Arkansas

Phosphorus and Potassium Fertilization Improves Rice Growth and Yield

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Arkansas research shows that frequency of phosphorus (P) and potassium (K) deficiencies in rice may be increasing and that P and K fertilization increase yields.

DEFICIENCIES OF P AND K in rice have been appearing more frequently across the rice-growing region of Arkansas. Symptoms commonly associated with K deficiency include brown leaf spot, reduced response to topdress nitrogen (N) application, and yellow older leaves.

Prior to 1992, the University of Arkansas did not recommend P fertilizer for rice except on recently leveled fields. Under flooded conditions, soil P availability increases and plants were believed to receive adequate P. Soil pH increases caused by lime deposition from irrigation water and neglected fertilizer application for soybeans in rotation have contributed to more frequent nutrition problems in rice.

The University of Arkansas currently recommends P and K for rice when soil test (Mehlich 3) values are below 25 and 175 lb/A, respectively. A 1993-94 summary of University of Arkansas soil test results indicated that 12 and 44 percent of the sampled rice acreage requires P and K based on these sufficiency levels. In addition, fields are not being sampled intensively enough to detect and manage soil fertility variability, with an average sample representing 44 acres.

Elevated soil salinity levels are also causing rice production difficulties. Many of the salt-affected soils are also low in P and K. Many growers are reluctant to apply potassium chloride (KCl), the most common K source, because of their concern that it may aggravate any existing soil salinity problem and result in partial or complete stand loss. Preliminary research in Arkansas has indicated that rice may suffer more from inadequate K than from a minor reduction in stand density following KCl application on soils with elevated salinity. Other work has indicated that the rice salinity damage may be eliminated or reduced if P has also been applied. Studies are underway to: 1) Evaluate current P and K recommendations, 2) evaluate the effects of KCl on soils low in K which also have a history of salinity problems, and 3) determine

Table 1. Soil test information for the 1994-95 P and K studies.

		0 to 6-inch Soil Test Levels (Mehlich 3), lb/A				
Location	pH	P	K	Ca	Mg	Cl[b]
Cross/1994	7.2	15	130	3540	555	–
Cross/1995	7.8	15	104	4057	494	16
Craighead/1995[a]	8.0	11	203	4458	455	116
Poinsett/1995	5.7	25	118	2052	316	14

[a] Soil sampled after application of 0-40-60-10 (N-P_2O_5-K_2O-Zn).
[b] Water-extractable.

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Table 2. Rice grain yields from a P and K study in Cross County, 1994.

$N-P_2O_5-K_2O$ lb/A	Grain yield, bu/A
0-0-0	172
0-0-60	182
0-0-80	192
0-0-120	181
0-40-60	198
0-40-80	192
0-40-120	197
Poultry litter, 1000 lb/A	182
Poultry litter, 2000 lb/A	179
$LSD_{.05}$	18

optimum nutrient concentrations in the plant tissue at various growth stages.

Field Studies

A preliminary test was conducted in 1994 in a producer's field that had soil test P and K levels below University of Arkansas sufficiency levels (**Table 1**), a history of rice seedling salinity damage, and a soil pH above 7.0

Treatments (**Table 2**) were broadcast on the soil surface after the field was planted. Salinity injury, maturity and grain yield were measured.

Experiments were initiated in 1995 at 15 locations on producer fields with various pH and soil fertility levels. Field information for three of the sites is reported in **Table 1** with treatments applied listed in **Table 3**. Plant samples were collected at each location by removing all the above-ground plant material in a portion of each plot at mid-tillering, mid-season (2-inch internode elongation), and three weeks after heading to measure dry matter production. Grain yields will be measured at all 15 locations.

Results

In 1994, elevated soil salinity caused stand reduction in the nonfertilized control (**Table 2**). Stand loss increased with increasing KCl rates, but no stand loss occurred when P was applied with KCl (data not shown). Stand density remained optimal in all treatments because a heavy seeding rate was used to counter stand reduction from salinity. The greatest yields were measured when both P and K were applied. Poultry litter was not an adequate substitute for inorganic P and K when applied to emerged rice since yields were only slightly higher than the nonfertilized control.

In 1995, only one of the 15 sites exhibited a significant stand reduction attributed to salinity. At that site in Craighead County, KCl alone caused moderate stand reductions where the grower had already

Table 3. Rice dry matter production at two growth stages with P and K fertilization (1995).

$N-P_2O_5-K_2O$ lb/A	Total dry matter production, lb/A					
	Mid-tillering			Mid-season (2-inch internode elongation)		
	Craighead[a]	Cross	Poinsett	Craighead[a]	Cross	Poinsett
0-0-0	527	1,875	982	6,295	5,741	6,607
0-40-0	589	2,500	1,152	8,357	5,571	7,036
0-80-0	768	3,125	1,214	8,500	7,134	6,250
0-0-60	—	2,116	1,250	—	6,241	6,946
0-0-90	420	2,071	982	6,196	6,170	6,946
0-0-120	—	2,571	1,339	—	6,411	7,250
0-40-60	—	2,839	1,496	—	6,804	7,714
0-40-90	679	3,384	1,643	8,741	7,304	7,661
0-40-120	—	3,241	1,438	—	7,884	6,536
0-80-90	973	3,170	1,223	8,482	8,000	6,464
Poultry litter, 2000 lb/A	607	—	—	7,250	—	—
Poultry litter +0-40-90	607	—	—	8,696	—	—
0-80-0 post flood	679	—	—	8,098	—	—
$LSD_{.05}$	232	1,125	438	2,723	1,911	1,607

[a] Treatments at this site were in addition to 0-40-60 preplant applied by cooperating grower.

preplant-applied 40 lb/A P_2O_5 and 60 lb/A K_2O plus 10 lb/A zinc (Zn). Bronzed lower leaves with yellow midribs were observed within 72 hours after flooding/flushing. Treatments which included P continued to grow and tiller, while KCl alone treatments (and the control) had more bronzed leaves, remained erect, and produced few tillers. The photos illustrate the increased vegetative growth with P fertilization in 1995 in Cross County.

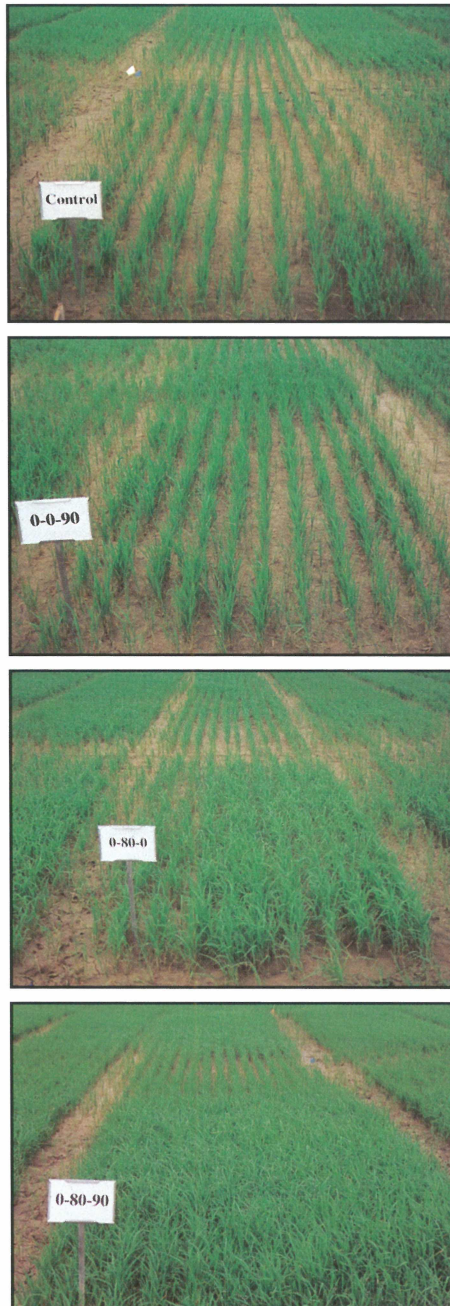
In 1995, treatments which included both P and K produced the greatest dry matter production at mid-tillering, which supports the visual observations. At mid-season, the P plus K treatments at Craighead and Cross counties produced the greatest dry matter, followed by the high P alone treatments. When KCl was applied without P, dry matter production increased at Cross and Poinsett counties, but tended to decrease in Craighead County.

The Poinsett County site had a lower pH and a higher soil P level than the other sites (**Table 1**). At mid-tillering, all treatments had dry matter production greater than or equal to the nonfertilized control, but treatments which included both P and K tended to be greatest. In contrast to the other sites which had higher soil pH levels, the highest rate of P alone tended to reduce dry matter production at mid-season.

Summary

These preliminary results indicate that P may need to be applied with K to increase rice yields, especially on soils with a pH greater than 7.0. Reduced plant populations and dry matter production tend to indicate that KCl alone may be detrimental on high pH soils. However, grain yield increases with KCl application suggest that the need for K is greater than the potential aggravation of soil salinity from KCl applications.

Further work is being conducted to measure plant nutrient concentrations and uptake at various growth stages. Grain yields will also be measured. Evaluations of P sources and P and K application timing are also planned. ■



PHOSPHORUS enhances rice growth response to K on soils testing low in P and K in Arkansas. Shown from top are plots with these treatments: control (no fertilizer); K_2O only, 90 lb/A; P_2O_5 only, 80 lb/A; and at bottom 80 lb/A P_2O_5 plus 90 lb/A K_2O.