

Phosphorus Fertilizer Studies in Southern Minnesota

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Justification:

A considerable amount of interest has been generated in phosphorus management with environmental concerns surrounding the Minnesota River basin and the phosphorus (P) trading agreement in which Southern Minnesota Beet Sugar Cooperative has entered into as part of the water treatment at the refinery. Research results nationwide indicate that using the correct application rate of phosphate is important to reduce the environmental effects of P in fresh water. Phosphorus fertilizer can be the most expensive fertilizer input in sugar beet production on a per unit basis. Little field research has been done in the Southern Minnesota sugar beet growing area with regard to phosphorus use in a sugar beet production system. Lamb 1986 reported results from two locations, one site with a low phosphorus soil test and one with a very high soil test phosphorus. The low soil test P site had a positive root yield response to phosphate fertilizer application while the very high soil test P site had no response. These studies did not have sufficient rates to determine what the optimum application rates should be. Sims 1999 reported small root yield responses to a broadcast application of phosphate in the Red River Valley. In further reports of this work, Sims 2000, indicated that the use of starter phosphate produced the same root yield responses at much reduced application rates. In response to concerns that the P recommendations were not current and the lack of recent information from the Southern Minnesota sugar beet growing area, a series of P rate studies were conducted in 2000 and 2001 with the objective to update fertilizer recommendations for sugar beet grown in the Southern Minnesota Beet Sugar Cooperative area.

Materials and Methods:

To meet the objectives, three P rate trials were conducted, two in 2000 and one in 2001. The sites for these studies were near Raymond and Bird Island, Minnesota in 2000 and near Renville, Minnesota in 2001. The initial Olsen soil test phosphorus results were 17 ppm at Raymond, 4 ppm at Bird Island, and 9 ppm at the Renville site. This represents a range of soil test P categories from low at Bird Island to very high at Raymond. At the Raymond site, phosphate fertilizer rates of 0, 20, 40, 60, and 80 pounds per acre were broadcast applied and incorporated in the spring 2000. The same rates of phosphate were applied at the Bird Island site. In addition to the broadcast and incorporated set of treatments at Bird Island, phosphate was also knifed into the soil to a depth of 5 inches with the knives spaced 22 inches apart. In 2001, the phosphate was broadcast applied at 0, 15, 30, 45, and 60 pounds per acre at the Renville site. Root yield and quality was determined in the fall.

Results and Discussion:

There were no significant root yield or quality responses to broadcast phosphate fertilizer application at any of the three research sites, Table 1, 2, and 3. At the Bird Island site, there were no root yield or quality responses to knife application. The lack of response at the Bird Island site was surprising as the Olsen soil test P was in the low category at 4 ppm. At this time it is not recommended to apply phosphate fertilizer at rates greater than the current University of Minnesota or North Dakota State University recommendations. Further research with the use of seed placement of phosphorus is warranted. The use of a knife placement (not in the sugar beet row) is not any better than a broadcast application.

Table 1. Root yield, sucrose concentration, loss to molasses, recoverable sucrose per ton, and recoverable sucrose per acre for phosphorus study near Raymond, Minnesota in 2000.

P rate	Root yield	Sucrose concentration	Loss to molasses	Recoverable sucrose	
lb phosphate A ⁻¹	tons A ⁻¹	----- % -----		lb ton ⁻¹	lb A ⁻¹
0	26.8	16.8	1.09	315	8430
20	26.2	16.9	1.09	316	8273
40	29.1	17.1	1.08	320	9240
60	28.2	16.7	1.09	313	8829
80	28.0	16.7	1.10	313	8754
Rate significance	NS	NS	NS	NS	NS

Table 2. Root yield, sucrose concentration, loss to molasses, recoverable sucrose per ton, and recoverable sucrose per acre for phosphorus study near Bird Island, Minnesota in 2000.

P rate	Root yield	Sucrose concentration	Loss to molasses	Recoverable sucrose	
lb phosphate A ⁻¹	tons A ⁻¹	----- % -----		lb ton ⁻¹	lb A ⁻¹
0	25.4	17.7	1.03	333	8446
20	27.4	17.3	1.06	325	8891
40	26.5	17.5	1.05	328	8703
60	26.2	17.4	1.04	328	8586
80	27.2	17.1	1.07	321	8711
Rate significance	NS	NS	NS	NS	NS

Table 3. Root yield, sucrose concentration, loss to molasses, recoverable sucrose per ton, and recoverable sucrose per acre for phosphorus study near Renville, Minnesota in 2001.

P rate	Root yield	Sucrose concentration	Loss to molasses	Recoverable sucrose	
lb phosphate A ⁻¹	tons A ⁻¹	----- % -----		lb ton ⁻¹	lb A ⁻¹
0	24.6	16.4	1.13	305	7477
15	26.1	16.3	1.14	303	7865
30	25.0	16.3	1.14	303	7563
45	25.0	16.3	1.14	304	7585
60	24.6	16.3	1.13	304	7506
Rate significance	NS	NS	NS	NS	NS