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Alfalfa Responds To High P Rates, P Banding

Oklahoma State University trials show that additional profit may be realized because implement and labor costs are decreased due to fewer applications.

Summary: *The response of alfalfa to high dose P fertilization has important economic implications. If a producer is able to maximize yields over a six-year period by supplying the fertilizer as a single event, additional profit may be realized because of reduced application costs. Band (knifed) placement of P provided an additional boost to P responses and to profits. It is important to note that alfalfa yield responses observed in this study may be particularly adapted to high-yielding environments (e.g., irrigated production).*

Alfalfa is an important forage legume crop in Oklahoma and many other states. It is preferred over other forage legumes due to its highyield potential, protein content, and palatability.

The N-fixing capability of alfalfa decreases the need for nitrogen fertilizer, but places a high demand on the soil for phosphorus (P) and potassium (K). Phosphorus and potassium concentrations range from 0.2 to *0.5* percent and 1.0 to 2.0 percent in dry alfalfa forage, respectively. This implies that a field producing *5* tons/A of alfalfa annually removes from soils 46 to 115 lbs/A of P_20_5, plus 120 to 240 lbs/A of K_20. quantities that must be replenished from fertilization or by mineral weathering.

Typically, producers supply P annually to meet the needs of the crop and recharge depleted P pools.

The objective of this research was to evaluate alfalfa yield response to broadcast and banded P at high rates. The project was initiated in 1992 and completed in 1998.

P response

Alfalfa response to P the first year showed a linear increase in yield as P rate was increased, yield being maximized by applying P_2O_5 at the rate of 600 lbs/A (Figure 1).

In the final year of the trial (1998), yield response to the initial 600-lb/A treatment of P_2O_5 had decreased while plots that had received annual and biennial P fertilization still showed marked increases in yields above the check (Figure 2).

Despite the drop in yield response to the 600-lb/A/6-yr rate of P_2O_5 late in the experiment, this treatment still yielded the highest of all broadcast P over the six years of the trials (Figure 3). Additionally, subsurface banding of fluid 10-34-0 (APP) stabilized alfalfa yields over the length of the trial, resulting in the highest yield over the six years of all P-only treatments.

Placement/rate/timing

The responses in this study support the theory that banding of P increases availability by placing the nutrient closer to plant roots, thus minimizing soil-fertilizer reactions and maintaining P availability for longer periods.

Supplying a large amount of incorporated P (600 lbs/A of P_20_5) during alfalfa establishment in a high yielding irri-

Table 1. Initial soil test of entire experimental area.

NO_3-N	P	K	pH
..... lbs/A			
27.2	30.2	326	6.6

NO_3-N-2M KCl extractant; P,K -Mehlich III; pH - 1:1 soil water

Table 2. Final soil tests of selected treatments.

Treatment	NO_3-N	P	K	pH
	----------lbs/A----------			
Check	7.0	15.5	717	7.2
100 lbs P_2O_5/A/yr	4.6	77.4	679	6.9
200 lbs P_2O_5/A/2-yr	5.5	77.6	738	6.9
600 lbs P_2O_5/A/6-yr	6.2	41.0	708	7.0
200 lbs P_2O_5/A/2-yr (knifed)	5.8	78.3	693	6.8
600 lbs P_2O_5 /A/6-yr (knifed)	5.8	25.6	679	7.0
200 lbs P_2O_5/A/2-yr + 500 lbs K_2O/A/yr	5.6	59.8	1,135	6.5
200 lbs P_2O_5/A/2-yr + 50 lbs S/A/yr	5.3	69.3	648	7.1

NO_3-N-2M KCl extractant; P,K - Mehlich III;
pH- 1:1 soil-water
All treatment, including check, received 500 lbs/A of K_2O in years 1,3 and 5

gated environment provides maximum response because plant density is high.

As stands age and plant density decreases, availability of P is lessened by reactions with soil, removal by crop uptake the first two years, and poorer extraction by a less dense root system. Smaller rates applied more frequently are better able to sustain a P-rich environment that supports higher yields in the sixth year.

K provides boost

Potassium fertilization also resulted in increased yields over the length of these trials. The rate of 200 lbs/A/2-yr of $\mathbf{P_2 0_5}$ in conjunction with 500 lbs/A/yr of K_2O yielded the highest of all treatments over the six years (Figure 4). This response was somewhat surprising since the initial soil test of 326 pp2m K was near the calibrated adequate level (K>350 pp2m), plus the comparison treatment received 1,500 lbs $\mathbf{K_2 0}$ over the six-year period.

We might conclude, then, that alfalfa responds to higher levels of available soil K in high-yielding environments. This statistically significant response of about 3 tons/A (value about $240) was from an input of an additional 1,500 lbs K_20 (cost about *$165),* thus merits serious economic consideration. it is possible that lower annual rates (e.g., 25 300 lbs/A of K_2O) might have also supported this maximum yield and that the yield difference would have been even larger compared to a no-K control. Sulfur fertilization only slightly affected yield over the six years of the trial.

Soil tests

Phosphorus. Initial P soil test levels appear in Table 1. Final P soil test levels in the 600-lb/A rate of P_2O_5 initial treatment plots (broadcast and injected) were significantly lower than treatments receiving annual and biennial P applications (Table 2). Soil test P was significantly lower in the unfertilized check than for all other treatments. Lower P tests on areas receiving banded P may reflect inability to hit P bands with random sampling.

Potassium. As expected, the treatment receiving 500 lbs/A/yr of K_2O had the highest K soil test value while other plots receiving only the initial and two subsequent blanket treatments of 500 lbs/A of K_2O still had higher than what is commonly considered adequate levels of K in the soil (Table 2).

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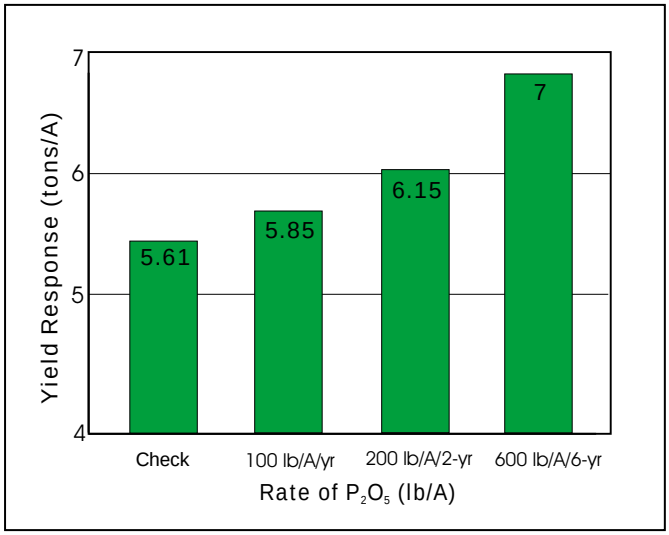

Figure 1. Response of alfalfa to P applications in year one.

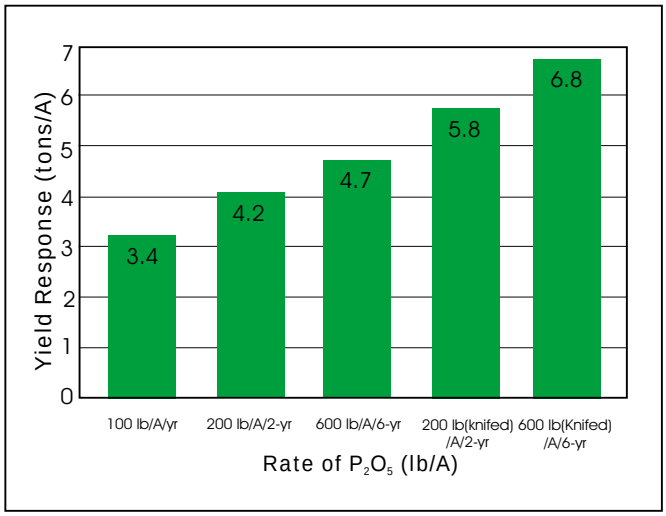

Figure 3. Total alfalfa yield increases from P fertilization (minus the check) after six years.

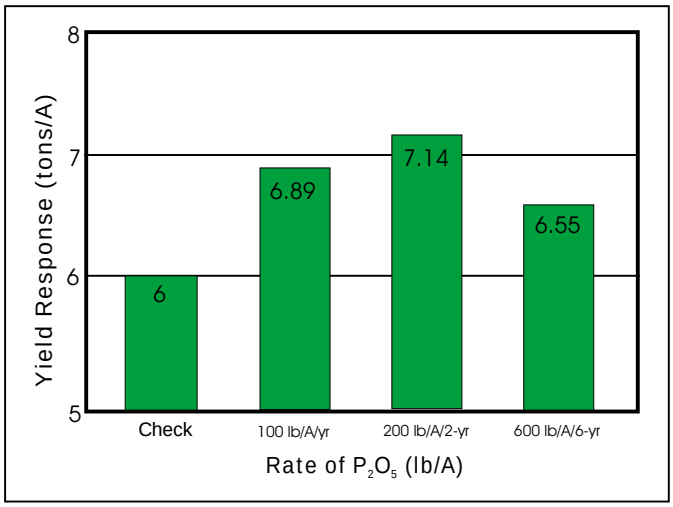

Figure 2. Response of alfalfa to P applications in 1998.

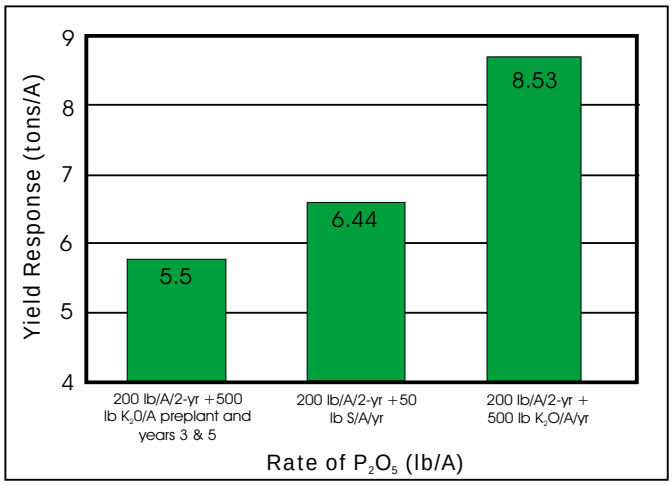

Figure 4. Total alfalfa increases (minus the check) from P, K and S treatments after six years.