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**WEST VIRGINIA UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
COLLEGE OF AGRICULTURE AND FORESTRY
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POTASSIUM FERTILIZATION STUDIES OF ALFALFA IN WEST VIRGINIA IN RELATION TO YIELD AND LONGEVITY OF ALFALFA STANDS (1955-1970)

R. F. Keefer

Alfalfa has more advantages than any other forage. Among these are high yields of high protein forage when managed properly, drought and heat tolerance, long-lived stands either alone or in mixtures with grasses, ability to recover quickly after cutting, adaptability to a wide variety of climatic conditions, ease of establishing a stand, palatability, no summer dormancy, high in calcium concentration, and rich in vitamins, especially vitamins A and D. In spite of the recent reduction in number of acres of alfalfa grown in West Virginia due to damage by the alfalfa weevil, this crop is still considered extremely important in livestock production. Control of the alfalfa weevil is under careful study and undoubtedly will be solved in a few years.

Several decades ago agronomists in West Virginia observed that the application of lime and phosphorus (P) fertilizer was the most important nutrient requirement for good stands and yields of alfalfa. Potassium (K) fertilization generally gave less response probably because yields were at lower levels than at the present and available soil K levels were at a high level. In this early work, fertilizer rates were considerably lower than those now used. Over a period of years, K reserves in soil were depleted. Recently, demonstration plots in West Virginia (1) showed that alfalfa yields harvested by farmers can be considerably increased by proper K fertilization. Total annual yield of alfalfa-grass on two farms was more than doubled, from 2 tons per acre (T/A) with no K to 4.2 and 4.7 T/A when K was applied at 200 lb K_2O/A . This K increased the yield by increasing the amount of alfalfa in the crop from 20 per cent to 89 per cent.

Average yields of alfalfa often are lower than desired and stands do not last long. Factors entering into stand longevity include genetic makeup of the plant, climate, soil conditions, crop management and nutrient availability. Proper management and other facets related to this have been reported recently by Jung *et al.* (27) for West Virginia conditions.

Numerous experiments have shown that successful alfalfa production depends on adequate supplies of K, either as available soil K or supplied as fertilizers. Alfalfa yields have been increased considerably at many locations (1,2,8,11,16,17,20,24,30,37,43,47) by application of K. Soils differ in their ability to supply K for adequate growth (3,4,16,22); hence, different rates of K have been reported as optimum for maximum production of alfalfa.

Annual alfalfa yields of 4 to 6 T/A were maintained for as long as five years in Minnesota (39) by annual topdressing with 120-240 lb K_2O/A ; however, initial benefits of a single high K application of 240 lb K_2O/A were gone by the third year. Marked alfalfa yield differences were also observed during the third year in Georgia (35) by application of K fertilizer at rates of 42 lb K/A for one variety and 167 lb K/A for another variety. Fertilized plots yielded an average of 4.5 T/A for the four-year period.

Alfalfa yields of 8-9 T/A/yr have been reported in the corn-belt (15,23). These have been from large field operations on "good corn soil" but did require very high soil fertility levels and large applications of K fertilizer of about 300 lb $K_2O/A/yr$. Intensive management and high soil fertility were required, such as five cuttings per year and the use of high-yielding Flemish varieties. These yields cannot be maintained for many years as these varieties are susceptible to bacterial and *Fusarium* wilt. The variety Saranac is now used extensively in the Northeast as it yields well and resists wilt.

Alfalfa can successfully compete with grasses in a mixture only when adequate K is provided (20). Blaser and Brady in New York (5) reported that when soil K was low, competition for, and hence uptake of, K was in the order: weeds>grasses>legumes. The cation exchange properties of the roots of these forage species have been used to explain this order of uptake (14). The absorptive ability of alfalfa for K is much less than that of grasses, hence large amounts of available K must be provided in order to insure adequate K uptake by the alfalfa.

Experiments in Rhode Island (41) have shown that in a legume-grass mixture, reduction in annually applied K from 100 to 50 lb K_2O/A lowered the proportion of legumes four years after seeding from 50 per cent to 3 per cent and yield from 3.1 to 1.6 T/A.

Analyses of alfalfa topgrowth for K have shown considerable variability from as low as 0.5 per cent (4,43) to as high as 4.5 per cent (22). When the percentage of K contained in the alfalfa crop was plotted against the logarithm of the number of pounds of exchangeable K/A in the soil on which the crop was grown, a linear relationship was observed (43). Likewise, data from Virginia (36) and Minnesota (24,39) showed that K content of alfalfa was affected by amount of K fertilizer applied.

Levels of K in the alfalfa crop necessary for optimum yield have been reported as 1.25 per cent (11,43), 1.42 to 1.84 per cent (17), 1.8 per cent (9), 1.75 to 2.00 per cent (30), and 2.2 per cent (34). The critical level has increased with time and at present probably levels above 2 per cent are required for high yields.

Fertilization with K has increased survival and persistence of alfalfa (2,6,11,17,20,21,27,43,47,49). Minimum levels of K in aerial alfalfa tissues for survival have been reported as 1.00 per cent (17), 0.9 to 1.1 per cent (47), 1.25 per cent (43), and 1.4 per cent (4). Jung and Smith (27) have shown that alfalfa plants have greater resistance to cold (freezing temperatures) when K is applied at 200 lb K/A and when K and P are kept at a 5:2 ratio than with lower rates of K or different K:P ratios. Potassium also has been found to be the most

important element in increasing longevity and yield of alfalfa in Maine (9) and New Jersey (32). This has been ascribed to the importance of K on the nutritional status of the alfalfa plant, particularly with respect to carbohydrate reserves (40).

Cutting management becomes less critical when alfalfa is adequately supplied with K (18,48); however, Smith in Wisconsin (44) warns that maintaining high fertility will not compensate for poor management.

Only limited data are available on time of K fertilization for maximum benefit. No difference was found between spring and fall application in Minnesota (37). However, Kresge and Younts reported (30) that the best time for application of K in Maryland was a split application ($\frac{1}{2}$ in spring and $\frac{1}{2}$ after first cutting), when compared to a single application, particularly when 83 lb of K/A was applied annually. When the K rate was increased from 83 lb to 165 or 331 lb K/A, no significant differences were observed in total alfalfa yield in pure stands, but there were differences when alfalfa was combined with orchardgrass. Maximum yields of the legume-grass mixture were obtained when K application was split between spring and after first cutting, or all applied in early spring or all applied after the first cutting. Brown and Stafford in Maine (9) reported no noticeable difference in yield of alfalfa from three locations when 200 lb K_2O/A was applied in a single annual topdressing in fall, or spring, or after the first cutting, or after the second cutting. They claimed the rate of K was more important than the time of application. No additional yield was obtained when 300 lb K_2O/A was applied in spring or as three split applications compared to 200 lb K_2O/A applied in early spring.

Data presented here will be a summary of K fertilization field experiments and demonstrations conducted with alfalfa in West Virginia from 1955 to 1970.

EXPERIMENT I

Procedures

Established stands of two varieties of alfalfa (Narragansett and Vernal) at the Agronomy Farm near Morgantown, W. Va., were divided into plots, and subjected to four K fertilization treatments, replicated four times, as follows:

Treatment No.	lb K O added/A/yr	
	1955	1956-1959
1	0	0
2	50	150
3	50 + 50	150 + 150
4	100	300

In treatment No. 3, the K was split between early spring and after first cutting. All plots were limed to pH 6.5 and received 100 lb P_2O_5/A in 1955 and 200 lb P_2O_5/A in 1956. The hay was harvested three times each year and total dry matter yield was calculated for each year.

Persistence of alfalfa was measured by counting the number of alfalfa plants in 2 sq. ft. on each plot in spring and fall of 1956 and by estimating the per cent of alfalfa in the plots in 1958.

RESULTS

Yield

Hay yields (12 per cent moisture) usually increased as the amount of applied K/A increased (Table 1). The Narragansett variety yielded about 0.2 T/A more than the Vernal variety over the five-year period; however, Vernal did yield better in the last year of the experiment indicating greater persistence. Application of more than 150 lb K_2O/A was usually not substantially beneficial.

Persistence

The number of alfalfa plants of both varieties in 1956 usually was related directly to the amount of K_2O/A applied (Table 2). More plants were found at the 300 lb K_2O/A level than at lower levels. No advantage was found for splitting the K application. Narragansett variety averaged more plants per plot than Vernal in 1956; however, persistence of alfalfa as measured by visual estimate of percentage of alfalfa in the plots by 1958 was greater for the Vernal variety. The rate of 150 lb K_2O/A again was just as desirable as the higher 300 lb A rate.

Table 1. Total yield of alfalfa hay for two varieties for five years in relation to amount of fertilizer K applied (Experiment I).

NARRAGANSETT

Treatment*		Total dry-matter yield (T/A)					5-yr. mean
No.	lb $K_2O/A/yr.$	1955	1956	1957	1958	1959	
1	0	3.54**	4.02	2.32	2.85	0.85	2.72
2	150	3.56	4.65	3.56	4.01	2.02	3.56
3	150 + 150	3.52	4.31	3.56	3.87	2.31	3.51
4	300	3.65	4.58	3.80	4.20	2.26	3.70

VERNAL

Treatment*		Total dry-matter yield (T/A)					5-yr. mean
No.	lb $K_2O/A/yr.$	1955	1956	1957	1958	1959	
1	0	3.11	3.47	2.15	3.02	1.08	2.57
2	150	3.00	3.91	3.13	3.96	2.36	3.27
2	150 + 150	3.22	3.98	3.56	3.99	2.80	3.51
4	300	3.38	4.13	3.45	4.07	2.55	3.52

* All plots received 100 lb P_2O_5/A in 1955 and 200 lb P_2O_5/A in 1956. In 1955, treatments No. 2, 3, and 4 received only 50, 50 + 50, and 100 lb K_2O/A , respectively.

** Mean of four replications from Agronomy Farm, Morgantown.

Table 2. Persistence of alfalfa as measured by stand counts and per cent of alfalfa in plots in relation to amount of fertilizer K applied (Experiment I).

NARRAGANSETT

Treatments*		Stand counts 1956			% alfalfa in plots—1958
No.	lb K ₂ O/A/yr.	Spring	Fall	mean	
1	0	9.8 **	8.5	9.2	33
2	150	11.8	8.8	10.3	52
3	150 + 150	10.8	11.0	10.9	43
4	300	11.5	10.8	11.2	51

VERNAL

Treatments*		Stand counts 1956			% alfalfa in plots—1958
No.	lb K ₂ O/A/yr.	Spring	Fall	mean	
1	0	7.2	6.2	6.7	53
2	150	8.5	9.0	8.8	74
3	150 + 150	9.2	9.5	9.4	65
4	300	10.5	9.5	10.0	71

*All plots received 100 lb P₂O₅/A in 1955 and 200 lb P₂O₅/A in 1956. In 1955, treatments No. 2, 3, and 4 received only 50, 50 + 50, and 100 lb K₂O/A, respectively.

**Mean of four replications from Agronomy Farm, Morgantown.

EXPERIMENT II

Procedures

Demonstration trials were established in ten West Virginia counties in 1959. Available K in the soil was determined initially by soil test and the farms were grouped into low, medium, or high. On each farm a 1/10 acre well-drained area was selected with uniform slope, fertility, soil type, and alfalfa stand, with a pH of 6.5 or higher. Alfalfa had been seeded by the farmer in 1957 or 1958. Four plots (1/40 A) were laid out on each farm. Plot 1 was the check plot. Plot 2 received 500 lb /A/yr of 0-20-0. Plot 3 received 500 lb /A/yr of 0-20-20. Plot 4 received 500 lb /A/yr of 0-20-40. All fertilizer was applied after the first cutting of alfalfa. Alfalfa weevil was controlled by granular heptachlor at the recommended rates, which was prior to its being removed from use. Alfalfa plants were counted in a 3-sq. ft. area at three locations randomly selected in each plot in 1961 and 1962 and the mean value was calculated.

In the spring of 1963, soil samples from some of the demonstration plots were analyzed for pH, lime requirement, P and K. First-cutting hay was harvested and yields were calculated. Percentage of alfalfa in the stand was

estimated visually and alfalfa yield in T/A was calculated. The data were analyzed statistically using each farm as a replication.

RESULTS

Persistence

Initial available soil K for the demonstration trials in ten West Virginia counties showed 9, 17, and 8 farms in the low, medium, and high available soil K categories, respectively (Table 3). In 1961, density of alfalfa stand and initial level of soil K for each level of K applied seemed to be related. However, by 1962, i.e. during the fourth or fifth year, stand counts were considerably lower on farms where available soil K was initially low or medium. Stand counts were higher on the farms where the initial available soil K was high. Application of 100 and 200 lb K_2O/A to the plots that were initially low or medium in available soil K helped to maintain a greater number of alfalfa plants per plot. By 1962, application of 200 lb K_2O/A was even beneficial on the farms initially high in available soil K.

Percentage of alfalfa found in the stands likewise increased (Table 4) as the amount of K applied increased. P was also beneficial in maintaining the amount of alfalfa in the stands.

These results demonstrate that alfalfa requires high levels of soil K to be persistent.

Table 3. Density of alfalfa plants in relation to initial amount of available soil K and applied K (Experiment II).

Available K in soil initially	No. of samples	Number of alfalfa plants per 3 sq. ft.					
		1961			1962		
		lb K_2O/A			lb K_2O/A		
		0	100	200	0	100	200
Demonstration trials in ten West Virginia counties							
Low	9	10.0	11.3	13.2	8.5	10.0	11.4
Medium	17	11.4	12.8	13.8	7.8	9.3	10.6
High	8	17.1	16.6	16.8	13.2	13.0	15.1

Available Soil K

The amount of available soil K significantly increased as K was added from 0 to 100 to 200 lb K_2O/A on the 14 West Virginia farms (Table 4).

Yield

First-cutting hay yield increased significantly (Table 4) as the amount of K added increased. Application of P gave significantly greater yield than the check which received only lime.

Table 4. Persistence estimates and first-cutting alfalfa hay yields from 14 West Virginia farms in 1963 in relation to available soil K levels and K fertilization (Experiment II).

Treatment	Available soil K* (lb K ₂ O/A)	Alfalfa (%)	First cutting hay yield (dry wt. T/A)
Lime only	83** c	45 d	0.97 d
Lime + 100 lb P ₂ O ₅ /A	98 c	58 c	1.21 c
Lime + 100 lb P ₂ O ₅ /A + 100 lb K ₂ O/A	149 b	75 b	1.42 b
Lime + 100 lb P ₂ O ₅ /A + 200 lb K ₂ O/A	207 a	85 a	1.61 a

*Sampled in spring of 1963 before fertilization.

**Means which are significantly different by Duncan's new multiple range test are followed by a different letter. Comparisons can be made only within a single column.

EXPERIMENT III

Procedures

Vernal alfalfa was established in 1961 at Point Pleasant on a Wheeling sandy loam soil, at Wardensville on a Litz shaly silt loam soil, and in 1962 at Morgantown on a Wharton silt loam soil. Prior to seeding, the areas were limed to a pH of 6.5 with ground agricultural lime as required by soil test and fertilized with 500 lb /A of 0-20-20 fertilizer. Each area was subdivided into three blocks with all treatments in each block on separate plots 9' x 15'. In each replication, time of application was the main plot and rates of application were used as sub-plots, both randomly assigned. Soil was tested annually in the early spring and K fertilizer was added as KCl (60 per cent K₂O) every year to maintain available soil K at 200, 300, and 400 lb K₂O/A.

Time of application of K to the plots was as follows:

1. All in early spring
2. All after first cutting
3. All after second cutting
4. All in late fall
5. Split—½ in early spring, ½ after second cutting
6. Split—½ after first cutting, ½ in late fall

The crop was harvested at early to mid-bloom stage and total plot yield was recorded. A subsample was dried to determine moisture content and used to calculate dry-matter yield on an acre basis. The sample was ground and a 0.5 g sub sample was dry ashed 6 hours at 475° C and suspended in 0.3 N HNO₃. K

and Mg contents were determined by flame emission on a Beckman DU spectrophotometer using wavelengths of 404.6 m μ and 383 m μ , respectively. Ca was also determined by flame emission at a wavelength of 422.7 m μ after addition of LaCl₃. Lanthanum was used to suppress interference from other ions. P content was determined using the molybdivanadophosphoric procedure (29). Percentage of alfalfa on each plot was estimated visually prior to each cutting in 1965. The experiment was terminated in 1966 due to severe weevil damage.

RESULTS

Yield

Prior to 1964, yields from the various treatments in this experiment were not significantly different and are not reported. Various treatments at Wardensville yielded no significant differences throughout the duration of the experiment, probably due to the very low rainfall received at that location during these years.

Maintenance of soil K at the 300 and 400 lb K₂O/A level significantly increased both total yield and yield of alfalfa at Pt. Pleasant in 1964 (Figure 1) and in 1965 (Figure 2) and at Morgantown in 1965 (Figure 3). Very little additional yield was obtained at Morgantown in the second and third cuttings probably due to the lower percentage of alfalfa in the stand compared to Pt. Pleasant.

Early spring application of K produced more total yield at both locations over all years and treatments (Figure 4). When K was applied as a split application at Morgantown, yields were lower compared to all other single application times. The reason for this is not apparent. This is contrary to results of split application of K on alfalfa by Kresge and Younts (30). Their maximum yield occurred when K was split between early spring and after the first cutting.

As the soil K level increased at Pt. Pleasant, the optimum time of application changed (Figure 5). At 200 lb K₂O in the soil, highest yield resulted from the early spring application of K and late fall yielded least. On the other hand, when the amount of K₂O was maintained at 300 or 400 lb/A in the soil, late fall was equal to or better than early spring application. The other application times, i.e. summer application or split treatments, gave lower yields when K was well supplied. The level of K in the soil was of less importance at Morgantown. Early spring application of K gave the best yield and the late fall and split applications were poorest.

K Removed in the Crop

The amount of K (lb/A/yr) removed in the crops increased progressively from the 200 to 300 to 400 lb/A levels of K₂O in the soil (Figures 1, 2, and 3). This was related to the amount of alfalfa present. For example, at Pt. Pleasant, where most of the second and third crop was alfalfa (Figure 2), large amounts of K were removed in the crop, but at Morgantown, where the per cent of alfalfa in the crop was not very high, especially for the second and third cuts (Figure 3), the amount of K removed in the crop was much less.

Figure 1. Effect of total available K_2O/A in soil on total dry-matter yield, amount of K removed from soil, and per cent K in hay at Pt. Pleasant (1964).

Figure 2. Effect of total available K_2O/A in soil on total dry-matter yield, yield of alfalfa, per cent alfalfa in stand, and amount of K removed from soil at Pt. Pleasant (1965).

Figure 3. Effect of total available K_2O/A in soil on total dry-matter yield, yield of alfalfa, per cent of alfalfa in stand, and amount of K removed from soil at Morgantown (1965).

Figure 4. Average dry-matter hay yield in relation to time of application of K at Morgantown and Pt. Pleasant.

Figure 5. Total dry-matter yield at each rate of K application as time of K application varied at Pt. Pleasant (1965).

The two higher levels of soil K gave significantly higher percentages of K in the forage than the lowest level at Pt. Pleasant, for all cuttings in 1964 (Figure 1). However, most of these percentages are below or on the borderline of the 2.0 per cent K value the most recent source has indicated as being necessary for optimum yield of alfalfa (34).

The amount of K removed in the forage was well correlated with total dry-matter yield, especially at Pt. Pleasant ($r = 0.94$) and less so at Morgantown ($r = 0.77$) (Figure 6).

The percentage of K in the hay from the first and second cuttings was correlated positively with yield of the first cutting (Table 5), but correlated negatively with the second and third cuttings, i.e. a higher amount of K absorbed by the plants initially, resulted in less yield later in the season. This is probably related to the ability of the indigenous grasses to compete with the alfalfa for K. Furthermore, the percentage of K in the third cutting was not related to yield nor per cent of alfalfa present (Table 5).

Persistence

The level of available soil K was influential in determining percentage of alfalfa during the first cutting at Pt. Pleasant in 1965 (Figure 2). The two higher K levels gave significantly more alfalfa than the lower K level. There was no significant difference in the percentage of alfalfa in the stand during the second and third cuttings due to level of K in the soil (Figure 2). Similar results were observed at Morgantown in 1965, but all were at a lower level of alfalfa percentage (Figure 3).

Table 5. Correlation coefficients relating yield and percentage of alfalfa in stand for each cutting with percentages of potassium and phosphorus in each cutting (Experiment III).

	% K1	% K2	% K3	% P1	% P2	% P3
Yield 1	.777*	.676*	.281	.481*	.496*	-.753*
% Alfalfa 1	.350	.410	.390	.061	-.133	-.203
Yield 2	-.592*	-.596*	.059	-.658*	.568*	.819*
% Alfalfa 2	-.164	-.130	.189	-.445*	*.319	.378
Yield 3	-.564*	-.564*	.112	-.662*	.563*	.801*
% Alfalfa 3	-.368	-.328	.168	-.462*	.409	.533*

Data are mean values for both locations, at all three rates, at all times of K application.

*Significant at 0.05 level.

Figure 6. Average dry-matter yield of alfalfa hay in relation to amount of K removed in the crop at Morgantown and Pt. Pleasant.

At Pt. Pleasant, there was little reduction in percentage of alfalfa present regardless of time K was applied (Figure 7). There was some benefit by splitting the K between late fall and after the first cut (Treatment No. 6) on this sandy loam soil. Quite a contrast is seen in the data from Morgantown (Figure 8). Application of K in the late fall (Treatment No. 4) or splitting the application at two times (Treatments No. 5 and 6) resulted in considerably lower percentage of alfalfa in the stand. Apparently this heavier Wharton silty clay loam soil fixed additional K more easily (26) than the more sandy Wheeling silt loam, especially when K was applied in the late fall of the year when growth slows down. Highest alfalfa percentage resulted from Treatments 1, 2, or 3 when K was applied during the early spring or during the actively growing period of alfalfa in the summer.

The percentage of alfalfa in the stands was not significantly correlated to per cent K in the crop (Table 5).

Figure 7. Percentage of alfalfa in stand in each of three cuttings as time of K application varied at Pt. Pleasant (1965).

Figure 8. Percentage of alfalfa in stand in each of three cuttings as time of K application varied at Morgantown (1965).

P, Ca, Mg Found in the Hay Crop

The percentage of P found in each cutting was positively correlated with yield of that cutting. The large negative correlation coefficients in the per cent P in the first cutting (per cent P1) associated with the yield and per cent alfalfa of the second and third cuttings (Table 5, column 4) indicate that large early uptake of P by the crop may be detrimental to later yield of hay and percentage of alfalfa.

Percentages of Ca and Mg in the plant tissue were not consistently correlated with any parameter.

EXPERIMENT IV

Procedures

An alfalfa-bromegrass stand was established at the Reedsville Experiment farm on a Rayne silt loam soil in 1967. Analysis of a composite soil sample of the 51' x 108' site showed a pH of 5.5, a 3.0 T/A lime requirement, 81 lb P_2O_5 /A (medium), and 157 lb K_2O /A (high). A uniform application of 3 T/A of ground agricultural limestone was applied. Eighteen plots 6' x 15' were laid out with a 3' border strip separating the three replications. The fertilizer treatments were randomly assigned to the plots within each replication and applied annually in the spring each year as follows:

Treatment		lb/A/yr	
No.	N	P ₂ O ₅	K ₂ O
A	0	0	0
B	0	45	45
C	0	90	90
D	0	135	135
E	0	180	180
F	0	90	0
G	0	180	0
H	0	0	90
I	0	0	180
J	25	90	90
K	12	45	45
L	50	180	180
M	0	90	90 + 30 lb Borax (10.6 % boron)
N	0	90	90 + 60 lb Borax
O	25	90	90 + 30 lb Borax
P	25	90	90 + 60 lb Borax
Q	0	180	180 + 30 lb Borax
R	0	180	180 + 60 lb Borax

N was applied as NH_4NO_3 ; P as 20 per cent superphosphate; K as KCl; and boron as borax. A 3' strip was harvested from the middle of each plot when the alfalfa was in early bloom stage. Three cuts were made annually and dry-matter production per acre was calculated. Fertilizer was applied at the same rate annually in the early spring, except a soil test for boron after the first year showed very high boron levels so the boron fertilization was discontinued. Soil was tested from the individual plots annually in the spring.

RESULTS

Yield

No significant yield differences were observed on the alfalfa-bromegrass hay harvested from the Reedsville farm for the first two years of the experiment. This may be ascribed to the initial high fertility level of the field. By the third year, dry-matter yield differences were observed (Table 6). The general ranking as to yield shows that K was the most beneficial nutrient of the three used (N, P, and K) to maintain top yields. Those plots receiving 180 lb K₂O/A ranked highest in yield, followed by those receiving 135, then 90, 45, and finally the lowest yields were observed on the plots not receiving K; however, those plots receiving more than 90 lb K₂O/A/yr were not different statistically. Yields from plots receiving N and P were not consistent. Results seem to show no response to K when applied above 90 lb K₂O/A/yr during the three-year period.

Table 6. Total alfalfa-bromegrass hay yield at Reedsville during the third year (1970) in relation to annual N, P, and K fertilization (Experiment IV).

Fertilizer applied (lb/A/yr)			Dry matter yield (T/A)
N	P ₂ O ₅	K ₂ O	
50	180	180	3.28* a
0	0	180	3.16 ab
0	180	180	3.11 ab
0	135	135	3.11 ab
0	90	90	3.04 ab
25	90	90	2.89 abc
0	0	90	2.88 abc
0	45	45	2.89 abc
12	45	45	2.77 bcd
0	90	0	2.55 cde
0	0	0	2.38 de
0	180	0	2.33 e

*Means significantly different by Duncan's new multiple range test are followed by a different letter.

SUMMARY AND CONCLUSIONS

Yield

Experiments reported here under a wide variety of environmental conditions in West Virginia indicate that application of K, at least up to 150 and often up to 300 lb K₂O/A/yr, is beneficial in increasing yields of alfalfa in most cases. No additional yield advantage was realized by maintaining available soil K above 300 lb K₂O/A. Other nutrients must be adequately supplied to make efficient use of the K applied. Proper management is also necessary for maximum economic yields as indicated by Jung in a recent bulletin (28).

Persistence

Alfalfa stands were usually maintained by annual application of at least 150 lb K₂O/A or maintaining available soil K at 300 lb K₂O/A. Those fields receiving less than 150 lb K₂O/A had fewer alfalfa plants surviving. Although of lesser importance than amount of K applied, as also reported by workers in Maine (9), time of K application may influence persistence depending on location. Probably soils, climate, and other environmental factors play a role in timing of K application. Early K application, i.e. especially in early spring, or sometimes after the first or second cutting, is usually helpful in maintaining a satisfactory proportion of alfalfa in the stands. Splitting the K application may or may not be beneficial. This agrees with results reported by others in Maryland (30).

K in the Hay Crop

These West Virginia experiments indicate that alfalfa hay usually removes about 35 to 40 lb K/T. Thus, a yield of 4 tons of hay/A removes about 160 lb of actual K or 192 lb of K_2O/A . Therefore, in order to supply enough K for a satisfactory hay yield, a minimum of 200 lb K_2O/A should be applied annually to an alfalfa hay crop. Of course, a wise farmer would choose to fertilize somewhat above this level until his fields were registering high in fertilizer nutrients according to soil tests.

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