Fertility Management in Rice

Project Leaders:
Chris van Kessel, Department of Agronomy and Range Science, University of California, Davis, CA

Bruce Linquist, Department of Agronomy and Range Science, University of California, Davis, CA

Cooperators:
Matt Ruark, Department of Plant Sciences, University of California, Davis, CA.

Johan Six, Department of Agronomy and Range Science, University of California, Davis, CA

Supporter:
Dana Dickey, Executive Director, California Rice Research Board, Yuba City, CA

Introduction

In 1991, the California Rice Straw Burning Reduction Act (AB1378) attempted to mitigate the negative impact of rice straw burning on air quality by requiring rice farmers to adopt alternative methods of straw disposal for the more than 500,000 acres of rice grown in the Sacramento Valley. Despite initial uncertainty over the impact of straw incorporation on rice growth and yield, in-field residue incorporation has transitioned from a burning "alternative" to the primary means of residue management. As a result, the amount of organic matter in the soil has increased and nutrient availability has been altered. From long-term experiments, it is clear that available soil N is increased after 3 years of residue incorporation and winter flooding (Eagle et al., 2000); however, the impact on soil fertility in growers' fields, where management options are frequently rotated to reduce pest and weed pressure, is uncertain.

Survey results indicate that 29% of growers reported reducing fertilizer applications in fields where they regularly incorporated residues, while 9% of growers increased fertilizer rates and 52% reported no change following legislated reductions in burning.[1] Given the reported lack of a clear consensus on the impact of straw management on soil fertility and fertilizer practices, it is not surprising that there is a perceived need among growers for improved fertility management guidelines. In an effort to address that need, we began a comprehensive evaluation of the impact of rice straw incorporation on nutrient cycling and fertility management by rice growers throughout the Sacramento Valley in 2003. The research included fertility trials conducted with 15 growers in 38 fields, self-reporting, extensive soil and plant sampling and monitoring of three different N rates across a variety of soils, under different management practices.[2]

---

[1] A summary of the results is available on the UCCE Rice web page: http://agronomy.ucdavis.edu/uccerice

[2] All rate manipulations were made to pre-plant fertilizer applications. The N rates were based upon grower standard practice for a given field, and included a 25% or 25 lb N ac^{-1} decrease in pre-plant N, standard practice, and a 25 % or 25 lb N ac^{-1} increase in pre-plant N.

When three year field histories provided by the growers were used to group the data for analysis, a comparison of relative yields within fields indicated that those fields with a history of residue incorporation had significantly greater yields under the reduced fertilizer treatment than those where residue was consistently burnt or baled (P=0.03), reaffirming that changes in straw management have altered nutrient availability. Furthermore, greater than 50% of those fields studied in 2003 were P-deficient according to current soil fertility guidelines, though less than 5% exhibited leaf tissue concentrations below the critical level at maximum tillering (<1000ppm) suggesting that either the soil or tissue guidelines should be reevaluated.

With the assistance of CDFA/FREP, we are continuing trials in grower managed fields and expand the scope of the trials to include sites where more complete fertilizer timing, material and rate response trials will occur. The specific objectives are: 1) To evaluate current starter fertilizer recommendations for flooded rice soils; 2) To improve critical N, P and K guidelines for mid-season tissue.

A summary of Year 1 results are as follows: All of the sites responded to both aqua and starter N fertilizer treatments. This is as expected as N is usually the most limiting nutrient in rice systems. Based on grain yield data, none of the sites was either P or K deficient. In relation to N and starter fertilizer applications a number of specific comments can be made:

1. There is a benefit to applying a complete starter (NPK) application. At all sites and early season sample times above ground biomass yield was significantly higher when there was a NPK starter application (T5) than when no starter was applied (T2). However, by harvest yields at only two of the sites (Tibbitts and Josiassen) were significantly higher due to a complete starter application.
2. At all sites there was a benefit to the application of starter N (comparison of T5 and T6). Where starter N was applied biomass was higher at sample time 1 (2 sites significant) and times 2 and 3 (4 sites significant). Again, by harvest the benefit of starter N was only apparent in the grain yields of two sites (Tibbitts and Josiassen).
3. Based on the early season biomass data the crop starts taking up the basal applied aqua N sometime before the first sampling date. A comparison of T1 and T6 shows that biomass was higher (significantly at 3 sites) where there was aqua-N.
4. Grain yields when no N was applied ranged from 3074 to 6940 kg/ha and reflects the amount and availability of soil indigenous N. It was highest at the Josiassen site where straw has been incorporated for over 10 consecutive years. The lowest was at the Mathews site where the soils were coarser textured but also where there was an early season drain which may have resulted in significant denitrification losses.
5. The efficiency of starter applied N varied widely between sites and ranged from -3 to 57 kg/kg. Low starter N use efficiency at the Massa site is most likely due to rainfall immediately after starter N application but several days before flooding. This allows the N to nitrify before flooding and when the field becomes flooded the nitrate denitrifies.
6. The efficiency of aqua-N was relatively similar across sites ranging from 34 to 43 kg/kg. It was lowest at the Josiassen site perhaps due to the high yields achieved in the 0N treatment.