Foliar Fertilization of Sugarbeets During the Winter Months

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Summary

Foliar applications of phosphorus and nitrogen in December and January were not effective in increasing yield, sucrose concentration or tissue phosphorus and nitrogen content of sugarbeets grown on soil low in residual phosphorus. Maintaining high residual soil phosphorus appears to be a better method of avoiding phosphorus deficiency in sugarbeets.

Introduction

Low soil temperatures in the winter months in central Arizona may reduce phosphorus (P) uptake and cause a temporary P deficiency in sugarbeets even though adequate soil P is available. When the soil is warm, 5 to 10 ppm soil P extracted by $NaHCO_3$ is adequate for seedling growth but in the December through February cold period this level may be inadequate. Low soluble P values (.075 to .120%) in the petioles have been found to be related to lower sugar yields at harvest.

One potential method of supplying nutrients when environmental conditions reduce nutrient uptake or prevent soil applications is foliar feeding. Foliar feeding offers a rapid and efficient method of supplying nutrients to plants. Foliar applications of P have been shown to increase yields of corn and soybeans. Nitrogen (N) in the form of urea has been successfully applied to certain crops as a foliar spray. The principal drawback to applying nutrients as foliar sprays is that only a small amount of the total nutrient required by a crop can be successfully supplied by this method. This study was designed to determine the effect of winter foliar applications of N, P and a combination of N and P on yield and sucrose concentration of beets grown for early season harvest.

Methods

The variety US H9B was planted on 26 September, 1980 on soil maintained at low residual P (no P fertilizer for 10 years) and soil maintained at high residual P (P fertilizer applied annually). A crop of sudan was produced without N fertilizer on this soil during May, June and July to reduce residual soil N. Nitrogen fertilizer application rates of 44, 144 and 244 lbs N/A were compared at both soil P levels. All plots received a sidedress application of 44 lbs N/A on 17 October. The remainder of the N was applied on 24 November. Foliar nutrients were applied on 4 December and 9 January (Table 1). No leaf injury was observed on sprayed beets, even when high concentrations of P were used.

Soil collected before planting in the top foot in low and high residual P plots contained 4.8 and 9.7 ppm $NaHCO_3$ extractable P, respectively. Petiole samples for N and P analysis were collected periodically from December through March. Soil temperatures were recorded at depths of 2, 4 and 12 inches in sugarbeet beds during the winter months. Plots were harvested in late May to determine yield and sucrose concentration of roots.

Results

Root yields, sugar yields and sucrose concentrations for foliar and N fertility treatments for low and high residual soil P levels are shown in Tables 2 and 3, respectively. Foliar nutrient sprays had no significant effect on any of the yield factors measured. It appears that foliar sprays contributed little, if any, P to beet plants, since soluble P in petioles was not noticeably increased by several foliar applications of P (Table 4).

In this study the only treatment that influenced tissue P content was the high residual soil P level. During the winter months, beets grown on high residual P soil had almost twice the petiole P content as those grown on low P soil (Table 4). In December and early January the soluble P content of petioles from low residual P soil was marginal (.08 to .12%) compared to adequate (.14 to .23%) for high residual P soil. However, by March the soluble P content of petioles indicated that beets in both residual soil P levels had a sufficient supply of P. In a statistical comparison between yields from the two residual P levels, the highest residual P level was found to result in the highest sugar yield.

No large decreases in soluble P in petioles were noted during the winter months, although petiole P from the high residual P soil decreased slightly in early January (Table 4). The generally mild temperatures that occurred in the 1980-81 winter may have been favorable for high P uptake. An examination of soil temperatures shows that the temperature at the 4 inch depth dropped below 50° F only for a short period in late January and early February (Table 5).

The highest N fertility level resulted in the highest root and sugar yields. This strong response to N fertilizer was not unexpected since residual soil N at planting time was very low. Foliar applications of N as urea had no measureable effect on yield or petiole NO_3-N content, even at the lowest N fertility level where beets were very deficient in N (Table 6).

Table 1. Description of foliar treatments.

Treatment No.	Compound(s)	Spray Concn*	Application Rate	Date of Application 4 Dec.	9 Jan.
1A	Orthophosphate	8g P/L	2.04 lbs P/A	X	
1B	Orthophosphate	8g P/L	4.08 lbs P/A	X	X
2A	Orthophosphate	16g P/L	4.08 lbs P/A	X	
2B	Orthophosphate	16g P/L	8.16 lbs P/A	X	X
3A	Pyrophosphate	8g P/L	2.04 lbs P/A	X	
3B	Pyrophosphate	8g P/L	4.08 lbs P/A	X	X
4A	Pyrophosphate	16g P/L	4.08 lbs P/A	X	
4B	Pyrophosphate	16g P/L	8.16 lbs P/A	X	X
5A	Urea	15g N/L	3.82 lbs N/A	X	
5B	Urea	15g N/L	7.64 lbs N/A	X	X
6A	Urea +	15g N/L	3.82 lbs N/A		
	Pyrophosphate	8g N/L	2.04 lbs P/A	X	
6B	Urea +	15g N/L	7.64 lbs N/A		
	Pyrophosphate	8g P/L	4.08 lbs P/A	X	X
7	Water check				

*All nutrient solutions adjusted to pH 5.6-5.8. The solutions contained 0.1% of Z77, a non-ionic surfactant.

Table 2. Effect of foliar N and P treatments on yield and sucrose concentration of sugarbeets grown on soil low in residual P.

Foliar Treatments[2]	Root Yield			Sugar Yield			Sucrose Concentration		
	N Fertility Level[1]								
	N1	N2	N3	N1	N2	N3	N1	N2	N3
	T/A			T/A			%		
1A	14.4	24.9	25.0	2.54	4.34	4.15	17.8	17.6	16.8
1B	14.8	24.7	27.4	2.60	4.28	4.65	17.8	17.5	17.0
2A	13.3	20.8	28.6	2.29	3.72	4.90	17.5	18.0	17.1
2B	13.5	22.9	31.2	2.42	4.03	5.39	18.1	17.6	17.4
3A	12.5	22.4	26.8	2.29	3.97	4.53	18.4	17.7	17.0
3B	14.9	21.4	28.0	2.67	3.91	4.65	17.8	18.1	16.7
4A	14.6	21.8	25.1	2.60	3.84	4.22	17.8	17.7	17.0
4B	13.7	22.2	28.3	2.42	3.97	4.84	18.1	17.8	17.0
5A	13.1	23.6	27.5	2.36	4.09	4.59	18.3	17.5	16.7
5B	13.7	24.6	29.0	2.48	4.28	4.77	18.3	17.6	16.5
6A	13.4	24.4	29.4	2.36	4.34	4.77	17.8	17.7	16.4
6B	16.0	23.2	27.7	2.85	4.03	4.65	17.9	17.6	16.8
7	13.8	24.7	27.9	2.48	4.34	4.71	18.2	17.5	16.9
Ave. of N Levels	14.0 c[3]	23.2 b	27.8 a	2.50 c	4.09 b	4.68 a	18.0 a	17.7 a	16.9 a

[1] N1 plots recieved 44 lbs N/A, N2 received 144 lbs N/A and N3 received 244 lbs N/A.

[2] For a description of foliar treatments see Table 1.

[3] N fertility means for a yield factor followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test.

Table 3. Effect of foliar N and P treatments on yield and sucrose concentration of sugarbeets grown on soil high in residual P.

Foliar Treatments[2/]	Root Yield			Sugar Yield			Sucrose Concentration		
	N Fertility Level[1/]								
	N1	N2	N3	N1	N2	N3	N1	N2	N3
	T/A			T/A			%		
1A	16.8	27.3	31.1	3.01	4.93	5.55	17.9	18.1	17.9
1B	14.7	27.5	36.6	2.67	5.15	6.51	18.5	18.8	17.8
2A	14.3	27.3	32.3	2.54	4.96	5.86	17.9	18.2	18.2
2B	16.1	27.5	32.7	3.04	5.15	5.86	18.8	18.8	18.0
3A	16.6	27.2	28.3	3.07	5.08	5.02	18.4	18.7	17.7
3B	19.1	26.8	27.8	3.47	4.93	4.84	18.1	18.5	17.5
4A	18.5	27.2	32.0	3.29	4.90	5.64	19.0	18.1	17.7
4B	13.5	26.6	31.0	2.42	4.71	5.58	17.9	18.0	18.0
5A	20.5	25.9	32.4	3.88	4.71	5.80	18.7	18.1	17.9
5B	16.4	25.2	29.1	2.95	4.34	5.24	18.0	18.9	18.1
6A	15.4	23.3	32.6	2.88	4.12	5.77	18.8	17.8	17.7
6B	16.6	24.9	34.9	3.04	4.40	6.08	18.4	17.8	17.5
7	15.4	26.7	31.5	2.79	4.90	5.55	18.2	18.3	17.7
Ave. of N Levels	16.4 c[3/]	26.4 b	31.7 a	3.00 c	4.79 b	5.64 a	18.4 a	18.3 a	17.8 a

[1/] N1 plots received 44 lbs N/A, N2 received 144 lbs N/A and N3 received 244 lbs N/A.

[2/] For a description of foliar treatments see Table 1.

[3/] N fertility means for a yield factor followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test.

Table 4. Effect of foliar N and P treatments and residual soil P level on soluble P content of petioles.

Foliar Treatment	18 Dec.		8 Jan.		21 Jan.		11 Mar.	
	Residual P Level							
	Low	High	Low	High	Low	High	Low	High
	% P							
1A[1/]	.104[2/]	.231	.106	.163	.155	.244	.135	.231
1B	-	-	-	-	.177	.293	.153	.215
2A	.130	.206	.106	.155	.184	.253	.142	.232
2B	-	-	-	-	.216	.284	.157	.232
3A	.111	.206	.111	.156	.166	.242	.144	.224
3B	-	-	-	-	.151	.262	.159	.227
4A	.108	.218	.102	.170	.181	.251	.137	.208
4B	-	-	-	-	.188	.301	.140	.243
5A	.091	.200	.114	.169	.145	.216	.138	.224
5B	-	-	-	-	.146	.222	.124	.228
6A	.116	.206	.110	.146	.153	.215	.139	.220
6B	-	-	-	-	.182	.258	.137	.232
7	.098	.192	.108	.172	.178	.269	.131	.233

[1/] For a description of foliar treatments see Table 1.

[2/] Values are means of data from all three N fertility levels.

Table 5. Minimum soil temperatures at 2, 4 and 12 inches in sugarbeet beds, 1980 and 81

Date	Soil Depth - inches		
	2	4	12
	° F		
Jan. 6	50	53	55
Jan. 16	52	55	56
Jan. 22	44	49	52
Feb. 6	43	47	50
Mar. 12	--	58	59
Mar. 24	52	52	59

Table 6. Effect of foliar N and P treatments and N fertility level on NO_3-N content of petioles sampled on 21 January in low residual P soil.

Foliar Treatment[1/]	N Fertility Level		
	N1	N2	N3
	NO_3-N (ppm)		
1A	2,900	7,430	9,000
1B	2,600	8,500	9,600
2A	3,200	8,200	8,200
2B	4,000	9,050	8,300
3A	3,100	8,600	7,900
3B	6,000	8,800	9,000
4A	3,350	8,050	9,100
4B	4,600	9,200	8,800
5A (N)	3,200	9,750	8,600
5B (N)	1,630	8,300	9,400
6A (N + P)	2,000	7,950	9,100
6B (N + P)	3,300	8,600	8,050
7 Check	5,000	8,100	8,850

[1/]For a description of foliar treatments see Table 1.

Phosphorus Fertilization of Fall-Planted Sugarbeets

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Summary

Data presented indicates that P availability plays a significant role in production of fall-planted sugarbeets, as both root yield and percent sucrose may be affected. Analyzing petioles for soluble P as well as nitrate concentration should aid in evaluating a P fertilization program, although the P concentration values may vary from year to year, depending on the climatic conditions. This is more practical than analyzing leaf blades, because the same petiole samples collected for nitrate analysis can also be analyzed for soluble P.

Application of P fertilizer would be recommended if soil tests indicate low to marginal available P. Soil P extracted by $NaHCO_3$ should not be below 10 ppm. Soil with test values from 5 to 10 ppm would be adequate for the seedling growing in warm soil, but in the December through February cold soil period, petiole soluble P concentration may drop to around 1,000 ppm, with inadequate growth and sucrose concentration the result.