Section 6: Sulfur and Other Micronutrient Management Practices

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Introduction

Sulfur (S) is an essential nutrient for all plants, but worth special attention for high-yield corn production. For corn, this nutrient in the past has largely been supplied through both soil organic matter and from atmospheric deposition. However, with improved air quality over the past two decades, more S deficiency has been seen throughout the US. Crop management practices including tillage, crop rotation, and use of cover crops can influence S availability to crops. Further, soil type and organic matter can also influence S availability and therefore fertilizer needs of crops (Bly et al., 2015). Additionally, adequate amounts of micronutrients (e.g., zinc, boron, manganese, iron copper, etc.) are essential to growing high-yielding corn. This survey evaluated the use of the 4Rs of nutrient management—Right: source, rate, timing, and placement for S by South Dakota (SD) farmers. In this chapter 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 S and micronutrient management practices for meeting crop needs. The local factors evaluated include geographic location within SD, tillage type, and farm size. Understanding these factors on farmer's decisions regarding S and micronutrient management practices can give guidance to government agencies, extension, and other professionals regarding needed research, educational resources, and trainings that are needed to help farmers adopt appropriate 4R nutrient management practices.

Sulfur and Other Micronutrient Sources

Sulfur Sources

Sulfur fertilizer is still only minimally used in SD as only up to 26% of farmers surveyed applied S fertilizer in the fall spring or in-season. Of those farmers that did use S fertilizers, ammonium sulfate was by far the most used S source (68%) follow by ammonium thiosulfate (11%), and elemental S (7%) while all other S sources were used < 4% of the time (Table 1). Regardless of application timing, ammonium sulfate was still the most used fertilizer applied (6-26%) with all other fertilizer sources being used less than 3% of the time within each application timing. Sulfur fertilizer source used by farmers was not affected by location, tillage, or farm size.

Table 1. Percentage of surveyed farmers who used various S fertilizer sources in the fall, spring or in season along with the percentage of S fertilizers and their use across S fertilizer sources and application timings.

Sulfur fertilizer source	Application timing			Across timings
	Fall	Spring	In-season	
	---------- % ----------			
Ammonium sulfate (21-0-0-24S)	8	26	6	68
Ammonium thiosulfate (12-0-0-26S)	1	3	1	11
Elemental sulfur (0-0-0-88-98S)	2	2	0.2	7
Calcium sulfate (gypsum) (0-0-0-17S)	1	0.2	0.2	2
Magnesium sulfate, or Epsom salts (0-0-0-14S)	0.4	0	0	1
Potassium magnesium sulfate, or Sulpomag (0-0-22-23S)	0.4	0	0.2	1
Potassium sulfate (0-0-50-18S)	1	1	0.4	4
Potassium thiosulfate (0-0-25-17S)	0.2	1	0.4	3
Other sulfur products	1	0.4	0	2
Across Products	27	59	15	--

Micronutrients

Zinc (Zn) is the most applied micronutrient for corn in SD (Table 2). The next most applied micronutrient is boron (13%), manganese (9%), copper (6%), and iron (5%). Overall, these micronutrients are not very commonly applied as less than 12% of farmers surveyed applied one or more of these nutrients. This low use of micronutrients is likely due to lack of consistently increasing yield due to the application of these various micronutrients. To this point in research conducted in SD, fertilization with Zn has most often resulted in yield increases among the micronutrients needed by crops (Clark et al., 2019) and is reflected in these survey results as it is the most commonly applied micronutrient. Micronutrient application and its was not affected by location, tillage, or farm size.

Table 2. Percentage of surveyed farmers who used various micronutrients in the fall, spring or in season along with the percentage of their use across micronutrients and application timings.

Micronutrient	Application timing			Across timings
	Fall	Spring	In season	
	---------- % ----------			
Zinc	3	8	1	68
Boron	0.4	1	0.6	13
Manganese	0.2	0.8	0.6	9
Iron	0	0.4	0.4	5
Copper	0.2	0.4	0.4	6
Across products	22	59	20	--

Sulfur and Micronutrient Rates

Sulfur Rates

Fertilizer-S rates used in corn production were not influenced by location, tillage type, or farm size (Table 1). Sulfur fertilizer rates across categories ranged from 14 to 17 lbs. S ac-1 with a mean of 16 lbs. S ac-1. The lack of location, tillage type, or farm size related to S rate decisions shows that these factors do not affect most farmers decisions.

Zn Rates

Fertilizer-Zn rates used in corn production were influenced by location but not tillage type or farm size (Table 1). Zinc fertilizer rates across categories ranged from 1 to 3 lbs. Zn ac-1 with a mean of 2 lbs. Zn ac-1. Location within SD was related to Zn fertilizer rate with farms in eastern SD applying 3 lbs ac-1 compared to central SD applying 1 lb. ac-1. This difference may be due to the greater precipitation and higher temperatures in eastern SD that often result in greater corn yields that have decreased natural Zn levels in the soil over time leading to Zn application more frequently increasing corn yields in eastern compared to central SD. Another reason may be differences in soil and geographical differences between eastern and central SD.

Table 3. Total fertilizer-S and Zn rate as affected by location, tillage system, and farm size.

Variable category	Variables	Fertilizer-S rate	Fertilizer-Zn rate
		lbs S ac-1	lbs Zn ac-1
Location	East	16	3aa
	Central	15	1b
Tillage	No-till	15	1
	Reduced	15	2
	Conventional	16	3
Farm size (ac)	>2000	17	2
	1,000-1,999	14	2
	500-1,999	16	3
	1-499	17	3

[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.

Micronutrient Rates

Other micronutrient rates besides Zn were not common among survey respondents. Therefore, they will not be discussed here. Information on rates of micronutrients applied with starter fertilizer can be found in the starter fertilizer section of this publication (Chapter 3).

Sulfur and Micronutrient Application Time

Sulfur Application Time

Evaluating across all S fertilizer sources, the spring application time was most used by farmers (59%) followed by fall (27%) and lastly in-season (15%) (Table 1). Farm location, tillage type, and farm size did not influence the decision of when to apply S fertilizer. Inorganic S that is available to plants is mostly found in the negatively charged sulfate form, which is susceptible to loss from leaching as water moves deeper in the soil profile (particularly with coarser textured soils). Therefore, it is important to apply S close to when the crop will need it and there will be sufficient precipitation to move the S fertilizer to where the corn roots can take it up. These results demonstrate that the majority of S fertilizer in SD is being applied in the spring and in-season. This is important as it shows farmers are normally applying it at times when it is less likely to be leached and more likely to be available to be utilized by the corn crop.

Micronutrient Application Time

When micronutrients were applied, they were most frequently applied in the spring (59%) with minimal applications occurring in the fall (22%) or in season (20%). Farm location, tillage type, and farm size were not related to this decision of when to apply micronutrients. The high use of spring application is important as except for low pH soils, soluble micro nutrients quickly precipitate into less soluble forms, and become unavailable to crops. Therefore it is important these nutrients are applied close to planting and near the seed.

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