ARKANSAS

Rice Response to Phosphorus Application Timing

By N.A. Slaton, C.E. Wilson, Jr., S. Ntamatungiro and R.J. Norman

Timing of phosphorus (P) application for rice in Arkansas can have a significant effect on total dry matter (TDM) and yield. Researchers are looking for results to guide recommendations.

Rice response to P fertilization in Arkansas has been researched for the past 30 years with mixed results. Field studies conducted during the 1960s determined that P application tended to result in rice yield decreases despite significant increases in vegetative growth. Many of the tests were conducted on acid soils. Application of P to soils having pH greater than 6.5 often resulted in leaf chlorosis due to zinc (Zn) deficiency. These studies were conducted before Zn was recognized as a yield limiting nutrient in rice production. More recent studies, stimulated by reports of rice response to P on alkaline soils from Extension agents and rice growers in northeast Arkansas, have found significant yield increases from P application in 75 percent of the tests.

Use of irrigation well water high in calcium bicarbonate has created alkaline soil conditions near water inlets in many Arkansas rice fields. Rice often exhibits bronzing on lower leaves, reduced tillering, erect leaves, and, if severe, death after flooding. All of these symptoms have been attributed to either P or Zn deficiency in high pH areas. In many instances, application of Zn has failed to prevent or alleviate the symptoms. Reduced soil conditions, created by continuous flood irrigation, generally increase P availability to rice by the reduction of ferric phosphates and hydroxides to more soluble ferrous forms. The release of P from reductant soluble P and ferric phosphates is often sufficient to supply rice P requirements. The predominant forms of P in alkaline soils are calcium phosphates. Soil reduction does not influence the solubility and subsequent availability of the calcium phosphate. Commonly used soil test methods, including Bray-1, Mehlich 3, and Olsen, tend to over predict P availability for rice and, are poorly correlated with rice response to P fertilization. As the frequency of P deficiency in Arkansas rice production fields increases, questions concerning application timing and rates are being asked by growers and consultants. Objectives of these tests were to evaluate

TABLE 1. Selected soil properties from P application timing studies conducted during 1997.

Location	Soil pH	0-4 inch Mehlich 3 soil test levels, ppm Ca	K	Mg	P	Zn
Brooks	6.6	1,435	65	209	14	9.9
Davis	7.6	1,970	74	277	10	2.0
Wimpy	8.0	2,830	66	349	28	20

rice response to rates and timing of P applied on silt loam soils differing in Mehlich 3 extractable P and soil pH.

Materials and Methods

Application timing studies were conducted in 1997 in three grower fields having different soil chemical properties (**Table 1**). Triple superphosphate was surface applied at rates of 0, 20, 40, and 80 lb P_2O_5/A prior to rice emergence (PE), preflood (PF), 7 days postflood (POF), and panicle differentiation or midseason (MS). Plots were managed identically to the surrounding field by cooperating producers. Total dry matter (TDM) was obtained by sampling a 3 ft. row three weeks after 50 percent heading. Grain yield was determined by harvesting 9 sq. ft. from the four middle rows of each 8 x 16 ft. plot with a small plot combine. Grain moisture was measured after harvest and adjusted to 12 percent moisture.

TABLE 2. Influence of P application rate on total dry matter production 3 weeks after 50 percent heading from three P timing studies in 1997.

Rate, lb P_2O_5/A	Total dry matter, lb/A		
	Brooks	Davis	Wimpy
0	18,699	14,847	18,244
20	19,689	16,497	17,076
40	20,045	17,460	18,084
80	22,952	16,826	18,191
LSD (0.05)	3,772	1,641	NS
Pr > F	0.048	0.064	.629
CV %	9.3	19.2	16.5

TABLE 3. Influence of P application rate on rice grain yield from three P timing studies conducted during 1997.

Rate, lb P_2O_5/A	Grain yield, bu/A		
	Brooks	Davis	Wimpy
0	191	110	143
20	182	145	148
40	171	153	155
80	178	142	156
LSD (0.05)	NS	23	NS
Pr > F	0.586	0.025	0.207
CV %	14.6	15.4	9.3

Results

Phosphorus rate significantly increased TDM measured three weeks after 50 percent heading at both the Brooks and Davis farms (**Table 2**). Only the 80 lb P_2O_5/A rate significantly increased TDM at the Brooks location. Phosphorus application rates of 20 lb P_2O_5/A and greater significantly increased TDM at the Davis site. Application timing did not affect TDM.

Significant grain yield increases were observed for both P rate and timing of application at the Davis farm. Application of 20, 40, or 80 lb P_2O_5/A increased grain yield compared to the untreated check (**Table 3**). Yields were highest when P was applied POF compared with at MS. The PE and PF applications also tended to produce higher yields than the MS application. This indicates that on soils that respond to P, fertilizer application should be made no later than the midtiller growth stage or shortly after flooding for most efficient use of fertilizer P. Data from the Wimpy farm suggest that P application at MS did not increase grain yield compared to the untreated check (**Tables 3** and **4**). However, a trend for grain yield to increase occurred for the 40 and 80 lb P_2O_5/A rates and the PE and POF application timing. A comparison of grain yields at the Davis farm for application timing (**Table 4**) to the 0 lb P_2O_5/A rate (**Table 3**) shows that the MS application tended to increase grain yield, but greater yield increases were obtained from the PE, PF and POF application timings. Additional studies are needed to determine if fertilizer P applied early in the growing season is subject to fixation on alkaline soils before crop utilization. Lower P rates applied at PF and POF tended to increase yields which suggests P may be fixed when applied before emergence.

Summary

Data from the P timing studies, and other P fertilization projects conducted during 1997 on alkaline silt loams, continue to show significant TDM and yield increases from P fertilization. Generally, acidic silt loam soils with acidic pH and following soybean in rotation have not shown rice yield increases from P fertilization in Arkansas. Fields that have been precision graded are an exception, since they typically respond to P fertilization for several years following leveling, regardless of pH. Phosphorus timing studies conducted during 1997 indicate that P should be applied before or during vegetative growth. Phosphorus applications made at MS in these field studies tended to produce lower yields than earlier applications on P responsive soils. Data also indicate that some benefit was obtained from either PF or POF P application at the Wimpy site. Additionally, yield data from the Davis farm indicate that P applied before emergence may be subject to fixation. Phosphorus applied either PF or seven days POF tended to produce the greatest overall yields at sites exhibiting a P response. More studies are needed to establish consistent trends among P application timings. Present and future research efforts are focused on development of more accurate P recommendations for rice. BC

TABLE 4. Influence of P fertilizer application timing on rice grain yield from three P timing studies conducted during 1997.

P Timing	Grain yield, bu/A		
	Brooks	Davis	Wimpy
Preemerge (PE)	184	145	150
Preflood (PF)	171	143	156
Postflood (POF)	172	157	156
Midseason (MS)	182	131	147
LSD (0.05)	NS	18	NS
Pr > F	0.611	0.018	0.410
CV %	14.6	15.4	9.3

The authors are with the Department of Agronomy, University of Arkansas. Dr. Slaton is Extension Agronomist-Rice, located at the Rice Research Extension Center, Stuttgart. Dr. Wilson is Extension Rice Specialist/Research Associate Professor, located at Monticello. Dr. Ntamatungiro is research specialist, located at Stuttgart. Dr. Norman is Professor of Soil Fertility, located at Fayetteville.
E-mail for Dr. Slaton: nslaton@comp.uark.edu.

Potassium Fertilization of Russet... *(continued from page 9)*

potato production in Idaho should be increased over what was previously considered adequate, particularly on coarse, sandy textured soils. Growers using the information from this study should be able to successfully manage the K needs of Russet Burbank potato production in Idaho. BC

Dr. Westermann is a Soil Scientist, USDA-ARS, Kimberly, Idaho. Dr. Tindall is Agronomist for J.R. Simplot Company, Pocatello, formerly Extension Soil Specialist, University of Idaho, Twin Falls.

Recent Idaho research indicates need for increased K application for higher potential yields of Russet Burbank potatoes.