilizer to the sugar beet crop much easier than it would be it there were a short period during which it must be applied if maximum benefits were to be obtained.

Tests relative to the placement of fertilizer have shown that, when fertilizer is applied prior to planting, there is some advantage to be gained by banding the fertilizer into the seed bed to a depth of at least four inches. Broadcasting fertilizer and working it into the surface of the seedbed markedly increased yields, but was not as effective as the fertilizer placed in bands.

The average response from side-dressed applications of fertilizer was as great as that from any other method of application, but it presented several problems in actual practice. In several areas beets are irrigated up. Fertilizer in these districts should be applied before irrigation. This can only be done in sufficient amount and at sufficient depth if fertilizers are applied to the seedbed before planting. In other areas, where irrigations are delayed until after thinning, it has proven to be a bad practice to also hold the fertilizer application until after thinning. Generally, when side-dressing is delayed until after thinning, the soil is so dry and hard that side-dressing is difficult, irrigation is unduly delayed, and the job of side-dressing comes at a time when there is heavy press of other work, such as irrigation of grain, cutting of hay, and in some areas the planting of late crops such as late potatoes, beans, etc.

Application of fertilizer to the seedbed following fall or spring plowing makes it easy to apply the fertilizer sufficiently deep so that it is always in adequate soil moisture to make it available to the growing plant.

The main facts concerning the time and method of applying mixed fertilizer to the sugar beet crop may be summarized as follows:

1. The average yield increase from the application of from 400 to 600 pounds of mixed fertilizers such as 16-20-0, 15-11-0, 13-15-0 or 14-14-0, has been approximately 3 tons per acre.

2. It has made very little difference whether the fertilizer was applied during fall land preparation, during spring land preparation, between planting and thinning, or immediately following thinning. Time of application should be determined largely by convenience or other considerations involved.

3. Application of the entire amount of fertilizer in one heavy application has given greater yield response than has split applications in which the same amount of total fertilizer was applied at successive periods.

4. Broadcast applications of fertilizer worked into the soil surface were not quite as effective as band applications.

5. Fertilizer banded 4 inches deep into the seedbed prior to planting proved to be an effective method of application.

6. It appeared to make little or no difference whether bands of fertilizer were 10 inches apart or 20 inches apart.

7. There was no significant interaction between kind of fertilizer and method of application or time of application.

8. In view of the above facts, the most important consideration appeared to be the adoption of a program which would result in stimulating the use of a good mixed fertilizer to supply nitrogen and phosphorus in proper balance and in adequate amounts.

Literature Cited

TOLMAN, BION—Response to nitrogen and phosphate fertilizers in the Intermountain Area. Proceedings of American Society of Sugar Beet Technologists, pp 45-53, 1946.

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