INFLUENCE OF SEED PLACED FERTILIZER ON CORN, SOYBEAN AND SUNFLOWER EMERGENCE

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ABSTRACT

Six phosphorous fertilizer materials were placed with corn, soybean and sunflower seed to determine their influence on seed injury and emergence. Fertilizer rates used were 0, 12.5, 25, 50 and 100 lb/A P_2O_5 as dry TSP (0-46-0), MAP (11-55-0), DAP (18-46-0) or liquid 10-34-0, 7-21-7 and 9-18-9. Seed emergence ranged from 0 to 100% depending on crop, fertilizer rate and materials used. Corn was most tolerant of fertilizer injury while soybean was extremely sensitive with stand reduction with even the lowest P_2O_5 rates when planted in 30 inch rows. Among the dry materials, DAP caused the most injury followed by MAP and TSP. The safest liquid material was 10-34-0 followed by 7-21-7 and 9-18-9. In addition to stand reduction, fertilizer also slowed crop emergence. Dry soil conditions enhanced seed injury.

INTRODUCTION AND OBJECTIVE

Many farmers are planting corn, soybean and sunflower in no-till or very limited till situations. These tillage choices restrict the application opportunities of a non-mobile nutrient such as phosphorous. Broadcast applications will remain on the surface and likely have reduced effectiveness especially in dryer regions of the country. Subsurface band applications can work but require separate equipment and trips across the field and do considerable soil disturbances. Banding phosphorous with the planter, however, saves time, application costs and places the fertilizer below the soil surface near plant roots for efficient uptake.

A fertilizer band placed two inches beside and two inches below the seed at planting has been shown to be an effective fertilizer placement for corn and soybean. Disadvantages of such a placement include cost of openers, weight, trash clearance, soil disturbance and possible seed placement difficulties. In addition, narrow row drill planting of soybeans does not allow space for separate fertilizer openers. Because of these faults, many growers are considering placement of phosphorous fertilizer directly with the seed at planting. Placing fertilizer with the seed, however, creates the potential for seed injury and reduced stands.

The objective of this study is to evaluate the effect of common phosphorous fertilizer materials placed with the seed on corn, soybean and sunflower emergence.

MATERIALS AND METHODS

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Thirteen sites (5 corn, 6 soybean, 2 sunflower) were selected for this study. All sites were located on or near SDSU experiment stations at Brookings, Beresford and Highmore in the east central, southeast and central parts of South Dakota respectively. Locations, test crops and soil characteristics are listed in Table 1. All sites were on medium to fine textured soils with organic matter levels ranging from 2.5-5.0 percent. Soil moisture (gravimetric basis) at seeding depth at planting ranged from a dry 7.7% at Highmore in 1994 to 25.9% at Beresford in 1994. The pH at all sites was less than 7.5. All sites were planted into conventionally tilled soil except soybean at Beresford in 1992 and corn at Beresford in 1994 which were planted in no-till.

Table 1. Site Characteristics for Fertilizer with Seed Studies

Location/year	Crop	Soil Texture[1]	Soil Moisture [2]	OM	pH	Tillage
			------%	-------		
Brookings 92	Corn	CL	13.0	2.8	6.9	chisel
Brookings 92	Soybean	SiL	16.1	3.4	6.0	chisel
Beresford 92	Soybean	SiC	24.0	2.9	6.3	no till
Brookings 93	Corn	CL	23.5	5.0	7.4	chisel
Brookings 93	Soybean	CL	18.0	2.4	6.9	plow
Highmore 93	Corn	CL	17.9	3.2	6.3	chisel
Highmore 93	Soybean	CL	17.9	3.2	6.3	chisel
Highmore 94	Corn	CL	8.6	3.2	6.5	chisel
Highmore 94	Sunflower	L	7.7	2.5	6.3	chisel
Brookings 94	Sunflower	SiCL	11.0	3.3	7.1	chisel
Centerville 94	Soybean	CL	17.6	2.6	6.2	chisel
Beresford 94	Soybean	SiCL	19.9	3.4	6.5	chisel
Beresford 94	Corn	SiCL	25.9	3.2	5.9	no till

[1] CL = clay loam, SiL = silt loam, L = loam, SiCL = silty clay loam
[2] Seeding depth at planting, gravimetric basis.

All sites with 30 inch rows were planted with normal planting units utilizing

double disc openers. Dry fertilizer was metered with a ground-driven cone which delivered the fertilizer down the seed tube with the seed. Liquid fertilizer was metered with electric pumps and dropped immediately behind the seed tube opening between the double disc openers. A John Deere 750 no-till drill was used to plant the three soybean sites with 7.5 inch rows. At these sites fertilizer was delivered with a conventional factory installed fertilizer attachment down the seed tube with the soybean seed. The experimental design for all sites consisted of a randomized split plot with a rate of P_2O_5 as the whole plot and the fertilizer material as the split. All plots were replicated four times.

The type of fertilizer used, rate of P_2O_5 per acre and the rate of total material used per acre are listed in Table 2. Rates used at most locations were 0, 12.5, 25, 50 and 100 lbs P_2O_5 /A. Not all materials and rates were used at each location. Because the different materials had different grades, the rate per acre of total material used for each phosphorous rate was different (Table 2). Rates of material ranged from 23 pounds per acre for the low rate of MAP to a high of 278 pounds per acre for the high rate 9-18-9 liquid. Nitrogen and potassium rates also varied with material at any given phosphorous rate (Table 3). The $N+K_2O$ rates ranged from 0 with 0-46-0 to 50 lb/A for the high rate of 9-18-9.

Table 2. Type of Fertilizer and Rate Used in Fertilizer with Seed Studies, 1992-1994

P_2O_5	Dry Fertilizer [1]			Liquid Fertilizer		
Rate	TSP	MAP	DAP	10-34-0	7-21-7	9-18-9
			lb/A			
0	0	0	0	0	0	0
12.5	27	23	27	37	60	69
25	54	45	54	73	119	139
50	109	91	109	147	238	278
100	217	182	217	- - -	- - -	- - -

[1] TSP = triple superphosphate (0-46-0), MAP = monoammonium phosphate (11-55-0), DAP = diammonium phosphate (18-46-0)

[2] Approximate lb/gal: 10-34-0, 11.6; 7-21-7, 11.2; 9-18-9, 11.0

Table 3. Type of Fertilizer and Rate of Nitrogen and Potassium Applied with Phosphorous

P_2O_5	Dry Fertilizer			Liquid Fertilizer		
Rate	TSP	MAP	DAP	10-34-0	7-21-7	9-18-9
lb/A	- - - - - - - - - - - - - - - - - - lb/A			$N+K_2O$ - - - - - - - - - - - - - - - - - -		
0	0	0	0	0	0	0
12.5	0	3	5	4	8	12
25	0	5	10	7	17	25
50	0	10	20	15	33	50
100	0	20	39	- - -	- - -	- - -

Corn, sunflower and soybean plant counts in 30 inch rows were made in two randomly selected 10 foot sections of row (corn and sunflower) or 5 foot sections of row (soybean) within each plot. Soybean counts in 7.5 inch rows were made on 3 randomly selected square yard areas within each plot at Beresford 92 and 3 ten foot sections of row at Beresford 94 and Centerville 94. Counting began at initial emergence and was done at the same locations within each plot every 2 or 3 days until plant emergence was complete. Only final plant stands are reported in this paper. The percent was based on the check stand as 100%.

RESULTS AND DISCUSSION

The high rates of dry fertilizer placed with corn seed reduced stand at all three locations (Tables 4 and 6). The TSP and MAP appeared to cause less injury than DAP. At the 50 lb P_2O_5 rate, emergence rates for TSP and MAP were approximately 90% or greater. DAP, however, resulted in 3 year mean stand of only 71% at the 50 lb P_2O_5 rate (Table 6). At Brookings in 1992, 25 lb P_2O_5/A as DAP resulted in a corn stand of 85%.

Liquid 10-34-0 and 7-21-7 placed in the seed furrow with corn did not reduce emergence below 93% even at 50 lb/A P_2O_5 (Table 5). However, stands were reduced to 41% and 66% at Highmore 94 and Beresford 94, respectively, when the same rate of phosphorous was applied as 9-18-9. The injury caused by 9-18-9 could be attributed to the larger quantity of $N+K_2O$ supplied by this material (Table 3). In addition, the N form supplied with the 9-18-9 used here was urea rather than ammonium N supplied by the other two materials. Some ammonia may be released from the urea N increasing seed injury.

All dry fertilizer materials and rates resulted in reduced stands on soybean when planted in 30 inch rows (Tables 7 and 9). Rates of only 12.5 lb/A P_2O_5 resulted in a mean stand of only 74%, 67% and 59% for TSP, MAP and DAP

respectively. Higher P_2O_5 rates resulted in lower stands. Soybean planted in 7.5 inch rows did not suffer such large stand reductions (Tables 8 and 9). This would be expected since decreasing row width by 75% would also reduce the concentration of fertilizer in contact with the seed by a similar amount. Twenty-five pounds P_2O_5 per acre as TSP or MAP did not reduce stands below 90% in 7.5 inch row soybean. The 25 pound rate of P_2O_5 as DAP, however, did reduce stands to 85% at two out of three sites (Table 8).

Table 4. Influence of Seed-Placed Dry Fertilizer on Corn Stand

P_2O_5	Brookings 92		Brookings 93			Highmore 93		
Rate[1]	MAP	DAP	TSP	MAP	DAP	TSP	MAP	DAP
lb/A	----------			% stand			----------	
0	102	98	101	96	103	99	102	99
12.5	96	102	96	101	93	97	102	97
25	104	85	96	96	95	101	97	99
50	96	75	90	93	65	101	89	72
100	78	48	89	80	60	86	93	58

[1] 30 inch rows

Table 5. Influence of Seed-Placed Liquid Fertilizer on Corn Stand

P_2O_5	Beresford 94			Highmore 94		
Rate [1]	10-34-0	7-21-7	9-18-9	10-34-0	7-21-7	9-18-9
lb/A	----------		% stand		----------	
0	97	105	98	100	99	101
12.5	90	108	105	106	105	106
25	109	106	98	101	98	95
50	102	105	66	93	95	41

[1] 30 inch rows

Table 6. Influence of Seed-Placed Fertilizer on Corn Stand, Mean across Site Years

P_2O_5	Dry Fertilizer			Liquid Fertilizer [2]		
Rate [1]	TSP [2]	MAP [3]	DAP [3]	10-34-0	7-21-7	9-18-9
lb/A	-% stand					
0	100	100	100	99	102	100
12.5	97	100	97	98	107	106
25	98	99	93	105	102	97
50	96	91	71	98	100	54
100	83	84	55	- - -	- - -	- - -

[1] 30 inch row
[2] 2 site years
[3] 3 site years

Table 7. Influence of Seed-Placed Dry Fertilizer on Soybean Stand in 30 Inch Rows

P_2O_5	Brookings 92		Brookings 93			Highmore 93		
Rate	MAP	DAP	TSP	MAP	DAP	TSP	MAP	DAP
lb/A	-% stand							
0	103	97	104	97	98	102	97	101
12.5	67	66	76	84	70	72	51	42
25	49	42	65	52	49	36	23	19
50	23	13	37	26	19	16	6	4
100	3	5	19	7	8	8	2	4

Table 8. Influence of Seed-Placed Dry Fertilizer on Soybean Stand in 7.5 Inch Rows

P_2O_5	Beresford 92		Beresford 94			Centerville 94		
Rate[1]	MAP	DAP	TSP	MAP	DAP	TSP	MAP	DAP
lb/A	- % stand -							
0	96	104	96	108	96	99	105	96
25	93	85	105	90	99	91	91	85
50	77	77	92	89	88	87	83	82
100	65	59	84	66	70	85	74	51

[1] 7.5 inch rows

Table 9. Influence of Seed-Placed Fertilizer on Soybean Stand, Mean across Site Years

P_2O_5	30 Inch Rows			7.5 Inch Rows		
Rate	TSP [1]	MAP [2]	DAP [2]	TSP [1]	MAP [2]	DAP [2]
lb/A	- % stand -					
0	103	99	99	98	103	99
12.5	74	67	59	- - -	- - -	- - -
25	51	41	37	98	91	90
50	27	18	12	90	83	82
100	14	4	6	85	68	60

[1] 2 site years
[2] 3 site years

Sunflower stand was reduced with all fertilizer materials and rates at the Highmore 94 site (Table 10). Even the 12.5 lb/A rate reduced stand to 81%, 70% and 71% with TSP, MAP and DAP respectively. Soil conditions were very dry at this location (Table 1) enhancing seed injury from fertilizer salts. The same fertilizer rate on sunflower at Brookings resulted in plant stands of over 90% for all three fertilizer materials. At Brookings, however, soil moisture content at planting was higher and significant rainfall occurred within one day of planting. At the 50 lb/A P_2O_5 rate, the sunflower stand was about two times greater at Brookings (Table 10).

In addition to stand reductions, placing fertilizer in direct contact with the seed can delay emergence. This effect can be seen in Table 11 for the Brookings 93 site with corn. To reach the 75% level of emergence required about 14 days for the check treatment while the 25 lb P_2O_5 rate took 19 days to reach the same level of emergence.

Table 10. Influence of Seed-Placed Fertilizer on Sunflower Stand

P_2O_5	Highmore 94			Brookings 94		
Rate [1]	TSP	MAP	DAP	TSP	MAP	DAP
lb/A	- % stand -					
0	109	90	101	104	95	101
12.5	81	70	71	104	91	93
25	85	55	44	91	87	82
50	44	27	19	88	61	41
100	9	19	0	60	43	11

[1] 30 inch rows

Table 11 . Influence of Rate of Phosphorous Applied with Seed on Rate of Corn Emergence, Brookings, 1993

	P_2O_5 Rate	
Emergence	0	25
%	- - - - - - - - - days after planting [1] [2] - - - - - - - - -	
75	14	19
90	19	23

[1] Days after planting to reach specified emergence level.
[2] Average of TSP, MAP and DAP treatments.

SUMMARY

A number of factors including rate and type of fertilizer, row width, crop to be grown and soil moisture influence the extent of any seed injury from seed placed fertilizer. In general, TSP and MAP were less injurious than was DAP in these studies. Soybean was much more sensitive than corn to fertilizer injury with sunflower somewhere in between in sensitivity. There is a large environmental influence on potential seed injury from fertilizer with higher soil moisture levels tending to dilute salts and reduce fertilizer injury.

From these studies, other studies and field observations, we make the following suggestions to minimize the risk of stand reductions when placing fertilizer with the seed.

For corn, sunflower and grain sorghum in 30 inch rows:

- do not use DAP, UAN or urea
- do not apply more than 100 lb/A of material as 0-46-0, MAP or 10-34-0
- do not apply more than 10 lb/A $N+K_2O$.

For soybean in 30 inch rows:

- do not apply any fertilizer with the seed.

For soybean in 7.5 inch rows:

- do not use DAP, urea or UAN
- do not apply more than 50 lb/A of material as 0-46-0, MAP or 10-34-0
- do not apply more than 5 lb/A $N+K_2O$.

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