

Soybean Nutrient Management Practices

Section 3: Phosphorus and Potassium Management Practices

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Introduction

Appropriate management of phosphorus (P) and potassium (K) fertilizers are important to maximizing soybean yields as well as reducing loss of these nutrients that can cause negative environmental effects. The management practices that lead to the highest chance of P and K use by the corn crop and lowest chance of loss to the environment is often referred to as the 4Rs of nutrient management—Right: source, rate, timing, and placement. In this section we will evaluate the results from the 2019 nutrient management survey to help us better understand the local factors that influence the use of various P and K management practices. The local factors evaluated include geographic location within South Dakota, tillage type, and farm size. Understanding these factors on farmer's decisions regarding P and K management practices can give guidance to government agencies, extension, and other professionals regarding needed research, educational resources, and training that are needed to help farmers adopt appropriate 4R nutrient management practices.

Phosphorus and Potassium Sources

Phosphorus

Phosphorus fertilizer source used by farmers regardless of application timing was not affected by location, tillage, or farm size. This result suggests that fertilizer sources are similarly available to farmers regardless of their location in SD and its associated annual rainfall and tillage practices did not affect the P fertilizer source decision. Farmers used MAP the most regardless of application timing (71%) followed by DAP (27%) and MESZ or MES (2%) (Table1).

Potassium

Potassium fertilizer source used by farmers regardless of application timing was not affected by location, tillage, or farm size. Similar to P fertilizer, this result suggests that fertilizer sources are similarly available to farmers regardless of their location in SD and similarly used regardless of tillage type or farm size. Farmers used K chloride (KCl) the most regardless of application timing (70%) followed by K sulfate (20%), K thiosulfate (6%), and K-magnesium sulfate (5%) (Table 1).

Table 1. Percentage use of phosphorus and potassium source by application timing with percentage use across fertilizer sources and application timings.

Nutrient Source	Application Timing			
	Fall (%)	Spring (%)	In-season (%)	Across Timings (%)
Phosphorus				
MAP (11-52-0)	13	15	1	71
DAP (18-46-0)	5	5	1	27
MESZ or MES	0	1	0	2
Across phosphorus products	45	51	4	-
Potassium				
Potassium chloride (0-0-60)	10	10	1	70
Potassium sulfate (0-0-50)	3	2	1	20
Potassium-magnesium sulfate (0-0-22-22S-11Mg)	1	0	0	5
Potassium thiosulfate (0-0-25-17S)	0	1	1	6
Across potassium products	45	47	8	-
Note. Percentages may not add up to 100 as individuals could input data in multiple categories.				

Phosphorus and Potassium Rates

Phosphorus

Fertilizer-P rates used in soybean production were not influenced by farm size but were influenced by tillage type and location (Table 2). Farms using conventional tillage applied the most P at 64 lbs P_2O_5 ac^{-1} whereas farms using no-till and reduced tillage only applied 55-56 lbs P_2O_5 ac^{-1} . This difference in application rates is likely associated with the differences found in P rate applied in eastern vs. central SD. Farmers in eastern SD applied approximately 62 lbs P_2O_5 ac^{-1} compared to farms in central SD that applied less at approximately 51 lbs P_2O_5 ac^{-1} . Phosphorus fertilizer rates across categories ranged from 62 to 72 lbs. P_2O_5 ac^{-1} with a mean of 68 lbs. P_2O_5 ac^{-1} . There are a greater number of farms in central SD that use no-till and less farms that use no-till in eastern SD. Further, soil test P values are also typically higher in central compared to eastern SD (unpublished data) and therefore typically require a lower rate of P fertilizer to optimize crop yields. The lack of farm size related to P rate decisions shows that farm size does not affect the rate of P fertilizer applied to soybeans.

Potassium

Fertilizer-K rates used in soybean production were only influenced by location and not by tillage type or farm size (Table 2). Similar to P, farms in eastern SD typically applied more K fertilizer (53 lbs K_2O ac^{-1}) compared to central SD (34 lbs K_2O ac^{-1}). This result is likely due to differences in typical soil test K levels in central compared to eastern SD. Central SD tends to have higher K levels in their soils and requires little to no additional K application to optimize soybean yield. The fact that farm size and tillage type did not affect K fertilizer rates used among farmers indicates that these rates applied are not likely being changed based on number of acres operated, equipment availability, or ability to absorb financial risk.

Table 2. Total fertilizer-P and -K rate as affected by location, tillage system, and farm size.

Variables	Fertilizer-P rate (lbs P_2O_5 ac^{-1})	Fertilizer-K use (lbs K_2O ac^{-1})
Location		
East	62a	53a
Central	51b	34b
Tillage		
No-till	56b	38
Reduced	55b	48
Conventional	64a	57

Variables	Fertilizer-P rate (lbs P ₂ O ₅ ac ⁻¹)	Fertilizer-K use (lbs K ₂ O ac ⁻¹)
Farm size (ac)		
>2000	55	45
1,000-1,999	55	42
500-1,999	64	58
1-499	62	56
^a Mean values with different letters within each column for each variable category (i.e. location, tillage, and farm size) are statistically different (P ≤ 0.05). If no letters are present, then there are no significant differences.		

Phosphorus and Potassium Application Time

There are only minimal applications of P and K fertilizers to soybean regardless of application timing (<15%). This low application percentage is likely due to some farmers applying P and K before their corn crop in sufficient quantities for the following years soybean crop. Unlike corn where approximately 1/3 of P and K fertilizer applications occur in the fall while more than 50% occur in the spring and only 4 to 7% occur during the growing season, P and K applications for soybean are equally likely to occur in the fall or spring (within 2%) (Table 1). In-season applications of P and K are very minimal when growing soybeans (<10%).

Farmers are equally likely to choose to apply P and K for one or two growing seasons before growing soybean (Table 3). Specifically, there were 11-31% of farmers that took the survey who fertilize enough P for the current or next two cropping seasons while less than 1% apply enough for three or more cropping seasons. For both P and K, the location of the farm in SD, size of the farm or tillage type were not related to making this fertilizer application rate strategy decision.

Table 3. Percentage of farmers that apply enough phosphorus or potassium for only the current growing season or for two or more growing seasons.

Phosphorus and potassium fertilizer application strategy	Phosphorus (%)	Potassium (%)
I apply enough for the current cropping season	27	22
I apply enough for the next two cropping seasons	31	11
I apply enough for the next three cropping seasons	0.21	0.62
I apply enough for longer than three cropping seasons	0	0

Phosphorus and Potassium Placement

The placement of P and K on the surface of the soil or incorporating it into the soil can affect its availability to plants and potential loss. In this survey we evaluated various placement methods of P and K when applied in the fall and spring. Whether P and K were applied in the fall or spring, the placement methods used were similar. Thus, when evaluated across application timings, broadcast, incorporated or unincorporated were the most common placement method (21-25%) with all other methods occurring less than 3% of the time (Table 4).

Fall applications of P and K regardless of location, tillage type or farm size, broadcast applications of P and K were the most common form of placement and whether this fertilizer was incorporated or not was influenced by location in SD and tillage type (Table 5). Incorporation of broadcasted fertilizer applications was most common in eastern SD and in reduced or conventional till soils. However, no incorporation was most common in central SD and in no-till conditions. This result was likely due to farms in central SD most often utilizing no-till so they are unable to incorporate broadcasted fertilizer applications whereas farms in eastern SD most often use conventional tillage and can incorporate broadcasted fertilizer applications. Central SD and no-till farms were also more likely than eastern SD or conventional till farms to band fertilizer under the row or next to the row (7-8%) vs in eastern SD (1-2%). This result is likely due because banding fertilizer under the soil can be done in no-till soils to incorporate the P and K fertilizer and in conventional till soils farmers typically use tillage to incorporate the fertilizer. Overall, these results show that most farmers in eastern and central SD use broadcast methods to apply P and K fertilizer and in conventional tillage farms it is incorporated and no-till farms it is banded under the row or unincorporated.

Spring applications of P and K followed a similar pattern of placement method as fall applications but with different percentages (Table 6). Generally, in eastern SD and in reduced or conventional till soils fertilizer was broadcast and incorporated whereas in central South Dakota the fertilizer was generally not incorporated and had a greater likelihood of being banded with strip till or under the soybean row.

Table 4. Percentage use of phosphorus and potassium fertilizer application timing by placement method along with percentage use across application timings and placement methods.

Variables	Fertilizer Application Timing		
	Fall (%)	Spring (%)	Across Timings (%)
Broadcast: incorporated	9	10	25
Broadcast: not-incorporated	10	6	21
Banding: with strip till	1	1	3
Banding: under the row	0	2	3
Sub-surface banding: next to row	0	2	3
Sub-surface banding: mid row	0	1	1
Surface banding: next to row	0	0.4	1
Surface banding: mid row	0	0	0
Across placement methods	26	31	-

Note. Percentages may not add up to 100 as individuals could input data in multiple categories.

Table 5. Percentage use of various fertilizer placement methods of spring applied phosphorus and potassium fertilizer as affected by location, tillage system, and farm size.

Variable	Fertilizer placement method						
	Broadcast:				Banding:		
	Incorporated	Not incorporated	With strip till	Under the row	Subsurface next to row	Subsurface mid row	Surface next to row
Location							
East	21a	8	0.6	0.6b	2b	1	1
Central	8b	11	3	8a	7a	1	1
Tillage							
No-till	11	13a	7a	7a	7a	1	2
Reduced	21	7b	0b	0b	0b	2	0
Conventional	18	3b	0b	1b	1b	1	0
Farm size (ac)							
>2000	9	9	2	7a	9a	2	2
1,000-1,999	15	8	1	1b	5b	1	1
500-1,999	16	11	0	0b	0b	0	0
1-499	24	12	3	0b	0b	1	0

^a Mean values with different letters within each column for each variable category (i.e. location, tillage, and farm size) are statistically different ($P \leq 0.05$). If no letters are present, then there are no significant differences.

Table 6. Percentage use of various fertilizer placement methods of fall applied phosphorus and potassium fertilizer as affected by location, tillage system, and farm size.

Variable	Fertilizer placement method			
	Broadcast:		Banding:	
	Incorporated	Not incorporated	With strip till	Under the row
Location				
East	19a	18	2	0
Central	3b	12	2	1
Tillage				
No-till	2c	17	0b	0
Reduced	16b	14	9a	2
Conventional	26a	14	1b	0
Farm size (ac)				
>2000	9	12	3	2
1,000-1,999	11	17	2	0
500-1,999	16	23	1	0
1-499	9	9	0	0
^a Mean values with different letters within each column for each variable category (i.e. location, tillage, and farm size) are statistically different ($P \leq 0.05$). If no letters are present, then there are no significant differences.				

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