

Potassium Deficiency and Plant Diseases Observed in Rice Fields

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Potassium deficiencies in rice were once thought to be rare in Arkansas. However, since 1991 the frequency of K deficiency has increased. Two main theories concerning the recent increase in visual symptoms of K deficiency have been proposed. One involves a gradual reduction in soil test K values over time, the other the release of new, high yielding varieties that may require high soil K levels.

A summary of University of Arkansas Soil Testing Laboratory results (1994-95) for rice indicates that 44 percent of the state rice acreage requires direct K fertilization based on soil test levels less than 175 lb K/A (Mehlich 3). Additionally, 12 percent of the total acreage tests less than 125 lb K/A.

Visual K deficiency symptoms and depressed yields are very likely on soils

testing below 100 lb K/A. Visual symptoms include yellowing of leaf tips and margins (normally beginning in the lower canopy), stunted plant growth, reduced tillering, black and deteriorated root systems, and reduced response to midseason topdress

nitrogen (N) applications. Plant deficiency symptoms usually begin to appear about midseason when yellowing of rice plants is normally attributed to N deficiency. In severe K deficiencies, leaf die-back will proceed from leaf tips down nearly to the base of upper

leaves. Potassium deficiency normally proceeds through a series of leaf color changes, depending on cultivar, including yellow, reddish brown, and eventually a tan/brown color resulting from leaf death. Premature leaf death and accompanying color changes often are a result of increased damage from various rice diseases.

Although potassium (K) deficiencies in rice were once thought to be rare in Arkansas, the frequency has been increasing. Severe disease problems are often associated with K deficiency.



BROWN SPOT attacks the panicle of K-deficient rice.

Potassium and Rice Diseases

Growers often notice severe disease problems on K-deficient rice rather than the early leaf symptoms typical for K-deficient plants. Therefore, they frequently interpret K deficiency as a disease problem rather than a nutrient deficiency. Diseases that are normally not significant problems, such as brown leaf spot (*Bipolaris oryzae*), scab (*Fusarium graminearum*), and stem rot (*Sclerotium oryzae*) overwhelm K-deficient rice. Analysis of diseased panicles from K-deficient fields in 1994 indicated that brown

TABLE 1. Selected parameters from tissue analysis of rice affected by K deficiency symptoms in 1994.

Visual damage	Number of samples	Nutrient, % ^a					Nutrient, ppm ^e		N/K ^d ratio
		N	P	K	Ca	Mg	Na	Mn	
None ^b	8	1.75	0.18	1.16	0.71	0.20	488	1,679	1.5
Moderate	11	2.37	0.29	0.91	0.69	0.24	1,490	1,104	2.6
Severe	14	2.08	0.27	0.45	0.67	0.26	2,627	899	4.6
Critical values (>) ^c		3.00	0.20	1.50	0.20	0.15	—	40	—

^a Tissue was sampled near plant maturity.

^b Data collected and provided by Dr. Rick Cartwright.

^c Critical values were taken from Sedberry, J.E., Jr., M.C. Amacher, D.P. Bligh, and O.D. Curtis. Plant-Tissue Analysis as a Diagnostic Aid in Crop Production. Louisiana State University Agricultural Experiment Station, Bulletin No. 783.

^d N/K ratio of plant tissue.

^e ppm = parts per million

spot was found on up to 90 percent of the grains and contributed the largest amount of yield reduction among diseases. Scab was isolated on up to 20 percent of grain from infected panicles. Other minor diseases were also isolated on affected panicles, including black kernel (*Curvularia lunata*) and Fusarium sheath rot (*Fusarium proliferatum*). Stem rot is a sheath/stem disease that is aggravated by K deficiency. Stem rot causes premature death of tillers and partial blanking of panicles, especially in K-deficient plants.

In most K-deficient rice fields that follow flood irrigated soybeans in rotation, the borrow ditch area of the previous year's soybean levees produces near normal growth. (Levees are graded level with the field after each crop.) The pattern appears as two parallel streaks of "healthier" rice ranging 12 to 18 inches in width and about 4 to 6 feet apart. Soil from the previous year's levee had no plant growth to mine soil K reserves. Since K values normally decrease with soil depth, rice growing in a borrow ditch for the current crop is usually most affected by K deficiency symptoms. This is probably due to low K values in the subsoil exposed by levee formation. Other factors considered to increase the likelihood of K deficiency

include rice water weevil larvae (*Lissorhoptus oryzophilus* K) damage to the rice root system, differences among cultivar K requirements, and inappropriate soil sampling procedures that do not accurately represent the soil fertility status.

Arkansas Conditions

Potassium deficiencies on rice in Arkansas are most likely to occur on sandy and silt loam fields following irrigated soybeans. Crop removal of K is high under intensive management for top soybean and rice yields. Nutritionally healthy rice at panicle differentiation should be greater than 1.5 percent K. **Tables 1** and **2** provide plant and soil analysis data from deficient fields sampled in 1994. Potassium-deficient rice showing severe symptoms commonly has K levels less than 0.5 percent K, high N/K ratio, high sodium (Na) concentrations, and lower manganese (Mn) levels. Limited information is available on yield reductions due to K deficiency, especially if diseases are present. Field observations suggest that grain quality and yield reductions of 50 to 80 percent are possible from K deficiency coupled with severe disease damage. Historically, severely affected areas are usually small in size, but in 1994 entire fields

TABLE 2. *Selected parameters from soil analysis of rice fields affected by K deficiency symptoms in 1994.*

Visual damage	Number of samples	Soil parameter measured ^a						
		pH ^b	P	K	Ca	Mg	Na	Mn
		lb/A ^c						
None ^d	5	6.1	27	164	2,973	571	122	377
Moderate	7	5.9	28	62	1,744	280	91	127
Severe	9	5.8	22	62	1,797	318	83	188

a Soil samples were taken near plant maturity.

b pH values of flooded soil samples, dried in the laboratory.

c University of Arkansas Soil Test Laboratory – Mehlich 3 extract.

d Data collected and provided by Dr. Cartwright.

were affected.

Two factors were common upon field examination of K deficiencies in grower fields...many growers did not have recent soil test results and many soil samples represented too large an area to account for soil variability. Educational programs have been implemented in county Extension grower meetings to address these problems. The main focus of educational efforts has centered on the correct use of soil test procedures in determining soil fertility status in rice/soybean rotations and early identification of K deficiency symptoms. Research projects are underway to evaluate University of Arkansas soil test K recommendations, determine yield loss potential due to low soil K values, evaluate the possibility of differences among rice variety K requirements, and compare application timing of K fertilizer to rice. Observations of

disease incidence are also being taken from K fertilization research.

Educational efforts thus far have led to increased soil testing and use of phosphorus (P) and K fertilizers on the 1995 rice crop, especially on the coarser soil textures in areas having severe disease epidemics in 1994. While not a total cure, the impact of this improvement to balanced rice nutrition has apparently already had a positive effect. For instance, dozens of K-deficient fields with severe disease damage were noted in 1994 in northeast Arkansas by the second author, whereas fewer than 10 have been observed in 1995. BC

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STEM ROT takes a heavy toll on K-deficient rice.