Potassium on Rice

And its effects on yield, grain quality, lodging, and stalk strength.

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Summary: *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. The statewide average yield was 110 bu/A in 1997 and has increased to over 156 bu/A by 2015. Traditionally, nitrogen (N) management has been given top priority by farmers. But with increased yields and rotations with soybeans, potassium (K) fertility is increasingly being recognized as a yield limitation in some Missouri rice fields. This article 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 of 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 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, or clay soils generally found to the east of Crowley's Ridge. The clay soils generally have high native available K levels (500 to 600 lbs 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.

Results

Grain yield. Of primary concern to rice producers is grain yield. Here proper K nutrition is a key to maintaining optimum yield levels. Data pooled over the 19 years studied show 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 indicate 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.

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, as 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.

"Proper K nutrition critical for modern rice production."

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 led to distinct differences in milling values for the different years. However, the increase in milling quality was consistent over both years.

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 preplant soil-applied K fertilization. In our opinion, this is due to reduced grain weight when soil-available K is inadequate.

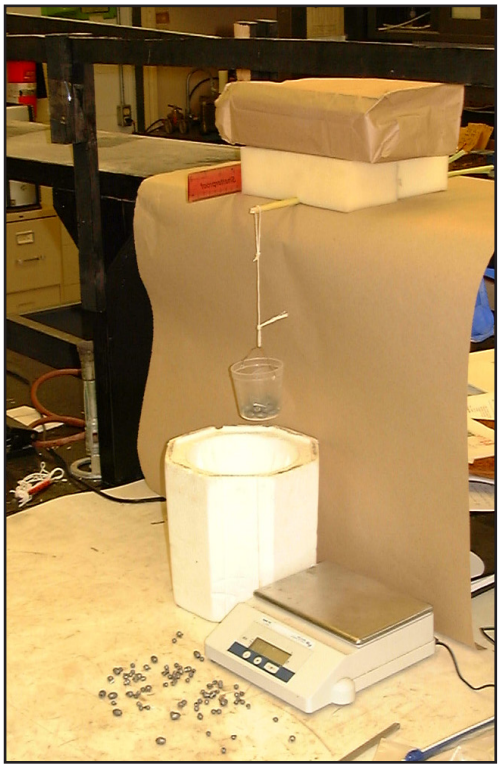

Figure 1. Apparatus used to measure rice stalk breaking strength.

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

% of soil test rec K applied	Rice yield Bu/acre			
	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

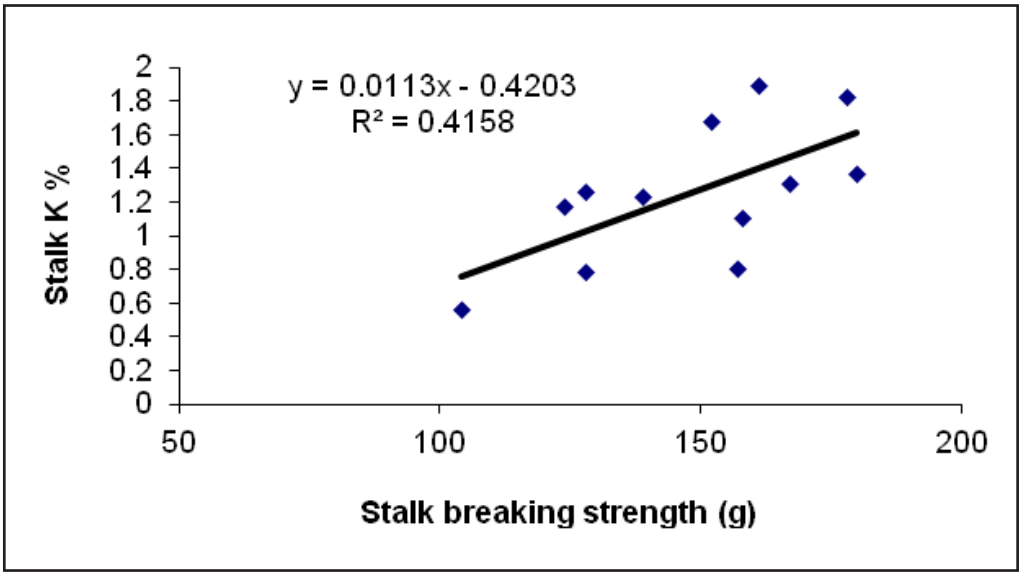

Figure 2. Relationship between stalk breaking strength and stalk K content for rice.

Table 2. Effect of pre-plant Potassium applications or rice grain milling quality.		
% of soil test rec K applied	Milling quality %Head/%Whole	
	2010	2011
0	50/61	66/73
50%	55/62	68/75
75%	56/63	69/75
100%	57/63	69/76

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

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 (Figure 1). 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 support the lodging data (Table 3).

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 2).

Summing up

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

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