POTASSIUM EFFECTS ON YIELD, GRAIN QUALITY, LODGING, AND STALK STRENGTH IN RICE

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ABSTRACT

Missouri has a long history of rice production, going back to 1910 when the crop was first grown in the northeast region of the state. From this 40-acre start, rice acreage has increased steadily over the years to over 180,000 acres currently. The statewide average yield was 110 bu/A in 1997 and increased to over 156 bu/A in 2015. Traditionally, nitrogen (N) management has been given top priority by farmers. But with increased yields and rotations with soybeans, K fertility is increasingly being recognized as a yield limitation in some Missouri rice fields. This presentation covers research conducted at the Missouri Rice Research Farm near Qulin, MO from 1997 through 2016.

INTRODUCTION

Potassium deficiency in rice can reduce grain yields, increase lodging and disease pressure. Visual symptoms of K deficiency in rice first appear in older leaves. These symptoms include a yellowing of leaf tips, increased lodging, decreased disease resistance, and reduced yields.

Research conducted at the MU-Fisher Delta Research Center, Portageville, MO, is now highlighting the importance of K in rice production. Initial soil testing and soil fertility research in Missouri focused on improving soil test recommendations for K and has now expanded to the diagnosis and correction of K deficiency at mid-season. In the early years of rice production in Missouri the importance proper K soil fertility was not recognized. This may have been due to low yield potentials and expectations for the rice varieties planted at that time. With the increased rice grain yields resulting from the introduction of modern semi-dwarf and hybrid cultivars the need for better soil K management has become clear. The evolution of the University of Missouri soil test recommendations for K in rice production follows this trend. Originally our recommendations were borrowed from neighboring states with a longer history of rice production. In the early 1990's the critical level for K in rice production was 5 X CEC in lbs of K_2O per acre. The result was very little K being recommended for rice production. As a result of research conducted in the late 1990's the critical level was changed to 125 + 5 X CEC in 2003. As this critical level is different from that of the soybean crop often grown in rotation with rice a good deal of confusion was experienced. We are currently in the process of raising the critical level for rice to match that of soybeans (220 + 5 X CEC).

Rice production in the Missouri boot heel is either on silt loam soils west of Crowley's Ridge, and the clayey soils generally found to the east of Crowley's Ridge. The clay soils generally have high native available K levels (500 to 600 lb K/A) and do not require K fertilization. Many of these clayey soils have been recently land leveled and have a limited history of rice production. If intensive rice and soybean production continues on these soils, they will eventually require K fertilization. The silt loam and silty clay loam soils west of Crowley's have a longer history of rice production and often require K fertilization.

DISCUSSION

Grain yield

Of primary concern to rice producers is grain yield. Here proper K nutrition is key to maintain optimum yield levels. Data pooled over the 19 years studied shows that yields are reduced 20% when K is not included in the fertilizer mix. Table 1 shows a typical response curve from a three-year evaluation conducted on a silt loam soil. The pooled data indicates that growing rice on a soil testing 100 lbs below the current critical level of 125 + 5 X CEC in K could lead to a 30-35 bushel reduction in yield. At current rice prices this represents a $150 per acre cost.

Table 1. Rice yields for pre-plant K treatments 2010-2012 on a silt loam soil, Qulin, MO.

	Rice yield Bu/acre			
% of soil test rec K applied	2010 Bu/acre	2011 Bu/acre	2012 Bu/acre	3-year average % relative yield
0	114	123	116	78
50%	138	134	141	91
75%	149	134	140	94
100%	161	138	154	100

Grain quality

A second yield consideration for rice producers is milling quality. As rice is often used for direct human consumption visual qualities have a bearing on the price that producers receive for their crop. The premium product is a whole, unbroken kernel of the appropriate length with a uniform pearly white translucent color. Broken, “chalky”, or discolored kernels result in steep price reductions. Before rice is sold at the elevator a sample is milled by sequentially removing the husk and bran. The percentage of rice remaining after this process is calculated and referred to as “Head rice”. Next the whole kernels are separated and their percentage calculated, this portion is referred to as “Whole rice”. By combining these two numbers a value of the rice can be determined. Good milling rice has the numbers for Head and Whole totaling greater than 125. The last step for value determination is color evaluation.

Potassium fertility has a positive effect on rice milling quality. Table 2. shows the milling results for two different years. For this trial a different harvesting schedule was employed each year. In 2010 our primary goal was to evaluate lodging effects, while in 2011 we sought to evaluate milling effects. This lead to distinct differences in milling values for the different years. However the increase in milling quality was consistent over both years.

Table 2. Effect of pre-plant Potassium applications or rice grain milling quality.

	Milling quality %Head/%Whole	
% of soil test rec K applied	2010	2011
0	50/61	66/73
50%	55/62	68/75
75%	56/63	69/75
100%	57/63	69/76

Lodging

Rice producers also consider the non-yield benefits of potassium fertilization. Lodging is a major issue for rice producers. Fallen rice is much slower to harvest and the quality of grain is reduced. In our studies lodging was not consistently reduced with proper pre-plant soil applied K fertilization. In our opinion this is due to reduced grain weight when soil available K is inadequate, but by delaying harvest lodging can be induced. However with foliar applied K fertilization lodging was consistently reduced even with adequate soil applied K. This amounted to reductions of 40% lodged to 15% lodged rice in one study.

Stalk strength

These findings challenged us to develop a method for measuring rice stalk breaking strength. In the method we developed weights were progressively added to a cup suspended on a rice stalk. The weight at which the stalk failed and the cup dropped was recorded. In this way breaking strength was measured. This procedure was followed for 10 representative stalks from each plot. The stalk strength data strongly supports the lodging data (Table 3).

Table 3. Stalk breaking strength in grams and lodging % for rice grown with pre-plant K treatments 2010 on a silt loam soil at Qulin, MO. Harvest was delayed to induce lodging.

% of soil test rec K applied	Stalk breaking strength (g)	Lodging (%)
0	70	30
50%	108	25
75%	125	20
100%	140	18

In order to confirm the relationship between stalk strength and Potassium the K content was measured for the individual stalks used in the strength analysis. A weak but positive relationship was found between stalk breaking strength and stalk K content. (Figure 1.)

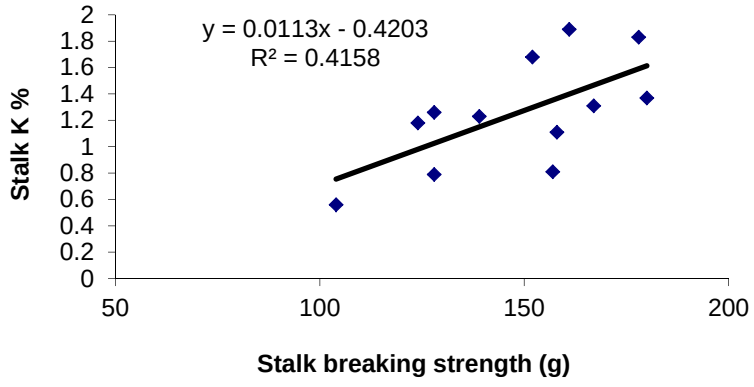

Figure 1. Relationship between stalk breaking strength and stalk K content for rice.

SUMMARY

In summary the need for proper Potassium nutrition has become critical for modern rice production. The University of Missouri soil test recommendations for K in rice has been evolving to meet this need. Our research, over the past 19 years has shown that maintain adequate soil K helps to maintain yield potential, while reducing lodging by increasing stalk strength.

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For further reading

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