

# Boron and Sulfur Fertilization on Rice

Division of Plant Sciences

Rice producers do not commonly think about fertilizing their fields with boron (B) or sulfur (S). The lack of interest in boron for rice is probably due to the lower requirement of boron for grasses than for broadleaf crops. Soil sulfur availability to rice plants is affected by temperature and moisture, which influences organic matter decomposition rates. Field tests with rice in Missouri showed that a yield response to boron and sulfur is possible.

Many rice farmers in the Upper Delta are unaware that their fields need boron fertilizer. Fifty soil samples from rice grower fields were randomly selected and tested for B at the University of Missouri Delta Regional Soils Testing Lab. More than half of the samples tested below 0.25 parts per million (ppm) B by hot water extraction. The majority of these low B soils were silt loam soils. This indicates that boron deficiency in rice might be more widespread on the lighter texture rice soils found west of Crowley's Ridge.

## Boron fertilization on rice

Boron is very water-soluble and is mobile in soil-water solutions. In southeast Missouri, hot water extractable B in rice soils ranges between 0.1 and 0.5 ppm.

- Rice soils testing below 0.25 ppm extractable B per acre should be treated annually with 0.5 to 1.0 pound of B per acre.
- In field tests, rice yields increased by more than 10 bushels per acre with B fertilization in two out of three years.
- Boron can be tank-mixed with some rice herbicides, saving time and money for rice producers.

### Authors

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Many irrigation wells used for rice production in southeast Missouri and northeast Arkansas contain high levels of calcium carbonate, which reduces the availability of boron in the soil to rice plants.

Considering the relatively low cost of boron fertilizers and the high value of rice grain, yield response to B could result in a 10:1 return to rice producers for their input costs.

Boron primarily occurs in the soil as the mineral borax. Boron may also bond with organic matter. In agricultural soils the majority of plant-available boron is associated with clay minerals. Boron is released, by weathered rocks, in the soil solution as boric acid ( $H_3BO_3$ ). Boric acid is highly soluble in water and is easily leached from the soil. Consequentially boron must be supplied each year as fertilizer in many cropping situations. Liming also decreases boron availability in soils. At higher pH levels, clay minerals absorb and strongly hold boron. The high pH of well waters buffered by calcium carbonate increases the pH of flooded rice soils and may limit boron availability.

Symptoms of boron deficiency in rice are sometimes difficult to detect visually in the field. Boron deficiency symptoms in rice begin with whitish discoloration and twisted new leaves. Severe deficiency symptoms in rice include thinner stems, shorter and fewer tillers, and failure to produce viable seeds. Boron-deficient stems and leaves are brittle, whereas boron-sufficient leaves and stems are flexible. Often the only symptom of boron-deficient rice is lower yields at harvest.

## Tank mixing boron

Rice producers prefer to minimize their trips across a field to apply chemicals. In drill-seeded rice, boron can be applied as a dry material with P and K fertilizers before planting or with urea before establishing a permanent flood. A second option is to mix soluble boron with postemergence herbicides before flooding. In 1999, a study was begun to evaluate boron fertilization for rice grown on a silt loam soil west of Crowley's Ridge in southeastern Missouri. Adding sodium borate to propanil + molinate increased the pH of the spray solution from 5.0 (without B) to pH 6.0 (with B). Boron had no adverse effects on barnyard grass control. Tank mixes both with and without boron produced acceptable rates and length of weed control. Crop injury by propanil + molinate was not increased by inclusion of boron in tank mixes. Further research is needed to determine how adding B might affect the activity of other rice herbicides.

## Sulfur fertilization on rice

Volcanoes and fossil-fuel-burning power plants release millions of tons of sulfur annually. Atmospheric S is brought to earth in rain and snow. Sulfur deposition in rainfall can be affected by the proximity of a field to the nearest coal-burning power facility and by wind direction during the last few rainfall events. Sulfur fumes from a volcano eruption in Washington State could even affect S levels in Missouri.

To comply with the U.S. Clean Air Act of 1970, coal-burning power facilities are decreasing their sulfur emissions. Consequently, S deficiencies in rice are increasing each year. Most of the S in soil is contained in soil organic matter or is attached to clay minerals. This sulfur is made available to plants by bacterial action. Soil bacteria increase in numbers and activity as the temperature goes up, making more sulfur available. Sulfur is also mobile in the soil. It is easily leached downward with water movement. Because rice roots are shallow, they may not be able to access sulfur that has been leached out of the upper soil profile.

## Sulfur recommendations

The University of Missouri soil test recommendations for sulfur are based on cation exchange capacity (CEC) and soil S found. CEC is a measure of clay content. A soil with a CEC of greater than 6.5 does not carry a recommendation for S regardless of the amount of S found. This reflects the potential S release from clay minerals and would preclude sulfur fertilization for most rice production fields.

However, a recent study conducted at the Missouri Rice Farm showed rice yield increases from sulfur fertilization on soil with a CEC of 10. In a three-year study, Delta Center scientists compared S fertilizer sources, rates and timings in rice. Elemental S took longer to become available to plants and was found to be unsuitable for in-season applications. For preplant applications, elemental S was pound-for-pound equivalent to ammonium sulfate. A summary of the results is as follows:

- Adding 12 pounds of S per acre before planting increased rice yields by 15 bushels per acre. No yield advantage was found from an additional 12 pounds of sulfur (24 lb total).
- Preplant S applied promoted rice tillering and full canopy closure three to four days earlier than nonsulfur treatments.
- Preflood sulfur treatments still provided 90 percent of the yield potential of preplant treatments. However, did not result in earlier canopy closure.
- Postflood sulfur treatments provided 50 percent or less of the yield potential of preplant treatments.

Sulfur deficiency in rice is often confused with nitrogen deficiency. In the early season, S deficiency shows as a yellowing of the new leaves, while N deficiency develops first in the older leaves. Later, brown spots begin to appear on the upper leaves. These spots may be confused with the rice disease brown spot. However, sulfur-deficient spots are found in rows corresponding to the leaf veins. Brown spots from disease are randomly distributed on the leaf surface.

### MU soil testing laboratories

#### Soil and Plant Testing Laboratory

University of Missouri  
23 Mumford Hall  
Columbia, MO 65211

#### Soil Testing Laboratory

University of Missouri  
Delta Research Center  
P.O. Box 160  
Portageville, MO 63873

Soil samples may also be submitted to any **County Extension center**.

For online information on sampling, testing and interpreting results, see [soilplantlab.missouri.edu](http://soilplantlab.missouri.edu).

For more information of crop nutrient deficiencies, see MU publication IPM1016, *Crop Nutrient Deficiencies and Toxicities*.