

SOIL FERTILITY AND FERTILIZER PROBLEMS WITH SUGAR BEETS IN CALIFORNIA
WITH SPECIAL REFERENCE TO THE SACRAMENTO--SAN JOAQUIN VALLEYS*

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Fertilization with common commercial fertilizers for better beet yields on the mineral soils of the Sacramento Valley has not given consistent results. Consequently no general fertilizer practice can be recommended. Early response to nitrogen can usually be secured, which may permit earlier thinning but generally is not reflected in the yield.

Observations indicate that fertilizer problems on these mineral soils should be approached from the standpoint of improving the organic matter supply, improved water penetration, and better knowledge of proper fertilizer placement.

On the peat soils of California the major problem in sugar beet production concerns the low sucrose synthesis often encountered.

Excess nitrate nitrogen supply in the soil appears to be a vital factor in low sucrose synthesis. The nitrogen content of the beet is directly correlated with the sucrose content of the beet.

Phosphate and potash fertilizers added to the soil to balance the nutriment ratio have not influenced the beet development.

Tillage practices may be an important factor in controlling the soil nitrate supply.

Certain important areas in the northern part of the Delta, and minor areas throughout the peat lands show strongly acid reactions and tests indicate high returns might be expected from the use of lime.

THE EFFECT OF ROTATIONS AND MANURE UPON SUGAR BEETS

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At the Scottsbluff station of the Office of Western Irrigation Agriculture, a number of rotations including sugar beets as one of the crops have been conducted since 1911. These plats are $\frac{1}{4}$ -acre in size and one plat of each crop is grown each year.

The results from these experiments are presented in Table 1.

Continuous sugar beets for 25 years at Scottsbluff on land which has received no manure, produced during the past six years an average of 5.2 tons of beets per acre with a sugar percentage of 18.3% and apparent purity of

*"This experimental work was conducted cooperatively by the Division of Soil Fertility and Division of Sugar Plants of the Bureau of Plant Industry, U.S. Department of Agriculture, and the University of California, Agricultural Experiment Station."

juice 93.4% with indicated available sugar per acre yield of 1774 pounds.

Five rotations which included corn, oats, wheat, potatoes with sugar beets in 2 or 3-year rotations, without any manure applications, produced 7.6 tons of beets per acre, which had a sucrose percentage of 17.9% and an apparent purity of juice of 93.1% and a yield of 2514 pounds of indicated available sugar per acre.

Four short rotations which included legumes but were not manured produced an average of 13.2 tons of beets per acre during the past six years. These beets had a sucrose percentage of 17.3%, with an apparent purity of juice of 90.8% and an indicated available sugar per acre yield of 4076 pounds. These all are sweet clover rotations.

There were 6 rotations not manured which were 4 years in length (2 with alfalfa and 4 with sweet clover). These rotations had an average yield of 14.2 tons of roots per acre which were 16.5% in sucrose percentage and 90.3% apparent purity in juice. Their yield of indicated available sugar per acre was 4224 pounds.

Four rotations which are 6 years in length not manured and have three years of alfalfa were grown, and the yield of sugar beets is 13.5 tons per acre, sucrose percentage 15.8% and apparent purity of juice 89.5% which indicates 3800 pounds of available sugar per acre.

At Scottsbluff, there are 5 rotations which are duplicated with the exception of one series not being manured at any time and the other series receives 12 tons of barnyard manure per acre before each beet crop. The manures produced an average yield of beets 16.5 tons per acre and the unmanured plats yield 9.7 tons which is a gain of 6.8 tons of beets per acre for the use of manure. The sucrose percentage of the beets from the manure plats average 16.4% and the apparent purity of juice is 89.9% while that from the untreated plats is 16.9% sucrose percentage and 91.5% purity of juice. Manuring produces 1915 more pounds of indicated available sugar per acre as the yield from manured plats is 4835 pounds per acre and, from the unmanured plats is 2920 pounds.

In the use of sweet clover in sugar beet rotations there is no very great advantage from planting sweet clover with a grain crop and plowing the land for sugar beets the following year. Pasturing the sweet clover for a full year gives increased returns. Pasturing of alfalfa for a full year before planting sugar beets is also advantageous. The plowing under of a heavy crop of spring growth of sweet clover for potatoes and following with sugar beets has been very successful.

A brief summary of these data shows that the indicated available sugar per acre presents the most reliable method of comparison of the value of the rotations. Continuous beets with only 1774 pounds of indicated available sugar per acre is a very unprofitable rotation. The yield of 2661 pounds of indicated available sugar from cash crop rotations is likewise unprofitable. The increase of the three other groups of rotations over the two mentioned heretofore gives sufficient evidence for the recommendation of these practices.

Table No. 1--THE EFFECT OF CROP ROTATION, MANURE AND LEGUMES
UPON SUGAR BEETS, SCOTTSBLUFF, NEBRASKA
1930 to 1935

	Continu- ous beets for 25 years	Cash Crop Rotations	Rotations including legume crops	Cash Crop rotations with manure	Rotations with legumes and manure
Tons of beets per acre	5.2	8.0	13.7	16.6	16.5
Percent Sucrose	18.3	17.9	16.5	17.0	15.6
Apparent Purity Percent	93.2	92.9	90.2	90.6	88.9
Gross Sugar Per Acre, Pounds	1903	2864	4521	5644	5148
Indicated Available Sugar Per Acre	1774	2661	4078	5113	4577

Table No. 2--THE EFFECT OF CATTLE, SHEEP, AND HORSE MANURES UPON SUGAR
BEETS: WHERE THE MANURES ARE APPLIED AT THE RATES OF 6, 12,
18, and 24 TONS PER ACRE.

Tons of Manure Per Acre	Harvested beets per acre	Tons of Beets per acre	Percent Sucrose	Apparent Purity Percent	Gross Sugar Per acre Pounds	Indicated Available Sugar per Acre, Pounds
None	20740	16.40	17.29	89.13	5671	5055
6-of cow 1 year old	21583	18.51	16.75	89.49	6201	5549
6-of sheep 1 yr. old	22423	18.94	16.94	89.25	6417	5727
6-of horse 1 yr. old	21303	18.54	16.95	88.36	6285	5553
6-of cow	20867	18.54	16.88	88.10	6259	5514
6-of sheep	21826	18.57	16.76	89.01	6225	5541
6-of horse	21521	18.33	17.04	88.81	6247	5548
12-of cow	21501	20.15	16.59	87.89	6686	5876
12-of sheep	21367	19.91	16.56	87.46	6594	5767
12-of horse	20982	18.82	17.01	88.55	6403	5670
18-of cow	21163	19.65	15.99	86.97	6284	5465
18-of sheep	21351	20.18	16.35	87.31	6599	5762
18-of horse	21399	20.08	16.39	87.87	6582	5784
24-of cow	20014	20.98	15.88	86.10	6377	5491
24-of sheep	20486	20.20	16.09	87.64	6500	5697
24-of horse	20347	19.56	16.37	87.53	6404	5605

Note: All manures are applied at the above rates calculated upon a 50 percent moisture content. There are 5 replications of each treatment.

Table No. 3--EFFECT OF VARIOUS RATES OF APPLICATION OF COW MANURE
UPON SUGAR BEETS. WITH THE ADDITION OF 150 POUNDS
SUPER PHOSPHATE TO ONE HALF OF THE PLATS--1936-1937
RESULTS AT TORRINGTON, WYOMING.

Treatments Manure Tons	Phosphate Pounds	Harvest- ed Beets Per Acre	Tons of Beets Per Acre	Per- cent Sucrose	Gross Sugar per Acre	Apparent purity Percent	Indicated Available Sugar per Acre
0	0	15700	8.9	16.8	2990	82.1	2455
0	150	19823	12.1	17.2	4162	87.0	3621
6	0	19482	13.4	16.9	4529	80.9	3664
6	150	20907	15.4	16.6	5113	84.6	4326
12	0	19925	14.4	17.0	4896	85.7	4196
12	150	20555	15.1	17.0	5134	81.5	4184
18	0	20378	15.3	16.5	5049	85.5	4317
18	150	19804	15.8	15.8	4993	82.6	4124
24	0	20506	16.1	15.9	5120	81.4	4168
24	150	20363	15.8	15.7	4961	83.0	4118

Note: All manures are applied at the above rates calculated upon a 50 percent moisture content. There are 5 replications of each treatment.

SUMMARY

1. As a whole the use of manure and legumes in the rotations have indicated increasement of yields of sugar beets and some decline in sucrose percentage but the yield increase has been so much greater than the sucrose percentage decline that profitable use of manure and legumes is usually indicated by the additional indicated available sugar per acre.
2. Excessive amounts of manure have not been profitably used if both use of manure and land is considered. Twelve tons per acre usually produces near maximum returns and 6 tons per acre produces the greatest gain per ton of manure used.
3. On phasphate deficient land less manure is needed if phosphate is added.
4. The sugar beet crop responds readily to the direct application of manure.

SOME DATA ON RARE ELEMENTS APPLIED TO BEETS IN THE FERTILIZER

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A diseased condition of an agricultural crop has often been the stimulus to discover a deficiency in the nourishment of the plant. The crop is in a diseased condition because of some pathogene at work in the tissues, but that pathogene is very often there because of some faulty soil condition.