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MINERAL AND NITROGEN CONTENT OF LESPEDEZAS AND OTHER HAY CROPS IN TENNESSEE

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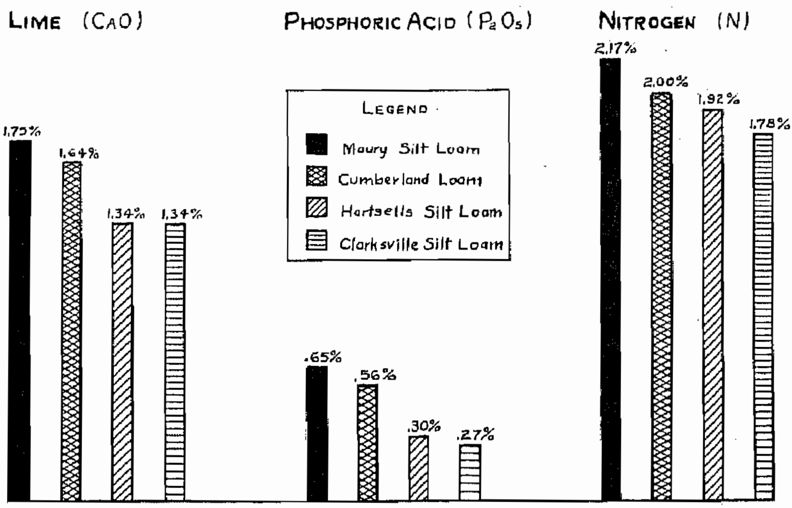

The effect of soil type on the content of lime, phosphoric acid, and nitrogen in annual lespedeza hay.

KNOXVILLE, TENNESSEE

CONTENTS

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INTRODUCTION

In the study of both human and animal nutrition, much attention has been given, during recent years, to the mineral elements, particularly calcium, phosphorus, and iron. These nutritive constituents have come to be looked upon as essential to animals as well as to man.

Since nitrogen is one of the highly important constituents of the proteins and is of great value in nutrition, it also should receive attention.

In 1932, a project was started at the Tennessee Agricultural Experiment Station to study the influence of soil, of season, and of stage of growth on the content of nitrogen and of the more important ash constituents of various cultivated legumes and grasses. Since the annual and perennial lespedezas had come into wide use, and very little was known about their mineral and nitrogen content, a major portion of the study has been devoted to these plants.

For a number of years, this Station has recommended for general use in the State three varieties of annual lespedeza—No. 76, Kobe, and Korean. More recently a perennial lespedeza, sericea, has been favorably reported upon and has received increasing attention from the farmers. These varieties have been planted in all parts of Tennessee, and, because of their ability to adapt themselves to varied soil conditions, there is hardly an area of considerable size anywhere in the State that does not grow one or more of them to advantage.

The analytical work done in 1932 and 1933 included the determination of percentages and separate analyses of leaves and stems. The analyses embraced the following components: Moisture, ash, calcium, magnesium, potassium, iron, manganese, phosphorus, and nitrogen. For the 1934 samples, and part of the 1935, the percentages of leaves and stems were not determined; but the chemical analyses of the plants as harvested covered all of the constituents mentioned.

It was decided in 1935 to get samples from some of the poorer soils of the State, since in previous years the samples had been taken from soils above the average in productivity. This was thought to be worth while for the reason that the lespedezas seemed to be tolerant of a wide range of soil fertility and were being grown on some of the poorest soils with success. The question to be answered was: What effect have these poor soils on the mineral and nitrogen content of the crop?

SAMPLES

The samples collected from a plot or a field consisted of from 3 to 5 pounds of green plants. Every precaution was taken to get pure samples and to discard any sort of contamination that might be present. The average height of the plants in a given area was determined by measurements taken at several points. Samples were obtained from a number of places on the same plot—places where the stand was not normal being avoided. The samples were cut with a hand sickle and put into burlap bags for curing. The usual method of curing was to place the bags on the roof of the plot barn, on days when the weather would permit. As soon as a sample was considered to be air-dry, it was weighed, and the percentages of leaves and stems were determined, following hand-separation. After the completion of this part of the process, the samples were ground in a Wiley mill. In some cases, leaves and stems were not determined separately, and the whole plants were put into the mill. After grinding, the samples were placed in Mason fruit jars, sealed, labeled, and set aside for analysis.

METHODS

The methods used in making the analyses were essentially those approved by the Association of Official Agricultural Chemists.

ANNUAL LESPEDEZAS

The annual lespedezas were harvested at different stages of maturity, approximately as shown in table 1.

TABLE 1—*Dates of harvesting annual lespedezas at four stages of growth.*

Stage	Dates cut		
	Korean	Kobe	No. 76
Pre-bloom	July 15	August 1	August 1
First-bloom	July 28	August 27	August 27
Late-bloom	August 30	September 17	September 17
Brown-seed[1]	September 15	October 7	October 7

[1]Stage at which first brown seed appears.

YIELDS

Korean

Table 2 gives a comparison of the yields of hay and leaves of the annual lespedezas cut in 1933 and 1934, at four stages of growth, at the Knoxville Station. Korean yielded an average of 1.08 tons per acre of hay in the pre-bloom stage, and, by a gradual but substantial increase at each following stage, it reached 3.05 tons in the brown-seed stage. The leaves also showed an increasing yield, although there was a decreasing percentage of leaves as the plants matured. The leaf yield was .77 ton per acre in the pre-bloom stage and 1.80 tons in the brown-seed stage. The leaf yield therefore increased 2.3 times, while the hay yield increased 2.8 times.

Kobe

Kobe gave a hay yield of 1.15 tons per acre in the pre-bloom stage, and showed a gradual increase at every successive stage, with a final yield of 2.17 tons in the brown-seed stage, or approximately twice that in the pre-bloom stage. The leaf yield increased from .75 ton per acre in the pre-bloom stage to .99 ton in the brown-seed stage, or about 1.3 times, in spite of a sharp decrease in leaf percentage (see table 2).

No. 76

No. 76 yielded .43 ton of hay per acre in the pre-bloom stage and 2.04 tons in the brown-seed stage, an increase of about 5 times. The leaf yield increased about 3 times, from .29 to .90 ton per acre.

TABLE 2—*Yields of hay of annual lespedezas, and of leaves only, at four stages of growth.*

Grown on Cumberland loam soil, at Knoxville Station, 1933 and 1934.

Variety	Place grown		Date cut	Stage	Yield per acre		Avg. yield	Leaves only
	BBR. 13	MR. 4			1933	1934		
					Tons	Tons	Tons	Tons
Korean	P1	-------	Jul 14, '33	Pre-bloom	.95	-------	1.08	.77
	-------	P1	" 17, '34	" "	-------	1.20	-------	-------
	P2	-------	" 28, '33	First-bloom	1.68	-------	1.84	1.17
	-------	P2	" 28, '34	" "	-------	2.00	-------	-------
	P3	-------	Sep 18, '33	Late-bloom	2.24	-------	2.37	1.45
	-------	P3	Aug 11, '34	" "	-------	2.50	-------	-------
	P4	-------	Sep 27, '33	Brown-seed	2.49	-------	3.05	1.80
	-------	P4	" 10, '34	" "	-------	3.61	-------	-------
Kobe	P5	-------	Aug 1, '33	Pre-bloom	1.15	Yields unreliable because of crabgrass contamination	1.15	.75
	P6	-------	" 23, '33	First-bloom	1.49		1.49	.70
	P7	-------	Sep 27, '33	Late-bloom	1.97		1.97	.87
	P8	-------	Oct 7, '33	Brown-seed	2.17		2.17	.99
No. 76	P9	-------	Aug 1, '33	Pre-bloom	.43	Yields unreliable because of crabgrass contamination	.43	.29
	P10	-------	Sep 18, '33	First-bloom	1.82		1.82	.87
	P11	-------	Sep 27, '33	Late-bloom	1.89		1.89	.85
	P12	-------	Oct 12, '33	Brown-seed	2.04		2.04	.90

The yields of hay should not be taken as indicative of the comparative yielding capacities of the three varieties, as the yields vary greatly with differences in season and soil. In this case, moreover, the yields are not on a truly comparative basis, for the reason that the averages are for different years.

LEAF PERCENTAGE

Table 3 shows that the leaf percentage for Korean decreased from 68.42 in the pre-bloom stage to 58.88 in the brown-seed stage; for Kobe, from 62.69 to 45.40; and for No. 76, from 67.14 to 44.35. Thus, the Korean variety retained a larger percentage of leaves in the later stages of growth and a higher average percentage of leaves in all stages.

TABLE 3—*Average leaf percentages of annual lespedezas at four stages of growth for the years 1932 and 1933.*

Stage	Korean	Kobe	No. 76
Pre-bloom	68.42	62.69	67.14
First-bloom	61.85	50.78	47.61
Late-bloom	53.15	48.59	44.93
Brown-seed	58.88	45.40	44.35
Average	60.58	51.87	51.01

COMPOSITION

Ash

Table 4 gives the composition of leaves, stems, and whole plant, of the annual lespedezas cut in 1932, 1933, and 1934, at each of four stages of growth. In general, the ash content was highest in the early and intermediate stages, and showed a sharp decline in the brown-seed stage. For example, the average percentage was 6.65 in the pre-bloom stage, 6.34 in the early-bloom stage, 6.25 in the late-bloom stage, and only 5.27 in the brown-seed stage. Korean contained the highest average percentage of ash, 6.50; followed by Kobe, with 6.08; and No. 76, with 5.81.

Lime (CaO)

Korean ranked first in lime, with an average of 2 percent; Kobe second, with 1.57 percent; and No. 76 third, with 1.46 percent. In Kobe and No. 76, the lime content was highest in the pre-bloom stage, with a gradual decline as maturity advanced; but in Korean it was highest in the first-bloom stage. There was a direct relationship between lime and ferric oxide in Korean, while no such relationship was evident in Kobe and No. 76.

Magnesia (MgO)

The magnesia content in all three annuals showed a tendency to decrease in the first three stages of growth; in the Korean and No. 76 varieties it showed a tendency to increase slightly in the fourth stage; while in Kobe it was the same in the late-bloom and brown-seed stages. Korean ranked first in magnesia, with a percentage of .43; Kobe second, with .39; and No. 76 third, with .32.

Potash (K_2O)

The potash content gradually decreased as the stage of maturity advanced, and was notably lower in all three varieties in the brown-seed stage. During the first three stages of growth it declined gradually in Korean and Kobe, but was maintained at nearly the same level in No. 76. There was little or no difference in potash content in the three varieties of lespedeza; Korean contained 1.31 percent and Kobe and No. 76 contained 1.25 percent each.

Iron Oxide (Fe_2O_3)

The iron oxide content in all three varieties was highest in the intermediate stages of growth. There was only a slight difference in the content of this constituent within the three varieties. No. 76 contained .052 percent; Kobe, .049; and Korean, .043.

TABLE 4—*Three-year-average percentage composition of annual lespedezas—hays harvested at four stages of growth.*

Grown at Knoxville Station, 1932, 1933, and 1934. Moisture-free basis.

Variety and stage	Ash	CaO	MgO	K_2O	Fe_2O_3	Mn_3O_4	P_2O_5	N
LEAVES								
Korean								
Pre-bloom	7.05	2.38	.67	1.30	.045	.023	.53	2.82
First-bloom	8.44	2.42	.63	1.27	.074	.024	.51	2.84
Late-bloom	8.05	2.06	.52	1.30	.049	.020	.58	3.04
Brown-seed	7.14	2.19	.61	1.04	.066	.024	.48	2.81
Average	7.67	2.26	.61	1.23	.059	.023	.53	2.88
Kobe								
Pre-bloom	7.14	2.22	.49	1.29	.061	.055	.50	2.87
First-bloom	7.29	2.14	.53	1.34	.074	.052	.56	3.08
Late-bloom	8.46	1.96	.49	1.28	.094	.047	.57	3.21
Brown-seed	6.43	1.84	.49	1.10	.050	.060	.60	3.38
Average	7.33	2.04	.50	1.25	.070	.054	.56	3.13
No. 76								
Pre-bloom	6.76	1.96	.45	1.13	.043	.052	.41	3.15
First-bloom	6.67	1.84	.40	1.27	.053	.053	.49	3.34
Late-bloom	6.51	1.76	.32	1.40	.052	.037	.46	3.16
Brown-seed	6.16	1.75	.31	1.26	.045	.040	.35	2.83
Average	6.53	1.83	.37	1.27	.048	.046	.43	3.12
STEMS								
Korean								
Pre-bloom	4.94	1.18	.36	1.27	.040	.006	.32	1.40
First-bloom	4.79	1.12	.26	1.26	.053	.009	.33	1.61
Late-bloom	4.59	.95	.19	1.17	.021	.006	.35	1.40
Brown-seed	3.28	.79	.18	.78	.025	.008	.18	.91
Average	4.40	1.01	.25	1.12	.035	.007	.30	1.33
Kobe								
Pre-bloom	5.49	1.20	.41	1.53	.044	.012	.42	1.76
First-bloom	4.77	1.05	.35	1.42	.034	.014	.45	1.63
Late-bloom	5.11	1.04	.28	1.26	.034	.015	.46	1.74
Brown-seed	3.46	.80	.33	.82	.024	.020	.46	1.73
Average	4.71	1.02	.34	1.26	.034	.015	.45	1.72
No. 76								
Pre-bloom	5.79	1.23	.44	1.42	.060	.016	.36	1.88
First-bloom	4.21	.94	.23	1.21	.028	.013	.27	1.39
Late-bloom	3.98	.92	.21	1.25	.024	.011	.29	1.57
Brown-seed	3.45	.79	.20	1.01	.028	.009	.15	1.27
Average	4.36	.97	.27	1.22	.035	.012	.27	1.53
WHOLE PLANT								
Korean								
Pre-bloom	6.89	1.94	.52	1.52	.041	.016	.50	2.36
First-bloom	6.88	2.31	.45	1.39	.054	.016	.45	2.32
Late-bloom	6.36	1.58	.36	1.30	.037	.013	.46	2.17
Brown-seed	5.87	1.67	.38	1.03	.039	.016	.45	1.96
Average	6.50	2.00	.43	1.31	.043	.015	.47	2.20
Kobe								
Pre-bloom	6.71	1.84	.44	1.39	.050	.034	.52	2.44
First-bloom	6.15	1.64	.41	1.32	.057	.033	.54	2.38
Late-bloom	6.42	1.40	.36	1.25	.054	.030	.54	2.43
Brown-seed	5.02	1.30	.36	1.04	.035	.035	.58	2.40
Average	6.08	1.57	.39	1.25	.049	.033	.55	2.41
No. 76								
Pre-bloom	6.34	1.63	.40	1.34	.046	.034	.45	2.48
First-bloom	5.98	1.47	.32	1.31	.053	.032	.44	2.33
Late-bloom	5.97	1.42	.28	1.32	.062	.027	.43	2.26
Brown-seed	4.93	1.31	.29	1.03	.046	.025	.36	2.11
Average	5.81	1.46	.32	1.25	.052	.030	.42	2.28

Manganese Oxide (Mn_3O_4)

Korean contained only about one-half as much manganese oxide as Kobe or No. 76. The percentage of this constituent in No. 76 declined as the stage of maturity advanced. It remained fairly constant in Korean and Kobe, except for a small decrease in the late-bloom stage. Korean contained an average of .015 percent, while Kobe and No. 76 contained .033 and .030 percent, respectively.

Phosphoric Acid (P_2O_5)

The phosphoric acid content in Korean and No. 76 declined gradually as the stage of maturity advanced, but in Kobe it increased slightly throughout the series. Kobe contained .55 percent of phosphoric acid, while Korean and No. 76 contained only .47 and .42 percent, respectively.

Nitrogen

The nitrogen content, as the stage of maturity advanced, showed a tendency to decrease in Korean and No. 76, but remained fairly constant in Kobe. The percentage of nitrogen was slightly higher in Kobe, being 2.41, while in No. 76 and Korean it was 2.28 and 2.20, respectively.

Leaves Versus Stems

The leaves of each annual lespedeza were richer than the stems in every constituent for which they were analyzed, except potash. In this constituent, on the average, there was practically no difference. The leaves contained approximately twice as much nitrogen and about 1½ times as much ash as the stems.

Lespedezas from Good and from Poor Land

Since it is a common practice to grow lespedezas on a great variety of soils, it was thought advisable to determine the effects of different soils upon the mineral and nitrogen content of lespedezas grown on them. Samples of both annual and perennial lespedezas were obtained, in 1935, from the Clarksville, Columbia, and Knoxville Stations and from farms in the vicinity of Knoxville. Samples were taken from long-time fertility plots at Knoxville, where deficiencies of various elements of plant food were known to exist. All of the samples taken for analysis were from places where the stand was good and the growth normal. The samples from the other stations were selected from representative soils of the particular area, but it should be observed that the Clarksville soil is very poor and the Columbia soil very rich in phosphate.

PHOSPHORIC ACID AND LIME CONTENT OF HAYS

The phosphoric acid content of hay from various regions of the world where cattle suffer from low phosphorus rations, ranges from .142 to .274 percent (1). It will be noted from table 5 that the Clarksville samples have an average phosphoric acid content which falls in the upper limits of this range. The nitrogen content also was considerably lower on the poor soils, but apparently not in direct proportion to the phosphoric acid content. This agrees with Orr's observation that forage deficient in minerals is low also in protein (2). Undoubtedly, if the samples had gone through the regular process of harvesting and curing, as it is carried out on the farm, with a consequent loss of leaves and an admixture of weeds, the figures would have been even lower. The analysis was made, however, on a pure sample that had been carefully handled and cured, and this fact should be borne in mind when the results are considered.

Data from Kentucky show that poor-land areas produce lespedeza hay as low as .10 to .17 percent in phosphoric acid content, while the best soils produce an all-legume hay which contains from .22 to .40 percent (3). The lowest figure obtained from the poor-land sections of Tennessee was .19 percent phosphoric acid. Since these areas, which were poor in phosphoric acid, were relatively poor also in lime and nitrogen, it is possible that cattle and other livestock depending largely on this poor-quality hay for their supply of minerals and nitrogen, may be of inferior quality (3). Sherman and Campbell have shown by experiment that increasing the calcium intake from .20 percent to .35 percent of the dry-food mixture results in a more efficient use of the food, more rapid growth, and greater adult vitality (4). Thus, it appears that the solution of this problem might be a basic factor in the improvement of the farm animal—that with an improvement in the quality of feed there might be an improvement in the quality of the animal.

It has been suggested recently that the optimum phosphoric acid content of rations for cattle is about .40 percent (3). High-grade cattle require a larger amount of minerals than low-grade, or native, cattle. If high-grade cattle receive an insufficient amount of minerals, they will in a few generations revert to a lower grade; and if either calcium or phosphorus is deficient enough, the cattle may even develop a calcium- or phosphorus-deficiency disease (1, 5). This disease has been found to develop especially in young, growing animals and in older animals that have borne young (6). Certain areas in Tennessee recently have been found to give evidence of mineral deficiency.

DISCUSSION OF DATA FROM 1935 SAMPLES

Table 5 gives a comparison of the data obtained on the mineral and nitrogen content of annual lespedezas from the Knoxville, Columbia, and Clarksville Stations. The percentages represent averages of all annual varieties of lespedeza collected at each place.

The claim has been made often by farmers that the area surrounding the Columbia Station produces hay and pasture which excel in nutritive elements, especially calcium, phosphorus, and nitrogen, The data show that the hay from the Columbia Station is of a superior quality, ranking above the hay from Knoxville, and especially above that from Clarksville, in the three constituents mentioned. The Columbia hay contained 31 percent more lime, 141 percent more phosphoric acid, and 22 percent more nitrogen than the hay from the Clarksville Station.

TABLE 5—*Mineral and nitrogen content of annual-lespedeza hay when grown on different soils and in different localities*, 1935.

Moisture-free basis.

Variety	Ash	CaO	MgO	K_2O	Fe_2O_3	Mn_3O_4	P_2O_5	Nitrogen	Ca : P ratio
Maury silt loam (good soil), Columbia Station									
	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	
Korean	6.58	1.71	.32	1.47	.031	.018	.66	2.11	
Kobe	6.41	1.65	.38	1.58	.035	.027	.67	2.19	
No. 76	6.83	1.77	.34	1.48	.059	.027	.62	2.10	
Common	6.73	1.85	.38	1.54	.031	.031	.66	2.28	
Average	6.64	1.75	.33	1.51	.039	.026	.65	2.17	4.41:1
Clarksville silt loam (poor soil), Clarksville Station									
Korean	5.20	1.31	.30	1.23	.020	.016	.28	1.77	
Kobe	4.72	1.29	.30	1.06	.018	.046	.25	1.76	
No. 76	5.14	1.41	.25	1.12	.033	.012	.28	1.82	
Average	5.02	1.34	.28	1.14	.024	.025	.27	1.78	8.13:1
Cumberland loam (good soil), Knoxville Station[1]									
Korean	5.90	1.76	.48	.87	.040	.008	.61	2.11	
Kobe	6.37	1.74	.57	.77	.056	.009	.62	2.14	
No. 76	6.79	1.43	.50	.90	.081	.010	.46	1.75	
Average	6.35	1.64	.52	.85	.059	.009	.56	2.00	4.81:1
Unfertilized fields in Knoxville and Clarksville areas[2]									
Average	5.29	1.39	.30	1.22	.025	.027	.29	1.85	7.85:1
Good land at Knoxville and Columbia Stations[3]									
Average	6.54	1.69	.39	1.29	.049	.019	.62	2.06	4.48:1

[1]Samples from plots (good soil).
[2]Includes all the samples from specially selected, unfertilized fields in both areas.
[3]Includes all the samples taken from good soils (unfertilized) at the Knoxville and Columbia Stations.

As table 5 shows, the Columbia samples excelled also in ash, potash, and manganese oxide, as well as in lime, phosphoric acid, and nitrogen, as already stated. The lespedeza good-land plots at the Knoxville Station were low in potash, having an average percentage of .85, while the average of the Clarksville samples was 1.14, and of the Columbia samples, 1.51. The samples from Knoxville also ranked lowest in manganese oxide. They were highest, however, in iron oxide and magnesia, while the Clarksville lespedeza was lowest in these constituents.

CALCIUM : PHOSPHORUS RATIO

Much attention has been paid recently to the calcium : phosphorus ratio, since the proper relationship of these two minerals seems to be important to the health of the animal consuming them. Experimental data indicate, however, that in a diet which contains adequate supplies of both calcium and phosphorus, the optimal Ca : P ratio is about 1.2 or 1.5. It is suggested also that the Ca : P ratio is of minor importance in comparison with the provision of liberal quantities of both calcium and phosphorus (7). It will be noted from the data that the Ca : P ratio is much wider in the samples from the Clarksville area than in those from the Columbia area. The ratio, on the average, was 4.41 : 1 in the Columbia samples, while in the Clarksville samples it was 8.13 : 1.

Since the relationship of calcium and phosphorus in nutrition is of importance, especially when the intake is low, it is interesting to make a special note of the calcium : phosphorus ratio in annual lespedezas harvested in 1935 from Knoxville, Columbia, and Clarksville, or from good- and poor-land areas. These data are given in table 5. Without exception, the ratio of calcium to phosphorus was narrowest on the good land and widest on the poor land. For example, the lespedeza from good land at Columbia and Knoxville had average calcium : phosphorus ratios of 4.41 : 1 and 4.81 : 1, respectively, while on the poor land at the Clarksville Station the ratio was 8.13 : 1.

A question which occurs naturally at this point is: What has caused this spread in the ratio of calcium and phosphorus in the poor-land plants? Is the calcium content much greater and the phosphorus content at about the same level? Or is the phosphorus content much greater and the calcium content at about the same level? Or has the calcium content remained about the same and the phosphorus content become much lower? Or are both calcium and phosphorus found in smaller amounts, but in different proportions? In other words, has the change in phosphorus content been considerably more than the change in calcium content?

This spread in the calcium : phosphorus ratio in poor land appears to be influenced mainly by a sharp decrease in the phosphoric acid content of the plants, with a much smaller decrease in lime content. For all three varieties of the annual lespedezas, considering the data obtained from the Columbia, Knoxville, and Clarksville samples, it was found that the average lime content of the Columbia samples was 1.75 percent, and the phosphoric acid content .65 percent; while the Knoxville samples had an average of 1.64 percent of lime and .56 percent of phosphoric acid; and the Clarksville samples showed the lowest content, 1.34 percent lime and only .27 percent phosphoric acid.

Table 6 shows the percentage difference in the lime and phosphoric acid content of lespedeza hay grown on good and on poor soils. Maury silt loam and Cumberland loam represent the good soils, and Clarksville silt loam represents the poor soil. The Clarksville silt loam produced hay which contained 18 percent less lime and 52 percent less phosphoric acid than the hay grown on Cumberland loam, and 23 percent less lime and 59 percent less phosphoric acid than the hay grown on Maury silt loam. This indicates that the

TABLE 6—*Comparison of the percentage difference in lime and phosphoric acid, and the calcium: phosphorus ratio, in lespedeza hay grown on good and on poor soils.*

Soil types on which crops were grown	Percent less on poor soil		Ca : P ratio		
			Good soil		Poor soil
	CaO	P_2O_5	Maury silt loam	Cumberland loam	Clarksville silt loam
Clarksville silt loam (poor soil) in comparison with Cumberland loam (good soil)	18.00	52.00	4.41 : 1	4.81 : 1	8.13 : 1
Clarksville silt loam (poor soil) in comparison with Maury silt loam (good soil)	23.00	59.00			
Average	20.50	55.50			

Maury silt loam is better supplied with lime and phosphoric acid than either the Cumberland loam or the Clarksville silt loam. The data show also that the percentage difference was considerably greater in phosphoric acid than in lime; the average difference in phosphoric acid being 55.50 percent and in lime only 20.50 percent.

The data show, furthermore, that the calcium : phosphorus ratio in the hay samples was wider on the poor soil than on the good soil.

KOREAN LESPEDEZA HAY FROM A FERTILITY EXPERIMENT

Korean lespedeza was grown in 1935 on plots at the Knoxville Station following a cowpea-wheat rotation and fertilizer experiment which had been running for a period of 30 years. Each plot had received a definite fertilizer treatment each year throughout the entire period. One half of each plot had been limed and the other half left unlimed. The 3-pound samples of Korean lespedeza were taken from the limed side, with the exception of the sample from plot H-8, which was taken from the unlimed side. All were harvested, treated, and analyzed the same as previous samples, and were in the bloom stage of growth. Table 7 gives the fertilizer treatment, yield, and composition of these samples. The soil type and the pH of the soil also are recorded.

TABLE 7—*Composition of Korean lespedeza hay from cowpea-wheat plots, on Cumberland loam soil, Knoxville Station,* 1935.

Moisture-free basis

Plot	Acre yield	Fertilizer treatment	Ash	CaO	MgO	K_2O	Fe_2O_3	Mn_3O_4	P_2O_5	N	Ca : P ratio	pH of soil
	Tons		P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.		
H-8[1]	2.30	PK U[2]	6.70	1.35	.29	2.12	.039	.022	.59	2.11	3.76 :1	5.58
F-6	1.52	M R	6.84	1.81	.33	1.33	.057	.018	.61	1.90	4.87 :1	5.86
G-6	1.49	MPK R	6.55	1.59	.31	1.55	.044	.018	.58	1.83	4.49 :1	5.58
J-8	1.28	K U	6.17	1.72	.26	1.67	.044	.014	.44	1.85	6.41 :1	5.03
F-5	1.25	PK U	6.87	1.79	.27	1.63	.042	.020	.62	1.91	4.74 :1	5.40
H-4	1.00	O U	6.26	2.11	.45	1.15	.036	.020	.49	2.21	7.07 :1	5.48
G-5	.97	PK R	6.92	2.12	.32	1.23	.045	.021	.54	1.82	6.45 :1	5.55
F-4	.84	P U	7.18	2.07	.46	.91	.062	.020	.53	2.07	6.41 :1	5.52
G-4	.77	P R	7.15	2.24	.43	.93	.052	.022	.51	1.97	7.20 :1	5.66
I-4	.38	O R	7.32	2.32	.45	.99	.059	.025	40	2.11	9.51 :1	5.74

[1]Taken from unlimed portion of plot. All samples cut August 26, 1935.
[2]P—Phosphate, K—Potash (KCl), M—Manure, O—No fertilizer, U—Cowpeas turned under, R—Cowpeas removed.

Yields of Korean Lespedeza Hay from Fertility Plots

Table 7 shows that plot H-8 received 150 pounds of phosphate and 75 pounds of muriate of potash annually, beginning with 1927. The cowpeas were turned under and wheat was omitted from the rotation. Of all the plots from which samples were taken for analysis, this one gave the highest yield—2.39 tons per acre. It is of particular interest from the soil-building standpoint.

Plot F-5, which had the same fertilizer treatment as H-8, and differed only in the fact that wheat was included in the rotation, produced only 1.25 tons of Korean lespedeza per acre.

Plot F-4 yielded .84 ton per acre. This plot received no potash fertilizer, and the peas were turned under. It is interesting to note that on F-5, where potash was added, the yield increased to 1.25 tons per acre.

Plot G-6, which received manure, acid phosphate, and muriate of potash, and had the peas removed, yielded 1.49 tons per acre, or practically the same as F-6, which yielded 1.50 tons per acre, received only manure, and had the peas removed.

The addition of potash to the treatment of superphosphate increased the yield from .77 ton per acre on G-4 to .97 ton per acre on G-5. The peas were removed each year from both plots. In the case of F-5, where the treatment was the same as for G-5, except that the peas were turned under, the yield was increased to 1.25 tons per acre.

The yields of H-4 and I-4 are interesting from the standpoint of the farmer who does not fertilize his soil, but who pastures, or can afford to turn under an occasional crop. Plot I-4 received no fertilizer treatment and had the cowpeas removed. In this case, the yield was only .38 ton per acre. However, in the case of H-4, which also received no fertilizer treatment, but had the cowpeas turned under, the yield was increased to 1.00 ton per acre, or approximately 2½ times as much as was raised under the exhaustive method of removing all the crops.

Plot J-8 received only potash. The cowpeas were turned under and yielded 1.28 tons per acre. F-5 received acid phosphate in addition to what J-8 received, but the yield remained practically the same, or 1.25 tons per acre. Such a result indicates the naturally excellent supply of phosphoric acid in this soil.

Composition of Korean Lespedeza Hay from Fertility Plots

Ash

In general, as appears from table 7, the lower the yield of hay the higher the ash content. For example, plot H-8 yielded 2.39 tons of hay per acre and contained 6.70 percent ash, while plot I-4, which yielded only .38 ton per acre, contained 7.32 percent ash. The hay produced on the plots from which the cowpeas were removed contained an average of 6.96 percent ash, while that from plots on which the cowpeas were turned under averaged 6.64 percent. The samples of hay with the highest ash content were from plots F-4, G-4, and I-4. Plot F-4 received phosphate and had the cowpeas turned under; G-4 also received phosphate, but had the cowpeas removed; while I-4 received no fertilizer and had the cowpeas removed. Hay from plot F-4 contained 7.18 percent ash; G-4, 7.15 percent; and I-4, 7.32 percent. It is noteworthy that the hay from plots which received phosphate alone, and from the plot which received no fertilizer and had the cowpeas removed, was higher in ash content than that from any of the other plots.

Lime (CaO)

The percent of lime ranged from 1.35, in the sample from the unlimed side of plot H-8, to 2.32 in the sample from the limed side of plot I-4; the latter being the plot that received no fertilizer and had the cowpeas removed. In general, the crops from plots which made the highest yields had the lowest lime content. The lime showed a tendency to occur in inverse proportion to the potash content.

Magnesia (MgO)

The magnesia content ranged from .26 percent, on plot J-8, to .46 percent, on plot F-4. It was considerably higher on plots G-4, H-4, I-4, and F-4, than on the other six plots from which samples were taken. In general, the magnesia content was highest where the fertilizer treatment consisted of acid phosphate alone, or where there was no fertilizer treatment. Removing or turning under the cowpeas appeared to have no effect. The plots which ranked lowest in yield ranked highest in magnesia.

Potash (K_2O)

The long-continued application of potash produced a decided effect. For example, the crop from plot F-4, which received phosphate and had the cowpeas turned under, contained only .91 percent potash; while the crops from plot F-5, which received both phosphate and potash fertilizer and had the cowpeas turned under, contained 1.63 percent—1.8 times as high as that from plot F-4. When the cowpeas were removed from a plot which received manure in addition to both muriate of potash and phosphate, the percentage increased to 1.55, and when only muriate of potash was added and the cowpeas turned under, as on plot J-8, the percentage mounted to 1.67. But in the case of the crop from the unlimed portion of plot H-8, which received both muriate of potash and phosphate, had the cowpeas turned under, and no grain crop grown, the percentage of potash rose to 2.12. This was the highest percentage of potash found in any of this group of samples, and this plot is the only one which received no lime. Under these particular conditions, this indicates that the liming of land may have some suppressive effect on the utilization of potash by the plant. The highest potash percentages were correlated with the highest-yielding plots.

Iron Oxide (Fe_2O_3)

The percentage of iron oxide ranged from .036, in the crop on plot H-4, to .062, in the crop on plot F-4. It ran higher for the plots on which the cowpeas were removed, with the exception of F-4, which produced Korean lespedeza with the highest percentage of iron oxide, .062. Some of the lowest-yielding plots contained the highest percentages of iron oxide. This was especially true of F-4, G-4, and I-4, but was not true in all cases. For example, H-8 was first in yield, but ninth in percent of iron oxide, or just the reverse of F-4, G-4, and I-4.

Manganese Oxide (Mn_3O_4)

The hay from plot J-8, which received potash and had the cowpeas turned under, contained the lowest percentage of manganese oxide, .014; while the hay from I-4, which received no fertilizer and had the cowpeas removed, contained the highest percentage, .025. There was no apparent relationship between yield and manganese oxide content.

Phosphoric Acid (P_2O_5)

The percent of phosphoric acid ranged from .40, in the crop from the untreated plot I-4, to .62, in the crop from plot F-5, which received acid phosphate and muriate of potash and had the cowpeas turned under. In this case the phosphoric acid content was increased 53 percent. The crop from plot F-6, which received manure, had .61 percent of phosphoric acid, or practically the same as that from F-5. The highest-yielding plots also produced the highest phosphoric acid content, with the exception of J-8, which ranked fourth in yield but ninth in phosphoric acid.

Nitrogen

The range in percentage of nitrogen was from 1.82, on plot G-5, to 2.21, on plot H-4. The sample that showed the highest nitrogen content was grown on the plot that received no fertilizer treatment but had the cowpeas turned under each year. A comparison of plots F-5 and H-8 shows that the absence of wheat in the rotation had a definite effect on the nitrogen content of the plant. That is, the crop from H-8, on which no wheat was grown and cowpeas were turned under, showed a nitrogen content of 2.21 percent; while that from F-5, on which wheat was grown and the cowpeas were turned under, showed a nitrogen percentage of 1.91. This result probably can be attributed to the much more fertile condition of plot H-8. The nitrogen content remained at a relatively high level even in the case of the plot which was unfertilized and had the cowpeas removed. In most instances it appeared that turning under the cowpeas resulted in an increased nitrogen content in the hay.

Calcium : Phosphorus Ratio

In general, the calcium : phosphorus ratio was widest on the lowest-yielding plots. For example, plot I-4, which yielded .38 ton of hay per acre, had a calcium : phosphorus ratio of 9.51 : 1; while plot H-8, which yielded 2.39 tons per acre, had a calcium : phosphorus ratio of 3.76 : 1.

pH of Soil

The pH of the soil varied from 5.03, on plot J-8, which received potash and had the cowpeas turned under, to 5.86, on plot F-6, which received manure only and had the cowpeas removed.

KOREAN LESPEDEZA HAY FROM CUMBERLAND PLATEAU AND KNOXVILLE STATION

In 1937, samples of Korean lespedeza hay grown on the Cumberland Plateau and at the Knoxville Station were analyzed for the constituents shown in table 8. The Cumberland Plateau samples were all grown on Hartsells silt loam, a soil type that responds markedly to both lime and phosphate. The Knoxville samples were grown on Cumberland loam soil, which is much better supplied with lime and phosphate, as indicated by the growth and the analyses of plants produced on it.

Fertilizer Treatment

The fertilizer treatment consisted of limestone and phosphate applications, except in the case of sample No. 32, which received 150 pounds of 4-10-4 fertilizer. Samples 42 and 44 received no fertilizer applications other than the wood ash which resulted from burned stump piles. This ash was scattered over both the fertilized and the unfertilized fields. The plant growth showed evidence of the application of this ash, but every effort was made to get the samples from normal areas. Since ash from burned stump piles was distributed over all of the fields from which samples of hay were taken, it is quite possible that the lespedeza, especially on the unfertilized fields, became established mainly in the places where the ash had been applied. This, if true, would give slightly different results from those which would have been obtained from strictly unfertilized fields. (See analysis of sample No. 35, which was taken from a place where a stump pile had been burned).

Yields

It was not possible to get yields of hay from the Cumberland Plateau; but some indication of the yields can be gained by a comparison of the average height of lespedeza grown on the Plateau with the average height of that grown at Knoxville, where the yields were determined. The hay from the Cumberland loam soil at Knoxville, which averaged 16 inches in height, yielded an average of 3.22 tons per acre. On this basis, the hay grown on the Hartsells silt loam soil, which received fertilizer treatments, averaged a little over 5 inches in height, and would probably have yielded about one-third as much, or approximately 1 ton per acre. On the unfertilized fields, the stand was very poor and the growth was of a horizontal rather than an upright character. The yield would have been extremely low; harvesting could not possibly have been done in any of the usual ways, and would not have been at all economical.

TABLE 8—*Mineral and nitrogen content of Korean lespedeza hay from Cumberland Plateau and Knoxville Station, 1937.*

Moisture-free basis

Sample No.	Ht.	Fertilizer applications 1936	Fertilizer applications 1937	Soil pH	Moisture	Sand- and silica-free ash	CaO	MgO	K_2O	Fe_2O_3	Mn_3O_4	P_2O_5	N
				CUMBERLAND PLATEAU Samples from Fertilized Fields									
	In.				P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.
33	---	None	240 lbs. S. P.[1]	6.15	8.26	4.47	1.42	.43	1.17	.051	.022	.46	1.90
34	---	"	240 " "	5.38	7.25	3.88	1.07	.38	.91	.038	.026	.25	1.73
36	---	"	240 " "	5.32	8.26	4.08	1.14	.41	.93	.046	.025	.28	1.95
31	---	440 lbs. S. P., 1-2 T. limestone	None	5.63	9.10	3.95	1.38	.36	.85	.026	.012	.30	2.16
43	7	440 lbs. S. P., 1-2 T. limestone	None	5.95	9.48	3.83	1.30	.34	.96	.049	.009	.35	2.39
32	3	150 lbs. 4-10-4, 1-2 T. limestone	240 lbs. S. P.	6.28	8.95	5.34	1.77	.36	.96	.058	.012	.32	1.88
46	5	Some burnt lime	100 " "	5.45	9.77	2.57	1.27	.25	.92	.109	.011	.20	1.61
41	8	440 lbs. S. P.	None	6.07	9.75	3.94	1.53	.30	.92	.031	.011	.29	2.07
37	3	400 " "	"	5.48	7.85	4.16	1.31	.39	1.02	.053	.018	.41	1.93
40	4	170 " "	"	6.08	8.42	4.09	1.39	.32	.88	.048	.013	.28	2.05
45	5	125 " "	300 lbs. S. P.	4.98	10.02	4.11	1.14	.43	.80	.084	.044	.31	1.83
38	9	440 " " 1-2 T. limestone	None	6.38	8.21	4.22	1.56	.33	.77	.061	.010	.22	1.79
30	---	440 lbs. S. P.	"	5.33	9.43	3.95	1.23	.32	.87	.043	.014	.25	1.88
39	4	150 " "	"	5.80	8.45	3.22	1.26	.25	.79	.033	.008	.21	1.71
Average				5.74	8.80	3.99	1.34	.35	.91	.052	.017	.30	1.92
				Samples from Unfertilized Fields									
42		None	None	5.85	8.98	3.41	1.23	.29	1.12	.190	.019	.47	2.36
44	---	"	"	5.27	9.40	2.79	.97	.36	.90	.131	.030	.29	2.11
Average				5.56	9.19	3.10	1.10	.33	1.01	.161	.025	.38	2.24
				Samples Where Stump Pile Burned									
25		None	240 lbs. S. P.	6.28	7.68	5.23	1.32	.37	1.52	.031	.010	.45	2.48
				KNOXVILLE STATION Samples from Unfertilized Fields									
47[2]	17	None	None	7.21	9.87	4.26	1.43	.33	.82	.052	.017	.49	2.32
48[3]	15	"	"	7.18	9.97	4.59	1.62	.30	.80	.046	.016	.44	2.08
Average				7.20	9.92	4.43	1.53	.32	.81	.049	.017	.47	2.20

[1]Superphosphate.
[2]Late variety of Korean lespedeza.
[3]Standard variety of Korean lespedeza.

pH of Soil[1]

The Hartsells silt loam soil from unfertilized fields on the Cumberland Plateau had an average pH of 5.56, while the average pH of the soil from the fertilized fields was 5.74. The pH of the soil where the stump pile had been burned was 6.28. The pH of the Cumberland loam soil at Knoxville was 7.20.

Chemical Composition of Cumberland Plateau Samples

Although there is little difference in chemical composition between the hay from the fertilized and the unfertilized fields on the Cumberland Plateau, it should be kept in mind that there was practically no growth on the unfertilized fields, while on the fertilized fields good stands were obtained and the plants were of normal, upright growth.

Table 8 shows that hay from fertilized fields contained 3.99 percent ash, 1.34 percent lime, .35 percent magnesia, .91 percent potash, .052 percent iron oxide, .017 percent manganese oxide, .30 percent phosphoric acid, and 1.92 percent nitrogen. Hay from unfertilized fields contained 3.10 percent ash, 1.10 percent lime, .33 percent magnesia, 1.01 percent potash, .161 percent iron oxide,[2] .025 percent manganese oxide, .38 percent phosphoric acid, and 2.24 percent nitrogen. The hay taken from the place where the stump pile had been burned contained 5.23 percent ash, 1.32 percent lime, .37 percent magnesia, 1.52 percent potash, .031 percent iron oxide, .010 percent manganese oxide, .45 percent phosphoric acid, and 2.48 percent nitrogen.

Chemical Composition of Knoxville Samples

Table 8 shows that the lespedeza hay grown on the Cumberland loam soil at the Knoxville Station contained 4.43 percent ash, 1.53 percent lime, .32 percent magnesia, .81 percent potash, .049 percent iron oxide, .017 percent manganese oxide, .47 percent phosphoric acid, and 2.20 percent nitrogen.

In the data presented in table 8, it is interesting to note the effect which the stump-pile ash had on the composition of Korean lespedeza. The sample was higher in ash, potash, and nitrogen than any of the others, and contained approximately the same percentage of phosphoric acid as the Knoxville samples but a higher percentage than any of those from the Plateau soil.

PERENNIAL LESPEDEZA (SERICEA)

The perennial lespedeza, sericea, was cut at 12, 18, 24, and 30 inches in height. On the average, the 12-inch height was cut 4 times, the 18- and 24-inch heights from 2 to 3 times, and the 30-inch height twice.

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[1]Determined with Beckman electrometric hydrogen-ion apparatus.

[2]This high iron oxide content is probably due to soil clinging to these plants, which were very sparse and growing close to the ground.

TABLE 9—*Cutting dates for the different heights.*

Height	Cutting			
	First	Second	Third	Fourth
Inches				
12	May 5	June 5	July 28	Sept. 7
18	May 23	July 20	Oct. 23 (11")	----------
24	May 31	July 26	Oct. 23 (11")	----------
30	June 8	Sept. 7	----------	----------

HAY YIELDS

Table 10 gives the yields of hay and leaves, and the protein content, of several cuttings of sericea at 12-, 24-, and 30-inch heights.

The yields of the 12-inch height from the third and fourth cuttings were larger than from the first and second, but the yields from all of these cuttings were smaller than from those at greater heights.

The yields of hay at the second cuttings of the 24- and 30-inch heights showed considerable increase over those at the first cuttings. This was especially true in the case of the 30-inch height, which yielded 2.51 tons per acre at the first cutting, and 4.07 tons at the second. Two cuttings of the 30-inch height practically embraced the total season's growth, with the exception of a late growth about 4 inches tall.

In 1934, the plots cut at 18 and 24 inches in height were each cut twice, and then produced a growth of 11 inches, which was cut October 23, before the first killing frost. At this 11-inch height the 24-inch plot yielded approximately 1 ton per acre, while the 18-inch plot yielded 1.46 tons.

The yield in total tons of sericea hay per acre was greatest at the 30-inch height and least at the 12-inch height. The 30-inch height yielded more protein per acre than any of the others, .862 ton. There was only a small difference in protein yield between the 12- and 18-inch heights, but the 24-inch height was significantly lower. In hay yield, the 30-inch height was 1.5 times as large as the 12-inch height, while in protein yield it was only 1.2 times as large. As the plants become older, however, they become coarse and fibrous; and it is probable that even though there is a somewhat larger total yield of protein in the greater heights, the digestibility factor will reduce this apparent advantage.

TABLE 10—*Average yields per acre of sericea hay by cuttings.*

Knoxville Station, 1932, 1933, 1934.

Height	Cutting				Total hay harvested	Total leaves harvested	Total protein (N x 6.25)
	First	Second	Third	Fourth			
Inches	Tons	Tons	Tons	Tons	Tons	Tons	Tons
12	1.04	.89	1.20	1.19	4.32	2.92	.721
18	1.90	1.77	[1]1.46	------	5.13	3.30	.732
24	1.86	2.01	[1].95	------	4.82	2.92	.600
30	2.51	4.07	------	------	6.58	------	.862

[1]The third cutting, made October 23, 1934, just before the first killing frost, was only 11 inches in height.

LEAF YIELDS

Table 10 shows that the total yield of leaves was greatest for the 18-inch height, being 3.30 tons per acre. The 12-inch height yielded 2.92 tons, or exactly the same as the 24-inch height, although the total hay yield for the 12-inch height was practically ½ ton less.

LEAF PERCENTAGES

The 12-inch height had a larger percentage of leaves than the other heights at every cutting, as shown in table 11. Each successive cutting at each height showed an increase in leaf percentage, except the fourth cutting at the 12-inch height, at which it dropped from 72.41 in the third cutting to 64.44.

TABLE 11—*Average percentage of leaves from cuttings made at 12, 18, and 24 inches, 1932 and 1933.*

Height	Cutting			
	First	Second	Third	Fourth
	Percent	Percent	Percent	Percent
12	63.54	69.67	72.41	64.44
18	61.69	65.57	65.61	--------
24	59.47	61.86	--------	--------

COMPOSITION OF WHOLE PLANT, ALL CUTTINGS AND HEIGHTS

Table 12 gives the chemical composition of sericea harvested at four different heights, and also the separate cuttings of each height. The 12-inch height gave a slightly better quality of hay, on the basis of chemical composition, than any other.

Ash

First cutting—12-, 18-, 24-, and 30-inch heights.—The 12-inch height ranked first in ash, with 7.43 percent; the 24-inch second, 7.06 percent; the 30-inch third, 5.76 percent; and the 18-inch fourth, 5.57 percent.

Second cutting—12-, 18-, 24-, and 30-inch heights.—The average percentage of ash for all heights was lower in this cutting, being 5.30, as compared with 6.46 in the first cutting. The 12-inch height ranked first, with 5.95 percent; the 18-inch second, 5.26 percent; the 24-inch third, 5.12 percent; and the 30-inch fourth, with only 4.87 percent.

Third cutting—12- and 18-inch heights.—The average ash contents for these heights showed some increase over those for the second cutting, but still remained at a lower level than those for the first cutting. The 12- and 18-inch heights were the only ones cut the third time. The 18-inch height, with 6.07 percent, ranked slightly above the 12-inch height, with 5.86 percent.

Fourth cutting—12-inch height.—The 12-inch height was the only one which gave a fourth cutting. It contained about the same amount of ash, 5.98 percent, as previous cuttings of this height.

TABLE 12—*Composition of sericea harvested at four different heights, 1932, 1933, and 1934.*

Moisture-free basis

Height	Ash	CaO	MgO	K_2O	Fe_2O_3	Mn_3O_4	P_2O_5	N
FIRST CUTTING								
Leaves								
Inches	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.
12	7.82	1.55	.45	1.58	.100	.014	.94	4.00
18	6.03	1.59	.42	1.38	.051	.019	.64	3.26
24	6.14	1.62	.36	1.35	.045	.023	.52	2.80
Average	6.66	1.59	.41	1.44	.065	.019	.70	3.35
Stems								
12	6.75	.98	.32	1.73	.060	.004	.73	2.36
18	4.58	.92	.30	1.59	.025	.004	.52	1.68
24	4.25	.92	.22	1.28	.036	.006	.37	1.33
Average	5.19	.94	.28	1.53	.040	.005	.54	1.79
Whole Plant								
12	7.43	1.34	.40	1.64	.086	.010	.86	3.40
18	5.57	1.36	.37	1.43	.042	.014	.59	2.72
24	7.06	1.70	.39	1.75	.056	.018	.60	2.89
[1]30	5.76	1.50	.40	1.16	.040	.016	.55	2.67
Average	6.46	1.48	.39	1.50	.056	.015	.65	2.92
SECOND CUTTING								
Leaves								
12	6.37	1.43	.47	1.46	.040	.016	.66	3.32
18	5.80	1.70	.41	1.21	.038	.019	.46	2.68
24	5.80	1.60	.41	1.19	.039	.013	.47	2.67
Average	5.99	1.58	.43	1.29	.039	.016	.53	2.89
Stems								
12	5.03	.87	.34	1.52	.022	.004	.64	1.85
18	4.15	1.04	.22	1.21	.023	.006	.44	1.51
24	3.85	.96	.22	1.05	.022	.004	.40	1.39
Average	4.34	.96	.26	1.26	.022	.005	.49	1.58
Whole Plant								
12	5.95	1.26	.43	1.48	.037	.012	.66	2.88
18	5.26	1.49	.36	1.17	.030	.015	.48	2.33
24	5.12	1.36	.34	1.18	.030	.010	.45	2.22
30	4.87	1.42	.34	.95	.019	.016	.47	2.09
Average	5.30	1.38	.37	1.20	.029	.013	.52	2.38
THIRD CUTTING								
Leaves								
12	6.27	1.56	.48	1.20	.053	.014	.52	2.63
18	6.90	2.08	.38	1.22	.045	.020	.57	3.14
Average	6.59	1.82	.43	1.21	.049	.017	.55	2.89
Stems								
12	4.79	1.01	.33	1.38	.042	.005	.48	1.45
18	4.46	1.14	.28	1.10	.024	.011	.52	1.58
Average	4.63	1.08	.31	1.24	.033	.008	.50	1.52
Whole Plant								
12	5.86	1.41	.44	1.25	.050	.012	.51	2.30
18	6.07	1.75	.31	1.18	.038	.020	.56	2.64
Average	5.97	1.58	.38	1.22	.044	.016	.54	2.47
FOURTH CUTTING								
Leaves								
12	6.41	1.74	.45	1.42	.026	.016	.66	3.63
Stems								
12	5.19	.95	.28	1.51	.021	.006	.77	2.10
Whole Plant								
12	5.98	1.45	.39	1.45	.024	.012	.70	3.09

[1]The leaves and stems were not determined separately on the 30-inch height—analysis on whole plant only.

Lime (CaO)

First cutting—12-, 18-, 24-, and 30-inch heights.—There was little difference in the lime content of the 12-, 18-, and 30-inch heights; being 1.34; 1.36, and 1.50 percent, respectively; but the 24-inch height contained appreciably more lime, 1.70 percent.

Second cutting—12-, 18-, 24-, and 30-inch heights.—The average lime content for all heights was only slightly lower than in the first cutting. The first cutting contained 1.48 percent, and the second, 1.38. The lime content ranged from 1.26 percent in the 12-inch height to 1.49 in the 18-inch height. The 24- and 30-inch heights contained 1.36 and 1.42 percent, respectively.

Third cutting—12- and 18-inch heights.—The average lime content for these heights, 1.58 percent, was slightly higher than in the first two cuttings. In the third cutting the 18-inch height contained 1.75 percent lime, while the 12-inch height contained 1.41 percent.

Fourth cutting—12-inch height.—The 12-inch height contained 1.45 percent lime, which was a slightly higher percentage than was found in the first cutting, but approximately the same as in the second and third cuttings.

Magnesia (MgO)

First cutting—12-, 18-, 24-, and 30-inch heights.—The magnesia content of .40 percent in the 12-inch height was practically the same as the percentages found in the other heights; the 18-, 24-, and 30-inch heights containing .37, .39, and .40 percent, respectively.

Second cutting—12-, 18-, 24-, and 30-inch heights.—The average magnesia content for all heights was practically the same in this cutting, with a percentage of .37, as compared to .39 for the first cutting. The 12-inch height ranked first in this cutting, with a percentage of .43, while the 18-, 24-, and 30-inch heights contained .36, .34, and .34 percent, respectively.

Third cutting—12- and 18-inch heights.—The average magnesia content for these heights remained at practically the same level in all three cuttings. The 12-inch height, with a percentage of .44, excelled the 18-inch height, with a percentage of .31.

Fourth cutting—12-inch height.—The magnesia content of .39 percent was slightly lower than that found in the first three cuttings of the 12-inch height.

Potash (K_2O)

First cutting—12-, 18-, 24-, and 30-inch heights.—In potash content the 24-inch height was highest, with a percentage of 1.75, but was followed closely by the 12- and 18-inch heights, with percentages of 1.64 and 1.43, respectively. The 30-inch height contained only 1.16 percent potash.

Second cutting—12-, 18-, 24-, and 30-inch heights.—The potash content for all heights was lower in this cutting, with an average of

1.20 percent, as compared with 1.50 in the first cutting. The 12-inch height contained 1.48 percent and the 18-, 24-, and 30-inch heights contained 1.17, 1.18, and .95 percent, respectively.

Third cutting—12- and 18-inch heights.—The average potash content of these heights, 1.22 percent, was practically the same as in the second cutting, but lower than in the first cutting, which contained 1.50 percent. There was little difference in the potash content of the 12- and 18-inch heights, the 12-inch height containing 1.25 percent and the 18-inch 1.18 percent.

Fourth cutting—12-inch height.—The potash content of 1.45 percent in this cutting was practically the same as the amount found in the first three cuttings of the 12-inch height.

Iron Oxide (Fe_2O_3)

First cutting—12-, 18-, 24-, and 30-inch heights.—The 12-inch height ranked above all the others in iron oxide, with a percentage of .086, while the 24-inch height contained .056. The 18- and 30-inch heights contained .042 and .040 percent, respectively.

Second cutting—12-, 18-, 24-, and 30-inch heights.—The average iron oxide content for all heights was approximately one-half as much in this cutting as in the first cutting. The first cutting contained .056 percent, while the second cutting contained only .029 percent. The 12-inch height contained .037 percent, the 18- and 24-inch heights contained .030 in each case, and the content decreased to .019 percent in the 30-inch height.

Third cutting—12- and 18-inch heights.—In the average iron oxide content for these heights the third cutting showed an increase over the second cutting, but still ranked below the first cutting. The first cutting contained .056 percent, while the second and third contained .029 and .044 percent, respectively. The 12-inch height excelled the 18-inch in iron oxide content in this cutting, the 12-inch height containing .050 percent and the 18-inch height .038 percent.

Fourth cutting—12-inch height.—The iron oxide content, .024 percent, was much lower than in the first three cuttings of the 12-inch height.

Manganese Oxide (Mn_3O_4)

First cutting—12-, 18-, 24-, and 30-inch heights.—The manganese oxide content ranged from .010 percent in the 12-inch height to .018 in the 24-inch height, while the 18- and 30-inch heights contained. .014 and .016 percent, respectively.

Second cutting—12-, 18-, 24-, and 30-inch heights.—In the average percentage of manganese oxide for all heights, there was little or no difference between the first and second cuttings. In the second cutting the content ranged from .010 percent in the 24-inch height to .016 in the 30-inch height, while the 12-inch height contained .012 and the 18-inch height contained .015 percent.

Third cutting—12- and 18-inch heights.—The average manganese oxide content for these heights remained at about the same level throughout all three cuttings. The 12-inch height contained .012 percent and the 18-inch height .020 percent.

Fourth cutting—12-inch height.—The manganese oxide content of .012 percent for this cutting was practically the same amount that was found in the three previous cuttings.

Phosphoric Acid (P_2O_5)

First cutting—12-, 18-, 24-, and 30-inch heights.—In phosphoric acid, the 12-inch height ranked first, with a percentage of .86; the percentage dropping to .59 in the 18-inch height, .60 in the 24-inch height, and finally to the lowest percentage of .55 in the 30-inch height.

Second cutting—12-, 18-, 24-, and 30-inch heights.—The average phosphoric acid content for all heights was considerably lower in this cutting, being .51 percent, while in the first cutting it was .65 percent. The 12-inch height ranked highest in this as in the first cutting, with a percentage of .66; followed by the 18-inch height, with .48; the 30-inch height, with .47; and the 24-inch height, with .45 percent.

Third cutting—12- and 18-inch heights.—The average phosphoric acid content for these heights in this cutting showed a slight increase over that in the second cutting, but did not reach the level of the first cutting. The average percent in the first cutting was .65; in the second, .51; and in the third, .53. The 18-inch height, with a percentage of .55, excelled the 12-inch height slightly, which had a percentage of .51.

Fourth cutting—12-inch height.—The phosphoric acid content of .70 percent was lower than the amount found in the first cutting, about the same as in the second cutting, but appreciably higher than in the third cutting of the 12-inch height, which contained .51 percent.

Nitrogen (N)

First cutting—12-, 18-, 24-, and 30-inch heights.—The 12-inch height ranked first in nitrogen, with a percentage of 3.40. The 18- and 30-inch heights contained the lowest percentages, 2.72 and 2.67, respectively. The 24-inch height ranked slightly above them, with a percentage of 2.89.

Second cutting—12-, 18-, 24-, and 30-inch heights.—The average nitrogen content for all heights was 2.38 percent in this cutting, as compared to 2.92 in the first cutting. The 12-inch height ranked first in this cutting, with a percentage of 2.88. The 18-, 24-, and 30-inch heights contained 2.33, 2.22, and 2.09 percent, respectively.

Third cutting—12- and 18-inch heights.—The average nitrogen content for these heights increased from 2.38 in the second cutting to 2.47 in this cutting, being considerably lower than in the first cutting, in which the percentage was 2.92.

Fourth cutting—12-inch height.—The 12-inch height contained 3.09 percent nitrogen in the fourth cutting, as compared with 3.40 percent in the first cutting, 2.88 in the second, and 2.30 in the third.

Leaves Versus Stems

The leaves contained a higher percentage than the stems of every constituent for which they were analyzed, except potash, and in this the two were about equal. Except in the first cutting, the stems were only slightly inferior to the leaves in phosphoric acid, and in the fourth cutting of the 12-inch height the stems excelled the leaves in this constituent.

Compositions of Different Cuttings

Table 13 shows the average percentages of ash and nitrogen in sericea at four separate cuttings. The figures were obtained from the four cuttings and for the 12-, 18-, 24-, and 30-inch heights, made in 1932, 1933, and 1934.

TABLE 13—*Average ash and nitrogen content of first, second, third, and fourth cuttings of all heights, Knoxville Station,* 1932, 1933, *and* 1934.

Moisture-free basis

Cutting	Ash	Nitrogen
	Percent	Percent
First	6.46	2.92
Second	5.30	2.38
Third	5.97	2.47
Fourth	5.98	3.09

The second and third cuttings were somewhat poorer than the first and fourth, especially in nitrogen. The second cutting was lowest in both ash and nitrogen. As a fourth cutting can seldom be made, any benefit from higher quality in this cutting ordinarily would not be gained in practice unless the crop were cut at the 12-inch height.

Composition of Late Cuttings

In 1934 there were only two cuttings of the full 18- and 24-inch heights, but a third cutting, only 11 inches in height, was made very late in the season, October 23. Table 14 gives the composition of cuttings made on two separate plots at this date and height.

TABLE 14—*Composition of late cuttings of sericea, Knoxville Station,* 1934.

Moisture-free basis

Whole plant	Ht.	Date	Ash	CaO	MgO	K_2O	Fe_2O_3	Mn_3O_4	P_2O_5	N	Ca:P ratio
	In.		P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	
On 18-in. plot	11	Oct. 23	8.61	2.91	.45	.86	.056	.032	.41	2.09	11.6 : 1
On 24-in. plot	11	Oct. 23	7.69	2.47	.33	1.11	.047	.026	.36	2.00	11.3 : 1
Average			8.15	2.69	.39	.99	.052	.029	.39	2.05	11.5 : 1

A comparison of the data in tables 12 and 14 shows that the ash content of these late cuttings increased sharply over those of cuttings made earlier in the season. The average lime content of the late cuttings almost double those of the second cuttings, which attained the full heights, 18 and 24 inches, at which they were to be cut. For example, hay from second cuttings, at 18 and 24 inches, contained an average of only 1.38 percent lime, while hay from third cuttings, on the same plots, at 11 inches, very late in the season, had an average lime content of 2.69 percent. Lime is the only ash constituent that was notably higher in these late cuttings. Phosphoric acid, potash, and nitrogen were found to be somewhat lower.

It is interesting to note that the average Ca : P ratio was 11.5 : 1 in the late cuttings. This wide ratio of calcium to phosphorus was induced by a very large increase in the lime content, with a somewhat lower than average phosphoric acid content. (See table 12).

Composition of First and Second Cuttings from Poor Land

Analyses of samples of sericea from poor land in 1935 show that the first cuttings were of slightly better quality than the second cuttings. Phosphoric acid, potash, and nitrogen are the principal constituents in which the first cuttings excelled. Table 15 gives a comparison of the ash and nitrogen in the first and second cuttings of sericea from poor land.

TABLE 15—*Average ash and nitrogen content, first and second cuttings—poor land, Knoxville area.*

Moisture-free basis

Cutting	Ash	Nitrogen
	Percent	Percent
First, May	6.03	2.27
Second, July and August	5.61	2.10

This information, collected during 1935 from the unfertilized farms, might have proved of even greater interest had it been possible to obtain hay yields. It may be assumed, however, that the yield as well as the quality of hay was much lower on the poor soils. The fact that the crops from the good land excel not only in quantity but also in quality gives the hay or pasture on the good land an even greater advantage than it would appear to have on the basis of mineral and nitrogen content.

Leaf percentages.—The second cutting from the poor land had a larger percentage of leaves than the first cutting. The second cutting had an average leaf percentage of 63.87, while the first had an average of 58.99. This increase in leaf percentage also occurred when sericea was grown on good land. However, the leaf percentage was somewhat higher on the hay from the good land. (See table 11).

Composition of Different Heights

Table 16 shows that the 12-inch height ranked first in ash, with an average percentage of 6.31; the 24-inch height second, with 6.09

percent; the 18-inch third, with 5.63; and the 30-inch fourth, with 5.32 percent. In the case of nitrogen, the 12-inch height also ranked first, with an average percentage of 2.92; the 18-, 24-, and 30-inch heights ranking in the order named, with 2.85, 2.56, and 2.38 percent, respectively.

TABLE 16—*Average ash and nitrogen content of all cuttings made of each height, Knoxville Station, 1932, 1933, and 1934.*

Moisture-free basis

Height	Ash	Nitrogen
Inches	Percent	Percent
12	6.31	2.92
18	5.63	2.85
24	6.09	2.56
30	5.32	2.38

Composition of Sericea from Good and from Poor Land

There was no opportunity for a satisfactory comparison of sericea collected in 1935 from good land and from poor land, since the land from which the samples were obtained at the Knoxville Station was in reality of a poor type, which had received fertilizer. In the comparison which can be found in table 17, however, plants from the "good" land made a better showing in lime, magnesia, iron oxide, phosphoric acid, and nitrogen; but the plants from the "poor" land had a higher content of ash, potash, and manganese oxide.

TABLE 17—*Average composition of lespedeza from good*[1] *and from poor*[2] *land.*

Moisture-free basis

Soil	Ash	CaO	MgO	K_2O	Fe_2O_3	Mn_3O_4	P_2O_5	N
	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.
Good[1]	5.54	1.55	.37	1.17	.035	.016	.51	2.37
Poor[2]	5.89	1.43	.33	1.43	.029	.021	.38	2.12

[1] 4-year average at Knoxville, 1932-1935.
[2] Samples from Clarksville and unfertilized fields from Knoxville area, 1935.

MISCELLANEOUS CROPS

Alfalfa and hop clover (*Trifolium procumbens*) are the chief miscellaneous crops analyzed. The alfalfa samples were obtained from the plots at the Knoxville Station, while the hop clover samples were obtained from the plots at the Middle Tennessee Station, near Columbia.

ALFALFA

Composition

Table 18 gives the composition of the leaves, stems, and whole plant of alfalfa cut in 1933 in the pre-bloom and bloom stages of maturity. The pre-bloom stage showed a higher percentage of ash and the bloom stage a slightly higher percentage of nitrogen. The early stage had 2.72 percent of lime, and the bloom stage only 1.89.

There was no significant difference in the content of phosphoric acid, iron oxide, and manganese oxide in the two stages of maturity; but the magnesia content was higher in the early stage and the potash content was higher in the later stage.

TABLE 18—*Average composition of alfalfa cut at two stages of growth, Knoxville Station,* 1933.

Moisture-free basis

Stage	Ash	CaO	MgO	K_2O	Fe_2O_3	Mn_3O_4	P_2O_5	N
Leaves								
	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.
Pre-bloom	10.75	3.79	.71	1.46	.050	.014	.72	3.43
Bloom	8.86	2.59	.60	1.82	.046	.013	.70	3.44
Average	9.81	3.19	.66	1.64	.048	.014	.71	3.44
Stems								
Pre-bloom	5.94	1.52	.50	1.49	.020	.004	.74	2.20
Bloom	5.85	1.15	.35	1.79	.023	.004	.76	2.41
Average	5.90	1.34	.43	1.64	.022	.004	.75	2.31
Whole Plant								
Pre-bloom	8.47	2.72	.62	1.47	.036	.010	.72	2.85
Bloom	7.38	1.89	.48	1.81	.034	.008	.73	2.94
Average	7.93	2.31	.55	1.64	.035	.009	.73	2.90

Leaves Versus Stems

The leaves excelled the stems in every constituent except potash and phosphoric acid, but the stems had only slightly more phosphoric acid, and the percentages of potash were identical.

The leaf percentage was 53.07 in the pre-bloom stage and 50.89 in the bloom stage.

TABLE 19—*Composition of late cuttings of alfalfa, Knoxville Station.*

Moisture-free basis

Date cut	Ht.	Ash	CaO	MgO	K_2O	Fe_2O_3	Mn_3O_4	P_2O_5	N
	In.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.
1932, Nov. 3	9	11.06	2.49	.56	3.76	.044	.010	.75	4.32
1932, Nov. 7	8	11.00	2.94	.68	2.79	.049	.011	.82	4.20
1934, Oct. 19	12	9.76	2.93	.74	2.17	.031	.013	.94	4.52

The data in table 19, when compared with the data in table 18, show that samples of alfalfa taken late in the seasons of 1932 and 1934—both favorable seasons for growth—were especially high in ash and nitrogen, yielding higher percentages than the very early and mid-season cuttings. In addition to ash and nitrogen, the late cuttings contained a slightly higher percentage of lime, magnesia, potash, and phosphoric acid.

HOP CLOVER

Composition

Table 20 gives the analyses of a variety of hop clover, *T. procumbens*, cut in 1933, at three stages of growth, at the Columbia Station. The ash content decreased from 9.45 percent in the pre-bloom stage to 6.58 percent in the late-bloom stage. The lime content increased from 1.63 to 1.89 percent in the bloom stage, and then dropped to 1.44 percent in the late-bloom stage. The phosphoric

TABLE 20—*Composition of hop clover cut at three stages of growth, in 1933.*

Moisture-free basis

Stage	Ash	CaO	MgO	K_2O	Fe_2O_3	Mn_3O_4	P_2O_5	N
	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.	P'ct.
Pre-bloom	9.45	1.63	.32	2.96	.074	.010	.97	3.09
Bloom	7.28	1.89	.36	2.07	.026	.008	.81	2.31
Bloom dying	6.58	1.44	.21	2.00	.019	.010	.54	2.19
Average	7.77	1.65	.30	2.34	.040	.009	.77	2.53

acid, potash, magnesia, and iron oxide all showed decreases as the stage of maturity advanced. The manganese oxide content remained fairly constant in all three stages of growth.

In phosphoric acid and nitrogen content, this crop was considerably higher than the annual lespedezas in the pre-bloom and bloom stages, but dropped to about the level of the lespedezas in the late-bloom stage. The potash content decreased as maturity advanced, but still remained at a much higher level than was found in the annual lespedezas. (See table 4).

SUMMARY

A 5-year investigation into the chemical composition of lespedezas (annual and perennial), alfalfa, and hop clover, as affected by soil, fertilizers, season, and stage of growth, has led to the following observations:

ANNUAL LESPEDEZAS

1. In most cases, for all varieties studied, there was a larger percentage of leaves than of stems.

2. The leaves were of better quality than the stems from the standpoint of minerals and nitrogen. They were about equal to the stems in potash content, but contained approximately twice as much nitrogen and 1.6 times as much ash as the stems.

3. On the basis of nitrogen, and of ash and its constituents, there was very little difference in the quality of Korean, Kobe, and No. 76 for the 4-year period, when grown on similar soils.

4. In general, the yields of hay and leaves increased as the plants matured, but there was a gradual decrease in the percentage of leaves.

5. Korean had a larger percentage of leaves than of stems in all the stages of growth examined. No. 76 had a larger percentage of leaves than of stems in the pre-bloom stage, but a smaller percentage of leaves in the bloom, late-bloom, and brown-seed stages. No. 76 had a much larger percentage of leaves than of stems in the pre-bloom stage, a slightly larger percentage in the bloom stage, but a smaller percentage in the late-bloom and brown-seed stages.

6. The mineral and nitrogen content of the whole plant tended to decrease as the plants matured. They showed a very gradual de-

cline in the stems, but in the leaves they showed a slight tendency to increase in the earlier stages and to decrease in the later stages.

7. Samples of annual lespedeza hay grown at the Columbia Station, on Maury silt loam, were superior in minerals and nitrogen to the hay grown at the Knoxville Station, on Cumberland loam, or at the Clarksville Station, on Clarksville silt loam. The annual lespedezas from the Columbia Station were notably richer than the Clarksville samples in lime, phosphoric acid, and nitrogen. The Columbia and Knoxville hays were considered satisfactory from the standpoint of mineral elements and nitrogen.

8. The calcium : phosphorus ratio was considerably wider on the poor lands. The ratio was 4.41 : 1 in the Columbia good-land samples and 8.13 : 1 in the Clarksville poor-land samples. The Ca : P ratio of Korean lespedeza from the low-yielding plots was much wider than from the high-yielding plots at the Knoxville Station. (See table 7).

9. The phosphoric acid content in the good-land hay dropped from .65 percent on Maury silt loam to .27 percent on the poorer Clarksville soil. There was a decrease also in the lime content, but the decrease was less marked than in the case of phosphoric acid. The lime decreased from 1.75 percent on the Maury silt loam to 1.34 percent on the Clarksville soil. Thus, the phosphoric acid content decreased 59.00 percent, while the lime content decreased 23.00 percent.

10. It was shown that the good-land hay contained approximately 31 percent more lime and 140 percent more phosphoric acid than the poor-land hay. These figures relate to the difference in lime and phosphoric acid content of hay grown on "good" and hay grown on "poor" soil types. The phosphoric acid content of hay grown on the 30-year-old cowpea-wheat rotation plots at Knoxville, all of which were the same soil type (Cumberland loam), was increased from .40 percent to an average of .56 percent. This gave an increase of approximately 40 percent in the phosphoric acid content of lespedeza hay from the use of fertilizers. However, this work was carried out on a soil fairly well supplied with phosphate. The lime content, on the contrary, was generally higher in the lespedeza from the unfertilized plots than in the lespedeza from the fertilized plots.

11. The annual lespedeza hay from good land contained an average of 23 percent more ash, 22 percent more lime, 30 percent more magnesia, 6 percent more potash, 96 percent more iron oxide, 30 percent less manganese oxide, 114 percent more phosphoric acid, and 11 percent more nitrogen than the hay from poor land.

It is interesting to note, however, that on the Hartsells silt loam soil, which is poorly supplied with lime and phosphate, the application of these materials increased the lime content in the plant only about 22 percent, while the phosphoric acid content was 5 percent less. Thus, it appears that on this type of soil, where lime and phosphate are greatly deficient, moderate applications of lime and phosphate have little effect on their content in the plant; or other elements may serve as limiting factors in the utilization of these materials. There was, nevertheless, a very distinct increase in the yield. Hence, as a result of moderate applications of lime and phosphate to Hartsells silt loam, there was a decided increase in the quantity of hay, but practically no improvement in the quality.

PERENNIAL LESPEDEZA (SERICEA)

1. The average content of ash in the perennial lespedeza, sericea, for all cuttings made of each height, showed that the 12-inch height ranked first, with a percentage of 6.31; the 24-inch second, with 6.09; the 18-inch third, with 5.63; and the 30-inch height fourth, with a percentage of 5.32. The average nitrogen content for all cuttings made of each height showed that the 12-inch ranked first, with 2.92 percent; the 18-, 24-, and 30-inch heights ranking in the order named, with 2.85, 2.56, and 2.38 percent, respectively. (See table 14). Thus, the first cutting apeared to give a slightly better quality of hay, from the standpoint of minerals and nitrogen, at about 12 inches in height, than at any of the other heights.

2. On the average for all heights, the calcium : phosphorus ratio was 2.15 : 1 in the first cutting, 2.65 : 1 in the second, 2.93 : 1 in the third, and 2.09 : 1 in the fourth.

3. The lime content reached a higher level in the cuttings made late in the season than in those made earlier. The increase occurred in both the leaves and stems, but was greater in the leaves.

4. The leaves were higher than the stems in every constituent for which they were analyzed. In the case of potash and phosphoric acid, however, there was only a slight advantage.

5. There was a larger percentage of leaves than of stems in all cuttings and at all heights. The 12-inch height had a larger percentage of leaves than either the 18- or 24-inch height.

6. The later cuttings on both good and poor land had a higher percentage of leaves than the earlier cuttings.

7. It is apparent that the number of cuttings influences the total yield of hay. The 12-inch height, which was cut four times, yielded 4.32 tons, while the 18- and 24-inch heights, which were cut three times, averaged 4.98, and the 30-inch height, which was cut twice, gave a total yield of 6.58 tons of hay.

ALFALFA

1. There was a slightly larger percentage of leaves than of stems in alfalfa at each stage of growth studied.

2. The pre-bloom stage excelled in ash, lime, and magnesia, while the bloom stage excelled in potash. There was hardly any difference in the percentages of phosphoric acid, nitrogen, iron oxide, and manganese oxide for the two stages studied.

3. The leaves were especially rich in lime in the pre-bloom stage.

4. The leaves contained about 1½ times as much ash and nitrogen as the stems.

5. The leaves excelled in every constituent for which they were analyzed, except potash and phosphoric acid, containing 4.31 percent less phosphoric acid than the stems, and approximately the same amount of potash.

6. The late cuttings contained a very high percentage of nitrogen.

HOP CLOVER

The phosphoric acid and nitrogen content of hop clover was considerably higher in the pre-bloom and bloom stages than the annual lespedezas, but dropped to about the level of the lespedezas in the late-bloom stage. (See table 20).

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