Effects of Rotation on Sugar Beets in the Red River Valley

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Sugar beet culture in the Red River Valley of Minnesota and North Dakota is relatively new. The East Grand Forks factory was completed in 1926, Moorhead in 1948, and Crookston will be completed in 1954. Acreage contracted for sugar beets was increased from 30,000 acres in 1944 to more than three times that acreage in 1954. This rapid expansion during the last ten years has led to one or more of the following questions by new growers: "What rotation practices are recommended for sugar beets? Why does the sugar company insist on summer fallowed land for beets? How can I clean up weedy land? Which green manure crop is the best?"

Answers to many of these questions have come from the experience and observations of the company's agricultural staff which pioneered sugar beet culture in the Red River Valley; but there was a lack of experimental results pertaining to rotation practices. To get accurate answers to these questions and also to keep abreast with the constantly changing economics of agriculture, it was decided in 1951 to set up a series of crop rotation plots on the company farm at East Grand Forks, Minnesota.

The soil type on which the rotation plots were located is Bearden silt loam, which is a silty clay loam that contains more sand and silt than the heavy Fargo clay soil of the Red River Valley. Sugar beets do well on either Bearden silt loam or Fargo clay soils. Both of these soils were rich in organic matter in their virgin state. The land on which the plots were located was purchased by the sugar company in 1950. This land had not been in a good soil building rotation; therefore, it was weedy and of below average fertility. Extreme care was taken to locate the plots in an area that was uniform as to soil type, fertility level, and was well drained. The entire plot area selected had been in the same crop each year, and had the same fertilizer history as far back as records could be obtained.

Considerable time and thought was used in planning the plot layout and rotations to be included. 100-foot x 200-foot rectangular plots, with 18-foot headlands on all sides of each plot, were agreed upon so that regular farm machinery could be used in caring for the crops. The 18-foot headland on all sides of each plot provided sufficient room to turn tractors and farm machinery without damaging adjacent plots. Each plot contained .46 of an acre with 18.50 acres in the entire test.

Eight rotations were selected. They ranged from what is considered to be the most desirable to the least desirable Red River Valley rotations that contain sugar beets. Four different green manure crops, of which three were legumes, were included. Two of the eight rotations did not include the summer fallow year. It mav be found desirable to have additional rotations and replications in the future; if so, there is adequate land adjoining the plot area for future extension. The eight rotations selected are shown in Table 1.

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Table 1.—Rotations Included in Red River Valley Rotation Plots.

Rotation Number	Rotation	No. of Years in Rotation
1	Beets, Grain and Sweet Clover, Sweet Clover Summer Fallow	3
2	Beets, Grain, Summer Fallow	3
3	Beets, Grain, Buckwheat (Green Manure) Summer Fallow	3
4	Beets, Grain, Oats (Green Manure) Summer Fallow	3
5	Beets, Grain, Grain and Sweet Clover, Sweet Clover Summer Fallow	4
6	Beets, Grain, Grain, Grain	4
7	Beets, Grain, Grain, Potatoes	4
8	Beets, Grain, Grain and Alfalfa, Alfalfa Hay, Alfalfa Summer Fallow	5

Each crop of each rotation in the test is planted each year; three plots for a three-year rotation; four plots for a four-year rotation, etc. Barley was selected for the grain crop *in* all rotations. Treble super phosphate (0-43-0) was applied to all sugar beet plots at the rate of 150 pounds per acre at planting time. Two hundred fifty pounds of 4-24-12 were applied to the potato plot at planting time. To date, this is the only commercial fertilizer applied in this test. The sugar beet tops and crowns were all worker into the soil after the beets were harvested. The barley straw was all left on the land. Normal tillage methods were followed as nearly as possible. The plots were all plowed in one direction to get away from dead furrows and to keep the area level for good drainage. The beets in all rotations were mechanically thinned by cross blocking and mechanically weeded with only enough hand hoeing done to keep the plots clean. Beet plots were harvested with an International sugar beet harvester.

The entire plot area was planted to potatoes in 1950 with the rotation test being laid out and plots planted to their respective crops in 1951. The only value of the yields taken in 1951 was to check differences due to soil variability. The1952 and 1953 crops were planted in their proper rotation sequence. We know that a test of this kind takes several years to produce statistically significant results, but using 1952 and 1953 yields and observations, certain trends are developing. The results to date have begun to answer with facts and figures such questions as: "Why does the company insist on summer fallow for beets?" and "What rotation will do to help clean up weedy land?"

Table 2.—Effect of Rotation on Yields, and Cost of Hoeing Sugar Beets in 1952 and 1953.

Rotation Number	1952 Tons Per Acre	1952 Cost Per Acre to Hoe[1]	1953 Tons Per Acre	1953 Cost Per Acre to Hoe[1]	Mean Tons Per Acre	Mean Cost Per Acre to Hoe
1	**12.58**	$2.50	14.32	**$3.00**	13.95	$2.75
2	**12-73**	2.25	14.22	5.50	13.48	3.88
3	**12.13**	2.25	15.06	2.78	13.60	2.52
4	**11.77**	2.25	13.52	3.75	12.65	3.00
5	**12.78**	2.50	14.01	3.50	13.40	**3.00**
6	**7.66**	7.75	9.17	**9.00**	8.42	8.38
7	**10.00**	10.75	11.57	7.02	10.79	**8.89**
8	**12.15**	2.50	14.75	5.25	13.45	**3.88**

[1] **Labor** was paid **75** cents per hour **for** hoeing.

In Table 2, the yields of sugar beets in different rotations are shown. Also included in this table is the cost of hoeing each of the mechanically thinned beet plots.

The average yield where beets followed summer fallow was 13.41 tons per acre, which is 4.99 tons per acre more than where beets followed fall-plowed stubble land as in rotation 6. The yield of beets following potatoes was 2.62 tons per acre lower than where the beets were preceded by a year of summer fallow. In this area of limited rainfall, and no irrigation, it is essential to store up moisture in the summer fallow year for the following beet crop. In 1953, there was adequate spring and summer rainfall, while 1952 was below average in rainfall. This accounts for the generally higher yields in 1953. In the short period of two years, resultant differences between the various green manure crops and black summer fallow were not reflected in the beet yield. Only time will tell whether the plowing down of heavy leguminous green manure crops will raise the fertility level to the point where it will increase the yield over black summer fallow.

The results on the cost of hoeing clearly demonstrated the value of summer fallow as a weed control measure. In rotations where summer fallow preceded beets, the average cost to hoe was $3.17 per acre; while the average cost of hoeing beets that followed potatoes or grain was $8.64 per acre. The difference of $5.47 per acre represents a substantial saving as the cost of hoeing was more than cut in half by the use of summer fallowing.

Yield data were also kept on the barley plots and, using two years' results, no differences between rotations was recorded. However, it was found that the barley plots which followed beets were almost free of weeds, especially wild oats, while the barley plots which did not follow beets were badly infested with wild oats.

In addition to keeping yield and cost data on all plots, records were kept on the amount and analysis of various green manure crops plowed down. Samples were dug from each green manure crop just before it was plowed. Care was taken to get all of the roots possible from each green manure. These samples were weighed green, and turned over to our laboratory for analysis. The total amount of nitrogen, phosphorus (P_2O_5) and potassium (K_2O) being returned by the various green manures was determined. With this program, we are attempting to get an accurate answer to the question, "Which green manure crop is the best?" Table 3 gives the 1952 and 1953 results on the analysis of green manure crops. Calculations were made, placing the amounts of N, $P_2 0_5$ and $K_2 0$ on an acre basis.

Summary

Results obtained so far indicate that sweet clover green manure returns the highest tonnage of organic matter to the soil. However, in rotation studies a period of two years is a very short time, and it would be hazardous to attempt to draw definite conclusions. This test is being continued and further results will be reported at a future date.

Table 3.—Analysis of Green Manure Crops.

	Green Wt. Per Acre		Moisture at 70 Degrees C.		Pounds N Per Acre		Pounds P_2O_5 Per Acre		Pounds K_2O Per Acre	
	1952	1953	1952	1953	1952	1953	1952	1953	1952	1953
Alfalfa										
Roots	6,305	7,587	50.88	58.58	63.2	67.4	9.7	3.9	24.9	22.7
Tops	9,258	10,516	64.99	75.22	93.0	72.5	15.5	4.6	67.9	61.1
Total	15,563	18,103			156.2	139.9	25.2	8.5	92.8	83.8
Sweet Clover										
Roots	5,787	8,787	76.91	79.88	19.0	37.1	4.7	2.6	20.1	39.1
Tops	24,687	41,247	76.42	79.58	117.5	153.4	40.9	14.5	155.8	230.9
Total	30,474	50,034			136.5	190.5	45.6	17.1	175.9	270.0
Oats										
Roots	2,587	1,633	76.59	70.29	4.6	5.7	1.6	.7	7.8	4.9
Tops	15,616	18,246	69.30	80.26	62.3	50.4	10.9	15.4	73.1	98.8
Total	18,203	19,879			66.9	56.1	12.5	16.1	80.9	103.7
Buckwheat[1]										
Roots	1,710		76.16		2.4		1.7		4.7	
Tops	13,718		84.43		31.3		8.6		47.4	
Total	15,428				33.7		10.3		52.1	

[1] Buckwheat crop froze out in 1953.