THE HOLGATE ROTATIONS EXPERIMENTS WITH SUGAR BEETS - A PROGRESS REPORT(1)

Robert E. Yoder, Chief
Department of Agronomy
Ohio Agricultural Experiment Station

A new set of sugar beet rotations were initiated by the Ohio Agricultural Experiment Station at its Northwestern Experiment Farm, Holgate, Ohio, in 1942. Seven different five-year rotations and soil-crop management systems are included in the experiment. Each crop of each rotation occurs in triplicate each year. The experimental design is such that each rotation systematically samples the experimental area. During the beet years, the beet crop of each rotation is grown once in a position immediately adjacent to the beet crop of each of the six other rotations. The soil productivity balance of the rotations ranges from highly soil depleting to strongly soil building. The soil type is Brookston silty clay loam.

The crop sequences of the different 5-year rotations are as follows:

Rotation No.	1st Crop	2nd Crop	3rd Crop	4th Crop	5th Crop
1	Oats	Alfalfa grass	Alfalfa grass	Corn	Beets
2	Corn	Oats	Alfalfa grass	Alfalfa grass	Beets
3	Oats	Sweet clover	Corn	Wheat(sw.cl.)*	Beets
4	Oats	Alfalfa grass	Wheat(sw.cl.)*	Soybeans	Beets
5	Oats	Alfalfa grass	Wheat	Sweet clover	Beets
6	Corn	Soybeans	Oats	Alfalfa grass	Beets
7	Oats	Alfalfa grass	Wheat	Alf. grass(soys)**	Beets

* sweet clover as green manure

** alfalfa grass sod plowed after 1st cutting of hay; soybeans as green manure

It may be observed that in the above rotations that beets follow each of the crops grown extensively in northwestern Ohio. The corn stover, grain straw, soybean haulm and sweet clover remain on the land for organic matter replenishment. The beet crop in each rotation receives 10 tons of shed manure and 200 pounds of sulfate of ammonia plowed under in addition to 3-12-12 row fertilization at planting; the land is fall plowed in all rotations. Other crops are so fertilized that each rotation receives a total of 750 pounds of commercial fertilizer during the rotation.

In addition, three different six-year rotations are included in the experiment; each crop of each rotation appears each year, but the crop sequences are not replicated. Rate, grade and placement of fertilizers and manure are directly comparable to that used in the five-year rotations.

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Obviously, since the rotations were initiated in 1942, the first legitimate evaluation of the influence of rotation on the sugar crop cannot be made until 1947.

Interesting observations can be obtained regarding crop sequence influences on beet yields, during the past three years, from data summarized in Table 1, 2 and 3.

Table 1. Beet Yields in the Holgate Rotations - 1944

Rot'n. No.	Previous crops by years 1941	1942	1943	1944 Beets Tons per acre
2	Alfalfa	Oats	Alfalfa grass	14.5
7	"	"	Alfalfa grass(soys)*	14.0
6	"	"	Alfalfa grass	14.0
4	"	Wheat(sw.cl)*	Soybeans	12.7
5	"	Wheat	Sweet clover**	12.6
3	"	Corn	Wheat(sw.cl.)*	12.4
1	"	(soys)*	Corn	11.6

*green manuring crop. ** manuring crop (mature)

Table 2. Beet Yields in Holgate Rotations - 1945

Rot'n. No.	Previous crops by years(1) 1942	1943	1944	1945 Beets Tons per acre
2	Oats	Alfalfa grass	Alfalfa grass	16.4
1	"	" "	Corn	16.2
7	(soys)*	Wheat	Alf.grass(soys)*	15.8
6	Soybeans	Oats	Alfalfa grass	15.3
4	(soys)*	Wheat sw.cl*	Soybeans	14.5
5	(sw.cl.)*	Wheat	Sweet clover**	14.0
3	(sw.cl.)*	Corn	Wheat (sw.cl.)*	14.0

* green manuring crop. ** manuring crop (mature)
(1) corn on entire area in 1941

Table 3. Beet Yields in the Holgate Rotations - 1946

Rot'n. No.	Previous crops by years(1) 1942	1943	1944	1945	1946 Beets(2) Tons per acre
7	Oats	Alfalfa grass	Wheat	Alfalfa grass(soys)*	9.6
2	Corn	Oats	Alfalfa grass	Alfalfa grass	9.2
6	Corn	Soybeans	Oats	Alfalfa grass	9.1
1	Oats	Alfalfa grass	Alfalfa grass	Corn	9.1
5	Oats	Alfalfa grass	Wheat	Sweet Clover**	9.0
3	Oats	(sw.cl.)*	Corn	Wheat(sw.cl.)*	8.6
4	Oats	Alfalfa grass	Wheat(sw.cl.)*	Soybeans	8.5

*sweet clover and soybeans used as green manure. **manuring crop (mature)
(1) Entire area in oats in 1941. (2) The low beet yields of 1946 may be attributed to the fact that all plots stood under water for over 2 days during the mid-June flood period.

In general, the highest sugar beet yields have been obtained in those crop sequences where the beets have been preceded by good legume-grass sods. This observation is in keeping with previous research work of the Ohio Agricultural Experiment Station, wherein it was found that soil physical condition (soil aeration capacity and internal drainage characteristics) very frequently was the limiting factor in sugar beet production in northwestern Ohio. Sugar beet root-beds following legume-grass sods possess relatively high structural stability as compared with those following either green manure crops or the depleting intertilled crops such as corn and soybeans.

A portion of the results obtained, during the past three years, from the use of manure and fertilizer combinations in a four-year rotation of beets, oats and two years of alfalfa-timothy are summarized in Table 4. The treatments were all carried out in quadruplicate, with random placement in each of the four sub-blocks of the experiment. During the previous decade this land had been excessively row cropped with corn, beets and soybeans. Black root incidence was high each year. The yields are essentially reflections of relative stand survival associated with the several treatments.

Table 4. Fertilization of Sugar Beets Following Alfalfa-grass Sods(1)

Treatment No.	Fertilization Row	Plow under	3-yr.av.yield Tons/acre	No. marketable beets per acre
2	None	None	4.9	8,130
1	300# 3-12-12	None	7.5	12,580
3	" "	8 Tons shed manure	10.1	12,850
6	" "	ditto + 200# 20-20-20	10.8	13,400
10	450# 2-12-6	8 T. manure + N-P-K*	11.5	14,730
7	180# 0-20-0	" " + N-P-K*	9.9	11,670
8	270# 0-20-0	" " + N-P-K*	10.3	12,540
9	540# 0-20-0	" " + N-K	10.9	13,830

* Plow under fertilization sufficient to make total fertilization equal to treatment No. 6.
(1) Data obtained on Brookston silty clay loam, Holgate, Ohio.

Summary

The limited data included in this progress report is in keeping with results of previous research work of the Ohio Agricultural Experiment Station on sugar beet culture. The beet crop is exacting in its soil requirements and highly sensitive to soil physical conditions, particularly aeration and internal drainage. Long rotations, inherently soil building in nature, wherein the depleting effects of clean-cultivated crops are systematically offset by the rejuvenating effects of legume grass sods are recommended. The favored spot in the rotations for any row crop is immediately following the sod crop. This is the only position in the rotation that insures a structural stability of the root bed sufficient to insure adequate aeration and drainage for beets. High organic matter input and grass roots both contribute to water resistant soil granulation. Liberal manure applications and the use of heavier than average rates of row fertilization are to be strongly recommended. On the heavy lake bed soils, fall plowing followed by a minimum number of well-timed seedbed preparation operations, is conductive to high yields. Plant early, using good seed; control soil crust and weeds. Pyramid these favorable soil-crop management practices for best results with sugar beets.