Alfalfa Variety Response to Phosphorus and Potassium

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Alfalfa varieties respond differently to supplemental phosphorus (P) and potassium (K), but all varieties require adequate amounts of these two nutrients to produce good yields of high quality hay.

ALFALFA HAY from the intermountain areas of Idaho and Utah is some of the most sought after in the U.S. International sales are also important. Yields have increased over the past 25 years and now approach 8 tons/A. This increase is due in part to better water management and new varieties which are better adapted to the western U.S.

Phosphorus and Potassium Critical

Nutrient requirements have increased in proportion to increased yields. Production efficiency is dependent on the availability of P and K. Once these two nutrients drop below plant critical levels, yield restrictions occur. In most western calcareous soils, the P critical level is around 12 to 15 parts per million (ppm), sodium bicarbonate extraction. The critical level for exchangeable K is about 100 to 125 ppm. If there are no other soil or management problems, growers should expect to see a response to either P or K when soil tests are below these levels.

Deficiency Symptoms

Varieties differ in their utilization of P and K, and in their expression of K deficiency symptoms. Phosphorus deficiency symptoms are generally associated with shorter plants with a more compact leaf area. Color of normal and P-deficient plants is similar, but deficient plants may be somewhat darker green. Traditional K deficiency symptoms have been described as fawn-like spots near the leaf margins. However, other plants within the same variety and within the same area can also exhibit marginal necrosis. This is caused by high tissue sodium (Na) concentrations which result as the plant tries to come to ionic equilibrium.

DEFICIENCIES of P and K can lead to serious alfalfa yield losses and lower forage quality. Utah research has demonstrated these effects on a number of common varieties. The area in the center shows depressed growth due to P and K deficiency.

Utah Studies

Experiments conducted in central Utah on a coarse-textured, calcareous soil low in K (68 ppm) and P (3.2 ppm) and with low K in the irrigation water (1.5-2.5 ppm) showed a favorable yield response to both P and K fertilizer applications. Yields were measured on three cuttings during 1989, 1990 and 1991. Fertilizer rates ranged from control levels to 458 lb/A P_2O_5 and 480 lb/A K_2O supplied as triple superphosphate (0-45-0) and potassium chloride (0-0-60). All nutrients were applied preplant and incorporated. The

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Table 1. Alfalfa yield increase with P and K with cultivars.

Variety	Treatment P_2O_5	Treatment K_2O	Year 1 Yield, tons/A	Year 1 Fertilizer Response, %	Year 2 Yield, tons/A	Year 2 Fertilizer Response, %	Year 3 Yield, tons/A	Year 3 Fertilizer Response, %	3-Year Summary Total tons/A	3-Year Summary Fertilizer Response, %
Fortress	0	0	5.5	—	6.2	—	5.0	—	16.7	—
	229	0	6.7	22.2	7.9	27.9	6.2	24.3	20.9	25.0
	229	480	7.3	31.8	8.1	31.1	6.6	31.6	21.9	31.5
DK125	0	0	5.2	—	5.7	—	3.9	—	14.9	—
	229	0	6.5	24.9	7.3	27.8	5.9	50.9	19.7	32.9
	229	480	7.1	36.3	7.9	39.1	6.3	61.7	21.4	44.1
WL316	0	0	4.7	—	6.0	—	4.7	—	15.4	—
	229	0	5.9	26.0	7.2	19.8	6.3	33.4	19.4	25.9
	229	480	6.2	31.5	7.7	28.2	6.3	33.2	20.2	30.7
P-5432	0	0	5.5	—	6.8	—	5.7	—	18.0	—
	229	0	6.7	20.9	7.7	13.8	6.8	18.2	21.1	17.4
	229	480	7.3	31.2	8.1	19.4	7.0	23.2	22.4	24.2
Vector	0	0	4.5	—	5.9	—	4.0	—	14.1	—
	229	0	6.3	38.6	7.7	37.7	6.1	51.2	20.0	41.8
	229	480	6.8	49.8	8.1	44.1	6.2	53.4	21.0	48.6

study involved five alfalfa varieties especially selected for regional environmental conditions. Yield data for three cuttings/year for three years are presented in **Table 1**.

Results

Production levels were increased by fertilization in all three years of the study, regardless of variety. The greatest percent increase over the control occurred when only P or P-K combinations were applied. Yield increases from P and K varied from year to year, but were significant each year. There was a positive response to K alone, but the yields were not nearly as high as when P was supplied. Apparently, alfalfa grown under the conditions of low P and low K needs to satisfy the P requirements prior to that for K. However, P and K in combination increased dry matter yields up to 11.2 percent over P alone for the three-year period.

Varietal Effects

The individual varieties did not respond similarly to P or K applications. Yields in the third year were increased 23.2 to 61.7 percent by P-K applications, depending on variety.

There was a much greater difference among variety yields that were not fertilized than when adequate P and K were provided. This would indicate that the selection for release of these varieties was based on soils which were not deficient in either P or K. Selection of a variety would be more critical for soils where P or K is expected to be limited. But when adequate P and K are provided, this study indicates little difference in variety performance.

Phosphorus and K applications affected tissue concentrations of P, K, and Na (**Table 2**). Whole plant samples were

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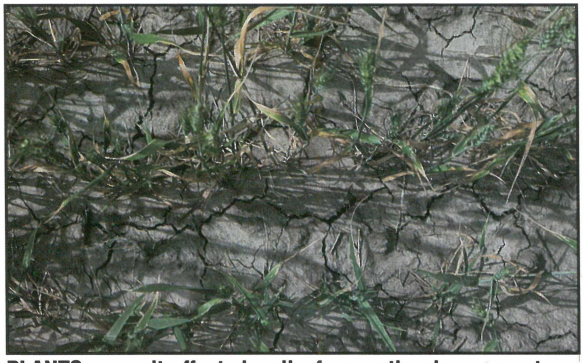
Table 2. Concentration of P, K, and Na in alfalfa tissue of the 1st and 3rd cutting, 1990.

Treatment P_2O_5	Treatment K_2O	Cutting 1st (% P)	Cutting 3rd (% P)	Cutting 1st (% K)	Cutting 3rd (% K)	Cutting 1st (% Na)	Cutting 3rd (% Na)
0	0	0.16	0.20	1.25	1.32	0.14	0.23
0	240	0.15	0.18	1.36	1.57	0.12	0.17
0	480	0.14	0.17	1.47	1.53	0.08	0.14
229	0	0.20	0.23	1.12	1.27	0.22	0.31
229	240	0.19	0.24	1.42	1.44	0.15	0.24
229	480	0.18	0.22	1.25	1.48	0.12	0.18
LSD 0.5		0.02	0.03	0.19	0.25	0.04	0.08

Phosphorus-enhanced salt tolerance in tomato has been demonstrated in Australia with higher than normal P levels required when tomatoes are grown in saline environments. Similar results have been reported for the salt sensitive crops, millet and clover.



PLANTS on salt-affected soils frequently show symptoms similar to those of P deficiency.

Progress has been made in our understanding of how P increases salt tolerance of crops. The observation that plant P uptake and concentrations are often reduced as salinity increases suggests that higher soil or fertilizer P levels may be needed to compensate. Plants with adequate P appear to have an enhanced ability to regulate ionic distribution among leaves of different age, causing reduced levels of sodium (Na) and chloride (Cl) in sensitive young tissues.

Summary

Growers with salt-affected soils should be aware of the importance of providing adequate P to their crops. Banding has been the most effective method of application. The potential exists for a need to adjust soil test P interpretation for saline soils. However, the magnitude of the adjustment, if any, has not been defined. Monitoring the P status of crops using plant analysis may help determine if current practices are sufficient. ■

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collected during the 1st and 3rd cutting of the second year. Phosphorus tissue concentrations ranged from 0.14 to 0.24 percent and related nicely to treatment effects. Phosphorus levels decreased with initial K application when plant P requirements were not being satisfied. When adequate levels of P and K were present in the soil system, P tissue level was 0.18 to 0.20 percent for the first cutting and 0.22 to 0.24 percent for the third cutting. These concentrations reflect critical P levels for whole plants and for the alfalfa varieties evaluated.

Tissue K levels ranged from 1.12 to 1.57 percent when only P or K was provided. When both P and K were at adequate levels, tissue concentrations for the first cutting ranged between 1.25 and 1.42 percent. Third cutting of alfalfa contained higher overall concentrations of both P and K.

Sodium uptake is noteworthy as it relates to K. There is a direct competition within the plant between K and Na. When soil K is high, Na in the tissue is low. The opposite occurs when soil K levels are deficient or low. An increase in tissue Na results in the marginal necrosis seen on some cultivars. This necrosis should be identified as a K deficiency symptom, although it is not always recognized as such.

Summary

In the final analysis, adequate supplies of P and K must be made available to all alfalfa varieties for top yields and top profits. Adequate plant nutrition is essential for efficient production, high water use efficiency, and production of a high quality crop. Although alfalfa varieties do differ in their abilities to cope with low P and K availability, adequate P and K fertilization is essential for all varieties in a profitable production operation. ■