Fertilizers Plowed Under Versus Soil Application at or After Planting[1]

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Fertilization of sugar beets *in* northeastern Colorado has generally been accomplished by plowing under green and barnyard manures and drilling commercial fertilizers into the surface layers of the soil prior to planting, at planting, or after planting. The application of commercial phosphate fertilizezr on barnyard manure and plowing it under is not a new practice, but is nevertheless not used extensively. On occasions, water-soluble fertilizers such as phosphoric acid and nitrogen have been applied in irrigation water after the beets are beyond the thinning stage.

The experimental results reported in this paper were not set up primarily to study methods of application. Yet, the comparisons which it is possible to make between methods of application as a result of these tests serve well to further the information on this important subject.

Materials and Methods

The treatments used in the studies include both organic and inorganic fertilizers. There were four tests, all similar, conducted on farmers' fields in northeastern Colorado; namely, one each in the following factory districts: Windsor, Fort Lupton, Brush, and Sterling. The experimental design used was a randomized complete block with nine treatments and two replications per test. Restrictions were placed on the randomization of treatments since only one strip of sweet clover was planted per field. Consequently, the three treaments including sweet clover always made up the center six plots of the eighteen-plot test. The plots extended the length of the field but were no wider than to allow for ample borders on the sides of the two or four central rows used for yield measurements.

The four tests were started in the spring of 1947 by planting a strip of Hubam sweet clover through the central area of a spring-planted grain field (barley or oats) scheduled to be planted in beets in 1948. The strip was planted so that its course would be the same as that of the beet rows to be planted the following year. The sweet clover was allowed to grow for a time after the grain was harvested, but all fields were plowed before occurrnce of any severe frosts the fall of 1947.

A list of treatments used on tests initiated in 1947 and completed in 1948 is presented in Table 1.

The above fertilizers were applied with standard type farm equipment carefully calibrated and checked for the various rates of application. The harvest results were obtained in the same manners as in 1947 tests.[3]

One test of a different design conducted on the Experiment Station at

[1] Results presented are from projects conducted cooperatively by Colorado A & M College and The Great Western Sugar Company.

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[3] Nelson, R. T., et al. Harvest results of inorganic fertilizer tests on sugar beets conducted in four states, 1947. Proc. Am. Soc. Sug. Beet Tech., pp. 407-420, 1948.

Table 1.—Kind, rate per acre, time and manner of application of fertilizers used as treatments in four tests, including sweet clover.

Tr. No.	Treatment
1	Sweet clover (Hubam).
2	Sweet clover + 250 pounds triple superphosphate broadcast on sweet clover and plowed under.
3	Sweet clover + 800 pounds finely ground raw rock phosphate broadcast on sweet clover and plowed under.
4	Barnyard manure 8 tons plowed under.
5	Barnyard manure 8 tons + 150 pounds triple superphosphate (broadcast on surface prior to manure application) and plowed under.
6	Inorganic fertilizer only; 250 pounds triple superphosphate + 200 pounds ammonium nitrate + 200 pounds muriate of potash broadcast and plowed under.
7	Same as 6 except fertilizers side-dressed immediately after planting beets.
8	Barnyard manure 20 tons, plowed under.
9	Check, without sweet clover or manure or inorganic fertilizer.

Longmont was placed on newly leveled ground on cut areas where depths of one to five feet of soil had been removed. The experimental design was that of a split plot with seven fertilizer treatments and two methods of application. Eight replications were made of each main treatment. Rates and kind of fertilizer formed the main plots, with method of application as top-dressing or side-dressing versus plowing under fertilizer being the subplots. Main plots were 22 feet wide and subplots 11 feet wide; all plots were 55 feet long. Kinds, amounts, and manner of application of fertilizers are listed in Table 2. The manure was analyzed and the treatment 10 tons manure + 100 pounds triple superphosphate was taken as a base rate. The elements applied by use of inorganic fertilizers in other treatments was calculated to coincide with this established base rate.

Table 2.—Fertilizer treatments in rate per acre applied to deeply cut, low fertility area, spring 1948.

Tr. No.	Treatment (a
1	Check no fertilizer
2	Manure, 10 tons
3	Manure, 10 tons + triple superphosphate, 100 pounds (43 percent P_2O_5)
4	Ammonium sulfate, 567 pounds (20.5 percent N)
5	Triple superphosphate, 351 pounds
G	Treatment 4 -4- treatment 5
7	Treatment 6 4- muriate of potash, 260 pounds (60 percent K_2O)

(a Each treatment was applied in two ways on different subplots:
A. Fertilizer broadcast before plowing and plowed under.
B. Fertilizers applied after plowing; treatments 2 and 3 were applied broadcast and disced in, whereas treatments 4-7 were side-dressed at planting time.

The yield results were obtained from the four center rows of each subplot. On the higher yielding plots only one-half the total number of beets were rasped for sugar analysis, while on the lower yielding plots all the beets were rasped and analyzed for sugar.

Results

In Table 3 are given the combined results for the four tests conducted in four different factory districts of northeastern Colorado.

Table 3.—Mean results of four tests. Tons beets, percentage sugar, and pounds sugar are given as increase or decrease over check.

Treatment No.	Treatment in rate per acre (a	Yield of Beets	Sugar Content	Total Sugar	Beets (b per 100' of Row
		(tons/A)	(percent)	(lbs./A)	
9	Check, no clover or fertilizer	12.69	14.00	3580	82
1	Sweet clover (c	.25	—.52	—55	75
2	Sweet clover + 250 pounds 43% P_2O_5	.87	—.17	163	76
3	Sweet clover + 800 pounds rock phos.	.90	—.87	—16	82
4	Manure, 8 tons	1.16	—.12	251	72
5	Manure, 8 tons + 150 pounds 43% P_2O_5	1.94	—.14	481	78
6	250 pounds 43% P_2O_5 + 200 pounds NH_4NO_3 + 200 pounds Kcl	2.93	.04	601	84
7	Same as 6, but side-dressed	.92	—.11	180	77
8	Manure, 20 tons	1.68	—.23	338	81
LSD 5% pt.		1.36	ns	446	....
LSD 1% pt.		1.82	ns	ns	....

(a For more complete description of treatments see Table 1.
(b Average of only three tests.
(c Average yield 1.2 tons per acre air dry weight.

The results for the individual test conducted on subsoil exposed by leveling operations are presented in Tables 4 and 5.

Table 4.—Main plot treatments and harvest results for test conducted at Longmont

Tr. No.	Treatments in rate per acre(a	Tr. Totals N	P_2O_5	K_2O	Yield of Beets	Sugar Content	Total Sugar	Beets per 100' of Row
		(lbs./A)			(tons/A)	(percent)	(lbs./A)	
1	Check	0	0	0	2.73	15.31	836	64
2	Manure, 10 tons	116	108	156	6.12	15.63	1919	84
3	Manure, 10 tons + 100 pounds 43% P_2O_5	116	151	156	6.47	15.35	1986	89
4	566 pounds ammonium sulfate	116	0	0	6.29	16.32	2053	68
5	351 pounds 43% P_2O_5	0	151	0	4.60	15.62	1437	85
6	Treatment 4 + treatment 5	116	151	0	9.86	15.34	3025	99
7	Treatment 6 + 260 pounds muriate of potash	116	151	156	8.41	16.88	2839	91
LSD 5% pt.					2.45	.85	777(b	20
LSD 1% pt.					3.27	1.14	1045	26

(a For more complete description of treatments see Table 2.
(b LSD calculated as for example:

$$\text{LSD} = \text{mean pounds sugar} \sqrt{\left[\frac{\text{LSD tons beets}^2}{\text{mean tons beets}}\right] + \left[\frac{\text{LSD \% sugar}^2}{\text{mean \% sugar}}\right]}$$

Discussion

The results in Table 3 show little gain in the yield of sugar beet roots from the growing and plowing under of Hubam sweetclover. In these tests the growth made by the sweetclover was somewhat disappointing. The amount of sweet clover plowed under on the different tests ranged from 0.7 to 1.5 tons per acre air dry weight. The individual analysis of variance on two tests showed no significant difference between treatments for yield at the 5% point, suggesting that these two fields were relatively high in fertility. The other two tests showed definite yield increases from manure and commercial fertilizers plowed under, while only one of these tests showed

a significant increase in yield for commercial fertilizer side-dressed. For the two tests, and as an average of the four tests, plowing under the commercial fertilizer, even though done in the fall, was more effective in increasing yields than a comparable application made as a side dressing at planting time.

Results presented in Table 4 show the effectiveness of commercial fertilizers in sustaining plant growth in direct comparison with nutrient supplements supplied in the form of barnyard manure.

Table 5.—Harvest results for methods of application, as means of all treatments presented in table 4.

Treatments	Yield of Beets	Sugar Content	Total Sugar	Beets per 100' of Row
	(tons/A)	(percent)	(lbs./A)	
A. Fertilizer broadcast and plowed under ahead of seedbed preparation	6.91	15.92	2200	88
B. Manure broadcast and disced in ahead of planting; inorganic fertilizers side-dressed immediately after planting	5.79	15.66	1813	77
LSD 5% pt.	.65	ns	209(a	5
LSD 1% pt.	.87	ns	282	6

(a Calculated by similar manner to footnote b, Table 4.

The results given in Table 5 indicate significantly higher yield for treatment A, fertilizer broadcast and plowed under, as compared with treatment B, including the discing in of manure and side-dressing of inorganic fertilizers at planting time. Results of other fertilizer trials in northeastern Colorado support the view that fertilizers should be placed relatively deep[4]. The statements on deep placement of fertilizer have usually been confined to refer only to phosphate. On the other hand, fertilizer applied during periods of limited precipitation, even if very water-soluble, may not penetrate below the applied depth. Irrigation water, if available, might be used to carry down the soluble fertilizer, provided the fertilizer is not pushed to the top of the ditch in the ditching operation to remain on high dry ground during most or all of the irrigation run. It was interesting to note that, on tests showing visible response to fertilizer, plots with the fertilizer applied and plowed under showed the response as early as the cotyledon stage of the beet plant. In the case of the test at Longmont, the greater vigor of the plants on subplots with fertilizer plowed under was undoubtedly responsible for the significantly better stand reported in Table 5. In regard to stand, the analysis of variance showed an interaction significant above the 1% level between method of application and fertilizer. In contrast to this, yield and sugar content did not show an interaction between method of application and fertilizer at the 5% level of significance.

Summary

Greater yields of beets and total sugar were secured where fertilizers were broadcast and plowed under as compared with similar fertilizers, and similar quantities, top- or side-dressed at planting time.

Inorganic fertilizers containing N and P or NP and K gave equal or greater production of beets and total sugar than did comparable amounts of NP and K applied in similar manner in the form of barnyard manure.

[4] **Whitney, Robert S., Robert Gardner, and D. W. Robertson. Methods of increasing the productive capacity of subsoils exposed by leveling. I. Manure and commercial fertilizer. Jour. Am. Soc. Agron. (in press), 1950.**