Managing Acid Soils for Optimum Wheat Production

By Ray E. Lamond and David A. Whitney

Kansas data emphasize the importance of liming acid soils for profitable wheat production. Banded phosphorus (P) fertilizer placed with the seed at planting is a viable short-term management alternative when liming is not possible.

ACID SOILS with accompanying high aluminum (Al) levels are reducing wheat yields in the heavy production regions of southcentral Kansas and northcentral Oklahoma. The thirteen counties in the South Central Kansas Crop Reporting District represent 2.5 to 3.0 million acres of wheat, much of which is used for a combination of grazing and grain production. The region is predominately continuous wheat with aggressive fertility management which includes additional nitrogen (N) applied for fall and winter grazing.

Over the years, continual use of ammoniacal N at rates to meet forage and grain production needs has gradually lowered soil pH levels. During the past 10 to 15 years, forage and grain yield responses to lime application have been demonstrated by Kansas and Oklahoma researchers. More than a third of the soil samples from the southcentral Kansas area tested by the KSU soil testing lab over the past four years had pHs of 5.5 or less.

Lime costs are substantial due to the fact that lime quarries are more than 100 miles away from much of the area. Because of high lime costs and reluctance of land owners to cost-share, producers are interested in alternatives to aglime. Kansas research has evaluated lime rates, P application, and varieties as management tools for wheat production on these acid, high Al soils.

A lime rate study was initiated in the fall of 1985 on a site in Kingman County that had an initial soil pH of 4.7 and a potassium chloride (KCl)-extractable Al level of 84 parts per million (ppm). Aglime was applied at rates of 3,000, 6,000, or 12,000 lb/A effective calcium carbonate (ECC). The 12,000 lb/A ECC rate was the full recommended rate to bring soil pH back to 6.8 based on the SMP buffer lime requirement test and neutralization of 2 million pounds of soil (about a 6 to 7 inch depth). Lime was applied in September and incorporated prior to seeding. Newton wheat, which is sensitive to Al, was used. The site was conventionally tilled during the four years of the trial with no additional lime applied. **Table 1** summarizes the effects of lime rate on wheat yields and soil pH and Al levels.

Table 1. Lime effects on wheat yields and soil pH and Al levels.

Lime rate, lb ECC/A	1986-1989 avg. wheat yield, bu/A	1989, 0-6 in. depth Soil/pH	Al, ppm
0	14	4.6	102
3,000	37	5.1	26
6,000	38	5.9	0
12,000	37	6.4	0

Kingman County, KS

Application of lime, regardless of rate, increased average yearly wheat yields by over 20 bu/A. Over the four years of this study, 3,000 and 6,000 lb/A rates of lime (ECC) performed just as well as the full rate in terms of yield response. However, four years after application, the 3,000 lb/A rate pH was 5.1 and KCl-extractable Al was 26, indicating a need to relime. The pH resulting from the application of the full rate of lime was 6.4 with no KCl-extractable Al. These data indicate that application of less than full recommended lime rates is effective, but more frequent reliming will be necessary.

Phosphatic fertilizer is known to react with soluble soil Al and could be used to

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LIME application is very effective on acid soils.

BANDED P (with seed) is effective in overcoming Al toxicity on Al-sensitive varieties when liming is not possible.

reduce Al toxicity. Wheat varieties are also known to differ in susceptibility to Al toxicity. A study was established to evaluate half and full recommended lime rates (0, 3,750, 7,500 lb ECC/A), P treatments (none, 40 lb P_2O_5/A broadcast, 40 lb P_2O_5/A banded with the seed), and two wheat varieties (Karl–sensitive to Al; 2163–tolerant to Al). The study site in Sedgwick County had an initial soil pH of 4.7 with 47 ppm KCl-extractable Al and a Bray-1 P level of 54 ppm.

Lime and broadcast P were applied and incorporated in late July, 1991, and wheat was seeded in September. Two consecutive wheat crops were evaluated with the broadcast and banded P applied each year. Conventional tillage operations were employed. Soil samples were taken after harvest of the second wheat crop in June, 1993.

The photos show the effect of liming on wheat growth, and the dramatic response of banding P on this acid, high Al soil where no lime had been applied. The response to P was possibly due largely to the banded P complexing Al out of the soil solution and reducing Al toxicity. **Table 2** summarizes the effects of liming, P, and varieties on wheat grain yields.

Application of lime to this acid soil significantly increased wheat grain yields of both varieties when no P was applied. Even though 2163 is considered tolerant to Al toxicity, a 9 bu/A yield increase to lime was obtained, showing genetic tolerance cannot completely overcome the effects of acidity and Al toxicity. The 3,750 lb ECC/A rate (half of the full recommended rate) performed as well as the full 7,500 lb ECC/A rate in terms of increasing yields.

Banded P with the seed at planting was very effective in overcoming Al toxicity without lime. Broadcast P was not nearly as effective as banded P. The response to banded P was not likely a nutrient response because of the high (54 ppm) Bray-1 P soil test.

Table 3 summarizes lime effects on soil pH and Al levels two years after lime application on samples taken to a 6 inch depth. The data indicate that lime is effectively raising soil pH and reducing soluble Al levels. The use of less than the full recommended rate of lime is a viable short-term option, although reliming on a more frequent basis will be necessary. ■

Table 2. Lime, P and variety effects on two-year average wheat grain yields.

Variety	Lime rate, lb ECC/A	Method of application and P_2O_5 rate, lb/A: None	40 Broadcast	40 Banded
		--- Wheat grain yield, bu/A ---		
Karl	0	38	42	54
	3,750	51	51	57
	7,500	49	49	55
2163	0	49	53	56
	3,750	58	57	60
	7,500	58	54	61

Sedgwick County, KS

Table 3. Lime effects on soil pH and Al.

Lime rate, lb ECC/A	Soil pH	KCl-Extractable Al, ppm
0	4.7	50
3,750	5.3	0
7,500	5.8	0

Initial soil pH 4.7, soluble Al 47 ppm. Sedgwick County, KS