PHOSPHORUS FERTILITY IN STRIP TILLAGE

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Introduction

This study examines the possibility of reducing phosphorus (P) application rates in strip tillage. We examined the effect of 20%, 30%, 40%, and 50% P application reductions on low P testing soils compared to full rate applications with strip tillage. We included similar P rate treatments with broadcast application in conventional tillage for comparison.

Phosphorus (P) fertilizer prices have shown tremendous volatility during the past several years and prices remain unpredictable for future years. In the soil, P is readily "fixed" into unavailable forms in some soils of the Red River Valley of ND and MN and Southern MN (most notably high pH and calcareous soils); under such soil conditions, accurate P application rate and placement becomes critical. Banding P fertilizer near or in the crop row can increase P availability for plants under the soil conditions described. Strip tillage allows banding of P fertilizer in the crop row at the same time that strips are placed. By improving the efficiency of P uptake into sugarbeet tissues, it may be possible to reduce the application rate that is recommended for conventional broadcast fertilization application. **This study investigated 1) banding P fertilizer with strip tillage equipment to increase plant availability of P relative to conventional broadcast application, and 2) the potential reduction of P fertilizer application rates (without sacrificing beet root yield and quality) if it is determined that P uptake efficiency increases with strip tillage.** Results that indicate that P fertilizer application rates can be reduced in strip tillage systems would represent cost savings to farmers currently strip tilling and may influence other farmers to consider strip tillage for their farming operations.

A study conducted in 1996 in Waseca, MN on corn determined that under very low soil test P conditions, banding P fertilizer at half the recommended broadcast rate was not sufficient to optimize corn grain yield relative to conventional tillage with full rate broadcast application (Randall et al., 2001). For this reason, we select rates of P reduction between 20% and 50% to examine the full range and allow us to more exactly identify the effect of P rate reduction.

Materials and Methods

The study was designed in a randomized complete block design, with four replications, near Amenia, ND on a well drained sandy loam soil with no serious history of root rot diseases. Strips were applied in an east/west row orientation in October 2009. Soil samples taken in September 2009 indicated that there was 60 lb N a^{-1} (to a depth of 4 ft.) and 8 ppm P (Olsen extraction). In October 2009, we applied 70 lb. N a^{-1} as urea and 55 lb. P_2O_5 as triple super phosphate or some fraction thereof, as described in Table 2. Starter fertilizer was not applied to any treatments. In strip tillage treatments, N fertilizer was applied with the strip tiller using urea and triple super phosphate at the same time strips were made. The conventionally tilled treatment was also fertilized with urea and triple super phosphate by broadcasting and incorporating twice with a chisel plow in the fall and lightly cultivated in the spring with a harrow/packer combination before planting. Nine treatments comprised this experiment, as detailed in Table 2.

Individual treatment plots measured 11 feet wide and 30 feet long. Sugarbeet variety Crystal 658RR was planted in a smooth, moist, firm, seedbed on April 19, 2010 with a John Deere MaxEmerge 2 planter. Sugarbeet was placed 1.25 inches deep with a 5-inch in row spacing was used. Excellent emergence and plant vigor was noted. Roundup Ready herbicide was applied three times, plots were not cultivated and some late hand labor was used as needed for weed control. Quadris fungicide was applied at the four to six leaf stage and again three weeks later to help control rhizoctonia root rot. Two fungicide applications, Eminent and Headline, were applied for Cercospora leafspot control. Plots were harvested on September 22, 2010. Yield determinations were made and quality analysis performed at American Crystal Sugar Quality Tare Lab, East Grand Forks, MN.

Results and Discussion

Average root yields ranged from 33.3 tons per acre for the Conventionally Tilled/Broadcast 80% P Rate (Treatment 3) to 37.5 tons per acre for the Strip Tilled 70% P rate (Treatment 7, Table 2). Although Treatment 7 produced the greatest root yields, the following treatments were statistically equal to it: Strip Tilled Full P Rate (37.0 t/a, Treatment 5), Strip Tilled 80% P Rate (37.0 t/a, Treatment 6), Strip Tilled 60% P Rate (35.9 t/a, Treatment 8), Conventionally Tilled/Broadcast 60% P Rate (35.4 t/a, Treatment 4), and the 0 P Added Check (35.2 t/a, Treatment 1). No treatments were statistically greater than or less than the No P Added Check (Treatment 1); however, the Conventionally Tilled/Broadcast Full P Rate (Treatment 2), Conventionally Tilled/Broadcast 80% P Rate (Treatment 3), and Strip Tilled 50% P Rate (Treatment 9) all produced statistically lower root yields than the Strip Tilled 70% P Rate (Treatment 7). In general, strip tilled treatments at the full, 80%, and 70% P rates performed better than the conventionally tilled/broadcast treatments at the same P rates. The conventionally tilled/broadcast treatments at the full and 80% rates produced non-statistically lower root yields than the no-P added check, suggesting that broadcasting P fertilizer on low-P soils is not as effective as banding the same rates of P fertilizer for optimizing sugarbeet root yield.

In terms of sugar quality, the greatest gross sugar content came from treatment 3, Conventionally Tilled/Broadcast 80% P Rate, which was also the lowest root-yielding treatment. The lowest gross sugar content was from the 0 P added Check (Treatment 1). Sugar loss to molasses values were all relatively low with the exception of the Strip Tilled Full P Rate treatment (Treatment 5), which was statistically greater than all other treatments. Net sugar was greatest for the lowest root-yielding treatment, Conventionally Tilled/Broadcast 80% P Rate (Treatment 3); this treatment produced the 2nd lowest RSA but the highest RST. Strip tillage treatments at all P rates produced moderate gross sugar and net sugar concentrations. RSA was greatest for the highest-yielding treatment, Strip Tilled 70% P rate (Treatment 7) and lowest for the Strip Tilled 50% P Rate (Treatment 9). The poor RSA results for Treatment 9 agree with the previously referenced Randall et al. 2001 results of banding 50% P rate in corn. Obviously, 50% of the recommended rate is too low, but 70% or more of the full rate may be adequate since this rate (Treatment 9) resulted in the greatest tonnage, RSA, and gross revenue per acre of all treatments tested in this study.

These results suggest that banding P fertilizer with strip tillage is a more effective means of providing P nutrients to sugarbeet on low-P soils than the conventional broadcast-with-incorporation method. These results suggest that it may be possible to reduce P fertilizer application rates with banding and/or strip tillage, but a greater body of data from additional site-years is required before safe and specific recommendations can be made.

References

Randall, G.W.; J.A. Vetsch, T.S. Murrell. 2001. Corn Response to Phosphorus Placement under Various Tillage Practices. Better Crops. 85(3): 12-15.

Acknowledgement-

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Table 2. Phosphorus Rate and Placement Effects on Strip-tilled and Conventionally-tilled Sugarbeet Yields at 2 locations. 2010 Growing Season. Least significant difference (LSD) values provided for P<0.05; n.s. signifies no significant differences.

Treatment	Root Yield (Tons/a)	Gross Sucrose (%)	%SLM* (%)	Net Sucrose (%)	RSA† (lb/a)	RST‡ (lb/ton)	Tare (%)	GrossTon§ ($/Ton)	GrossAcre¶ ($/acre)
1. Strip Till 0 P	35.23	15.3975	1.0039	14.3936	10152.19	287.87	4.82	49.94	1762.57
2. Broadcast Full	34.62	15.4950	0.9981	14.4969	10046.88	289.94	3.59	50.56	1753.23
3. Broadcast 80%	33.28	16.0525	1.0072	15.0453	10013.35	300.91	4.18	53.85	1791.82
4. Broadcast 60%	35.38	15.8000	1.0040	14.7960	10477.35	295.92	3.71	52.36	1854.62
5. Strip Till Full	37.02	15.4475	1.1219	14.3256	10612.18	286.51	4.50	49.53	1835.29
6. Strip Till 80%	37.00	15.5600	1.0248	14.5352	10761.76	290.70	5.03	50.79	1881.06
7. Strip Till 70%	37.48	15.7100	1.0106	14.6994	11017.66	293.99	4.51	51.78	1940.11
8. Strip Till 60%	35.94	15.8300	1.0275	14.8025	10655.66	296.05	3.66	52.40	1887.66
9. Strip Till 50%	33.88	15.7700	1.0137	14.7563	9990.11	295.13	4.37	52.12	1763.08
LSD (P<0.05)	**2.79**	**0.6388**	**0.0829**	**0.6871**	**989.49**	**13.74**	**1.07**	**4.12**	**n.s.**

*%SLM = Sucrose Loss to Molasses, a measure of impurity content
† RSA = Recoverable Sucrose per Acre
‡ RST = Recoverable Sucrose per Ton
§ GrossTon = Gross Revenue per Ton
¶ GrossAcre = Gross Revenue per Acre