A COMPARISON OF POINT INJECTED AND KNIFED PHOSPHORUS FOR WINTER WHEAT

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INTRODUCTION

There are almost 2 million acres of winter wheat grown in South Dakota. Most is produced in the southwest part of the state on residual clay soils in a wheat fallow rotation with only limited, shallow sweep tillage. Very reduced tillage is necessary for wind and water erosion control, and water conservation on the long steep slopes. The continued use of shallow tillage on highly buffered, high pH soils has made broadcast phosphorus fertilizer inefficient in increasing wheat yields, even though phosphorus soil test levels are low. Because of the apparent lack of yield increases, producers use of phosphorus fertilizer is low. Starter phosphorus can be effective, but the inconvenience of this placement method has minimized producers acceptance of starter fertilizer.

An alternative method of phosphorus placement was needed for winter wheat. The development of the spoke wheel injection system may fill that need. It has desirable characteristics such as no residue or soil disturbance, low power requirements and would place phosphorus below the surface where moisture and root growth would be more abundant. Most recent yield data with spoke wheel injection has been with nitrogen. Results have been promising, especially with reduced or no till. Less is known concerning phosphorus placement with this device. Theoretical calculations indicate that there may be a problem caused by insufficient root contact when phosphorus is point injected on some soils compared to knifed phosphorus in a continuous band. However, the limited soil-fertilizer contact may be an advantage on highly buffered soils such as the vertisoils of central South Dakota where very high rates of broadcast phosphorus are needed to maximize yields (Figure 1).

To test the usefulness of spoke injected phosphorus on winter wheat on the highly buffered soils in central and western South Dakota, experiments were established with the following objectives:

1) Compare point injected and knifed phosphorus for winter wheat.
2) Encourage interest in non-broadcast application of phosphorus.
3) Demonstrate phosphorus response by winter wheat in central South Dakota.

MATERIALS AND METHODS

Experiments were established at three locations on residual clay soils in Jones County, SD in the fall of 1989. Winter wheat was the test crop grown in a wheat fallow rotation. Four rates of P_2O_5; 0, 30, 60, 120 lb per acre, were applied prior to planting. The phosphorus source was 10-34-0. Nitrogen rates were balanced in each phosphorus treatment with broadcast

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ammonium nitrate at the time phosphorus treatments were applied. Two placement methods were used; knifing in 14 inch spacing and point injection in 10 inch spacing using the Cady spoke injection wheel. Depth of placement for both applications was five inches. The winter wheat was planted by cooperators with rows perpendicular to the direction of phosphorus application. The experimental design was a split plot randomized complete block with placement the main plot and rate the subplot. Each treatment was replicated four times. Plot size was six feet by 35 feet. Parameters measured were early dry matter production at jointing (Feekes' scale 6) and grain yield. Grain yield was measured with a small plot combine.

Soil test levels at the three sites are presented in Table 1. Bray phosphorus soil test levels in the top six inches of soil were considered low at the Patterson and Rankin sites and low to medium at the Fuoss site. Olsen phosphorus soil tests were also considered low. Further evaluation of phosphorus soil test levels by depth show soil test phosphorus is concentrated in the top two inches of soil at all three sites (Table 2). The mean soil test in the top two inches was 14 ppm phosphorus, compared to only three ppm for the four to six inch soil depth. This segregation of phosphorus is likely due to the shallow, non-inversion tillage used on these soils. Placing phosphorus in the four to six inch soil layer could be more efficiently used than shallow placed phosphorus during the hot and dry periods of early summer when the soil surface dries rapidly.

Soils at all three sites were calcarious, with pH ranging from 7.8 to 8.0 in the top six inches. The soil texture at all three sites was clay. Textural analysis on the soil series (Promise and Opal) found at the sites indicate they are 50 to 70% clay.

RESULTS AND DISCUSSION

Phosphorus fertilizer increased dry matter yield taken at the early jointing stages at all locations (Table 3). Dry matter yield increases were significant to the 60 lb P_2O_5 rate at the Patterson site and to the 120 lb rate at the Rankin and Fuoss sites. These are higher P_2O_5 rates than would have been predicted by regular soil test recommendations, especially at the Rankin and Fuoss locations. This may be an indication of inefficient phosphorus use due either to placement or the soils capacity to rapidly change phosphorus to less available forms.

The influence of phosphorus placement on winter wheat early dry matter production is displayed in Table 4. Even though there appears to be a trend for knife application to have higher dry matter yields, statistically there was no difference in placement methods at the 0.10 level at any of the sites. Visual field observation of fall growth showed knifing to increase early growth while spoke injection did not. Visual field observations in spring, however, showed both placements to stimulate growth equally.

Phosphorus fertilizer increased grain yields at all three locations (Table 5). Similar to the early growth responses, 60 lbs P_2O_5 were required for maximum yield at the Patterson site and the Rankin and Fuoss sites responded to the 120 lb/A rate. These grain yield responses to high phosphorus fertilizer rates are an indication of inefficient phosphorus use due to soil characteristics or placement. Grain yield increases of up to 13 bushels per acre (Rankin site) indicate that phosphorus deficiencies are severely limiting winter wheat grain yields at some locations in western South Dakota.

Phosphorus placement significantly affected yields at the Patterson site (Table 6). Knifing phosphorus at this site resulted in higher grain yields than point injection. The rate by placement interaction at this site was nonsignificant. Placement did not have a significant affect on yields at the Rankin and Fuoss sites.

The early growth and grain yield responses to point injection of phosphorus in this study indicate it is a competitive placement method when compared to knife applications on high pH; highly buffered clay soils. More work needs to be done, however, to determine the frequency in which other placement methods, including starter, would result in more efficient phosphorus use by wheat.

SUMMARY

1) Phosphorus application by point injection or knifing increased winter wheat early plant growth and grain yield.

2) Phosphorus rate required to reach maximum yields was higher than predicted by current soil test calibration.

3) Phosphorus placement by either knife or point injection were equally effective in increasing early dry matter production.

4) Knife placement of phosphorus was more effective in increasing winter wheat grain yield than point injection at one of three locations, point injection was equal to knifing at two of three locations.

Fig. 1. Influence of broadcast phosphorus on winter wheat grain yield at Patterson site, 1986, Jones County, SD.

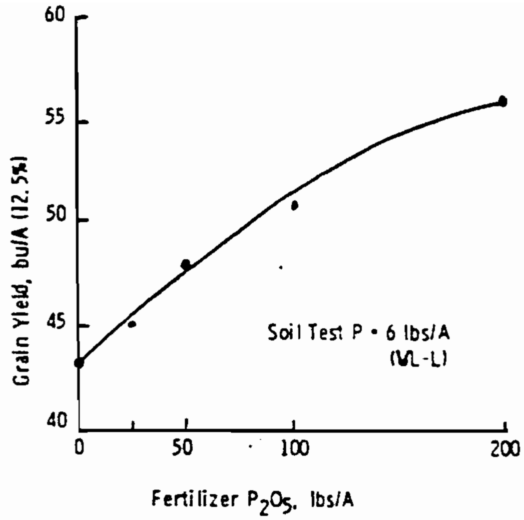

Table 1. Soil Test Level, Phosphorus Placement Studies, Jones Co. 1990

Site	Soil Test Level (0-6 inch) P[1]	K	pH	OM	Texture
	---ppm---			%	
Patterson	6	525	8.0	2.3	Clay
Rankin	7	600	7.8	3.0	Clay
Fuoss	8	575	7.8	2.2	Clay

[1] Bray test

Table 2. Phosphorus Soil Test Levels by Depth, Phosphorus Placement Studies, Jones Co. 1990

Sample depth	Phosphorus Soil Test[1] Patterson	Rankin	Fuoss
inches	---ppm-P---		
0- 2	10	17	14
2- 4	6	9	5
4- 6	3	3	2
6-12	3	2	1

[1] Bray test

Table 3. Influence of Phosphorus Rate on Winter Wheat Dry Matter Production at Jointing, Jones Co. 1990

P_2O_5 rate	Dry Matter[1]		
	Patterson	Rankin	Fuoss
lb/A	---------------lb/A---------------		
0	915 a[2]	827 a	2317 a
30	1090 a	1122 ab	2525 ab
60	1526 b	1242 ab	2820 a
120	1486 b	1422 b	3155 c

1 Yields are means of 2 placements
2 Column means followed by the same letter are not significantly different at the 0.05 level.

Table 4. Influence of Phosphorus Placement on Winter Wheat Dry Matter Production at Jointing, Jones Co. 1990

P_2O_5 rate	Dry Matter Yield					
	Patterson		Rankin		Fuoss	
	Knife	Spoke	Knife	Spoke	Knife	Spoke
lb/A	---------------------bu/A---------------------					
0	781	1048	848	805	2309	2324
30	1193	985	1209	1034	2534	2516
60	1714	1337	1253	1229	2799	2841
120	1678	1293	1588	1256	3185	3124
Placement (Pr > F)	0.127		0.371		0.966	

Table 5. Influence of Phosphorus Rate on Winter Wheat Grain Yields, Jones Co. 1990

P_2O_5 rate	Grain Yield[1]		
	Patterson	Rankin	Fuoss
lb/A	---------------bu/A---------------		
0	33 a	37 a	64 a
30	35 a	41 b	66 ab
60	40 b	44 c	65 ab
120	39 b	50 d	68 b

1 Yields are means of 2 placements
2 Column means followed by the same letter are not significantly different at the 0.05 level.

Table 6. Influence of Phosphorus Placement on Winter Wheat Grain Yields, Jones Co. 1990

P_2O_5 rate	Grain Yield					
	Patterson		Rankin		Fuoss	
	Knife	Spoke	Knife	Spoke	Knife	Spoke
lb/A	bu/A					
0	35	31	36	38	64	64
30	35	35	41	40	66	65
60	43	38	46	43	65	66
120	40	38	51	48	68	68
Placement (Pr > F)	0.017		0.237		0.950	
Rate (Pr > F)	0.0006		0.0001		0.041	
Rate x Place. (Pr > F)	0.483		0.218		0.755	
C.V. (%)	8.5		6.5		4.1	

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