# THE EFFECT OF SEVERAL FERTILIZERS AND LIME ON THE YIELD AND BOTANICAL COMPOSITION OF A PASTURE SWARD ON SHERBROOKE SANDY LOAM

by

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C O N T E N T S

# 1 - INTRODUCTION

Pastures are of prime importance to Canadian grassland husbandry. Under proper management, they are a source of abundant and nutritious feed produced at low cost as well as providing an ideal use of the land. According to the 1941 federal census, there are in Canada, 8,666,910 acres of improved pasture, and 52,744,171 acres of prairie or natural pasture. In Quebec, improved pasture amounts to 2,693,337 acres, and prairie or natural pasture comprises 2,442,431 acres or 26.6% of occupied farm land. And yet, till a few decades ago, no crop perhaps received scanter attention than pastures. They have been too frequently assumed to yield without any particular care or attention.

On the average farm, they were grazed year after year without any effort towards their improvement or maintenance by fertilization, good grazing practices, and proper management. Mortimer and Richards (1930) stressed that: "The soils of permanent pasture are not new. Land that has been grazed continuously in the past has had much available fertility removed in the sale of milk, meat and bones and in manures dropped elsewhere on the farm. This constant drain, slow and silent as it has been, is now being felt quite generally throughout permanent pasture lands in humid regions, until limited fertility is recognized as an important factor affecting production".

An anonymous author (1923) wrote that: "Only the fact that grass will stand an almost incredible amount of abuse has prevented its utter destruction". Literature from all parts of the world shows the low production of most permanent grasslands. This low productivity is diversely attributed to lack of fertility, deficiency in management, and improper grazing practices. It is also seen that the yield and the vegetation of pastures can be materially and profitably improved by proper treatments.

## II - REVIEW OF LITERATURE

Pastures which had been one of the most neglected problems until a few decades ago have now become the object of extensive research. Barnes (1924) mentioned that very little experimental work on the effects of fertilizers on pasture vegetation was done prior to 1897. No attempt will be made in this paper to review all the literature bearing on pastures, but only that which deals with subjects related to the present study.

The soils of permanent pastures have become depleted mostly by the constant removal of herbage. Impoverished soils are responsible for low carrying capacity and poor type of sward. Many investigators, Skinner and Noll (1919), Brown and Slate (1929), Nowosad (1933), Robinson and Pierre (1938), Pohlman and Cornell (1943) found that the productivity of permanent pastures can be greatly increased by fertilization. Bender (1934) reported that: "unfertilized pastures seldom produce either grazing enough or grazing of good enough quality". Sprague et al (1940), Seath and Rusoff (1945) stressed the importance of fertilization in producing herbage of excellent quality.

From the voluminous data of pasture research workers, the influence of N, P, K, and Ca on both the production and the vegetation of pastures was studied.

In Pennsylvania, results from investigations carried by Skinner and Noll (1919) revealed that the highest yields were obtained from fertilizers high in nitrogen. It was observed that white clover disappeared from plots receiving

such a fertilization. Gardner et al (1935) also reported a pronounced effect from nitrogen fertilization in increasing yield and thickening pasture sward. Grasses were stimulated by nitrogen but clovers were crowded out. Phosphorus was responsible for the largest increase in yield and the greatest improvement in turf while potash has shown little benefit. Noll et al (1944) found that phosphorus gave larger increases in production than either nitrogen or potash. Likewise, White and Holben (1925) obtained valuable response from superphosphate.

Mortimer and Richards (1930) working in Wisconsin presented data to show that "nitrogen fertilization becomes effective in proportion to the correction of mineral limitations. A suitable clover-grass ratio can be maintained only by a proper mineral "set up" in the soil, of which phosphorus is a leading element along with potash and lime".

Tyson (1930) working on native pastures in Michigan reported that: "in general, applications of superphosphate, potash and lime had little effect on the growth of grass in these pastures except when applied in combination with nitrogen".

Hutcheson and Wolfe (1919), obtained valuable response from superphosphate in Virginia. O'Brien and Obenshain (1942) also working in Virginia reported a depressing effect on yield from liming, whether lime was used with or without phosphate fertilizers. Phosphorus increased the production and was considered as the limiting factor for clover.

In Connecticut, Brown and Slate (1929) showed that phosphorus was the element most needed and that calcium was effective in increasing the productivity of pastures especially when applied with carriers of phosphorus. Results obtained from potash were conflicting. Brown (1933) in reviewing his results concluded that no worthwhile increases in yield were secured and no change in the character of the herbage was noted from limestone, potash and nitrogen applied alone or in combination when phosphorus was omitted. White clover and Kentucky bluegrass increased greatly on the phosphated plots but where limestone was also applied, changes in the flora were still more striking. The turf on the NPK plots had the fewest weeds. Brown and Munsell (1943) presented data to show that potash was the least important element while phosphorus was essential for the improvement and maintenance of pasture. Lime was effective only in combination with phosphorus. They also stressed the importance of Ca and P in maintaining white clover in large quantities in grassland.

Johnstone-Wallace (1938) pointed out that an adequate supply of available phosphorus is the first essential in pasture improvement on New York soils. Lime is seoond in importance. Pastures respond less frequently to potash. Wiggans (1926) in his pasture studies also in New York found that acid phosphate as well as lime gave significant increases while potash failed to show conclusive results.

Investigations carried by Sprague et al (1934) on three types of soil in New-Jersey showed that lime, phosphorus and potash must be applied together for best results. Sprague (1935) mentioned that "lime alone rarely produces striking improvement in growth, but its presence is usually essential for satisfactory response from all types of fertilizers". The LPK treatments gave the highest yields of grass. Sprague et al (1940) found that nitrogen improved the production of pasture when used with lime and minerals. They also observed that the percentage of white clover was considerably reduced by the addition of nitrogen. Bender (1934) reported that nitrogen increased the yield of herbage but had a depressing effect on white clover.

Studies of Midgley and Weiser (1936) on Vermont soils low in available potash revealed that all treatments containing K have increased both the clover content of the sward and the yield. Potash alone gave a good response but its effect was more striking when used with superphosphate. Liming tended to increase the clovers and raised the yields in most cases. Nitrogen applied in conjunction with minerals favoured the grasses at the expense of clovers and increased yield followed the application of this element.

Haskell (1926) working in Massachusetts showed that potash was the limiting factor. Lime and superphosphate applied either alone or together were effective only when associated with potash. Beaumont (1932) also in Massachusetts found that the most effective single element in producing desirable changes in the vegetation was lime,

the best combination of two materials: Ca, and K but a combination of Ca, P, and K produced the greatest change.

Prince et al (1940) recorded their highest yields from NPK treatment in New-Hampshire. They obtained a well balanced sward of grass and clover from both NPK and NK treatments. Potash gave positive results.

Nowosad (1933) working in the Eastern Townships of Quebec on brown forest soils reported that: "Phosphorus, potash, and nitrogen increased the yield wherever applied". In a report from the Experimental Station, Lennoxville (1940), it is shown that on Coaticook sandy loam, lime has produced the highest increase in yield. Phosphorus was second in importance followed by nitrogen. Potash has given little response.

In summarizing the literature cited, it may be stated that in general:

a) - Fertilization and liming improved both the yield and the vegetation of pastures.

b) - Nitrogen increased the yield materially and favoured mainly the grass species.

c) - Phosphorus gave very good responses. It improved both the stand and the growth of useful species and increased the yield markedly.

d) - Potash showed conflicting results. Valuable responses resulted from its application on some pastures while on others no beneficial effects were noted.

e) - Lime showed good results on most pastures.

## III - PLAN AND DESCRIPTION OF THE EXPERIMENT

Location:

This experiment was conducted on a pasture situated at the Experimental Station, Lennoxville, Que.

History of the fields:

The two fields selected for this purpose are designated in this paper as field 1 and field 2. Each field contained 2.5 acres. Field 1 broken from rough pasture in 1928 received a light dressing of manure and was seeded down with a nurse crop of oats to the following mixture: red clover 8 lb., alsike clover 2 lb. and timothy 10 lb. A crop of hay was cut in 1929 and grazing started in 1930. Field 2 was broken in the fall of 1929 and seeded in 1930 with a nurse crop of oats to the following mixture: timothy 4 lb., red clover 2 lb., alsike clover 2 lb., white Dutch clover 2 lb., Kentucky bluegrass 2 lb., red top 2 lb. and orchard grass 2 lb. Grazing started in 1931.

In the spring of 1931 and 1935, both fields received 300 lb. superphosphate and 75 lb. muriate of potash per acre. In addition, sulphate of ammonia at 100 lb. per acre was applied each spring and again about June 15 from 1931 to 1934 inclusive. From 1935 to 1938 inclusive, only the spring application of nitrogen was resorted to. In the fall of 1933, both fields received two tons of ground limestone per acre. The present study was undertaken in 1939 and covers six years.

Type of soil:

The experiment was laid out on Sherbrooke sandy loam. Cann and Lajoie (1939) who surveyed the land gave the following description of this soil type: "The Sherbrooke sandy loam is quite prominent in both Stanstead and Compton counties but does not occur to any large extent in Sherbrooke county..... This type is usually found on smooth, rolling topography at an elevation between 500 and 900 feet. It resembles the Coaticook loam in appearance, but is developed on different material of glacial origin. The profile is described below.

$A_1$. 0-2 inches, brown loam. pH 5.2

$A_2$. 2-4 inches, dark gray material streaked with humus. pH 5.2

$B_1$. 4-10 inches, reddish brown, very sandy loam. pH 5.6

$B_2$. 10-26 inches, yellowish brown sandy loam. pH 5.6

C. 26 inches, compact yellowish gray to gray till. pH 5.8 - 6.0

Occasional stones are found in the B horizons. The soil is well drained and easy to cultivate, but is acid..... The soil contains the average amount of nitrogen, phosphorus and potash found in soils of this type throughout the county".

Chemical and physical analyses of this type of soil are given in Appendix Table I.

Lay-out of the experiment:

Twenty-one treatments and a check were compared in duplicate. The plots were laid down according to a randomized block arrangement. In both fields, each treatment occupied an eight foot wide strip, one in each of the fields mentioned above, right across the field. Only one section of each field was devoted to these plots which were located on land slightly better drained than adjacent areas with a somewhat different flora. The beef cattle used for grazing were not confined to the experimental areas only but had access to the whole of each field. These conditions might be responsible for some of the variations noted in the botanical analysis as a bias might have been introduced in the grazing.

Fertilizer Formulae and Amendment:

The combinations of fertilizers and the lime used as well as their rates per acre and their frequency of applications are shown in Text Table I.

TEXT TABLE I - DESCRIPTION OF FERTILIZER TREATMENTS AND LIME

| Treatment No. | Formulae | Ingredients | | | | When applied |
|---|---|---|---|---|---|---|
| | | Sulphate of ammonia 20% | Superphosphate 20% | Muriate of potash 50% | Ground limestone | |
| | | lb. | lb. | lb. | lb. | |
| 1 | 0-0-0 | 0 | 0 | 0 | 0 | - |
| 2 | 4-0-0 | 120 | 0 | 0 | 0 | Every 3 years |
| 3 | 0-12-6 | 0 | 360 | 75 | 0 | " " " |
| 4 | 0-16-6 | 0 | 480 | 75 | 0 | " " " |
| 5 | 2-12-6 | 60 | 360 | 75 | 0 | " " " |
| 6 | 4-12-6 | 120 | 360 | 75 | 0 | " " " |
| 7 | 8-12-6 | 240 | 360 | 75 | 0 | " " " |
| 8 | 0-12-0 | 0 | 360 | 0 | 0 | " " " |
| 9 | 0-16-0 | 0 | 480 | 0 | 0 | " " " |
| 10 | 4-0-6 | 120 | 0 | 75 | 0 | " " " |
| 11 | 4-6-6 | 120 | 180 | 75 | 0 | " " " |
| 12 | 0-0-6 | 0 | 0 | 75 | 0 | " " " |
| 13 | 4-12-0 | 120 | 360 | 0 | 0 | " " " |
| 14 | 4-12-12 | 120 | 360 | 150 | 0 | " " " |
| 15 | 4-12-6 | 90 | 270 | 54 | 0 | " " " |
| 16 | 4-12-6 | 40 | 120 | 25 | 0 | Annually |
| 17 | 4-12-6 | 120 | 360 | 75 | 0 | N - annually<br>P+K every 3 yea |
| 18 | Ca | 0 | 0 | 0 | 2000 | Every 3 years |
| 19 | Ca | 0 | 0 | 0 | 4000 | " " " |
| 20 | Ca+0-12-0 | 0 | 360 | 0 | 2000 | " " " |
| 21 | Ca+0-12-6 | 0 | 360 | 75 | 2000 | " " " |
| 22 | Ca+4-12-6 | 120 | 360 | 75 | 2000 | " " " |

Rates of application of treatments 2 to 14 inclusive were based on 600 lb. of a 4-12-6 fertilizer mixture applied every three years. Treatment 15 was applied at the rate of 450 lb. every three years, treatment 16 at the rate of 200 lb. annually while in treatment 17, nitrogen was applied annually and minerals every three years.

For brevity, the symbols 1N, 2N and 4N will be used to designate fertilizers containing 2% (2-12-6), 4% (4-12-6) and 8% (8-12-6) nitrogen. The same will apply to phosphorus, potassium and lime: 1P, 2P and 3P will correspond to fertilizers containing 6%, 12% and 16% phosphorus; 1K and 2K to fertilizers containing 6% and 12% potassium; 1Ca and 2Ca will mean an application of one ton and two tons of ground limestone.

The treatments were applied in 1939 and 1942 so as to cover two 3-year periods. The fertilizers and the lime were spread early in the spring as a top dressing without any cultural treatment.

The experiment was drawn up and started before the writer took charge of the work in 1940. The design was set up as factorial with N at 4 levels, P at 4 levels, and K at 3 levels, where no application of each of these elements was considered as one of the levels of application.

In making up all possible combinations with N,P,K, at their respective levels, a total of 48 treatments would have been arrived at. However, in this experiment, only 14 different combinations or formulae were tested. In a number of cases, orthogonality was, therefore, lost since for

nitrogen effect, four formulae were compared against six, for phosphorus effect, four were compared against seven, etc.

The experiment also included rates and frequency of fertilizer application as well as rates of lime application and lime usage in combination with P, PK, and NPK.

The study of so many contributing factors would suggest a more complete design of a different nature or perhaps better a few separate experiments with more replications. A factorial experiment with NPK along with a test on lime or else a factorial experiment with NPK Ca at constant level would allow for better comparisons. And then, a test could be developed where the treatments are used at different levels.

Yields of forage:

The fields were grazed with beef cattle and the yields of herbage were based on clippings from cage protected areas; one cage (one square yard) being placed on each plot and moved to a new location after each cutting. The clippings were done with grass shears and close to the ground. In 1939, three clippings were taken while in 1940, 1941, 1942, 1943, and 1944, the cages were cut four times during each season. The green forage was weighed, sampled and the dry matter determined. Yields are reported in pounds of dry matter per acre.

Botanical analysis:

A survey of the plant population was made each year on the two plots of each treatment. The percentage area method based on visual estimations was used. One reading at two different places was taken on each plot for each year during the month of July.

## IV - METEOROLOGICAL DATA

The data presented in Text Table II on precipitation and in Appendix Tables II, III and IV on temperature were secured from the Meteorological Bureau located at the Experimental Station, Lennoxville, Que., where this experiment was carried on.

TEXT TABLE II - TOTAL PRECIPITATION IN INCHES FOR EACH MONTH DURING THE GROWING SEASON 1939-1944, COMPARED WITH LONG-TIME AVERAGE

| Month | 1939 | 1940 | 1941 | 1942 | 1943 | 1944 | 30-Year average |
|---|---|---|---|---|---|---|---|
| April ..... | 4.14 | 2.83 | 0.97 | 2.93 | 3.65 | 2.66 | 2.80 |
| May ..... | 2.05 | 3.06 | 2.55 | 2.77 | 2.42 | 1.90 | 2.79 |
| June ..... | 6.33 | 4.13 | 3.19 | 7.91 | 9.31 | 3.36 | 4.14 |
| July ..... | 3.97 | 4.91 | 3.90 | 2.94 | 5.55 | 5.39 | 4.24 |
| August ..... | 4.04 | 2.65 | 1.75 | 2.94 | 3.57 | 1.45 | 3.53 |
| September ... | 5.64 | 2.89 | 2.53 | 4.30 | 2.24 | 6.10 | 3.76 |
| October ..... | 3.97 | 2.68 | 3.81 | 4.42 | 4.32 | 2.93 | 3.73 |
| Total ..... | 30.14 | 23.15 | 18.70 | 28.21 | 31.06 | 23.79 | 24.99 |

In the years 1939, 1942 and 1943, high precipitations were recorded. For each of these years, the rainfall was particularly heavy in June. The good moisture conditions reflected themselves on the production of herbage as the greatest yields were secured during these years. The drought that prevailed in 1941, coupled with the fact that the residual effects of fertilizers were low, resulted in the lowest yields of herbage obtained. The rainfall in 1940 and 1944 was about average.

## V - RESULTS AND DISCUSSION

In studying the data presented, in which there are many contributing factors, variations must be expected and allowed for in drawing conclusions. However, it has been possible in this study, by the use of approved methods in botanizing, yield taking, and statistical interpretation, to show the influence of several fertilizers and lime on the yield and botanical composition of a pasture sward on Sherbrooke sandy loam.

### A - Botanical composition

The data showing the percentage ground covered by useful grasses, white clover, miscellaneous plants, bare ground, and moss for each treatment and for each year are given in Appendix Tables V to XI.

The analysis of variance of these data is summarized in Appendix Tables XII to XV.

The percentage ground covered by useful grasses, white clover, miscellaneous plants, bare ground, and moss for the twenty-one treatments is compared with that of the check in a frequency distribution table based on -8 to +8 times the standard error of a difference. Text Table III shows the frequency distribution of the percentage ground covered according to the grouping of the years.

The standard error of a difference found by the analysis of variance of the percentages (the percentages were not transformed into degrees of an angle) covering the six years of the experiment is 2,8 for useful grasses, 2.6 for white clover, 1.2 for miscellaneous plants and 1.0 for bare

ground and moss. Each of the treatments is compared with the check by taking the difference in the percentages between the check and the treatment concerned, as shown in Appendix Table XI, and placed in the correct frequency distribution with class centres 0, + or - 1, + or -2, etc. The 0 class includes all deviations lying from 0 to plus or minus 1.4 for useful grasses, 1.3 for white clover, 0.6 for miscellaneous plants, 0.5 for bare ground and moss, class 1 from 1.5 to 4.2 for useful grasses, 1.4 to 3.9 for white clover, 0.7 to 1.8 for miscellaneous plants, 0.6 to 1.5 for bare ground and moss, class 2 from 4.3 to 7.0 for useful grasses, 4.0 to 6.5 for white clover, 1.9 to 3.0 for miscellaneous plants, 1.6 to 2.5 for bare ground and moss, etc.

The same procedure was followed for both the first and the second period as well as for the years of fertilization and liming and for the first and the second years after. The class centres for each group of plants and for each grouping of the years were established according to the computed standard error of a difference in each case.

The botanical survey showed that the composition of the sward has undergone significant changes as to groups of plants with fertilizing, liming, as well as with seasons. The statistical analysis for the six-year average (Appendix Tables XII to XV) revealed that changes due to treatments and years were highly significant for useful grasses, miscellaneous plants, bare ground, and moss. The variations recorded in the white clover population were highly significant as to treatments but failed to reach significance as to years.

Likewise, the frequency distribution table showed that the treatments gave significant increases in the stand of useful grasses and legumes and significant decreases in the miscellaneous plants, bare ground, and moss over the check. Useful grasses and white clover behaved similarly as to their response to fertilization. Useful grasses have a mean deviation of $1.76 \pm .32$ and white clover $2.09 \pm .34$. The difference between these two groups of plants is $.33 \pm .47$ and the t value observed is .70. There is (21 + 21) - 2 = 40 degrees of freedom involved, and the t value at the 5% point is 2.02. The difference, therefore, between the two groups of plants is not significant. The difference between the useful grasses and the miscellaneous plants is $5.28 \pm .37$. As the t value observed is 14.27 and the t value at the 1% point is 2.70, the difference between these two groups of plants is highly significant. Similarly, the difference between the useful grasses and the bare ground,

and moss, 7.95 ± .46 is highly significant as the t value observed is 17.28 and the t value at the 1% point is 2.70. As a result of fertilization, high significance is also reached when comparing white clover with miscellaneous plants (difference 5.61 ± .39) and with bare ground, and moss (difference 8.28 ± .47). In the former case, the t value observed is 14.38 and in the latter 17.61. As the t value at the 1% point is 2.70, the differences are, therefore, highly significant. There is a significant decrease of bare ground and moss over the miscellaneous plants resulting from fertilizer applications. The difference is 2.67 ± .38. The t value observed is 7.03 and the t value at the 1% point is 2.70 and, therefore, the difference is highly significant.

In both periods, the percentage ground covered by useful grasses and white clover increased while that of miscellaneous plants, bare ground, and moss decreased. Although the useful plants - grasses and white clover - occupied more ground in the second period than during the first one, the increase was not significant. The second period, however, brought a highly significant decrease in the miscellaneous plants when compared with the first one while the bare ground and moss remained at a low level.

White clover recorded its highest percentage ground coverage the years the fertilizers were applied and the first years after, to decline slightly the second years. The trend exhibited by useful grasses shows that they remained more or less constant the years the fertilizers were applied but increased significantly the first years after and continued to

Connecticut has noted that "although its prevalence may vary from season to season, clover is usually most abundant in the first few seasons after clearing or fertilizing". This is in agreement with the results obtained. Dore (1936) in reporting on the grass-clover relationship has pointed out that the differences in the proliferation of grasses and legumes as well as in their ability to spread rapidly can influence the percentage ground covered by these two groups of plants. Also white clover by means of its surface runners is in a better position to utilize the plant nutrients contained in the surface soil than the deeper-rooted grasses and responds quickly to increased fertility. Further, he stated that: "an increase in soil nitrates accompanies the increase of legumes..... The clovers, then, by building up an excess of nitrates in the soil, indirectly tend to modify their environment in such a manner as to make it relatively more ameliorative to grasses than to themselves".

Treatments were highly significant in modifying the flora on this pasture type. Nitrogen, phosphorus, potash and lime were effective in bettering the quality of the sward.

Nitrogen:

Nitrogen produced significant changes in the botanical composition of the sward as summarized in Text Table IV.

TEXT TABLE IV - EFFECT OF NITROGEN ON THE PERCENTAGE GROUND COVERED BY USEFUL GRASSES, WHITE CLOVER, MISCELLANEOUS PLANTS, BARE GROUND, AND MOSS 1939-1944

| Group of plants | Nitrogen plots | No nitrogen plots | Increase or decrease | Least significant difference (P = .05) |
|---|---|---|---|---|
| Useful grasses..... | 60.5 | 54.9 | 5.6 | 2.5 |
| White clover ..... | 22.1 | 23.7 | -1.6 | 2.3 |
| Miscellaneous plants | 10.2 | 11.6 | -1.4 | 1.1 |
| Bare ground and moss | 7.2 | 9.8 | -2.6 | 0.9 |

Nitrogen has increased the grasses significantly while the miscellaneous plants, bare ground, and moss were significantly decreased. The use of nitrogen slightly depressed the percentage ground covered by white clover.

The rates of nitrogen application induced appreciable changes in the ratio of useful grasses to white clover as shown in Text Table V.

TEXT TABLE V - EFFECT OF RATES OF NITROGEN APPLICATION ON THE PERCENTAGE GROUND COVERED BY USEFUL GRASSES, AND WHITE CLOVER 1939-1944

| Group of plants | 1N | 2N | 4N |
|---|---|---|---|
| Useful grasses ..... | 54.7 | 60.3 | 62.9 |
| White clover ..... | 26.9 | 23.8 | 22.1 |

Nitrogen stimulated the grasses to the detriment of white clover. Each increase in the per cent of N encouraged the grasses to occupy more ground while a similar reduction was noticed in the white clover population.

Phosphorus:

Striking improvements in the vegetation resulted from the application of phosphorus as summarized in Text Table VI.

TEXT TABLE VI - EFFECT OF PHOSPHORUS ON THE PERCENTAGE GROUND COVERED BY USEFUL GRASSES, WHITE CLOVER, MISCELLANEOUS PLANTS, BARE GROUND, AND MOSS 1939-1944

| Group of Plants | Phosphorus plots | No phosphorus plots | Increase or decrease | Least significant difference (P= .05) |
|---|---|---|---|---|
| Useful grasses .... | 58.6 | 56.6 | 2.0 | 2.5 |
| White clover ..... | 25.0 | 20.6 | 4.4 | 2.3 |
| Miscellaneous plants | 9.7 | 12.5 | -2.8 | 1.1 |
| Bare ground and moss | 6.7 | 10.3 | -3.6 | 0.9 |

The effect of phosphorus was expressed in a greater occupation of the soil by all useful plants. Phosphorus highly stimulated both the growth and the stand of white clover, reduced the abundance of weeds and made the sward more dense by diminishing the bare ground and moss. Grasses also were more prevalent.

The increases in the rates of phosphorus application (2P plots and 3P plots) brought some changes in the composition of the sward but not significantly so.

Potash:

Potash had a beneficial effect on white clover as indicated in Text Table VII.

TEXT TABLE VII - EFFECT OF POTASH ON THE PERCENTAGE GROUND COVERED BY USEFUL GRASSES, WHITE CLOVER, MISCELLANEOUS PLANTS, BARE GROUND, AND MOSS 1939-1944

| Group of plants | Potash plots | No potash plots | Increase or decrease | Least significant difference (P = .05) |
|---|---|---|---|---|
| Useful grasses ..... | 56.8 | 58.9 | -2.1 | 2.4 |
| White clover ..... | 25.5 | 21.1 | 4.4 | 2.2 |
| Miscellaneous plants | 10.1 | 11.2 | -1.1 | 1.0 |
| Bare ground and moss | 7.6 | 8.8 | -1.2 | 0.8 |

Potassium had a marked influence on white clover. It has increased significantly the percentage ground covered by white clover to the detriment of miscellaneous plants, bare ground, and moss which were decreased significantly. Useful grasses also were depressed but not significantly.

The addition of an extra 6% potassium (2K over 1K) has contributed to accentuate the ratio of useful grasses to white clover as shown in Text Table VIII.

TEXT TABLE VIII - EFFECT OF RATES OF POTASH APPLICATION ON THE PERCENTAGE GROUND COVERED BY USEFUL GRASSES AND WHITE CLOVER 1939-1944

| Group of plants | 1K | 2K |
|---|---|---|
| Useful grasses ..... | 60.3 | 55.5 |
| White clover ..... | 23.8 | 27.4 |

The beneficial effect of potash on white clover is again indicated. The increase in white clover was accompanied by a corresponding decrease in useful grasses.

Lime:

Lime usage produced significant botanical changes as summarized in Text Table IX.

TEXT TABLE IX - EFFECT OF LIME ON THE PERCENTAGE GROUND COVERED BY USEFUL GRASSES, WHITE CLOVER, MISCELLANEOUS PLANTS, BARE GROUND, AND MOSS 1939-1944

| Group of plants | Lime plots | No lime plots | Increase or decrease | Least significant difference (P = .05) |
|---|---|---|---|---|
| Useful grasses .... | 61.6 | 56.7 | 4.9 | 2.6 |
| White clover ..... | 21.9 | 23.5 | -1.6 | 2.4 |
| Miscellaneous plants | 9.0 | 11.0 | -2.0 | 1.2 |
| Bare ground and moss | 7.5 | 8.8 | -1.3 | 1.0 |

Lime markedly improved the grass stand while the miscellaneous plants, the bare ground and moss were significantly depressed. A small reduction was also noted in the white clover.

The rates of lime application induced some changes in the botanical composition of the sward but not significantly so.

The differential response of pasture species to fertilizer treatments is well known. As noted by various workers and as observed during the course of this study, grasses, rather than legumes, are more dependent on nitrogen, the legumes being often depressed by the application of nitrogeneous carriers; results also indicate that minerals strongly stimulated the white clover, reduced the abundance of weeds, the bare ground and moss.

B - Percentage of total yield for year at each cutting date for fertilizer treatments and lime

Dates on which cuttings were made are given for each year as well as average dates for five years (1940-1944) in Text Table X. The year 1939 is not included in the average since three cuttings only were made that year.

TEXT TABLE X - DATES ON WHICH CUTTINGS WERE MADE 1939-1944

| Cutting | 1939 | 1940 | 1941 | 1942 | 1943 | 1944 | Average date 1940-1944 |
|---|---|---|---|---|---|---|---|
| 1st.... | June 21 | June 5 | May 30 | June 2 | June 9 | June 1 | June 3 |
| 2nd.... | Aug. 3 | July 9 | June 29 | July 7 | July 7 | July 6 | July 6 |
| 3rd.... | Sept.29 | Aug. 28 | Aug. 1 | Aug. 8 | Aug. 12 | Aug. 25 | Aug. 15 |
| 4th.... | - | Oct. 3 | Oct.17 | Oct.21 | Sept.30 | Oct. 3 | Oct. 9 |

Data on the percentage of total yield for year at each cutting date for fertilizer treatments and lime are presented in Appendix Table XVI. In this table, the year 1939 is again omitted in the average since three cuttings only were made that year. The distribution of pasturage fluctuated to some extent from season to season, weather conditions being chiefly responsible. For the 5-year average, the yields of herbage of the first three cuttings as shown in Appendix Table XVI did not vary materially. Production from the beginning of the season to mid-August remained fairly constant and this applied to all treatments. The good distribution of the rainfall during the summer months tended to maintain a high

grass production up to mid-August. From mid-August to the end of the season, a rapid decrease was noted as indicated by the fourth cutting. It is possible that heavier applications than the ones used (600 lb. every three years) would have tended to extend the production over a longer period and provide good grazing for approximately another month.

Text Table XI summarizes the average percentage of total yield (1940-1944) for each cutting as influenced by nitrogen, phosphorus, potash and lime.

TEXT TABLE XI - AVERAGE PERCENTAGE OF TOTAL YIELD FOR EACH CUTTING AS INFLUENCED BY NITROGEN, PHOSPHORUS, POTASH AND LIME 1940-1944

| Treatment | 1st cutting | 2nd cutting | 3rd cutting | 4th cutting |
|---|---|---|---|---|
| Nitrogen plots | 27.4 | 29.8 | 29.7 | 13.1 |
| No nitrogen plots | 27.0 | 31.8 | 29.4 | 11.8 |
| Phosphorus plots | 28.0 | 29.4 | 29.1 | 13.5 |
| No phosphorus plots | 28.4 | 30.1 | 29.1 | 12.4 |
| Potash plots | 27.9 | 30.4 | 27.7 | 14.0 |
| No potash plots | 28.4 | 29.5 | 29.4 | 12.7 |
| Lime plots | 28.3 | 30.1 | 28.7 | 12.9 |
| No lime plots | 26.3 | 31.5 | 29.2 | 13.0 |

The three fertilizing elements, N, P, K, and the lime behaved similarly as to the seasonal distribution of herbage. All treatments maintained a uniform production till late summer as shown by the first three cuttings to decline rapidly for the rest of the season.

Various workers, Robinson and Pierre (1942), Noll et al (1944) reported that spring applications of nitrogen greatly increased the yields of pasture in the early part of the season. Gardner et al (1935) mentioned that the carrying

capacity for grazing cattle on the plots receiving nitrogen was very high during the flush of the season and relatively low in late summer and fall. They also stated that the plots receiving mineral fertilizers, without nitrogen, have given a more even distribution of grass for grazing through the season than the plots receiving nitrogen.

Very little support can be given to these statements in regard to the results obtained under the conditions of the present experiment as the fertilizers containing nitrogen and those containing no nitrogen followed a similar trend in respect to seasonal distribution of pasturage.

Sprague et al (1934) who studied the relation of pasture yields to weather conditions found that an even distribution of rainfall during one of the years of their study had permitted relatively uniform production of feed throughout the season for that year. Brown (1933) in reporting on the influence of fertilizers on the total and seasonal production of pasture pointed out that: "differences in fertilizing had little effect in changing the seasonal distribution of feed".

The results obtained in New Jersey and in Connecticut substantiate those observed under the conditions of this experiment. Regardless of the fertilization, the distribution of herbage production tended to be uniform from the beginning of the season to late summer.

C - Yields of dry matter

Data on the yields of dry matter per acre for each treatment and for each year are given in Appendix Table XVII.

The analysis of variance of these data is presented in Appendix Table XVIII.

The yields of dry matter for the twenty-one treatments are compared with that of the check in a frequency distribution table based on - 7 to + 7 times the standard error of a difference. Text Table XII shows the frequency distribution of the yields of dry matter according to the grouping of the years.

The standard error of a difference found by the analysis of variance of the data covering the six years of the experiment is 303.3 pounds. Each of the treatments is compared with the check by taking the difference in yields between the check and the treatment concerned, as shown in Appendix Table XVII, and placed in the correct frequency distribution with class centres 0, + or - 1, + or - 2, etc. The 0 class includes all deviations lying from 0 to plus or minus 151.6, class 1 from 151.7 to 454.9, class 2 from 455.0 to 758.2, etc.

The computed standard error of a difference for the first and the second period is 428.9 pounds. The 0 class contains all deviations lying from 0 to plus or minus 214.4, class 1 from 214.5 to 643.3, class 2 from 643.4 to 1072.2, etc.

The computed standard error of a difference for the years of fertilization and liming and for the first and the second years after is 525.4 pounds. The 0 class contains all deviations lying from 0 to plus or minus 262.7, class 1 from 262.8 to 787.1, class 2 from 787.2 to 1313.5 etc.

TEXT TABLE XII - FREQUENCY DISTRIBUTION OF THE YIELDS OF DRY MATTER AS INFLUENCED BY FERTILIZER TREATMENTS AND LIME WHEN COMPARED WITH THE CHECK

| Grouping of the years | Class centres of plus and minus 1 to 7 times the standard error of a difference | | | | | | | | | | | | | | | Total | Mean clas |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | -7 | -6 | -5 | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | |
| 6-Year average 1939-1944 | | | | | | | | | 3 | 2 | 8 | 1 | 6 | | 1 | 21 | 3.43 ± .35 |
| 1st period 1939-1941 | | | | | | | 2 | 4 | 6 | 6 | 2 | 1 | | | | 21 | 1.24 ± .28 |
| 2nd period 1942-1944 | | | | | | | | | 3 | 1 | 4 | 6 | 6 | 1 | | 21 | 3.67 ± .42 |
| Years of fertilization and liming 1939 and 1942 | | | | | | | | 1 | 3 | 6 | 3 | 6 | 1 | | 1 | 21 | 2.85 ± .35 |
| 1st Years after fertilization and liming 1940 and 1943 | | | | | | | | 4 | 6 | 5 | 6 | | | | | 21 | 1.62 ± .24 |
| 2nd Years after fertilization and liming 1941 and 1944 | | | | | | | | | 5 | 14 | 2 | | | | | 21 | 1.85 ± .13 |

The difference between the first and the second years after fertilization and liming is .23 ± .27. As the t value observed is .85 and the t value at the 5% point for 40 degrees of freedom is 2.02, there is no significant difference between the two groups of years.

In breaking up the effects of the fertilizer treatments and lime, it has been possible to study the influence of nitrogen, phosphorus, potash, and lime as well as their interactions on the yields of dry matter.

Nitrogen:

Text Table XIII summarizes the effect of nitrogen on the yields of dry matter obtained.

TEXT TABLE XIII - EFFECT OF NITROGEN ON THE YIELDS OF DRY MATTER

| Grouping of the years | Mean yields in pounds per acre | | Increase | Least significant difference (P =.05) |
|---|---|---|---|---|
| | Nitrogen plots | No nitrogen plots | | |
| 6-Year average 1939-1944 | 4,989.8 | 4,529.4 | 460.4 | 271.4 |
| 1st period 1939-1941 | 4,554.8 | 4,156.4 | 398.4 | 383.8 |
| 2nd period 1942-1944 | 5,424.8 | 4,902.5 | 522.3 | 383.8 |
| Years of fertilization 1939 and 1942 | 5,545.8 | 4,516.3 | 1,029.5 | 664.8 |
| First years after fertilization 1940 and 1943 | 5,124.3 | 5,051.7 | 72.6 | 664.8 |
| Second years after fertilization 1941 and 1944 | 4,299.2 | 4,020.2 | 279.0 | 664.8 |

Nitrogen gave a significant increase over the 6-year average. In both periods, the nitrogen effect was significant. This element proved to be highly beneficial the years it was applied. In the remaining years, benefits from N were almost negligible.

The application of nitrogen at different levels has shown the effectiveness of this element in increasing the yields as indicated in Text Table XIV.

TEXT TABLE XIV - EFFECT OF RATES OF NITROGEN APPLICATION ON THE YIELDS OF DRY MATTER 1939-1944

| Rate of nitrogen | Mean yields in pounds per acre |
|---|---|
| 1N | 4,961.0 |
| 2N | 5,420.8 |
| 4N | 5,900.8 |

The use of nitrogen has stimulated the production of herbage on this soil type. Each increase in the rates of nitrogen has brought an increase in the yields of dry matter.

Phosphorus:

Phosphorus was one element most needed on this soil type as shown in Text Table XV.

TEXT TABLE XV - EFFECT OF PHOSPHORUS ON THE YIELDS OF DRY MATTER

| Grouping of the years | Mean yields in pounds per acre | | Increase | Least significant difference (P = .05) |
|---|---|---|---|---|
| | Phosphorus plots | No phosphorus plots | | |
| 6-Year average 1939-1944 | 5,189.1 | 4,129.1 | 1,060.0 | 263.5 |
| 1st period 1939-1941 | 4,601.3 | 4,041.4 | 559.9 | 372.7 |
| 2nd period 1942-1944 | 5,776.9 | 4,216.9 | 1,560.0 | 372.7 |
| Years of fertilization 1939 and 1942 | 5,597.1 | 4,195.7 | 1,401.4 | 456.4 |
| 1st Years after fertilization 1940 and 1943 | 5,643.7 | 4,398.3 | 1,245.4 | 456.4 |
| 2nd Years after fertilization 1941 and 1944 | 4,326.4 | 3,793.3 | 533.1 | 456.4 |

The application of phosphorus resulted in highly significant increased yields over the 6-year average. Both periods were highly significant. These increased yields which were still more striking during the second period of the study than during the first one indicated cumulative effect of phosphorus. The years the P carriers were applied and the first years after proved to be highly signficant while the second years reached significance.

The increases in the rates of phosphorus application brought further increases in the production of herbage as illustrated in Text Table XVI.

TEXT TABLE XVI - EFFECT OF RATES OF PHOSPHORUS APPLICATION ON THE YIELDS OF DRY MATTER 1939-1944

| Rate of phosphorus | Mean yields in pounds per acre |
|---|---|
| 1P | 4,864.2 |
| 2P | 5,420.8 |
| 2P | 4,961.0 |
| 3P | 5,390.5 |

The design of the experiment did not allow a direct comparison between the 1P and the 3P plots. In the first comparison, 1P vs 2P, phosphorus was tested in presence of N and K while in the second, 2P vs 3P, phosphorus was used alone and also in association with K.

The importance of phosphorus was clearly indicated. Increased yields resulted from increases in the rates of application of this element.

Potash:

Potash proved to be the least essential element in the improvement of pasture production as summarized in Text Table XVII.

TEXT TABLE XVII - EFFECT OF POTASH ON THE YIELDS OF DRY MATTER 1939-1944

| Treatment | Mean yields in pounds per acre |
|---|---|
| Potash plots ..... | 4,807.0 |
| No Potash plots ..... | 4,793.9 |
| Increase ..... | 13.1 (not significant) |

The influence of potash on the yields of dry matter was almost nil. If K failed to give good returns, it has, however, given rise to a better sward which was more densely carpeted with white clover while the weeds, the bare ground, and moss have decreased. Wrenshall and Marcello (1941) in studies relative to potash fertilization carried in the Eastern Townships of Quebec on Hatley sandy loam found that: "Potassium increased (significantly) the clover in the sward....." Frankton (1940) who analyzed the yield data for the same experiment reported that the effect of potash was not significant. Their results are similar to those obtained in this study.

Text Table XVIII shows that the addition of an extra 6% K reduced the yields.

TEXT TABLE XVIII - EFFECT OF RATES OF POTASH APPLICATION ON THE YIELDS OF DRY MATTER 1939-1944

| Rate of potash | Mean yields in pounds per acre |
|---|---|
| 1K | 5,420.8 |
| 2K | 4,836.0 |

Heavy application of potash resulted in decreased yields. This is in agreement with the findings of Midgley and Wieser (1936) working in Vermont who reported that larger applications of potash salts than 75 to 100 lb. of muriate often decreased the yields.

**Lime:**

Plots receiving ground limestone gave no significantly larger yields than the unlimed plots as shown in Text Table XIX.

TEXT TABLE XIX - EFFECT OF LIME ON THE YIELDS OF DRY MATTER 1939 - 1944

| Treatment | Mean yields in pounds per acre |
|---|---|
| Lime plots ..... | 4,970.5 |
| No lime plots ..... | 4,814.8 |
| Increase ..... | 155.7 (not significant) |

Lime gave little increases in pasturage. Likewise the 2Ca plots outyielded the 1Ca plots by a small margin only as summarized in Test Table XX.

TEXT TABLE XX - EFFECT OF RATES OF LIME ON THE YIELDS OF DRY MATTER 1939 - 1944

| Rate of lime | Mean yields in pounds per acre |
|---|---|
| 1Ca | 4,439.8 |
| 2Ca | 4,594.0 |

The additional dose of limestone produced but small increases.

Interactions:

None of the interactions NP, NK, PK, NPK, CaP, CaPK, and CaNPK brought significant changes in the production of this type of pasture over the 6-year average.

Rates of application of a 4-12-6 fertilizer:

A heavy application of a complete fertilizer out-yielded a medium application of the same fertilizer as illustrated in Text Table XXI.

TEXT TABLE XXI - EFFECT OF RATES OF APPLICATION OF A 4-12-6 FERTILIZER APPLIED EVERY THREE YEARS ON THE YIELDS OF DRY MATTER 1939-1944

| Rate of application | Mean yields in pounds per acre | Least significant difference (P=.05) |
|---|---|---|
| 600 lb. ..... | 5,420.8 | |
| 450 lb. ..... | 4,735.1 | |
| Increase ..... | 685.7 | 594.6 |

A significantly better response for a 6-year average was obtained from a triennial application of 600 lb. than from 450 lb. of a 4-12-6 fertilizer. The replenishing of plant nutrients made in 1942 reacted significantly in increasing the production during the second period. The higher application also provided for a greater occupation of the ground in increasing the grasses at the expense of the bare ground and moss.

Frequency of application of a 4-12-6 fertilizer:

A triennial application of 600 lb. of 4-12-6 compared favourably with an annual application of 200 lb. of the same fertilizer as shown in Text Table XXII.

TEXT TABLE XXII - EFFECT OF FREQUENCY OF APPLICATION OF A 4-12-6 FERTILIZER ON THE YIELDS OF DRY MATTER 1939-1944

| Treatment | Mean yields in pounds per acre |
|---|---|
| 600 lb. every 3 years | 5,420.8 |
| 200 lb. annually .... | 4,965.0 |
| Increase ..... | 455.8 (not significant) |

Although the difference in yields was not large enough to be significant, the results indicated that slightly higher yields can be expected from heavy periodical application than from lighter annual one. Baker and Mayton (1944) reported similar results with superphosphate. Brown and Munsell (1943) found that the ten-year average production for their annually and triennially phosphated pastures was practically the same.

The lighter annual application favoured the white clover to the detriment of the grasses without modifying the weed population. As the fertilizer was top-dressed and as the white clover has a shallow root system, this legume had a better opportunity to absorb the nutrients before they reacted with the soil components and became less available.

Frequency and rate of nitrogen application:

Text Table XXIII summarizes the effect of frequency and rate of nitrogen application in combination with minerals on the yields of dry matter.

TEXT TABLE XXIII - EFFECT OF FREQUENCY AND RATE OF NITROGEN APPLICATION IN COMBINATION WITH MINERALS ON THE YIELDS OF DRY MATTER 1939-1944

| Treatment | Mean yields in pounds per acre |
|---|---|
| N every 3 years ..... | 5,420.8 |
| N annually ..... | 5,336.1 |
| Increase ..... | 84.7 (not significant) |

An annual application of N along with minerals applied every three years failed to increase the production of herbage over a triennial application of the same element associated with minerals over a 6-year average. During the first period, the annual application of N was of some benefit but decreased the yields appreciably during the second period. For the duration of the experiment, the extra dose of N induced little changes in the character of the vegetation with the exception of the weeds which have declined significantly.

## VI - SUMMARY AND CONCLUSIONS

The results obtained from a fertilizer experiment on pasture conducted at the Experimental Station, Lennoxville, Que., covering a six-year period are summarized as follows:

A - Botanical composition.

1. - Wide variations occurred in the percentage ground covered by different groups of plants as influenced by fertilization and seasons.

2. - White clover recorded its highest percentage ground coverage the years the fertilizers were applied and the first years after. The useful grasses increased the first years after fertilization and remained high the second years. Miscellaneous plants decreased significantly the first years after fertilization and continued to decline the second years. Bare ground and moss were considerably reduced the years the fertilizers were applied, a further decrease was noted the first years after fertilization but bare ground and moss tended to rise the second years after although they remained at a low level.

3. - Nitrogen resulted in an increase of useful grasses and a decrease in miscellaneous plants, bare ground, and moss. White clover was also slightly depressed.

4. - Phosphorus provided for a greater occupation of the ground; it highly stimulated the white clover, favored the useful grasses, reduced the abundance of weeds and lowered the area occupied by bare ground and moss.

5. - Potassium effect was largely expressed by a stand more densely carpeted with white clover. Miscellaneous plants, bare ground, and moss were also decreased. Useful grasses were slightly depressed.

6. - Lime usage markedly improved the grass stand at the expense of the weeds, bare ground and moss. A decrease was also noted in the white clover.

B - Distribution of herbage production.

1. - Fluctuations in the seasonal distribution of pasture herbage were noted from season to season.

2. - Differences in fertilizer treatments did not modify materially the seasonal distribution of the herbage production.

C - Yields of dry matter.

1. - Nitrogen significantly increased the yields of dry matter. The highest production was obtained with the heaviest rate of nitrogen application.

2. - Phosphorus was one element most needed on this soil type, and wherever applied resulted in highly significant increased yields.
3. - Potassium effect was nil.
4. - The use of lime failed to show any significance in increasing dry matter yields.
5. - Heavy application of a complete fertilizer out-yielded a medium application of the same fertilizer over a six-year period.
6. - Heavy triennial application of a complete fertilizer compared favourably with annual light application of the same fertilizer.
7. - An annual application of N was ineffective in increasing the production over a triennial application of the same element when used with minerals applied every three years.

## VII - ACKNOWLEDGMENTS

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APPENDIX TABLE I - CHEMICAL AND PHYSICAL ANALYSES OF A SHERBROOKE SANDY LOAM *

| Sample | % Moisture | % Loss on ignition | pH | % Nitrogen | % Total $P_2O_5$ | p.p.m. Avail. $P_2O_5$ | % Total $K_2O$ | p.p.m. Avail. $K_2O$ | Lb. per acre. Lime required |
|---|---|---|---|---|---|---|---|---|---|
| $5A_1$ | 3.98 | 11.77 | 5.20 | 0.33 | 0.25 | 10.70 | 0.94 | 80.0 | 13680 |
| $5A_2$ | 2.34 | 1.04 | 5.20 | 0.41 | 0.24 | 6.20 | 0.83 | 35.0 | 13680 |
| $5B_1$ | 4.43 | 10.32 | 5.60 | 0.19 | 0.24 | 4.58 | 1.10 | 15.0 | 10040 |
| $5B_2$ | 2.10 | 4.30 | 5.80 | 0.11 | 0.25 | 7.36 | 1.20 | 19.0 | 2880 |
| 5C | 0.40 | 0.85 | 6.00 | 0.10 | 0.26 | 9.50 | 1.23 | 11.0 | ..... |

| Sample | % Total $SiO_2$ | % $Al_2O_3$+ $Fe_2O_3$+ $Ti_2O_3$ | % CaO | % MgO | % Gravel | % Sand | % Silt | % Clay |
|---|---|---|---|---|---|---|---|---|
| $5A_1$ | 70.70 | 13.65 | 0.48 | 1.07 | 13.0 | 42.0 | 37.4 | 7.6 |
| $5A_2$ | 75.60 | 9.33 | 0.44 | 0.90 | 41.0 | 40.8 | 38.4 | 9.8 |
| $5B_1$ | 70.40 | 20.36 | 0.50 | 1.04 | 27.0 | 30.0 | 36.0 | 7.0 |
| $5B_2$ | 76.00 | 24.85 | 0.55 | 1.33 | 30.0 | 35.6 | 27.4 | 7.0 |
| 5C | 81.60 | 17.16 | 0.70 | 1.06 | 22.0 | 54.4 | 19.4 | 4.2 |

* - Calculated on oven dry basis.

APPENDIX TABLE II - MEAN TEMPERATURE IN DEGREES FAHRENHEIT FOR EACH MONTH DURING THE GROWING SEASON, 1939-1944, COMPARED WITH LONG-TIME AVERAGE

| Month | 1939 | 1940 | 1941 | 1942 | 1943 | 1944 | 30-Year average |
|---|---|---|---|---|---|---|---|
| April ..... | 35.03 | 36.46 | 44.19 | 40.88 | 33.27 | 35.60 | 39.39 |
| May ..... | 51.97 | 54.98 | 52.59 | 57.57 | 51.14 | 56.85 | 51.83 |
| June ..... | 60.97 | 60.90 | 63.18. | 62.96 | 62.47 | 62.26 | 61.36 |
| July ..... | 66.80 | 66.65 | 67.92 | 66.02 | 66.11 | 67.21 | 66.38 |
| August ..... | 68.10 | 63.47 | 61.15 | 63.25 | 63.49 | 67.73 | 64.08 |
| September ..... | 55.33 | 55.83 | 56.93 | 56.47 | 53.98 | 57.96 | 56.15 |
| October ..... | 44.13 | 41.32 | 43.46 | 46.16 | 45.40 | 44.04 | 45.04 |
| Average ..... | 54.62 | 54.23 | 55.63 | 56.19 | 53.69 | 55.95 | 54.89 |

APPENDIX TABLE III - MEAN MAXIMUM TEMPERATURE IN DEGREES FAHRENHEIT FOR EACH MONTH DURING THE GROWING SEASON, 1939-1944, COMPARED WITH LONG-TIME AVERAGE.

| Month | 1939 | 1940 | 1941 | 1942 | 1943 | 1944 | 30-Year average |
|---|---|---|---|---|---|---|---|
| April ..... | 43.80 | 46.27 | 58.27 | 52.70 | 43.73 | 46.17 | 50.01 |
| May ..... | 65.39 | 66.90 | 66.13 | 69.65 | 63.52 | 71.55 | 64.37 |
| June ..... | 72.93 | 71.77 | 76.63 | 74.60 | 74.10 | 73.93 | 73.48 |
| July ..... | 78.29 | 78.61 | 79.87 | 77.10 | 78.42 | 79.58 | 78.33 |
| August ..... | 81.03 | 77.00 | 74.06 | 75.42 | 74.06 | 81.55 | 76.58 |
| September ..... | 66.97 | 66.30 | 70.93 | 69.53 | 66.93 | 69.23 | 68.20 |
| October ..... | 54.77 | 52.23 | 52.39 | 59.81 | 56.71 | 55.06 | 56.01 |
| Average ..... | 66.17 | 65.58 | 68.32 | 68.40 | 65.35 | 68.15 | 66.71 |

APPENDIX TABLE IV - MEAN MINIMUM TEMPERATURE IN DEGREES FAHRENHEIT FOR EACH MONTH DURING THE GROWING SEASON, 1939-1944, COMPARED WITH LONG-TIME AVERAGE

| Month | 1939 | 1940 | 1941 | 1942 | 1943 | 1944 | 30-Year average |
|---|---|---|---|---|---|---|---|
| April ..... | 26.27 | 26.93 | 31.13 | 31.00 | 23.50 | 25.67 | 28.91 |
| May ..... | 38.55 | 42.48 | 37.77 | 46.03 | 38.90 | 41.45 | 39.23 |
| June ..... | 49.00 | 50.03 | 49.50 | 51.03 | 50.33 | 49.93 | 49.18 |
| July ..... | 55.32 | 55.19 | 54.94 | 54.42 | 54.03 | 54.06 | 54.38 |
| August ..... | 55.16 | 50.48 | 48.84 | 51.71 | 53.29 | 53.71 | 51.65 |
| September ..... | 43.70 | 45.80 | 44.10 | 44.20 | 42.30 | 47.50 | 44.24 |
| October ..... | 34.94 | 32.19 | 34.19 | 34.16 | 36.03 | 34.10 | 34.32 |
| Average..... | 43.27 | 43.30 | 42.92 | 44.65 | 42.62 | 43.77 | 43.13 |

APPENDIX TABLE V - PERCENTAGE GROUND COVERED BY USEFUL GRASSES, WHITE CLOVER, MISCELLANEOUS PLANTS, BARE GROUND, AND MOSS FOR THE YEAR 1939 AS INFLUENCED BY FERTILIZER TREATMENTS AND LIME

| Treatment No. | Useful Grasses | | | | | | White Clover | Miscellaneous Plants | Bare and M |
|---|---|---|---|---|---|---|---|---|---|
| | Timothy | Ky. Blue-grass | Red Top | Brown Top | * Others | Total | | | |
| 1 | 1.0 | 23.8 | 19.2 | 17.7 | 0.0 | 61.7 | 19.0 | 6.0 | 13.3 |
| 2 | 3.0 | 27.0 | 26.0 | 5.5 | 0.0 | 61.5 | 14.0 | 13.5 | 11.0 |
| 3 | 5.8 | 20.0 | 15.5 | 5.7 | 0.2 | 47.2 | 35.8 | 7.3 | 9.7 |
| 4 | 4.0 | 45.0 | 11.5 | 1.5 | 0.0 | 62.0 | 26.0 | 4.0 | 8.0 |
| 5 | 4.8 | 21.5 | 14.2 | 13.7 | 0.0 | 54.2 | 22.3 | 14.5 | 9.0 |
| 6 | 6.5 | 25.7 | 16.2 | 7.6 | 0.5 | 56.5 | 23.9 | 11.6 | 8.0 |
| 7 | 4.8 | 25.3 | 11.7 | 8.5 | 2.0 | 52.3 | 26.5 | 10.2 | 11.0 |
| 8 | 9.3 | 26.0 | 17.3 | 4.2 | 0.0 | 56.8 | 19.5 | 11.0 | 12.7 |
| 9 | 7.0 | 33.0 | 17.5 | 1.0 | 0.0 | 58.5 | 24.0 | 6.0 | 11.5 |
| 10 | 2.3 | 19.5 | 32.5 | 8.2 | 2.5 | 65.0 | 16.3 | 9.2 | 9.5 |
| 11 | 2.5 | 31.2 | 16.0 | 1.5 | 0.0 | 51.2 | 30.3 | 11.0 | 7.5 |
| 12 | 2.0 | 17.5 | 20.0 | 10.5 | 0.0 | 50.0 | 30.5 | 7.5 | 12.0 |
| 13 | 4.5 | 41.6 | 25.8 | 0.0 | 0.0 | 71.9 | 11.0 | 9.1 | 8.0 |
| 14 | 2.8 | 22.0 | 14.2 | 5.0 | 0.0 | 44.0 | 41.1 | 8.6 | 6.3 |
| 15 | 5.4 | 17.0 | 20.8 | 18.7 | 0.0 | 61.9 | 17.2 | 9.4 | 11.5 |
| 16 | 9.8 | 14.5 | 23.9 | 3.7 | 0.0 | 51.9 | 28.3 | 10.2 | 9.6 |
| 17 | 6.3 | 20.5 | 20.0 | 2.3 | 0.0 | 49.1 | 31.3 | 10.9 | 8.7 |
| 18 | 6.0 | 15.0 | 27.1 | 11.0 | 2.0 | 61.1 | 15.9 | 7.8 | 15.2 |
| 19 | 4.5 | 17.5 | 30.0 | 7.5 | 0.0 | 59.5 | 20.8 | 8.0 | 11.7 |
| 20 | 6.7 | 26.3 | 15.5 | 7.0 | 0.0 | 55.5 | 29.0 | 7.8 | 7.7 |
| 21 | 4.0 | 35.3 | 19.5 | 0.0 | 0.2 | 59.0 | 21.3 | 9.2 | 10.5 |
| 22 | 6.8 | 22.8 | 19.2 | 9.5 | 0.0 | 58.3 | 25.0 | 10.2 | 6.5 |

* Others: - Annual Bluegrass, Red Fescue, Orchard Grass.

APPENDIX TABLE VI - PERCENTAGE GROUND COVERED BY USEFUL GRASSES, WHITE CLOVER, MISCELLANEOUS PLANTS, BARE GROUND, AND MOSS FOR THE YEAR 1940 AS INFLUENCED BY FERTILIZER TREATMENTS AND LIME

| Treatment No. | Useful Grasses | | | | | | White Clover | Miscellaneous Plants | Bare Ground and Moss |
|---|---|---|---|---|---|---|---|---|---|
| | Timothy | Ky. Bluegrass | Red Top | Brown Top | * Others | Total | | | |
| 1 | 5.5 | 15.5 | 27.0 | 5.0 | 1.5 | 54.5 | 18.5 | 11.0 | 16.0 |
| 2 | 6.5 | 22.0 | 25.5 | 7.0 | 1.0 | 62.0 | 24.0 | 7.5 | 6.5 |
| 3 | 7.0 | 21.5 | 13.5 | 10.5 | 0.0 | 52.5 | 22.5 | 11.0 | 14.0 |
| 4 | 10.5 | 30.0 | 21.0 | 0.0 | 1.5 | 63.0 | 27.5 | 5.5 | 4.0 |
| 5 | 5.5 | 27.5 | 16.0 | 4.0 | 0.0 | 53.0 | 28.5 | 11.0 | 7.5 |
| 6 | 14.0 | 29.0 | 18.0 | 2.0 | 0.5 | 63.5 | 20.5 | 11.0 | 5.0 |
| 7 | 10.5 | 19.0 | 25.0 | 9.5 | 2.0 | 66.0 | 21.0 | 5.5 | 7.5 |
| 8 | 9.0 | 20.0 | 24.5 | 2.5 | 1.0 | 57.0 | 28.5 | 8.5 | 6.0 |
| 9 | 10.0 | 34.5 | 24.0 | 0.0 | 1.5 | 70.0 | 18.5 | 5.5 | 6.0 |
| 10 | 8.0 | 24.0 | 23.5 | 9.0 | 0.5 | 65.0 | 20.5 | 10.5 | 4.0 |
| 11 | 6.0 | 30.5 | 21.5 | 5.5 | 0.5 | 64.0 | 22.0 | 10.5 | 3.5 |
| 12 | 6.0 | 19.5 | 25.0 | 7.5 | 0.0 | 58.0 | 27.0 | 8.5 | 6.5 |
| 13 | 13.0 | 24.5 | 18.5 | 8.0 | 0.5 | 64.5 | 22.5 | 7.0 | 6.0 |
| 14 | 8.5 | 26.0 | 14.0 | 8.0 | 1.5 | 58.0 | 27.5 | 7.5 | 7.0 |
| 15 | 11.0 | 25.5 | 2.5 | 14.0 | 4.0 | 57.0 | 21.5 | 10.5 | 11.0 |
| 16 | 7.0 | 19.0 | 21.5 | 0.5 | 2.0 | 50.0 | 31.5 | 10.0 | 8.5 |
| 17 | 9.0 | 32.0 | 22.0 | 3.0 | 1.0 | 67.0 | 22.5 | 5.0 | 5.5 |
| 18 | 10.0 | 21.0 | 22.0 | 16.0 | 0.0 | 69.0 | 13.0 | 11.0 | 7.0 |
| 19 | 5.0 | 28.5 | 28.0 | 6.0 | 2.5 | 70.0 | 13.5 | 6.5 | 10.0 |
| 20 | 12.0 | 28.0 | 17.5 | 5.0 | 0.5 | 63.0 | 21.5 | 9.5 | 6.0 |
| 21 | 8.5 | 30.5 | 21.5 | 1.5 | 1.0 | 63.0 | 27.5 | 6.5 | 3.0 |
| 22 | 8.0 | 28.5 | 19.0 | 8.0 | 0.5 | 64.0 | 23.5 | 5.5 | 7.0 |

* Others: - Annual Bluegrass, Red Fescue, Orchard Grass.

APPENDIX TABLE VII - PERCENTAGE GROUND COVERED BY USEFUL GRASSES, WHITE CLOVER, MISCELLANEOUS PLANTS, BARE GROUND, AND MOSS FOR THE YEAR 1941 AS INFLUENCED BY FERTILIZER TREATMENTS AND LIME

| eatment No. | Useful Grasses | | | | | | White Clover | Miscellaneous Plants | Bare an... |
|---|---|---|---|---|---|---|---|---|---|
| | Timothy | Ky. Blue-grass | Red Top | Brown Top | * Others | Total | | | |
| 1 | 7.0 | 20.7 | 18.0 | 5.2 | 0.0 | 50.9 | 17.6 | 20.7 | 10.8 |
| 2 | 7.8 | 31.5 | 23.5 | 3.0 | 1.7 | 67.5 | 14.9 | 10.6 | 7.0 |
| 3 | 6.2 | 26.1 | 19.0 | 6.5 | 1.5 | 59.3 | 23.5 | 13.2 | 4.0 |
| 4 | 6.8 | 40.5 | 10.2 | 0.0 | 1.3 | 58.8 | 28.1 | 9.2 | 3.9 |
| 5 | 8.2 | 25.0 | 11.8 | 8.0 | 3.6 | 56.6 | 29.0 | 11.4 | 3.0 |
| 6 | 8.8 | 36.2 | 17.7 | 0.8 | 1.3 | 64.8 | 18.8 | 11.4 | 5.0 |
| 7 | 8.1 | 33.5 | 25.3 | 1.9 | 2.3 | 71.1 | 16.2 | 8.7 | 4.0 |
| 8 | 8.2 | 33.2 | 15.2 | 1.3 | 2.5 | 60.4 | 21.8 | 13.5 | 4.3 |
| 9 | 10.3 | 29.8 | 10.5 | 1.5 | 0.0 | 52.1 | 31.9 | 12.0 | 4.0 |
| 10 | 6.2 | 25.3 | 16.2 | 6.0 | 1.6 | 55.3 | 21.1 | 15.9 | 7.7 |
| 11 | 6.0 | 27.8 | 16.5 | 3.7 | 0.3 | 54.3 | 22.5 | 16.7 | 6.5 |
| 12 | 6.0 | 27.0 | 15.6 | 6.8 | 0.5 | 55.9 | 20.0 | 16.4 | 7.7 |
| 13 | 10.2 | 34.5 | 12.6 | 1.3 | 0.3 | 58.9 | 25.8 | 10.8 | 4.5 |
| 14 | 8.2 | 25.0 | 12.1 | 6.3 | 1.5 | 53.1 | 29.5 | 13.9 | 3.5 |
| 15 | 7.7 | 28.2 | 18.3 | 1.5 | 0.0 | 55.7 | 26.3 | 12.5 | 5.5 |
| 16 | 6.0 | 24.8 | 9.7 | 2.7 | 0.4 | 43.6 | 36.8 | 14.3 | 5.3 |
| 17 | 8.7 | 33.6 | 14.0 | 8.0 | 0.0 | 64.3 | 20.3 | 12.4 | 3.0 |
| 18 | 9.0 | 32.3 | 18.5 | 9.2 | 1.5 | 70.5 | 12.7 | 12.1 | 4.7 |
| 19 | 8.0 | 30.2 | 19.4 | 3.0 | 2.8 | 63.4 | 19.0 | 11.6 | 6.0 |
| 20 | 7.3 | 35.2 | 10.5 | 5.0 | 0.3 | 58.3 | 30.5 | 8.5 | 2.7 |
| 21 | 6.0 | 35.7 | 19.0 | 0.0 | 0.0 | 60.7 | 25.8 | 10.0 | 3.5 |
| 22 | 7.4 | 35.7 | 15.7 | 3.5 | 0.3 | 62.6 | 24.2 | 10.9 | 2.3 |

* Others: - Annual Bluegrass, Canada Bluegrass, Meadow Fescue, Red Fescue, Orchard Grass.

APPENDIX TABLE VIII - PERCENTAGE GROUND COVERED BY USEFUL GRASSES, WHITE CLOVER, MISCELLANEOUS PLANTS, BARE GROUND, AND MOSS FOR THE YEAR 1942 AS INFLUENCED BY FERTILIZER TREATMENTS AND LIME

| Treatment No. | Useful Grasses | | | | | | White Clover | Miscellaneous Plants | Bare and Moss |
|---|---|---|---|---|---|---|---|---|---|
| | Timothy | Ky. Bluegrass | Red Top | Brown Top | * Others | Total | | | |
| 1 | 4.5 | 31.0 | 10.5 | 7.5 | 0.0 | 53.5 | 19.0 | 15.0 | 12.5 |
| 2 | 5.5 | 29.2 | 12.0 | 5.5 | 0.8 | 53.0 | 23.0 | 14.0 | 10.0 |
| 3 | 5.0 | 24.8 | 8.5 | 15.5 | 0.0 | 53.8 | 31.2 | 9.3 | 5.7 |
| 4 | 6.5 | 34.7 | 7.0 | 0.0 | 1.5 | 49.7 | 38.0 | 6.3 | 6.0 |
| 5 | 14.5 | 34.3 | 4.5 | 3.0 | 2.0 | 58.3 | 25.5 | 9.7 | 6.5 |
| 6 | 10.5 | 36.7 | 7.3 | 3.5 | 1.5 | 59.5 | 27.5 | 9.0 | 4.0 |
| 7 | 9.5 | 38.5 | 7.0 | 2.5 | 1.5 | 59.0 | 26.5 | 8.5 | 6.0 |
| 8 | 11.8 | 27.7 | 16.5 | 5.5 | 2.0 | 63.5 | 22.5 | 11.5 | 2.5 |
| 9 | 7.5 | 23.3 | 8.5 | 0.0 | 2.5 | 41.8 | 27.7 | 19.0 | 11.5 |
| 10 | 7.0 | 22.2 | 14.8 | 9.0 | 1.5 | 54.5 | 19.2 | 14.3 | 12.0 |
| 11 | 10.0 | 36.0 | 4.5 | 1.5 | 1.0 | 53.0 | 29.5 | 10.0 | 7.5 |
| 12 | 7.5 | 18.8 | 14.5 | 8.5 | 0.2 | 49.5 | 24.5 | 16.8 | 9.2 |
| 13 | 9.0 | 40.0 | 7.5 | 2.0 | 0.5 | 59.0 | 29.0 | 9.0 | 3.0 |
| 14 | 9.7 | 24.0 | 17.0 | 8.5 | 0.5 | 59.7 | 20.5 | 12.5 | 7.3 |
| 15 | 8.2 | 30.0 | 15.0 | 3.8 | 0.0 | 57.0 | 25.7 | 10.8 | 6.5 |
| 16 | 6.5 | 27.3 | 15.0 | 4.0 | 0.0 | 52.8 | 27.2 | 12.0 | 8.0 |
| 17 | 11.5 | 35.5 | 14.0 | 6.0 | 0.0 | 67.0 | 24.0 | 5.0 | 4.0 |
| 18 | 7.5 | 36.2 | 13.3 | 10.0 | 0.0 | 67.0 | 16.5 | 9.0 | 7.5 |
| 19 | 8.5 | 24.5 | 21.0 | 11.0 | 2.5 | 67.5 | 16.5 | 7.0 | 9.0 |
| 20 | 13.7 | 34.0 | 7.5 | 3.5 | 0.0 | 58.7 | 23.5 | 9.3 | 8.5 |
| 21 | 9.5 | 32.8 | 6.0 | 0.0 | 2.5 | 50.8 | 35.2 | 9.0 | 5.0 |
| 22 | 6.5 | 28.5 | 13.5 | 3.0 | 0.8 | 52.3 | 32.2 | 9.5 | 6.0 |

* Others: - Annual Bluegrass, Canada Bluegrass, Red Fescue, Orchard Grass.

APPENDIX TABLE IX - PERCENTAGE GROUND COVERED BY USEFUL GRASSES, WHITE CLOVER, MISCELLANEOUS PLANTS, BARE GROUND, AND MOSS FOR THE YEAR 1943 AS INFLUENCED BY FERTILIZER TREATMENTS AND LIME

| Treatment No. | Useful Grasses | | | | | | White Clover | Miscellaneous Plants | Bare and Moss |
|---|---|---|---|---|---|---|---|---|---|
| | Timothy | Ky. Bluegrass | Red Top | Brown Top | * Others | Total | | | |
| 1 | 8.5 | 26.0 | 12.0 | 6.0 | 0.0 | 52.5 | 16.0 | 18.8 | 12.7 |
| 2 | 6.5 | 30.0 | 16.0 | 0.0 | 0.0 | 52.5 | 20.0 | 15.0 | 12.5 |
| 3 | 7.5 | 31.3 | 10.5 | 7.2 | 0.0 | 56.5 | 28.5 | 7.5 | 7.5 |
| ✓ 4 | 7.0 | 45.5 | 10.5 | 0.0 | 2.0 | 65.0 | 20.0 | 10.5 | 4.5 |
| 5 | 7.5 | 29.0 | 9.5 | 3.5 | 0.0 | 49.5 | 34.5 | 11.5 | 4.5 |
| 6 | 12.0 | 33.2 | 8.0 | 2.0 | 1.8 | 57.0 | 26.0 | 11.0 | 6.0 |
| 7 | 6.5 | 44.0 | 9.5 | 2.0 | 0.5 | 62.5 | 23.0 | 8.3 | 6.2 |
| 8 | 12.5 | 37.7 | 7.3 | 2.3 | 2.0 | 61.8 | 22.5 | 10.2 | 5.5 |
| 9 | 8.0 | 30.5 | 7.5 | 2.5 | 0.5 | 49.0 | 28.0 | 14.5 | 8.5 |
| 10 | 6.5 | 27.5 | 17.5 | 10.0 | 0.0 | 61.5 | 24.0 | 8.5 | 6.0 |
| 11 | 11.5 | 33.8 | 9.5 | 2.5 | 0.0 | 57.3 | 29.5 | 9.0 | 4.2 |
| 12 | 6.5 | 27.0 | 9.5 | 6.0 | 2.0 | 51.0 | 27.3 | 13.7 | 8.0 |
| 13 | 11.0 | 45.0 | 10.0 | 2.5 | 0.5 | 69.0 | 20.2 | 7.8 | 3.0 |
| 14 | 4.5 | 37.0 | 15.0 | 5.3 | 1.5 | 63.3 | 20.0 | 10.2 | 6.5 |
| 15 | 8.0 | 33.7 | 8.5 | 1.0 | 0.0 | 51.2 | 33.0 | 7.8 | 8.0 |
| 16 | 10.0 | 28.0 | 6.3 | 8.5 | 0.5 | 53.3 | 27.5 | 11.2 | 8.0 |
| 17 | 7.5 | 38.0 | 8.7 | 6.0 | 0.5 | 60.7 | 31.0 | 4.8 | 3.5 |
| 18 | 9.0 | 38.7 | 11.5 | 10.0 | 0.3 | 69.5 | 15.5 | 7.0 | 8.0 |
| ✓ 19 | 6.5 | 27.0 | 18.0 | 0.0 | 1.5 | 53.0 | 23.5 | 13.0 | 10.5 |
| 20 | 7.5 | 39.0 | 9.5 | 6.5 | 2.5 | 65.0 | 19.0 | 9.0 | 7.0 |
| 21 | 5.5 | 46.0 | 9.5 | 0.0 | 0.0 | 61.0 | 25.2 | 9.0 | 4.8 |
| 22 | 8.0 | 29.0 | 12.5 | 0.0 | 0.0 | 49.5 | 35.5 | 9.5 | 5.5 |

* Others: - Canada Bluegrass, Meadow Fescue, Red Fescue, Orchard Grass.

APPENDIX TABLE X - PERCENTAGE GROUND COVERED BY USEFUL GRASSES, WHITE CLOVER, MISCELLANEOUS PLANTS, BARE GROUND, AND MOSS FOR THE YEAR 1944 AS INFLUENCED BY FERTILIZER TREATMENTS AND LIME

| Treatment No. | Useful Grasses | | | | | | White Clover | Miscellaneous Plants | Bare and |
|---|---|---|---|---|---|---|---|---|---|
| | Timothy | Ky. Bluegrass | Red Top | Brown Top | * Others | Total | | | |
| 1 | 7.5 | 28.9 | 9.0 | 4.0 | 0.1 | 49.5 | 20.6 | 13.7 | 16.2 |
| 2 | 11.3 | 35.7 | 15.2 | 6.4 | 0.0 | 68.6 | 12.1 | 10.1 | 9.2 |
| 3 | 6.0 | 26.5 | 10.6 | 5.8 | 0.3 | 49.2 | 31.2 | 6.6 | 13.0 |
| 4 | 6.8 | 39.5 | 11.0 | 8.0 | 0.0 | 65.3 | 22.5 | 5.1 | 7.1 |
| 5 | 7.1 | 32.2 | 15.0 | 2.0 | 0.0 | 56.3 | 21.9 | 9.7 | 12.1 |
| 6 | 7.1 | 43.8 | 8.2 | 0.5 | 0.7 | 60.3 | 26.2 | 7.5 | 6.0 |
| 7 | 8.0 | 34.7 | 12.3 | 11.2 | 0.0 | 66.2 | 19.9 | 7.4 | 6.5 |
| 8 | 8.3 | 37.3 | 8.5 | 3.1 | 0.7 | 57.9 | 24.3 | 7.8 | 10.0 |
| 9 | 7.5 | 34.5 | 10.5 | 4.0 | 0.3 | 56.8 | 23.4 | 11.2 | 8.6 |
| 10 | 5.3 | 20.5 | 9.0 | 8.4 | 6.8 | 50.0 | 27.3 | 10.4 | 12.3 |
| 11 | 8.0 | 38.6 | 10.5 | 0.0 | 0.2 | 57.3 | 24.1 | 10.5 | 8.1 |
| 12 | 8.8 | 31.5 | 12.7 | 0.0 | 0.4 | 53.4 | 18.5 | 13.0 | 15.1 |
| 13 | 7.0 | 52.7 | 11.0 | 0.0 | 0.6 | 71.3 | 13.9 | 5.8 | 9.0 |
| 14 | 8.0 | 34.4 | 9.8 | 2.3 | 0.5 | 55.0 | 26.1 | 8.9 | 10.0 |
| 15 | 5.3 | 34.2 | 11.7 | 6.3 | 0.0 | 57.5 | 23.3 | 7.6 | 11.6 |
| 16 | 8.0 | 28.9 | 7.8 | 4.0 | 0.0 | 48.7 | 34.2 | 8.2 | 8.9 |
| 17 | 7.7 | 37.2 | 14.9 | 4.0 | 0.0 | 63.8 | 23.9 | 5.2 | 7.1 |
| 18 | 5.5 | 47.0 | 16.6 | 1.5 | 0.0 | 70.6 | 13.1 | 7.4 | 8.9 |
| 19 | 8.7 | 33.5 | 16.2 | 3.8 | 4.0 | 66.2 | 12.4 | 10.3 | 11.1 |
| 20 | 6.5 | 31.6 | 10.9 | 7.5 | 0.0 | 56.5 | 23.8 | 9.0 | 10.7 |
| 21 | 6.0 | 43.1 | 9.0 | 1.8 | 1.2 | 61.1 | 21.8 | 8.5 | 8.6 |
| 22 | 8.0 | 34.6 | 19.2 | 0.0 | 0.3 | 62.1 | 19.2 | 10.0 | 8.7 |

* Others: - Canada Bluegrass, Red Fescue, Orchard Grass.

APPENDIX TABLE XI - PERCENTAGE GROUND COVERED BY USEFUL GRASSES, WHITE CLOVER, MISCELLANEOUS PLANTS, BARE GROUND, AND MOSS FOR A 6-YEAR AVERAGE (1939-1944) AS INFLUENCED BY FERTILIZER TREATMENTS AND LIME

| reatment No. | Useful Grasses | | | | | | White Clover | Miscellane-ous Plants | Bare Gro and Mo |
|---|---|---|---|---|---|---|---|---|---|
| | Timothy | Ky. Blue-grass | Red Top | Brown Top | * Others | Total | | | |
| 1 | 5.7 | 24.3 | 16.0 | 7.5 | 0.3 | 53.8 | 18.4 | 14.2 | 13.6 |
| 2 | 6.8 | 29.2 | 19.7 | 4.5 | 0.6 | 60.8 | 18.0 | 11.8 | 9.4 |
| 3 | 6.3 | 25.1 | 12.9 | 8.5 | 0.3 | 53.1 | 28.8 | 9.1 | 9.0 |
| 4 | 6.9 | 39.2 | 11.9 | 1.6 | 1.0 | 60.6 | 27.0 | 6.8 | 5.6 |
| 5 | 7.9 | 28.3 | 11.8 | 5.7 | 0.9 | 54.7 | 26.9 | 11.3 | 7.1 |
| 6 | 9.8 | 34.1 | 12.6 | 2.7 | 1.1 | 60.3 | 23.8 | 10.3 | 5.6 |
| 7 | 7.9 | 32.5 | 15.1 | 5.9 | 1.4 | 62.9 | 22.1 | 8.1 | 6.9 |
| 8 | 9.9 | 30.3 | 14.9 | 3.1 | 1.4 | 59.6 | 23.2 | 10.4 | 6.8 |
| 9 | 8.4 | 30.9 | 13.1 | 1.5 | 0.8 | 54.7 | 25.6 | 11.4 | 8.3 |
| 10 | 5.9 | 23.2 | 18.9 | 8.4 | 2.1 | 58.5 | 21.4 | 11.5 | 8.6 |
| 11 | 7.3 | 33.0 | 13.1 | 2.5 | 0.3 | 56.2 | 26.3 | 11.3 | 6.2 |
| 12 | 6.1 | 23.5 | 16.3 | 6.6 | 0.5 | 53.0 | 24.6 | 12.7 | 9.7 |
| 13 | 9.1 | 39.7 | 14.2 | 2.3 | 0.4 | 65.7 | 20.4 | 8.3 | 5.6 |
| 14 | 6.9 | 28.1 | 13.7 | 5.9 | 0.9 | 55.5 | 27.4 | 10.3 | 6.8 |
| 15 | 7.6 | 28.1 | 12.8 | 7.5 | 0.7 | 56.7 | 24.5 | 9.8 | 9.0 |
| 16 | 7.9 | 23.7 | 14.0 | 3.9 | 0.5 | 50.0 | 30.9 | 11.0 | 8.1 |
| 17 | 8.4 | 32.8 | 15.6 | 4.9 | 0.3 | 62.0 | 25.5 | 7.2 | 5.3 |
| 18 | 7.8 | 31.7 | 18.2 | 9.6 | 0.6 | 68.0 | 14.4 | 9.1 | 8.5 |
| 19 | 6.9 | 26.9 | 22.1 | 5.2 | 2.2 | 63.3 | 17.6 | 9.4 | 9.7 |
| 20 | 8.9 | 32.4 | 11.9 | 5.8 | 0.5 | 59.5 | 24.5 | 8.9 | 7.1 |
| 21 | 6.6 | 37.2 | 14.1 | 0.6 | 0.8 | 59.3 | 26.1 | 8.7 | 5.9 |
| ✓ 22 | 7.4 | 29.9 | 16.5 | 4.0 | 0.3 | 58.1 | 26.6 | 9.3 | 6.0 |

* Others: - Annual Bluegrass, Canada Bluegrass, Red Fescue, Meadow Fescue, Orchard Grass.

APPENDIX TABLE XII - ANALYSIS OF VARIANCE FOR USEFUL GRASSES 1939-1944

| Source of Variance | Sum of squares | Degrees of freedom | Mean Square | F Value obtained | F Value for 5% | F Value for 1% |
|---|---|---|---|---|---|---|
| Treatments ..... | 4,964.83 | 21 | 236.42 | 4.83 | 1.68 | 2.06 |
| Blocks ..... | 1,059.20 | 1 | 1,059.20 | 21.63 | 3.94 | 6.90 |
| Years ..... | 790.63 | 5 | 158.12 | 3.23 | 2.30 | 3.20 |
| Treatments x Years ..... | 5,456.55 | 105 | 51.96 | 1.06 | 1.39 | 1.59 |
| Treatments x Blocks ..... | 2,501.01 | 21 | 119.09 | 2.43 | 1.68 | 2.06 |
| Blocks x Years ..... | 3,347.90 | 5 | 669.58 | 13.67 | 2.30 | 3.20 |
| Error ..... | 5,140.97 | 105 | 48.96 | | | |
| Total ..... | 23,261.09 | 263 | | | | |

APPENDIX TABLE XIII - ANALYSIS OF VARIANCE FOR WHITE CLOVER 1939-1944

| Source of Variance | Sum of squares | Degrees of freedom | Mean Square | F Value obtained | F Value for 5% | F Value for 1% |
|---|---|---|---|---|---|---|
| Treatments ..... | 4,138.32 | 21 | 197.06 | 4.80 | 1.68 | 2.06 |
| Blocks ..... | 2,392.22 | 1 | 2,392.22 | 58.27 | 3.94 | 6.90 |
| Years ..... | 404.70 | 5 | 80.94 | 1.97 | 2.30 | 3.20 |
| Treatments x Years ..... | 4,582.45 | 105 | 43.64 | 1.06 | 1.39 | 1.59 |
| Treatments x Blocks ..... | 1,266.35 | 21 | 60.30 | 1.47 | 1.68 | 2.06 |
| Blocks x Years ..... | 2,530.41 | 5 | 506.08 | 12.32 | 2.30 | 3.20 |
| Error ..... | 4,311.07 | 105 | 41.05 | | | |
| TOTAL ..... | 19,625.52 | 263 | | | | |

APPENDIX TABLE XIV - ANALYSIS OF VARIANCE FOR MISCELLANEOUS PLANTS 1939-1944

| Source of Variance | Sum of squares | Degrees of freedom | Mean Square | F Value obtained | F Value for 5% | F Value for 1% |
|---|---|---|---|---|---|---|
| Treatments ..... | 805.49 | 21 | 38.35 | 4.05 | 1.68 | 2.06 |
| Blocks ..... | 175.26 | 1 | 175.26 | 18.54 | 3.94 | 6.90 |
| Years ..... | 522.43 | 5 | 104.48 | 11.05 | 2.30 | 3.20 |
| Treatments x Years ..... | 1,139.17 | 105 | 10.85 | 1.15 | 1.39 | 1.59 |
| Treatments x Blocks ..... | 281.99 | 21 | 13.43 | 1.42 | 1.68 | 2.06 |
| Blocks x Years ..... | 98.39 | 5 | 19.68 | 2.08 | 2.30 | 3.20 |
| Error ..... | 992.51 | 105 | 9.45 | | | |
| Total..... | 4,015.24 | 263 | | | | |

APPENDIX TABLE XV - ANALYSIS OF VARIANCE FOR BARE GROUND AND MOSS 1939-1944

| Source of Variance | Sum of squares | Degrees of freedom | Mean Square | F Value obtained | F Value for 5% | F Value for 1% |
|---|---|---|---|---|---|---|
| Treatments ..... | 983.63 | 21 | 46.84 | 7.61 | 1.68 | 2.06 |
| Blocks ..... | 8.12 | 1 | 8.12 | 1.32 | 3.94 | 6.90 |
| Years ..... | 803.35 | 5 | 160.67 | 26.12 | 2.30 | 3.20 |
| Treatments x Years ..... | 734.55 | 105 | 6.99 | 1.13 | 1.39 | 1.59 |
| Treatments x Blocks ..... | 218.20 | 21 | 10.39 | 1.69 | 1.68 | 2.06 |
| Blocks x Years ..... | 237.96 | 5 | 47.59 | 7.73 | 2.30 | 3.20 |
| Error ..... | 645.63 | 105 | 6.15 | | | |
| Total ..... | 3,631.44 | 263 | | | | |

APPENDIX TABLE XVI - PERCENTAGE OF TOTAL YIELD FOR YEAR AT EACH CUTTING DATE FOR FERTILIZER TREATMENTS AND LIME 1939-1944

| Treatment No. | Cutting | 1939 | 1940 | 1941 | 1942 | 1943 | 1944 | Average percentage 1940-1944 |
|---|---|---|---|---|---|---|---|---|
| 1 | 1st | 18.2 | 27.9 | 23.1 | 31.0 | 25.3 | 33.0 | 28.1 |
| | 2nd | 36.2 | 26.8 | 28.9 | 36.2 | 31.8 | 40.7 | 32.8 |
| | 3rd | 45.6 | 36.5 | 39.1 | 24.3 | 25.4 | 21.2 | 29.3 |
| | 4th | - | 8.8 | 8.9 | 8.5 | 17.5 | 5.1 | 9.8 |
| 2 | 1st | 32.4 | 17.1 | 29.9 | 35.2 | 19.0 | 38.5 | 28.0 |
| | 2nd | 35.7 | 23.6 | 17.8 | 29.9 | 26.7 | 34.7 | 26.5 |
| | 3rd | 31.9 | 43.0 | 39.9 | 26.3 | 28.5 | 21.5 | 31.8 |
| | 4th | - | 16.3 | 12.4 | 8.6 | 25.8 | 5.3 | 13.7 |
| 3 | 1st | 33.1 | 23.5 | 21.4 | 29.2 | 31.2 | 23.7 | 25.8 |
| | 2nd | 39.9 | 31.9 | 30.9 | 38.1 | 22.9 | 38.9 | 32.6 |
| | 3rd | 27.0 | 32.1 | 36.5 | 13.7 | 26.1 | 27.7 | 27.2 |
| | 4th | - | 12.5 | 11.2 | 19.0 | 19.8 | 9.7 | 14.4 |
| 4 | 1st | 38.1 | 21.6 | 33.1 | 38.5 | 34.2 | 29.5 | 31.4 |
| | 2nd | 39.0 | 28.9 | 22.5 | 25.4 | 20.7 | 36.9 | 26.9 |
| | 3rd | 22.9 | 36.0 | 30.3 | 21.9 | 30.3 | 23.7 | 28.4 |
| | 4th | - | 13.5 | 14.1 | 14.2 | 14.8 | 9.9 | 13.3 |
| 5 | 1st | 32.7 | 17.7 | 26.1 | 32.5 | 24.5 | 30.9 | 26.3 |
| | 2nd | 36.0 | 34.3 | 25.3 | 33.4 | 26.1 | 31.4 | 30.1 |
| | 3rd | 31.3 | 39.0 | 34.8 | 26.7 | 32.7 | 29.7 | 32.6 |
| | 4th | - | 9.0 | 13.8 | 7.4 | 16.7 | 8.0 | 11.0 |
| 6 | 1st | 36.6 | 14.5 | 21.9 | 34.4 | 28.7 | 27.8 | 25.5 |
| | 2nd | 35.9 | 27.2 | 33.2 | 29.7 | 22.9 | 34.0 | 29.4 |
| | 3rd | 27.5 | 44.2 | 32.5 | 21.7 | 28.4 | 22.0 | 29.7 |
| | 4th | - | 14.1 | 12.4 | 14.2 | 20.0 | 16.2 | 15.4 |
| 7 | 1st | 45.1 | 18.3 | 19.5 | 28.1 | 29.6 | 33.8 | 25.9 |
| | 2nd | 31.9 | 31.9 | 33.0 | 34.6 | 26.1 | 38.4 | 32.8 |
| | 3rd | 23.0 | 32.9 | 41.4 | 21.5 | 28.5 | 20.3 | 28.9 |
| | 4th | - | 16.9 | 6.1 | 15.8 | 15.8 | 7.5 | 12.4 |
| 8 | 1st | 40.5 | 7.1 | 28.0 | 32.7 | 31.1 | 30.8 | 25.9 |
| | 2nd | 27.9 | 38.1 | 27.7 | 32.9 | 25.3 | 31.5 | 31.1 |
| | 3rd | 31.6 | 38.9 | 32.0 | 23.1 | 27.9 | 30.5 | 30.5 |
| | 4th | - | 15.9 | 12.3 | 11.3 | 15.7 | 7.2 | 12.5 |
| 9 | 1st | 45.5 | 26.6 | 30.9 | 33.1 | 31.2 | 31.7 | 30.7 |
| | 2nd | 26.7 | 27.7 | 28.1 | 23.7 | 24.7 | 32.5 | 27.3 |
| | 3rd | 27.8 | 32.7 | 29.2 | 26.1 | 20.3 | 17.1 | 25.1 |
| | 4th | - | 13.0 | 11.8 | 17.1 | 23.8 | 18.7 | 16.9 |
| 10 | 1st | 30.7 | 21.7 | 29.2 | 31.7 | 30.6 | 33.3 | 29.3 |
| | 2nd | 39.0 | 31.2 | 30.3 | 30.2 | 24.0 | 35.5 | 30.3 |
| | 3rd | 30.3 | 24.2 | 33.7 | 22.6 | 25.5 | 18.2 | 24.8 |
| | 4th | - | 22.9 | 6.8 | 15.5 | 19.9 | 13.0 | 15.6 |
| | 1st | 44.5 | 12.7 | 25.7 | 39.7 | 33.1 | 27.5 | 27.7 |
| | | .0 | 29.7 | 29.9 | 22.6 | 23.7 | 37.7 | 28.7 |
| | | .5 | 46.1 | 35.1 | 26.3 | 25.9 | 27.6 | 32.1 |
| | | | | | | 17.3 | 7.8 | 11.5 |

APPENDIX TABLE XVI - PERCENTAGE OF TOTAL YIELD FOR YEAR AT EACH CUTTING DATE FOR FERTILIZER TREATMENTS AND LIME 1939-1944 (cont'd)

| Treatment No. | Cutting | 1939 | 1940 | 1941 | 1942 | 1943 | 1944 | Average percentage 1940-1944 |
|---|---|---|---|---|---|---|---|---|
| 12 | 1st | 21.5 | 22.3 | 27.9 | 35.9 | 26.7 | 28.1 | 28.2 |
| | 2nd | 49.1 | 29.1 | 29.3 | 35.7 | 26.7 | 33.3 | 30.8 |
| | 3rd | 29.4 | 34.0 | 37.2 | 20.0 | 27.3 | 34.1 | 30.5 |
| | 4th | - | 14.6 | 5.6 | 8.4 | 19.3 | 4.5 | 10.5 |
| 13 | 1st | 47.1 | 23.1 | 32.3 | 35.0 | 25.7 | 31.1 | 29.4 |
| | 2nd | 33.3 | 29.6 | 26.5 | 28.8 | 24.0 | 39.6 | 29.7 |
| | 3rd | 19.6 | 34.9 | 33.7 | 26.3 | 32.6 | 24.2 | 30.4 |
| | 4th | - | 12.4 | 7.5 | 9.9 | 17.7 | 5.1 | 10.5 |
| 14 | 1st | 43.2 | 17.9 | 21.3 | 35.1 | 26.0 | 35.9 | 27.2 |
| | 2nd | 31.2 | 31.3 | 34.1 | 35.0 | 31.7 | 29.7 | 32.4 |
| | 3rd | 25.6 | 35.3 | 33.1 | 12.5 | 22.9 | 24.6 | 25.7 |
| | 4th | - | 15.5 | 11.5 | 17.4 | 19.4 | 9.8 | 14.7 |
| 15 | 1st | 33.0 | 12.6 | 20.3 | 38.3 | 28.7 | 37.9 | 27.6 |
| | 2nd | 37.6 | 23.7 | 22.9 | 30.1 | 28.8 | 37.3 | 28.6 |
| | 3rd | 29.4 | 51.0 | 43.2 | 17.2 | 27.5 | 20.4 | 31.8 |
| | 4th | - | 12.7 | 13.6 | 14.4 | 15.0 | 4.4 | 12.0 |
| 16 | 1st | 21.2 | 14.9 | 30.0 | 31.9 | 30.4 | 27.7 | 27.0 |
| | 2nd | 40.7 | 34.9 | 24.6 | 33.5 | 27.4 | 46.9 | 33.5 |
| | 3rd | 38.1 | 31.1 | 34.9 | 23.5 | 27.5 | 16.5 | 26.7 |
| | 4th | - | 19.1 | 10.5 | 11.1 | 14.7 | 8.9 | 12.8 |
| 17 | 1st | 51.3 | 15.0 | 22.9 | 33.5 | 34.7 | 37.9 | 28.8 |
| | 2nd | 29.1 | 28.3 | 28.7 | 33.3 | 31.9 | 26.1 | 29.7 |
| | 3rd | 19.6 | 39.7 | 40.7 | 21.4 | 20.1 | 24.5 | 29.3 |
| | 4th | - | 17.0 | 7.7 | 11.8 | 13.3 | 11.5 | 12.2 |
| 18 | 1st | 29.6 | 19.9 | 24.1 | 36.3 | 30.7 | 30.4 | 28.3 |
| | 2nd | 35.0 | 29.1 | 25.7 | 25.9 | 26.6 | 32.1 | 27.9 |
| | 3rd | 35.4 | 31.3 | 39.5 | 29.1 | 23.4 | 25.9 | 29.8 |
| | 4th | - | 19.7 | 10.7 | 8.7 | 19.3 | 11.6 | 14.0 |
| 19 | 1st | 23.0 | 21.3 | 24.3 | 32.1 | 32.2 | 28.5 | 27.7 |
| | 2nd | 40.5 | 37.9 | 25.7 | 37.5 | 28.0 | 29.0 | 31.6 |
| | 3rd | 36.5 | 25.6 | 41.1 | 18.5 | 23.9 | 33.1 | 28.4 |
| | 4th | - | 15.2 | 8.9 | 12.0 | 15.9 | 9.4 | 12.3 |
| 20 | 1st | 26.1 | 21.9 | 23.4 | 33.9 | 31.3 | 38.2 | 29.7 |
| | 2nd | 34.7 | 25.7 | 28.6 | 33.7 | 27.9 | 35.9 | 30.4 |
| | 3rd | 39.2 | 38.3 | 34.9 | 18.3 | 25.2 | 18.2 | 27.0 |
| | 4th | - | 14.1 | 13.1 | 14.1 | 15.6 | 7.7 | 12.9 |
| 21 | 1st | 33.1 | 22.3 | 32.5 | 31.5 | 26.9 | 31.0 | 28.8 |
| | 2nd | 38.5 | 33.7 | 25.3 | 29.5 | 23.0 | 38.9 | 30.1 |
| | 3rd | 28.4 | 31.5 | 31.7 | 26.8 | 33.3 | 19.9 | 28.6 |
| | 4th | - | 12.5 | 10.5 | 12.2 | 16.8 | 10.2 | 12.5 |
| 22 | 1st | 46.7 | 21.9 | 21.4 | 33.2 | 27.3 | 31.9 | 27.1 |
| | 2nd | 21.9 | 28.1 | 27.7 | 36.3 | 27.7 | 31.1 | 30.2 |
| | 3rd | 31.4 | 38.3 | 40.5 | 18.8 | 27.2 | 24.5 | 29.9 |
| | 4th | - | 11.7 | 10.4 | 11.7 | 17.8 | 12.5 | 12.8 |

APPENDIX TABLE XVII - YIELDS OF DRY MATTER IN POUNDS PER ACRE FOR EACH YEAR 1939-1944

| Treatment No. | 1939 | 1940 | 1941 | 1942 | 1943 | 1944 | 6-Year average |
|---|---|---|---|---|---|---|---|
| 1 | 4,138.1 | 4,404.4 | 3,557.4 | 3,775.2 | 4,549.6 | 3,073.4 | 3,916.3 |
| 2 | 4,210.8 | 4,162.4 | 4,017.2 | 4,767.4 | 4,477.0 | 3,702.6 | 4,222.9 |
| 3 | 3,993.0 | 5,057.8 | 3,847.8 | 5,953.2 | 6,534.0 | 4,477.0 | 4,977.1 |
| 4 | 4,670.6 | 5,783.8 | 4,041.4 | 5,880.6 | 6,316.2 | 4,694.8 | 5,231.2 |
| 5 | 4,331.8 | 4,815.8 | 4,065.6 | 6,800.2 | 5,517.6 | 4,235.0 | 4,961.0 |
| 6 | 5,348.2 | 4,743.2 | 4,089.8 | 6,848.6 | 6,171.0 | 5,324.0 | 5,420.8 |
| 7 | 7,574.6 | 5,082.0 | 4,065.6 | 7,211.6 | 6,292.0 | 5,178.8 | 5,900.8 |
| 8 | 3,581.6 | 4,719.0 | 3,968.8 | 6,025.8 | 6,509.8 | 4,864.2 | 4,944.9 |
| 9 | 5,953.2 | 6,122.6 | 3,678.4 | 6,897.0 | 5,638.6 | 5,009.4 | 5,549.9 |
| 10 | 3,412.2 | 4,114.0 | 3,872.0 | 4,598.0 | 4,840.0 | 3,751.0 | 4,097.9 |
| 11 | 5,929.0 | 3,630.0 | 3,388.0 | 5,832.2 | 6,509.8 | 3,896.2 | 4,864.2 |
| 12 | 4,065.6 | 4,501.2 | 4,041.4 | 4,598.0 | 4,138.2 | 4,331.8 | 4,279.4 |
| 13 | 5,082.0 | 4,815.8 | 4,183.6 | 6,364.0 | 6,461.4 | 5,106.2 | 5,335.6 |
| 14 | 5,808.0 | 4,864.2 | 3,388.0 | 6,534.0 | 4,622.2 | 3,799.4 | 4,836.0 |
| 15 | 4,162.4 | 5,517.6 | 4,186.6 | 5,880.6 | 4,307.6 | 4,356.0 | 4,735.1 |
| 16 | 4,549.6 | 4,719.0 | 4,525.4 | 5,977.4 | 5,735.4 | 4,283.4 | 4,965.0 |
| 17 | 5,420.8 | 5,590.2 | 4,114.0 | 6,316.2 | 6,050.0 | 4,525.4 | 5,336.1 |
| 18 | 2,879.8 | 4,017.2 | 3,920.4 | 5,778.8 | 5,638.6 | 4,403.9 | 4,439.8 |
| 19 | 4,380.2 | 3,968.8 | 3,823.6 | 5,445.0 | 5,348.2 | 4,598.0 | 4,594.0 |
| 20 | 4,840.0 | 4,985.2 | 3,920.4 | 5,662.8 | 5,832.2 | 3,968.8 | 4,868.2 |
| 21 | 5,977.4 | 5,469.2 | 4,356.0 | 6,267.6 | 6,195.2 | 4,864.2 | 5,521.6 |
| 22 | 5,638.6 | 5,517.6 | 3,678.4 | 6,195.2 | 6,243.6 | 5,299.8 | 5,428.9 |

APPENDIX TABLE XVIII - ANALYSIS OF VARIANCE FOR YIELDS OF DRY MATTER 1939-1944

| Source of Variance | Sum of squares | Degrees of freedom | Mean Square | F Value obtained | F Value fc | |
|---|---|---|---|---|---|---|
| | | | | | 5% | 1% |
| Treatments ..... | 67,710,639.89 | 21 | 3,224,316.18 | 5.84 | 1.68 | 2.06 |
| Blocks ..... | 5,607,468.92 | 1 | 5,607,468.92 | 10.15 | 3.94 | 6.90 |
| Years ..... | 116,671,634.25 | 5 | 23,334,326.85 | 42.26 | 2.30 | 3.20 |
| Treatments x Years ..... | 72,442,730.65 | 105 | 690,034.03 | 1.25 | 1.39 | 1.59 |
| Treatments x Blocks .... | 28,221,657.93 | 21 | 1,343,888.47 | 2.43 | 1.68 | 2.06 |
| Blocks x Years ..... | 2,174,394.54 | 5 | 434,878.91 | 0.79 | 2.30 | 3.20 |
| Error ..... | 57,978,660.49 | 105 | 552,177.72 | | | |
| Total ..... | 350,807,186.67 | 263 | | | | |

| Source of Variance | Sum of square | Degrees of freedom | Mean Square | F Value obtained | F Value for | |
|---|---|---|---|---|---|---|
| | | | | | 5% | 1% |
| Years: ..... | 116,671,634.25 | 5 | 23,334,326.85 | 42.26 | 2.30 | 3.20 |
| Periods ..... | 40,974,739.55 | 1 | 40,974,739.55 | 74.23 | 3.94 | 6.90 |
| Years within 1st period | 23,169,596.40 | 2 | 11,584,798.20 | 20.98 | 3.09 | 4.82 |
| Years within 2nd period | 52,527,298.30 | 2 | 26,263,649.15 | 47.56 | 3.09 | 4.82 |
| Years within two periods | 75,696,894.70 | 4 | 18,924,223.67 | 34.27 | 2.46 | 3.51 |