SOIL NITROGEN TESTS FOR SUGARBEETS IN MICHIGAN -- 1968 [1/]

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INTRODUCTION

The judicious use of fertilizer nitrogen is essential for profitable sugarbeet production. With the declining cost of fertilizer N in recent years, there has been a trend toward higher rates of application. However, previous research has shown a reduction in sugar content, purity, and extractability from sugarbeets that receive excessively high rates of N fertilizer. The sugar from a ton of beets can be reduced to such an extent that the extractable sugar per acre is substantially reduced, even though beet tonnage remains high or may even increase.

OBJECTIVES

Beginning in 1965, research was undertaken cooperatively with industry personnel and farmers in the sugarbeet areas of Michigan to evaluate several soil tests for predicting the need for fertilizer N in advance of planting. Such tests could also be used for diagnosing the status of N nutrition in the current crop to guide management practices for later crops. Beet yields and quality factors were usefully correlated in 1965 and 1966 with KCl extractable -- or boiling water extractable -- N in soil samples taken before planting, in mid-season or at harvest. Useful correlations were less frequent with incubation released N, total N, or a fertility index calculated from total N, total carbon and clay plus silt. These results have been reported (Gascho, Ph. D. Thesis, 1968) and are being prepared for publication (Agron. Abstr., 1968).

The 1968 studies were extended to include soil samples taken in the fall of 1967 and beet petiole samples taken in mid-season, 1968. Also, in preparation for the next season, a range of residual N was imposed by applying 40 to 480 pounds of N on corn or navy beans at six locations that will be in sugar beets in 1969.

EXPERIMENTAL (1968)

Eleven farm locations were selected in the Saginaw Valley area and the experimental plots received total N applications of 20, 50, 100 and 150 pounds per acre as ammonium nitrate. All N was applied as a sidedressing in early June and none at or prior to planting.

Preplant soil samplings were made in the fall and spring, and one postplant sampling was made in late July. Mineral-N (extractable with 2N KCl) and boiling water-extractable N are the soil tests which have been completed on 1967-68 samplings. Beet yields were taken and brei analyses have been made by the Michigan Sugar Company laboratories.

RESULTS AND DISCUSSION

Of the two N fractions studied, more N is removed by boiling water than by KCl (Table 1). In 1968, significant differences among locations were found in both fractions in samples taken either in the fall or the spring.

1/ Michigan Agr. Exp. Sta. Journal Article No. 4650

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The fall sampling showed greater variation in mineral N among locations than the spring test. This suggests that the influence of previous crop and associated management practices is better reflected in the fall sampling. The narrow range in values in the spring mineral N test indicates that leaching or some other transformation has occurred during the winter to minimize differences among locations.

The N fraction removed by boiling water is apparently less susceptible to seasonal changes. If the boiling water test should prove to be usefully correlated with sugarbeet parameters, the time of sampling would be less critical than for the mineral N test.

Over all locations and N treatments, the average beet yield was 24.5 tons per acre with an average sugar content of 16.0 percent. Average yields and quality factors for locations (ignoring N treatments) are shown in Table 2. Highly significant location differences are observed for all determinations.

Locations 7 and 6 gave the highest and lowest results, respectively, for yield and recoverable sugar per acre. Differences in soil N tests for the same locations (Tables 1 and 3) or in responses to fertilizer N (Table 4) do not show any interpretable relationships between these two locations. An explanation for differences in productivity between these two locations may appear when soil test levels for other nutrients are known. All 1968 samples are currently being analyzed for pH, available P, and exchangeable K, Ca and Mg.

On the other hand, large accumulations of mineral N in mid-season (Table 3) at location 8 were associated with poor stand and at locations 10 and 11 with prolonged drought. The diagnostic value of the mid-season test is illustrated at these locations. Mid-season accumulations of mineral N in excess of 20 to 30 pounds per acre are a positive indication that some factor other than N availability is holding the crop back in its development at this critical period. The 1965-66 data indicate that as this imbalanced high N availability is prolonged toward harvest time, the probability increases that sugar content and juice purity will be greatly reduced.

The range of soil N test values encountered in 1968 was much less than in previous years. Spring mineral N values in 1968 nearly all fell in the range of 10 to 20 pounds per acre; whereas, values of from 0 to 60 pounds were encountered in 1965 and 1966. Hot water soluble N in 1968 ranged from 30 to 90 pounds, on contrast with 95 to 175 pounds in the two previous seasons. It is hoped that the residual N variable introduced by 1968 fertilizer applications in preparation for next season's studies will provide a more complete overlapping of soil test levels and 1969 fertilizer N levels.

SUMMARY

The full significance of 1968 data reported here cannot be assessed until extensive multiple correlation analyses have been completed. The data are consistent, however, with previous work here and elsewhere. The industry is generally becoming aware that rarely are there situations where sugarbeets will respond favorably to fertilizer N applications in excess of 100 pounds per acre. The three year's data at hand give reason to expect that currently available N soil tests can be interpreted to identify fields where less nitrogen should be used until other more limiting factors of production can be identified.

PUBLICATIONS:

(1) Gascho, G. J. Soil nitrogen availability indexes and effects of potassium carriers and levels of potassium on nitrogen fertilization on the yield and quality of sugarbeets. Ph.D. thesis, Michigan State University, 1968.

(2) Gascho, G. J., Wolcott, A.R., Frakes, M.G., and Fogg, R.A. Soil nitrogen availability indexes as guides for fertilization of sugarbeets (Beta vulgaris). Amer. Soc. Agron. Abstr., 1968.

TABLE 1. Averages of nitrogen soil tests for eleven locations

	Soil N Extracted			
	Mineral-N		Boiling H_2O-N	
Location	Fall 1967	Spring 1968	Fall 1967	Spring 1968
		Lbs./A.		
1	15.6	14.7	64.3	66.2
2	11.1	16.9	42.3	44.0
3	13.1	14.8	49.4	47.2
4	11.9	14.4	43.2	52.3
5	14.5	18.8	58.6	55.3
6	8.6	14.9	49.1	45.6
7	10.1	10.6	55.0	47.7
8	21.5	12.7	67.2	68.6
9	51.2	18.4	80.1	72.8
10	13.5	15.9	88.6	86.1
11	13.7	15.9	46.3	37.5
Avg. for Tests	16.8	15.3	58.6	56.7
LSD_{05}	10.43	7.46	18.67	25.6
(P)	$<.005$	$<.01$	$<.005$	$<.005$

TABLE 2. Average beet parameters for eleven locations - 1968

Location	Beets/A.	Yield Tons/A.	Sucrose %	C.J.P. %	Sugar Lbs./Ton	Recoverable Sugar Lbs./A.
1	19,310	27.4	15.73	93.13	271	7413
2	19,650	25.1	16.64	94.52	295	7395
3	21,530	23.8	16.05	95.54	290	6927
4	16,840	27.8	16.26	94.20	286	7951
5	16,220	28.7	15.94	93.32	276	7938
6	19,450	19.3	15.13	95.50	273	5276
7	19,760	30.8	16.14	95.76	293	9014
8	18,730	24.4	15.91	94.58	284	6990
9	15,570	21.2	16.19	95.74	294	6243
10	19,360	20.6	16.17	94.42	286	5921
11	19,680	20.3	15.79	94.82	281	5724
Avg. All Locations	18,740	24.5	16.00	94.69	285	6980
LSD_{05}	1,228.8	1.92	.478	.665	10.9	628.4
(P)	$<.005$	$<.005$	$<.005$	$<.005$	$<.005$	$<.005$

TABLE 3. Mineral N in late July-early August 1968 soil sampling as related to location and applied N

Location	Mineral N (mid-season 1968)				
	Applied N (lbs./A)				Location Averages
	20	50	100	150	
			Lbs./A.		
1	10.0	11.2	16.1	19.4	14.2
2	7.0	7.0	21.4	15.1	12.6
3	16.4	8.7	11.4	15.1	12.9
4	10.1	13.3	11.9	32.4	16.9
5	7.1	9.3	9.7	13.5	9.9
6	8.0	7.9	6.4	9.4	7.9
7	8.8	8.6	7.6	11.5	9.1
8	39.4	33.4	35.6	41.2	37.4
9	7.8	8.6	13.5	12.7	10.6
10	52.3	57.2	56.2	66.1	57.9
11	84.6	72.2	83.5	75.6	79.0
Applied N Avg.	22.9	21.6	24.9	28.4	24.4

For comparing:

Location averages	LSD_{05}=6.35	($P < .005$)
Locations within N	LSD_{05}=12.70	
Applied N averages	LSD_{05}=3.51	($P = .045$)
N within locations	LSD_{05}=11.64	

TABLE 4. Recoverable sugar per acre as related to location and applied N

Location	Applied N (Lbs./A.)				Location
	20	50	100	150	Averages
1	7,876	7,593	6,986	7,195	7,413
2	6,827	7,699	8,230	6,825	7,395
3	7,145	7,157	6,898	6,507	6,927
4	7,539	8,517	8,215	7,531	7,951
5	8,432	8,034	8,272	7,014	7,938
6	5,182	5,300	5,659	4,963	5,276
7	9,024	8,681	9,027	9,322	9,014
8	7,029	7,245	6,996	6,652	6,990
9	6,320	6,650	5,749	6,253	6,243
10	6,607	6,390	5,382	5,305	5,921
11	5,424	6,334	5,628	5,512	5,724
Applied N Avg.	7,038	7,236	7,005	6,643	6,980

For comparing: Location averages LSD_{05}=628.4 ($P<.005$)

Locations within N LSD_{05}=1,256.8

Applied N averages LSD_{05}=330.0 ($P=.007$)

N within locations LSD_{05}=1,043.6