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Yields and Soil Test Values Resulting From Topdressing Forage Crops

Summary of Southeast Missouri Tests, 1961 to 1970

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INTRODUCTION

The highly weathered residual soils of Southwest Missouri are suited for grass production but are naturally low in fertility and have low available water storage capacities. Erratic rainfall distribution, coupled with the low available water storage capacities, produces drouth conditions at times during nearly every growing season.

Decker (3) (4) reported that dry periods of two weeks or more can be expected during the last half of June and all of July and August and that 25 percent of the time the monthly precipitation from June through August will be 1.75 inches or less. Meyers (10) reported that it was the low soil moisture that limited alfalfa hay yields to about 3.5 tons per acre, rather than shortage of soil phosphorus when the soil test value was 128 pounds P_2O_5 per acre or higher. Because low soil moisture is one of the major limiting elements in forage production, it was thought that annual surface applications would produce the maximum yield possible each season. This practice would probably cost less than applying full treatment to the entire plow layer to bring it up to levels recommended for new seedings of forage crops. (1)

An analysis of forage production as related to climatic and soil areas in Missouri was outlined by Kroth *et al.* (7).

PURPOSE AND DESIGN OF EXPERIMENTS

Topdressing was evaluated as a method for applying nutrients (1) to stands of forage crops established according to recommended methods, and (2) to new stands not receiving the plowdown treatments indicated by soil tests. Changes in soil nutrient levels at various depths in the plowlayer after several years of topdressed applications of P_2O_5 and K_2O were used to evaluate treatments. Yield changes were also compared.

Most of the studies reported here were conducted at the Southwest Missouri Center, Mount Vernon, on two common soil types of Southwest Missouri, the Baxter and Gerald silt loams. Studies were also established on Baxter silt loam on leased land near Purdy, Mo. Fragipans were found at about 28" in the soils originally classified in the Baxter Series and were therefore not true Baxter soils. However, the Baxter series name is used in this report, meaning "Baxter-like." These soils are classified as Typic Fragiudalfs, fine, mixed, messic. The Gerald soil with a clay pan is an Umbric Fragiudalf, fine, mixed messic. The cation exchange capacities of the individual surface soils in the study ranged from 7 to 11 me/100 grams.

The available water storage capacities to a depth of 28 inches according to Kroth *et al.* (7), were 4 and 6 inches in the Baxter and Gerald soils, respectively. Observations indicated the available water storage capacities of the actual Baxter sites would have been less than these estimates due to considerable chert in the plow layer. Rainfall data at the Southwest Missouri Center during the studies are given in Table 1. Soil testing procedures outlined by Fisher (5) were used on all soil samples.

Plot size was 50 feet by 10 feet, trimmed to 40 feet in length at harvest. Plots were harvested with a modified five-foot flail type forage harvester. The green material was caught in a large burlap bag and weighed. A sample for moisture determination was taken from each bag and yields were calculated and reported in tons of hay, 15 percent moisture. Data from each study were subjected to analysis of variance and the significant differences among the treatments were evaluated by Duncan's New Multiple Range Test. Yields followed by the same letter in an individual table are not significantly different. The list of treatments for each study is given in a table.

CONCLUSIONS

1. Topdressing alfalfa-grass mixtures with nitrogen did not increase total yields of hay but did increase the percentage of grass and the yield of the first cutting. (Studies I, III.)
2. Thirty pounds of nitrogen per acre topdressed in March to fescue-lespedeza increased spring growth of fescue and did not reduce the stand of lespedeza providing the fescue was removed when in the boot stage. Sixty pounds of nitrogen per acre increased spring growth but extensively reduced the stand of lespedeza. Forty pounds of nitrogen per acre was indicated as a suitable rate if the spring growth was removed in or before the boot stage. (Studies I, IV.)
3. Alfalfa-grass mixtures established by recommended methods extracted P and K to low levels in the lower portion of the plow layer. Annual topdressings of P_2O_5 and K_2O (0+30+150) adequately supplemented these nutrients so that optimum yields were maintained. (Study I.)
4. The fiberous nature of the alfalfa and grass roots in the upper portion of the plow layer absorbed sufficient nutrients to produce optimum growth under the soil moisture conditions of these studies. (Studies I, III.)

5. Fescue-lespedeza stands established by recommended methods extracted P and K from the plow layer in the same pattern as the alfalfa-grass mixtures. The half treatment yields were optimum due to the topdressing of P_2O_5 and K_2O. (Study I.)
6. Orchardgrass-alfalfa and fescue-lespedeza mixtures established with starter fertilizers on limed but otherwise unfertilized seed beds produced optimum yields with annual topdressed applications of P_2O_5 and K_2O. Orchardgrass-alfalfa responded best to 0+50+150 and fescue-lespedeza to 30+25+100. Terminal soil test values for P_2O_5 and exchangeable K within the plow layer of these soils were high in the surface inches but relatively low in the lower three or four inches. (Studies II, III, IV.)
7. Average soil test values of the plow layers did not reflect the high P_2O_5 and exchangeable K values in the surface inch under grass-legume mixtures which had received topdressed applications of P_2O_5 and K_2O. (Studies II, III, IV.)
8. A pHs of 5.5 when compared with a pHs of 6.5 appeared to increase the availability of P to grass-legume mixtures. The relationship between top-dressed nitrogen, limestone, and phosphorus carriers needs more clarification. (Studies II, III, IV.)
9. A pure stand of alfalfa, established by recommended methods, extracted P and K from the plow layer by the same pattern as the alfalfa-grass mixtures. Maintenance applications resulted in high P_2O_5 and exchangeable K values in the surface one or two inches. (Study V.)
10. Three tons per acre of limestone was as good as 6 tons per acre when applied in the surface 3 to 4 inches of a fescue-lespedeza pasture establishment study when the original pHs was 4.1. (Study VI.)
11. Under the conditions of these studies—low available water storage capacities and 10 me. cation exchange capacities—an annual topdressing of 0+40+140 would be expected to supply adequate P and K to produce optimum yields of grass-legume mixtures resulting in average soil test values in the plowlayer of 80 to 100 pounds per acre of $P_2O_5(P_2)$ and 180-200 pounds per acre exchangeable K.
12. Sampling the 0 to 3 inch depth in addition to the 0 to 7 inch layer when evaluating the fertility needs of pastures seems desirable. More detailed research is needed to quantify the P_2O_5 and exchangeable K levels in the 0 to 3 inch depth necessary to produce optimum forage yields. (Studies II, III, IV)

Study I

TOPDRESSING GRASS-LEGUME MIXTURES WITH NITROGEN

Procedure

The objective of this study was to evaluate the effect of nitrogen on yields of grass-legume mixtures and to determine the distribution of P and exchangeable K in the plowlayer at the end of the study. The study was carried out on Baxter silt loam near Purdy, Mo. Rainfall data at this location were incomplete but they indicated the same general amounts and distribution for the period as recorded at Mount Vernon (Table 1).

Table 1--Preciptation Southwest Missouri Center 1967-1971

	Preciptation in Inches						
Months	1966	1967	1968	1969	1970	1971	Avg.
January	1.56	1.13	3.53	3.30	.17	1.54	1.87
February	4.04	1.01	1.59	.86	.84	1.65	1.67
March	2.69	1.51	4.59	3.31	3.86	1.23	2.87
April	4.12	4.88	2.38	1.90	4.81	2.79	3.48
May	3.14	4.75	6.31	1.62	3.95	2.94	3.79
June	1.47	7.74	4.12	5.68	5.23	5.26	4.95
July	4.56	3.17	2.00	1.66	.13	5.41	2.82
August	5.87	2.23	6.05	1.82	1.17	1.79	3.24
September	2.03	1.42	3.60	3.31	9.79	7.10	4.54
October	1.14	10.92	3.13	5.38	6.04	3.21	4.97
November	2.60	1.14	8.22	.89	1.78	2.21	2.85
December	2.09	2.93	2.81	1.26	2.11	5.47	2.78
Total	35.31	43.10	48.33	30.95	40.44	40.60	39.83
Departure from long term mean	-5.77	2.02	7.21	-10.07	-.58	-.48	-1.19

Nutrients, other than nitrogen, were brought up to recommended levels (full treatment) in plots of the alfalfa-grass mixtures and one set of the fescue-lespedeza plots with one ton of dolomitic limestone, 500 pounds of P_2O_5 as triple superphosphate, and 200 pounds of K_2O as muriate of potash per acre. One set of fescue-lespedeza plots (half treatment) received no limestone, 250 pounds of P_2O_5 and 100 pounds of K_2O per acre. The limestone, superphosphate, and muriate of potash were thoroughly mixed through the plowlayer. Seedings made in the spring of 1965, with 40+20+20[1] starter fertilizer broadcast, failed due to dry weather. A successful seeding was made in the fall of 1965, with a broadcasting of 24+24+24, as starter fertilizer. Vernal alfalfa, Summit lespedeza, Southern bromegrass, Potomac orchardgrass and Kentucky 31 fescue were used at recommended rates for the seedings. To further insure adequate P and K, all plots were topdressed annually with 0+30+75 in March and 0+0+75 after the first cutting.

Nitrogen treatments were 0, 30, 60, and 90 pounds of nitrogen per acre as ammonium nitrate, applied to all mixtures annually in March in a randomized

[1]All references this type indicate $N+P_2O_5+K_2O$ in lbs per acre.

block design with four replications. Alfalfa-grass mixtures were harvested when the alfalfa was at 1/10 bloom. These mixtures were harvested three times in 1966 and four times the remaining four years of the study.

The three 1966 harvests are not included in this report; total yields were about the same as reported for the last four years.

The fescue-lespedeza plots were harvested when the fescue was in the boot stage with alternate rows of flails of the harvester replaced with shorter ones to simulate grazing. This technique did not completely defoliate the lespedeza, permitting it to set seed each year. Yields of this mixture are reported as two cuttings (before and after July 1), even though in some years two harvests were made before July 1. In the latter case the two yields were summed and reported as one cutting.

At the end of the studies (October 1970) a block of soil six inches by 18 inches was removed from an orchardgrass-alfalfa plot and the soil was carefully washed away to observe the rooting systems and quantity of chert. The soil of each plot was also sampled by one inch depths to a depth of seven inches. Eight cores were taken from each plot and each depth was composited from all four replications into a single composite sample for each treatment. The average of the soil test values of the seven depths should be equal to the values obtained by conventionally sampling the plowlayer.

In the case of phosphorus, this value should be comparable to the P_2O_5 test value used when interpreting soil tests in Missouri (2). Phosphorus was determined by Bray's P_1 and P_2 extractants, K by ammonium acetate extraction and soil pHs was measured in 1:1 soil: 0.01 M $CaCl_2$ suspension. Samples of alfalfa, orchardgrass, and fescue growing on the plots at the time the soil was sampled were taken for P and K determinations.

Results and Discussion

Hay Yields: Grass-Alfalfa Mixtures

Average total yields and yields for each cutting with its percentages of the total yield for each treatment are given in Table 2. The four cutting dates for the alfalfa mixtures varied between years due to rainfall distribution but cuttings 1, 2, 3, and 4 occurred in May, June, July, and September, respectively. The data show that for the grass-alfalfa mixtures there was no significant difference in total yield among nitrogen treatments. Nitrogen did increase the first cutting yields of these mixtures but the reduced third and fourth cutting yields for orchardgrass-alfalfa offset the benefit of the added nitrogen. In the case of bromegrass-alfalfa the yield reduction occurred in the second and third cuttings. Bromegrass tended to thin out so that by the end of the study only about one-fourth of the original quantity remained, which accounts for the overall lower average yield of the bromegrass-alfalfa mixture.

Table 2--Effect of Topdressed Nitrogen on Yields of Grass-Legume Mixtures
Baxter Silt Loam-Purdy, Mo. (1966-1970)
Yields Tons Hay/Acre

Nitrogen* Lbs./Acre	Total	1st cut	% Total	2nd cut	% Total	3rd cut	% Total	4th cut	% Total
Orchardgrass-Alfalfa (4-year means)									
0	4.66a	1.75	37.6	1.13	24.2	1.08	23.1	0.70	15.1
30	4.75a	1.98	41.7	1.10	23.2	1.06	21.4	0.65	13.7
60	4.81a	2.02	41.9	1.18	24.6	0.97	20.1	0.65	13.5
90	4.63a	1.96	42.4	1.11	24.0	0.95	20.5	0.61	13.1
Bromegrass-Alfalfa (4-year means)									
0	4.33a	1.45	33.5	1.03	23.8	1.08	25.0	0.77	17.7
30	4.23a	1.58	37.5	0.93	21.9	0.97	22.9	0.75	17.7
60	4.27a	1.62	37.9	0.96	22.6	0.97	22.6	0.72	16.9
90	4.21a	1.68	39.9	0.91	21.6	0.88	21.0	0.74	17.6
Fescue-Lespedeza (Full Treatment) (5-year means)									
0	1.49b	0.75	52.4	0.74	47.6				
30	1.53b	1.01	66.7	0.52	33.3				
60	1.57b	1.18	75.5	0.39	24.5				
90	1.95a	1.60	82.2	0.35	17.8				
Fescue-Lespedeza (Onehalf Full Treatment) (5-year means)									
0	1.59d	0.81	51.8	0.78	48.2				
30	1.71c	1.12	64.9	0.59	35.1				
60	1.88b	1.39	74.0	0.49	26.0				
90	2.23a	1.75	79.1	0.47	20.9				

* All plots topdressed annually with 0+30+75 in March and 0+0+75 after first cutting
Full treatment--dolomitic limestone, superphosphate and muriate of potash as required by soil test recommendations.
Values followed by the same letter are not significantly different--Duncan's Multiple Range Test.

Hay Yields: Fescue-Lespedeza Mixtures

The results for the full treatment fescue-lespedeza plots show the 30 and 60 pound N rates did not significantly increase total yields over the zero N plots (Table 2). The first cutting yields increased with the increased N rates but the increased yield of grass in the first cutting was offset by the reduced yield of the second cutting due to reduction of lespedeza in the stand. The 90 pound N rate increased the total yield over the zero N rate due to the considerably higher first cutting, but second cutting yield was similar to that of the 60 pound rate. Lespedeza was virtually absent in the stands on the plots getting the 60 and 90 pound N applications.

All total yields of the half treatment plots were slightly higher (.2 T/A) than those of the full treatment plots, apparently because they were nearly level and retained more rainfall than the full treatment plots. Total yields on the half treatment plots increased significantly with increasing rates of N. The plots receiving the 60 and 90 pounds of N had very little lespedeza in the stands and the fescue produced only about .5 ton of hay after July 1 due to lack of available N.

The amount and distribution of rainfall after July 1 influenced the growth of lespedeza on the zero and 30 pound N plots. The highest second cutting yield was 1.4 tons in 1967 on the zero N plots of both fescue-lespedeza studies due to a favorable rainfall distribution (Table 1). For the entire study the average second cutting yields for the first two N treatments of both sets of plots was 0.66 ton per acre compared with 0.43 ton per acre for the third and fourth N treatments. The quality of the forage from the second cuttings of the first two N treatments would be considerably higher due to the lespedeza in the stand.

The results indicate an application of 30 to 40 pounds of N could be topdressed in March on fescue-lespedeza pastures without injuring the stand of lespedeza, provided the first growth of fescue was grazed off in time to allow seedling lespedeza to get established.

Soil Test Values

Three sets of the plots were brought up to desired nutrient levels by thoroughly mixing the recommended amounts of lime, superphosphate, and muriate of potash through the plowed layer at the beginning of the study. One set of plots was brought up to half soil treatment. Each plot received 0+30+150, topdressed annually.

The soil test values of the plow layer for the experimental area and the distribution of P and K at one inch increments in the plow layer at the end of the study are given in Table 3. The values of all initial soil tests and the complete results of the final samplings are given in Appendix Tables I, II, III, and IV.

Grass-Alfalfa Mixtures

The results of Bray's P_2 (Bray's P_1 determinations were not made on the initial samples) phosphate test on the final samples of both groups of grass-alfalfa plots show an interesting distribution of phosphorus in the plow layer, Table 3. After the soil was brought to recommended nutrient levels, the grass and alfalfa plants extracted phosphorus to its initial values at the third depth and below. All of the phosphorus applied prior to seeding was removed from the lower five depths. The first depth had a higher level due to the annual application of phosphorus.

Potassium was extracted to its initial value in the second depth of both grass-alfalfa mixtures and considerably below the initial value in the lower depths. Potassium accumulated in the first depth due to the annual applications of potassium. A greater amount of K was removed by the orchardgrass-alfalfa mixture than by the bromegrass-alfalfa mixture because of the greater quantity of orchardgrass in the first cutting.

The pattern of nutrient withdrawal similar to that shown in Table 3 was found in results of other studies given in this report. Evidently this is the pattern of nutrient distribution in the plow layer under a forage crop when maintenance applications have been topdressed for several years following a plowdown or

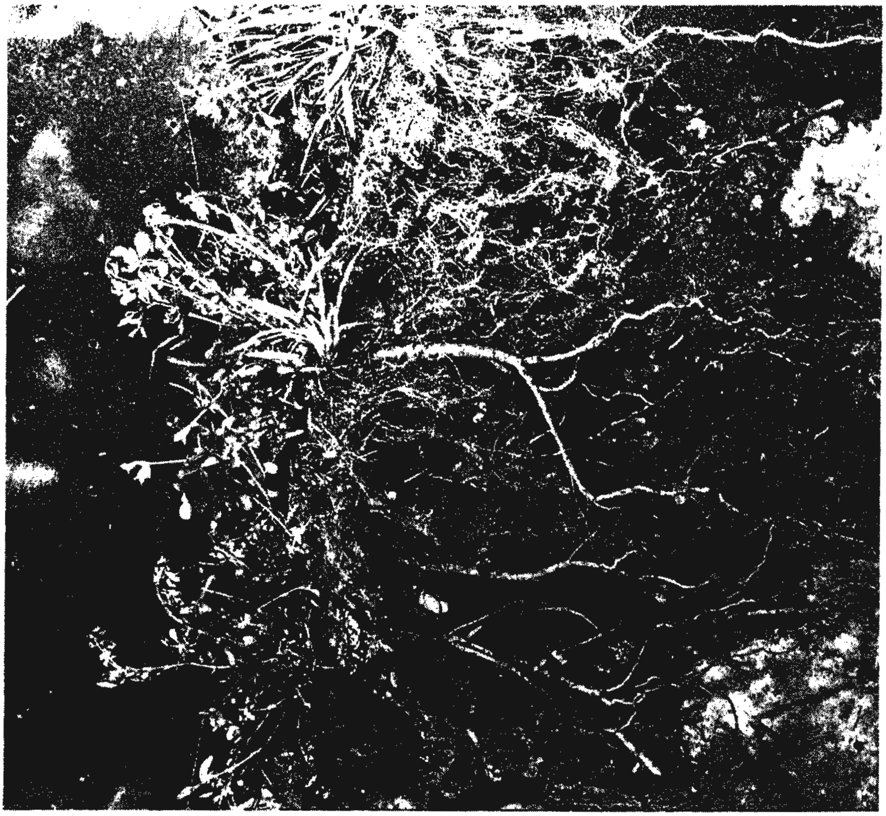

Figure 1: The fibrous root systems that developed in the upper portion of the plowlayer of orchardgrass-alfalfa plots.

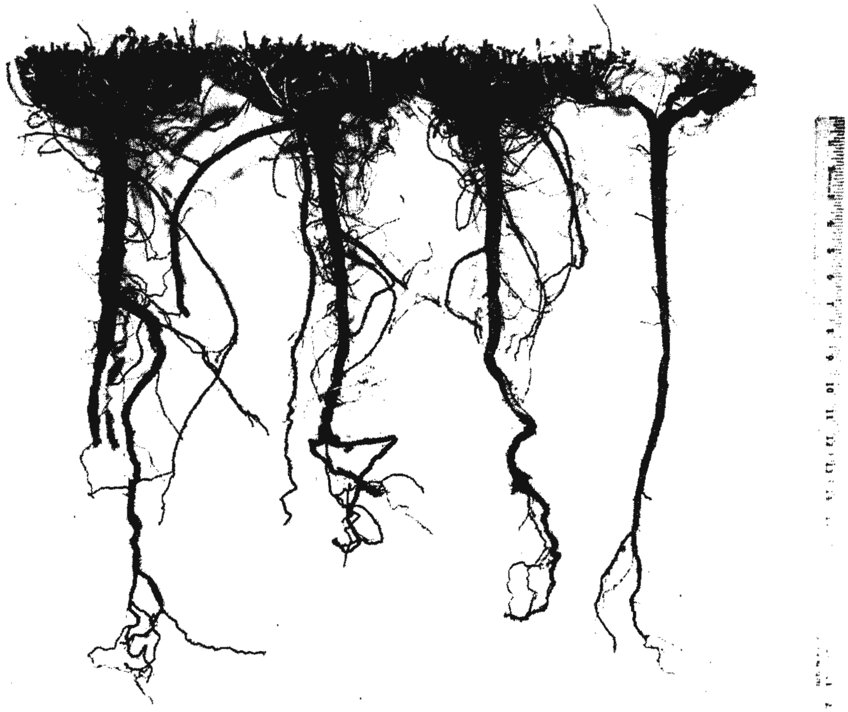

Figure 2: Alfalfa roots showing the fibrous nature developed in the upper three inches, making possible the uptake of topdressed nutrients.

corrective application at time of seeding. The extensive root systems of the orchardgrass and alfalfa plants in the plow layer, especially in the upper three inches, are shown in Figures 1 and 2. These systems would readily absorb nutrients from the surface one to three inches, adequately supplying the plant needs for the extent of yield permitted by soil moisture.

The P and K contents of the alfalfa on the alfalfa-bromegrass plots were 0.55 percent and 2.18 percent, respectively, at the time of final soil sampling (October 1970). Phosphorus and K contents of the plants on the orchardgrass-alfalfa plots were: Alfalfa 0.52 percent P, 2.32 percent K; orchardgrass 0.48 percent P, 3.7 percent K. All these values are well above critical ones reported by Martin and Matocha (9), indicating that the alfalfa and orchardgrass had effectively absorbed topdressed P and K. The topdressed P and K apparently did not move below the surface two or three inches before being fixed by soil colloids or absorbed by the plant roots. Such conditions would account for nutrient accumulation only in the surface two or three inches.

Table 3 Grass--Legume Mixtures Topdressed with N P K. Final P_2O_5, and Exchangeable K Soil Test Values by One Inch Depths, Baxter Silt Loam--Purdy, Mo.(1970)

Orchardgrass--Alfalfa

Depths Inches	P_2O_5 (Bray P_2) Lbs./A Treatments* 1	2	3	4	avg.	Exchangeable K Lbs./A Treatments 1	2	3	4	avg.
0-1	215	188	183	215	200	280	228	252	192	238
1-2	92	68	60	92	78	168	132	140	140	145
2-3	37	41	41	41	40	100	76	80	72	82
3-4	41	41	55	50	47	88	64	60	56	67
4-5	41	50	50	50	48	76	56	48	56	59
5-6	41	46	46	64	49	64	56	64	52	59
6-7	32	41	55	41	42	68	64	64	60	64
Avg.	71	68	70	79	72	121	97	101	90	102

Bromegrass--Alfalfa

Depths Inches	P_2O_5 (Bray P_2) Lbs./A Treatments 1	2	3	4	avg.	Exchangeable K Lbs./A Treatments 1	2	3	4	avg.
0-1	206	202	224	234	217	316	352	384	376	357
1-2	73	73	50	60	64	192	172	168	228	190
2-3	46	64	50	50	53	100	96	100	100	99
3-4	50	50	82	60	61	80	68	76	72	74
4-5	50	46	64	55	54	64	56	64	68	63
5-6	55	50	50	64	55	68	60	72	60	65
6-7	41	41	60	50	48	84	60	56	76	69
Avg.	74	75	83	82	79	129	123	131	140	131

Fescue--Lespedeza (Full Treatment)

Depths Inches	P_2O_5 1	2	3	4	avg.	K 1	2	3	4	avg.
0-1	183	178	183	151	174	568	556	556	476	539
1-2	142	124	137	110	128	500	508	456	372	459
2-3	101	105	96	96	100	396	400	340	244	345
3-4	92	110	87	96	96	340	340	304	172	289
4-5	87	119	96	101	101	200	292	184	112	197
5-6	92	115	96	119	106	176	200	168	112	164
6-7	46	82	82	73	71	160	192	176	104	158
Avg.	106	119	111	106	111	334	355	312	227	307

Fescue--Lespedeza (Half--Treatment)

Depths Inches	P_2O_5 1	2	3	4	avg.	K 1	2	3	4	avg.
0-1	170	202	192	183	187	540	504	536	460	510
1-2	96	115	119	87	104	568	500	392	376	459
2-3	46	50	69	41	52	480	400	340	308	382
3-4	46	50	55	41	48	372	336	240	184	283
4-5	46	55	46	37	46	324	236	192	140	223
5-6	41	60	37	46	46	220	192	144	104	165
6-7	37	50	37	32	39	160	144	132	92	132
Avg.	69	83	79	62	75	381	330	282	238	306

Initial Soil Test Values for the area: 48 Lbs P_2O_5/A (P_2), 168 Lbs K/A

*See Table 2 for description of treatments.

Magnesium was at its initial level and the pHs and calcium values were below initial values at the end of the studies. A topdressing of dolomitic limestone would be indicated for both sets of grass-alfalfa plots (Appendix Tables 1 and 2).

Fescue-Lespedeza Mixtures

The P_2O_5 levels at all depths for the full treatment plots were above the initial value with high values in the surface layers (Table 3). Exchangeable potassium was very high in the upper three layers with treatment 4 having the lower values due to greater forage removal. Treatment 4 showed lower than initial K values at the fifth depth and below. The other treatments did not extract K below the initial level at any depth. It is apparent that the corrective application for full treatment plus the annual topdressings had supplied P and K in excess of removal by the forage. The data from the full treatment plots show the distribution of P_2O_5 and exchangeable K in the plow layer when these nutrients were applied in excess of crop removal.

The P_2O_5 levels for the half treatment plots were at the initial value at the third depth, with lower values at the fourth depth and below. Treatment 4 had lower values due to the greater forage removal. The exchangeable K values for this group of plots were near those of the full treatment plots because the initial application of K differed by only 100 pounds K_2O/A and forage removal was nearly the same from both sets of plots. The data for these fescue-lespedeza plots show the distribution of P_2O_5 in the plow layer when it was topdressed at about the rate equal to crop removal. It is apparent that fescue and lespedeza roots extract soil P to low values below the surface 2 or 3 inches while drawing on the annually applied P.

The P and K contents of the fescue on the plots at the time of final soil sampling were: 0.42 percent P and 3.31 percent K for the full treatment plots and 0.36 percent P and 3.26 percent K for the half treatment plots. These values are well above the critical ones for fescue and neither nutrient would be considered a factor limiting forage yields (9).

The pHs, calcium, and magnesium were near initial values in the full treatment plots and below initial levels in the half treatment plots at the termination of the study.

Study II

TOPDRESSING ORCHARDGRASS-ALFALFA WITH PHOSPHORUS AND POTASSIUM

Procedure

The last four years' data of an eight-year P and K topdressing study with orchardgrass alfalfa is reported. The first four years' data were given by Kroth *et al.* (7).

Potomac orchardgrass and Buffalo alfalfa were seeded on limed seedbeds of Baxter and Gerald silt loams at the Southwest Center, Mount Vernon, Mo., August, 1961. A 16+64+30 starter fertilizer was banded with a grain drill before making the planting with a brillion seeder. Four tons per acre of calcitic limestone had been mixed with the plow layer when the seedbed was prepared.

An additional 2 tons per acre of dolomitic limestone were topdressed on the Baxter plots and 3 tons per acre were topdressed on the Gerald plots in 1963. Seven annual topdressing treatments were used with three replications in a randomized block design. The P_2O_5 of treatment 4 was plowed down as rock phosphate in 1961. The 100 pounds of K_2O in treatment 4 was an annual application.

The soil test values for the plow layer produced by these treatments by 1966 are given in Appendix Tables VI and VIII. The values for P_2O_5 and exchangeable K from the 1966 sampling are included in Table 5.

At the end of this study, October 1969, the soils of all plots were sampled by one inch depth layers to a depth of six inches using the method described above and tested by the same procedures. Final values for P_2O_5 and exchangeable K are given in Table 5 with the complete results given in Appendix Tables V and VII. Treatments and yields for the final four years of the study are given in Table 4.

Results and Discussion

Hay Yields

Hay yields of all treatments on the Gerald plots exceeded those on the Baxter plots. The Gerald plots were nearly level and possibly there was less rainfall runoff from these plots; the Baxter plots were on a 4 percent slope. On the average, the Gerald plots produced 0.6 ton per acre more than the Baxter plots. Yields were affected by the differing amounts of P_2O_5 and K_2O of the treatments. The effect of topdressed K_2O was evaluated by comparing differing rates of K_2O at a uniform rate of 50 pounds P_2O_5. Topdressed P_2O_5 was compared at a rate of 100 pounds K_2O, a rate that proved to be inadequate for optimum yields. However, treatment 7, 0+50+150, supplied both P_2O_5 and K_2O in adequate amounts. The effects on yields of differing rates of K_2O at an optimum rate of P_2O_5 are shown in Figure 3. The effects of differing rates of P_2O_5 with 100 pounds per acre are shown in Figure 4.

Table 4--Effect of Topdressed Phosphorus and Potassium on Yields of Orchardgrass-Alfalfa on Baxter and Gerald Silt Loams
Yields Tons Hay/Acre (1966-1969)

	Baxter Silt Loam (4year- means)							Gerald Silt Loam (4-year means)						
Treatments*	Total	1st cut	% Total	2nd cut	% Total	3rd cut	% Total	Total	1st cut	% Total	2nd cut	% Total	3rd cut	% Total
1. 0+50+0	1.46e	.77	52.7	.37	25.3	.32	22.1	1.85e	.93	50.2	.50	27.2	.42	22.6
2. 0+50+50	2.10c	.90	42.9	.65	31.2	.54	25.9	2.71b	1.20	44.2	.75	27.5	.76	28.2
3. 0+50+100	2.41b	1.06	43.8	.70	29.3	.65	26.9	3.10b	1.48	47.2	.83	26.6	.82	26.2
4. 0+480+100	2.22c	.96	43.6	.65	29.3	.60	27.1	2.75b	1.22	44.3	.80	29.0	.73	26.7
5. 0+25+100	2.25c	1.00	44.2	.66	29.2	.60	26.6	2.97b	1.41	47.5	.78	26.1	.79	26.4
6. 0+0+100	1.66d	.80	48.5	.43	25.9	.42	25.6	2.27c	1.11	48.9	.54	24.0	.62	27.1
7. 0+50+150	2.59a	1.09	42.0	.76	29.4	.74	28.6	3.41a	1.56	45.7	.85	25.0	1.00	29.4

* Treatments topdressed in the spring, ½ K_2O of treatments 3,4,5,6, and 7 in April, ½ in June. The P_2O_5 of treatment 4 plowed down as rock phosphate in 1961.

Table 5--Orchardgrass--Alfalfa Topdressed with Phosphorus and Potassium
Final P_2O_5 and Exchangeable K Soil Test Values by One Inch
Baxter and Gerald Silt Loams (1969)

Depth Inches	P_2O_5 (Bray P_2) Lbs./A — Treatments*							Exchangeable K Lbs./A — Treatments						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Baxter Silt Loam														
0-1	311	302	247	284	96	37	284	156	208	412	376	440	512	600
1-2	128	124	64	353	41	18	87	84	116	272	316	252	388	456
2-3	55	60	41	344	32	18	60	80	92	144	160	152	280	264
3-4	37	41	37	105	41	27	32	80	88	104	136	104	180	160
4-5	27	32	41	41	32	14	37	80	84	100	100	96	152	124
5-6	18	32	27	46	23	14	32	100	92	100	100	96	132	116
Avg.	96	99	76	196	44	21	89	97	113	189	198	223	274	287
Soil test values 1966	94	72	68	156	59	67	117	120	167	233	277	220	277	333
Gerald Silt Loam														
0-1	293	234	206	247	69	27	183	136	264	420	480	392	540	580
1-2	96	46	50	128	37	18	50	72	120	188	300	204	384	340
2-3	41	23	32	60	23	14	32	64	80	96	144	120	208	168
3-4	18	18	18	32	27	14	18	56	64	68	108	92	124	112
4-5	18	18	18	18	14	14	14	60	72	68	84	80	116	84
5-6	23	18	27	18	18	14	18	60	72	80	84	76	112	84
Avg.	82	59	59	84	31	17	53	75	112	153	200	161	247	228
Soil test values 1966	84	72	73	116	38	23	47	82	123	143	167	167	227	160

Baxter Silt Loam: Initial soil tests for the area 1961; 58 Lbs. P_2O_5/A (P_2), K 204 lbs/A.

Gerald Silt Loam: Initial soil test values for the area 1961; 46 lbs. P_2O_5/A (P_2), K 186 Lbs/A.

*See Table 4 for discription of treatments.

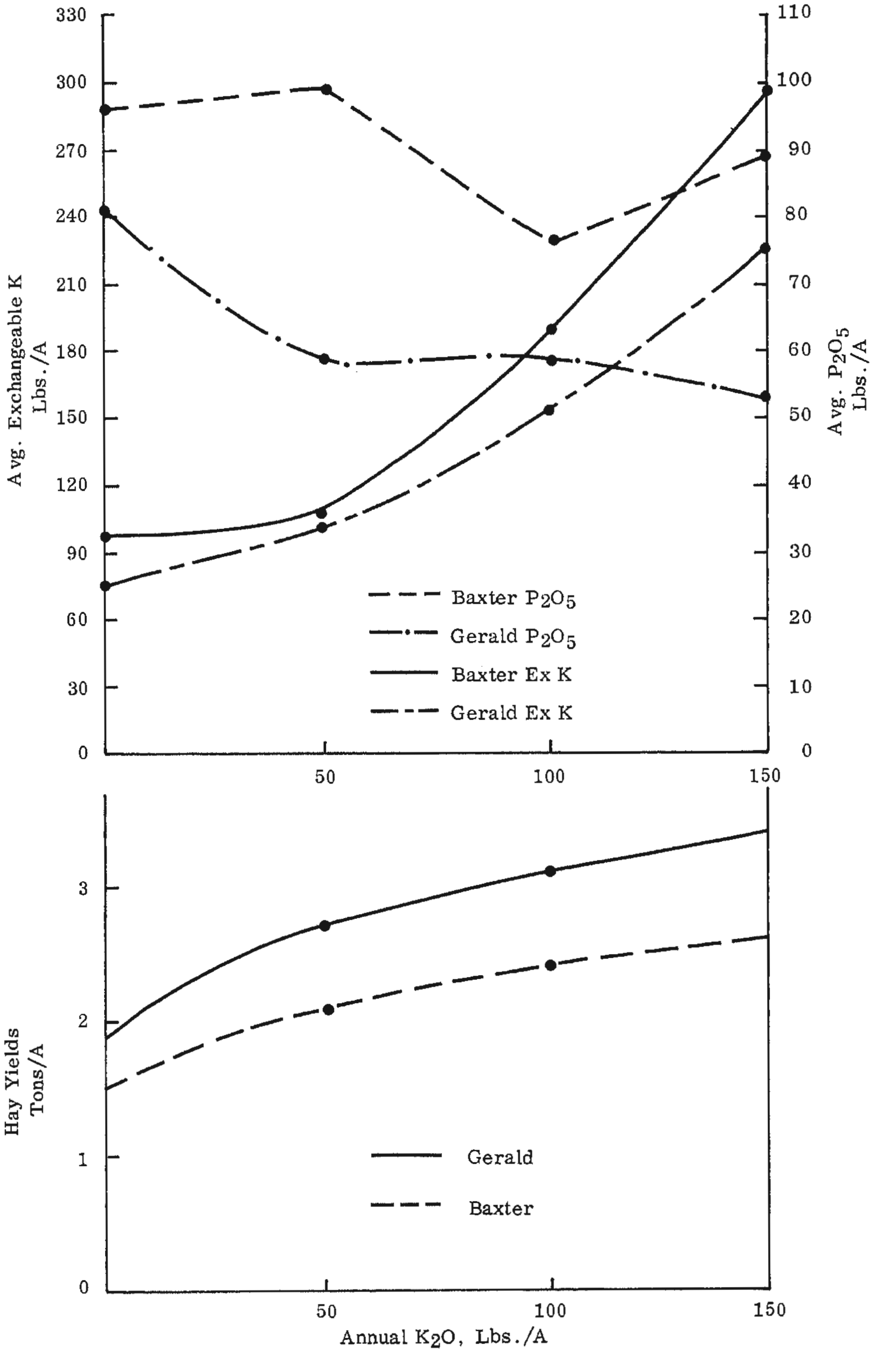

Figure 3: The relationship between hay yields of orchardgrass-alfalfa, average P_2O_5 (P_2) and exchangeable K values, and rate of topdressed K_2O, at a uniform rate of 50 lbs. P_2O_5/A.

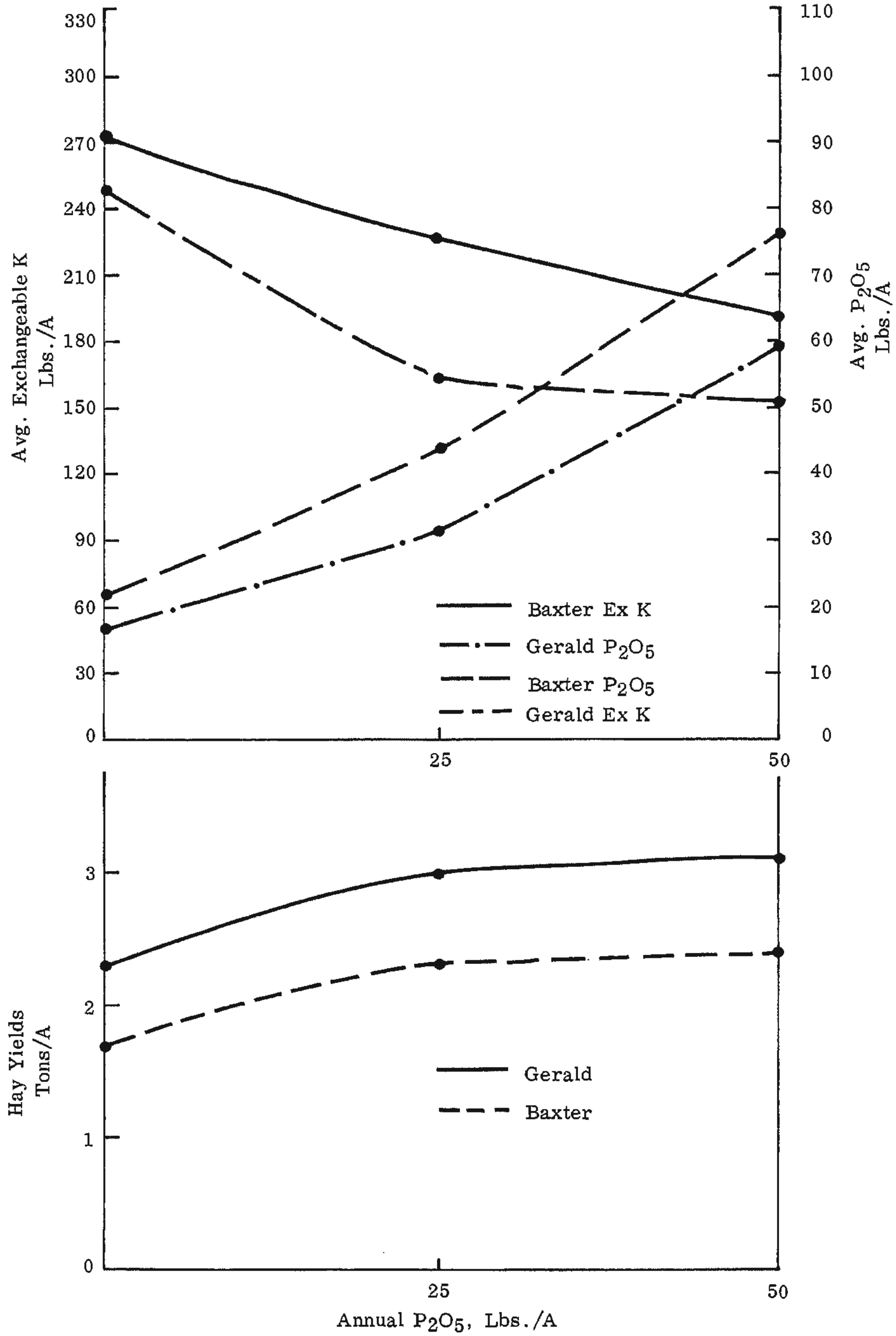

Figure 4: The relationship between hay yields of orchardgrass-alfalfa, average soil test P_2O_5 (P_2) and exchangeable K values, and rates of P_2O_5, at a uniform rate of 100 lbs. K_2O/A.

Baxter Silt Loam

The data in Table 4 show that treatment 7, 0+50+150, produced the highest total yield and the yields of all three cuttings were higher than the same cuttings of the other treatments. About 43 percent, 29 percent, and 28 percent of total yield under all treatments were produced by the 1st, 2nd, and 3rd cuttings.

Treatment 3, 0+50+100, produced the second highest yield, the implication being that K was the limiting nutrient. The soil test data (Table 5) show that at the end of the study the average K value for the plow layer for treatment 3 was 100 pounds per acre lower than that for treatment 7.

Treatments 2 (0+50+50) and 5 (0+25+100) produced the third highest yields, treatment 2 for lack of K_2O and treatment 5 for lack of K_2O and P_2O_5. Table 5 shows the soil receiving treatment 2 had a lower average K value than treatment 3 and treatment 5 to have a relatively high average K value but a quite low average P_2O_5 value, indicating that P was the more limiting nutrient in this treatment.

Treatment 4, with 100 pounds of K_2O topdressed annually, produced a lower yield than treatment 3 and the same yield as treatment 5, indicating that P was the limiting nutrient in treatment 4. The rock phosphate, though giving relatively high soil test values with Bray's P_2 extractant, only supplied available P equal to that in 25 pounds of P_2O_5 topdressed as superphosphate.

Treatment 1 (0+50+0), which produced the lowest yield, permitted the soil K to be extracted to very low levels, while treatment 6 (0+0+100) produced the next lowest yield and caused the extraction of P_2O_5 to low levels. The ranking of the yields of these two treatments indicate that both P and K limited yields on the Baxter soil but K to the greater extent.

Gerald Silt Loam

The highest yield on this soil, 3.41 tons per acre (Table 4), was also produced by treatment 7 (0+50+150). The three cuttings were somewhat larger than those on the Baxter plots but had the same percentage ranges. The total yield was 0.82 tons per acre higher than the yield on the Baxter soil, which, consequently, extracted the P and K to lower levels in the Gerald plots than in the Baxter plots (Table 5). Since these yields are near those found by Meyers (13) it is believed that they are close to the highest average yields that could be expected from the available moisture. The next highest yield was produced by treatments 2 (0+50+50), 3 (0+50+100), 4 (0+480+100), and 5 (0+25+100). Treatments 2 and 3 would be limiting in K_2O and treatment 5, in P_2O_5 and K_2O when compared with treatment 7. The rock phosphate of treatment 4 supplied P at the same rate as treatment 5, as was observed on the Baxter plots.

Treatments 1 (0+50+0) and 6 (0+0+100) ranked the same on the Gerald soil as the Baxter soil, extracting the exchangeable K in the case of treatment 1 and the P_sO_5 in the case of treatment 6 to very low levels. This ranking indicates that the Gerald soil also supplied P and K to the plants at about the same levels as the Baxter soil.

Soil Test Values

The P_2O_5 and exchangeable K soil test values by one inch depths given in Table 5 show the same pattern of P_2O_5 and K removal as given in Table 3. Since the treatments were applied over an eight-year period the values obtained at the end of the study at the various depths, except for treatment 4, could be reasonably stable ones produced by the interaction of treatment, fixation, and plant removal. Comparison of the average values of the six depths for each treatment (Table 5) with the plow layer values produced by each treatment in 1966 and the initial values for the experimental areas showed some interesting relationships. A nutrient not in high demand due to absence of another nutrient remained at about the same level while the deficient nutrient was withdrawn to a level much below the original value. The P_2O_5 of treatment 1 (0+50−0), for instance, remained at a fairly constant value after 1966, but exchangeable K was lowered during this period. Exchangeable K for treatment 6 (0+0+100) was maintained at a reasonably constant value in both soils while P_2O_5 was reduced to quite low levels. Treatment 7 (0+50+150) apparently supplied both P_2O_5 and K_2O at rates needed for crop growth and fixation. Treatment 3 (0+50+100) was an example of a treatment somewhat low in K_2O, thereby lowering the final average exchangeable K value below the initial value, but not to the degree of treatment 1.

Baxter Silt Loam

Soil test P_2O_5 values, with the exception of treatment 4, were equal to or below the initial value at the lower four depths of all treatments with treatment 5 showing removal of P_2O_5 from the lower five and treatment 6 from all depths (Table 5). The average P_2O_5 values over all depths for treatments 1, 2, 3, and 7 were above the initial value due to the high value in the surface inch. Although treatment 4 showed considerable rock phosphate remaining in the plow layer, it did not appear to greatly affect crop yields since the yield produced by treatment 4 was no better than that produced by treatment 5 (0+25+100) and less than treatment 3 (0+50+100). It may be that the pHs of 6.5 could slow the rate of solution of the rock phosphate of treatment 4 (Appendix Table V). On the other hand, the 25 pounds of P_2O_5 in treatment 5 appeared to be efficiently used. The average value and array of P_2O_5 values of treatment 7 are interpreted to be the conditions necessary to produce optimum yields on Baxter silt loam.

The exchangeable K values show K removal below the initial value at all depths for treatment 1, at the second depth and below for treatment 2, and at the third depth and below for treatment 6 and 7. The high average K value, and the high K values for the first and second inches for treatment 7 may be the conditions necessary to produce optimum yields on Baxter silt loam. However, Figure 3 shows a rapid increase in soil test exchangeable K between treatments 3 and 7, indicating the possibility of an efficient application rate of K_2O lower than 150 pounds K_2O per acre.

Gerald Silt Loam

Soil test P_2O_5 values for the Gerald plots were lower than the corresponding values for the Baxter plots, reflecting the greater P removal in the higher yields of the Gerald plots. It may be that the lower pHs of the Gerald plots at the third depth and below increased the solubility of P_2O_5 so that the plants were able to extract P to a lower level than in the Baxter soil. At these depths the pHs is nearly 1 point lower than that of the Baxter plots and the P_2O_5 values from the P_1 and P_2 extractants are nearly equal (Appendix, Tables V, VIII). The lower pHs could explain the greater use of rock phosphate for treatment 4 on the Gerald plots than on the Baxter plots and may be the reason for higher yield on the Gerald plots, rather than more available moisture as postulated above. The data from treatment 7 (0+50+150) in Table 5 show that the top yield of 3.41 tons per acre was produced with low P_2O_5 soil test values at the second depth and below, indicating that the 50 pounds of P_2O_5 topdressed annually was effectively adsorbed and used by the plants.

The lower soil test K values on the Gerald plots also reflect the higher yields of these plots over yields of the similarly treated Baxter plots. The same decrease in soil test value with depth is noted, showing that K was extracted under some treatments to near the levels produced by orchardgrass-alfalfa on the Baxter soil of the Purdy plots (Table 3).

The data for both soils show that optimum yields of orchardgrass-alfalfa produced by topdressing K_2O result in high exchangeable K values in the upper three inches and especially in the surface inch. Figure 3 shows a rapid rise in average exchangeable K due to application of 150 pounds of K_2O in comparison with 100 pounds of K_2O while producing only 0.3 tons per acre more yield. According to Figure 3, an application of 130 pounds of K_2O on the Gerald soil would have produced 0.1 tons per acre and reduced average exchangeable K from 228 to 195 pounds per acre. The proportionate decrease in exchangeable K would have been greater on the Baxter soil, a reduction from 287 to 246 pounds per acre.

The high exchangeable K values in the surface two or three inches could result in excessive uptake of K at the expense of Mg in periods of rapid growth, resulting in forage low in Mg. Further studies are necessary to evaluate this relationship and to determine what K levels in the upper two or three inches would be undesirable.

Study III

TOPDRESSING ORCHARDGRASS-ALFALFA WITH NITROGEN, PHOSPHORUS AND POTASSIUM

Procedure

Two studies to evaluate the effect of combining N with topdressed P_2O_5 and K_2O on yields of orchardgrass-alfalfa were started at the Southwest Center on plots where P_2O_5 and K_2O topdressing studies on timothy-red clover, begun in 1961, were terminated in 1964 and 1965 on Baxter and Gerald silt loams respectively. These plots were replanted to orchardgrass-alfalfa in the fall of the year following termination of the timothy-red clover studies, i.e. 1965 and 1966. The original timothy-red clover stands had been established at the same time, in the same way, received the same limestone applications, and the same seven treatments as the orchardgrass-alfalfa studies reported above. By reseeding the timothy-red clover plots to orchardgrass-alfalfa the effect of 40 pounds of nitrogen per acre added to the P_2O_5 and K_2O treatments could be estimated by comparison with the yields in the studies reported previously (Table 4).

To give a further check on the effects of N, N was not added to treatment 2. For these studies the timothy-red clover plots were plowed, the seed-bed was conventionally prepared and Potomac orchardgrass and Vernal alfalfa were seeded without additional lime or fertilizer. The plots were restaked so that the same topdressed P_2O_5 and K_2O treatments were applied to the plots receiving them in the timothy-red clover studies. The timothy-red clover plots on the Baxter soil had three years while those on the Gerald soil had received four years of treatments before the orchardgrass-alfalfa plots were established. Studies on both sets of these orchardgrass-alfalfa plots were terminated in 1970, after a total of eight years of treatment had been made to all plots. The initial soil test values and those of the plow layer for all treatments of both soils in 1968 are given in Appendix Tables X and XII. At the end of the study the soils of all plots were sampled and tested by 1 inch depths to a depth of six inches by the methods described above. Results of tests for P_2O_5 and exchangeable K are given in Table 7 and results of all tests are given in the Appendix (Tables IX and XI). Treatments and yield data are given in Table 6.

Results and Discussion

Hay Yields

Comparison of yield data for the same treatments in Tables 4 and 6 shows no effect on total yield due to 40 pounds of N. The N appeared to increase the first cutting yields from an average of 46 percent to 64 percent of total yields on both soils, the corresponding decreases being shared by the second and third cuttings, each averaging about 18 percent as compared with 27 percent for each of the cuttings where no N was applied. However, the first cutting of treatment 2

Table 6--Effect of Topdressed Nitrogen, Phosphorus, and Potassium on Yields of Orchardgrass-Alfalfa (1965-1970)

	Baxter Silt Loam-- (5-year mean)							Gerald Silt Loam-- (4-year mean)						
Treatments*	Total	1st cut	% Total	2nd cut	% Total	3rd cut	% Total	Total	1st cut	% Total	2nd cut	% Total	3rd cut	% Total
1. 40+50+0	1.76e	1.20	68.9	0.22	12.6	0.32	18.5	1.93e	1.32	68.0	0.29	15.0	0.33	17.0
2. 0+50+50	2.19cd	1.14	52.1	0.42	19.2	0.63	28.8	2.44b	1.32	54.1	0.55	22.5	0.57	23.5
3. 40+50+100	2.47b	1.64	66.0	0.34	13.7	0.50	20.3	2.83a	1.72	60.9	0.51	18.0	0.60	21.1
4. 40+480+100	2.19cd	1.40	63.8	0.31	14.1	0.48	22.1	2.69ab	1.62	60.0	0.49	18.4	0.58	21.6
5. 40+25+100	2.35bc	1.50	63.7	0.33	14.2	0.52	22.2	2.47b	1.60	64.7	0.42	16.8	0.46	18.5
6. 40+0+100	2.07d	1.32	62.0	0.33	15.4	0.48	22.6	1.96b	1.25	63.7	0.34	17.3	0.37	19.0
7. 40+50+150	2.76a	1.71	61.7	0.43	15.4	0.63	22.9	2.79a	1.78	63.7	0.50	17.8	0.52	18.5

* Treatments topdressed in the spring, $\frac{1}{2}$ K_2 of treatments 3,4,5,6 and 7 in April, $\frac{1}{2}$ in June. The P_2O_5 of treatment 4 plowed down as rock phosphate in 1961.

Table 7--Orchardgrass-Alfalfa Topdressed with Nitrogen, Phosphorus and Potassium. Final P_2O_5 and Exchangeable K Soil Test Values by One Inch Depths, Baxter and Gerald Silt Loams (1970)

	P_2O_5 (Bray P_2) Lbs./A Treatments*							Exchangeable K Lbs./A Treatments						
Depth Inches	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Baxter Silt Loam														
0-1	247	302	224	156	96	37	188	108	208	332	352	364	476	456
1-2	114	96	64	215	50	32	59	88	152	236	268	248	344	352
2-3	50	73	50	247	37	27	46	88	120	200	168	156	208	228
3-4	46	59	50	243	32	32	46	92	112	140	136	132	152	128
4-5	46	50	46	224	37	32	46	80	108	128	116	128	128	116
5-6	37	50	41	284	32	27	46	84	116	124	124	116	128	116
Avg.	90	105	79	228	47	31	72	90	136	193	194	191	239	233
Soil Test Values 1968	75	100	76	234	56	35	79	113	187	228	227	235	230	283

Initial soil test values for the area 1961; 66 Lbs. P_2O_5/A (P_2), 247 Lbs. K/A.

	P_2O_5 (Bray P_2) Lbs./A Treatments*							Exchangeable K Lbs./A Treatments						
Gerald Silt Loam														
0-1	256	174	188	82	59	32	224	108	132	268	296	332	456	476
1-2	69	64	55	82	23	23	69	80	92	156	164	172	268	284
2-3	46	46	41	114	23	23	41	84	80	108	92	92	148	148
3-4	41	37	37	110	27	23	37	80	92	96	92	96	96	112
4-5	50	41	41	160	27	18	55	80	92	96	92	84	96	104
5-6	37	32	37	110	23	18	46	84	80	96	92	88	92	96
Avg.	83	66	67	110	30	23	79	86	95	137	138	144	193	203
Soil Test Values 1968	82	76	78	133	41	42	80	80	98	197	170	172	178	228

Initial soil test values for the area 1961; 44 Lbs. P_2O_5/A (P_2) 137 Lbs. K/A.

*See Table 6 for description of treatments.

(0+50+50) was increased from 43 percent to 52 percent, on Baxter soil, and from 44 percent to 54 percent, on Gerald soil (Tables 4 and 6), indicating part of the first cutting yield increases would have been due to some factor other than N.

There would appear to be no advantage to the use of N on the orchardgrass-alfalfa mixture in this study except possibly in years when a good supply of spring moisture would be followed by a prolonged drouth in June, July, and August. In some cases the increased yield of the first cutting would be an advantage where the later summer growth could be grazed, thereby eliminating costs of harvesting 0.5 ton per acre or less.

Yields on the Gerald soil (Table 6) were slightly higher than the Baxter soil for all treatments except treatments 6 and 7. The lower yields of these Gerald plots may be due to lower exchangeable K values than on the Baxter plots; the higher percentage of grass in the forage removed may have reduced the exchangeable K to a point where a K shortage limited yield. Treatment 7 (40+50+150) (Table 6) produced the highest yield on both soils although on the Gerald plots the yields of treatments 3 and 4 were not significantly different from that of treatment 7. As in the previous two studies the ranking of the yields of the various treatments were related to the levels of P_2O_5 and K_2O applied, which in turn affected the soil test levels of the plots. It was apparent that the available P_2O_5 supplied by the rock phosphate of treatment 4 was equal to that supplied by treatment 5.

Soil Test Values

It is assumed that the phosphorus and potassium levels in the plow layer under the timothy-red clover plants had resulted in an array of values as illustrated by the data from the Purdy plots (Table 3). It is also assumed that plowing and preparation for the new seed bed on these plots had remixed the soil so that the pHs, phosphorus, and potassium levels were uniform throughout the plow layer. At the end of the study (Fall 1970) fertilizer application, plant removal, and soil fixation produced the array of P_2O_5 and exchangeable K values by one inch depths as given in Table 7. The averages of these values compared with the values obtained by sampling the plow layer in 1968 indicate that by 1968 each treatment, with the exception of the rock phosphate of treatment 4, had developed a set of values in the plow layer which had some degree of stability. By 1970 eight annual fertilizer applications had been made to all plots so that plots receiving treatments identical to those of the previous study had received equal quantities of P_2O_5 and K_2O. A comparison of the data in Tables 5 and 7 shows similar relationships between soil test values of comparable treatments and depths.

Figures 3 and 5 show marked similarity, except for the lower average exchangeable K value of Figure 5, indicating greater K removal of the orchardgrass in the first cutting. Thus, an increased rate of K_2O is possibly needed to produce optimum yields when N is applied to this forage mixture.

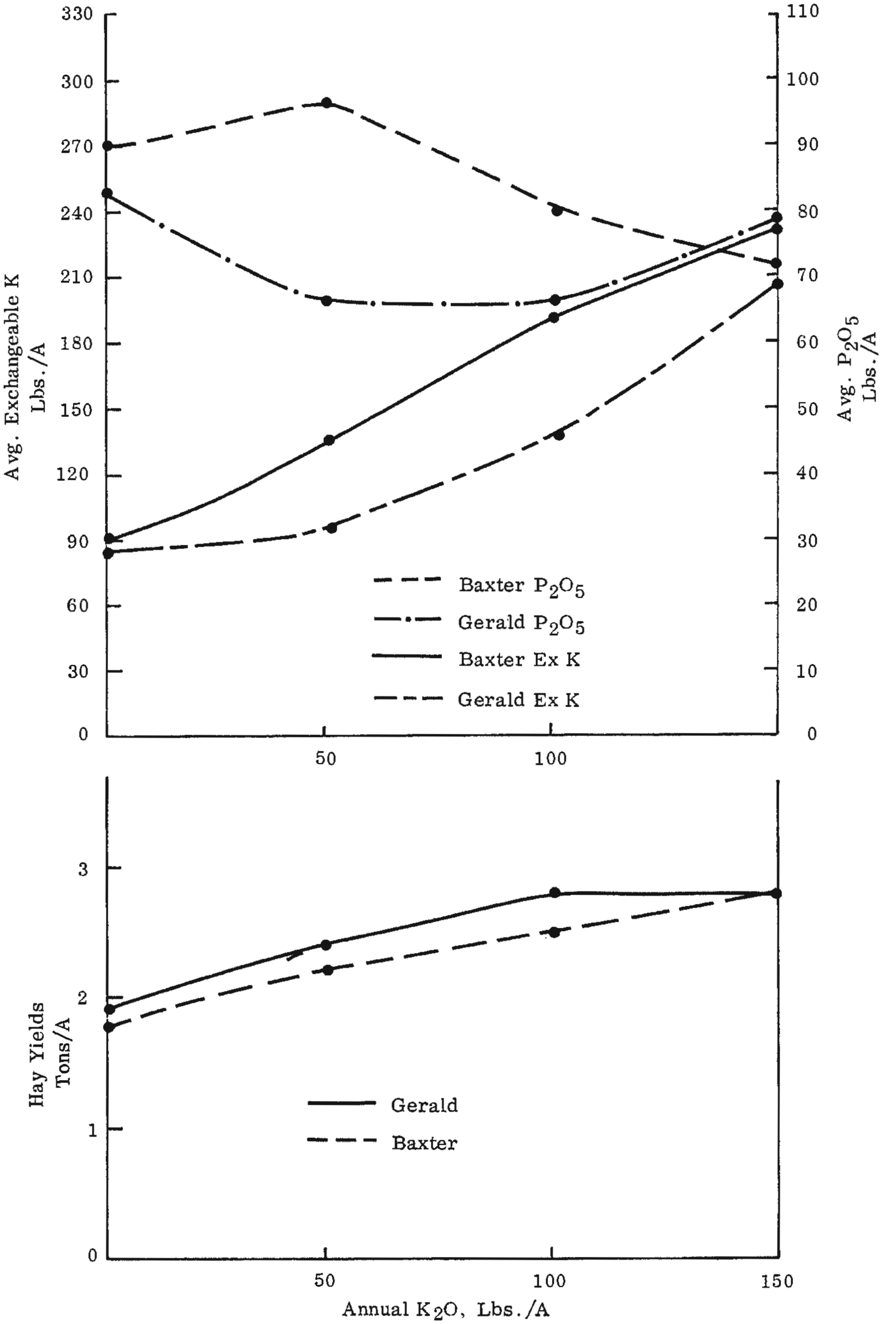

Figure 5: The relationship between hay yields of orchardgrass-alfalfa, average soil test P_2O_5 (P_2) and exchangeable K values, and rates of topdressed K_2O, at a uniform rate of 50 lbs. P_2O_5 and 40 lbs. N/A.

Figures 4 and 6 also indicate yields were reduced where N was applied and K was reduced to more limiting levels by the orchardgrass. Average terminal soil test values of both soils for treatments 3, 5, and 6 were nearly identical, indicating similar relationships between application, plant removal, and soil fixation of P_2O_5 and K_2O in both groups of studies.

The original timothy-red clover plots were topdressed with Mg limestone in 1963: 3 tons per acre on the Gerald plots and 2 tons per acre on the Baxter plots. When these plots were plowed and reseeded to orchardgrass-alfalfa mixture, the limestone should have been uniformly mixed throughout the plow layer. Tables X and XII in the Appendix show that by 1968 the pHs was an average of 6.5 for the Baxter soil and 5.2 for the Gerald soil. By 1970 the average pHs of all treatments and all depths for the Baxter soil was 6.1 and 5.2 for the Gerald soil (Appendix Tables IX and XI). Assuming a uniform distribution of limestone in the plow layer of the plots of both soils when planted to orchardgrass-alfalfa, the topdressed nitrogen produced a lower pHs in the upper two inches of both soils by 1970 (Appendix Tables IX and XI).

A summary of the effects of pHs on P_2O_5 soil test values is given in Table 8. Data from Appendix Tables V and VII show the relationships between the average pHs and the average P_2O_5 levels in the plow layer of the Baxter and Gerald soils. The lower pHs resulted in lower P_2O_5 values, indicating the P_2O_5 was more soluble at the lower pHs values and had been removed in greater amounts from the Gerald plots by the plants. However, the Mg limestone topdressed in 1963 maintained a high pHs in the upper two inches of both soils until 1970, resulting in corresponding higher P_2O_5 values, especially in the surface inches. Appendix Tables IX and XI show the effect of the applied N on the pHs of the surface inch and the resulting average lower P_2O_5 values of both soils. Apparently, the lower pHs due to annual application of 40 pounds N resulted in greater solubility of P_2O_5 of both topdressed superphosphate and the rock phosphate of treatment 4.

These data suggest that large amounts of limestone topdressed on established stands of forage crops could reduce phosphate solubility in the upper two inches of the soil. Also, nitrogen applied to forage crops topdressed with rock phosphate could increase the availability of the P_2O_5 of the rock phosphate, making this carrier an economical source of phosphate for pasture crops.

Table 8--Effect of pHs on P_2O_5 Soil Test Values (Bray P_2)
Baxter and Gerald Silt Loams

	Averages of Six Depths				Surface Inch			
	Avg. Treatments 1, 3, 5, 6, 7		Treatment 4		Avg. Treatments 1, 3, 5, 6, 7		Treatment 4	
Tables 5, 7 Appendix	pHs	P_2O_5 Lbs./A	pHs	P_2O_5 Lbs./A	pHs	P_2O_5 Lbs./A	pHs	P_2O_5 Lbs./A
Baxter	6.5	65	6.5	196	6.7	195	6.8	284
Gerald	5.6	48	5.5	84	6.3	156	6.3	247
Tables 9, 11 Appendix								
Baxter	6.1	64	6.1	228	5.5	158	5.5	156
Gerald	5.2	56	5.3	110	5.0	152	5.1	82

Study IV

TOPDRESSING FESCUE-LESPEDEZA WITH NITROGEN, PHOSPHORUS AND POTASSIUM

Procedure

Studies with Kentucky 31 fescue and Summit lespedeza topdressed with P_2O_5 and K_2O were started at the Southwest Center in 1961. The same seeding conditions and seven combinations of P_2O_5 and K_2O treatments were used as with the orchardgrass-alfalfa studies reported above. Yields for the first five years, reported by Kroth, *et al.* (10) were low with the fescue always being a light green color. Beginning in 1967, 30 pounds of N were topdressed to all plots in March in addition to the regular P_2O_5 and K_2O treatments. Plots were harvested with the modified flail type forage harvester, alternate rows of flails being replaced with shorter ones to simulate grazing and avoid completely defoliating the lespedeza. The first harvest was made when the fescue was in the boot stage and data are reported as two harvests, before and after July 1, even though rainfall in some years permitted a June or August harvest in addition to those in May and November. Treatments, total yields, yields by harvests and their percentages of total yields, are given in Table 9. At the termination of the studies in 1969 plots were sampled and tested by one inch increments to a depth of six inches by the methods described above. Results of the tests for P_2O_5 and exchangeable K are given in Table 10 and the results of all tests are given in Appendix Tables XIII and XV. Initial soil test values for the areas in 1961, and soil test results due to treatments by 1966 are given in Appendix Table XIV and XVI.

Results and Discussion

Hay Yields

The addition of 30 pounds of nitrogen per acre to plots receiving P_2O_5 and K_2O applications (treatments 2, 3, 4, 5, 7) produced an average of 1.80 tons per acre on the Baxter and 1.86 tons per acre on the Gerald soils. This was an increase of 0.42 tons per acre on the Baxter plots and 0.81 ton per acre on the Gerald plots over the original study when only P_2O_5 and K_2O were applied to the plots (Kroth *et al.* (9)). The average percentages of the total yield produced by the first cuttings of the five treatments compared were 58.3 percent and 56.3 percent for the Baxter and Gerald plots, respectively. The average second cutting yield for the same five treatments on the Baxter soil was 0.75 ton per acre , and for the Gerald soil, 0.78 ton per acre; both second cuttings consisted of about three-fourths lespedeza. The percentages compare favorably with 59.9 percent for the 30 pounds of nitrogen per acre rate reported for the fescue-lespedeza study on the Purdy plots which produced a total of 1.81 tons per acre (half treatment) (Table 2). The yield data of these studies support the Purdy fescue-lespedeza results which indicated the application of 30 to 40 pounds nitrogen per acre to a fescue-lespedeza mixture would increase forage yields without injuring the stand of lespedeza.

Appendix Table XIV shows the Baxter plow layer had, in 1966, high exchangeable K values in all plots and high P_2O_5 values (Bray P_2) for plots other than those getting treatments 5 and 6. Yield data (Table 9) show that for the other five treatments there were no significant differences in yield, indicating that for treatments 5 and 6, P was the limiting nutrient. The yield from treatment 4, however, was not significantly greater than that from treatment 5, giving evidence that the rock phosphate was supplying available P at a rate equivalent to an application of about 25 pounds P_2O_5 annually.

In 1966, the Gerald plots, in contrast to the Baxter plots (Appendix Table XVI), had lower exchangeable K values where plots had received treatments 5 and 6. The data (Table 9) show that treatments 1, 2, 4, and 6 did not produce optimum yields while the yield of treatment 5 was equal to those of treatments 3 and 7. The high yield of treatment 5 gave further evidence that a topdressing of 25 pounds of P_2O_5 was efficiently used by the plants.

Soil Test Values

The data of Table 10 show the same pattern of nutrient removal by fescue-lespedeza as for orchardgrass-alfalfa. P_2O_5 and exchangeable K were extracted to quite low levels in the lower three depths, in some cases without a reduction in yield. The actual values at the end of the studies in 1969 were related to the initial level of a nutrient, rates of application, and forage yields.

Baxter Silt Loam

The site for the study on Baxter silt loam had been limed and some P_2O_5 had been applied prior to establishment of the fescue-lespedeza in 1961. The initial P_2O_5 and exchangeable K levels were 63 and 230 pounds per acre respectively. The exchangeable K was such that only treatment 1 (30+50+0) showed a slight yield reduction due to lack of K. In this set of plots, the average exchangeable K value was 105 pounds per acre with values below 84 pounds in the lower three depths. On the other hand, a high yield of 1.86 tons per acre produced by treatment 2 (30+50+50) had an average exchangeable K value 173 pounds per acre with values ranging below 124 pounds in the lower three depths. Other treatments had very high exchangeable K values of over 300 pounds per acre, undoubtedly excessive for a soil having only 9.0 Me per 100 gm. cation exchange capacity.

The lower yields of treatments 5 and 6 were due to lack of phosphorus. Treatment 6 (30+0+100) had an average P_2O_5 value of 31 pounds P_2O_5 per acre. Treatment 5 (30+24+100) would have had an average value somewhat higher, due to the 25 pounds P_2O_5 applied in this treatment, but the P_2O_5 would have been at a limiting value. The yield and soil test data for the Baxter soil indicate that the average value of 110 pounds P_2O_5 per acre of treatment 2 could be in excess of crop needs.

Table 9--Effect of Topdressed Nitrogen, Phosphorus and Potassium on Yields of Fescue-Lespedeza (1966-1969)

Yields Tons Hay/Acre (3-year Means)

	Baxter Silt Loam					Gerald Silt Loam				
Treatments*	Total	1st cut	% Total	2nd cut	% Total	Total	1st cut	% Total	2nd cut	% Total
1. 30+50+0	1.71abc	1.06	62.0	0.65	38.0	1.35e	0.89	66.8	0.45	33.2
2. 30+50+50	1.86ab	1.07	57.6	0.79	42.4	1.77bc	1.04	58.9	0.73	41.1
3. 30+50+100	1.91a	1.11	58.3	0.79	41.7	1.98a	1.12	56.7	0.86	43.3
4. 30+480+100	1.79ab	1.13	62.9	0.67	37.1	1.71c	1.02	59.8	0.69	40.2
5. 30+25+100	1.68bc	0.96	57.3	0.72	42.7	1.88ab	1.11	59.0	0.77	41.0
6. 30+0+100	1.57c	0.95	60.4	0.62	39.6	1.47d	0.89	60.5	0.58	39.5
7. 30+50+150	1.76abc	0.98	55.5	0.79	44.5	1.95ab	1.11	57.2	0.83	42.8

* Treatments topdressed in the spring, ½ K_2O of treatments 3,4,5,6,and 7 applied in April, ½ in June. The P_2O_5 of treatment 4 plowed down in 1961.

The 2 tons per acre of Mg limestone topdressed on the Baxter plots in 1963 maintained high pHs values both for the surface inch and the plowlayer, each being 6.5 at the end of the study (Appendix XIII). It may be that the high average P_2O_5 value of treatment 4 is related to this high pHs.

Gerald Silt Loam

The Gerald plots, in contrast to the Baxter plots, had low initial P_2O_5 and exchangeable K levels and yields were related to application of both nutrients (Tables 9 and 10). Treatments 3 (30+50+100), 5 (30+25+100), and 7 (30+50+150) all produced statistically the same yield, indicating that treatment 5 supplied adequate P_2O_5 and K_2O to produce optimum yields on this soil. The average exchangeable K values for treatments 3 (213) and 5 (259) may be the levels necessary to produce optimum yields; however, treatment 2 (30+50+50) produced a yield only 0.11 ton per acre less than treatment 3 and had an average exchangeable K value lower by 100 pounds per acre.

The average P_2O_5 value for treatment 5 (33 pounds P_2O_5 per acre) is near the initial value of 30 pounds P_2O_5 per acre, indicating that a topdressing of P_2O_5 can be efficiently used. In this case, 25 pounds of P_2O_5 per acre, topdressed annually, produced the top yield without increasing the average plowlayer value, in contrast to the average P_2O_5 values produced by treatment 3 (86 pounds per acre) and treatment 7 (80 pounds per acre).

Three tons per acre of Mg limestone were topdressed on these Gerald plots in 1963. This limestone maintained a pHs of 6.3 and 6.0 in the first and second depths (Table XV Appendix), with an average pHs of 5.5 for the plowlayer. The corresponding pHs values for the Baxter plots are 6.5, 6.5, and 6.5. Allowing for the loss of the 0-1 inch sample of treatment 5 of the Baxter plots, the array of higher P_2O_5 values for the Baxter plots compared with the array of values for the Gerald plots for this treatment may be due to the differences in pHs values of the two soils. A greater availability of phosphorus in the Gerald soil may have resulted, producing the 0.20 ton per acre increase in yield. These results suggest the need for more information on the effect of pHs on the availability of phosphorus to forage crops in the upper two or three inches of soil.

Table 10--Fescue Lespedeza Topdressed with Nitrogen, Phosphorus, and Potassium. Final P_2O_5 and Exchangeable K Soil Test Values by One Inch Depths, Baxter and Gerald Silt Loams (1970)

Baxter Silt Loam

Depth Inches	P_2O_5 (Bray P_2) Lbs./A — Treatments* 1	2	3	4	5*	6	7	Exchangeable K Lbs./A. — Treatments 1	2	3	4	5*	6	7
0-1	257	270	270	371	---	46	311	204	376	528	504	---	580	580
1-2	170	178	211	353	78	32	224	108	204	392	480	436	528	592
2-3	73	101	344	344	55	32	137	84	124	600	320	304	352	508
3-4	46	50	64	247	41	27	64	80	108	276	268	284	324	380
4-5	41	37	41	96	37	23	41	80	115	280	296	240	280	376
5-6	27	27	37	46	32	27	41	76	108	264	212	240	240	332
Avg.	102	110	161	243	---	31	136	105	173	390	347	---	384	461
Soil Test Values 1966	127	130	161	355	97	36	163	215	250	395	418	447	405	507

Initial soil tests for the area 1961; 63 Lbs. P_2O_5/A (P_2), 230 Lbs. K/A.

*The 0-1 inch sample of treatment 5 lost.

Gerald Silt Loam

Depth Inches	P_2O_5 1	2	3	4	5	6	7	K 1	2	3	4	5	6	7
0-1	284	279	234	321	92	27	224	132	288	520	560	548	600	600
1-2	133	115	110	353	41	18	110	64	120	272	356	376	460	600
2-3	50	60	60	257	18	18	60	60	76	168	240	220	304	384
3-4	27	32	37	60	14	14	37	52	76	116	156	152	200	336
4-5	14	18	23	27	14	9	23	52	64	112	144	132	180	256
5-6	18	14	18	23	18	14	23	60	72	92	144	128	168	216
Avg.	88	86	80	174	33	17	80	70	116	213	250	259	319	399
Soil Test Values 1966	83	63	79	210	43	32	83	108	145	272	305	275	307	368

Initial soil tests for the area 1961; 30 Lbs. P_2O_5/A (P_2), 140 lbs. K/A.

*See Table 9 for description of treatments.

Study V

EFFECT OF PLOWDOWN AND TOPDRESSED APPLICATIONS OF PHOSPHORUS AND POTASSIUM ON YIELDS OF ALFALFA

Studies with alfalfa testing the effect of different rates of plowdown applications of P_2O_5 on hay yields were started on Baxter and Gerald silt loams at the Southwest Center in the fall of 1961. The stand on the Baxter plots remained for eight years or more but the stand on the Gerald plots thinned severely in the winter of 1965-66. Consequently, the study was terminated with the top yields of 3.3 tons per acre being produced on the better treatments as reported by Kroth *et al.* (7).

To check the adequacy of the original treatments, the study was reestablished using results of tests on soil samples taken from the plowlayer in the spring of 1966. The original treatments, the initial soil test values in 1961, and results of the tests on the 1966 samples are given in Appendix Table XVIII. For the new study 4 tons of calcium limestone per acre were added to all plots and the same amounts of plowdown P_2O_5 were applied to the same plots which received the original treatments in 1961. Half of the new treatments was applied to the plot surfaces and disced in. The plots were then plowed and the remaining half was disced into the plowed surface when the seedbed was prepared for the new seeding of Buffalo alfalfa in the fall of 1966. In addition to the plowdown applications, some plots were to get annual topdressings of P_2O_5 and K_2O.

The experimental design was a randomized block with four replications. Treatments, total yields, and yields of four different cuttings and their percentages of total yields are given in Table 11. Yields for 1970 were not included in the report as dry weather did not allow a fourth cutting; however, total yields were only reduced from 0.2 to 0.6 ton per acre by the drouth (Table 1).

At the termination of the study (fall of 1971) the plots were sampled and tested by 1 inch depths to a depth of six inches by the methods reported above. Results of the tests for P_2O_5 and exchangeable K are given in Table 12. Complete test results are given in Appendix Table XVIII.

Results and Discussion

Hay Yields

Data from the original study indicated that potassium could have been a limiting nutrient, although Myers (10) showed that rainfall during the period of that study would have limited hay yields to about 3 tons per acre. Results of this study (Table 11) show optimum yields of 3.5 tons per acre were produced by treatments 5, 6, 7, 8, which included annual topdressings of P_2O_5 and K_2O. Average soil test values for P_2O_5 and exchangeable K (Table 12) are at acceptable levels, or above, on these treatment plots, indicating these nutrients were not further limiting yields. Rainfall data for the period of the study (Table 1) show

Table 11--Effects of Plowdown and Topdressed Applications of Phosphorus and Potassium on Yields of Alfalfa Gerald Silt Loam (1967-70)

Treatments: Plowdown P_2O_5	Treatments: Plowdown K_2O	Treatments: Topdress	Yields of Hay Tons/Acre (4-year means): Total	1st cut	% Total	2nd cut	% Total	3rd cut	% Total	4th cut	% Total
1. 200	240		2.89b	1.07	37.0	0.80	27.7	0.59	20.4	0.43	14.9
2. 400	240		2.91b	1.06	36.4	0.80	27.5	0.58	19.9	0.47	16.2
3. 0	240		2.01c	0.68	33.8	0.54	26.9	0.41	20.4	0.38	18.9
4. 600	240		3.03b	1.18	38.9	0.80	26.4	0.57	18.8	0.48	15.8
5. 400	240	0+30+90	3.35a	1.14	34.0	0.94	28.1	0.70	20.9	0.57	17.0
6. 400	120	0+30+90	3.60a	1.23	34.2	1.01	28.1	0.77	21.4	0.59	16.4
7. 400	240	0+90+180	3.50a	1.23	35.1	0.96	27.4	0.71	20.4	0.60	17.1
8. 400	120	0+90+180	3.35a	1.19	35.5	0.92	27.5	0.64	19.1	0.60	17.9
9. 400	240	0+90+180	3.00b	1.13	37.7	0.80	26.6	0.54	18.0	0.53	17.7

Table 12--Final P_2O_5 and Exchangeable K Values by One Inch Depths under Alfalfa Receiving Plowdown and Topdressed Applications of Phosphorus and Potassium (1971)

Depth Inches	P_2O_5 (Bray P_2) Lbs./Acre — Treatments*: 1	2	3	4	5	6	7	8	9	Exchangeable K Lbs./Acre — Treatments: 1	2	3	4	5	6	7	8	9
0-1	60	119	41	247	234	224	394	385	408	304	268	244	212	380	368	608	520	672
1-2	37	69	23	151	115	105	279	279	321	140	124	124	108	212	216	352	300	420
2-3	32	64	18	133	69	82	133	151	170	88	72	88	80	108	104	188	180	276
3-4	27	60	18	105	60	60	96	110	96	80	84	68	76	84	80	120	116	168
4-5	18	41	18	128	55	60	55	87	73	80	72	68	76	92	76	96	104	112
5-6	18	41	18	124	50	60	60	119	73	56	68	72	72	80	76	80	92	100
Avg.	32	66	23	148	97	99	170	189	190	125	115	111	104	159	153	241	219	291

*See Table 11 for description of treatments.

numerous dry periods during the growing seasons, indicating that soil moisture very probably limited yields to the levels reported.

Soil Test Values

Care was taken to uniformly mix the plowdown P_2O_5, K_2O, and limestone treatments throughout the plowlayer before seeding the plots in the fall of 1966. The pHs data (Appendix Table XVIII) indicate uniform mixing was obtained: pHs values for all six depths and all treatments were uniform with an average value of 6.4.

The array of P_2O_5 and exchangeable K values at the six different depths for treatments 5, 6, 7, and 8 obtained in the fall of 1971 (Table 12) are of special interest. The data show that alfalfa also extracted nutrients to low levels in the lower portion of the plowlayer. Treatments 5 and 6 have practically equal average P_2O_5 and exchangeable K values of 98 pounds and 156 pounds per acre, respectively; however, plots receiving these two treatments had low P_2O_5 and exchangeable K values at the third depth and below. The average P_2O_5 and exchangeable K values for treatments 7 and 8 are considerably higher than those of treatments 5 and 6 and have low values for these nutrients only in the lower two depths. This data would indicate that where surface P_2O_5 and K_2O applications are high, the alfalfa plants use the surface-applied nutrients and are less likely to extract the nutrients to low levels from the plowlayer.

These results agree with those of Peterson and Smith (11) who recently reported the ease with which alfalfa absorbs K from topdressed applications of K_2O. Although there were no significant differences in the four-year average yields for treatments 5, 6, 7, and 8, the yields in 1971 were 3.02, 3.10, 3.42, and 3.50 tons per acre, respectively. These data indicate that by 1971, treatments 5 and 6 could have been limiting in both P_2O_5 and K_2O since the higher topdressed applications of 7 and 8 sustained appreciably higher yields in 1971. The average soil test values for P_2O_5 and exchangeable K for treatments 7 and 8 are fairly high, indicating a smaller P_2O_5 and K_2O application rate, possibly 0+60+150, could have been as effective in maintaining yields as 0+90+180. Treatment 4, getting only plowdown treatments of P_2O_5 and K_2O produced yields equal to any treatment the first two years of the study. By 1971 the yield declined to 2.24 tons per acre, reducing the four-year average yield to 3.03 tons per acre. The average soil test values for this treatment are 148 and 104 pounds per acre for P_2O_5 and exchangeable K, respectively. The low K value indicates it was the limiting factor.

The lower average yield of treatment 9 was caused by the yield of the fourth replication being low three out of the four years. The yields of the other replications of the treatment were equal to those of treatments 7 and 8. The reason for the low yield of the fourth replication of treatment 9 is unknown.

The results of this study indicate that the exchangeable K level during the original study was low and could have resulted in the loss of stand. Also indicated, is that alfalfa plants extract nutrients to low levels in the lower portion of the plowlayer without a reduction in yield if adequate amounts of P_2O_5 and K_2O are topdressed annually.

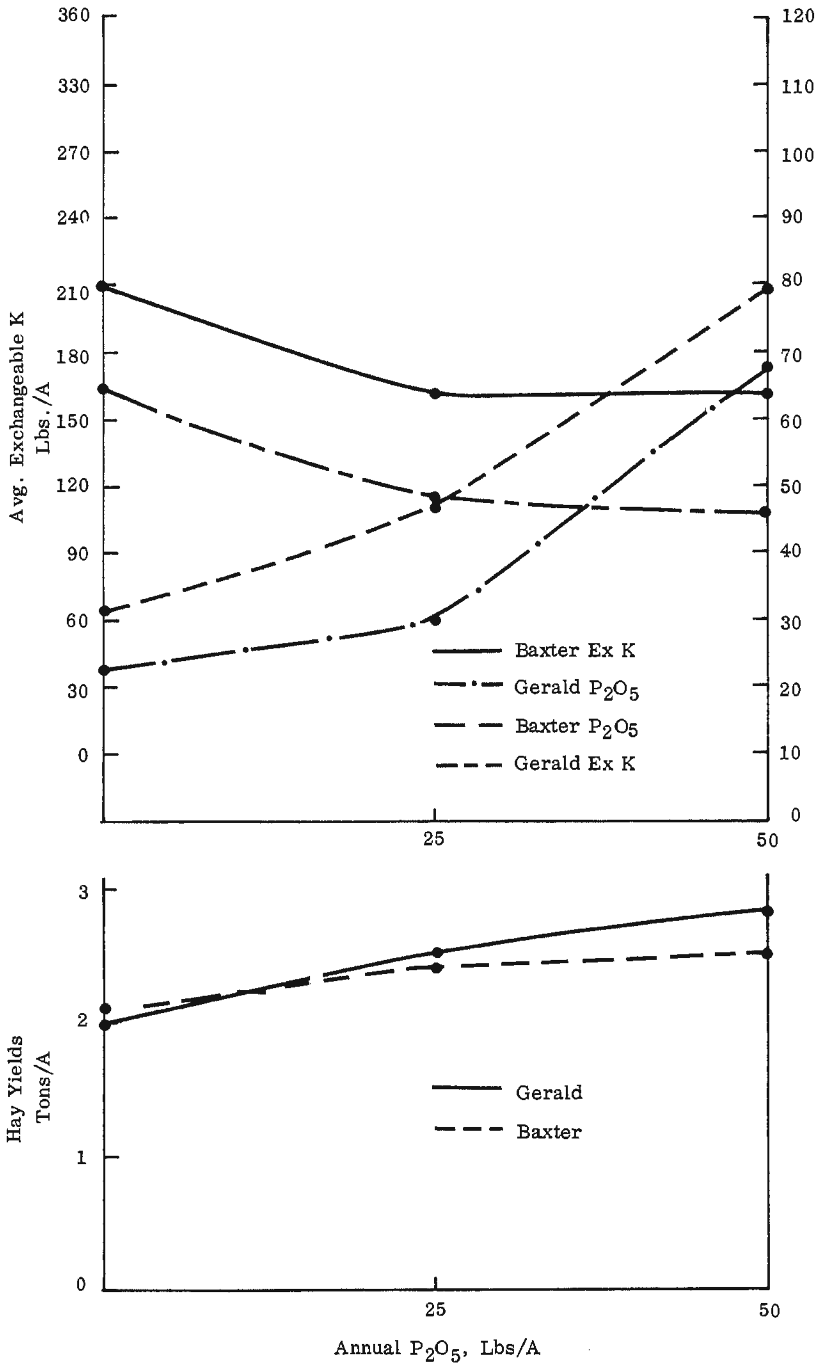

Figure 6: The relationship between yields of orchardgrass-alfalfa, average soil test $P_2O_5(P_2)$ and exchangeable K values, and rates of P_2O_5, at a uniform rate of 100 lbs. K_2O and 40 lbs. N/A.

Study VI

EFFECT OF LIMESTONE AND TOPDRESSED NITROGEN, PHOSPHORUS AND POTASSIUM ON THE PRODUCTION OF FESCUE-LESPEDEZA PASTURES, GERALD SILT LOAM

A study to evaluate the effect of limestone and topdressed nitrogen, phosphorus, and potassium, on the establishment and production of fescue-lespedeza pastures was started at the Southwest Center in the fall of 1963. The basic objective was to find the minimum amounts of limestone and fertilizer necessary to establish and maintain an effective fescue-lespedeza pasture. The site selected was an unlimed and unfertilized portion of Gerald silt loam, the structure of which proved to be very unstable as hard crusts formed after rains on the new seedbeds making emergence of the grass seedlings difficult. In fact a stand of fescue was not obtained until enough plant residues were produced and incorporated into the soil to produce a relatively porous soil surface.

Procedure

The seed bed for this study was prepared by first applying dolomitic limestone at the rates selected on the appropriate plots and mixing the limestone in the surface three or four inches by discing. Seeding of Kentucky 31 fescue was first attempted in August, 1963, by broadcasting 250 pounds 12-12-12 fertilizer and 18 pounds fescue seed per acre by a brillion seeder. The plots were reseeded by the same method in August 1964. The stand of fescue was poor in the spring of 1965 so additional fescue seed was drilled into the plots using a conventional small grain drill in May and again in October, 1965. Summit lespedeza was overseeded on all plots in the fall of 1965 and again in 1966.

Seven treatments of different nitrogen, phosphorus, and potassium combinations were first topdressed on the limed plots in 1966. The study was terminated in 1970 and results of four of the topdressed combinations on different lime levels are reported in Table 13. Results of the remaining treatments are similar to data for fescue-lespedeza studies reported above and are omitted. In the fall of 1970, soil samples were taken by one inch increments to a depth of seven inches by the sampling method reported above. Results are reported in Table 14 and Appendix Table XIX.

Hay Yields

The data of Table 13 show that 3 tons per acre of magnesium limestone increased yields over no limestone and that 6 tons per acre was no better than 3 tons per acre in affecting yields. The choice of rate and ratio of topdressed nutrients proved to be unfortunate: although nitrogen increased yields (treatments 3 and 4), comparison with treatment 3, Table 9 (Gerald Silt Loam), would indicate that treatment 3 of this study was too low in K_2O to use either the nitrogen or phosphorus efficiently. The results given in Table 9 indicate that for most efficient results, 100 pounds K_2O per acre would have been a minimum under the conditions of this study where the forage was removed. Under a true pasture situation, 50 pounds K_2O per acre annually would possibly be adequate. Rates and time of application of potassium on permanent pastures which have also been topdressed with limestone is an area that needs further study.

Soil Test Results

The three and six tons of limestone per acre had affected the pHs, exchangeable Ca, and exchangeable Mg, to a depth of seven inches during the seven years since discing the limestone into the surface three or four inches. The data in Appendix Table 19 show that the plots treated with three tons of limestone had an average pHs of 5.4, and those treated with six tons, an average of 5.6, as compared to the untreated soil pHs of 4.1. The percent Ca saturation was low however, 47 percent and 50 percent, respectively, with the percent Mg being 21 percent and 23 percent for the same treatments, giving total percent base saturations of 68 percent and 73 percent. The low percent base saturation of this soil at the beginning of the study, 39 percent, could have persisted for several years, explaining the difficulty in getting the stand of fescue.

Comparison of the P_2O_5 and exchangeable soil test values in Table 14 with those in Table 10 would indicate that K was the most probable limiting element in the study since the forage was removed at each harvest. Further study, preferably under pasture conditions, is necessary to determine the rate of K_2O application needed to supply K in needed amounts but not to an excess.

Table 13--Effect of Limestone and Topdressed Nitrogen, Phosphorus and Potassium on Yields in Tons of Hay/Acre of Fescue-Lespedeza Gerald Silt Loam. (1966-70)

Treatments			Yields T/Acre				
No	Limestone T/A	Topdressing	Total	1st cut	% Total	2nd cut	% Total
1.	0	25+25+25	1.00	0.74	74.5	0.26	25.5
2.	3	25+25+25	1.40	0.94	67.0	0.46	33.0
3.	3	50+50+50	1.56	1.16	74.2	0.40	25.8
4.	3	0+50+50	1.08	0.47	43.8	0.61	56.2
5.	6	25+25+25	1.19	0.79	76.3	0.40	23.7
6.	6	50+50+50	1.56	1.18	75.9	0.37	24.1
7.	6	100+50+100	2.30	1.84	79.7	0.47	20.3

Table 14--Final P_2O_5 and Exchangeable K Soil Test Values Under Fescue-Lespedeza Treated with Limestone, Nitrogen, Phosphorus and Potassium Gerald Silt Loam (1970)

	P_2O_5 (Bray P_2) Lbs./A							Exchangeable K Lbs./Acre Lbs./A						
	Treatments*							Treatments						
Depth Inches	1	2	3	4	5	6	7	1	2	3	4	5	6	7
0-1	192	147	257	224	160	284	257	376	192	304	232	292	340	348
1-2	55	50	115	96	60	133	110	240	124	200	140	150	220	176
2-3	32	60	50	41	60	50	60	192	76	136	92	88	120	100
3-4	32	87	41	32	50	50	41	140	72	112	80	88	108	84
4-5	27	142	32	119	64	41	41	164	68	100	76	92	92	80
5-6	27	32	32	27	32	37	32	140	68	96	76	92	88	96
6-7	18	18	27	18	23	23	18	144	76	112	80	96	92	104
Avg	55	77	79	80	64	88	80	199	97	151	111	128	151	141

Initial soil test values 1963: 22 Lbs. P_2O_5/A (P_2), 112 Lbs. K/A, 4.0 pHs.

*See Table 13 for description of treatments.

Table I--Orchardgrass-Alfalfa Topdressed with Nitrogen, Phosphorus and Potassium. Final Soil Test Values by One Inch Depths. Baxter Silt Loam, Purdy, Mo. (1970)

	Organic Matter%					P_2O_5 Bray P_1) Lbs./Acre					P_2O_5 (Bray P_2) Lbs./Acre				
	Treatments					Treatments					Treatments				
Depths	1	2	3	4	Avg	1	2	3	4	Avg	1	2	3	4	Avg
0-1	2.6	2.5	2.5	3.1	2.7	229	174	215	234	213	215	188	183	215	200
1-2	2.1	2.0	2.0	1.9	2.0	69	50	50	73	61	92	69	60	92	78
2-3	1.7	1.7	1.9	1.7	1.8	23	18	27	27	24	37	41	41	41	40
3-4	1.9	1.9	1.7	1.6	1.8	23	23	27	27	25	41	41	55	50	47
4-5	1.7	1.8	1.7	1.8	1.8	18	27	23	27	24	41	50	50	50	48
5-6	1.8	1.7	1.7	1.8	1.8	18	27	23	32	25	41	46	46	64	49
6-7	1.6	1.7	1.6	1.6	1.6	14	18	23	28	18	32	41	55	41	42
Avg	1.9	1.9	1.9	1.9	1.9	56	48	55	63	56	71	68	70	79	72

	Ca Lbs./Acre					Mg Lbs./Acre					K Lbs./Acre				
0-1	1100	900	1100	800	975	110	100	110	90	103	280	228	252	192	238
1-2	1100	1100	1100	1100	1100	90	80	80	70	80	168	132	140	140	145
2-3	1600	1300	1700	1500	1525	110	90	110	90	100	100	76	80	72	82
3-4	1900	1700	1800	1800	1800	140	110	110	110	118	88	64	60	56	67
4-5	1900	2000	1800	1900	1900	140	120	110	110	120	76	56	48	56	59
5-6	1700	1900	2000	1700	1825	130	120	130	230	153	64	56	64	52	59
6-7	1800	2100	1900	1900	1925	130	130	120	120	125	68	64	64	60	64
Avg	1586	1571	1629	1529	1579	121	107	110	117	114	121	97	101	90	102

	pHs					Neutralizable Acidity Me/100 gms.					Cation Exchange Capacity Me/100 gms.				
0-1	4.5	4.4	4.4	4.3	4.4	4.0	4.0	4.0	4.5	4.1	7.5	7.0	7.5	7.0	7.3
1-2	4.4	4.7	4.6	4.4	4.5	4.0	3.0	3.5	4.0	3.6	7.5	6.0	7.0	7.0	6.9
2-3	4.8	5.1	5.2	5.2	5.1	3.0	2.5	2.5	2.5	2.6	7.5	6.0	7.5	6.5	6.9
3-4	5.2	5.3	5.5	5.4	5.4	2.0	2.0	2.0	2.0	2.0	7.5	7.0	7.0	7.0	7.1
4-5	5.4	5.6	5.6	5.6	5.6	1.5	1.5	2.0	2.0	1.8	7.0	7.0	7.0	7.5	7.1
5-6	5.5	5.7	5.6	5.7	5.6	1.5	1.5	2.0	1.5	1.6	6.5	7.0	7.5	7.0	7.0
6-7	5.6	6.0	5.8	5.7	5.8	1.5	1.5	2.0	2.0	1.8	6.5	7.5	7.5	7.5	7.3
Avg	5.1	5.3	5.2	5.2	5.2	2.5	2.3	2.6	2.6	2.5	7.1	6.8	7.3	7.1	7.1

Initial Soil Test Values:

O.M. %	P_2O_5 (Bray P_2) Lbs./A	Ca Lbs./A	Mg Lbs./A	K Lbs./A	pHs	H Me/100 gms.	CEC Me/100 gms.
1.5	45	2400	108	165	6.1	1.6	8.3

Table II--Bromegrass-Alfalfa Topdressed with Nitrogen, Phosphorus and Potassium. Final Soil Test Values by One Inch Depths. Baxter Silt Loam, Purdy, Mo. (1970)

	Organic Matter %					P_2O_5 (Bray P_1) Lbs./Acre					P_2O_5 (Bray P_2) Lbs./Acre				
	Treatments					Treatments					Treatments				
Depths	1	2	3	4	Avg	1	2	3	4	Avg	1	2	3	4	Avg
0-1	2.7	2.9	2.6	3.1	2.8	183	215	206	247	213	206	202	224	234	217
1-2	2.0	1.9	2.0	1.7	1.9	64	50	32	46	48	73	73	50	60	64
2-3	1.7	1.8	1.9	1.6	1.8	23	32	23	23	25	46	64	50	50	53
3-4	1.6	1.6	1.7	1.6	1.6	23	23	32	23	25	50	50	82	60	61
4-5	1.6	1.7	1.8	1.7	1.7	23	23	23	27	24	50	46	64	55	54
5-6	1.6	1.7	1.7	1.6	1.7	23	23	23	32	25	55	50	50	64	55
6-7	1.6	1.7	1.6	1.4	1.6	18	18	27	27	23	41	41	60	50	48
Avg	1.8	1.9	1.9	1.8	1.9	51	55	52	61	55	74	75	83	82	79

	Ca Lbs./Acre					Mg Lbs./Acre					K Lbs./Acre				
0-1	1500	1300	1100	1100	1250	120	130	100	110	115	316	352	384	376	357
1-2	1700	1300	1600	1700	1575	110	90	100	110	103	192	172	168	228	190
2-3	2300	1900	2000	2100	2075	130	110	120	120	120	100	96	100	100	99
3-4	2500	2000	2300	2300	2275	150	110	140	130	133	80	68	76	72	74
4-5	2300	2100	2300	2500	2300	120	110	130	130	123	64	56	64	68	63
5-6	2700	2200	2400	2300	2400	130	120	130	120	125	68	60	72	60	65
6-7	2600	2200	2200	2600	2400	160	130	120	150	140	84	60	56	76	69
Avg	2230	1860	1990	2090	2039	131	114	120	124	123	129	123	131	140	131

	pHs					Neutralizable Acidity Me/100 gms.					Cation Exchange Capacity Me/100 gms.				
0-1	4.7	4.5	4.2	4.2	4.4	3.5	4.0	5.0	5.5	4.5	8.0	8.0	8.5	9.0	8.4
1-2	4.7	4.6	4.8	4.6	4.7	3.5	3.5	3.5	3.5	3.5	8.5	7.5	8.0	8.5	8.1
2-3	5.4	5.4	5.4	5.5	5.4	2.0	2.0	2.0	2.0	2.0	8.5	7.5	7.5	8.0	7.9
3-4	5.7	5.5	5.7	5.9	5.7	2.0	2.0	1.5	1.5	1.8	9.0	7.5	8.0	8.0	8.1
4-5	5.8	5.7	5.8	6.0	5.8	1.5	1.5	1.5	1.0	1.4	8.0	7.5	8.0	8.0	7.9
5-6	6.0	5.8	5.7	6.1	5.9	1.0	1.5	1.5	1.0	1.3	8.5	7.5	8.0	7.5	7.9
6-7	6.0	5.8	6.0	6.1	6.0	1.0	1.5	1.0	1.0	1.1	8.5	7.5	7.0	8.0	7.8
Avg	5.5	5.3	5.4	5.5	5.4	2.1	2.3	2.3	2.2	2.2	8.4	7.6	7.9	8.1	8.0

Initial Soil Test Values:

O.M. %	P_2O_5 (Bray P_2) Lbs./A	Ca Lbs./A	Mg Lbs./A	K Lbs./A	pHs	H Me/100 gms.	CEC Me/100 gms.
1.7	54	2700	126	157	6.5	1.0	8.0

Table III--Fescue Lespedeza (Full Treatment) Topdressed with Nitrogen, Phosphorus and Potassium. Final Soil Test Values by One Inch Depths. Baxter Silt Loam, Purdy, Mo. (1970)

Depths	Organic Matter % Treatments 1	2	3	4	Avg	P_2O_5 (Bray P_1) Lbs./Acre Treatments 1	2	3	4	Avg	P_2O_5 (Bray P_2) Lbs./Acre Treatments 1	2	3	4	Avg
0-1	4.3	4.4	4.7	4.4	4.5	211	192	224	202	207	183	178	183	151	174
1-2	2.3	2.3	2.1	2.3	2.3	119	119	105	101	111	142	124	137	110	128
2-3	1.6	2.0	1.8	2.1	1.9	78	87	64	73	76	101	105	96	96	100
3-4	1.8	2.0	1.9	1.8	1.9	73	87	60	69	72	92	110	87	96	96
4-5	1.9	1.8	1.8	1.8	1.8	64	92	64	69	72	87	119	96	101	101
5-6	2.0	1.9	1.7	1.7	1.8	73	87	69	82	78	92	115	96	119	106
6-7	1.6	1.6	1.5	1.6	1.6	32	55	69	41	49	46	82	82	73	71
Avg	2.2	2.3	2.2	2.2	2.3	93	103	94	91	95	106	119	111	106	111

Depths	Ca Lbs./Acre 1	2	3	4	Avg	Mg Lbs./Acre 1	2	3	4	Avg	K Lbs./Acre 1	2	3	4	Avg
0-1	1700	1300	1400	1200	1400	240	230	270	230	243	568	556	556	476	539
1-2	1400	1400	1600	1600	1500	170	190	220	220	200	500	508	456	372	459
2-3	1700	1800	1700	2000	1800	180	190	190	200	190	396	400	340	244	345
3-4	2100	1900	2100	2100	2050	190	160	210	200	190	340	340	304	172	289
4-5	1900	2000	2200	1900	2000	150	180	220	170	180	200	292	184	112	197
5-6	2100	2000	2000	2200	2075	180	180	230	220	203	176	200	168	112	164
6-7	2200	2200	2300	2000	2175	210	220	280	210	230	160	192	176	104	158
Avg	1870	1800	1930	1860	1857	189	193	231	207	205	334	355	312	227	307

Depths	pHs 1	2	3	4	Avg	Neutralizable Acidity Me/100 gms. 1	2	3	4	Avg	Cation Exchange Capacity Me/100 gms. 1	2	3	4	Avg
0-1	5.0	4.8	4.6	4.4	4.7	3.5	4.0	4.5	5.0	4.3	9.5	9.0	10.0	9.5	9.5
1-2	4.7	4.8	4.8	4.8	4.8	3.5	3.0	3.0	4.0	3.4	8.5	8.0	8.5	9.5	8.6
2-3	5.0	5.1	5.1	5.2	5.1	3.0	3.0	3.0	3.0	3.0	8.5	9.0	8.5	9.0	8.8
3-4	5.1	5.2	5.3	5.3	5.2	2.5	2.5	2.0	2.5	2.4	9.0	8.5	8.5	9.0	8.8
4-5	5.4	5.3	5.4	5.5	5.4	2.0	2.5	2.0	2.5	2.3	7.5	8.5	8.5	8.0	8.1
5-6	5.5	5.5	5.4	5.5	5.5	2.0	2.0	2.0	2.0	2.0	8.0	8.0	8.5	8.5	8.3
6-7	5.5	5.5	5.1	5.5	5.4	2.5	2.0	3.0	2.0	2.4	9.0	8.5	10.0	8.0	8.9
Avg	5.2	5.2	5.1	5.2	5.2	2.7	2.7	2.8	3.0	2.8	8.6	8.5	8.9	8.8	8.7

Initial Soil Test Values:

O.M. %	P_2O_5 (Bray P_2) Lbs./A	Ca Lbs./A	Mg Lbs./A	K Lbs./A	pHs	H Me/100 gms.	CEC Me/100 gms.
1.8	41	2030	214	193	5.6	2.6	7.8

Table IV--Fescue Lespedeza (Half Treatment) Topdressed with Nitrogen, Phosphorus and Potassium. Final Soil Test Values by One Inch Depths. Baxter Silt Loam, Purdy, Mo. (1970)

	Organic Matter %					P_2O_5 (Bray P_1) Lbs./Acre					P_2O_5 (Bray P_2) Lbs./Acre				
	Treatments					Treatments					Treatments				
Depths	1	2	3	4	Avg	1	2	3	4	Avg	1	2	3	4	Avg
0-1	4.9	4.2	4.3	4.2	4.4	156	170	178	183	172	170	202	192	183	187
1-2	2.3	2.1	2.3	2.3	2.3	92	96	82	64	84	96	115	119	87	104
2-3	2.0	1.8	2.3	2.0	2.0	32	32	37	27	32	46	50	69	41	52
3-4	2.0	1.8	2.0	2.0	1.9	32	27	32	27	30	46	50	55	41	48
4-5	2.0	1.9	2.0	2.0	2.0	27	32	27	18	26	46	55	46	37	46
5-6	2.0	2.0	1.8	1.9	1.9	27	32	18	27	26	41	60	37	46	46
6-7	1.9	1.8	1.7	1.9	1.8	23	23	18	18	21	37	50	37	32	39
Avg	2.4	2.2	2.3	2.3	2.3	56	59	56	52	56	69	83	79	62	75

	Ca Lbs./Acre					Mg Lbs./Acre					K Lbs./Acre				
0-1	1300	1000	1200	800	1075	190	170	200	150	178	540	504	536	460	510
1-2	1200	1200	1200	1200	1200	120	120	120	110	118	568	500	392	376	459
2-3	1400	1400	1500	1700	1500	90	90	90	90	90	480	400	340	308	382
3-4	1500	1500	1500	1700	1550	70	60	60	50	60	372	336	240	184	283
4-5	1700	1600	1800	1800	1725	60	50	60	50	55	324	236	192	140	223
5-6	1700	1800	1900	1800	1800	60	50	60	50	55	220	192	144	104	165
6-7	1600	1800	1800	1800	1750	70	60	60	60	63	160	144	132	92	132
Avg	1490	1470	1560	1540	1514	94	86	93	80	88	381	330	282	238	306

	pHs					Neutralizable Acidity Me/100 gms.					Cation Exchange Capacity Me/100 gms.				
0-1	5.0	4.7	4.7	4.5	4.7	3.0	4.0	4.0	4.0	3.8	7.5	8.0	8.5	7.0	7.8
1-2	4.9	4.9	4.9	4.8	4.9	3.0	3.0	3.0	3.0	3.0	7.0	7.0	7.0	7.0	7.0
2-3	5.1	5.2	5.2	5.2	5.2	2.5	2.5	2.5	2.5	2.5	7.0	7.0	7.0	7.5	7.1
3-4	5.3	5.3	5.4	5.5	5.4	2.5	2.0	2.0	2.0	2.1	7.0	6.5	6.5	6.5	6.6
4-5	5.4	5.5	5.5	5.6	5.5	2.0	2.0	2.0	2.0	2.0	7.0	6.5	7.0	7.0	6.9
5-6	5.5	5.6	5.6	5.6	5.6	2.0	2.0	2.0	2.0	2.0	7.0	7.0	7.0	7.0	7.0
6-7	5.6	5.8	5.7	5.8	5.7	2.0	1.5	2.0	1.5	1.8	6.5	6.5	7.0	6.5	6.6
Avg	5.3	5.3	5.3	5.3	5.3	2.4	2.4	2.5	2.4	2.5	7.0	6.9	7.1	6.9	7.0

Initial Soil Test Values

O.M. %	P_2O_5 (Bray P_2) Lbs./A	Ca Lbs./A	Mg Lbs./A	K Lbs./A	pHs	H Me/100 gms.	CEC Me/100 gms.
1.9	51	2040	131	156	6.0	1.7	7.6

Table V--Orchardgrass-Alfalfa Topdressed with Phosphorus and Potassium (Baxter Silt Loam) Final Soil Test Values by One Inch Depths (1969)

	Organic Matter %							P_2O_5 (Bray P_1) Lbs./Acre							P_2O_5 (Bray P_2) Lbs./Acre						
	Treatments							Treatments							Treatments						
Depths	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
0-1	3.5	3.5	3.2	3.4	3.4	3.0	3.8	234	270	202	27	50	18	202	311	302	247	284	96	37	284
1-2	2.3	2.3	2.3	2.0	2.3	2.3	2.1	105	92	41	14	18	9	50	128	124	64	353	41	18	87
2-3	2.3	2.0	2.0	2.0	2.0	2.0	2.0	32	37	23	18	14	9	27	55	60	41	344	32	18	60
3-4	2.0	2.0	2.0	1.6	2.0	2.0	1.9	18	23	18	14	18	9	14	37	41	37	105	41	27	32
4-5	2.0	1.8	1.9	1.8	1.9	1.9	1.8	18	18	18	14	14	9	18	27	32	41	41	32	14	37
5-6	1.7	1.8	2.0	1.7	1.9	1.9	1.6	14	14	14	14	14	9	18	18	32	27	46	23	14	32
Avg	2.3	2.2	2.2	2.1	2.3	2.2	2.2	70	76	53	17	21	11	55	96	99	76	196	44	21	89

	Ca Lbs./Acre							Mg Lbs./Acre							K Lbs./Acre						
0-1	3200	2800	2500	2200	2700	2600	2800	470	500	460	390	490	490	480	156	208	412	376	440	512	600
1-2	2800	2700	2700	2600	2400	2600	2500	300	390	400	380	360	400	380	84	116	272	316	252	388	456
2-3	2900	2900	2600	2400	2800	2500	2500	250	330	320	290	330	320	330	80	92	144	160	152	280	264
3-4	2700	2700	2500	2700	2500	2600	2800	230	280	280	290	260	280	300	80	88	104	136	104	180	160
4-5	2600	2700	2700	2500	2500	2700	2700	230	260	300	260	220	270	380	80	84	100	100	96	152	124
5-6	2800	2800	2400	2500	2700	2700	2500	320	340	330	280	270	300	320	100	92	100	100	96	132	116
Avg	2830	2770	2570	2480	2600	2620	2630	300	350	350	320	320	340	370	97	113	189	198	223	274	287

	pHs							Neutralizable Acidity Me/100 gms.							Cation Exchange Capacity Me/100 gms.						
0-1	6.8	6.5	6.5	6.8	6.7	6.9	6.7	0.0	1.0	0.5	0.5	0.5	0.0	0.5	10.0	10.5	9.0	8.0	10.0	9.0	10.5
1-2	6.8	6.5	6.4	6.5	6.5	6.7	6.3	0.0	1.0	1.0	1.0	1.0	0.5	1.0	8.5	9.5	10.0	9.5	9.0	9.0	9.5
2-3	6.7	6.5	6.4	6.5	6.4	6.6	6.3	0.5	1.0	1.0	1.0	1.0	0.5	1.0	9.0	9.5	9.0	8.5	9.5	8.5	9.0
3-4	6.7	6.5	6.4	6.4	6.4	6.5	6.4	0.5	1.0	1.0	1.0	1.0	0.5	1.0	8.5	9.0	8.5	9.0	8.5	8.5	9.5
4-5	6.6	6.4	6.3	6.5	6.5	6.5	6.4	0.5	1.0	1.0	1.0	1.0	1.0	1.0	8.0	9.0	9.0	8.5	8.5	9.0	9.5
5-6	6.5	6.4	6.3	6.4	6.5	6.6	6.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	9.5	9.5	8.5	8.5	9.0	9.0	8.5
Avg	6.7	6.5	6.4	6.5	6.5	6.6	6.4	0.6	1.0	0.9	0.9	0.9	0.6	0.9	8.9	9.5	9.0	8.7	9.1	8.8	9.4

Table VI--Soil Test Values for Plow Layer Orchardgrass-Alfalfa Phosphorus and Potassium Topdressing Study Baxter Silt Loam (1966)

Treatments	O.M. %	P_2O_5 P_1 Lbs./A	P_2O_5 P_2 Lbs./A	Ca Lbs./A	Mg Lbs./A	K Lbs./A	pHs	H Me/100 gms	CEC Me/100 gms
1. 0+50+50	2.1	57	94	3800	280	120	6.6	.8	11.6
2. 0+50+0	2.3	38	72	3430	330	167	6.4	1.0	11.2
3. 0+50+100	2.1	29	68	3670	320	233	6.5	1.2	12.0
4. 0+480+100	2.0	21	156	3500	290	277	6.3	1.5	11.8
5. 0+25+100	2.3	22	59	3230	320	220	6.5	1.3	11.0
6. 0+0+100	2.1	31	67	3100	330	277	6.5	1.3	10.8
7. 0+50+150	2.2	66	117	2900	300	333	6.4	1.3	10.2
Initial Values 1961	1.8	--	58	2790	347	204	6.0	1.7	10.8

Treatments topdressed in spring, ½ K_2O of treatments 3, 4, 5, 6 and 7 in April, ½ in June. The P_2O_5 of treatment 4 plowed down as rock phosphate in 1961.

Table VII--Orchardgrass-Alfalfa Topdressed with Phosphorus and Potassium (Gerald Silt Loam) Final Soil Test Values by One Inch Depths (1969)

	Organic Matter %							P_2O_5 (Bray P_1) Lbs./Acre							P_2O_5 (Bray P_2) Lbs./Acre						
	Treatments							Treatments							Treatments						
Depth	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
0-1	3.8	4.4	3.4	4.2	3.6	3.3	4.2	215	151	133	137	37	18	128	293	234	206	247	69	27	183
1-2	2.8	2.9	2.8	2.9	3.1	2.7	2.7	60	32	32	32	18	14	32	96	46	50	128	37	18	50
2-3	2.6	2.7	2.6	2.6	2.6	2.8	2.6	27	14	18	14	14	9	18	41	23	32	60	23	14	32
3-4	2.5	2.6	2.5	2.4	2.4	2.7	2.6	18	14	14	14	14	9	14	18	18	18	32	27	14	18
4-5	2.5	2.5	2.3	2.3	2.5	2.4	2.3	14	14	14	14	9	9	14	18	18	18	18	14	14	14
5-6	2.6	2.5	2.3	2.3	2.5	2.6	2.3	14	14	14	9	14	9	14	23	18	27	18	18	14	18
Avg	2.8	2.9	2.7	2.8	2.8	2.8	2.8	58	40	38	37	18	11	37	82	59	59	84	31	17	53

	Ca Lbs./Acre							Mg Lbs./Acre							K Lbs./Acre						
0-1	2800	3000	2800	2700	2800	2700	2700	480	490	450	470	520	490	480	136	264	420	480	392	540	580
1-2	2800	2800	2500	2700	2600	2600	2300	360	370	330	410	410	410	380	72	120	188	300	204	384	340
2-3	2600	2800	2400	2300	2600	2600	2400	280	290	270	290	360	340	340	64	80	96	144	120	208	168
3-4	2100	2300	2100	2300	2400	2300	2400	200	200	180	230	280	240	260	56	64	68	108	92	124	112
4-5	2100	2400	1900	2000	2300	2400	2200	180	180	150	170	220	210	200	60	72	68	84	80	116	84
5-6	1900	2100	1700	1800	2100	2100	2000	170	180	140	160	200	200	170	60	72	80	84	76	112	84
Avg	2380	2570	2230	2300	2470	2450	2330	278	285	253	288	284	315	305	75	112	153	200	161	247	228

	pHs							Neutralizable Acidity Me/100 gms.							Cation Exchange Capacity Me/100 gms.						
0-1	6.6	6.2	6.2	6.3	6.3	6.3	6.2	0.5	1.0	1.0	1.0	1.0	1.0	1.5	9.5	11.0	10.5	10.5	10.5	10.5	11.0
1-2	6.2	6.0	5.9	6.0	6.1	6.1	5.7	1.0	1.0	1.5	2.0	1.0	1.5	2.0	9.5	9.5	9.5	11.0	9.5	10.0	10.0
2-3	5.7	5.8	5.6	5.7	5.8	5.9	5.6	2.0	1.5	2.0	2.0	2.0	2.0	2.0	9.5	10.0	9.0	9.0	10.0	10.0	9.5
3-4	5.3	5.6	5.4	5.3	5.6	5.6	5.5	3.0	2.0	2.5	2.5	2.0	2.0	3.0	9.0	8.5	8.5	9.5	9.5	9.0	10.0
4-5	5.0	5.2	5.1	5.1	5.3	5.4	5.3	4.0	3.0	3.0	3.0	3.0	3.0	3.0	10.0	10.0	8.5	9.0	10.0	10.0	9.5
5-6	4.9	5.0	4.8	4.8	5.0	5.2	5.0	4.0	3.5	4.0	3.5	4.0	3.5	3.5	9.5	9.5	9.0	9.0	10.0	9.5	9.5
Avg	5.6	5.6	5.5	5.5	5.7	5.8	5.6	2.4	2.0	2.3	2.3	2.2	2.2	2.5	9.5	9.8	9.2	9.7	9.9	9.8	9.9

Table X--Soil Test Values for Plow Layer Orchardgrass-Alfalfa Nitrogen, Phosphorus and Potassium. Topdressing Study Baxter Silt Loam (1968)

Treatments	O.M. %	P_2O_5 P_1 Lbs./A	P_2O_5 P_2 Lbs./A	Ca Lbs./A	Mg Lbs./A	K Lbs./A	pHs	H Me/100 gms	CEC Me/100 gms
1. 40+50+0	2.1	49	75	3330	303	113	6.4	1.2	10.9
2. 0+50+50	1.9	45	100	4520	303	187	6.7	1.0	12.8
3. 40+50+100	2.1	41	76	3950	293	228	6.5	1.2	12.6
4. 40+480+100	2.0	22	234	4100	273	227	6.5	1.5	13.2
5. 40+25+100	1.9	27	56	3850	303	235	6.6	1.2	12.4
6. 40+0+100	2.2	23	35	3980	280	230	6.5	1.2	12.6
7. 40+50+150	2.1	38	79	3900	277	283	6.5	1.3	12.6
Initial Values 1961	1.8	--	66	2900	301	247	5.7	2.9	11.72

Treatments topdressed in spring, ½ K_2O of treatments 3,4,5,6 and 7 in April, ½ in June. The P_2O_5 of treatment 4 plowed down as rock phosphate in 1961.

Table XI--Orchardgrass-Alfalfa Topdressed with Nitrogen, Phosphorus and Potassium (Gerald Silt Loam) Final Soil Test Values by One Inch Depths (1970)

Organic Matter %

Depths	Treatments 1	2	3	4	5	6	7
0-1	3.7	3.0	3.8	3.7	4.1	3.7	3.8
1-2	2.7	2.4	2.7	2.7	2.7	2.8	2.5
2-3	2.7	2.3	2.4	2.5	2.2	2.3	2.3
3-4	2.4	2.3	2.4	2.4	2.3	2.4	2.3
4-5	2.3	2.5	2.3	2.2	2.3	2.4	2.3
5-6	2.3	2.2	2.3	2.4	2.2	2.4	2.3
Avg	2.7	2.5	2.7	2.7	2.6	2.7	2.6

P_2O_5 (Bray P_1) Lbs./Acre

Depths	Treatments 1	2	3	4	5	6	7
0-1	211	137	160	41	41	37	174
1-2	59	46	46	27	32	32	59
2-3	37	32	32	23	32	32	41
3-4	37	32	27	27	32	27	37
4-5	46	37	37	23	27	27	46
5-6	37	37	32	27	37	23	41
Avg	71	54	56	28	34	30	66

P_2O_5 (Bray P_2) Lbs./Acre

Depths	Treatments 1	2	3	4	5	6	7
0-1	256	174	188	82	59	32	224
1-2	69	64	55	82	23	23	69
2-3	46	46	41	114	23	23	41
3-4	41	37	37	110	27	23	37
4-5	50	41	41	160	27	18	55
5-6	37	32	37	110	23	18	46
Avg	83	66	67	110	30	23	79

Ca Lbs./Acre

Depths	1	2	3	4	5	6	7
0-1	2600	2600	2000	2300	2000	2000	2000
1-2	2800	2600	2700	2600	2300	2200	2000
2-3	2900	2700	2700	2600	2400	2400	2400
3-4	2800	2800	2800	2600	2700	2500	2600
4-5	2600	2800	2600	2600	2600	2600	2500
5-6	2300	2400	2500	2300	2500	2400	2200
Avg	2670	2650	2550	2500	2420	2350	2280

Mg Lbs./Acre

Depths	1	2	3	4	5	6	7
0-1	410	360	270	310	300	310	260
1-2	360	310	330	310	290	280	240
2-3	360	320	320	310	300	310	290
3-4	320	330	330	310	350	320	340
4-5	310	340	330	310	350	330	350
5-6	290	310	300	310	370	320	330
Avg	342	328	313	310	327	312	302

K Lbs./Acre

Depths	1	2	3	4	5	6	7
0-1	108	132	268	296	332	456	476
1-2	80	92	156	164	172	268	284
2-3	84	80	108	92	92	148	148
3-4	80	92	96	92	96	96	112
4-5	80	92	96	92	84	96	104
5-6	84	80	96	92	88	92	96
Avg	86	95	137	138	144	193	203

pHs

Depths	1	2	3	4	5	6	7
0-1	5.2	5.2	4.9	5.1	4.9	5.0	4.8
1-2	5.4	5.2	5.2	5.2	4.9	5.1	4.8
2-3	5.5	5.3	5.3	5.4	5.2	5.2	5.2
3-4	5.5	5.4	5.2	5.3	5.4	5.4	5.4
4-5	5.3	5.3	5.3	5.3	5.5	5.6	5.4
5-6	4.9	5.1	5.1	5.2	5.3	5.3	5.2
Avg	5.3	5.3	5.2	5.3	5.2	5.3	5.1

Neutralizable Acidity Me/100 gms.

Depths	1	2	3	4	5	6	7
0-1	4.0	3.0	5.0	4.0	4.0	3.5	4.5
1-2	3.0	3.0	3.5	3.5	4.5	3.5	4.5
2-3	3.0	3.5	3.0	3.0	3.5	3.0	4.0
3-4	3.0	3.0	3.0	3.0	3.0	3.0	3.0
4-5	3.0	3.0	3.5	3.5	2.5	2.5	3.0
5-6	4.5	3.5	4.0	4.0	3.0	3.0	3.5
Avg	3.4	3.2	3.7	3.5	3.4	3.1	3.8

Cation Exchange Capacity Me/100 gms.

Depths	1	2	3	4	5	6	7
0-1	12.5	11.0	11.5	11.5	10.5	10.5	11.0
1-2	11.5	11.0	12.0	11.5	11.5	10.5	11.0
2-3	12.0	11.5	11.0	11.0	11.0	10.5	11.5
3-4	11.5	11.5	11.5	11.0	11.5	10.5	11.0
4-5	11.0	11.5	11.5	11.5	10.5	10.5	11.0
5-6	11.5	11.0	11.5	11.0	11.0	10.5	10.5
Avg	11.7	11.3	11.5	11.3	11.0	10.5	11.0

Table XII--Soil Test Values for Plow Layer Orchardgrass-Alfalfa Nitrogen, Phosphorus and Potassium Topdressing Study Gerald Silt Loam (1968)

Treatments	O.M. %	P_2O_5 P_1 Lbs./A	P_2O_5 P_2 Lbs./A	Ca Lbs./A	Mg Lbs./A	K Lbs./A	pHs	H Me/100 gms	CEC Me/100 gms
1. 40+50+0	2.8	48	82	2300	240	80	5.3	3.8	10.7
2. 0+50+50	2.6	51	76	2230	356	98	5.3	3.7	10.9
3. 40+50+100	2.6	55	78	2670	257	197	5.4	3.7	11.7
4. 40+480+100	2.3	34	133	2450	253	170	5.2	3.7	11.1
5. 40+25+100	2.4	35	41	2770	243	172	5.2	3.7	11.9
6. 40+0+100	2.4	34	42	2270	253	178	5.2	3.5	10.48
7. 40+50+150	2.4	62	80	2070	327	228	5.0	4.0	10.8
Initial Values 1961	2.2	--	44	970	173	137	4.3	4.7	8.0

Treatments topdressed in spring, ½ K_2O of treatments 3,4,5,6 and 7 in April, ½ in June. The P_2O_5 of treatment 4 plowed down as rock phosphate in 1961.

Table XIII-Fescue-Lespedeza Topdressed with Nitrogen, Phosphorus and Potassium (Baxter Silt Loam) Final Soil Test Values by One Inch Depths (1970)

	Organic Matter %							P_2O_5 (Bray P_1) Lbs./Acre							P_2O_5 (Bray P_2) Lbs./Acre						
	Treatments							Treatments							Treatments						
Depths	1	2	3	4	5*	6	7	1	2	3	4	5*	6	7	1	2	3	4	5*	6	7
0-1	4.7	4.4	3.9	4.3	---	4.2	4.8	234	243	234	50	---	32	257	257	270	270	371	---	46	311
1-2	2.5	2.5	2.5	2.5	2.5	2.7	2.5	147	170	174	32	60	18	206	170	178	211	353	78	32	224
2-3	2.0	2.1	2.3	2.3	2.3	2.0	2.0	55	73	94	32	41	14	101	73	101	344	344	55	32	137
3-4	1.9	2.0	2.3	1.9	2.1	2.0	2.0	27	32	37	32	27	14	46	46	50	64	247	41	27	64
4-5	2.0	2.1	2.0	1.9	1.9	2.0	2.0	27	27	27	37	27	14	27	41	37	41	96	37	23	41
5-6	1.9	2.1	1.8	2.0	2.0	2.0	2.0	18	18	23	18	23	18	27	27	27	37	46	32	27	41
Avg	2.5	2.5	2.5	2.5	---	2.5	2.6	85	94	98	34	---	18	111	102	110	161	243	---	31	136

	Ca Lbs./Acre							Mg Lbs./Acre							K Lbs./Acre						
0-1	2900	2900	2400	2400	----	2600	2300	590	530	450	450	---	550	460	204	376	528	504	---	580	580
1-2	2600	2400	2200	2400	2400	2400	2300	440	380	360	390	360	420	370	108	204	392	480	436	528	592
2-3	2600	2300	2400	2300	2300	2300	2400	320	280	360	270	260	310	310	84	124	600	320	304	352	508
3-4	2400	2500	2300	2400	2600	2400	2400	240	250	250	220	230	260	250	80	108	276	268	284	324	380
4-5	2500	2700	2400	2600	2400	2500	2800	220	240	230	220	180	210	240	80	115	280	296	240	280	376
5-6	2200	2600	2300	2700	2500	2300	2700	200	220	210	190	190	170	310	76	108	264	212	240	240	332
Avg	2530	2570	2330	2470	----	2420	2480	335	317	310	290	---	320	307	105	173	390	347	---	384	461

	pHs							Neutralizable Acidity Me/100 gms.							Cation Exchange Capacity Me/100 gms.						
0-1	6.5	6.4	6.5	6.7	---	6.6	6.4	1.0	1.0	0.5	0.5	---	0.5	0.5	11.0	11.0	9.0	9.0	---	10.0	9.0
1-2	6.5	6.4	6.4	6.6	6.4	6.6	6.4	1.0	1.0	1.0	0.5	1.0	0.5	1.0	9.5	9.0	8.5	8.5	9.0	9.0	9.0
2-3	6.4	6.5	6.6	6.6	6.5	6.5	6.4	1.0	1.0	1.0	0.5	1.0	1.0	1.0	9.0	8.0	9.5	8.0	8.0	8.5	9.0
3-4	6.4	6.5	6.4	6.6	6.6	6.5	6.4	1.0	1.0	1.0	0.5	0.5	1.0	1.0	8.0	8.5	8.0	8.0	8.5	8.5	8.5
4-5	6.4	6.5	6.3	6.5	6.5	6.5	6.5	1.0	1.0	1.0	0.5	0.5	1.0	0.5	8.5	9.0	8.5	8.5	7.5	8.5	9.0
5-6	6.4	6.4	6.4	6.6	6.5	6.6	6.6	1.0	1.0	1.0	0.5	0.5	0.5	0.5	7.5	8.5	8.0	8.5	8.0	7.5	8.5
Avg	6.4	6.5	6.4	6.6	---	6.6	6.5	1.0	1.0	0.9	0.5	---	0.8	0.8	8.9	9.0	8.6	8.4	----	8.7	8.8

* 0-1 inch sample of treatment 5 lost.

Table XIV--Soil Test Values for Plow Layer Fescue-Lespedeza Nitrogen, Phosphorus and Potassium Topdressing Study Baxter Silt Loam (1966)

Treatments	O.M. %	P_2O_5 P_1 Lbs./A	P_2O_5 P_2 Lbs./A	Ca Lbs./A	Mg Lbs./A	K Lbs./A	pHs	H Me/100 gms	CEC Me/100 gms
1. 30+50+0	2.2	85	127	3150	270	215	6.3	1.0	10.3
2. 30+50+50	2.3	83	130	3080	270	250	6.3	1.0	10.1
3. 30+50+100	2.4	112	161	3000	275	395	6.2	.8	10.0
4. 30+480+100	2.2	42	355	3750	260	418	6.5	.7	11.7
5. 30+25+100	2.3	64	97	2950	240	447	6.5	1.0	10.0
6. 30+0+100	2.5	21	36	2880	237	405	6.4	1.0	9.7
7. 30+50+150	2.3	118	163	3030	240	507	6.3	1.2	10.4
Initial Values 1961	2.0	---	63	3240	264	230	5.8	2.1	11.6

Treatments topdressed in spring, ½ K_2O of treatments 3,4,5,6 and 7 in April, ½ in June. The P_2O_5 of treatment 4 plowed down in 1961.

Table XV--Fescue-Lespedeza Topdressed with Nitrogen, Phosphorus and Potassium (Gerald Silt Loam) Final Soil Test Values by One Inch Depths (1970)

	Organic Matter %							P_2O_5 (Bray P_1) Lbs./Acre							P_2O_5 (Bray P_2) Lbs./Acre						
	Treatments							Treatments							Treatments						
Depths	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
0-1	4.9	5.2	4.0	4.4	4.3	4.0	4.4	215	188	183	32	50	18	174	284	279	234	321	92	27	224
1-2	2.7	3.0	2.9	2.5	2.9	2.5	3.0	105	87	87	32	18	14	87	133	115	110	353	41	18	110
2-3	2.3	2.6	2.4	2.6	2.5	1.9	2.5	41	41	37	27	14	14	46	50	60	60	257	18	18	60
3-4	2.4	2.6	2.8	2.5	2.0	2.1	2.5	18	27	23	14	14	14	27	27	32	37	60	14	14	37
4-5	2.1	2.3	2.5	2.3	2.3	2.0	2.4	14	14	18	14	14	14	18	14	18	23	27	14	9	23
5-6	2.3	2.6	2.4	2.5	2.3	2.0	2.1	18	14	14	14	14	14	18	18	14	18	23	18	14	23
Avg	2.8	3.1	2.8	2.8	2.7	2.4	2.8	69	62	60	22	21	15	62	88	86	80	174	33	17	80

	Ca Lbs./Acre							Mg Lbs./Acre							K Lbs./Acre						
0-1	3200	3200	2800	2800	2600	2700	2700	620	620	510	560	530	590	500	132	288	520	560	548	600	600
1-2	2600	2600	2300	2400	2500	2500	2700	380	410	330	380	390	410	400	64	120	272	356	376	460	600
2-3	2500	2500	2400	2400	2300	2300	2300	260	280	260	290	270	290	280	60	76	168	240	220	304	384
3-4	2300	2300	2200	2100	1900	2200	2400	170	190	160	210	150	200	230	52	76	116	156	152	200	336
4-5	2100	2200	1800	1900	1800	2000	2100	130	140	120	150	130	140	150	52	64	112	144	132	180	256
5-6	2000	2200	1500	1800	1800	1800	1700	120	120	110	140	110	120	120	60	72	92	144	128	168	216
Avg	2450	2500	2170	2230	2150	2250	2320	280	293	248	288	263	292	280	70	116	213	250	259	319	399

	pHs							Neutralizable Acidity Me/100 gms.							Cation Exchange Capacity Me/100 gms.						
0-1	6.3	6.3	6.2	6.2	6.3	6.4	6.2	1.0	1.0	1.5	1.5	1.0	1.0	1.5	12.0	12.0	11.5	11.5	10.5	11.0	11.0
1-2	6.2	6.0	5.9	5.8	6.0	6.1	6.0	1.0	1.5	2.0	2.0	2.0	1.0	2.0	9.0	10.0	9.5	10.0	10.5	9.5	11.0
2-3	5.9	5.7	5.4	5.6	5.5	5.9	5.8	2.0	2.0	3.0	2.5	2.5	2.0	2.0	9.5	9.5	10.5	10.0	9.5	9.5	9.5
3-4	5.5	5.4	5.2	5.4	5.2	5.7	5.5	3.0	2.5	3.0	3.0	3.0	2.0	2.5	9.5	9.0	9.5	9.5	8.5	8.5	10.0
4-5	5.2	5.2	4.7	5.1	4.9	5.3	5.2	3.5	3.5	4.5	3.5	4.0	2.5	3.0	9.5	9.5	9.5	9.0	9.0	8.5	9.0
5-6	4.9	4.9	4.5	4.7	4.7	5.0	4.8	4.5	4.0	5.5	4.5	5.0	4.0	4.5	10.0	10.0	10.0	10.0	10.0	9.0	9.5
Avg	5.7	5.6	5.3	5.5	5.4	5.7	5.6	2.6	2.4	3.3	2.8	2.9	2.1	2.6	9.9	10.0	10.1	10.0	9.6	9.3	10.0

Table XVI--Soil Test Values for Plow Layer Fescue-Lespedeza Nitrogen, Phosphorus and Potassium Topdressing Study Gerald Silt Loam (1966)

Treatments	O.M. %	P_2O_5 P_1 Lbs./A	P_2O_5 P_2 Lbs./A	Ca Lbs./A	Mg Lbs./A	K Lbs./A	pHs	H Me/100 gms	CEC Me/100 gms
1. 30+50+0	2.9	61	83	2450	263	108	5.4	5.0	12.4
2. 30+50+50	2.7	53	63	2700	227	145	5.4	4.8	12.7
3. 30+50+100	2.9	56	79	2630	200	272	5.3	5.3	13.1
4. 30+480+100	2.8	24	210	2780	223	305	5.3	5.2	13.5
5. 30+25+100	2.5	32	43	2600	213	275	5.4	4.8	12.5
6. 30+0+100	2.4	20	32	2480	207	307	5.4	4.0	11.5
7. 30+50+150	2.8	55	83	3130	240	368	5.4	4.5	13.8
Initial Values 1961	2.3		30	1760	208	140	4.3	4.2	9.7

Treatments topdressed in spring, ½ K_2O of treatments 3,4,5,6 and 7 in April, ½ in June. The P_2O_5 of treatment 4 plowed down as rock phosphate in 1961.

Table XVII--Final Soil Test Values by One Inch Depths Under Alfalfa Receiving Basic and Topdressed Applications of Phosphorus and Potassium*(1971)

	Organic Matter %									P_2O_5 (Bray P_2) Lbs./Acre								
	Treatments									Treatments								
Depths	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
0-1	3.4	3.7	3.2	3.8	3.7	3.7	4.0	3.8	3.4	60	119	41	247	234	224	394	385	408
1-2	2.4	2.4	2.0	2.5	2.2	2.8	2.7	2.3	2.3	37	69	23	151	115	105	279	279	321
2-3	2.2	2.2	1.9	2.3	1.9	2.7	2.2	2.2	2.2	32	64	18	133	69	82	133	151	170
3-4	2.3	2.2	1.9	2.1	2.2	2.4	2.2	2.3	2.2	27	60	18	105	60	60	96	110	96
4-5	2.3	2.2	1.8	2.2	2.2	2.2	2.2	2.2	2.0	18	41	18	128	55	60	55	87	73
5-6	2.4	2.3	2.1	2.3	2.0	2.3	2.3	2.2	2.1	18	41	18	124	50	60	60	119	73
Avg	2.5	2.5	2.2	2.5	2.4	2.7	2.6	2.5	2.4	32	66	23	148	97	99	170	189	190
	Ca Lbs./Acre									Mg Lbs./Acre								
0-1	3600	3200	3200	3200	2900	2800	3000	2800	3100	370	300	240	310	240	230	230	200	230
1-2	3500	3700	3600	3900	3400	3500	3200	2800	3500	200	170	160	190	160	160	130	110	160
2-3	3500	3000	3800	4100	3400	3400	3700	3400	3400	130	100	130	130	120	120	130	110	120
3-4	3700	3800	3500	4000	3500	3600	3400	3400	3500	120	110	110	120	110	110	110	100	120
4-5	3800	3300	3500	3800	3500	3400	3500	3600	3100	140	100	130	140	120	110	120	120	110
5-6	2800	3200	3400	3700	3200	3300	3200	3300	3300	130	130	160	150	130	130	130	130	140
Avg	3480	3370	3500	3780	3320	3330	3330	3220	3320	182	152	155	173	147	143	142	128	147
	K Lbs./Acre									pHs								
0-1	304	268	244	212	380	368	608	520	672	6.6	6.6	6.7	6.4	6.1	6.0	5.9	6.0	5.9
1-2	140	124	124	108	212	216	352	300	420	6.5	6.6	6.7	6.5	6.2	6.2	5.9	6.1	6.1
2-3	88	72	88	80	108	104	188	180	276	6.6	6.7	6.8	6.6	6.4	6.4	6.3	6.4	6.4
3-4	80	84	68	76	84	80	120	116	168	6.6	6.6	6.8	6.5	6.5	6.4	6.4	6.5	6.4
4-5	80	72	68	76	92	76	96	104	112	6.5	6.5	6.8	6.5	6.5	6.5	6.3	6.5	6.3
5-6	56	68	72	72	80	76	80	92	100	6.5	6.5	6.6	6.3	6.5	6.4	6.2	6.5	6.1
Avg	125	115	111	104	159	153	241	219	291	6.6	6.6	6.7	6.5	6.4	6.3	6.2	6.3	6.2

Table XVII (Continued)

Depths	Organic Matter % — Treatments 1	2	3	4	5	6	7	8	9	P_2O_5 (Bray P_2) Lbs./Acre — Treatments 1	2	3	4	5	6	7	8	9
	Neutralizable Acidity Me/100 gms.									Cation Exchange Capacity Me/100 gms.								
0-1	0.5	0.5	0.0	0.5	1.5	1.0	1.5	1.5	1.5	11.5	10.0	9.5	10.0	10.0	9.5	10.5	10.0	11.0
1-2	0.5	0.5	0.0	0.5	1.0	1.0	1.5	1.0	1.0	10.5	10.5	10.0	11.0	10.5	10.5	10.5	9.0	11.0
2-3	0.5	0.5	0.0	0.5	1.0	0.5	1.0	1.0	1.0	10.0	8.5	10.0	11.5	10.0	9.5	11.0	10.0	10.5
3-4	0.5	0.5	0.0	1.0	0.5	0.5	1.0	0.5	1.0	10.5	10.5	9.5	11.5	10.0	10.0	10.0	9.5	10.5
4-5	0.5	0.5	0.0	1.0	0.5	0.5	1.0	0.5	1.0	10.5	9.5	9.5	11.0	10.0	9.5	10.5	10.0	9.5
5-6	0.5	0.5	0.5	1.0	0.5	1.0	1.0	0.5	1.0	8.0	9.0	10.0	11.0	9.0	10.0	9.5	9.5	10.0
Avg	0.5	0.5	0.1	0.8	0.8	0.8	1.2	0.8	1.1	10.2	9.7	9.8	11.0	9.9	9.8	10.3	9.7	10.4

* Tests with Bray P_1 extractant were not made on this set of samples.

Table XVIII--Soil Test Values in 1965 for Plow Layer under Alfalfa Receving Applications of Phosphorus and Potassium beginning in 1961

Treatments	Plowdown P_2O_5	Plowdown K_2O	Topdress	O.M. %	P_2O_5 P_2 Lbs./A	Ca Lbs./A	Mg Lbs./A	K Lbs./A	pHs	H Me/100 gms	CEC Me/100 gms
1.	200			2.1	30	3450	240	95	5.5	2.8	12.5
2.	400			2.0	59	3480	245	95	5.6	2.8	12.7
3.	0			1.9	21	3330	190	105	5.6	2.3	11.6
4.	600			2.2	140	3630	230	80	5.6	2.8	12.9
5.	400	100		2.0	62	3280	215	95	5.4	3.0	12.3
6.	400		0+0+60	2.2	68	3450	265	93	5.6	3.3	13.2
7.	400			2.2	77	3580	260	75	5.3	3.3	13.4
8.	400			2.1	62	3400	215	85	5.5	3.0	12.6
9.	400			2.1	81	3480	225	85	5.3	3.3	13.0

Initial soil test values 1961: 24 Lbs. P_2O_5/A (P_2), 161 Lbs. K/A, 4.5 pHs

Table XIX--Effect of Limestone and Topdressed Nitrogen, Phosphorus and Potassium on Fescue-Lespedeza (Gerald Silt Loam) Final Soil Test Values by One Inch Depths (1970)

Organic Matter %

Depths	Treatments 1	2	3	4	5	6	7
0-1	4.0	2.7	2.1	2.4	4.7	4.4	4.7
1-2	2.8	2.6	2.3	2.3	3.2	3.0	3.2
2-3	2.6	4.3	2.3	4.7	3.0	2.9	2.7
3-4	2.6	2.7	2.3	2.7	3.0	2.8	2.8
4-5	2.6	2.5	2.0	2.5	2.9	2.9	2.7
5-6	2.8	3.7	3.7	2.6	2.8	2.7	2.7
6-7	2.6	2.5	2.8	2.5	2.6	2.8	2.5
Avg	2.9	3.0	2.5	2.8	3.2	3.1	3.0

P_2O_5 (Bray P_1) Lbs./Acre

Depths	Treatments 1	2	3	4	5	6	7
0-1	165	110	270	224	105	284	215
1-2	46	41	96	73	41	110	78
2-3	27	37	41	32	27	37	37
3-4	27	46	27	27	23	37	27
4-5	27	55	27	73	27	32	27
5-6	27	18	23	27	23	27	23
6-7	18	18	18	18	18	18	14
Avg	48	46	72	68	38	78	60

P_2O_5 (Bray P_2) Lbs./Acre

Depths	Treatments 1	2	3	4	5	6	7
0-1	192	147	257	224	160	284	257
1-2	55	50	115	96	60	133	110
2-3	32	60	50	41	60	50	60
3-4	32	87	41	32	50	50	41
4-5	27	142	32	119	64	41	41
5-6	27	32	32	27	32	37	32
6-7	18	18	27	18	23	23	18
Avg	55	77	79	80	64	88	80

Ca Lbs./Acre

Depths	1	2	3	4	5	6	7
0-1	1200	1600	1300	1700	2100	1600	1700
1-2	1000	1800	1700	1300	2200	2000	2300
2-3	1200	1800	1900	1500	2100	2200	2400
3-4	1100	2000	2100	1700	2300	2200	2300
4-5	1300	2000	2200	1600	2500	2300	2500
5-6	1300	2000	2000	1400	2300	2200	2400
6-7	1400	1900	2100	1100	2200	2000	2200
Avg	1210	1840	1930	1470	2240	2070	2260

Mg Lbs./Acre

Depths	1	2	3	4	5	6	7
0-1	210	490	320	480	620	410	480
1-2	180	570	450	460	680	580	670
2-3	180	570	530	530	640	660	710
3-4	150	610	590	580	690	690	680
4-5	160	610	600	530	740	700	720
5-6	150	560	580	480	690	650	730
6-7	180	500	540	530	650	610	680
Avg	173	559	516	487	673	614	667

K Lbs./Acre

Depths	1	2	3	4	5	6	7
0-1	376	192	304	232	292	340	348
1-2	240	124	200	140	156	220	176
2-3	192	76	136	92	88	120	100
3-4	140	72	112	80	88	108	84
4-5	164	68	100	76	92	92	80
5-6	140	68	96	76	92	88	96
6-7	144	76	112	80	96	92	104
Avg	199	97	151	111	128	151	141

PHs

Depths	1	2	3	4	5	6	7
0-1	4.1	5.1	4.6	5.1	5.2	4.7	4.7
1-2	4.1	5.4	5.1	5.0	5.6	5.1	5.7
2-3	4.1	5.7	5.4	5.3	5.9	5.5	6.0
3-4	4.1	5.9	5.7	5.4	6.1	5.6	6.1
4-5	4.1	5.9	5.7	5.4	6.1	5.7	6.2
5-6	4.2	5.7	5.9	5.1	6.1	5.6	6.1
6-7	4.2	5.4	5.9	4.6	5.6	5.2	5.5
Avg	4.1	5.6	5.5	5.1	5.8	5.3	5.8

Neutralizable Acidity Me/100 gms.

Depths	1	2	3	4	5	6	7
0-1	7.5	4.0	5.5	4.0	4.0	5.5	5.0
1-2	8.0	3.0	4.0	4.5	3.0	4.0	2.5
2-3	8.0	2.5	3.0	3.5	2.5	3.0	2.0
3-4	8.0	2.0	2.5	3.5	2.0	3.0	2.0
4-5	8.5	2.0	2.0	3.5	2.0	2.5	1.0
5-6	7.5	3.0	2.0	4.0	2.0	2.5	1.5
6-7	7.5	3.0	3.0	6.0	3.0	4.0	3.0
Avg	7.9	2.8	3.1	4.1	2.6	3.5	2.4

Cation Exchange Capacity Me/100 gms.

Depths	1	2	3	4	5	6	7
0-1	12.0	10.5	10.5	10.5	12.0	11.5	11.5
1-2	11.5	8.0	10.5	10.0	11.5	11.5	11.5
2-3	12.0	9.5	10.0	9.5	10.5	11.5	11.0
3-4	11.5	9.5	10.5	10.5	10.5	11.5	10.5
4-5	12.5	9.5	10.0	10.0	11.5	11.5	10.5
5-6	11.5	10.0	10.0	9.5	10.5	11.0	10.5
6-7	12.0	9.5	10.5	10.5	11.5	11.5	11.5
Avg	11.9	9.5	10.3	10.1	11.1	11.4	11.0

Initial soil test values 1963: 22 Lbs. P_2O_5/A (P_2), 112 Lbs. K/A, 4.0 pHs

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