Sugar Beet Fertilizer Experiments on Recently Leveled Land[1]

ROBERT S. WHITNEY, D. W. ROBERTSON and ROBERT GARDNER[2]

IN ORDER to facilitate the uniform application of irrigation water, a portion of the Agronomy farm at Fort Collins, Colorado, was leveled in the spring of 1946. The land surface was graded to an exactly uniform slope of ½ percent at right angles to the farm ditch. The cut necessary to accomplish the leveling varied from 2 to 28 inches. Over most of the land, the surface soil was completely removed exposing light colored subsoil layers which were high in lime and had a very coarse columnar structure. This land was divided into five series with five plots in each series to test the effect of barnyard manure and commercial fertilizers on the yield of crops grown in a normal 8-year rotation (corn, sugar beets, wheat, sugar beets, alfalfa with barley companion crop, 3 years of alfalfa). A latin square design was used in the experiment. The second year of the test was completed in 1947.

The fertilizer treatments for both years are given in table 1. The commercial fertilizer combinations were applied at a rate equal to one-half of the amounts of total nitrogen (N), phosphorus (P_2O_5), and potassium (K_2O) contained in the manure. With the exception of the check plot, all plots had received the same total amounts of N, N and P, and N, P, and K, as the case may be by the beginning of the second year of the experiment.

Table 1. Fertilizer treatments.

Treatments	Analysis	Rate per acre Spring, 1946	Rate per acre Fall, 1946
I Manure	0.81% Total N 0.41% Total P_2O_5 0.98% Total K_2O	26.7 tons	
II Treble superphosphate	0-43-0	262 pounds	262 pounds
III Ammonium nitrate	32.5-0-0	662 pounds	662 pounds
Treble superphosphate	0-43-0	262 pounds	262 pounds
IV Ammonium nitrate	32.5-0-0	662 pounds	662 pounds
Treble superphosphate	0-43-0	262 pounds	262 pounds
Potassium sulfate	0-0-50	523 pounds	523 pounds
V No treatment			

Experimental Results

In preparation for the first crop (corn) the land was spring plowed; it was not possible to prepare a good seedbed due to the cloddy nature of the soil. The manure was turned under and the commercial fertilizer was

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[2]Associate Agronomist, and Agronomists, respectively, Colorado Agricultural Experiment Station, Fort Collins, Colo. Authorized by the Director of the Colorado Agricultural Experiment Station for publication as Scientific Journal Series Article No. 270. Received for publication in January 1948.

drilled in with a seed drill having a fertilizer attachment. The plots treated with manure yielded 45.28 bushels of shelled corn per acre, and were the only ones producing a significant increase over the check plots which yielded 15.64 bushels. The commercial fertilizer plots varied in yield from 18 to 23 bushels per acre. The major limiting factors in these tests were a lack of available phosphorus and nitrogen. A deficiency of phosphorus was apparent even on those plots receiving this nutrient.

For the sugar beet crop in the second year, commercial fertilizers were applied in the fall in amounts equal to the applications for the corn crop (table 1) and the entire test area was immediately plowed. In the spring of 1947, the land was worked into a very good seedbed. The limey lumps and clods showed a remarkable mellowing. The plots were seeded to sugar beets on April 3 and harvested about the middle of October. The beets were irrigated July 13, August 12, and September 2, never being allowed to suffer for water.

Table 2.—Yields sugar beets 1947.

Treatments	Tons beets per acre	Pounds sugar per acre	Percent Sugar	Percent Stand	Tons tops per acre	
					Green	Dry
I Manure	16.64	4719	14.14	98.2	10.45	1.47
II P	12.13	3444	14.23	95.6	6.84	1.05
III N and P	18.60	4793	12.85	97.6	17.47	2.12
IV N, P, and K	19.57	4997	12.76	97.8	17.22	2.03
V No treatment	8.17	2189	13.42	77.8	8.19	1.12
Difference for significance						
5 percent point	1.71	697	0.80	8.91	2.16	0.29
1 percent point	2.40	997	1.12	12.49	3.02	0.41

All treatments resulted in a significant increase in yield of beets and total sugar per acre over the check plot. Greater than a two-fold increase in yield and total sugar per acre was obtained on all plots that received nitrogen in addition to phosphorus (including the residual manure plots). The effectiveness of the treatments was obvious throughout the growing period (figure 1).

The percentage sugar in all treatments was low. Phosphorus alone gave a slight increase in sugar percentage over the check plot while those plots treated with ammonium nitrate were more than 1 percent lower than either the manure or phosphate plots. Of interest was the fact that in these trials the beets receiving nitrogen did not vary significantly in percentage sugar from the beets on the no treatment plot.

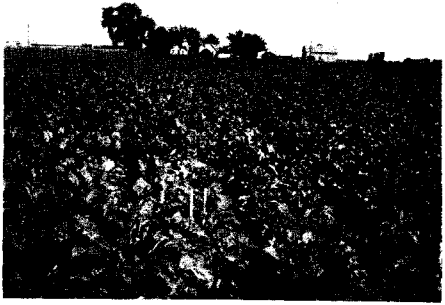
The death of young beets on the "no treatment" plots resulted in a real depression in percentage of stand on these plots. The yield of tops, as was expected, was increased by the nitrogen fertilizers.

While the fertilizer application in each case was rather high, all treatments resulted in a monetary profit if compared with the check plot even when all the fertilizer applied in both years of the test was charged to the one beet crop.

Figure 1—Views of the plots treated with ammonium nitrate and treblesuperphosphate (left) and the check plot (right).

←23 June, 1947

10 July, 1947→



←10 September, 1947

Discussion

The experiment demonstrated that the main limiting factors for the production of sugar beets on this recently leveled land were the nitrogen and phosphorus supply. This was previously demonstrated for a number of Colorado subsoils (1)[3] under greenhouse conditions. No response to potassium was apparent.

Both manure and commercial fertilizers were effective in producing normal yields of beets. The yields from the plots treated with commercial nitrogen and phosphorus were somewhat better than the yields from the manured plots, but this might be expected since only the residual effect of the manure (applied in the spring of 1946) was involved. For sugar beets on normal land, Gardner and Robertson (2) demonstrated the comparable efficacy of manure, and commercial nitrogen plus phosphorus when the latter were applied at a rate equal to the amounts of these elements contained in the soluble portion of manure. Manure and manure plus phosphate fertilizer applied to leveled land were previously shown to be effective in increasing the yields of spring barley (3). The fact that manure and commercial fertilizers failed to produce equivalent results on corn the first year of the test was probably due to a lack of phosphorus. Insufficient phosphorus may have been related to improper placement, insufficient amounts, or too late an application of phosphate fertilizer. This matter is receiving further study.

Summary

1. Sub-soil exposed by recent leveling operation was shown to be seriously deficient in nitrogen and phosphorus.

2. Manure plowed under gave significant increases in yields of corn and sugar beets. Commercial fertilizer drilled in before planting did not increase the yield of corn, but when additional fertilizer was plowed in at the time of fall preparation of the land for the second crop, yields of sugar beets twice as high as those from the "no treatment" plots were obtained.

3. The stand of sugar beets on those plots receiving no fertilizer was significantly lower than the treated plots.

4. Even at the high rate of fertilizer application used, all treatments resulted in a net profit.

Literature Cited

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[3]The numbers in parentheses refer to literature cited.

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(3) ROBERTSON, D. W., AND GARDNER, ROBERT
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