Managing Phosphorus in California Rice Fields

Why is it Important?

Phosphorus (P) is the second most commonly applied fertilizer to rice (nitrogen is the first). Plants use P for membrane integrity, energy storage and phloem transport. Phosphorus deficiencies are not common in California as many farmers apply P fertilizer (on average, 40-45 lb P_2O_5/ac). However, in a recent study, we found 10% of fields tested to be deficient. With farmers achieving higher yields, deficiencies may become more common unless P fertilizer rates are increased.

Deficiency Symptoms & Critical Levels

Deficiency symptoms often diminish with time but include: Stunted dark green plants, narrow leaves, reduced tillering, and delayed flowering.

Figure 1. Phosphorus deficiency symptoms showing narrow dark green leaves.

The Olsen-P soil test (sodium-bicarbonate) is the best test for identifying P-deficient rice soils in California. The Bray test does not work as well. An Olsen P value above 6-9 ppm is indicative of a soil that is not P deficient.

For plant tissue, if the Y-leaf P concentration at 35 days after seeding (DAS) is below 0.2% P, then a deficiency is possible.

Soil Phosphorus Budgets

A P budget accounting for all of the P fertilizer added and removed in grain or straw over the past five years also provides a good indicator of soil P status. If more P has been removed from the soil than has been applied, it is likely the soil P status is low (Table 1). Importantly, at harvest, about 70% of the P in the plant is in the grain; therefore, P removal in grain is the major pathway that P is removed from the system. Very little P is lost via leaching or in the tailwater drain. Given that these losses are low, it is possible to build up P in the soil.

The Four Rs of P Fertilizer Management

Right rate: First ask, should you apply? If your soil test levels are high (>15 ppm Olsen P), you probably do not need to apply any P fertilizer. If soil P levels are between 6 and 15 ppm Olsen P, apply the maintenance application rate. If Olsen P levels are below 6 ppm consider build-up application rates (rates higher than maintenance). To calculate the maintenance application rate you can go to "rice.ucanr.edu/P_Budget_calculator/". However, Table 1 provides general guidelines that will give you a rough estimate based on your expected yields and straw management.

Right time: Phosphorus fertilizer can be applied anytime from before flooding to about 30 DAS for optimal yield response. Applying P before planting can lead to algae (scum) build up in the water and lead to poor stand establishment (Fig. 2). This is especially the case when the P fertilizer

is not incorporated or the water temperatures are warm. If scum is an issue, P can be applied into the water up to 30 DAS.

Right place: If applied before flooding, it should be incorporated into the soil to help reduce scum.

Table 1. The amount of P removed (hence the amount required to maintain soil P levels) from the field based on rice grain yields and straw management. Removing straw (i.e. bailing) assumes 50% of straw is removed. Retained straw includes any operation (including burning) where straw remains in the field after harvest.

Grain yield	Straw management	Maintenance P fertilizer requirement
(cwt/ac)		lb P_2O_5/ac
70	Retained	36
70	Removed	44
80	Retained	42
80	Removed	50
90	Retained	47
90	Removed	56
100	Retained	52
100	Removed	63

Right source: The most common P sources are various forms of calcium phosphates or ammonium phosphates (e.g. 16-20-0; 11-52-0). In California, ammonium phosphates are most commonly available, thus the application of P also includes nitrogen. In general, we recommend using a P source with the lowest amount of N because the more N applied as aqua-ammonia, the more efficient the N uptake.

Manure is also a source of P and can contain a relatively high amount of P (especially poultry). Thus, organic rice field soils often have high soil P values. The nutrient content of manure is highly variable and depends on a number of factors including the source, how it has been stored, and its moisture content.

Figure 2. Rice field early in the season with algae (scum) on the water surface, which prevents good stand establishment.

For more on this topic:

- ✓ Agronomy Research and Information Center-Rice: rice.ucanr.edu
- ✓ Dobermann, A and T. Fairhurst. 2000. Rice: Nutrient Disorders & Nutrient Management. International Rice Research Institute.
- ✓ Linquist, B.A. and M.D. Ruark. 2011. Re-evaluating diagnostic phosphorus tests for rice systems based on soil phosphorus fractions and field level budgets. *Agronomy Journal* 103:501-508.
- ✓ Lundy, M.E., D.F. Spencer, C. van Kessel, J.E. Hill and B.A. Linquist. 2012. Managing phosphorus fertilizer to reduce algae, maintain water quality, and sustain yields in water-seeded rice. *Field Crops Research* 131:81-87.
- ✓ Spencer, D. and B.A. Linquist. (2014) Reducing rice field algae and cyanobacteria by altering phosphorus fertilizer applications. Paddy and Water Environment 12:147-154.

Agronomy Research and Information Center

http://agric.ucdavis.edu/

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