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Phosphorus Management for Drill-Seeded Rice

Division of Plant Sciences

Proper phosphorus (P) nutrition is critical for producing maximum rice grain yields. Phosphorus promotes strong early plant growth and development of a strong root system. Maximum tillering of rice plants also depends on P availability in the soil. Often P deficiency in rice is referred to as a "hidden hunger" because the symptoms are not apparent unless P-deficient plants are directly compared with plants that have sufficient P. When compared with healthy rice of the same age, P-deficient rice is characterized by an abnormal bluish green color of the foliage with poor tillering and plants that are slow to canopy and slow to mature. When plant comparisons are not available, plant tissue testing is the best tool for diagnosis of P deficiency.

At the first tiller stage of development, the only visual symptom of phosphorus deficiency is that P-deficient rice (at right) shows less vigorous growth than rice with sufficient phosphorus (at left). However, at harvest the P-deficient rice produced 15 bushels less per acre.

Phosphorus in the soil

Phosphorus bonds easily to soil minerals, forming compounds that are insoluble. Its availability to plants is largely controlled by soil pH. At pH 5.0 or less, phosphorus binds to iron minerals, while at a pH above 7.4 it readily binds to calcium minerals. Phosphorus bound to iron or calcium is not available to plants. Generally only 10 percent of the total phosphorus in the soil is available to plants at any one time. The other 90 percent, while not immediately available, will gradually become available as soil bacteria break it down. Your soil test will reveal only the plant-available phosphorus, but your fertilizer recommendation also reflects the other 90 percent. Below are some important concepts to remember when fertilizing P on rice fields.

- Soil test levels of 30 lb P/acre by Bray-1 are required to achieve maximum rice yields.
- Preflood phosphorus fertilizer applications are as effective as preplant applications.
- Visual symptoms of P deficiency may not be present in yield-limiting cases. Tissue test whole plants at the preflood stage to ensure that adequate P is available to rice plants. Tissue levels should be at least 0.18 percent P to ensure maximum yields.

Soil testing is the key to profitable phosphorus fertilizer use. Research shows that when your soil contains more than 30 lb Bray-1 P/acre of phosphorus, the addition of more phosphorus will probably not increase rice yields. However, rice will remove 0.30 lb phosphorus per bushel of grain. This will need to be replaced, so soil test recommendations often include a maintenance addition reflecting anticipated yield goal. There is a point at which maintenance additions do not make economic sense. In the University of Missouri system, at a yield goal of 160 bushels, soils testing above 55 lb P/acre do not have a phosphorus fertilizer recommendation. Annual retesting is recommended to make sure the phosphorus levels remain above 30 lb P/acre. Some labs recommend maintenance phosphorus regardless of what is found. This could be a good place to save fertilizer dollars. Take a hard look at the amount of phosphorus found, not just the amount of fertilizer recommended.

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The soil chemistry following flooding may also limit the availability of soil phosphorus. Many southeast Missouri irrigation wells, used for flooding rice fields, contain water with large amounts of dissolved calcium. This calcium can bond with soil phosphorus after flooding to limit phosphorus availability. This effect sometimes continues for several months after the flood is removed. Studies of rice soil showed that immediately after the flood was removed phosphorus availability was low and progressively increased during the fall and winter.

Rice/soybean rotation

Rice is often grown in rotation with soybeans. The soil test P requirements are higher for soybeans than for rice. A soybean crop requires a minimum of 45 lb Bray-1 P/acre, whereas a rice crop requires 30 lb P/acre. Conventional wisdom holds that fertilizer applications that are adequate for soybeans are also good for rice. But if you consistently fertilize for rice, you will eventually limit your soybean yields. Lime and pH may also be an issue. Soybeans need a higher soil pH than rice. Higher pH levels may produce zinc deficiency in rice if soils become alkaline (pH greater than 7.0).

Bray-1 and Mehlich-3 phosphorus extraction

Many farmers use private labs to test their fields for soil test P. Soil test results from a given field vary from lab to lab depending on what type of extraction solution is used. Soil test P values from the University of Missouri soil testing laboratories, which use Bray-1 P extraction solution, will differ from values reported by labs that use Mehlich-3 extraction. As a rough approximation, multiply Mehlich-3 P values by 0.75 to make comparisons with Bray-1 P levels.

Note: Some government environmental incentive programs require that laboratories use University of Missouri methods including Bray-1 P to qualify farmers to be compensated for nutrient management practices.

Fertilizing rice

In the drill-seeded rice production system commonly used in southeastern Missouri and northeastern Arkansas, rice is grown to the growth stage first tiller, nitrogen fertilizer is applied to dry soil, and a permanent flood is established. Additional supplemental nitrogen may be applied later in-season as needed. Because the preflood urea is applied with ground-based equipment, a piggyback of P fertilizers represents an added material cost only.

Subsequent applications must by made by air and represent an additional $5 to $10 per acre above the cost of materials. This combines to make a preflood P application the most cost-effective in-season timing. There are two methods of evaluating plant P status (soil and tissue sampling) at the preflood stage. Of the two, tissue testing provides a better prediction of yield than soil testing. In field tests, tissue P levels greater than 0.18 percent consistently correlated with maximum rice yields (relative yields greater than 95 percent). Preflood soil testing was much less successful as a predictor of yield. Tissue testing is the preferred method for assessing P status.

Collecting a rice tissue sample

To properly collect rice tissue samples from fields before flooding, producers should select areas in each field that have similar characteristics (including crop history, soil texture, fertilization history). These areas may be fertilized as a unit. The aboveground tissue from 1 foot of drill row at four or five randomly selected locations within each unit should be collected. Care should be taken that the sample is not contaminated with soil, as this will influence the results. The basal portion of the sample may be washed with distilled water if contamination is suspected. Samples should be placed in paper containers (not plastic) to allow drying during subsequent handling. Proper labeling of samples ensures consistent identification later. The samples may now be transported to a qualified tissue testing lab for analysis. When selecting a lab, close attention should be paid to turnaround time. If test results are not returned in a timely manner, producers can miss timing windows for preflood application of fertilizer or be delayed in establishing the flood.

Summary

Rice producers have the opportunity to correct P deficiency in rice as late as the preflood stage and still obtain maximum yield benefit. Preflood tissue testing for P can indicate possible P deficiency. Producers should consider preflood tissue testing of rice fields and then apply P fertilizers if the tissue P level is 0.18 percent or below.

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