For Immediate Release
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Sulfur Deficiency in Winter Wheat

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Sulfur (S) deficiencies in wheat have become more common in recent years. The main reason for this is the decreased input of industrially generated S into the atmosphere, resulting in less S deposition on farmland as acid rain. In the meantime, wheat responses to S are increasing because of declining organic matter levels in soil under intensive cropping, erosion losses of topsoil, decreased S in pesticides, increased use of high-analysis low S fertilizers (anhydrous ammonia, urea and urea-ammonium nitrate) and high yielding varieties (higher nutrient removal). Sulfur deficiency reduces wheat yield and negatively affects quality. Changes in dough mixing properties in wheat grown in soils with low S content are recognized even if yield responses of S applications are small or undetectable. Differences in soil S content may, therefore, cause unpredictable and unwanted variations in wheat quality, which causes difficulties for the milling and baking industry. Optimal S fertilization management is one important factor to ensure high yield and good and stable wheat quality.

Generally, S-deficient wheat is yellow and stunted and observed in patches in the field (Picture 1), especially in areas where there has been previous soil erosion. Often, the patchy S-deficient areas of the field are found on hilltops or side-slopes where erosion has occurred, and soil organic matter is low or where leaching is more pronounced. Wheat in areas where topsoil was removed, or significant cuts were made (i.e. terraced or leveled fields) commonly shows symptoms.

Visual symptoms generally show up early in the spring, shortly after green up, before organic S is mineralized from soil organic matter and until wheat roots can grow into the subsoil to utilize any available S (sulfate). Deficiencies of S are often difficult to identify because the chlorosis is not always obvious. Sulfur deficiency has a pronounced delaying effect on crop growth, and it is characterized by uniformly chlorotic plant, stunted, thin-stemmed, and spindly. Sulfur deficiency symptoms resemble nitrogen (N) deficiency and have undoubtedly led to many incorrect diagnoses. Unlike N, however, S is not easy translocated from older to younger leaves, therefore, deficiency symptoms occur first in younger leaves.

Picture 1. Wheat field showing sulfur deficiency symptoms.

The best way to diagnose a deficiency is with a plant tissue analysis that includes an assay for both S and N. Sulfur concentrations in most plants should range from about 0.2% to 0.5%. Desirable total N to total S ratios range from 7:1 to 15:1. Wider ratios may point to possible S deficiency but should be considered along with actual N and S concentrations in making diagnostic interpretations.

Soil S is present in organic (proteins) and inorganic forms (sulfate, SO4=). In many Colorado calcareous soils, sulfate is found in the subsoil as gypsum (Calcium sulfate, CaSO4). A soil test for available sulfate-S in the soil profile is available. For proper interpretation of this test, soil organic matter, soil texture, the crop to be grown, and yield goal all need to be considered. Since sulfate is mobile in the soil, sampling to a 24-inch depth is important. It is a key to remember that subsoil S may not be available to wheat in the early spring, especially where soils are cold.

Sulfur sources include atmospheric S, S in irrigation water, organic S, inorganic S and elemental S. Irrigation waters may contain significant quantities of sulfur. When the irrigation water exceeds about 5 parts per million (ppm) sulfates, an S deficiency is unlikely. Most S containing fertilizers (sulfates) are moderately to highly soluble in water. The most important water-insoluble sulfur source is elemental S, which must be oxidized through bacterial action to the sulfate form before it can be utilized by plants. Other S containing fertilizers are ammonium sulfate, potassium sulfate, gypsum, and 40-rock among others.

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