SUGARBEET RESPONSE TO NITROGEN IN TEXAS

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Summary

The major nitrogen problem in Texas sugarbeets is that too much of the planted area is very high in residual nitrogen. In commercial field areas sampled in May of 1979 to 1984, 40% of the area had between 415 and 1528 lbs/acre nitrate nitrogen in the sugarbeet root zone. These high residual nitrogen levels reduce sugar 2% or more compared to optimum amounts.

A large positive response to applied nitrogen can only be expected when residual nitrogen is below 30 lbs/acre, 0-4 ft. A small positive response occurs when residual nitrogen is between 30 and 90 lb/acre. Average increase in return at the optimum applied nitrogen rate compared to none applied is 72, 13, and 5 percent when residual nitrogen is 30, 31-90, and 91-150 lb/acre, respectively. These responses were measured at yield levels of 35 to 45 tons/acre. Less response to applied nitrogen would be expected at lower yield levels.

Nitrogen should be applied to provide near 8 lb/ton of residual plus fertilizer nitrogen if residual nitrogen is less than 30 lb/acre 0-4 ft. If residual nitrogen is above 30 lb/acre, 5 to 7 lb/ton is adequate. When in doubt, apply a lower rate. If beet top growth slows greatly in July, don't fertilize, instead give thanks and start spraying for foliar diseases if necessary. If enough nitrogen is present to close the rows in June, grower bottom line will not be materially lowered by a later deficiency.

Recommended Action to Improve Sugarbeet Quality in Texas

Initiate a good soil sampling program 2 to 3 years prior to planting beets to lower soil residual nitrogen. Follow the fertilizer application recommendations in Table 2. Protect leaves from foliar diseases. Manage soil-borne disease. Plant root aphid resistant cultivars.

Introduction

Experience and research results indicate that sugarbeets must be nitrogen deficient for a considerable period prior to harvest to achieve high quality. In Texas, the necessary period of deficiency is 2 to 3 months compared to the 3 or 4 weeks recommended elsewhere. A long period of deficiency prior to harvest will not materially lower profit if enough nitrogen was present to close the rows in June.

The primary nitrogen management problems in Texas stem from soils that are mostly very slowly permeable. Thus, neither rainfall nor irrigation reliably leach excess nitrate from the root zone. The result is frequently high and variable nitrate nitrogen levels (Table 1). This is the major nitrogen management problem with sugarbeets in Texas. We need a way to reduce the area planted to beets that is in the high nitrogen categories. Fully 40% of the area sampled had greater than 415 lb/acre available nitrogen. This 40% averaged 733 lb/acre available and ranged from 415 to 1528 lbs/acre. Frequently these areas of high residual nitrogen are on the lower portion of furrow irrigated fields with much lower residual nitrogen on the upper end of the field. As a result, sugar is frequently 2% or more higher on the upper end of the field.

Table 1. Sugarbeet yield and gross return in five nitrogen categories each representing 20% of 50 sites sampled.

Nitrogen category	Total available nitrogen[a/]	Mean sugar	Mean root yield	Mean gross $24 NSP
	lbs/acre	%	tons/acre	$/acre
Lowest 20%	176 d	14.64 a	24.1 a	857 a
2nd 20%	262 d	14.61 a	25.0 a	887 a
3rd 20%	372 c	14.11 ab	26.5 a	889 a
4th 20%	500 b	13.09 b	26.6 a	789 b
Highest 20%	965 a	11.86 c	28.6 a	715 c
Mean	455	13.66	26.2	827

a/ Total nitrate nitrogen in the sugarbeet root zone in May after fertilzer application.

The range of nitrogen levels over which good quality and yield can be obtained is larger than most realize. Therefore, the major problem is not fine tuning nitrogen recommendations to the last pound, rather it is eliminating the acreage with grossly excessive residual nitrogen. The way to reduce residual nitrogen prior to beets is to intensively sample fields when applying nitrogen to crops grown prior to beets.

This paper reports on what levels of residual and applied nitrogen are necessary to maximize profit given the present payment system of Holly Sugar at Hereford, TX. The payment system at Hereford is nearly equal to one based on extractable sugar. Proper nitrogen management can maximize profit to the grower and provide a high quality product to the factory for processing.

Methods

Fields were cropped to wheat, sorghum, or corn with a wide range of applied nitrogen rates to determine economically optimum rates on prior crops and to provide a range of residual nitrogen levels for beet production. Soils were all very slowly permeable Pullman clay loam. Experiments were conducted such that sugarbeets were grown in 1989, 1990, 1991, and 1993. Unfortunately, during 1989 and 1993 the results were not very helpful. In 1989, all soil residual nitrate levels prior to beets were very low, 40 lb/acre or less. After 1989, the range of nitrogen rates applied to prior crops was expanded. In 1993, the lowest residual level achieved (98 lb/acre) after applying no nitrogen to the prior crop was not low enough to get a positive response to applied nitrogen on beets despite yields of 43 tons/acre with 16.7% sugar. In 1990 and 1991, six experiments were conducted where a wide range in residual nitrogen was achieved prior to beets. These results are presented here. In addition, some prior data where nitrogen rates and irrigation were varied was used to estimate recommended nitrogen rates for various yield levels.

Results and Discussion

Soil residual nitrate nitrogen levels must be very low, below 30 lb/acre 0-4 ft, to expect a strong positive root yield response to applied nitrogen (Table 2). The optimum applied nitrogen rate increased gross return 72% when residual nitrogen was below 30 lb/acre. Gross return increased only 13 and 5% on average at the optimum applied nitrogen rate when residual nitrogen was 31-90 and 91-150 lb/acre, respectively. A positive response to applied nitrogen was always achieved when residual nitrogen was below 90 lb/acre. Above 90 lb/acre residual nitrogen, there was usually not a positive response and above 150 lb/acre there was no positive response to applied nitrogen (Table 2). These responses were measured at a 35 to 45 ton/acre yield level. Even less response to applied nitrogen would be expected at lower yield levels.

The recommendations for total residual plus applied nitrogen given in Table 2 are generally lower than prior recommendations of 8 lb/ton. The exception is when residual nitrogen is 30 lb/acre or less. In that case, 8 lb/ton residual plus applied is not excessive. With residual levels above 30 lb/acre, 5-7 lb/ton is usually adequate but 8 lb/ton will not measurably reduce grower profit. If in doubt, apply a lower rate because beet quality will be better with very little effect on the bottom line.

While the results given in Table 2 are pretty specific, applied nitrogen levels can be generalized pretty broadly with no measurable effect on results. For instance, in high yield situations, with a yield above 35 tons/acre, if residual nitrogen is below 30 lb/acre applying 240 to 360 lb/acre will maximize return. The difference between applying 240 and 360 is very small in economic terms for the grower. Beet quality will be slightly but measurably better at the lower rate which makes the lower rate preferable. If residual nitrogen is above 30 lb/acre, there is unlikely to be any improvement in return for applying much more than 120 lb/acre. Like wise, if residual is above 150 lb/acre a significant positive response to applied nitrogen is unlikely. These nitrogen levels are adequate for yields as high as we've ever grown, 45 to 50 tons/acre.

Table 2. Sugarbeet response to applied nitrogen at several soil residual levels and recommended residual plus applied nitrogen totals to maximize return at three root yield levels.

Residual nitrogen 0-4 ft	Percent response to optimum applied nitrogen[a/]	Frequency of a positive response[b/]	Root yield level, tons/acre		
			35+	25	18
lbs/acre	%	%	Residual + applied, lbs/acre[c/]		
< 30	72	100	270	200	150
31-90	13	100	220	180	130
91-150	5	40	200	150[d/]	120[d/]
>150	0	0	180[d/]	150[d/]	120[d/]

a/ Percent increase in gross dollars above the cost of fertilizer at the optimum applied nitrogen rate compared to zero applied nitrogen. This increase is in a maximum yield environment. Less response would be expected at a lower yield level.

b/ Frequency of increase in gross return above fertilizer cost at some applied nitrogen rate compared to the zero rate. A positive response would be less frequent in a lower yield environment.

c/ Recommended total of residual plus applied nitrogen to maximize gross return above fertilizer cost.

d/ A starter fertilizer might be necessary if the surface foot of soil tested below 20 lbs available nitrogen or particularly if undecomposed low nitrogen residues, such as wheat straw, were present in the surface soil. The later situation can lead to large root yield losses.

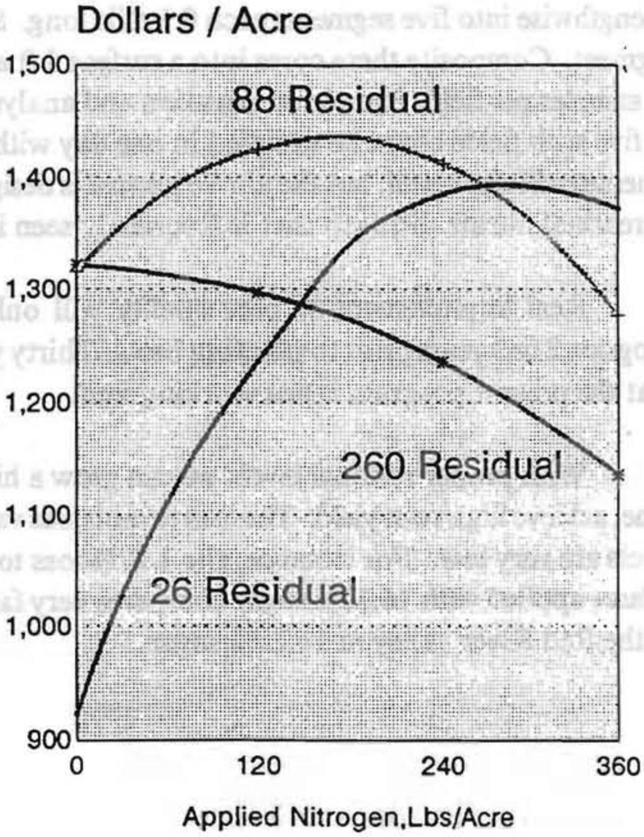
A couple of cautions are in order. If residual nitrogen is very low, some nitrogen should be applied soon enough and in a position where it will be available to the newly emerged seedling. Also, even when residual nitrogen is fairly high, incorporating low nitrogen residues such as wheat straw into the surface soil that are not completely decomposed prior to beet emergence can result in serious yield loss. Two or three times we have had significant root yield loss from one or a combination of the above conditions.

Sugarbeet response to applied nitrogen at three levels of residual nitrogen averaged over six tests are presented in Table 3 and Figure 1. Gross return above fertilizer, harvest, and

Table 3. Sugarbeet response to applied nitrogen at three levels of residual nitrogen. Mean of six tests in 1990 and 1991.

Nitrogen Res.	Nitrogen App.	Root yield	Sugar	Na	K	Amino-N	Loss mol.	Rec. Sugar
lbs/A		tons/A	%		ppm		% units	lbs/A
26	0	23.5	16.60	274	1841	186	1.00	7024
	120	32.9	16.53	338	1849	275	1.15	9729
	240	36.7	16.39	370	1873	322	1.23	10686
	360	38.1	16.19	489	1975	439	1.47	10751
88	0	34.1	16.48	332	1814	248	1.10	10100
	120	38.2	16.32	422	1878	327	1.27	11017
	240	39.4	15.96	512	1948	427	1.46	10930
	360	39.1	15.27	689	2000	561	1.74	10105
260	0	40.0	15.00	786	1886	469	1.66	10180
	120	40.5	14.95	855	2019	584	1.85	10105
	240	40.4	14.55	894	2028	619	1.92	9723
	360	40.0	14.14	963	2050	726	2.10	9174

Figure 1. Net return above the cost of fertilizer and harvest at three levels of residual nitrogen with applied nitrogen from 0 to 360 lbs/A.



hauling in these high yield environments was maximized at a residual level of 88 lb/acre with 120 to 150 lb/acre applied nitrogen. Average yield was near 38 tons/acre with 16.3% sugar. Maximum yield achieved at any nitrogen level was near 40 tons/acre while the highest average sugar was near 16.6% at deficient nitrogen. It is to be expected that the optimum nitrogen rate for return/acre will provide root yield and sugar both somewhat below maximum levels.

It looks like 16 to 17.5% sugar will be near the maximum that can be achieved most years at a high root yield level. As residual nitrogen increases from 200 lbs/acre to the very high levels seen in 20% of the field areas in Table 1, maximum achievable sugar will decline from around 15% to 11 or 12%. If one combines high nitrogen with poor stands and leaf spot or root aphid, sugar can be much worse. However, all of these problems can be overcome.

Soil sampling prior to any nitrogen application in the 2 or 3 years preceding beets would greatly improve the residual nitrogen situation. Lowering residual nitrogen levels is the key to maximizing sugarbeet quality! The present nitrogen management program of petiole sampling and soil sampling prior to beet planting is too late to materially improve beet quality unless high residual fields are rejected.

Proper soil sampling is easier, faster, and less expensive than most expect. My recommendation for sampling a typical 0.5 mile furrow irrigated field would be to divide it lengthwise into five segments each 0.1 mile long. Sample 4 to 5 cores diagonally across each segment. Composite these cores into a surface 1 ft and subsurface 3 ft section. This results in 10 samples per field. Sample preparation and analysis should cost $2.00/sample or less. Four or five such fields could be sampled in one day with good equipment. Many other sampling schemes will work well, but the above scheme is designed to detect and correct for the gradient in residual nitrate nitrogen that is frequently seen in furrow irrigated fields.

Real improvement in beet quality will only occur if we institute such a sampling program 2 or 3 years prior to planting beets. Thirty years of little or no improvement indicates that the present program is not working well.

With proper residual levels we can grow a high quality beet in Texas and, at the same time, achieve high root yield. The loss to molasses values given in Table 3 at optimum nitrogen levels are very low. For instance, the 1.27% loss to molasses at 88 lbs/acre residual plus 120 lb/acre applied with 16.32% sugar compares very favorably to the average 1.43% loss in 1994 in the Red River valley at 16.75% sugar.