THE FERTILIZATION OF IRRIGATED GRASS AND GRASS-CLOVER PASTURE SWARDS WITH EMPHASIS ON THE RATE AND FREQUENCY OF NITROGEN APPLICATIONS

by

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THE FERTILIZATION OF IRRIGATED GRASS AND GRASS-CLOVER PASTURE SWARDS WITH EMPHASIS ON THE RATE AND FREQUENCY OF NITROGEN APPLICATIONS

INTRODUCTION

Two important factors to be considered in the management of pastures are the use of chemical fertilizers and the selection of plant species. In this study, certain aspects pertaining to the chemical fertilization of grass and grass-clover pasture were investigated. The experiment was conducted on the Experimental Farm, Saanichton, British Columbia.

The study of fertilization centered around the use of nitrogen fertilizer on irrigated grass and grass-clover pasture swards. The effects of frequency and rate of nitrogen application on yields and botanical and chemical composition of the herbage were studied.

The study of pasture plants was limited to three species; namely, Ladino clover, (*Trifolium repens*), perennial ryegrass (*Lolium perenne*) and orchardgrass (*Dactylis glomerata*). The productivity of two pasture mixtures was investigated under varying fertility treatments. One mixture consisted of the two grass species and the second mixture consisted of the two grass species plus Ladino clover. The evaluation of the comparative performances of grass and grass-clover pasture herbage under varying nitrogen treatments was considered a major objective of this study.

The effects of potassium and phosphorus fertilizer applications on the grass and grass-clover pasture herbage were also studied.

In the evaluation of the various treatments, dry matter yields, plant chemical composition, and the distribution of herbage growth throughout the growing season were considered.

REVIEW OF LITERATURE

The choice of pasture plants and mixtures for this study was based on the performance of pasture species in forage test plots on Vancouver Island. Species which had given comparatively high productivity were chosen. Ladino clover has been an outstandingly productive pasture legume on Vancouver Island under irrigated conditions (7). Hollowell (14) reports that Ladino clover has given excellent performance in the irrigated regions of the West. Hafenrichter (13) states that the use of Ladino clover has become general in improved irrigated pastures of the West. Nelson and Robins (23) state that Orchard grass with Ladino clover is a commonly used pasture mixture under irrigation in Central Washington.

Orchard grass and Perennial rye have been outstanding pasture producers in test plots and field experiments on Vancouver Island. Meyers (22) states that, because of its vigor and productivity, Orchardgrass is an important constituent of high producing, intensively managed pastures. They also recommend Orchardgrass as a component of permanent pasture mixtures which include Ladino clover, Hoover _et al_. (15, p.644) consider Orchardgrass to be a desirable pasture grass in the humid temperate regions of the United States.

According to Hoover _et al_. (15, p. 676) the best results with perennial ryegrass in the United States have been on the Pacific and Atlantic Coasts. The principal use for perennial ryegrass in the United States is for permanent pasture seedings.

The rate of seeding used in this experiment was based on the results of seed mixtures experiments on Vancouver Island. The seeding rate used was somewhat higher than is often recommended for the Pacific Coast area (15, p. 677) but this higher seeding rate has given better results on Vancouver Island.

Several experiments (7) have indicated that grass responds to nitrogen applications on Vancouver Island. Some of these experiments have indicated that irrigated grass requires frequent nitrogen applications for maximum production. Similar results have been obtained in the State of Washington (16, 18, 33). Also it is known (38) that grasses, when grown in mixtures with clovers and other legumes, derive nitrogen from the legumes. Therefore the nitrogen fertilizer requirements of grasses grown in association with legumes should be reduced by comparison with grasses not grown in association with legumes.

Nitrogen applications through encouragement of grass growth (3, 6, 8, 18) should tend to increase the proportion of grass in grass-legume pasture swards. In this study the relative amounts of grasses and clovers in the various stands were recorded in an attempt to relate fertilizer treatment to the stands of grasses and clovers in a mixture containing these two forage components.

EXPERIMENTAL METHODS

Field Plot Design

The field plots were laid out in the form of a split-plot experiment with four replications. The sub-plots consisted of two seeding mixtures and the main plots consisted of eight fertilizer treatments. The sub-plots were randomized within the main plots and the main plots were randomized within each replication. The sub-plots measured 10 x 40 feet and two strips each 30 x 3 feet were harvested from each sub-plot for yield and other data.

Seeding Mixtures

The two seeding mixtures used in this experiment were as follows:

Table 1. Seeding Mixtures

Seeding Mixture	Species	Seeding Rate (lbs/acre)
I	Perennial Rye	12
	Orchard Grass	12
II	Perennial Rye	12
	Orchard Grass	12
	Ladino Clover	2

The plots were seeded on June 8, 1954, following a blanket treatment of the plot area with an N, P_2O_5, K_2O application of 40, 40 and 20 pounds per acre respectively. The seed mixtures were broadcast by hand and the seed was covered and packed using a "culti-packer". No yield clips were taken in 1954 but the plot area was trimmed to remove excess growth. Sprinkler irrigations sufficient to maintain soil moisture levels well above wilting point were applied following seeding in 1954. A satisfactory stand of grasses and clovers resulted from this seeding.

Fertilizer Treatments

Throughout the experiment N, P_2O_5 and K_2O were supplied as ammonium nitrate, 19 per cent superphosphate, and muriate of potash respectively. The following fertilizer treatments were laid down:

Table 2. Fertilizer Treatments, 1955

Treatment	Pounds per Acre ($N - P_2O_5 - K_2O$)						Total N applied per season (lbs./acre)
	March 15	May 1	June 1	July 1	Aug. 1	Sept. 1	
A	0	0	0	0	0	0	0
B	15-0-0	15-0-0	15-0-0	15-0-0	15-0-0	15-0-0	90
C	30-0-0	30-0-0	30-0-0	30-0-0	30-0-0	30-0-0	180
D	45-0-0	45-0-0	45-0-0	45-0-0	45-0-0	45-0-0	270
E	60-0-0		60-0-0		60-0-0		180
F	60-60-0		60-0-0		60-0-0		180
G	60-60-30		60-0-0		60-0-0		180
H	60-30-30		60-0-0		60-30-0		180

The plots received a blanket application of borax at 25 pounds per acre on June 4 in an attempt to eliminate reddish-brown marginal discoloration of the leaves on a small proportion of clover plants. The borax treatment was successful in eliminating the foliar discoloration.

Table 3. Fertilizer Treatments, 1956

Treatment	Pounds per Acre ($N - P_2O_5 - K_2O$) March 15	May 1	June 1	July 1	Aug. 1	Sept. 1	Total N applied per season (lbs./acre)
A	0	0	0	0-0-100	0	0-0-100	0
B	15-0-0	15-0-0	15-0-100	15-0-0	15-0-0	15-0-100	90
C	30-0-0	30-0-0	30-0-100	30-0-0	30-0-0	30-0-100	180
D	45-0-0	45-0-0	45-0-100	45-0-0	45-0-0	45-0-100	270
E	60-0-0		60-0-100		60-0-0	0-0-100	180
F	60-60-0		60-0-0		60-0-0		180
G	60-60-30		60-0-70		60-0-0	0-0-100	180
H	60-30-30		60-30-70		60-30-0	0-0-100	180

During the 1956 season severe potassium deficiency symptoms became apparent on the clover leaves. As a result, potassium treatments were applied to all plots, excepting those under treatments A and F on June 1. Treatment A received potassium on July 1. Further evidence of potassium deficiency in August necessitated a further potassium application to all plots, excepting treatment F on September 1. A total of 200 pounds per acre of K_2O was applied to all plots excepting treatment F in 1956.

On June 11 a blanket application of gypsum at 188 pounds per acre was made to plots receiving treatments A to E inclusive. This application was made to supply plots A to E with sulfur equivalent to the amount applied to plots F to H as a constituent of 19 per cent superphosphate. The sulfur treatment was made in order to avoid possible confusion of sulfur and phosphorus responses.

On August 17 soil samples were removed from the 0-6, 6-12, and 12-18 inch depths from plots receiving treatments B and D. Thus plots receiving both low and high rates of nitrogen were sampled. The samples were removed from the grass mixture plots in each case and two replicates were sampled.

A test for nitrate nitrogen (diphenylamine) and a pH test were run on each sample. The test for nitrate was negative in each case indicating no residual accumulation of nitrate either in the surface soil or sub-surface soil down to 18 inches. pH readings also failed to indicate any residual acidity due to the ammonium nitrate applications.

The pH readings for the lighter nitrogen treatment (treatment B) were 5.67, 5.62 and 5.99 for the 0-6, 6-12 and 12-18 inch depths respectively. For the heavier nitrogen treatment (Treatment D) the pH readings were 5.53, 5.66 and 6.04 respectively.

Table 4. Fertilizer Treatments, 1957

Treat-ment	March 15 (1)	May 1	June 1	July 1	Aug. 1	Sept. 1	Total N appl. per season lbs./acre
	Pounds per Acre ($N - P_2O_5 - K_2O$)						
A	0-0-100	0	0-0-100	0	0-0-100	0	0
B	15-0-100	15-0-0	15-0-100	15-0-0	15-0-100	15-0-0	90
C	30-0-100	30-0-0	30-0-100	30-0-0	30-0-100	30-0-0	180
D	45-0-100	45-0-0	45-0-100	45-0-0	45-0-100	45-0-0	270
E	60-0-100		60-0-100		60-0-100		180
F	60-60-0		60-0-0		60-0-0		180
G	60-60-100		60-0-100		60-0-100		180
H	60-30-100		60-0-100		60-30-100		180

(1) Gypsum was applied to all plots, treatments A to E inclusive, at 188 pounds per acre on March 15.

It is to be observed in Tables 2, 3 and 4 that the same rates and frequencies of nitrogen application were applied during each of the three years of the experiment. These are given in Table 5. The treatments used to compute mean responses to potassium and phosphorus applications over the three-year period of the experiment are given in Table 6.

Table 5. Frequency and Rate of Nitrogen Applications, 1955-57

Fertilizer Treat- ment	No. of N applica- tions per year	Dates of N application	lbs./acre of N applied at each appli- cation
A	none	-	-
B	6	March 15, May 1, June 1 July 1, August 1, September 1	15
C	6	- ditto -	30
D	6	- ditto -	45
E	3	March 15, June 1 and August 1	60

Note: for treatments in addition to Nitrogen, see Tables 2, 3 and 4.

Table 6. Potassium and Phosphorus Treatments, 1955-57

Fertilizer Treatment (1)	Pounds/acre N - P_2O_5 - K_2O		
	1955	1956	1957
+K	180-60-30	180-60-200	180-60-300
-K	180-60-0	180-60-0	180-60-0
+P	180-60-0	180-60-200	180-60-300
-P	180-0-0	180-0-200	180-0-300

(1) +K means Potassium was applied
-K means no Potassium was applied
+P means Phosphorus was applied
-P means Phosphorus was not applied

<u>Soil</u>

The experiment was laid down on a soil type known as Tolmie Sandy Clay Loam on the Experimental Farm, Saanichton, British Columbia. The soil is described (30) as an imperfectly drained soil developed under Douglas-fir, maple, willow, fern or bracken cover and owing its origin to marine wave action.

Soil samples for cation exchange capacity and exchangeable K, Ca, Mg, and Na determination were removed from plots under Treatment F. Phosphorus determinations were made on soil samples from Treatment E. Composite samples from the 0-6 inch and 12-18 inch depths were removed from two replicates in each case. The cation exchange capacity of these soils was determined using 1 normal ammonium acetate and phosphorus determinations were made using the sodium carbonate method. The soil samples were taken in August, 1956.

Table 7. Results of Soil Analysis

Depth of Sampling (inches)	M.E. per 100 grams of Soil C.E.C.	Exch. K	Exch. Ca.	Exch. Mg.	Exch. Na.	P (p.p.m.)
0-6	15.35	0.13	9.2	1.61	0.17	12.1
12-18	14.10	0.17	11.0	4.00	0.20	3.3

The soil analysis indicates that the soil had a moderately-low cation exchange capacity and a low level of exchangeable potassium. The amounts of exchangeable calcium and magnesium appear to be adequate for plant growth. The available phosphorus level was considerably lower in the sub-soil than in the surface soil.

Irrigation

Bouyoucos gypsum blocks (4, p.37) located at 6, 9, 12, 18, 24 and 36 inch depths were used as a guide to irrigation. Resistance readings were not allowed to exceed 20,000 ohms which insured that soil moisture was maintained well above wilting point at all times. Sets of electrical resistance blocks were located in each subplot for treatments D, G and H in two replications. It was estimated that these treatments would have comparatively high water requirements. Irrigations were applied as blanket applications to the entire plot area with sprinklers being used to apply the irrigation water.

Irrigation water was applied at each irrigation until all resistance blocks recorded a reading not exceeding 1,000 ohms.

Chemical Control of Volunteer Species

Bi-annual applications of a 2,4-D; 2,4,5-T combination at the rate of two pounds active ingredient per acre were required to control volunteer white clover and certain broad leaved weeds in the grass mixture plots. Weed and volunteer species control was not a problem in the grass-clover plots.

Clipping

The initial clip each season was taken when six inches of growth was registered on any of the plots. Subsequent clips were taken on a three-week clipping interval to permit accurate evaluation of seasonal production trends. Clips were performed using a mower with a three-foot cutter bar set at a height of one inch. Growth on the more productive plots equaled or exceeded six inches on each clipping date. The relatively short cutting interval probably tended to enhance the percentage stand of Ladino clover and decrease the total seasonal dry matter yield. Peterson and Hagan (25) found that the percentage of Ladino clover in a grass-clover pasture mixture increased as the clipping interval was decreased stepwise from five to two weeks. They also found that the yield increased as the clipping interval was increased from two to five weeks. Brown and Munsell (5, p.15) also noted that pasture yields decreased as more frequent clipping was performed.

The relatively short clipping height would tend to enhance the percentage stand of Ladino clover. Robinson *et al*.(29) found that the percentage stand of Ladino clover in a clover-grass pasture sward increased as the clipping height was reduced from two to one to one-half inches.

The first and last cutting dates for each year of the experiment were as follows:

Table 8. First and Last Cutting Dates, 1955-57

Year	First Cutting Date	Last Cutting Date	Cutting Interval
1955	April 22	September 16	3 weeks
1956	April 20	September 13	3 weeks
1957	April 16	September 9	3 weeks

Note: Cuttings were performed every 21 days following the initial cutting in each case.

Eight cuttings were taken during each year of the experiment.

Plant Material

Green weights were recorded at the time of clipping. Weighed samples were removed for dry matter and chemical analysis and botanical separation immediately following cutting. Dry matter yields were based on oven drying at 95°C (2, p.404) and percentage clover is based on the air dry weights of all separates. Samples for botanical separation were maintained in a green and succulent state by means of refrigeration until hand separations had been completed.

Chemical Analysis of Plant Material

Plant chemical contents are expressed as percentages of oven dry weight of plant material.

The protein content of the herbage was obtained by multiplying the nitrogen content by a factor of 6.25 (2, p.405). The Kjeldahl method (2, p.26) was used to determine the nitrogen content of the forage.

The procedures used in the determination of phosphorus, potassium, calcium, and magnesium were reported by Ward and Johnston (37, p.14-25). The extract was prepared by ashing the plant material at 500°C. This ash was taken up in a warm solution of HCl and H_2O and filtered. The residue from this filtration was again ashed at 500°C, taken up in HCl and H_2O, boiled and filtered. The two filtrates constitute the extract. All colorimetric or turbidimetric determinations were made using a Beckman Model B spectrophotometer.

Phosphorus was determined colorimetrically using ammonium molybdate and amino-naphthol-sulfonic acid solution. The phosphomolybdate complex is reduced in this procedure to the complex molybdenum blue which is measured colorimetrically.

Potassium was determined using sodium cobaltinitrite which combines with potassium at a controlled temperature and pH to form a fine yellow precipitate of sodium potassium cobaltinitrite. Potassium was measured by a turbidimetric determination on a suspension of this fine precipitate.

Calcium was determined turbidimetrically. Calcium was precipitated as a calcium soap by adding a soap solution to the plant extract in the presence of ammoniacal citrate solution.

Magnesium was measured colorimetrically by a procedure which is based on the adsorption of thiazole yellow on colloidal magnesium hydroxide.

Figure a - Partial view of the experimental plots. The greater productivity of the grass-clover plots as compared to the grass plots is apparent. Photograph taken in July, 1955.

Figure b - Clipping and weighing herbage from the plots.

EXPERIMENTAL RESULTS

A. Yield of Dry Matter

I. Results - Dry Matter Yields

Table 9. Analysis of Variance - Dry Matter Yields

	Degrees of Freedom	Mean Square 1955	1956	1957
Fertilizer Treatments	7	826114**	783876**	1503325**
Replicates	3	18627	473602	597921
Error "A"	21	27976	8507	38291
Mixtures	1	39724600**	49633176**	32349453**
Mixtures x Fertilizers	7	334386**	475033**	651480**
Error "B"	24	34847	76488	61939
Cuts	7	4462485**	2484731**	3946500**
Mixtures x Cuts	7	665700**	990144**	376763**
Fertilizers x Cuts	49	126457**	86362**	126109**
Fertilizers x Mixtures x Cuts	49	13412*	41876**	28160**
Error "C"	336	12718	11910	16761

* Effect significant at 5% Probability level.
** Effect significant at 1% Probability level.

Table 10. 1955-57 Mean Dry Matter Yields for Varying Fertilizer Treatments (Fertilizers x Mixtures x Cuts and Fertilizers x Mixtures)

Fert. Trtmt.	Mix. (3)	Dry Matter Yields - lbs per acre (1955-57 Means) 1	2	3	4	5	6	7	8	Fert. x Mix. Means
A(1)	1	235	486	291	211	109	84	92	81	199
	2	1029	1124	1009	935	1203	1134	1190	794	1075
B	1	534	883	489	447	288	214	272	251	422
	2	1299	1201	1112	1042	1239	1134	1244	915	1148
C	1	744	1077	694	731	513	365	534	477	642
	2	1296	1294	1116	1130	1210	1078	1254	896	1159
D	1	837	1149	830	922	707	508	826	665	805
	2	1268	1287	1140	1202	1234	1053	1268	909	1170
E	1	906	1152	376	686	531	184	769	475	635
	2	1445	1331	998	1109	1294	997	1341	883	1175
+K(2)	1	1072	1148	413	803	592	211	818	515	696
	2	1732	1285	1040	1174	1295	1014	1412	937	1236
-K	1	845	1109	384	710	495	200	770	451	620
	2	1265	1312	830	921	912	691	1067	691	961
+P	1	1001	1183	399	797	572	211	801	474	680
	2	1667	1309	1016	1144	1250	956	1333	879	1194
-P	1	906	1154	376	686	531	184	769	475	635
	2	1445	1331	998	1109	1294	997	1341	883	1175

(1) See Table 5; (2) see Table 6; (3) see Table 1.

Table 11. 1955-57 Mean Dry Matter
Yields per Cut - Mixtures

Mixtures	Mean Dry Matter Yield per Cut (lbs./acre)
1. Grass	582
2. Grass-Clover	1144

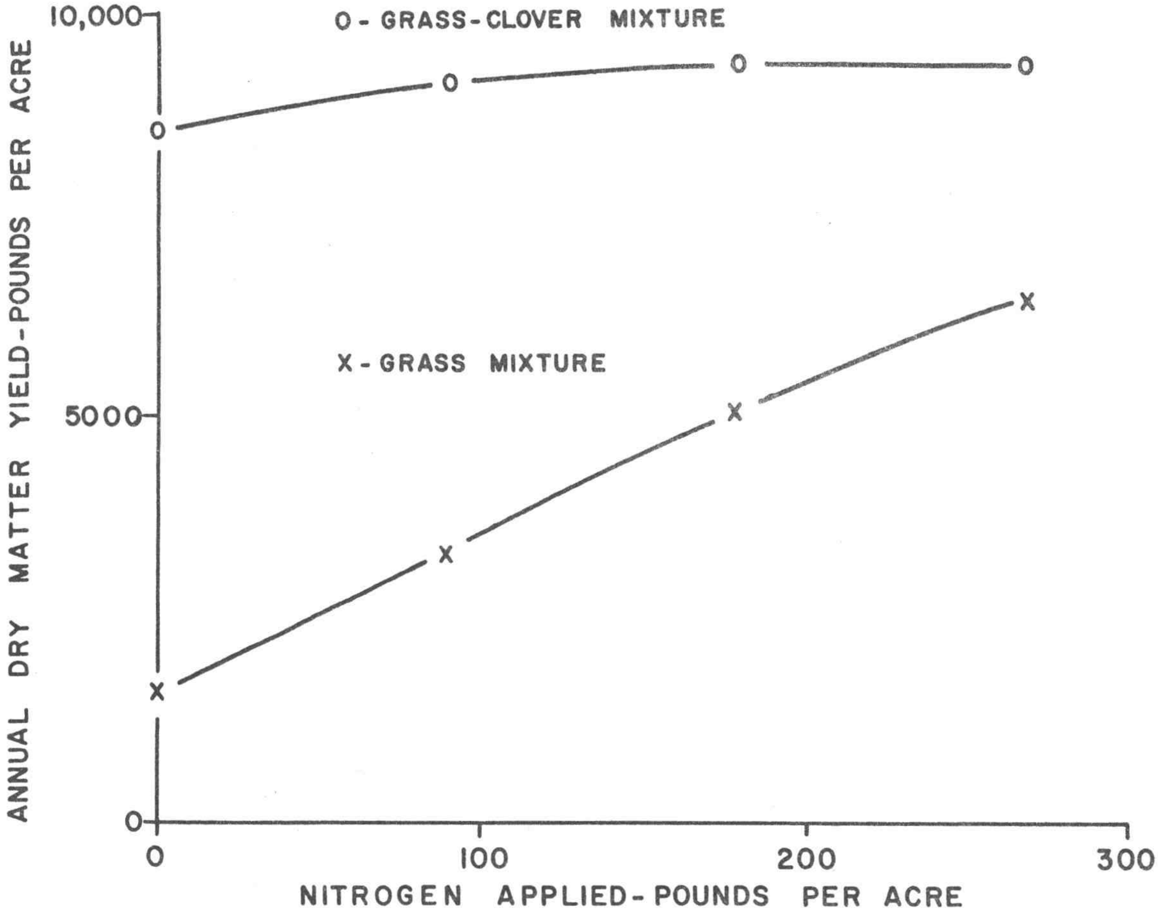

FIGURE I: 1955-1957 MEAN DRY MATTER YIELDS RESULTING FROM DIFFERENT RATES OF NITROGEN APPLICATION

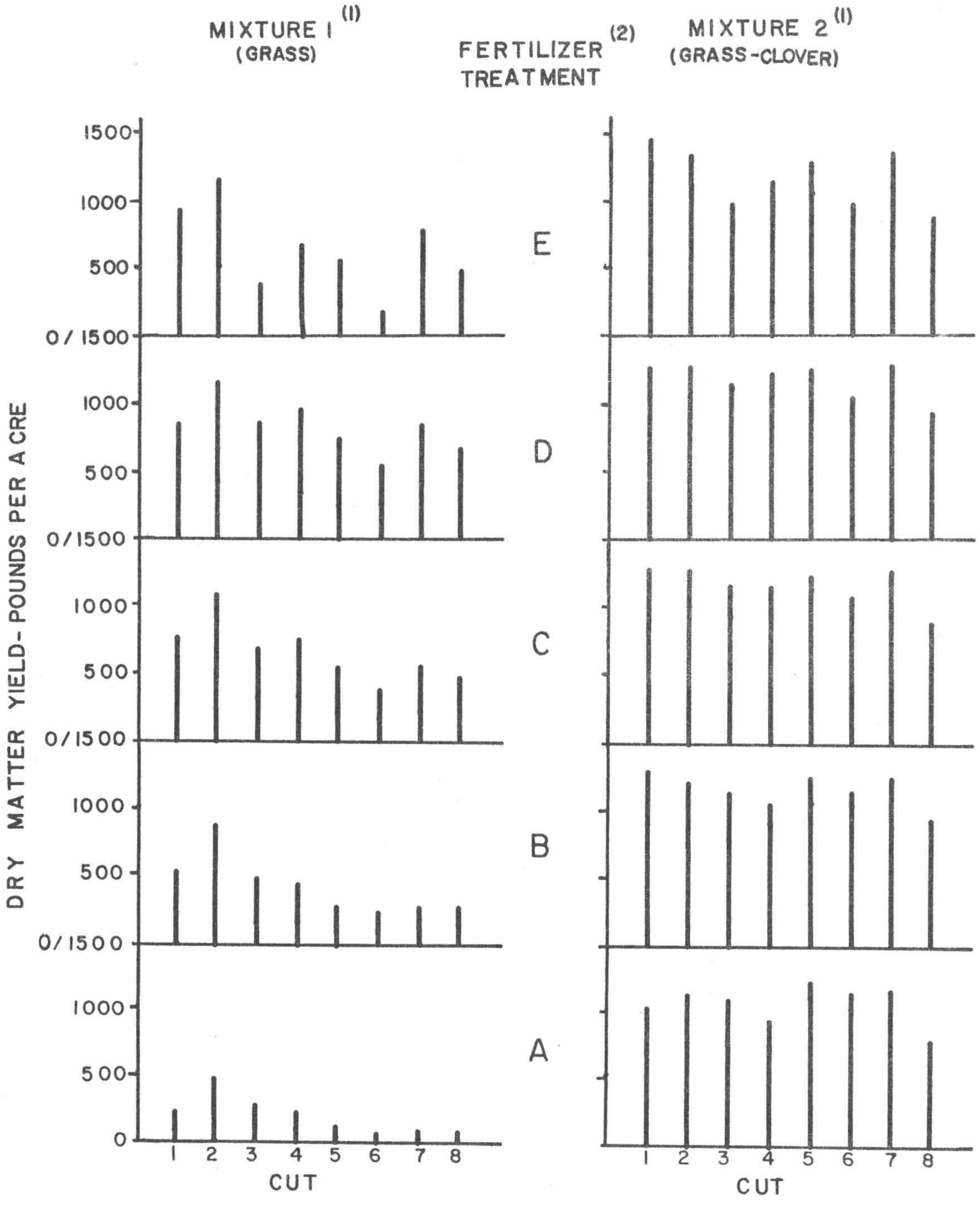

FIGURE 2: 1955-1957 MEAN DRY MATTER YIELDS (MIXTURES X CUTS X NITROGEN TREATMENTS)

(1) SEE TABLE 1 (2) SEE TABLE 2

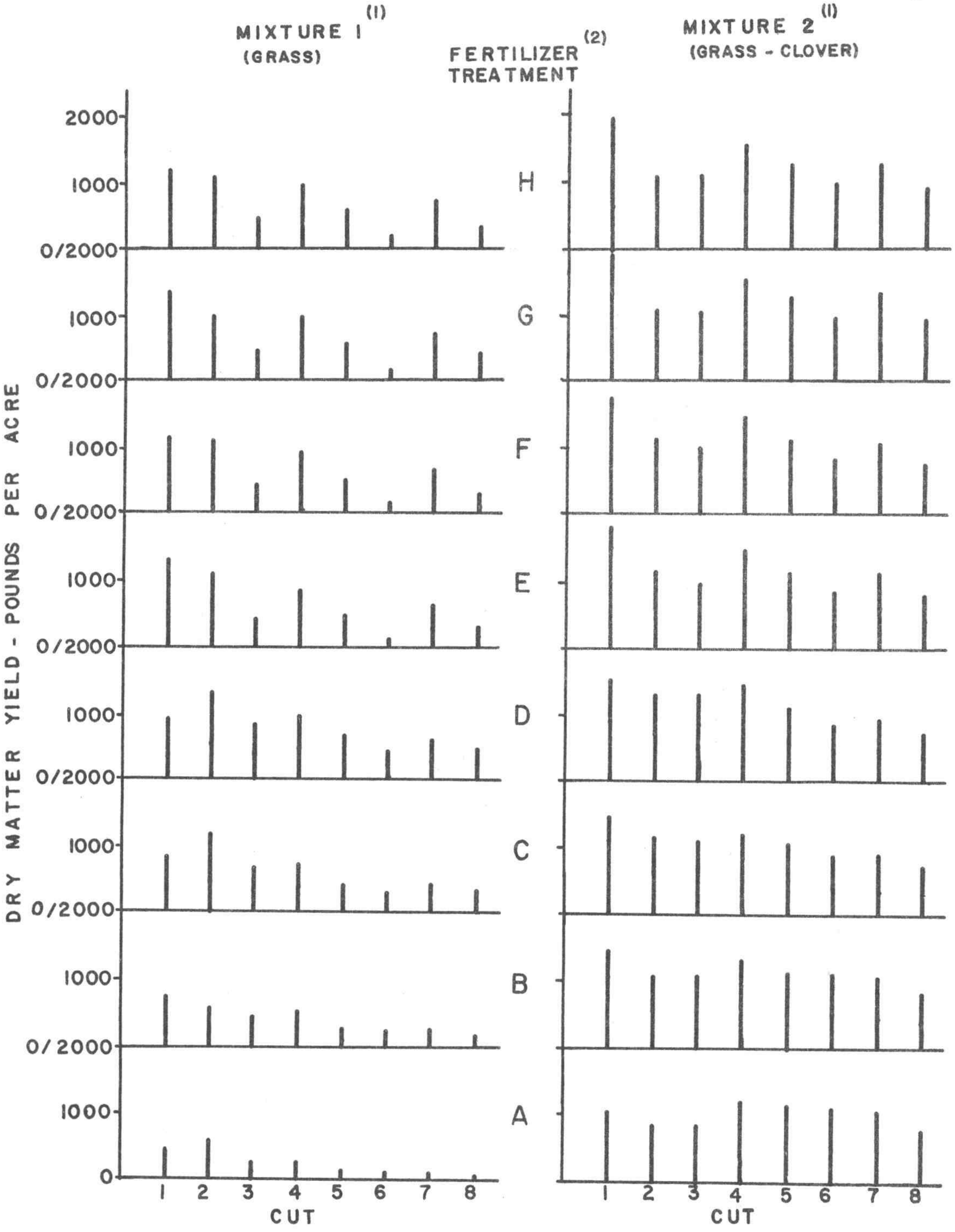

FIGURE 3: DRY MATTER YIELDS - 1955 (MIXTURES X CUTS X FERTILIZERS)

(1) SEE TABLE 1.

(2) SEE TABLE 2.

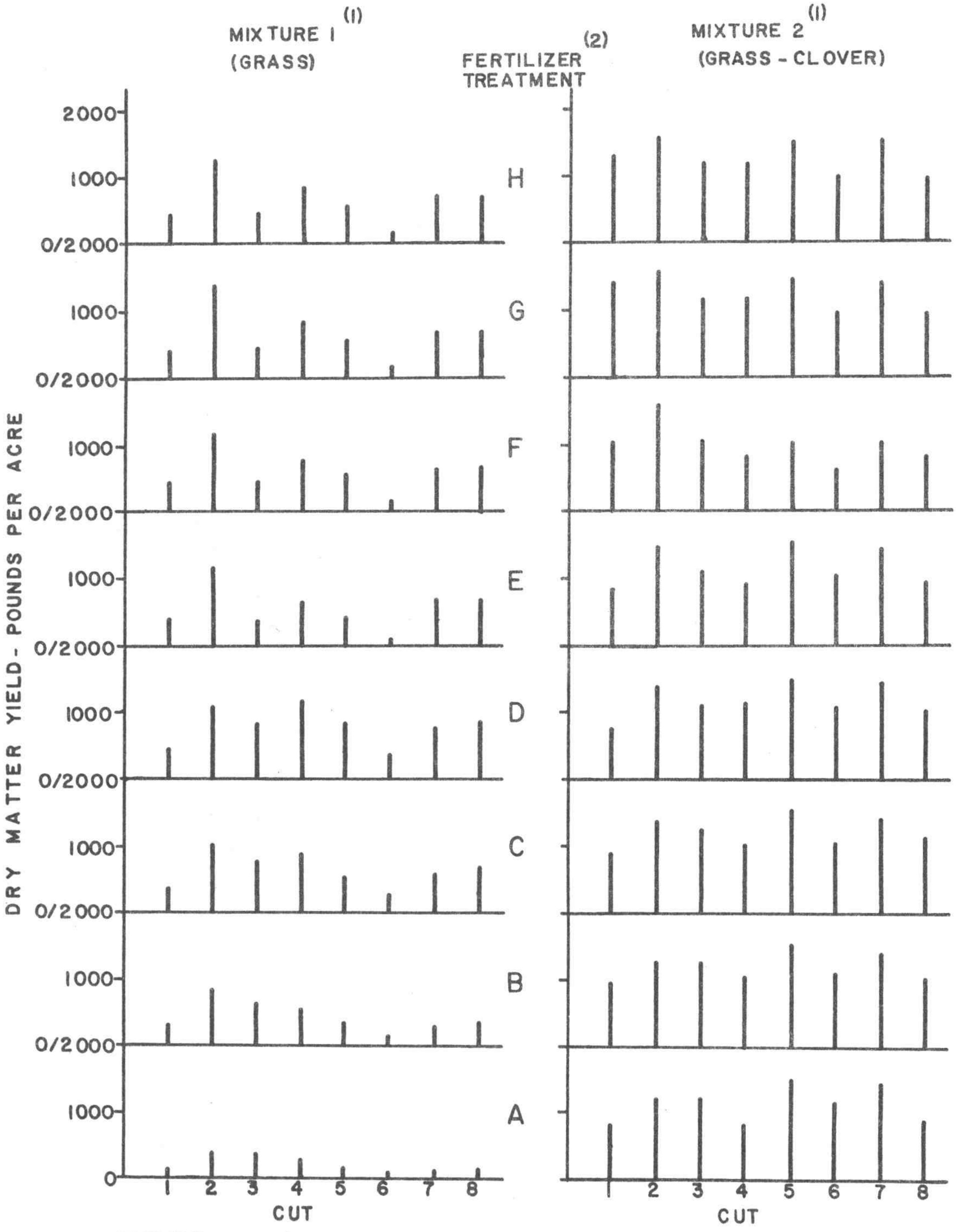

FIGURE 4: DRY MATTER YIELDS - 1956 (MIXTURES X CUTS X FERTILIZERS)

(1) SEE TABLE 1.

(2) SEE TABLE 2.

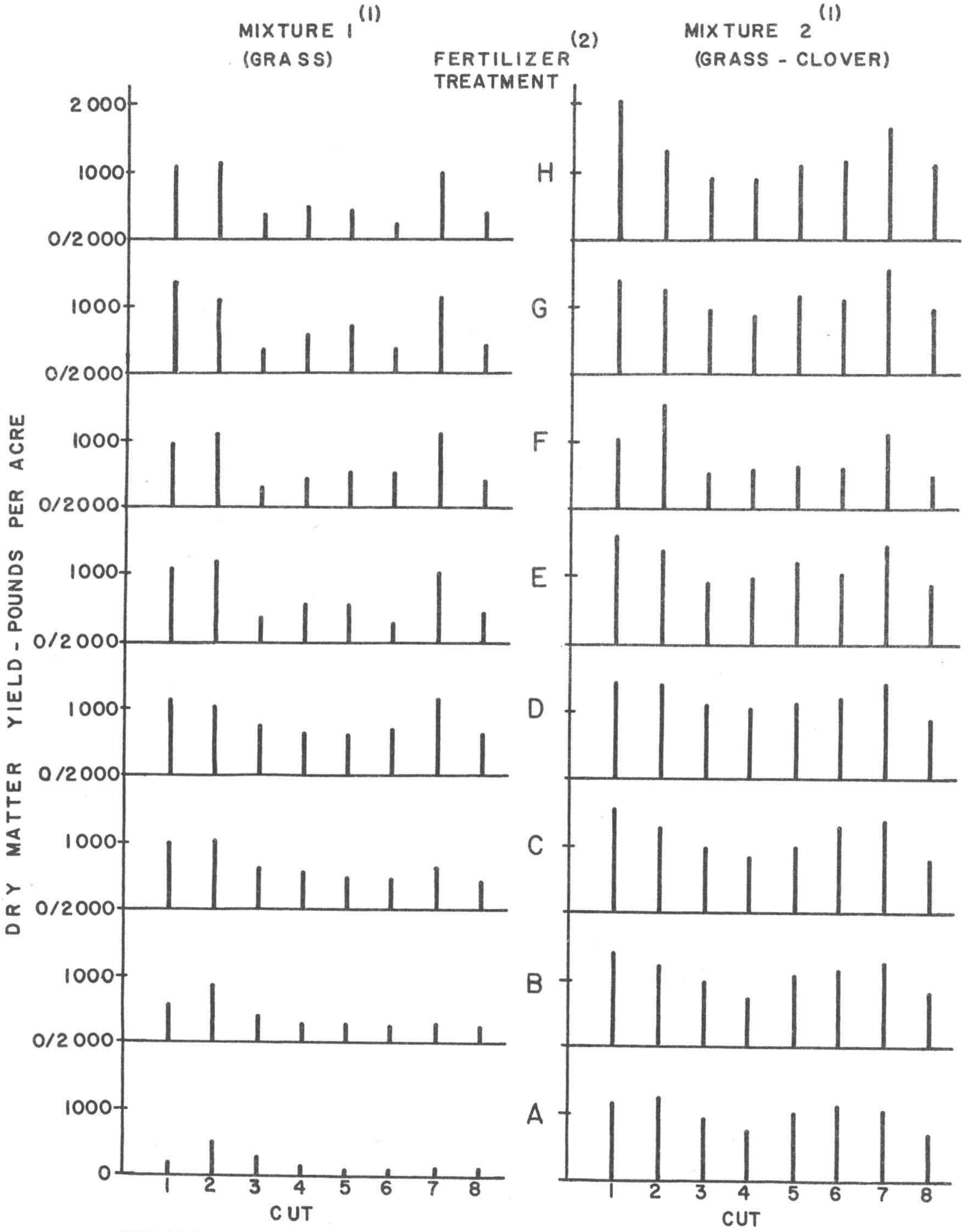

FIGURE 5: DRY MATTER YIELDS - 1957 (MIXTURES X CUTS X FERTILIZERS)

(1) SEE TABLE 1.

(2) SEE TABLE 2.

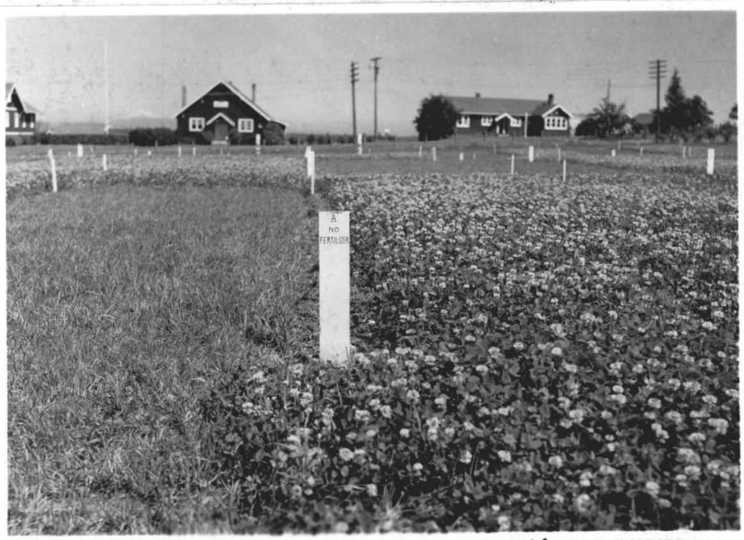

Figure c - The greater growth of the grass-clover mixture, on the right, as compared to the grass mixture is illustrated in this photograph taken in July, 1955.

Figure d - A comparison of herbage removed from grass-clover and grass subplots receiving the same fertilizer treatment. Grass herbage shown on the left. Photographed in July, 1955.

II. Discussion of Results - Yields of Dry Matter

(1) Mixtures

It is apparent from Figures 3, 4, and 5 that the yield of Mixture 2, the grass-clover mixture, considerably exceeded the yield of Mixture 1, the grass mixture, during each of the three years of the experiment. The three-year mean annual dry matter yield recorded by Mixture 2 and Mixture 1 were 9152 and 4656 pounds per acre respectively (Table 11). The inclusion of two pounds per acre of Ladino clover seed in the seed mixture therefore resulted in almost a 100 per cent increase in dry matter production.

A study of Figures 3, 4, and 5 reveals that the least nitrogen fertilized grass-clover mixture produced considerably more dry matter during each of the three years of the experiment than the most heavily nitrogen fertilized grass mixture. This indicates that the inclusion of Ladino clover in the seeding mixture resulted in considerably more economical production of dry matter. Over the three year period of the experiment, the grass-clover mixture which received no nitrogen fertilization produced an average of 8660 pounds of dry matter per acre per year (Table 10). The grass mixture when fertilized with 270 pounds of nitrogen per year produced 6440 pounds of dry matter per acre per year. Non-nitrogen fertilized grass produced only 1592 pounds of dry matter per acre per year. It is apparent from a study of Figures 2, 3, 4, and 5 that for nearly every fertilizer treatment, the grass-clover mixture gave less variable production over the growing season than the grass mixture. As even production is often desirable with pastures, the tendency for Ladino clover to enhance this trend is further evidence of the value of this species in the pasture mixtures under study. Wagner (35) also reports more even production for an orchard grass-Ladino clover sward as compared to a nitrogen fertilized orchard grass sward.

(2) Fertilizer Treatments

It is apparent that the dry matter yield of the grass mixture increased as the rate of application of nitrogen increased (Table 10 and Figures 1, 2, 3, 4, and 5). Over the three-year period of the experiment grass plot dry matter yields were 1592, 3376, 5136, and 6440 lbs. per acre per year for plots receiving 0, 90, 180, and 270 pounds per acre of nitrogen per year respectively. The first, second, and third 90-pound increments of nitrogen applied increased dry matter yields by 1784, 1760, and 1304 pounds per acre respectively. The first, second, and third 90-pound increments of nitrogen therefore resulted in dry matter increases of 19.8, 19.5, and 14.5 pounds respectively for each pound of nitrogen applied. It can thus be seen that the efficiency of the third 90-pound nitrogen increment was lower than the efficiency of the first and second 90-pound nitrogen increments.

More frequent nitrogen applications resulted in a more even production of dry matter by the grass mixture over the growing season (Table 10 and Figures 2, 3, 4, and 5 - Treatments C and E). More frequent nitrogen applications failed to result in consistent dry matter yield increases by either mixture.

Nitrogen applications totaling 90 pounds per acre per year increased the dry matter yield recorded by the grass-clover mixture (Table 10, and Figures 1, 2, 3, 4, and 5) but increasing nitrogen applications beyond 90 pounds per acre per year failed to consistently further increase yields.

Over the three-year period of the experiment, grass-clover plots yielded 8600 and 9184 pounds per acre per year of dry matter for the 0 and 90-pound annual nitrogen treatments respectively (Table 10). In 1956 and 1957 the mean clover content of the grass-clover mixture was 75 and 68 per cent for the 0 and 90-pound per acre nitrogen treatments respectively (Table 18).

These results indicate that the 90-pound per acre nitrogen treatment increased the dry matter yield and, at the same time, decreased the percentage stand of clovers. Other results reported for this experiment (Table 11) indicate that the clover mixture yielded considerably more dry matter than the grass mixture. It would therefore be anticipated that a reduced per cent stand of clover would be associated with a reduced dry matter yield. The increase of dry matter yield which resulted from the 90 pounds per acre application of nitrogen is probably associated with a substantial increase in the growth of grass resulting from nitrogen fertilizer. The increased growth of grass probably more than offset the decreased yield resulting from the slight decrease in the per cent stand of clover1 Applications of nitrogen in excess of 90 pounds per acre per year resulted in further reductions in the percentage stand of clover but failed to further increase the dry matter yield of the grass-clover mixture. The heavier nitrogen applications therefore apparently enhanced the growth of grass to the point where increased grass yields offset the loss in yield associated with the reduced stand of clover.

Nitrogen was not nearly as effective in increasing the yield of the grass-clover mixture as it was in increasing the yield of the grass mixture. Three-year average seasonal dry matter yields of 8600, 9184, and 9272 pounds per acre were recorded by grass-clover plots receiving 0, 90, and 270 pounds of N per acre per year respectively (Table 10).

The dry matter yields of both mixtures were increased by the application of potassium fertilizer (Table 10 and Figures 3, 4, and 5). Potassium applications resulted in a larger yield increase with the grass-clover mixture than with the grass mixture. The yield increases resulting from potassium applications became greater as the duration of the experiment increased. This is probably related to an increasingly acute deficiency of potassium on the non-potassium fertilized plots as the duration of the experiment increased. In 1957 three applications of 100 pounds per acre of K_2O each resulted in grass and grass-clover dry matter yields of 5920 and 9640 pounds per acre respectively. Non-potassium fertilized grass and grass-clover plots yielded 5024 and 6184 pounds per acre of dry matter respectively in 1957 (Table A-7). In 1955 a single K_2O application of 30 pounds per acre resulted in grass and grass-clover dry matter yields of 5632 and 9960 pounds per acre respectively. In 1955 non-potassium fertilized grass and grass-clover plots yielded 5232 and 8960 pounds per acre of dry matter respectively (Table A-1). The rate and frequency of potassium fertilization was increased in 1956 and again in 1957 (Tables 2, 3, and 4). Visual potassium deficiency symptoms were obvious on Ladino clover plants on non-potassium fertilized plots in 1955 and 1956. Reasonably frequent potassium applications were required during the second and third years of the experiment to prevent the development of visible potassium deficiency symptoms on Ladino clover (Tables 3 and 4). Over the three-year period of the experiment the grass mixture recorded mean seasonal dry matter yields of 4960 and 5568 pounds per acre for non-potassium and potassium fertilized plots respectively (Table 10). The corresponding yields for the grass-clover mixture were 7688 and 9888 pounds per acre dry matter per year for non-potassium and potassium fertilized plots.

Under the discussion on "Per cent Clover", it is to be noted that potassium applications increased the per cent clover in the pasture sward. The tendency of potassium fertilization to increase the per cent clover is probably related to the increase in yield associated with potassium fertilization of the grass-clover mixture. The increased yield of grass resulting from potassium fertilization would also be a factor in the increased yield of grass-clover herbage resulting from potassium fertilization.

Phosphorus applications resulted in a small increase of dry matter yield with the grass mixture but did not appreciably increase the dry matter yield recorded by the grass-clover mixture (Table 10). A 60-pound per acre application of P_2O_5 increased the grass mixture seasonal dry matter yield from 5080 to 5440 pounds per acre on the basis of the three-year mean (Table 10). The no-phosphorus and 60-pound per acre phosphorus treatments resulted in dry matter yields of 9400 and 9552 pounds per acre respectively for the grass-clover mixture on a seasonal basis averaged over three years. Splitting the phosphorus application and applying half in the spring and half in the fall did not increase grass mixture yields as much as a single spring phosphorus application. In the case of the grass-clover mixture, single and double phosphorus applications resulted in essentially the same dry matter yields.

The results indicate that phosphorus was not as effective in increasing yields as was potassium. Nitrogen was the most effective of the nutrient elements tested in increasing grass mixture yields, and potassium was the most effective in increasing grass-clover mixture yields.

B. Percentage Protein

I. <u>Results - Percentage Protein</u>

Table 12. Analysis of Variance - Percentage Protein

	Degrees of Freedom	Mean Square		
		1955	1956	1957
Fertilizer Treatments	7	9.74	1.36	55.3**
Replicates	3	78.57	7.44	17.7
Error "A"	21	6.82	5.95	6.3
Mixtures	1	7067**	4630**	8840**
Mixtures x Fertilizers	7	34.64**	9.90*	68.9**
Error "B"	24	7.69	3.60	11.5
Cuts	7	466.1**	307.0**	321.9**
Mixtures x Cuts	7	58.75**	38.52**	49.4**
Fertilizers x Cuts	49	24.70**	9.53**	52.4**
Fertilizers x Mixtures x Cuts	49	5.85**	3.22**	5.5
Error "C"	336	1.86	0.623	4.0

* Effect significant at the 5% probability level.
** Effect significant at the 1% probability level.

Table 13. 1955-57 Mean Percentage Protein recorded by Varying Rates and Frequencies of Nitrogen Application (Fertilizers x Mixtures x Cuts and Fertilizers x Mixtures)

Fert. Trtmt. (1)	Mix. (2)	Percentage Protein (1955-57) Means — Cut 1	2	3	4	5	6	7	8	Fert. x Mix. Means
A	1	13.5	12.5	14.7	17.2	16.4	16.9	18.2	18.3	16.0
	2	26.2	24.5	25.5	26.9	26.9	28.2	28.4	30.5	27.1
B	1	16.0	15.0	15.6	18.7	18.2	16.2	18.8	21.0	17.4
	2	25.5	24.0	25.1	25.5	26.2	27.6	26.9	30.4	26.4
C	1	18.8	16.7	16.1	18.6	20.9	16.8	19.4	24.1	18.9
	2	25.9	25.7	23.6	24.8	26.2	25.1	26.9	30.2	26.0
D	1	19.5	18.4	16.7	19.8	21.9	16.3	21.0	25.8	19.9
	2	25.4	25.4	23.6	24.7	26.8	24.8	26.1	30.4	25.9
E	1	22.3	14.0	14.0	22.7	14.6	14.8	23.7	16.9	17.9
	2	27.6	23.1	23.7	27.8	24.0	26.3	28.5	27.4	26.0

(1) See Table 5; (2) see Table 1.

Table 14. 1955-57 Mean Percentage Protein recorded by Plots receiving and not receiving a) Potassium, b) Phosphorus. (Mixtures and Fertilizers)

Fertilizer Treatment (1)	1955-57 Mean Per cent Protein		
	Mixture 1	Mixture 2	Fertilizer Mean
+K	18.3	25.9	22.1
-K	18.2	25.5	21.8
+P	18.0	25.7	21.8
-P	17.9	26.0	21.9

(1) See Table 6.

Table 15. 1955-57 Mean Per cent Protein-(Mixtures)

Mixture	Mean Percentage Protein
1 - Grass	18.0
2 - Grass-clover	26.1

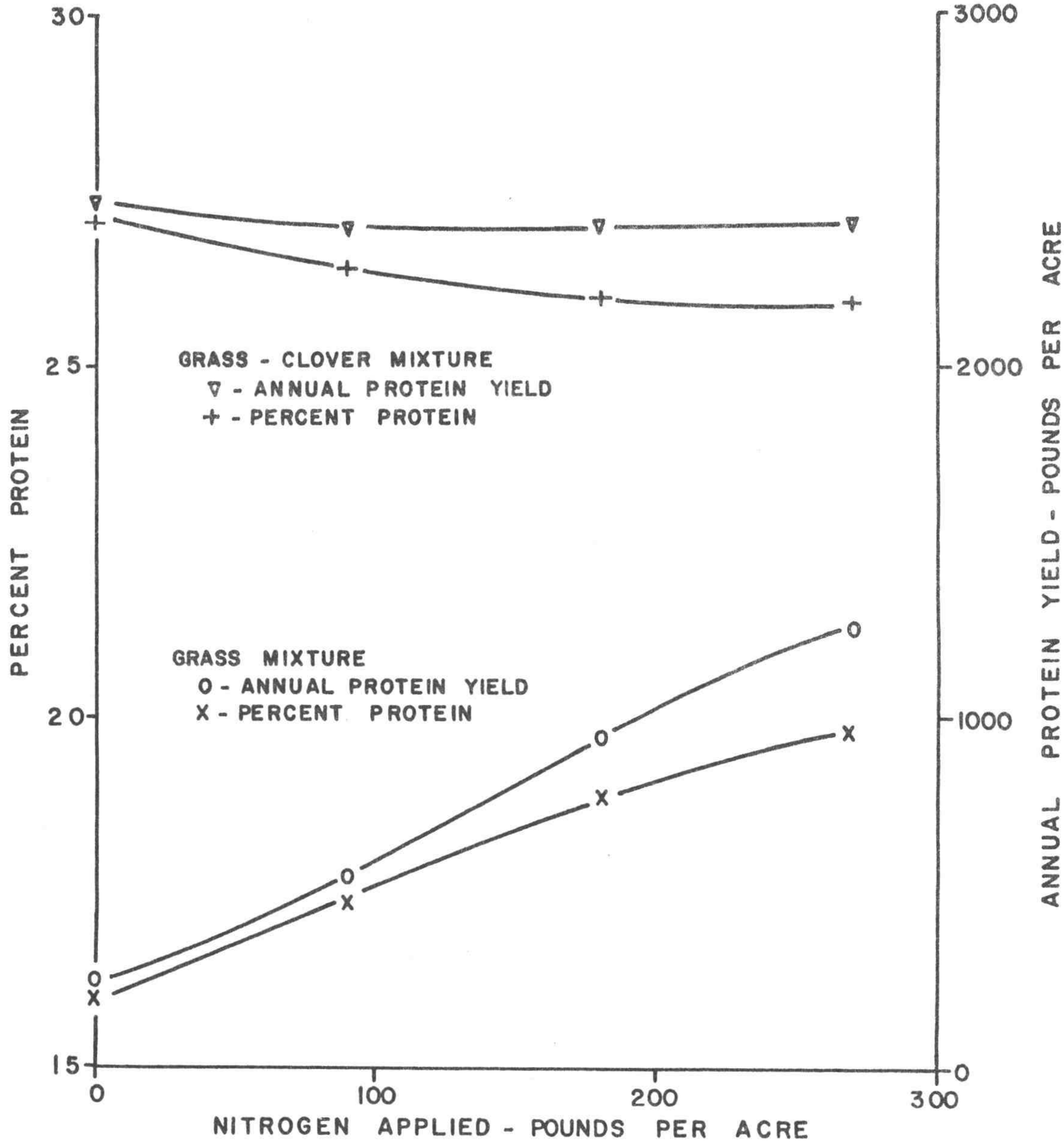

FIGURE 6 - 1955 - 1957 MEAN PERCENT PROTEIN AND ANNUAL PROTEIN YIELD RESULTING FROM DIFFERENT RATES OF NITROGEN APPLICATION

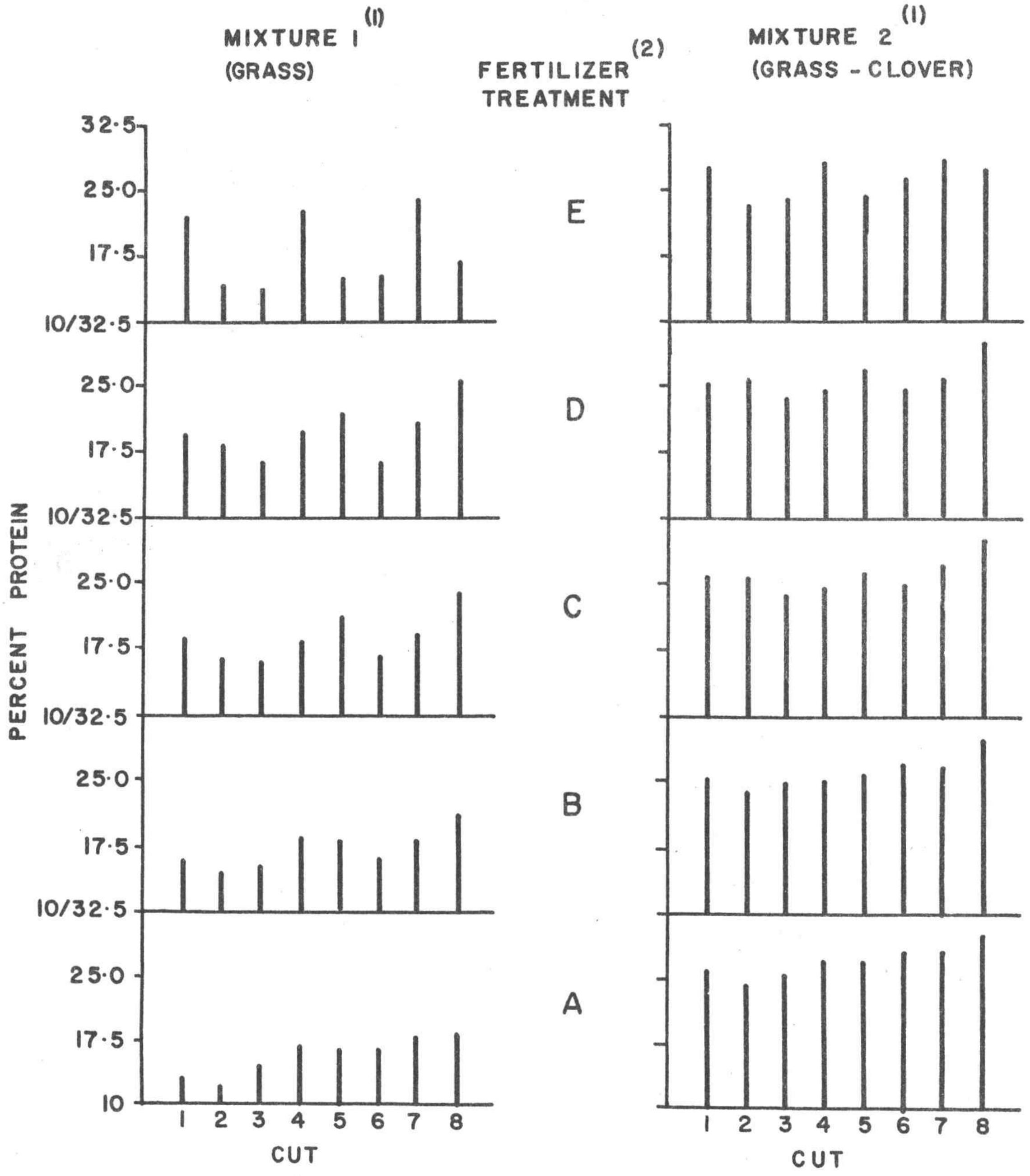

FIGURE 7 - 1955 - 1957 MEAN PERCENTAGE PROTEIN RECORDED BY VARYING RATES AND FREQUENCIES OF NITROGEN APPLICATION (FERTILIZERS X MIXTURES X CUTS)

(I) SEE TABLE I (2) SEE TABLE 2

II. Discussion of Results - Percentage Protein

(1) Mixtures

The grass-clover herbage contained a considerably higher percentage protein than the grass herbage during each of the three years of the experiment (Tables A-11, A-14, and A-17). Average percentages of 18.0 and 26.1 were recorded for the protein content of the grass and grass-clover mixtures respectively over the three-year period (Table 15). This indicates the important role played by Ladino clover in the production of protein.

Figure 6 indicates that the grass-clover mixture yielded a great deal more protein than the grass mixture. Over the three-year period of the experiment the annual protein yields recorded by the grass-clover and grass mixtures, for the four treatments (A to D) involving the varying rates of nitrogen application, were 2362 and 750 pounds per acre respectively.

Morrison (21, p.1092) reports protein contents of 20.3 and 14.1 per cent for mixed grass-clover and grass pasture herbage respectively. These values are lower than the corresponding protein contents reported in this study. Morrison's figures do, however, indicate a substantially higher protein content for the grass-clover herbage as compared to the grass herbage.

Wagner (35) reports a protein content varying from 10 to 18.5 per cent for orchard grass pasture herbage receiving variable nitrogen treatments. He also reports non-nitrogen fertilized orchard grass-Ladino clover pasture produced herbage containing from 12 to 24 per cent protein.

It is to be observed (Table 13 and Figure 7) that the protein content of the non-nitrogen fertilized grass-clover herbage tended to increase in the fall. This phenomenon was also observed by Wagner (35) in his studies of an orchard grass-Ladino clover pasture sward.

Further information regarding protein production is to be found under the section entitled "Yield of Nitrogen." Nitrogen yields can be converted to protein yields using a factor of 6.25 (2, p.405).

(2) <u>Fertilizers</u>

Nitrogen applications tended to increase the protein content of the grass herbage and decrease the protein content of the grass-clover herbage (Table 13 and Figure 10). Grass receiving no nitrogen and 270 pounds of nitrogen per year produced herbage containing 16.0 and 19.9 per cent protein respectively on the basis of three-year average results (Table 13). For the same nitrogen treatments (0 and 270 pounds per acre) the grass-clover herbage recorded 27.1 and 25.9 per cent protein respectively over the three-year period. The decrease in the herbage protein content resulting from nitrogen applications to the grass-clover mixture is probably associated with the reduced per cent stand of clover induced by nitrogen applications (Table 18). This is discussed further under the heading "Percentage Clover." Wagner (35) showed that nitrogen fertilization substantially increased the protein content of orchardgrass but had little effect on the protein content of an orchardgrass-Ladino clover pasture sward.

Nitrogen fertilized grass herbage produced less protein both on a yield and percentage basis than a non-nitrogen fertilized grass-clover herbage (Tables 13 and 16 and Figures 6, 7, 8, and 9). The use of Ladino clover in the seed mixture was far more effective in increasing protein production than was nitrogen fertilization of the grass mixture.

More frequent nitrogen applications increased the protein content of the grass herbage (Table 13 - Treatments C and E). Grass mixture plots receiving six applications totaling 180 pounds per acre of nitrogen produced herbage averaging 19.9 per cent protein over a three-year period. Three applications of nitrogen, totaling 180 pounds an acre, to the grass mixture resulted in herbage containing 17.9 per cent protein.

More frequent applications of nitrogen resulted in less variation of the grass herbage protein content over the growing season than less frequent nitrogen applications (Figure 7 - Treatments D and E). More frequent nitrogen applications did not increase the protein content of the grass-clover herbage but resulted in less variation of protein content over the growing season (Figure 7 - Treatments D and E).

The application of potassium or phosphorus fertilizers did not appreciably alter the per cent protein content of either mixture (Table 14).

C. Nitrogen Yields

I. Results - Nitrogen Yield

Table 16. 1955-57 Mean Nitrogen Yields for Varying Rates and Frequencies of Nitrogen Application (Fertilizers x Mixtures x Cuts and Fertilizers)

Fert. Trtmt. (1)	Mix. (2)	Nitrogen Yield - Pounds per Acre, Cut 1	2	3	4	5	6	7	8	Fert. x Mix. Means
A	1	5	10	7	6	3	2	3	2	5
	2	42	45	41	39	51	51	54	39	45
B	1	13	21	12	13	8	5	8	8	11
	2	52	46	45	41	52	50	54	44	48
C	1	22	29	18	21	17	10	17	18	19
	2	53	53	42	44	50	43	54	43	48
D	1	25	34	22	28	24	13	28	27	25
	2	49	52	43	47	52	42	53	44	48
E	1	31	26	8	24	12	4	29	13	18
	2	62	49	38	48	49	42	62	39	49
Cut Means		35	36	28	31	32	26	36	28	

(1) See Table 5; (2) see Table 1.

Table 17. 1955-57 Mean Nitrogen Yields for Varying Rates and Frequencies of Nitrogen Application (Mixtures)

Mixture (1)	Nitrogen Yield per Cut - lbs./ acre
I Grass	16
II Grass-clover	48

(1) See Table 1.

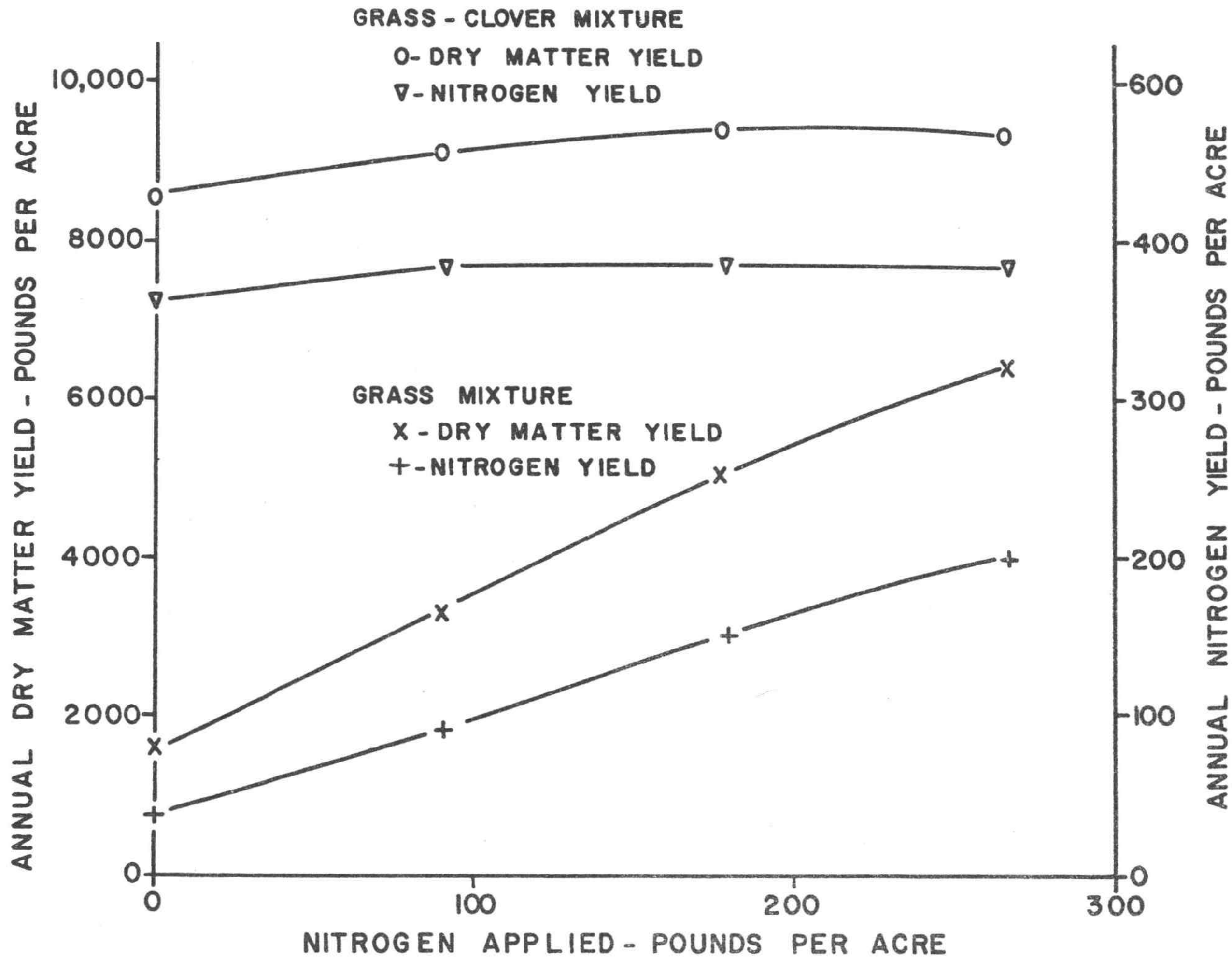

FIGURE 8: 1955-1957 MEAN NITROGEN AND DRY MATTER YIELDS RESULTING FROM DIFFERENT RATES OF NITROGEN APPLICATION

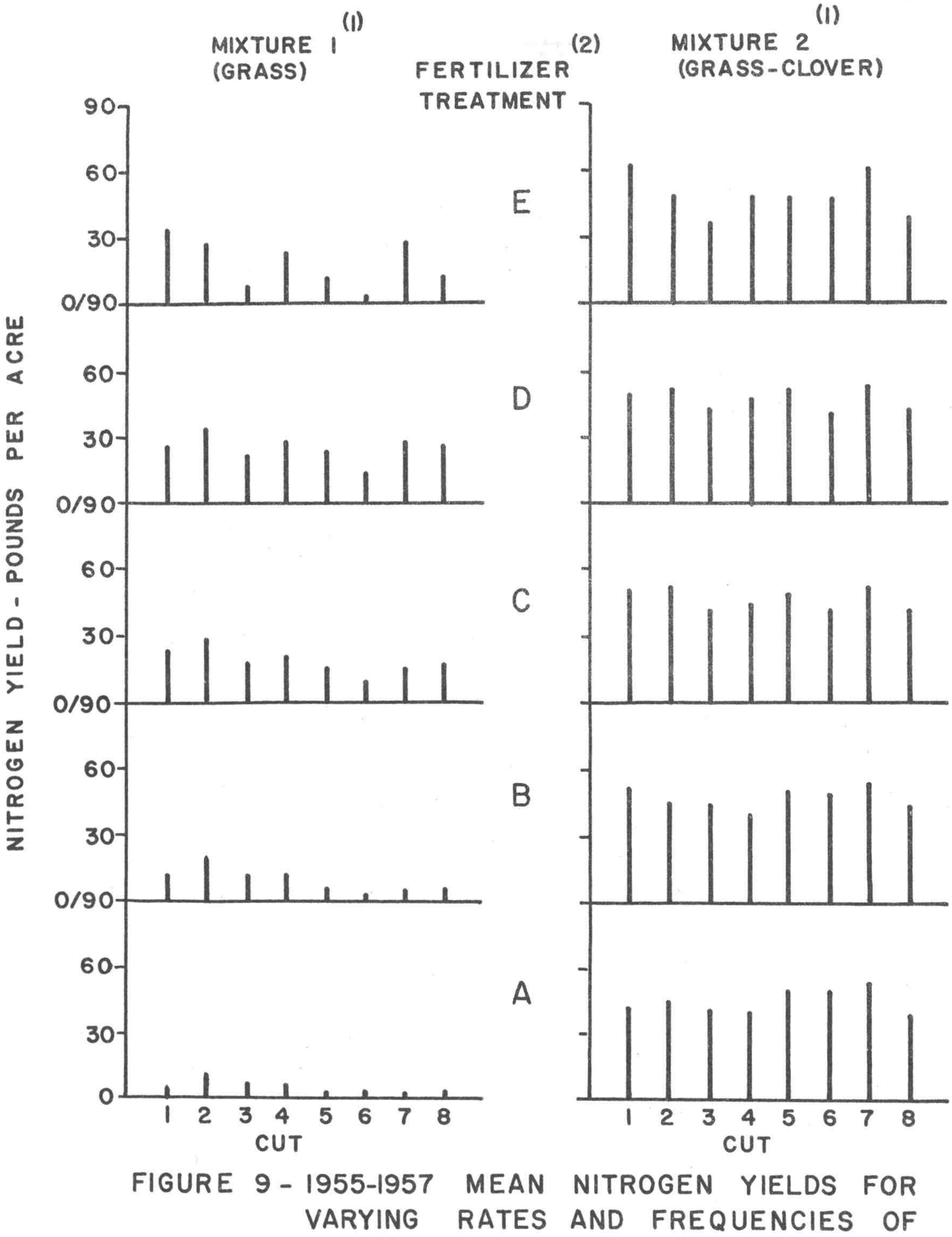

FIGURE 9 - 1955-1957 MEAN NITROGEN YIELDS FOR VARYING RATES AND FREQUENCIES OF NITROGEN APPLICATION (MIXTURES X FERTILIZERS X CUTS)

(1) SEE TABLE 1 (2) SEE TABLE 5

II. Discussion of Results - Nitrogen Yields

(1) Mixtures

It is apparent from Table 17 and Figures 8 and 9 that the grass-clover herbage yielded considerably more nitrogen than the grass herbage. Over the three-year period the mean nitrogen yield per season for the grass and grass-clover mixtures was 128 and 384 pounds per acre respectively. The non-nitrogen fertilized grass-clover mixture (Treatment A) produced an average of 360 pounds of nitrogen per acre per season. The most heavily nitrogen fertilized grass mixture (Treatment D) produced an average of only 200 pounds of nitrogen per acre per season. The non-nitrogen fertilized grass mixture yielded an average of only 40 pounds per acre of nitrogen per season. The inclusion of Ladino clover in the mixture therefore increased the nitrogen yield by 320 pounds per acre per season for non-nitrogen fertilized swards. This represents a nitrogen yield increase of 800 per cent for the non-nitrogen fertilized grass-clover mixture over the non-nitrogen fertilized grass mixture.

(2) Fertilizers

Table 16 and Figures 8 and 9 show that nitrogen fertilization did not appreciably increase the nitrogen yield recorded by the grass-clover mixture over the three-year period of the experiment. This was probably due to a decrease in percentage stand of clover as nitrogen fertilization was increased (Table 19). The nitrogen yield recorded by the grass mixture, however, was substantially increased by nitrogen fertilization. Non-nitrogen fertilized grass yielded only 40 pounds per acre per season of nitrogen whereas 270 pounds of nitrogen in six applications (Treatment D) when applied to grass resulted in a yield of 200 pounds per acre per season of nitrogen. Three applications of nitrogen totaling 180 pounds per acre resulted in essentially the same mean nitrogen yield when applied to grass as six applications of nitrogen totaling 180 pounds per acre. Figure 9, however, indicates that the grass plots receiving six applications of nitrogen gave a more even production of nitrogen than plots which received only three applications.

(3) <u>Nitrogen Fixation</u>

It has been indicated under the discussion pertaining to mixtures that non-nitrogen fertilized grass and grass-clover mixtures yielded 40 and 360 pounds per acre per season of nitrogen averaged over the three years of the experiment. It can thus be seen that the grass-clover mixture yielded 320 pounds or 800 per cent more nitrogen per acre than the grass mixture. These figures indicate that the Ladino clover in the non-nitrogen fertilized grass-clover mixture probably fixed in excess of 300 pounds per acre of nitrogen.

In an experiment with orchard grass-Ladino clover pasture, Wagner (39) concluded that the fixation of nitrogen by Ladino clover exceeded 200 pounds per acre.

It is to be noted (Table 16 and Figure 8) that nitrogen applications to the grass-clover mixture failed to appreciably increase nitrogen production by this mixture. The non-nitrogen fertilized grass-clover mixture yielded 360 pounds per acre of nitrogen per year and grass-clover plots receiving 270 pounds of nitrogen per acre yielded 384 pounds of nitrogen per acre per year. This indicates a lower nitrogen fixation by the nitrogen fertilized grass-clover mixture as compared to the non-nitrogen fertilized grass-clover mixture. This is undoubtedly associated with the fact that nitrogen applications resulted in a lower percentage stand of clover (Table 18).

D. Percentage Clover - Mixture 2

I. Results - Percentage Clover

Table 18. Analysis of Variance - Percentage Clover 1956-57

	Degrees of Freedom	Mean Square 1956	Mean Square 1957
Fertilizer Treatments	7	1304**	5437**
Replicates	3	237	1645*
Error "A"	21	122	360.6
Cuts	7	1760**	5197**
Fertilizer Treatments x Cuts	49	33**	130.1**
Error "B"	168	13	43.15

* Effect significant at the 5% probability level.
** Effect significant at the 1% probability level.

Table 19. 1956-57 Mean Percentage Clover (Mixture 2)[1] resulting from varying Rates and Frequencies of Nitrogen Application (Cuts x Fertilizers and Fertilizers).

Fert. Trtmt. (2)	1956-57 Mean Percentage Clover -Cut 1	2	3	4	5	6	7	8	Fert. Mean
A	62	53	74	75	85	84	85	84	75
B	56	48	67	69	75	82	72	72	68
C	45	40	58	59	66	75	58	62	58
D	32	28	44	51	59	63	50	48	47
E	38	38	61	59	66	77	60	62	58

(1) See Table 1; (2) see Table 5.

Table 20. 1956-57 Mean Percentage Clover (Mixture 2)[1] recorded by plots fertilized and not fertilized with a) Potassium, b) Phosphorus.

Fertilizer Treatment (2)	Mean Percentage Clover
+K	55
-K	38
+P	55
-P	58

(1) See Table 1; (2) see Table 6.

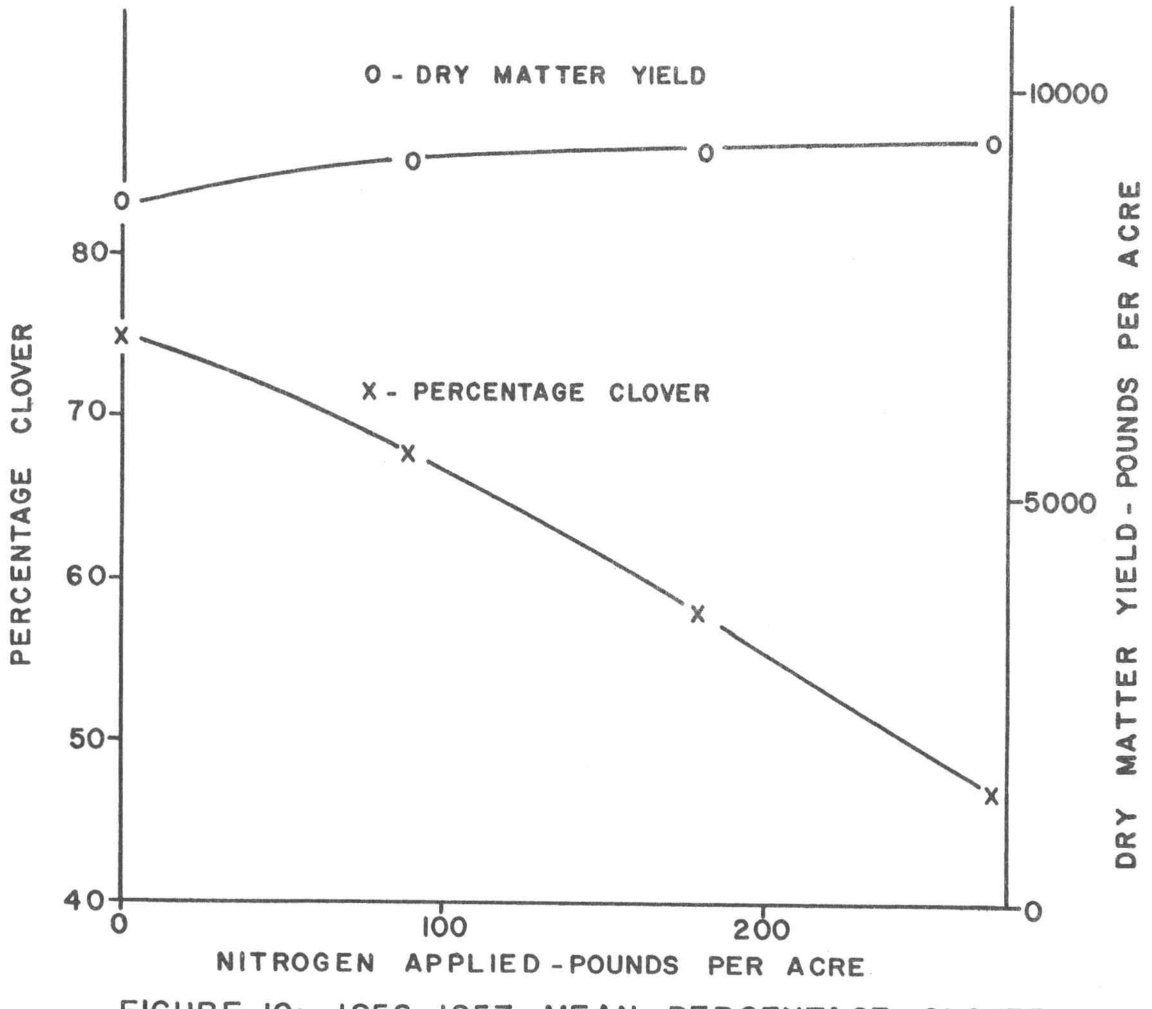

FIGURE 10: 1956-1957 MEAN PERCENTAGE CLOVER AND ANNUAL DRY MATTER YIELDS RECORDED BY THE GRASS-CLOVER MIXTURE FOR VARYING RATES OF NITROGEN APPLICATION

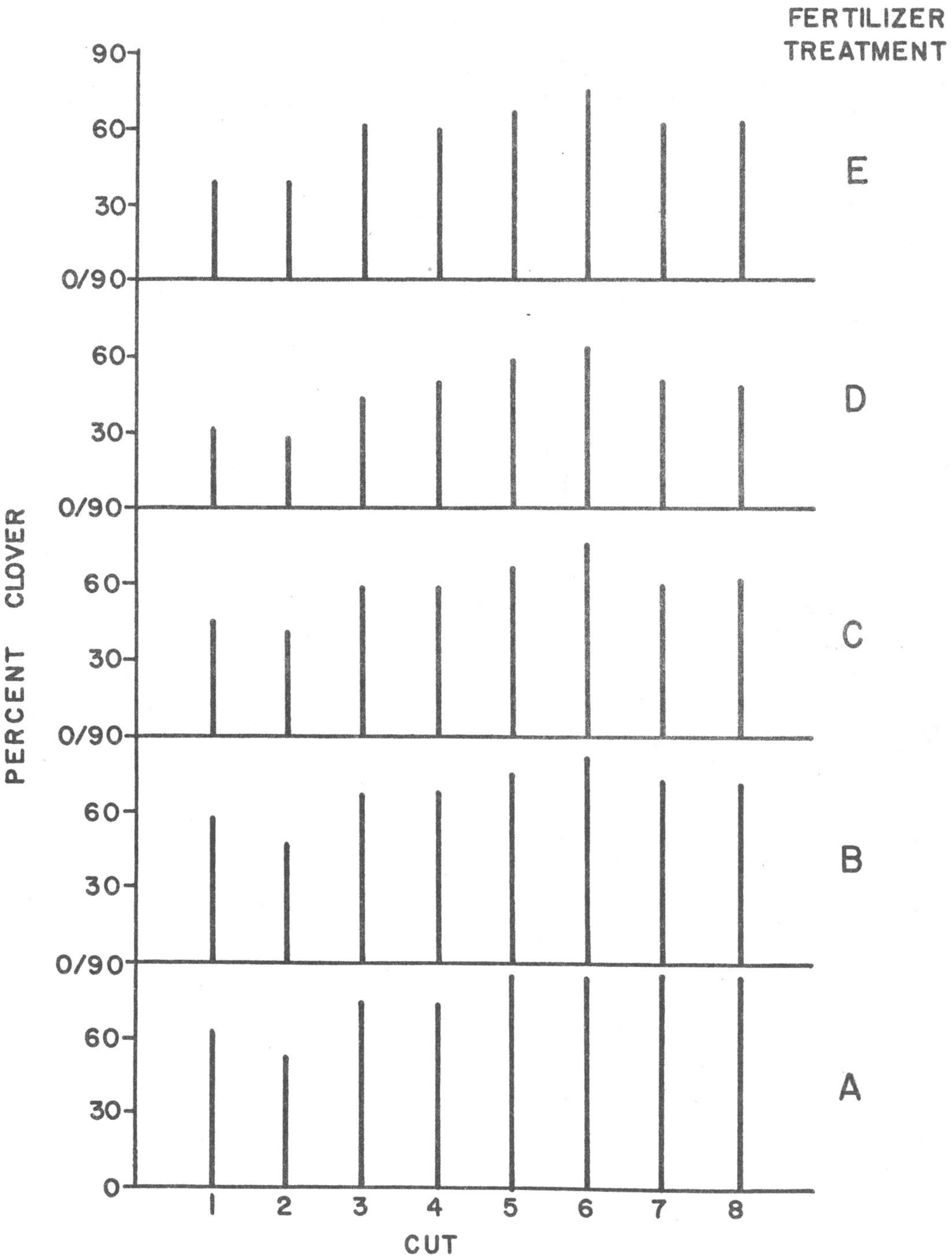

FIGURE 11: 1956-1957 MEAN PERCENTAGE CLOVER RECORDED BY THE GRASS-CLOVER MIXTURE FOR VARYING RATES AND FREQUENCIES OF NITROGEN APPLICATION

(1) SEE TABLE 5

II. Discussion of Results - Percentage Clover (Grass-Clover Mixture)

(1) Fertilizer

The rate of application of nitrogen had a marked effect on the percentage of clover present in the grass-clover sward. The results for 1956 and 1957 (Figures 10 and 11, and Table 19) show that the percentage of clover in the sward decreased as the rate of nitrogen application increased. The average percentage clover in the grass-clover sward for the no-nitrogen treatment for 1956 and 1957 was 75 per cent and for the same period, the average percentage clover for the 270 pound per acre nitrogen treatment was 47 per cent. Although these results indicate a marked reduction in the proportion of clover in the sward resulting from a comparatively heavy application of nitrogen, they also indicate that under the conditions of the experiment Ladino clover was quite tolerant to nitrogen applications. This was indicated by the fact that Ladino clover constituted almost 50 per cent of the stand in a grass-clover mixture when six applications totaling 270 pounds of nitrogen were made during each growing season.

In an experiment conducted in central Washington (23) nitrogen applications to an irrigated Ladino clover-orchard grass pasture resulted in decreased percentages of Ladino clover in the pasture sward.

The reduction of the percentage stand of clover in a grass-clover sward resulting from nitrogen applications has been observed by other workers (3, 6, 36).

Varying the frequency of nitrogen application apparently had little effect on the percentage stand of Ladino clover (Table 19 - Treatments C and E).

Fertilization with phosphorus had little effect on the per cent stand of Ladino clover (Table 20). Plots receiving 60 pounds of P_2O_5 per acre each year recorded 55 per cent clover and plots not receiving phosphorus recorded 58 per cent clover in the sward in 1956 and 1957.

The 1955-57 mean phosphorus content of the grass and grass-clover mixtures was 0.43 and 0.41 per cent respectively (Table 22). This is somewhat in excess of the minimum phosphorus content associated with the satisfactory growth of Ladino clover and alfalfa reported by other workers (11, 31). It appears therefore that the soil was adequately supplied with phosphorus. The fact that no appreciable yield response to phosphorus fertilizer was realized in this experiment also indicates an adequate level of soil phosphorus. The phosphorus content of the non-phosphorus fertilized plots was 12.1 p.p.m. using the sodium carbonate method (Table 7).

The application of potassium fertilizer had a very marked effect on the percentage of Ladino clover in the pasture sward (Table 20). The mean percentage clover in plots receiving potassium in 1956 and 1957 was 55 per cent and for plots not receiving potassium the per cent clover was 38 for 1956 and 1957. This is in accord with the findings of Rich and Odland (28) who reported that potassium fertilization increased the percentage stand of legumes in grass-legume hay.

The 1955-57 potassium content of the grass-clover herbage from plots receiving no potassium applications was 1.01 per cent (Table 24). This potassium content indicates a somewhat low level of potassium in the herbage which was undoubtedly related to a low potassium level in the soil as was indicated by the soil test, (Table 7.) Plant potassium content is further discussed under the heading "Per cent Potassium."

(2) Per cent Clover and Dry Matter Yield

On the basis that the grass-clover mixture was considerably more productive than the grass mixture one would expect that an increase in the proportion of clover in the stand would tend to increase yields. A study of Figure 10, however, indicates that this was not necessarily the case. The dry matter yield of the grass-clover mixture increased as the nitrogen application was increased from 0 to 180 pounds per acre, and the percentage clover decreased from 75 to 58. The dry matter yield of the grass-clover mixture reached a maximum when the nitrogen application approximated 180 pounds per acre under which treatment the grass-clover plots averaged 58 per cent clover. The first 90-pound increment of nitrogen increased the dry matter yield of the grass-clover mixture by 745 pounds per acre per season while the second 90-pound increment further increased the dry matter yield by only 202 pounds per acre per season. Based on these results it is doubtful if nitrogen applications to the grass-clover mixture would be economical. It is probable that yield increases due to nitrogen fertilization of the grass-clover mixture were associated with the increased growth of the grass component. This was discussed under the heading "Dry Matter Yields."

Under conditions where the per cent stand of clover was varied due to factors other than nitrogen fertilization, an increase in clover content resulted in an increased yield of dry matter. Non-potassium fertilized grass-clover plots yielded 7688 pounds of dry matter per acre on a seasonal basis and produced 38 per cent clover over the three year period. Potassium fertilized grass-clover plots yielded 9888 pounds of dry matter per acre and produced 55 per cent clover.

Phosphorus fertilization had no appreciable effect on botanical composition or yield in this experiment. This is very likely due to the fact that available phosphorus was not deficient in the soil.

(3) Per cent Clover and Protein Content of Herbage

There was a slight tendency for the protein content of the herbage to increase as the percentage clover content increased. Fertilizer Treatment A, which resulted in 75 per cent clover in the sward in 1956 and 1957 (Table 19) produced herbage containing 28.2 per cent protein whereas Treatment D which resulted in 47.0 per cent clover in the sward produced herbage containing 27.1 per cent protein in 1956 and 1957. The reduction in percentage protein content of the herbage resulting from the decreased per cent clover in the sward in this example is not great, but Treatment A received no nitrogen and Treatment D received 270 pounds of nitrogen per acre per year. Under these circumstances the fact that even a small decrease in protein content occurred indicated the relative importance of clover in maintaining the protein level of the herbage. Also 270 pounds per acre per year of nitrogen when applied to a grass sward resulted in herbage containing 19.9 per cent protein whereas the grass-clover mixture which received no nitrogen fertilization produced herbage that contained 27.1 per cent protein over the three-year period. This indicates that under the conditions of the experiment Ladino clover was a much more effective protein producer than was grass which was fertilized with 270 pounds of nitrogen per acre.

(4) Per cent Clover and Mineral Content of Herbage

Figure 12 shows that, of the minerals analyzed for, the calcium content varied most with respect to the percentage clover content of the grass-clover mixture. The 1956-57 average mean calcium content of the herbage was 1.13 and 0.68 per cent for Treatments A and D respectively. Treatment A resulted in 75 and Treatment D in 47 per cent clover in the sward (Table 19). This indicates that the calcium content of the herbage decreased as the percentage clover content of the sward decreased. It will be noted under the discussion pertaining to calcium that the calcium content of the grass-clover mixture was higher than the calcium content of the grass mixture.

Figure 12 indicates that the per cent clover content in the sward had little influence on the phosphorus content of the herbage. The phosphorus content of the grass-clover herbage averaged 0.38 per cent for plots receiving the varying nitrogen treatments. It will be noted under the discussion pertaining to phosphorus that herbage from the grass and grass-clover mixtures contained similar percentages of phosphorus. On this basis it would not be anticipated that the percentage of clover in the sward would greatly affect the phosphorus content of the herbage. Figure 12 shows that there was a slight tendency for the potassium content of the herbage to increase as the percentage of clover in the sward decreased from 75 to 68 per cent. The potassium content of the herbage was not further decreased by further decreases in the clover content of the sward.

It will be observed under the discussion pertaining to potassium that the grass herbage contained a higher percentage of potassium than the grass-clover herbage. On this basis it would be expected that a reduction in clover content of the sward would be accompanied by an increase in potassium content of the herbage.

Figure 12 shows that the per cent clover in the sward had no appreciable influence on the magnesium content of the herbage.

E. Percentage Phosphorus

I. Results - Percentage Phosphorus

Table 21. Analysis of Variance - Percentage Phosphorus

	Degrees of Freedom		Mean Square		
	1955	1956-57	1955	1956	1957
Fertilizer Treatments	7	7	.0187**	3.176**	.252**
Replicates	3	3	.0147	.5517	.0111
Error "A"	21	21	.0032	.2972	.0072
Mixtures	1	1	.0023	.2743	.1444**
Mixtures x Fertilizers	7	7	.0037	.3949**	.0194**
Error "B"	24	24	.0028	.0910	.0044
Cuts	2	7	.2109**	15.99**	.0811**
Mixtures x Cuts	2	7	.0163**	1.266**	.0342**
Fertilizers x Cuts	14	49	.0052**	.1338**	.0056**
Fertilizers x Mixtures x Cuts	14	49	.0023	.0806 *	.0035**
Error "C"	96	336	.0022	.0547	.0021

* Effect significant at the 5% probability level.
** Effect significant at the 1% probability level.

Table 22. 1955-57 Mean Percentage Phosphorus for Different Fertilizer Treatments (Mixtures x Fertilizers, Fertilizers and Mixtures)

Fertilizer Treatment	Mean Percentage Phosphorus: Mixture 1	Mixture 2	Fertilizer Mean
A (1)	.45	.38	.41
B	.42	.39	.40
C	.37	.37	.37
D	.37	.37	.37
E	.41	.40	.40
+K (2)	.48	.46	.47
-K	.44	.50	.47
+P	.45	.45	.45
-P	.41	.40	.40
Mixture Mean	.43	.41	

(1) See Table 5; (2) see Table 6.

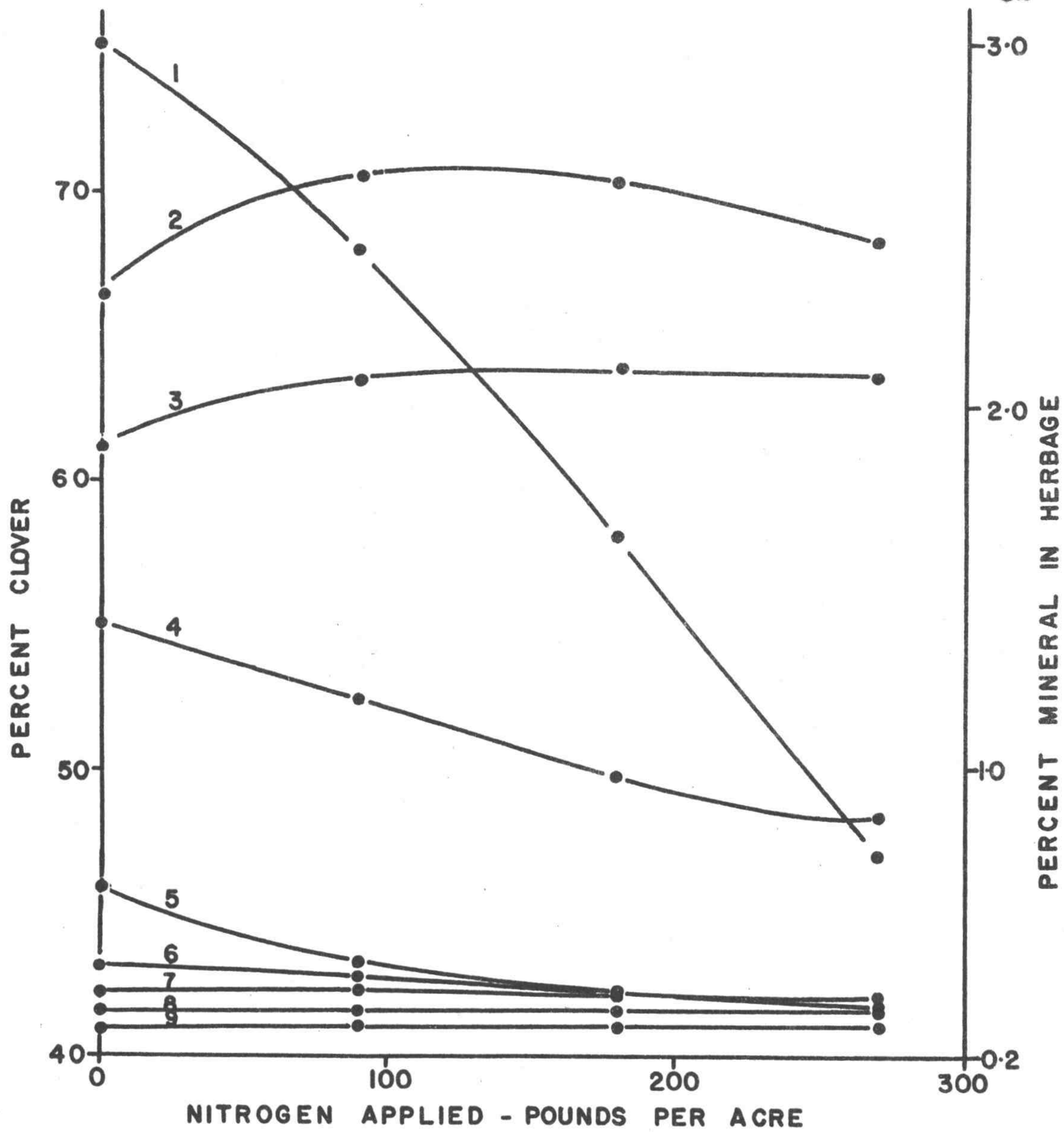

FIGURE 12: 1955-1957 MEAN MINERAL CONTENT OF HERBAGE FOR VARYING RATES OF NITROGEN APPLICATION

LEGEND:

GRASS-CLOVER MIXTURE
1) 1956-1957 MEAN PERCENT CLOVER
3) % POTASSIUM
4) % CALCIUM
7) % PHOSPHORUS
9) % MAGNESIUM

GRASS MIXTURE
2) % POTASSIUM
5) % CALCIUM
6) % PHOSPHORUS
8) % MAGNESIUM

II. Discussion of Results - Percentage Phosphorus

(1) Mixtures

The phosphorus content of the herbage from the two mixtures did not differ appreciably (Table 22 and Figure 12). Over the three-year period of the experiment the grass and grass-clover mixtures produced herbage containing 0.43 and 0.41 per cent phosphorus respectively (Table 22). Morrison (21, p.1093) reports 0.32 per cent phosphorus for grass-clover pasture herbage and 0.24 per cent phorphorus for grass pasture herbage. Other values reported by Morrison and other workers indicate that legumes do not consistently contain more phosphorus than grasses. It is not uncommon for grasses to contain more phosphorus than legumes.

Stivers' et al. (31) results indicate that a plant phosphorus content of 0.30 per cent is adequate for good growth of alfalfa and Giddens and Toth (11) reported satisfactory growth of Ladino clover at plant phosphorus levels of between 0.20 and 0.34 per cent.

(2) Fertilizers

There was a slight tendency for the phosphorus content of the grass herbage to decrease as the amount of nitrogen applied was increased (Table 22 and Figure 12).

This tendency was not apparent with the grass-clover herbage. Over the three-year period of the experiment grass plots receiving zero and 270 pounds per acre of nitrogen produced herbage containing 0.45 and 0.37 per cent phosphorus respectively. Due to the substantial dry matter yield increases of grass resulting from nitrogen applications, the yield of phosphorus increased with nitrogen fertilization.

The grass-clover herbage contained 0.38 and 0.37 per cent phosphorus for the zero and 270-pound nitrogen applications respectively.

Fudge (10) studied the effect of the application of various nitrogenous fertilizers on the availability of phosphate. He found that nitrogenous fertilizers having an acidic residual effect decreased phosphorus availability. Pierre (26) found that ammonium nitrate, which was used as the nitrogen source in this study, had an acidic residual effect. Soil tests (see discussion under "Fertilizer Treatments"), however, did not indicate any prolonged residual effect from ammonium nitrate applications in this experiment. The possibility of short periods of acidity resulting from nitrogen fertilization cannot, however, be discounted. Such short periods of acidity could result in reduced phosphorus availability.

The application of phosphorus fertilizer tended to increase the phosphorus content of both mixtures (Table 22). Over the three-year period the grass plots produced herbage containing 0.41 and 0.45 per cent phosphorus for the zero and 60 pounds per acre phosphorus treatments respectively. Grass-clover plots produced herbage containing 0.40 and 0.45 per cent phosphorus for the same treatments (0 and 60 pounds per acre phosphorus) respectively.

It is to be observed that the phosphorus content of even the non-phosphorus fertilized herbage in this experiment was adequate. This indicates that the soil was relatively well supplied with phosphorus which would account for the fact that yield increases due to phosphorus applications were not appreciable (Table 10).

Potassium fertilization did not have a consistent effect on the phosphorus content of the herbage (Tables A-24, A-27, A-30 - Treatments F and G). Potassium fertilization did, however, consistently increase phosphorus yields. This is related to the fact that potassium fertilization increased the dry matter yields of both mixtures (Table 24).

In 1955 grass plots receiving 0 and 30 pounds per acre of K_2O yielded 2.44 and 3.38 pounds per acre per year of phosphorus respectively based on three clippings, and produced herbage containing 0.41 and 0.45 per cent of phosphorus respectively. In 1956 grass plots receiving 0 and 200 pounds per acre of K_2O yielded 2.67 and 3.09 pounds per acre per cut of phosphorus respectively, based on eight clippings, and produced herbage containing 0.49 and 0.51 per cent phosphorus respectively. In 1957 grass plots receiving 0 and 300 pounds per acre of K_2O yielded 3.06 and 3.47 pounds per acre per cut phosphorus respectively and produced herbage containing 0.48 and 0.47 per cent phosphorus respectively. Over the three-year period of the experiment non-potassium fertilized and potassium fertilized grass plots produced 2.72 and 3.31 pounds per acre per cut of phosphorus and herbage containing 0.44 and 0.48 per cent phosphorus respectively.

Non-potassium fertilized grass-clover plots produced herbage containing 0.45, 0.53 and 0.51 per cent phosphorus in 1955, 1956 and 1957 respectively. Grass-clover plots receiving 30, 200 and 300 pounds of potassium in 1955, 1956 and 1957 produced herbage containing 0.46, 0.49 and 0.42 per cent phosphorus respectively. The heavier potassium applications in 1956 and 1957 therefore tended to reduce the phosphorus content of the grass-clover mixture. Over the three-year period non-potassium and potassium fertilized grass-clover plots produced herbage containing 0.50 and 0.46 per cent phosphorus respectively.

Due to the increased dry matter yield of the grass-clover mixture resulting from potassium applications, the potassium fertilized plots consistently yielded more phosphorus than the non-potassium fertilized plots. Over the three-year period of the experiment non-potassium and potassium fertilized grass-clover plots produced 4.82 and 5.84 pounds of phosphorus per acre per cut respectively. The fact that the yield of phosphorus increased as the dry matter yield increased is related to the fact that the soil contained adequate phosphorus levels for plant growth. This resulted in only slight reductions of plant phosphorus content as the dry matter yield was increased. For soils whose phosphorus content was near marginal with respect to plant growth an increase of yield would probably be accompanied by a decreased plant phosphorus content.

F. Percentage Potassium

I. Results - Percentage Potassium

Table 23. Analysis of Variance - Percentage Potassium

	Degrees of Freedom		Mean Square		
	1955	1956-57	1955	1956	1957
Fertilizer Treatments	7	7	.574*	32.92**	39.23**
Replicates	3	3	.821	1.55	1.09
Error "A"	21	21	.185	1.52	.137
Mixtures	1	1	10.14**	401.9**	17.31**
Mixtures x Fertilizers	7	7	.065	5.28	.586**
Error "B"	24	24	.084	3.60	.160
Cuts	2	7	5.21**	71.50**	7.703**
Mixtures x Cuts	2	7	2.97**	6.19**	.703**
Fertilizers x Cuts	14	49	.346**	4.63**	.567**
Fertilizers x Mixtures x Cuts	14	49	.067	1.26**	.140
Error "C"	96	336	.088	.573	.139

* Effect significant at 5% probability level.
** Effect significant at 1% probability level.

Table 24. 1955-57 Mean Percentage Potassium for Different Fertilizer Treatments (Mixtures x Fertilizers, Fertilizers, and Mixtures)

Fertilizer Treatment	Mean Percentage Potassium: Mixture (3) 1	2	Fertilizer Mean
A (1)	2.31	1.89	2.10
B	2.64	2.08	2.36
C	2.62	2.10	2.36
D	2.45	2.08	2.26
E	2.67	2.16	2.41
+K (2)	2.81	2.17	2.49
-K	1.65	1.01	1.33
+P	2.68	2.11	2.39
-P	2.67	2.16	2.41
Mixture Mean	2.47	1.95	

(1) See Table 5; (2) see table 6; (3) see table 1.

II. Discussion of Results - Per cent Potassium

(1) Mixtures

The grass herbage was higher in potassium content than the grass-clover herbage during each of the three years of the experiment (Tables A-34, A-37, and A-40). The average potassium contents for the grass and grass-clover herbage were 2.47 and 1.95 per cent respectively over the three-year period of the experiment (Table 24 and Figure 12). The total amount of potassium removed, however, was greater for the grass-clover mixture than for the grass mixture due to the substantially higher dry matter yield recorded by the grass-clover mixture.

The reported potassium contents of grasses and legumes are extremely variable. Potassium contents of grasses and legumes range from 0.75 per cent to 5.00 per cent (6, 11, 21, p.1154, 31) with grasses tending to be somewhat higher in potassium content than clovers. Stivers' and Ohlrogge (31) consider a plant potassium content of at least 1.0 per cent to be essential to the survival of alfalfa. The work of Stivers and Ohlrogge and of Giddens and Toth (11) indicates a minimum plant potassium content of approximately 1.5 per cent to be required for the optimum growth of alfalfa and Ladino clover. Brown (6) reported that grass tended to remove more potassium than did White clover and Giddens and Toth (11) report luxury consumption of potassium by Ladino clover. There is some evidence of luxury consumption of potassium in this experiment with this tendency being most prevalent in 1957 when the heaviest potassium treatments were applied (Tables A-39, A-40, and A-41).

(2) Fertilizers

Nitrogen applications totaling 90 pounds per year increased the potassium content of the grass herbage during each year of the experiment (Tables A-33, A-36, A-39). Grass herbage receiving no-nitrogen and 90 pounds of nitrogen contained 2.31 and 2.64 per cent potassium respectively, over the three-year period (Table 24). Nitrogen applications in excess of 90 pounds per acre tended to decrease the potassium content of the grass herbage (Figure 12). Due to increased yield of grass resulting from nitrogen fertilization, however, the potassium yield was increased by nitrogen fertilization. A nitrogen application of 90 pounds per acre increased the potassium content of the grass-clover herbage from 1.89 to 2.08 per cent (Table 24 and Figure 12). Further nitrogen applications in excess of 90 pounds per acre did not further increase the potassium content of the grass-clover herbage. As grass herbage contained more potassium than grass-clover herbage it would be anticipated that the increase in per cent grass in the sward resulting from nitrogen applications would tend to increase the potassium content of the grass-clover herbage.

Thomas (32), Ulrich (34) and Jenny (17) all cite cases where nitrogen fertilization has increased potassium uptake by plants. Jenny states that small amounts of NH_4 ions on the colloidal particles seem to stimulate K intake by plant roots.

Other workers (1, 24, p.12) report that the fixation of ammonia by soils can block the release of potassium.

It is now known that ammonia-potassium interactions in the soil depend on the clay mineralogy of the soil.

The frequency of nitrogen applications had no appreciable effect on the potassium content of either mixture (Table 24, Treatments C and E).

Phosphorus applications had no consistent effect on the herbage potassium content of either mixture (Table 24).

Applications of potassium fertilizer considerably increased the potassium content of the herbage for each mixture during each year of the experiment (Tables A-33, A-36, and A-39 - Treatments F and G). Potassium fertilization increased the potassium content of the grass herbage from 1.65 to 2.81 per cent and the potassium content of the grass-clover herbage from 1.01 to 2.17 per cent on the basis of three years' results (Table 24).

G. Percentage Calcium

I. Results - Percentage Calcium

Table 25. Analysis of Variance - Percentage Calcium

	Degrees of Freedom		Mean Square		
	1955	1956-1957	1955	1956	1957
Fertilizer Treatments	7	7	.698**	12.39**	.577*
Replicates	3	3	.028	.887	.353
Error "A"	21	21	.084	.081	.089
Mixtures	1	1	16.38**	1086. **	26.14**
Mixtures x Fertilizers	7	7	.027	1.49	.254**
Error "B"	24	24	.039	1.27	.051
Cuts	2	7	1.689**	33.57**	2.597**
Mixtures x Cuts	2	7	.686**	10.95**	.476**
Fertilizers x Cuts	14	49	.037	1.07*	.093**
Fertilizers x Mixtures x Cuts	14	49	.074	1.34**	.045
Error "C"	96	336	.056	.703	.057

* Effect significant at the 5% probability level.
** Effect significant at the 1% probability level.

Table 26. 1955-57 Mean Percentage Calcium for different Fertilizer Treatments (Mixtures x Fertilizers, and Fertilizers)

Fertilizer Treatment	Mean Percentage Calcium: Mixture (3) 1	2	Fertilizer Mean
A (1)	.67	1.40	1.03
B	.47	1.20	.83
C	.37	.98	.67
D	.35	.88	.61
E	.38	.98	.68
+K (2)	.44	1.07	.75
-K	.49	1.00	.74
+P	.39	1.05	.72
-P	.38	.98	.68
Mixture Means	.45	1.07	

(1) See Table 5; (2) see Table 6; (3) see Table 1.

II. Discussion of Results - Per cent Calcium

(1) Mixtures

The grass-clover herbage recorded a higher calcium content than the grass herbage during each year of the experiment (Tables A-43, A-46, and A-49). Calcium contents of 0.45 and 1.07 per cent were recorded by the grass and grass-clover herbage respectively over the three-year period (Table 26). It can thus be seen that the calcium content of the forage was considerably enhanced by Ladino clover.

Other workers (6, 21, p.7) have reported that clover normally contains considerably more calcium than grass. Calcium contents reported for Ladino clover range from 0.50 to 1.80 per cent (11, 21, p. 1154). Satisfactory growth of Ladino clover has been reported when the plant calcium content was as low as 0.50 per cent (12). Morrison (21, p.1154) reports 0.48, 1.05 and 1.32 per cent calcium for grass, grass-Ladino clover, and Ladino clover-hay respectively. Brown and Rouse (6) report satisfactory growth of white clover and Dallisgrass having plant calcium contents of 3.36 and 1.45 per cent respectively. The soil test values obtained for exchangeable calcium in this experiment indicate an adequate supply of calcium in the soil.

(2) Fertilizers

Nitrogen applications reduced the plant calcium content of both mixtures appreciably (Table 26 and Figure 12). Over a three-year period herbage from grass plots receiving no nitrogen applications recorded a mean calcium content of 0.67 per cent and grass plots receiving 270 pounds of nitrogen per year yielded herbage containing 0.35 per cent calcium. On the same basis grass-clover herbage contained 1.40 and 0.88 per cent calcium for the non-nitrogen and nitrogen treated plots respectively. Undoubtedly the reduced per cent stand of clover induced by the nitrogen treatments was largely responsible for the reduction in herbage calcium content with nitrogen fertilization of the grass-clover mixture. This is clearly depicted in Figure 12. Grass-clover herbage receiving no nitrogen and 270 pounds of nitrogen per acre contained 75 and 47 per cent clover respectively. Nitrogen fertilization reduced the calcium yield of the grass-clover mixture and increased the calcium yield of the grass mixture. The frequency of nitrogen application had no consistent effect on the calcium content of either mixture (Table 26 - Treatments C and E).

The application of phosphorus fertilizer had no appreciable effect on the herbage calcium content of either mixture (Table 26).

In 1955 grass mixture plots receiving 0 and 30 pounds per acre of potash produced herbage containing 0.43 and 0.59 per cent calcium respectively. Thirty pounds per acre of potash therefore tended to increase calcium content of grass herbage.

In 1956 the potash application was increased to 200 pounds per acre. This application resulted in a grass herbage content of 0.41 per cent calcium as compared to 0.51 per cent calcium for the grass plots receiving no potassium applications. In 1956 therefore, a 200-pound per acre potash application tended to reduce the calcium content of grass herbage. The calcium yield for the two treatments was the same.

In 1957 a 300-pound per acre application of potash reduced grass herbage calcium content from 0.53 to 0.34 per cent and resulted in a substantially lower yield of calcium.

These results indicate that the calcium content of grass herbage was reduced as a result of the heavier application of potassium and that the 300-pound per acre potassium application reduced the calcium yield.

Several workers (9, 19) have shown that calcium uptake by plants can be reduced by applications of potassium.

The calcium content of the grass-clover herbage was not appreciably affected by potassium applications (Table 26). The fact that potassium applications to the grass-clover mixture did not decrease the herbage calcium content is probably related to the increased per cent clover content resulting from the potassium applications. As clover herbage contained considerably more calcium in this experiment than grass herbage, any treatment which tended to increase the clover content of a mixture would tend to increase the calcium content of that mixture.

H. Per cent Magnesium

I. Results - Per cent Magnesium

Table 27. Analysis of Variance - Per cent Magnesium

	Degrees of Freedom		Mean Square		
	1955	1956-1957	1955	1956	1957
Fertilizer Treatments	7	7	.005	.290*	.063**
Replicates	3	3	.018	.187	.003
Error "A"	21	21	.007	.080	.0015
Mixtures	1	1	.137**	22.49**	.252**
Mixtures x Fertilizers	7	7	.004	.130**	.0023*
Error "B"	24	24	.006	.023	.0009
Cuts	2	7	.332**	8.42**	.1011**
Mixtures x Cuts	2	7	.044*	.670**	.0104**
Fertilizers x Cuts	14	49	.008	.077**	.0027
Fertilizers x Mixtures x Cuts	14	49	.006	.065**	.0010
Error "C"	96	336	.014	.037	.0024

* Effect significant at 5% probability level.
** Effect significant at 1% probability level.

Table 28. 1955-57 Mean Percentage Magnesium for Different Fertilizer Treatments (Mixtures x Fertilizers and Fertilizers)

Fertilizer Treatment	Mean Percentage Magnesium		
	Mixture (3)		Fertilizer Mean
	1	2	
A (1)	.28	.33	.30
B	.28	.34	.31
C	.28	.33	.30
D	.29	.33	.31
E	.26	.32	.29
+K (2)	.27	.34	.30
-K	.30	.37	.33
+P	.26	.34	.30
-P	.26	.32	.29
Mixture Mean	.28	.34	

(1) See Table 5; (2) see Table 6; (3) see Table 1.

II. Discussion of Results - Per cent Magnesium

(1) Mixtures

Over the three-year period of the experiment herbage from the grass and grass-clover mixtures recorded 0.28 and 0.34 per cent magnesium content respectively (Table 28). The clover-grass herbage therefore contained slightly more magnesium than the grass herbage.

Magnesium contents ranging from 0.10 to 0.34 per cent for grasses and from 0.20 to 0.44 per cent for legumes have been reported (12, p. 33; 20, p. 298). Legumes normally contain more magnesium than grasses. Giddens and Toth (11) report satisfactory growth of Ladino clover over a plant magnesium content ranging from 0.22 to 0.80 per cent. The magnesium content of herbage in this experiment indicates an adequate supply of magnesium. Also the soil test values for magnesium (Table 7) indicate the presence of adequate magnesium in the soil.

(2) Fertilizers

Applications of nitrogen or phosphorus did not have any appreciable effect on the magnesium content of herbage from either mixture (Table 28 and Figure 12).

Potassium applications slightly decreased the herbage magnesium content of both mixtures (Table 27).

The tendency for potassium fertilization to reduce the uptake of magnesium by plants has been observed by other workers (29, 4, 28). Prince <u>et al</u>.(27) state that the most important single factor affecting magnesium uptake by plants is the quantity of potassium that is available. In 1955 magnesium uptake was not appreciably affected by potassium applications with either mixture (Table A-51 - Treatments F and G). This was undoubtedly due to the relatively small potassium application made in 1955.

Thirty, 200 and 300 pounds per acre of potash were applied in 1955, 1956 and 1957 respectively (Table 6). The 200-pound potash application in 1956 decreased the magnesium content of the grass herbage from 0.35 to 0.31 per cent and decreased the magnesium content of the grass-clover herbage from 0.42 to 0.40 per cent (Table A-54 - Treatments F and G). In 1957 a 300-pound per acre potash application decreased the magnesium content of the grass herbage from 0.35 to 0.27 per cent and decreased the magnesium content of the grass herbage from 0.40 to 0.32 per cent (Table A-57 - Treatments F and G). These results indicate that increased rates of potassium application resulted in greater reductions of magnesium content of the herbage. Potassium fertilization did not appreciably affect the magnesium yield of the grass mixture as the increased yield of herbage due to potassium fertilization tended to offset the reduced magnesium content of the herbage. Potassium fertilization increased the magnesium yield of the grass-clover mixture in spite of the fact that the herbage contained a lower percentage of magnesium when potassium fertilized.

SUMMARY

Over a three-year period, under irrigated conditions, a pasture mixture consisting of orchard grass, perennial rye and Ladino clover outyielded a pasture mixture consisting of orchard grass and perennial rye by 96 per cent on a dry matter basis. The presence of Ladino clover in the pasture sward therefore greatly enhanced the productivity of the pasture.

The grass-clover mixture possessed a considerably greater content of protein than the grass mixture. Over a three-year period the grass-clover mixture produced 184 per cent more protein than the grass mixture.

A grass mixture receiving frequent and relatively heavy nitrogen applications had a lower protein content and produced less dry matter and protein than a grass-clover mixture which received no nitrogen applications. Ladino clover was therefore a more important factor in the production of dry matter and protein than were nitrogen applications to a grass mixture.

In addition to its higher yielding ability the grass-clover mixture gave a more equable production of pasture herbage throughout the growing season.

Nitrogen applications greatly increased the productivity of the grass mixture with the yield of dry

matter increasing with increased rates of nitrogen application. Increasing the frequency of nitrogen applications to the grass-clover and grass mixtures from three per season to six per season failed to increase the seasonal yields but was effective in leveling out production over the growth period with both mixtures.

A nitrogen application of 90 pounds per acre in six applications of 15 pounds each per year increased the yield recorded by the grass-clover mixture. Nitrogen applications in excess of this amount, however, failed to further appreciably increase the productivity of the grass-clover mixture.

Nitrogen applications more effectively increased the yield of the grass mixture than the grass-clover mixture.

Potassium fertilization increased both grass and grass-clover yields and two to three applications of potassium per year were found necessary to maintain production particularly with the grass-clover mixture. The potassium level in the unfertilized soil was low.

Phosphorus applications did not appreciably increase the dry matter yield of either mixture due to a relatively high level of available phosphorus in the soil.

Nitrogen applications tended to increase the protein content of the grass mixture and decrease the protein content of the grass-clover mixture. The decrease in protein content resulting from nitrogen applications to the grass-clover mixture is probably associated with the reduction in the per cent stand of clover resulting from the nitrogen applications. Nitrogen applications tended to enhance the growth of grass more than the growth of clover.

The grass-clover mixture yielded considerably more nitrogen than the grass mixture. Nitrogen fertilization increased the nitrogen yield of the grass mixture but did not appreciably influence the nitrogen yield of the grass-clover mixture due to the reduction in the per cent stand of clover resulting from nitrogen application. Non-nitrogen fertilized grass-clover herbage yielded 800 per cent more nitrogen than non-nitrogen fertilized grass herbage, thus indicating a high level of nitrogen fixation by the clover component of the grass-clover mixture.

The percentage stand of clover in the grass-clover sward decreased as the rate of nitrogen fertilization was increased but Ladino clover exhibited good tolerance to nitrogen fertilization. Varying the frequency of nitrogen application had little tendency to alter the percentage stand of clover in the grass-clover mixture. Potassium fertilization considerably increased the per cent stand of clover but phosphorus fertilization was not effective in this regard. The reduction of clover content resulting from nitrogen fertilization did not result in a reduced yield by the grass-clover mixture due to the increase in the growth of the grass component resulting from nitrogen fertilization. The calcium content of the herbage increased as the percentage stand of clover increased. The potassium content of the herbage increased as the per cent stand of clover decreased from 75 to 68 per cent but further decreases in per cent clover did not result in further decreases of potassium content of the herbage. The per cent content of phosphorus and magnesium were not appreciably affected by the per cent clover content.

Herbage from the two mixtures differed very little in phosphorus content. The grass-clover herbage contained more calcium, slightly more magnesium and less potassium than the grass herbage.

Nitrogen applications slightly reduced the phosphorus content but increased the phosphorus yield of the grass mixture. Nitrogen applications did not reduce the phosphorus content of the grass-clover herbage. Phosphorus applications slightly increased the herbage phosphorus content of both mixtures. Potassium fertilization tended to slightly decrease the per cent phosphorus content of grass-clover herbage but increased the phosphorus yield recorded by this mixture.

Six nitrogen applications totaling 90 pounds per acre per year tended to increase the per cent potassium content of the grass herbage whereas heavier nitrogen applications tended to decrease the per cent potassium content. Nitrogen applications increased the potassium yield of the grass-clover mixture.

Six nitrogen applications totaling 90 pounds per acre per year increased the per cent potassium content of the grass-clover herbage but heavier nitrogen applications failed to further increase the per cent potassium content.

Phosphorus fertilization had no consistent effect on the herbage potassium content of either mixture.

Potassium fertilization increased the herbage potassium content of both mixtures.

Nitrogen fertilization reduced the herbage per cent calcium content of both mixtures, increased the calcium yield of the grass mixture and reduced the calcium yield of the grass-clover mixture.

Phosphorus fertilization had no appreciable influence on the herbage calcium content of either mixture.

Heavier potassium applications reduced the calcium content and calcium yield of grass herbage. Potassium applications did not appreciably affect the calcium content of the grass-clover herbage.

Nitrogen or phosphorus applications did not appreciably affect the magnesium content of either mixture. Potassium applications slightly decreased the magnesium content of both mixtures.

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APPENDIX

APPENDIX

Tables reporting yields and nutrient contents of the two mixtures on a yearly basis are presented in the following appendix. The analyses of variance for the data reported are to be found in the preceding portions of the thesis.

Table A-1. 1955 Mean Dry Matter Yields (Fertilizers x Mixtures x Cuts and Fertilizers x Mixtures, and Cuts)

Fert. Trtmt. (1)	Mix. (2)	Dry Matter Yields - lbs./acre: Cuts 1	2	3	4	5	6	7	8	Fert. x Mix. Means
A	1	428	544	244	251	127	100	78	59	229
	2	1101	902	916	1260	1184	1154	1070	797	1084
B	1	745	936	434	508	271	218	232	180	441
	2	1507	1086	1071	1341	1139	1124	1075	851	1149
C	1	873	1202	666	747	461	327	431	324	629
	2	1484	1227	1134	1438	1081	942	977	772	1132
D	1	950	1341	901	1010	696	437	613	512	808
	2	1569	1281	1289	1439	1106	873	972	789	1165
E	1	1346	1103	413	863	500	155	618	316	664
	2	1816	1173	981	1429	1137	849	1124	813	1165
F	1	1160	1086	416	955	486	172	645	312	654
	2	1745	1145	951	1420	1097	817	1043	739	1120
G	1	1371	983	459	973	546	173	696	434	704
	2	1941	1074	1023	1510	1230	991	1282	911	1245
H	1	1180	1024	408	952	545	160	670	309	656
	2	1917	1018	1021	1502	1214	960	1219	891	1218
Cut Means		1321	1071	770	1100	801	591	797	563	

(1) See Table 2.
(2) See Table 1.

Table A-2. 1955 Mean Dry Matter Yields (Mixtures x Cuts and Mixtures)

Mixture	Dry Matter Yields lbs./acre								
	Cut								Mixture
	1	2	3	4	5	6	7	8	Means
1 (Grass)	1007	1028	493	783	454	218	498	306	598
2 (Grass-clover)	1635	1113	1048	1417	1148	964	1095	820	1158

Table A-3. 1955 Mean Dry Matter Yields (Fertilizers x Cuts and Fertilizers)

Fert. Trtmt. (1)	Dry Matter Yields lbs./acre								
	Cut								Fert.
	1	2	3	4	5	6	7	8	Means.
A	765	723	580	755	655	627	574	428	638
B	1126	1011	753	925	705	671	653	516	795
C	1178	1215	900	1093	771	635	704	548	880
D	1259	1311	1095	1224	901	655	793	651	986
E	1581	1138	697	1146	818	502	871	565	915
F	1452	1116	684	1188	792	494	844	526	887
G	1656	1029	741	1242	888	582	989	673	975
H	1549	1021	715	1227	880	560	945	600	937

(1) See Table 2.

Table A-4. 1956 Mean Dry Matter Yields (Fertilizers x Mixtures x Cuts, Fertilizers x Mixtures, and Cuts)

Fert. Trtmt. (1)	Mix. (2)	Dry Matter Yields - lbs./acre Cuts 1	2	3	4	5	6	7	8	Fert. x Mix. Means
A	1	93	398	357	264	121	66	95	101	187
	2	811	1261	1236	858	1487	1155	1448	885	1143
B	1	295	877	636	520	322	166	274	356	431
	2	981	1297	1313	1043	1557	1085	1439	1037	1219
C	1	376	1011	809	891	575	269	534	688	644
	2	894	1391	1232	1079	1548	1022	1428	1119	1214
D	1	445	1100	835	1122	810	383	720	856	784
	2	766	1399	1080	1143	1514	1076	1423	1064	1183
E	1	335	1154	377	674	516	131	671	685	568
	2	868	1467	1106	972	1573	1067	1452	951	1182
F	1	417	1171	426	740	497	131	620	633	579
	2	1042	1505	1023	824	1027	616	1077	816	991
G	1	555	1326	428	843	530	130	668	682	645
	2	1361	1554	1178	1190	1477	956	1402	954	1259
H	1	440	1234	401	838	545	131	685	698	621
	2	1275	1512	1151	1119	1480	985	1484	989	1249
Cut Means		685	1229	849	882	974	586	964	782	

(1) See Table 3.
(2) See Table 1.

Table A-5. 1956 Mean Dry Matter Yields (Mixtures x Cuts and Mixtures)

Mixture	Dry Matter Yields lbs./per acre								
	Cut								Mixture
	1	2	3	4	5	6	7	8	Means
1 (Grass)	369	1034	534	736	489	176	533	587	557
2 (Grass-Clover)	1000	1423	1165	1028	1458	995	1394	977	1180

Table A-6. 1956 Mean Dry Matter Yields (Fertilizers x Cuts and Fertilizers)

Fert. Trtmt. (1)	Dry Matter Yields - lbs./acre								
	Cut								Fert.
	1	2	3	4	5	6	7	8	Means
A	452	829	796	561	804	610	771	493	664
B	638	1087	974	781	939	625	856	696	824
C	635	1201	1020	985	1061	645	981	903	929
D	605	1249	957	1132	1162	729	1071	960	983
E	601	1310	741	823	1044	599	1061	818	875
F	729	1338	724	782	762	373	848	724	785
G	958	1440	803	1016	1003	543	1035	818	952
H	857	1373	776	978	1012	558	1084	843	935

(1) See Table 3.

Table 7. 1957 Mean Dry Matter Yields (Fertilizers x Mixtures x Cuts, Fertilizers x Mixtures and Cuts)

Fert. Trtmt. (1)	Mix. (2)	Dry Matter Yields - lbs./acre								Fert. x Mix. Means
		Cuts								
		1	2	3	4	5	6	7	8	
A	1	183	516	272	117	80	87	103	82	180
	2	1175	1210	876	688	937	1093	1052	701	967
B	1	563	836	397	312	272	257	310	216	395
	2	1409	1220	952	743	1020	1191	1218	858	1077
C	1	982	1018	607	555	502	498	638	418	652
	2	1510	1265	983	874	1002	1269	1356	796	1132
D	1	1117	1007	753	635	616	703	1146	627	826
	2	1468	1181	1051	1025	1082	1209	1409	874	1162
E	1	1036	1200	338	522	578	267	1018	425	673
	2	1650	1354	907	927	1172	1074	1446	885	1177
F	1	959	1071	310	435	503	296	1045	408	628
	2	1009	1285	516	520	613	641	1082	517	773
G	1	1289	1136	352	594	699	330	1091	428	740
	2	1895	1228	919	823	1177	1096	1553	945	1205
H	1	1109	1113	341	513	446	226	993	358	637
	2	2045	1305	900	866	1092	1161	1655	1071	1262
Cut Means		1212	1122	655	634	737	712	1070	601	

(1) See Table 4.
(2) See Table 1.

Table A-8. 1957 Mean Dry Matter Yields (Mixtures x Cuts, and Mixtures)

Mixture	Dry Matter Yields - lbs./acre, Cut 1	2	3	4	5	6	7	8	Mixture Means
(1) Grass	905	987	421	461	462	333	793	370	592
(2) Grass-Clover	1520	1256	888	808	1012	1092	1346	831	1094

Table A-9. 1957 Mean Dry Matter Yields (Fertilizers x Cuts and Fertilizers)

Fert. Trtmt. (1)	Dry Matter Yields lbs./acre, Cut 1	2	3	4	5	6	7	8	Fert. Means
A	679	863	574	402	508	590	577	391	573
B	986	1028	674	527	646	724	764	537	736
C	1246	1141	795	714	752	883	997	607	892
D	1292	1094	902	830	849	956	1277	750	994
E	1343	1277	622	724	875	670	1232	655	925
F	984	1178	413	477	558	468	1063	462	700
G	1592	1182	635	708	938	713	1322	686	972
H	1577	1209	620	689	769	693	1324	714	949

(1) See Table 4.

Table A-10. 1955 Mean Percentage Protein (Fertilizers x Mixtures x Cuts, Fertilizers x Mixtures, and Cuts)

Fert. Trtmt. (1)	Mix. (2)	Per cent Protein: Cut 1	2	3	4	5	6	7	8	Fert. x Mix. Means
A	1	11.0	11.8	12.7	14.2	16.4	14.8	16.0	21.1	14.8
	2	19.8	22.3	24.0	23.8	24.8	26.3	27.9	31.8	25.1
B	1	12.1	15.9	13.5	14.6	17.6	15.0	17.6	22.6	16.1
	2	19.2	19.0	23.5	21.7	24.5	25.5	27.3	30.5	23.9
C	1	14.2	18.4	12.9	15.3	19.1	14.5	17.9	26.0	17.3
	2	19.8	25.6	19.9	20.8	23.8	23.9	25.1	30.5	23.7
D	1	15.7	20.0	13.1	16.3	20.7	14.7	19.3	25.9	18.2
	2	19.7	25.8	19.8	20.8	24.0	22.5	25.2	30.2	23.6
E	1	18.2	13.9	12.6	19.1	13.5	13.8	21.4	17.7	16.3
	2	21.3	20.9	20.9	22.7	21.7	25.4	27.1	29.1	23.7
F	1	17.4	14.5	12.5	18.8	13.7	13.5	20.5	17.8	16.1
	2	22.2	20.7	20.3	22.3	21.0	25.1	27.0	28.3	23.4
G	1	17.5	19.1	13.5	18.8	13.5	14.1	22.1	18.4	17.2
	2	21.0	22.4	21.4	23.5	21.3	26.6	26.8	28.6	24.0
H	1	17.2	14.1	12.2	18.8	13.6	13.6	21.1	17.4	16.0
	2	21.4	23.0	22.2	23.6	21.2	25.1	27.2	29.4	24.2
Cut Means		18.0	19.2	17.2	19.7	19.4	19.6	23.1	25.3	

(1) See Table 2;
(2) See Table 1.

Table A-11. 1955 Mean Percentage Protein (Mixtures x Cuts and Mixtures)

Mixture	Per cent Protein Cut 1	2	3	4	5	6	7	8	Mixture Means
1. Grass	15.4	16.0	12.9	17.0	16.0	14.2	19.5	20.9	16.5
2. Grass-Clover	20.5	22.5	21.5	22.4	22.8	25.0	26.7	29.8	23.9

Table A-12. 1955 Mean Percentage Protein (Fertilizers x Cuts, and Fertilizers)

Fert. Trtmt. (1)	Per cent Protein Cut 1	2	3	4	5	6	7	8	Fert. Means
A	15.3	17.0	18.4	19.0	20.6	20.5	22.0	26.4	20.0
B	15.6	17.5	18.5	18.1	21.0	20.3	22.5	26.6	20.0
C	17.0	22.0	16.4	18.0	21.5	19.2	21.5	28.2	20.5
D	17.7	22.9	16.5	18.6	22.3	18.6	22.2	28.1	20.9
E	19.7	17.4	16.7	20.9	17.6	19.6	24.2	23.4	19.2
F	19.8	17.6	16.4	20.6	17.4	19.3	23.7	23.0	19.8
G	19.3	20.8	17.5	21.2	17.4	20.3	24.5	23.5	20.6
H	19.3	18.5	17.2	21.2	17.4	19.4	24.1	23.4	20.1

(1) See Table 2.

Table A-13. 1956 Mean Percentage Protein (Fertilizers x Mixtures x Cuts, Fertilizers x Mixtures, and Cuts)

Fert. Trtmt. (1)	Mix. (2)	Per cent Protein: Cut 1	2	3	4	5	6	7	8	Fert. x Mix. Means
A	1	17.6	12.1	17.7	21.3	16.8	16.9	19.4	17.3	17.4
	2	31.4	24.6	26.1	28.0	26.8	27.8	26.8	30.3	27.8
B	1	19.7	12.4	17.3	19.7	17.5	16.2	18.6	19.0	17.6
	2	30.4	23.6	26.7	25.9	24.8	28.3	26.0	30.2	27.0
C	1	21.8	11.9	17.8	18.3	19.0	17.2	20.0	21.7	18.5
	2	29.3	21.1	25.7	25.7	24.5	26.4	27.0	30.1	26.3
D	1	22.7	11.5	18.8	19.6	20.2	16.5	20.4	23.1	19.1
	2	29.8	18.9	25.9	24.7	25.3	24.8	25.8	29.5	25.6
E	1	25.4	12.3	14.1	21.9	13.3	14.5	24.4	16.7	17.9
	2	31.6	20.7	24.6	28.0	24.0	24.0	28.3	28.3	26.2
F	1	23.5	12.5	14.3	22.5	13.0	14.5	23.6	17.2	17.7
	2	32.1	21.6	26.1	28.3	23.4	27.0	26.8	26.0	26.4
G	1	24.8	12.3	14.9	21.6	13.3	14.3	24.0	17.7	17.9
	2	30.3	22.1	24.7	28.0	23.6	27.4	27.2	28.6	26.5
H	1	24.9	11.9	14.6	22.0	12.6	14.5	24.5	16.9	17.8
	2	31.4	21.4	25.5	28.2	22.9	26.9	27.6	28.8	26.6
Cut Means		26.7	16.9	20.9	24.0	20.1	21.1	24.4	23.8	

(1) See Table 3.
(2) See Table 1.

Table A-14. 1956 Mean Percentage Protein (Mixtures x Cuts, and Mixtures)

Mixture	Per cent Protein — Cut 1	2	3	4	5	6	7	8	Mixture Means
1. Grass	22.5	12.1	16.2	20.9	15.7	15.6	21.9	18.7	17.9
2. Grass-Clover	30.8	21.7	25.6	27.1	24.4	26.6	27.0	29.0	26.5

Table A-15. 1956 Mean Percentage Protein (Fertilizers x Cuts, and Fertilizers)

Fert. Trtmt. (1)	Per cent Protein — Cut 1	2	3	4	5	6	7	8	Fert. Means
A	24.5	18.3	21.9	24.6	21.8	22.4	23.1	23.8	22.6
B	25.1	18.0	22.0	22.8	21.1	22.2	22.3	24.6	22.3
C	25.6	16.5	21.7	22.0	21.8	21.8	23.5	25.9	22.4
D	26.2	15.2	22.3	22.2	22.8	20.6	23.1	26.3	22.4
E	28.5	16.5	19.3	24.9	18.6	19.3	26.4	22.5	22.1
F	27.8	17.1	20.2	25.4	18.2	20.8	25.2	21.6	22.1
G	27.5	17.2	20.5	24.8	18.5	20.8	25.6	23.1	22.3
H	28.2	16.6	20.0	25.1	17.7	20.7	26.0	22.1	22.2

(1) See Table 3.

Table A-16. 1957 Mean Percentage Protein (Fertilizers x Mixtures x Cuts, Fertilizers x Mixtures, and Cuts)

Fert. Trtmt. (1)	Mix. (2)	Per cent Protein, Cut 1	2	3	4	5	6	7	8	Fert. x Mix. Means
A	1	16.2	13.7	13.6	16.1	15.9	19.1	19.2	16.5	16.3
	2	27.3	26.7	26.4	28.9	29.0	30.6	30.6	29.5	28.6
B	1	16.3	17.8	16.1	21.9	19.5	17.4	20.1	21.4	18.7
	2	26.9	29.4	25.1	28.8	29.2	28.9	27.5	30.6	28.3
C	1	20.4	19.7	17.7	22.3	24.7	18.8	20.4	24.7	21.1
	2	28.7	30.3	25.1	28.0	30.3	25.0	28.6	30.1	28.3
D	1	20.0	23.6	18.2	23.6	24.8	17.7	23.2	28.4	22.5
	2	26.8	31.6	25.2	28.6	31.1	27.1	27.2	31.6	28.7
E	1	23.4	15.8	15.3	27.0	17.0	16.0	25.3	16.3	19.6
	2	30.0	27.6	25.5	32.6	26.2	29.6	30.1	24.8	28.3
F	1	24.9	17.0	15.7	28.6	16.9	15.8	26.6	19.8	20.7
	2	33.2	24.0	22.9	33.5	26.0	22.1	30.2	22.2	26.8
G	1	24.4	17.1	15.6	29.6	16.8	16.5	24.1	15.2	19.9
	2	28.5	27.7	22.6	32.5	25.7	27.1	30.1	23.4	27.2
H	1	23.3	15.6	15.0	25.4	16.4	15.8	23.6	15.1	18.8
	2	28.3	27.5	23.5	31.2	26.4	29.6	30.3	25.6	27.8
Cut Means		24.9	22.8	20.2	27.4	23.5	22.3	26.1	23.4	

(1) See Table 4.
(2) See Table 1.

Table A-17. 1957 Mean Percentage Protein (Mixtures x Cuts and Mixtures)

Mixture	Per cent Protein Cut 1	2	3	4	5	6	7	8	Mixture Means
1.Grass	21.1	17.4	15.9	24.3	19.0	17.1	22.8	19.7	19.7
2.Grass-Clover	28.7	28.1	24.5	30.5	28.0	27.5	29.3	27.2	28.0

Table A-18. 1957 Mean Percentage Protein (Fertilizers x Cuts and Fertilizers)

Fert. Trtmt. (1)	Per cent Protein Cut 1	2	3	4	5	6	7	8	Fert. Means
A	21.8	20.2	20.0	22.5	22.5	24.8	24.9	23.0	22.5
B	21.6	23.1	20.6	25.3	24.4	23.1	23.8	26.0	23.5
C	24.5	25.0	21.4	25.1	27.5	21.9	24.5	27.4	24.7
D	23.4	27.6	21.7	26.1	27.9	22.4	25.2	30.0	25.6
E	26.7	21.7	20.4	29.8	21.6	22.8	27.7	20.5	23.9
F	29.1	21.5	19.3	31.1	21.4	19.0	28.4	21.0	23.8
G	26.4	22.4	19.1	31.0	21.2	21.8	27.1	19.3	23.6
H	25.8	21.6	19.2	28.3	21.4	22.7	27.0	20.3	23.3

(1) See Table 4.

Table A-19. 1955 Mean Nitrogen Yields recorded by varying rates and Frequencies of Nitrogen Application (Fertilizers x Mixtures x Cuts, Fertilizers x Mixtures, and Cuts)

Fert. Trtmt. (1)	Mix. (2)	Nitrogen Yield - lbs./acre								Fert. x Mix. Means
		Cut								
		1	2	3	4	5	6	7	8	
A	1	7	10	5	6	3	2	2	2	5
	2	34	32	35	48	47	48	48	40	41
B	1	14	24	9	12	8	5	6	6	10
	2	46	33	40	46	45	46	47	41	43
C	1	20	35	14	18	14	8	12	13	17
	2	47	50	36	48	41	36	39	38	42
D	1	24	43	19	26	23	10	19	21	23
	2	49	53	41	48	42	31	39	38	43
E	1	39	24	8	26	11	3	21	9	18
	2	62	39	33	52	39	34	49	38	43
Cut Means		34	34	24	33	27	22	28	25	

(1) See Table 2.
(2) See Table 1.

Table A-20. 1956 Mean Nitrogen Yields recorded by varying rates and frequencies of nitrogen application (Fertilizers x Mixtures x Cuts, and Fertilizers x Mixtures, and Cuts)

Fert. Trtmt. (1)	Mix. (2)	Nitrogen Yield - lbs./acre: Cut 1	2	3	4	5	6	7	8	Fert. x Mix. Means
A	1	3	8	10	9	3	2	3	3	5
	2	41	50	52	38	64	51	62	43	50
B	1	9	17	18	16	9	4	8	11	11
	2	48	49	56	43	62	49	60	50	52
C	1	13	19	23	26	17	7	17	24	18
	2	42	47	51	44	61	43	62	54	50
D	1	16	20	25	35	26	10	23	32	23
	2	36	42	45	45	61	43	59	50	48
E	1	14	23	8	24	11	3	26	18	16
	2	44	49	43	43	60	41	66	43	49
Cut Means		27	32	33	32	37	25	39	33	

(1) See Table 3.
(2) See Table 1.

Table A-21. 1957 Mean Nitrogen Yields recorded by varying Rates and Frequencies of nitrogen application (Fertilizers x Mixtures x Cuts, Fertilizers x Mixtures, and Cuts)

Fert. Trtmt. (1)	Mix. (2)	Nitrogen Yield - lbs./acre: Cut 1	2	3	4	5	6	7	8	Fert. x Mix. Means
A	1	5	11	6	3	2	3	3	2	4
	2	51	52	37	32	43	53	51	33	44
B	1	15	22	10	11	8	7	10	7	11
	2	61	57	38	34	48	55	54	42	49
C	1	32	32	17	20	20	15	21	16	22
	2	69	61	39	39	49	51	62	38	51
D	1	36	38	22	24	24	20	42	28	29
	2	63	60	42	47	54	52	61	44	53
E	1	39	30	8	22	16	7	41	11	22
	2	79	60	37	48	49	50	70	35	54
Cut Means		45	42	26	28	31	31	41	26	

(1) See Table 4.
(2) See Table 1.

Table A-22. 1956 Mean Percentage Clover-Mixture 2 (Fertilizer Treatments x Cuts and Fertilizer Treatments and Cuts)

Fert. Trtmt. (1)	Per cent Clover Cut 1	2	3	4	5	6	7	8	Fert. Trtmt. Means
A	77	62	83	82	87	89	89	85	82
B	68	61	75	77	82	87	80	75	76
C	49	47	62	65	73	82	75	67	65
D	34	33	47	53	66	70	63	54	52
E	46	45	67	63	73	85	77	68	65
F	45	38	58	54	61	67	47	48	52
G	42	44	61	62	78	82	72	61	63
H	41	43	59	64	74	88	68	65	63
Cut Means	50	47	64	65	74	81	71	65	

(1) See Table 3.

Table A-23. 1957 Mean Percentage Clover-Mixture 2 (Fertilizer Treatments x Cuts and Fertilizer Treatments and Cuts)

Fert. Trtmt. (1)	Per cent Clover Cut 1	2	3	4	5	6	7	8	Fert. Trtmt. Means
A	47	44	65	69	84	80	82	83	69
B	45	35	59	62	69	77	65	69	60
C	42	34	55	54	60	69	52	57	53
D	30	24	42	49	52	56	37	43	42
E	31	31	56	55	59	70	53	56	51
F	14	14	33	26	31	42	22	19	25
G	22	27	51	50	55	69	49	59	48
H	25	34	53	56	66	74	54	60	53
Cut Means	32	30	52	53	59	67	52	56	

(1) See Table 4.

Table A-24. 1955 Mean Percentage Phosphorus (Fertilizers x Mixtures x Cuts, Fertilizers x Mixtures, and Cuts)

Fert. Trtmt. (1)	Mixture (2)	Per cent Phosphorus Cut 1	Cut 5	Cut 8	Fertilizer x Mixture Means
A	1	.31	.44	.53	.43
	2	.35	.40	.42	.39
B	1	.31	.41	.46	.39
	2	.36	.38	.43	.39
C	1	.30	.38	.43	.37
	2	.37	.38	.45	.40
D	1	.31	.42	.42	.39
	2	.32	.40	.44	.39
E	1	.37	.41	.49	.42
	2	.36	.40	.50	.42
F	1	.33	.40	.50	.41
	2	.43	.42	.50	.45
G	1	.40	.43	.53	.45
	2	.46	.42	.50	.46
H	1	.40	.35	.54	.43
	2	.43	.41	.53	.46
Cut Means		.36	.40	.48	

(1) See Table 2.
(2) See Table 1.

Table A-25. 1955 Mean Percentage Phosphorus (Mixtures x Cuts and Mixtures)

Mixture	Per cent Phosphorus: Cut 1	5	8	Mixture Means
1 (Grass)	.34	.41	.49	.41
2 (Grass-Clover)	.39	.40	.47	.42

Table A-26. 1955 Mean Percentage Phosphorus (Fertilizers x Cuts and Fertilizers)

Fert. Trtmt. (1)	Per cent Phosphorus: Cut 1	5	8	Fert. Means
A	.33	.42	.47	.41
B	.33	.39	.44	.39
C	.34	.38	.44	.39
D	.32	.41	.43	.39
E	.37	.40	.49	.42
F	.38	.41	.50	.43
G	.43	.43	.51	.46
H	.42	.38	.53	.45

(1) See Table 2.

Table A-27. 1956 Mean Percentage Phosphorus (Fertilizers x Mixtures x Cuts, Fertilizers x Mixtures, and Cuts)

Fert. Trtmt. (1)	Mix. (2)	Per cent Phosphorus: Cut 1	2	3	4	5	6	7	8	Fert. x Mix. Means
A	1	.43	.31	.35	.40	.60	.58	.64	.65	.49
	2	.44	.36	.37	.41	.36	.48	.50	.56	.43
B	1	.43	.31	.38	.40	.45	.66	.61	.60	.48
	2	.46	.38	.36	.39	.33	.48	.50	.54	.43
C	1	.36	.30	.31	.32	.36	.54	.56	.53	.41
	2	.37	.34	.37	.37	.33	.50	.50	.52	.41
D	1	.37	.29	.37	.32	.32	.52	.49	.49	.40
	2	.44	.35	.39	.34	.32	.49	.51	.48	.41
E	1	.41	.29	.39	.34	.41	.59	.52	.54	.44
	2	.42	.36	.38	.40	.36	.52	.49	.55	.43
F	1	.43	.34	.44	.35	.48	.64	.63	.63	.49
	2	.49	.45	.47	.47	.51	.61	.59	.67	.53
G	1	.44	.34	.45	.50	.47	.65	.60	.63	.51
	2	.48	.44	.45	.43	.40	.54	.57	.63	.49
H	1	.39	.33	.43	.45	.45	.62	.63	.67	.50
	2	.40	.41	.40	.40	.40	.54	.60	.63	.47
Cut Means		.42	.35	.39	.39	.41	.56	.56	.58	

(1) See Table 3.
(2) See Table 1.

Table A-28. 1956 Mean Percentage Phosphorus (Mixtures x Cuts and Mixtures)

Mixture	Per cent Phosphorus: Cut 1	2	3	4	5	6	7	8	Mixture Means
1. Grass	.41	.31	.39	.38	.44	.60	.58	.59	.46
2. Grass-Clover	.44	.39	.40	.40	.38	.52	.53	.57	.45

Table A-29. 1956 Mean Percentage Phosphorus (Fertilizers x Cuts, and Fertilizers)

Fert. Trtmt. (1)	Per cent Phosphorus: Cut 1	2	3	4	5	6	7	8	Fert. Means
A	.43	.33	.36	.40	.48	.53	.47	.60	.45
B	.44	.34	.37	.39	.39	.57	.55	.57	.45
C	.36	.32	.34	.34	.34	.52	.53	.52	.41
D	.40	.32	.38	.33	.32	.50	.50	.48	.40
E	.41	.32	.38	.37	.38	.55	.50	.54	.43
F	.46	.39	.45	.41	.49	.62	.61	.65	.51
G	.46	.39	.45	.46	.43	.59	.58	.63	.50
H	.39	.37	.41	.42	.42	.58	.61	.65	.48

(1) See Table 3.

Table A-30. 1957 Mean Percentage Phosphorus (Fertilizers x Mixtures x Cuts, Fertilizers x Mixtures, and Cuts)

Fert. Trtmt. (1)	Mix. (2)	Per cent Phosphorus — Cut 1	2	3	4	5	6	7	8	Fert. x Mix. Means
A	1	.32	.36	.40	.40	.40	.39	.51	.57	.42
	2	.31	.39	.35	.30	.27	.32	.34	.33	.33
B	1	.33	.40	.42	.36	.33	.41	.47	.44	.40
	2	.34	.42	.34	.30	.28	.42	.36	.34	.35
C	1	.31	.38	.36	.31	.25	.37	.37	.37	.34
	2	.31	.38	.32	.29	.25	.31	.29	.31	.31
D	1	.25	.38	.34	.31	.26	.36	.35	.33	.32
	2	.27	.40	.31	.29	.25	.29	.28	.32	.30
E	1	.31	.38	.42	.33	.30	.38	.38	.44	.37
	2	.32	.39	.38	.30	.29	.34	.32	.35	.34
F	1	.50	.50	.50	.44	.42	.35	.51	.58	.48
	2	.59	.57	.48	.42	.44	.59	.47	.51	.51
G	1	.49	.45	.49	.41	.42	.41	.50	.57	.47
	2	.50	.52	.42	.37	.37	.38	.39	.44	.42
H	1	.44	.44	.48	.39	.37	.43	.48	.52	.44
	2	.45	.47	.40	.36	.34	.39	.41	.45	.41
Cut Means		.38	.43	.40	.35	.33	.38	.40	.43	

(1) See Table 4.
(2) See Table 1.

Table A-31. 1957 Mean Percentage Phosphorus (Mixtures x Cuts and Mixtures)

Mixture	Per cent Phosphorus: Cut 1	2	3	4	5	6	7	8	Mixture Means
1. Grass	.37	.41	.43	.37	.35	.39	.45	.48	.41
2. Grass-Clover	.39	.44	.38	.33	.31	.38	.36	.38	.37

Table A-32. 1957 Mean Percentage Phosphorus (Fertilizers x Cuts and Fertilizers)

Fert. Trtmt. (1)	Per cent Phosphorus: Cut 1	2	3	4	5	6	7	8	Fert. Means
A	.32	.38	.38	.35	.34	.35	.42	.45	.37
B	.34	.41	.38	.33	.30	.41	.42	.39	.37
C	.31	.38	.34	.30	.25	.34	.33	.34	.32
D	.26	.39	.32	.30	.26	.33	.32	.33	.31
E	.31	.38	.40	.31	.30	.36	.35	.39	.35
F	.55	.54	.49	.43	.43	.47	.49	.55	.49
G	.49	.49	.46	.39	.39	.39	.45	.51	.44
H	.44	.46	.44	.38	.36	.41	.45	.48	.42

(1) See Table 4.

Table A-33. 1955 Mean Percentage Potassium (Fertilizers x Mixtures x Cuts, Fertilizers x Mixtures, and Cuts)

Fert. Trtmt. (1)	Mixture (2)	Percentage Potassium: Cut 1	Cut 5	Cut 8	Fertilizer x Mixture Means
A	1	1.83	2.37	1.82	2.01
	2	1.77	1.60	.97	1.45
B	1	2.25	2.36	2.26	2.29
	2	2.03	1.91	1.19	1.71
C	1	1.92	2.39	2.02	2.11
	2	1.99	1.89	1.21	1.70
D	1	2.02	1.99	1.94	1.98
	2	1.77	1.72	1.41	1.63
E	1	2.37	2.09	2.13	2.20
	2	2.32	1.53	1.40	1.75
F	1	2.06	2.25	1.95	2.09
	2	2.17	1.64	1.09	1.63
G	1	2.65	2.45	2.31	2.47
	2	2.79	1.73	1.19	1.91
H	1	2.57	2.10	2.13	2.27
	2	2.86	1.75	1.28	1.96
Cut Means		2.21	1.99	1.64	

(1) See Table 2.
(2) See Table 1.

Table A-34. 1955 Mean Percentage Potassium (Mixtures x Cuts and Mixtures)

Mixture	Per cent Potassium — Cut 1	Cut 5	Cut 8	Mixture Means
1. Grass	2.21	2.25	2.07	2.18
2. Grass-Clover	2.21	1.72	1.22	1.72

Table A-35. 1955 Mean Percentage Potassium (Fertilizers x Cuts and Fertilizers)

Fert. Trtmt. (1)	Per cent Potassium — Cut 1	Cut 5	Cut 8	Fert. Means
A	1.80	1.99	1.40	1.73
B	2.14	2.14	1.73	2.00
C	1.96	2.14	1.61	1.91
D	1.90	1.85	1.68	1.81
E	2.34	1.81	1.77	1.97
F	2.11	1.95	1.52	1.86
G	2.72	2.09	1.75	2.19
H	2.72	1.93	1.71	2.12

(1) See Table 2.

Table A-36. 1956 Mean Percentage Potassium (Fertilizers x Mixtures x Cuts, Fertilizers x Mixtures, and Cuts)

Fert. Trtmt. (1)	Mix. (2)	Per cent Potassium — Cut 1	2	3	4	5	6	7	8	Fert. x Mix. Means
A	1	1.98	1.83	1.71	1.87	2.63	2.25	2.52	2.73	2.19
	2	1.21	0.74	0.76	0.88	2.00	1.42	1.66	2.68	1.42
B	1	2.28	1.94	2.07	3.03	2.63	2.53	2.85	2.94	2.53
	2	1.50	0.97	0.74	2.46	1.80	1.72	1.45	2.83	1.68
C	1	1.46	1.55	1.83	3.21	2.60	2.00	2.68	3.05	2.30
	2	1.04	0.78	0.79	2.69	1.80	1.30	1.50	2.84	1.59
D	1	1.47	1.34	1.31	3.22	2.29	2.01	2.08	2.96	2.08
	2	1.44	1.04	0.87	2.77	1.86	1.39	1.46	2.92	1.72
E	1	1.60	1.54	1.81	3.41	2.61	2.08	2.94	3.14	2.39
	2	1.86	0.92	0.79	2.40	1.87	1.99	1.47	3.08	1.80
F	1	2.08	1.61	1.81	1.67	1.52	1.47	1.74	1.98	1.73
	2	0.95	0.73	0.78	0.63	0.67	1.06	0.76	0.35	0.74
G	1	2.55	1.93	2.10	3.29	2.56	2.37	2.70	2.93	2.55
	2	1.51	1.00	1.01	2.29	1.54	1.73	1.25	2.70	1.63
H	1	1.57	1.83	2.08	3.17	2.48	2.02	2.45	2.71	2.29
	2	1.69	1.07	0.98	2.12	1.58	1.33	1.38	2.52	1.58
Cut Means		1.64	1.30	1.34	2.44	2.03	1.79	1.93	2.65	

(1) See Table 3.
(2) See Table 1.

Table A-37. 1956 Mean Percentage Potassium (Mixtures x Cuts and Mixtures)

Mixtures	Per cent Potassium — Cut 1	2	3	4	5	6	7	8	Mixture Means
1. Grass	1.87	1.70	1.84	2.86	2.41	2.09	2.49	2.80	2.26
2. Grass-Clover	1.40	0.91	0.84	2.03	1.64	1.49	1.37	2.49	1.52

Table A-38. 1956 Mean Per cent Potassium (Fertilizers x Cuts and Fertilizers)

Fert. Trtmt. (1)	Per cent Potassium — Cut 1	2	3	4	5	6	7	8	Fert. Means
A	1.59	1.28	1.23	1.37	2.31	1.83	2.09	2.70	1.80
B	1.89	1.45	1.40	2.74	2.21	2.12	2.15	2.88	2.10
C	1.25	1.16	1.31	2.95	2.20	1.65	2.09	2.94	1.94
D	1.45	1.19	1.09	2.99	2.07	1.70	1.77	2.94	1.90
E	1.73	1.23	1.30	2.90	2.24	2.03	2.20	3.11	2.09
F	1.51	1.17	1.29	1.15	1.09	1.26	1.25	1.16	1.23
G	2.03	1.46	1.55	2.79	2.05	2.05	1.97	2.81	2.09
H	1.63	1.45	1.53	2.64	2.03	1.67	1.91	2.61	1.93

(1) See Table 3.

Table A-39. 1957 Mean Percentage Potassium (Fertilizers x Mixtures x Cuts, Fertilizers x Mixtures, and Cuts)

Fert. Trtmt. (1)	Mix. (2)	Per cent Potassium — Cut 1	2	3	4	5	6	7	8	Fert. x Mix. Means
A	1	2.60	2.77	2.60	2.39	2.48	2.76	3.19	3.11	2.74
	2	3.21	3.49	2.88	2.18	2.17	2.34	3.31	2.82	2.80
B	1	2.66	2.92	3.09	3.05	2.90	2.89	4.02	3.18	3.09
	2	3.07	3.44	2.72	2.46	2.44	2.29	3.49	2.79	2.84
C	1	3.55	3.40	3.26	3.35	3.25	3.08	4.28	3.48	3.46
	2	3.54	3.12	2.67	2.67	2.61	2.52	3.72	3.25	3.01
D	1	3.09	3.11	2.91	3.25	3.24	2.73	4.16	3.73	3.28
	2	3.14	3.16	2.28	2.67	2.72	2.38	3.81	2.94	2.89
E	1	3.74	3.50	3.06	3.84	3.06	2.63	4.08	3.54	3.43
	2	3.49	3.31	2.41	2.75	2.67	2.20	3.83	2.72	2.92
F	1	1.27	1.50	1.43	1.26	0.52	1.19	0.70	1.19	1.13
	2	0.48	0.85	1.03	0.41	0.30	1.22	0.49	0.50	0.66
G	1	3.87	3.44	3.05	3.17	2.97	3.03	3.97	3.68	3.40
	2	3.40	3.18	2.41	2.71	2.46	2.61	3.94	2.95	2.96
H	1	3.55	3.34	3.00	3.44	3.01	2.66	4.11	3.67	3.35
	2	3.13	3.11	2.35	3.02	2.21	1.99	3.87	3.14	2.85
Cut Means		2.99	2.98	2.57	2.66	2.44	2.41	3.44	2.92	

(1) See Table 4.
(2) See Table 1.

Table A-40. 1957 Mean Percentage Potassium (Mixtures x Cuts and Mixtures)

Mixture	Cut 1	2	3	4	5	6	7	8	Mixture Means
1. Grass	3.04	3.00	2.80	2.97	2.68	2.62	3.57	3.20	2.98
2. Grass-Clover	2.93	2.96	2.34	2.36	2.20	2.19	3.31	2.64	2.62

Per cent Potassium

Table A-41. 1957 Mean Percentage Potassium (Fertilizers x Cuts and Fertilizers)

Per cent Potassium

Fert. Trtmt. (1)	Cut 1	2	3	4	5	6	7	8	Fert. Means
A	2.90	3.13	2.74	2.29	2.33	2.55	3.25	2.97	2.77
B	2.86	3.18	2.91	2.76	2.67	2.59	3.76	2.99	2.96
C	3.54	3.26	2.97	3.01	2.93	2.80	4.00	3.37	3.23
D	3.12	3.14	2.59	2.96	2.98	2.55	3.98	3.34	3.08
E	3.62	3.41	2.73	3.29	2.86	2.42	3.96	3.13	3.17
F	0.88	1.18	1.23	0.84	0.41	1.21	0.59	0.85	0.89
G	3.64	3.31	2.73	2.94	2.71	2.82	3.96	3.31	3.18
H	3.34	3.23	2.68	3.23	2.61	2.33	3.99	3.41	3.10

(1) See Table 4.

Table A-42. 1955 Mean Percentage Calcium (Fertilizers x Mixtures x Cuts, Fertilizers x Mixtures, and Cuts)

Fert. Trtmt. (1)	Mixture (2)	Per cent Calcium — Cut 1	Cut 5	Cut 8	Fertilizer x Mixture Means
A	1	.58	.70	1.05	.78
	2	1.24	1.53	1.55	1.44
B	1	.25	.48	.65	.46
	2	.83	1.27	1.28	1.13
C	1	.12	.31	.41	.28
	2	.66	.95	.95	.86
D	1	.30	.31	.42	.34
	2	.72	.91	.93	.86
E	1	.43	.25	.36	.35
	2	.53	1.13	1.22	.96
F	1	.32	.47	.48	.43
	2	.64	1.15	1.21	1.00
G	1	.75	.45	.57	.59
	2	.70	1.28	1.22	1.07
H	1	.39	.28	.61	.43
	2	.66	1.07	1.32	1.02
Cut Means		.57	.79	.89	

(1) See Table 2.
(2) See Table 1.

Table A-43. 1955 Percentage Calcium (Mixture x Cuts and Mixtures)

Mixture	Per cent Calcium: Cut 1	Cut 5	Cut 8	Mixture Means
1. Grass	.39	.41	.57	.46
2. Grass-Clover	.75	1.16	1.21	1.04

Table A-44. 1955 Mean Percentage Calcium (Fertilizers x Cuts and Fertilizers)

Fert. Trtmt. (1)	Per cent Calcium: Cut 1	Cut 5	Cut 8	Fertilizer Means
A	.91	1.12	1.30	1.11
B	.54	.88	.97	.79
C	.39	.63	.68	.57
D	.51	.61	.67	.60
E	.48	.69	.79	.66
F	.48	.81	.85	.71
G	.73	.87	.90	.83
H	.53	.67	.97	.72

(1) See Table 2.

Table A-45. 1956 Mean Percentage Calcium (Fertilizers x Mixtures x Cuts, Fertilizers x Mixtures and Cuts)

Fert. Trtmt. (1)	Mix. (2)	Per cent Calcium: Cut 1	2	3	4	5	6	7	8	Fert. x Mix. Means
A	1	.39	.19	.99	1.35	1.18	.60	.89	.54	.77
	2	1.50	1.52	1.98	1.80	1.72	1.74	1.38	1.40	1.63
B	1	.53	.16	.58	.59	.66	.64	.56	.41	.52
	2	1.45	1.41	1.86	1.84	1.71	1.67	1.30	1.12	1.54
C	1	.72	.14	.45	.49	.48	.60	.55	.34	.47
	2	1.09	1.15	1.70	1.34	1.47	1.58	1.27	.96	1.32
D	1	.62	.06	.37	.37	.55	.64	.44	.25	.41
	2	1.06	.84	1.39	1.13	1.31	1.43	1.02	.71	1.11
E	1	.81	.23	.43	.37	.58	.50	.30	.57	.47
	2	.72	1.09	1.36	1.30	1.38	1.66	1.21	.97	1.21
F	1	.46	.10	.67	.50	.71	.69	.43	.51	.51
	2	1.32	.97	1.60	1.25	1.44	1.37	1.04	.96	1.24
G	1	.35	.07	.50	.42	.59	.53	.42	.41	.41
	2	1.31	.94	1.60	1.36	1.60	1.76	1.14	.98	1.34
H	1	.83	.08	.53	.33	.50	.85	.45	.46	.50
	2	.75	.98	1.73	1.20	1.49	1.72	1.07	1.22	1.27
Cut Means		.87	.62	1.11	.98	1.09	1.12	.84	.74	

(1) See Table 3.
(2) See Table 1.

Table A-46. 1956 Mean Percentage Calcium (Mixtures x Cuts and Mixtures)

	Per cent Calcium								
	Cut								Mixture
Mixture	1	2	3	4	5	6	7	8	Means
1. Grass	.59	.13	.56	.55	.66	.63	.50	.44	.51
2. Grass-Clover	1.15	1.11	1.65	1.40	1.51	1.62	1.18	1.04	1.33

Table A-47. 1956 Mean Percentage Calcium Fertilizers x Cuts and Fertilizers)

	Per cent Calcium								
Fert. Trtmt.	Cut								Fert.
(1)	1	2	3	4	5	6	7	8	Means
A	.94	.85	1.48	1.57	1.45	1.17	1.13	.97	1.19
B	.99	.78	1.22	1.21	1.18	1.15	.93	.76	1.03
C	.90	.64	1.07	.91	.97	1.09	.91	.65	.89
D	.84	.45	.88	.75	.93	1.03	.73	.48	.76
E	.76	.66	.89	.83	.98	1.08	.75	.77	.84
F	.89	.53	1.13	.87	1.07	1.03	.73	.73	.87
G	.83	.50	1.05	.89	1.09	1.14	.78	.69	.87
H	.79	.53	1.13	.76	.99	1.28	.76	.84	.88

(1) See Table 3.

Table A-48. 1957 Mean Percentage Calcium (Fertilizers x Mixtures x Cuts, Fertilizers x Mixtures, and Cuts)

Fert. Trtmt. (1)	Mix. (2)	Per cent Calcium: Cut 1	2	3	4	5	6	7	8	Fert. x Mix. Means
A	1	.19	.24	.39	.57	.50	.66	.47	.68	.46
	2	.61	.65	.92	1.72	1.59	1.33	1.04	1.17	1.13
B	1	.23	.03	.81	.47	.30	.76	.44	.41	.43
	2	.58	.40	.96	1.39	1.16	1.25	.68	.98	.92
C	1	.46	.06	.44	.32	.25	.66	.28	.31	.35
	2	.58	.37	.95	.72	1.10	1.17	.58	.68	.77
D	1	.19	.30	.27	.33	.25	.61	.14	.29	.30
	2	.56	.32	.75	.91	.87	1.08	.45	.47	.68
E	1	.11	.22	.28	.56	.35	.53	.02	.40	.31
	2	.48	.35	.72	1.00	.89	1.34	.63	.83	.78
F	1	.47	.18	.43	.55	.65	.93	.44	.67	.53
	2	.76	.35	.62	.85	.93	1.18	.48	.81	.75
G	1	.25	.37	.38	.39	.45	.48	.09	.42	.34
	2	.47	.45	.74	1.02	1.06	1.23	.54	.93	.81
H	1	.18	.12	.36	.60	.38	.48	.08	.49	.34
	2	.38	.52	.73	1.17	1.16	1.31	.54	.88	.84
Cut Means		.41	.31	.61	.79	.74	.94	.43	.65	

(1) See Table 4.
(2) See Table 1.

Table A-49. 1957 Mean Percentage Calcium (Mixtures x Cuts and Mixtures)

Mixture	Per cent Calcium								
	Cut								Mixture Means
	1	2	3	4	5	6	7	8	
1. Grass	.26	.19	.42	.47	.38	.64	.23	.46	.38
2. Grass-Clover	.55	.43	.80	1.10	1.10	1.24	.62	.84	.83

Table A-50. 1957 Mean Percentage Calcium (Fertilizers x Cuts, and Fertilizers)

Fert. Trtmt. (1)	Per cent Calcium								
	Cut								Fert. Means
	1	2	3	4	5	6	7	8	
A	.40	.44	.65	1.12	1.04	1.00	.75	.93	.79
B	.40	.21	.89	.93	.73	1.01	.55	.69	.67
C	.52	.22	.69	.52	.66	.92	.43	.50	.56
D	.38	.31	.51	.62	.56	.85	.30	.38	.49
E	.30	.29	.50	.78	.62	.94	.33	.61	.54
F	.61	.26	.52	.70	.79	1.05	.41	.74	.64
G	.36	.41	.56	.70	.70	.85	.32	.68	.57
H	.28	.32	.55	.89	.77	.89	.31	.68	.59

(1) See Table 4.

Table A-51. 1955 Mean Percentage Magnesium (Fertilizers x Mixtures x Cuts, Fertilizers x Mixtures, and Cuts)

Fert. Trtmt. (1)	Mixture (2)	Per cent Magnesium: Cut 1	Cut 5	Cut 8	Fertilizers x Mixture Means
A	1	.18	.29	.25	.24
	2	.16	.32	.29	.26
B	1	.18	.26	.34	.26
	2	.22	.32	.36	.30
C	1	.11	.28	.34	.24
	2	.17	.37	.38	.30
D	1	.18	.31	.30	.26
	2	.19	.37	.31	.29
E	1	.16	.18	.30	.21
	2	.20	.36	.28	.28
F	1	.19	.17	.25	.20
	2	.19	.31	.39	.30
G	1	.17	.18	.32	.22
	2	.23	.39	.26	.29
H	1	.14	.26	.25	.22
	2	.16	.39	.29	.28
Cut Means		.18	.30	.31	

(1) See Table 2.
(2) See Table 1.

Table A-52. 1955 Mean Percentage Magnesium (Mixtures x Cuts and Mixtures)

Mixture	Per cent Magnesium: Cut 1	Cut 5	Cut 8	Mixture Means
1. Grass	.17	.24	.29	.23
2. Grass-Clover	.19	.35	.32	.29

Table A-53. 1955 Mean Percentage Magnesium (Fertilizers x Cuts and Fertilizers

Fert. Trtmt. (1)	Per cent Magnesium: Cut 1	Cut 5	Cut 8	Fert. Means
A	.17	.30	.27	.25
B	.20	.29	.35	.28
C	.14	.33	.35	.27
D	.19	.34	.30	.28
E	.18	.27	.29	.24
F	.19	.24	.32	.25
G	.20	.29	.29	.26
H	.15	.32	.27	.25

(1) See Table 2.

Table A-54. 1956 Mean Percentage Magnesium (Fertilizers x Mixtures x Cuts, Fertilizers x Mixtures, and Cuts)

Fert. Trtmt. (1)	Mix. (2)	Per cent Magnesium: Cut 1	2	3	4	5	6	7	8	Fert. x Mix. Means
A	1	.25	.20	.32	.31	.40	.40	.43	.34	.33
	2	.34	.37	.47	.44	.42	.47	.44	.39	.42
B	1	.27	.20	.33	.31	.36	.42	.41	.36	.33
	2	.34	.36	.46	.43	.41	.45	.44	.39	.41
C	1	.29	.19	.33	.29	.37	.41	.45	.37	.34
	2	.30	.33	.44	.35	.41	.48	.46	.38	.39
D	1	.27	.22	.34	.30	.39	.44	.42	.37	.34
	2	.30	.31	.42	.37	.42	.46	.46	.38	.39
E	1	.30	.22	.32	.30	.36	.38	.37	.35	.32
	2	.27	.32	.46	.36	.40	.46	.44	.37	.38
F	1	.24	.23	.34	.35	.42	.42	.40	.43	.35
	2	.35	.33	.42	.39	.50	.46	.47	.48	.42
G	1	.26	.21	.30	.31	.33	.37	.37	.31	.31
	2	.33	.32	.40	.39	.43	.46	.44	.40	.40
H	1	.29	.21	.32	.30	.34	.41	.39	.35	.33
	2	.27	.31	.43	.38	.41	.48	.44	.42	.39
Cut Means		.29	.27	.38	.35	.40	.43	.43	.38	

(1) See Table 3.
(2) See Table 1.

Table A-55. 1956 Mean Percentage Magnesium (Mixtures x Cuts and Mixtures)

Mixture	Cut 1	2	3	4	5	6	7	8	Mix. Means
	Per cent Magnesium								
1. Grass	.27	.21	.32	.31	.37	.41	.40	.36	.33
2. Grass-Clover	.31	.33	.44	.39	.43	.46	.45	.40	.40

Table A-56. 1956 Mean Percentage Magnesium (Fertilizers x Cuts and Fertilizers)

Fert. Trtmt. (1)	Cut 1	2	3	4	5	6	7	8	Fert. Means
	Per cent Magnesium								
A	.29	.28	.39	.37	.41	.43	.43	.36	.37
B	.30	.28	.39	.37	.38	.43	.42	.37	.37
C	.29	.26	.38	.32	.39	.44	.45	.37	.36
D	.28	.26	.38	.33	.40	.45	.44	.37	.36
E	.28	.27	.39	.33	.38	.42	.40	.36	.35
F	.29	.28	.38	.37	.46	.44	.43	.45	.39
G	.29	.26	.35	.35	.38	.41	.40	.35	.35
H	.28	.26	.37	.34	.37	.44	.41	.38	.36

(1) See Table 3.

Table A-57. 1957 Mean Percentage Magnesium (Fertilizers x Mixtures x Cuts, Fertilizers x Mixtures, and Cuts)

Fert. Trtmt. (1)	Mix. (2)	Per cent Magnesium — Cut 1	2	3	4	5	6	7	8	Fert. x Mix. Means
A	1	.21	.25	.25	.30	.27	.24	.31	.32	.27
	2	.25	.28	.33	.39	.28	.35	.32	.31	.32
B	1	.20	.23	.29	.30	.25	.19	.31	.30	.26
	2	.21	.30	.32	.38	.30	.34	.32	.33	.31
C	1	.20	.25	.28	.29	.26	.24	.30	.31	.27
	2	.17	.28	.31	.37	.29	.32	.32	.32	.30
D	1	.23	.27	.30	.31	.24	.23	.29	.34	.28
	2	.24	.28	.32	.34	.26	.32	.32	.33	.30
E	1	.17	.24	.29	.31	.28	.22	.27	.30	.26
	2	.20	.27	.33	.35	.32	.34	.31	.33	.31
F	1	.27	.29	.32	.39	.36	.35	.40	.45	.35
	2	.28	.34	.39	.43	.40	.39	.46	.48	.40
G	1	.24	.25	.29	.30	.29	.21	.27	.29	.27
	2	.25	.30	.33	.37	.32	.35	.32	.35	.32
H	1	.16	.25	.30	.27	.26	.27	.27	.30	.26
	2	.19	.30	.34	.36	.33	.34	.33	.33	.32
Cut Means		.22	.27	.31	.34	.29	.29	.32	.34	

(1) See Table 4.
(2) See Table 1.

Table A-58. 1957 Mean Percentage Magnesium (Mixtures x Cuts and Mixtures)

Mixture	Cut 1	2	3	4	5	6	7	8	Mixture Means
	Per cent Magnesium								
1. Grass	.21	.25	.29	.31	.28	.25	.30	.33	.28
2. Grass-Clover	.23	.29	.33	.37	.31	.34	.34	.35	.32

Table A-59. 1957 Mean Percentage Magnesium (Fertilizers x Cuts and Fertilizers)

Fert. Trtmt. (1)	Cut 1	2	3	4	5	6	7	8	Fert. Means
	Per cent Magnesium								
A	.23	.27	.29	.34	.28	.30	.31	.32	.29
B	.20	.27	.30	.33	.27	.26	.31	.32	.28
C	.18	.27	.30	.32	.27	.28	.31	.32	.28
D	.24	.27	.31	.33	.25	.28	.31	.33	.29
E	.19	.26	.32	.33	.30	.28	.29	.32	.28
F	.27	.32	.36	.41	.38	.37	.43	.47	.37
G	.25	.28	.31	.33	.30	.28	.30	.32	.29
H	.18	.27	.32	.32	.30	.31	.30	.31	.29

(1) See Table 3.