Forage Legumes Respond to Lime and Phosphorus

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With increased emphasis being placed on environmental protection, forage legumes are receiving more attention, both as cash crops and to provide nitrogen (N) for other crops in the rotation. This review of two Alabama studies illustrates the importance of soil pH, liming, phosphorus (P) and potassium (K) on the yield and production of two common annual forage legumes grown in the southeastern U.S.

CROP PRODUCTION in the U.S. relies heavily on the use of commercially produced N fertilizers. About two-thirds of all N fertilizer used on agricultural crops in this country is commercially produced. Forage legumes, properly managed, offer an alternative N source which can satisfy the needs of the legume itself and provide additional N for other crops in the rotation. Two keys to successful forage legume production are proper soil pH and soil fertility.

In an Alabama study, crimson clover was fall seeded after cotton in a three-year rotation of cotton, corn and soybeans, then turned under as green manure ahead of corn. Soil from the experiment was also planted with crimson clover in a greenhouse study. Initial soil pH was 5.0.

Table 1 shows the influence of liming, P and K on the relative yield, N content and production and effectiveness of N-fixing bacteria (Rhizobia).

Table 1. Acid pH and P and K deficiencies limit crimson clover production.

Treatment	Relative yield, %	Relative N content, %	Effective Rhizobia in the soil, %
P deficient	42	35	68
K deficient	77	81	92
Strongly acid	54	45	92
Lime, P, K	100	100	90

Soil acidity limited both growth and N content of forage tissue to about half that of clover grown in a soil which had been limed and supplied with adequate fertility. Most of the plants grown without lime did not develop nodules, were stunted and chlorotic. Phosphorus deficiency had the greatest negative effect on crop growth, N content and effective Rhizobia population, followed by soil acidity and K deficiency.

In another study, Alabama researchers measured the effects of lime and P on the yield and N production of Dixie crimson and Yuchi arrowleaf clovers. Relative yields are shown in **Table 2**. The 250 lb/A P_2O_5 rate of fertilization significantly increased yields for both species, while the 500 lb/A rate produced no further benefit. Lime also increased yields, but to a lesser extent. Initial soil pH was 5.0, and soil P was very low prior to fertilization.

Table 2. Lime and P increase the yields of crimson and arrowleaf clovers.

P_2O_5 rate, lb/A	Relative yield, %			
	Crimson clover		Arrowleaf clover	
	No lime	Lime	No lime	Lime
0	42	39	14	28
250	72	100	95	100
500	80	90	92	99

Table 3 shows total N production for the two clover species. The percent tissue N at

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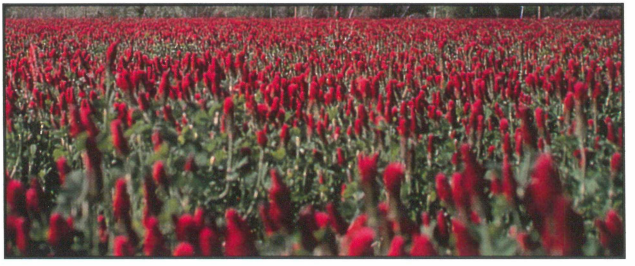

CRIMSON CLOVER is a popular legume among cattlemen in the southeastern U.S., although many do not give adequate attention to its nutritional requirements for economic production.

Table 3. Lime and P increase total N production by crimson and arrowleaf clovers.

P_2O_5 rate, lb/A	Total N production, lb/A			
	Crimson clover		Arrowleaf clover	
	No lime	Lime	No lime	Lime
0	40	26	16	40
250	61	100	136	136
500	66	78	110	142

maturity was multiplied by total dry matter production to arrive at the values shown in the table. Nitrogen production for each species increased slightly with liming, but was dramatically increased by P fertilization. Again, the best treatment was the 250 lb/A P_2O_5 rate. Differences in N production were due to effects of yield and Rhizobia nodulation, not N tissue concentration.

The results of these two Alabama studies show the critical importance of good fertilizer management and liming practices on the economic production of forage legumes. They illustrate the point that there is no 'free ride' for the farmer who is looking for ways to save on his or her fertilizer N bill by including legumes in the crop rotation. Legumes require sound management, just as do other crops. Anything less will result in uneconomical production and can increase the potential for damage to the environment. ■

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that did not increase yield. However, it would appear that increasing leaf and petiole K concentrations in a non-deficient situation would make these observations even more notable. Petiole K concentrations determined 4 and 6 weeks after bloom were 2.56 and 2.38 percent, respectively, which are higher than levels reported to be critical in the Arkansas research.

Potassium moves from the leaves through the petioles to points of demand within the plant, thus allowing leaf K concentrations to change more than the petiole. Petiole K concentrations were about double the leaf K concentrations. Petiole K decreased from 2.2 to 2.0 times leaf K as the number of weeks after bloom increased from two to six. But after eight weeks the ratio of petiole to leaf increased to 2.4. Leaf K concentrations decreased rather sharply six weeks after bloom, indicating a greater demand by the plant than the previous sample period. This decrease was also reflected by the petiole data.

Apparently, the critical time for applying K to these plots was six weeks after bloom. By August 26, six weeks after bloom, the cotton plant enters the maturation stage. During this time, increases in seed size, micronaire, and probably fiber strength also occur. In addition, drought conditions that are common during this period may have restricted root uptake of K since plots had not received irrigation or rainfall since August 19 and many leaves were approaching senescence.

Foliar application of 10 lb/A KNO_3 with either Penetrator Plus or X-77 increased leaf and petiole K concentrations. Applying 10 lb/A KNO_3 with Penetrator Plus consistently resulted in the highest leaf and petiole K concentrations. Applying KNO_3 with a surfactant to increase plant K uptake would be beneficial during periods of restricted soil uptake. Applying lower KNO_3 rates could reduce the possibility of leaf burn during drought stress. ■