

Liming in a Rice/Soybean Rotation

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Objective: The objective of this study is to determine the correct lime rates and application timings for a rice/soybean rotation.

Current Status/Importance of Research Area: Rotating rice with soybeans is a common practice in Southeast Missouri. These crops have different soil pH requirements with soybeans requiring a higher pH than rice to achieve maximum yields. Current University of Missouri soil test recommendations for lime treat rice and soybeans as separate crops. In 1999 a liming study was funded by the Missouri Rice Research and Merchandising Council. This study found that one ton of lime increased soybean yields 25%, however rice yields were lowered by 9 bu/acre. In the first year of this study the increased value of the soybean crop was approximately equal to the lost value in the rice crop. This study was not continued in 2000 due to funding cuts and the relative values of the subsequent years crops could not be determined. However, a news release from the University of AR indicated similar results on the soybean side but indicated that rice yields generally were increased with lime applications.

Procedure: This study investigates the lime requirements of both crops in the rice-soybean rotation. It was conducted on a Crowley silt loam soil located at the Missouri Rice Research Farm located near Qulin, MO. Here the initial soil pH was 5.6 and the lime recommendation was 755 ENM/acre or 1 ½ ton of lime. The experimental design is a complete block design with four replications. Plots representing six lime treatments were established for both rice and soybeans. The following lime treatments were applied 1) control, no lime applied, 2) 0.4 ton lime, 3) 0.8 ton lime, 4) 1.2 lime, 5) 1.6 lime, and 6) pell lime at 200 lbs/a. These lime recommendations cover a three-year time frame, consequently, no lime will be added to the plots in 2011 or 2012. However as pell lime is recommended annually this product will be added in both subsequent years. All methods of N, P, and K fertilization, weed & insect control and irrigation were the standard practices for a drill seeded rice and soybean rotation in Southeast Missouri. Each plot was harvested and the yield measured. Soil samples were collected and soil pH was measured for each plot at the beginning (May) and end (September) of each season.

Project accomplishments: Plots were established in 2010 for both rice and soybeans. The rice crop was successfully established, brought to harvest and yield measured. Protracted drought conditions in May through September of 2010 resulted in a failure to establish a consistent stand for the soybean crop. Consequently these plots had to be abandoned for 2010 and no yield measurement was possible. In both 2011 and 2012 favorable rainfall conditions returned. Both the rice and soybean crops were established brought to harvest and yield measured.

Crop yields for 2010, 2011 and 2012 are presented as Table 1 while relative yields are presented as Table 2. **Rice:** In all three years liming inconsistently affected rice yields

with relative yields ranging from 93-100%. The untreated check consistently produced relative yields of 94% or greater. The 0.8 ton/a lime rate (1/2 of recommended rate) produced the numerically greatest rice yields each year. However, the numerical lowest yields for rice were obtained with the rate 1.2 ton/a in 2010, while the 1.6 ton rate produced the lowest yields in 2011. The 200 lb/a pel lime treatment applied annually produced yields which averaged 2 bu/a greater than the untreated check. With this treatment an average of 95% relative yield was obtained. In terms of relative yields lime or no lime did not adversely affect rice yields.

Soybeans: For the two years that a soybean yields was measure liming consistently increased yields. The untreated check only produced a 75% average relative yield for the two years. In 2011 the greatest soybean yields were obtained with the 1.2 ton/a rate of lime, while in 2012 the 1.6 ton/a rate produced the greatest numerical yields. The 200 lb/a pel lime treatment applied annually produced yields numerically greater than the untreated check but less than any of the lime treatments. With this treatment an average of 80% relative yield was obtained. In terms of relative yields liming consistently raised soybean yields.

Soil pH was measured for each plot at the beginning (May) and end (September) of each season. This data is presented in Tables 3a and 3b. For each year when the end of the season pH was averaged for all treatments higher pH levels were found for the plots on which rice was cultivated that year. This reflects the lime contribution of the flood waters applied supporting the rice crop.

Summary

- Rice yields were largely unaffected by liming. The untreated check produced an average of 94% relative yield.
- Soybean yields were strongly affected by liming. With no lime added only 75% of the relative yield was obtained.
- Given that MU lime recommendations cover a 3-year time period, for maximum economic impact lime should be applied before the soybean crop. This allows 2 of the 3 years to be in the crop that will benefit the most from lime.
- Lime rates should be determined by using soybeans as the crop to be grown in this rotation.

Table 1. Rice and soybean yields for lime treatments at Qulin, MO 2010, 2011, and 2012

Trt#	Lime Rate	2010		2011		2012	
		Rice	Beans	Rice	Beans	Rice	Beans
1	check	141	----	138	34	129	25
2	0.4 ton (200 ENM)	141	----	139	40	134	31
3	0.8 ton (400 ENM)	149	----	146	42	137	31
4	1.2 ton (600 ENM)	140	----	140	45	130	33
5	1.6 ton (800 ENM)	144	----	136	44	131	34
6	200 lb pel lime (60 ENM)	142	----	140	37	131	27

Table 2. Relative yields for crops with lime treatments at Qulin, MO 2010, 2011, and 2012.

Trt#	Lime Rate	2010		2011		2012	
		Rice	Beans	Rice	Beans	Rice	Beans
1	check	95	----	95	76	94	74
2	0.4 ton (200 ENM)	95	----	95	89	98	91
3	0.8 ton (400 ENM)	100	----	100	93	100	91
4	1.2 ton (600 ENM)	94	----	96	100	95	97
5	1.6 ton (800 ENM)	97	----	93	98	96	100
6	200 lb pel lime (60 ENM)	95	----	96	82	96	79

Table 3a and 3b. Ph values measure in 3-year rice/soybean rotational experiment with lime additions at Qulin, MO 2010-2012.

Table 3a, Soil pH values for lime treatments for Rice-2010: Soybeans-2011: Rice-2012 (2 year rice, 1 year soybeans)							
Trt#	Lime Rate	5/1/10	9/30/10	5/1/11	9/30/11	5/1/12	9/30/12
		Rice		Soybeans		Rice	
1	check	5.6	5.8	5.6	5.4	5.5	5.6
2	0.4 ton (200 ENM)	5.6	6.0	6.0	5.9	5.7	5.7
3	0.8 ton (400 ENM)	5.5	6.1	6.2	6.2	5.9	5.8
4	1.2 ton (600 ENM)	5.6	6.1	6.3	6.3	6.0	5.9
5	1.6 ton (800 ENM)	5.6	6.2	6.4	6.4	6.1	6
6	200 lb pel lime (60 ENM)	5.5	5.9	5.7	5.9	5.7	5.6
<u>Average of all treatments</u>		<u>5.6</u>	<u>6.0</u>	<u>6.0</u>	<u>6.0</u>	<u>5.8</u>	<u>5.8</u>
Table 3b, Soil pH values for lime treatments for Soybeans-2010: Rice-2011: Soybeans-2012 (2 year soybeans, 1 year rice)							
Trt#	Lime Rate	5/1/10	9/30/10	5/1/11	9/30/11	5/1/12	9/30/12
		Soybeans		Rice		Soybeans	
1	check	5.6	5.4	5.5	5.7	5.6	5.4
2	0.4 ton (200 ENM)	5.6	5.8	5.9	6.1	5.9	5.7
3	0.8 ton (400 ENM)	5.5	5.9	6.1	6.2	5.9	5.8
4	1.2 ton (600 ENM)	5.5	6.1	6.2	6.2	6.0	5.9
5	1.6 ton (800 ENM)	5.6	6.3	6.3	6.4	6.2	5.9
6	200 lb pel lime (60 ENM)	5.6	5.8	5.7	5.8	5.6	5.5
<u>Average of all treatments</u>		<u>5.6</u>	<u>5.9</u>	<u>6.0</u>	<u>6.1</u>	<u>5.9</u>	<u>5.7</u>