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Forage Yield and Chemical Composition of an Orchardgrass-Bromegrass Pasture Mixture as Influenced by Clipping Frequency, Nitrogen Fertilization and Irrigation Regime

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FORAGE YIELD AND CHEMICAL COMPOSITION OF AN ORCHARDGRASS-BROMEGRASS PASTURE MIXTURE AS INFLUENCED BY CLIPPING FREQUENCY, NITROGEN FERTILIZATION AND IRRIGATION REGIME

by

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To my beloved wife Seema Gawai

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by

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The influence of agronomic practices on forage production and chemical composition of an orchardgrass-bromegrass pasture mixture was studied at the Greenville Farm, Logan, Utah, during 1960-1964. The soil is a well drained Millville Silt loam that has about a one percent slope and occurs on an alluvial fan. It is high in potash, phosphorus and calcium and is alkaline having a pH of 7.9 to 8.2.

Analysis of the clipping frequency showed that the yield of forage from four harvests was greater than from five harvests. This difference was greater on plots receiving high rates of nitrogen fertilization, and frequent irrigation. Nitrogen, phosphorus, calcium, copper, iron and zinc contents were lower with four harvests and potassium and manganese contents were lower with five harvests.

Forage production increased significantly as the available moisture in the soil increased, producing the highest yields for the 5-day irrigation interval. Nitrogen, copper, iron and zinc in the foliage decreased and phosphorus and calcium increased with increasing soil moisture. On

the contrary, potassium content did not show a specific trend with increasing soil moisture.

Nitrogen fertilization increased the forage dry matter production significantly giving the highest yield for 200 pounds of applied nitrogen per acre per season. The percentage of nitrogen in harvested forage decreased up to 100 pounds per acre of applied nitrogen and slightly increased with 200 pounds. Calcium, iron and manganese contents decreased and zinc content slightly increased with an increase in the amount of nitrogen fertilization. On the other hand, phosphorus, potassium and copper contents did not show a consistent trend with increasing nitrogen fertilization.

A difference was noted between the amount of forage produced for different years. However, there was a tendency of decreasing forage yield with increasing age of stand. Nitrogen and phosphorus contents increased and copper, iron and manganese decreased significantly with the increasing age of stand. Potassium, calcium, and zinc contents showed a gradual decrease with the age of forage but there was a fluctuating tendency in their content for different years.

(210 pages)

INTRODUCTION

The relation of soil to the composition of agricultural products and through these to the nutrition of man and other animals, has been the subject of continuing investigation since the beginning of agricultural science.

More food is required to provide the energy needs of animals than for all other purposes combined. If this need is satisfied, it is likely that all other essential requirements will be covered. Energy, therefore, is a highly significant measure of nutritive value of feeds.

The nutritive value of forages is determined by the presence of substances that are necessary for the health, growth, and reproductiveness of animals. Attention has shifted from earlier studies on the obvious and extensive relationships of soil constituents with general and skeletal nutrition of animals to more detailed observations. These include nutritional requirements for growth, lactation and reproduction, relations of the trace elements to the metabolism of other minerals, and to enzyme and vitamin synthesis and activation.

From the standpoint of practical application, the value of forages is primarily dependent upon the content of mineral elements, protein and carbohydrates and their availability as digestible nutrients.

Clipping and grazing studies have shown the yields of forage and plant nutrients to be inversely related to the frequency and the intensity of defoliation. In order to study the production and the quality of forage, the clipping interval and the number of clippings should be taken into consideration.

Water and the 13 mineral nutrients generally regarded as essential for higher plants are intricately intertwined in their effects on growth and reproduction. All are essential and yet so interdependent that one cannot be considered without the others during their transport from the soil to the roots, and their translocation within plants. A deficiency of one or more nutrients can arrest root development so that water extraction from the soil, particularly from deeper zones, is impaired. Nutrient deficiency can restrict the development of stems and leaves so that transpiration will be less than the potential evapotranspiration set by the heat available in the environment.

Forage production has been the objective of much research in the past. A large part of this research, however, has been more concerned with the establishment of the influence of nitrogen application on the botanical composition of forage rather than the chemical composition. After it has been established that crops respond to nitrogen application, it becomes, from both an economic and nutritional standpoint, an important consideration to establish the response of forages to the absorbtion of different minerals from the soil.

A study was therefore undertaken to obtain information on the response of specific grasses to two clipping frequencies (harvested four times and five times in a season), four nitrogen levels (0, 50, 100, and 200 pounds per acre annually applied in 50-pound increments), and four irrigation intervals (long, medium, medium short, and short) for dry matter production, nitrogen, phosphorus, potassium, calcium, copper, iron, manganese, and zinc content.

REVIEW OF LITERATURE

Influence of Cutting Management on Production and Quality of Forage

Among the more important factors which affect the production of pastures and forages are soil fertility, species, grazing or clipping management, and the maintenance of favorable soil moisture regions within the root zones. The influence of clipping frequency upon yield, botanical composition and feed quality has been reported by several workers.

The effect of cutting treatments on the yield and chemical composition of an alfalfa-bromegrass mixture was studied by Dotzenko and Ahlgren (1951). In their study, plots were cut when forage was 5", 10", pre-bud, 1/10 bloom, full bloom and pod stages. The results showed that protein, potassium, and phosphorus content of the herbage decreases with advancing maturity, whereas the fiber and calcium content showed the reverse trend. Previous studies of alfalfa-bromegrass mixtures by Fuellman (1948); Rather and Harrison (1939); Comstock and Low (1948); Wagner and Wilkins (1947) and Churchill (1947) have shown that both the height and the frequency of cutting influence the yield and quality of herbage produced.

Tesar and Ahlgren (1950) showed that under Wisconsin conditions, higher yields were obtained by making four cuttings per season than either two or six. In California, Peterson and Hagen (1953) studied the influence of clipping frequency on production and quality of four

irrigated pasture mixtures. They obtained increased yields as growth intervals were extended from two weeks to five weeks. Burton et al. (1953) working with coastal bermudagrass came to the conclusion that the annual dry matter yield of bermudagrass increased until 12 weeks and decreased afterwards. They also showed that forage harvested in the first 5 week period was about 4 percent more digestable than forage harvested during the next two 6 week periods. The three year average dry matter analysis of coastal bermuda cut at 3 to 24 week intervals ranged from 18.5 to 8.4 percent for crude protein, 27.0 to 33.9 percent for crude fibre and 199,900 to 32,800 I.U. per pound of vitamin A equivalent.

Clipping and grazing studies have shown that the yields for forages and plant nutrients are inversely related to the frequency and intensity of defoliation, (Biswell, 1933; Cook, 1953; Dwyer, 1963; Harlan, 1960; Neiland, 1956; Holscher, 1945 and Pond, 1961). Results have usually indicated that the more frequent and severe the defoliation treatment, the greater the reduction of dry matter yield, (Conard, 1954; Cook, 1953; Justus, 1955; Wagner, 1952). Under normal plant growth the percentage of crude protein in plant tissues decreases from early growth to maturity (Cook, 1950; Kik, 1943; McCall, 1939; Oelberg, 1956; Richards, 1962). Among many who have shown that tissues that regrow after defoliation have a high percentage of crude protein are Newell and Keim, 1947; Runyon, 1943; Watkins and Levern, 1951.

The higher content of cobalt in legumes as compared to grasses has been observed incidentally in certain field studies, (Beeson, 1941). Wain, Hunt, and Marsh (1939) noted a low content of manganese in timothy during periods of vigorous growth. In winter months when much

of the vegetation was dead or dying the grasses were richer in manganese than Legumes. Bolin (1934) reported that the manganese in timothy collected from grazed plots in Texas increased throughout the season from June 6 to October 11. Walrath, Ward and Struve (1948) found more manganese in rye grass than alfalfa collected from a farm in Connecticut. Gray and Smith (1945) found no marked changes in cobalt content of Arundinacia teeta sampled at monthly intervals throughout a period of one year. In general, there is only meager information in the literature relating to the iron, manganese, cobalt, and copper content of forages (Beeson, 1941). Beeson and MacDonald (1951) working on copper, manganese, and iron content of birdsfoot trefoil, ladino clover, alfalfa, and timothy, found that the iron content of all species increased as the plant matures. The copper content of timothy decreased as the plant matured. The manganese content of timothy and the leaf petiole of birdsfoot trefoil and ladino clover increased slightly as these plants matured. Timothy was found to have a lower content of copper, iron, and cobalt than the legumes. The iron content of timothy was about the same and the copper content slightly less than in the stems of legumes. In no case did the legumes with which the timothy was grown exert an influence on the absorption of cobalt, copper, iron, or manganese by the timothy.

Peterson and Hagen (1953) working on the influence of clipping frequency on the production and quality of irrigated pasture mixtures showed that ash, crude protein and ether extract decreased in percentage with wider intervals between cuttings while crude fibre increased. Nitrogen-free extract was not greatly influenced by cutting treatments. They also came to the conclusion that grazing intensity at intervals

of 25 days might be suitable for mixtures containing ladino clover as a primary legume.

Cooper (1956) confirmed the results of other workers showing that the crude protein content of hays decreased with advancing maturity and increased with cutting heights. The portion of the plants occurring above 6" contained 1 percent more crude protein than the portion occurring between 2 and 4 inches. There were no significant changes in botanical composition as a result of cutting treatment.

Prine and Burton (1956) reported from Georgia that by increasing the length of the clipping interval from two weeks to eight weeks, the yield of bermuda grass hay was increased; protein percentage was lowered, but had little effect on the protein yield. The general effects of increasing the length of clipping intervals increased stem length, length of longest leaf-blade per stem, plant height, number of internodes per stem, and internode length, and decreased leaf percentage. The percentage of seed heads observed in the forage samples was significantly higher (5.0 to 7.5 percent) at the 6 and 8 week clipping intervals than at the shorter clipping frequencies (2.0 percent).

Pierre and Jackobs (1953) working with birdsfoot trefoil found that the percentage of crude protein, phosphorus, potassium, calcium and magnesium was usually lower when the plants were harvested at prebloom, 1/10 bloom, fullbloom and maturity than when they were harvested at more immature stages.

Influence of Nitrogen Fertilization on Production and Quality of Pasture

Several experiments have been conducted to study the effect of nitrogen fertilization on grass-forages. Carey et al. (1952) while

working on the effect of nitrogen fertilization on chemical composition of bromegrass came to the conclusion that nitrogen content of bromegrass was increased progressively with applications of 0, 100, and 200 pounds of nitrogen per acre as ammonium nitrate. Application of 100 pounds of nitrogen per acre as ammonium nitrate caused an appreciable increase in the riboflavin content of bromegrass. They also found that young bromegrass fertilized very heavily with ammonium nitrate may accumulate enough nitrate to be toxic to livestock.

The effect of nitrogen fertilizer upon the palatability of some forages, however, is still a controversial matter. Burton et al. (1956) indicated that the daily gains of animals grazing heavily fertilized grass have sometimes been lower than those for animals grazing grasses receiving 50 pounds (or less) of nitrogen per acre per year. It has been suggested that high rates of nitrogen were unfavorable to the palatability of grass and were responsible for the results (Burton, Southwell, and Johanson, 1956). Under Georgia conditions Burton et al. (1956) did not find any evidence to indicate that the heaviest rate of nitrogen (1500 pounds per acre) reduced the palatability of grasses. The protein content, and yield increased with increasing increments of nitrogen up to 1500 pounds of nitrogen per acre.

Several workers have obtained increased yields from nitrogen fertilization when up to 800 pounds of nitrogen per acre were applied annually; (Burton, 1954; Kimbrough et al., 1955; Langford et al., 1955 and McCloud, 1955). Whenever reported, the protein content and protein production per acre have also been increased by nitrogen fertilization. Burton and DeVane (1952) increased the yield of a hybrid bermudagrass

eight times and nearly doubled the protein content by annual applications of 400 pounds of nitrogen per acre. Holt et al. (1951) summarizing the results of research with bermudagrass in Texas pointed out that lack of nitrogen is most often the factor limiting growth of bermudagrass, but phosphorus, and potash may also be needed. Prine et al. (1956) observed that generally, an increase in nitrogen application rate increased the hay yield, protein percentage, protein yield, and nitrate content of the hybrid bermudagrass, but reduced the percentage of nitrogen fertilizer recovered in the hay. Increasing the nitrogen rate resulted in increase in the stem length, plant height, length of longest leaf-blade per stem, number of internodes per stem, and length of internodes but resulted in a decrease in leaf percentage and percentage of stems with seed heads.

Brown and Hollowell (1940) emphasized the variation in chemical composition of some pasture and hay plants as affected by soils and fertilizer. Crampton (1934) and Crampton and Finlayson (1935) found by using rabbits as test animals, that there was a highly significant difference between the nutritive value of herbage from pastures treated with mineral fertilizers and herbage from similar unfertilized pastures. The fertilized treatments were superior in total protein, energy value, mineral contents (calcium and phosphorus) to non-fertilized treatments.

Dotzenko (1961) showed that highly significant increases in the yield of grass forage can be obtained from nitrogen application. Intermediate wheatgrass (Agropyron intermedium) produced the highest yield under high nitrogen rates, followed in order of decreasing yields by tall wheatgrass (Agropyron elongatum), tall fescue (Festuca arundinacea), tall oatgrass (Arrhenatherum elatius), smooth bromegrass (Bromus inermis) and orchard grass (Dactylis glomerata). Nitrogen application increased

the total nitrogen content of the forage. In general, smooth bromegrass had the highest nitrogen content followed in order of decreasing percentage by orchardgrass, intermediate wheatgrass, tall wheatgrass, tall fescue and tall oatgrass. A high rate of nitrogen fertilization resulted in loss of stand, as well as a reduced percentage of nitrogen fertilized recovered in the forage.

Brown and Rouse (1953) under greenhouse and laboratory conditions found that dallisgrass (Paspalum dilatatum) removed more potassium than white clover (Trifolium repens) under five clippings and heavy potash fertilization.

Work of Morris and Celecia (1962) revealed that the time of nitrogen fertilization had a marked effect on the total amount of nitrogen removed by the forages. Fall application of nitrogen to coastal bermudagrass (Cynodon dactylon) resulted in a loss of nitrogen comparable to that of corn (Zea mays) under similar soil and climatic conditions, although the deep root system of coastal bermudagrass would be expected to reduce the loss of nitrogen from leaching. The 4-split nitrogen applications produced the greatest uptake of phosphorus by the forage entirely as a result of the high yields obtained with this treatment. The effect of nitrogen applications on potassium uptake was similar to those obtained with phosphorus.

Gordon et al. (1962) working with orchardgrass found that fertilization with 400 to 1200 pounds of ammonium nitrate produced forage with a markedly higher crude protein and nitrate content and a lower dry matter content than control forage. Nitrogen fertilization has been effective in increasing soluble nitrogen and/or nitrate accumulation (Carey et al., 1952; Ferguson, 1956; Perez et al., 1960; and Sprague

et al., 1950). Working with orchardgrass-ladino clover mixture, Nelson et al. (1957) reported that the total nitrogen uptake increased in the grass and decreased in the clover with increased nitrogen fertilizer rates. Nitrogen uptake in the grass resulting from growing in association with the clover decreased with increased nitrogen applications of 50, 100, 150, and 200 pounds per acre.

Lewis et al. (1957) found that nitrogen application increased the crude protein percentage and yield of all grasses. The highest percentage of crude protein was found in orchardgrass. The nitrogen percentages recovered from the 80 and 160 pound application were 77.6 and 78.8 percent, respectively. Nitrogen fertilizer application increased the calcium content of orchardgrass to the highest degree. This was also true for the phosphorus content of orchardgrass.

Nitrogen availability exerts its influence upon the competitive ability of grasses and legumes, by the fact that nitrogen limits the growth of grasses but not of legumes at low levels of soil nitrogen while at high levels neither species is limited (Wagner, 1954).

Influence of Irrigation on Production and Quality of Grass Forages

All evidence indicates that low soil water suction should be most favorable for rapid uptake of nutrients by plants. According to Richards and Wadleigh (1952) continual removal of water from the soil by plants and evaporation produces a linear or almost linear decrease in water content and a logarithmic increase in water suction until rain or irrigation restores the water balance, usually quickly.

Some of the early experiments on irrigated pastures were conducted at the Huntley Branch Station. Hansen (1924), recommended irrigation intervals of two to four weeks during the grazing season, depending upon conditions of growth and natural rainfall. The object was to keep the surface soil thoroughly supplied with moisture.

Soil moisture extraction by irrigated pasture mixtures as influenced by clipping frequency was studied by Hagen and Peterson (1953) in California. They found that the absorption of moisture under ladino clover grass mixture was confined to the top four feet of soil, while the birdsfoot trefoil-grass mixture extracted throughout the depth of eight feet, below which a clay layer interfered with root activity. They further found that there was very little difference between pasture mixtures on the consumptive use of water. They averaged approximately 0.3 inches of water per day during the hot, dry summer months of July and August.

Myers and Shockly (1955) studied the pattern of moisture extraction by irrigated crops, including forage crops under Idaho conditions. Of the total moisture extracted, about 40 percent came from the upper quarter, 30 percent from the second quarter, 20 percent from the third quarter, and 10 percent from the bottom quarter. They recommended that forage crops should be irrigated when about half of the available moisture in the root zone has been used.

In a study made at Thorsby, Alabama, Bennett et al. (1964) reported that yields of sorghum species increased as available moisture increased with Sart sorghum producing the highest yields at all moisture levels. Under their work the three moisture levels were established as (M-1)-Natural rainfall, (M-2)- and (M-3)- irrigated to field

capacity when 65 and 30 percent, respectively, of available soil moisture was removed from the top 24 inches. The percentage of nitrogen and potassium in the plants decreased with increasing soil moisture, but since irrigation increased yields, total uptake was usually higher with irrigation. Total potassium uptake by millet in the above ground portion of plants at the high soil moisture regime exceeded the amount applied to the soil (initial potassium content of the soil was high). Potassium recovery of the amount applied varied from 55 percent with sudangrass (M-1) to as high as 143 percent with Starr millet (M-3). From 40 to 93 percent of the amount of applied nitrogen was found in the above ground portion of plants, depending upon species and soil moisture regime. Water was used by the plants in proportion to the amount available for evapotranspiration.

Comprehensive literature reviews on the subject have been made by Richards and Wadleigh (1952) and Wadleigh and Richards (1951). The latter two stated that for a given level of fertility, decreasing soil moisture supply is associated with a definite increase in nitrogen content of plant tissue, a definite decrease in potassium content, and a variable effect upon content of phosphorus, calcium, and magnesium. A more recent study by Haddock (1952) indicated that conditions of soil moisture are as important in making phosphorus available to sugar beets as is fertilizer application and placement. His results showed that high moisture was closely associated with increased amounts of soluble phosphorus in the petioles of sugar beets. Jenne et al. (1958) showed no effect of soil moisture stress on the nitrogen and phosphorus percentage of whole corn plants. However, percentages of potassium, clacium, and magnesium in the corn plants increased as the supply of available

soil moisture decreased.

Kilmer et al. (1960) working with the effects of levels of soil moisture on the yield and mineral composition of forage species came to the conclusion that the concentration of nitrogen, sulfur, and boron in the plants was not significantly affected by variations in the soil moisture supply. However, the concentration of phosphorus in all eight species increased as soil moisture supply increased. The general overall effect of increasing the soil moisture supply was to increase the total uptake of all of the major elements.

Richards (1941) stated that the proximity of a water table definitely influences moisture relations in field soils. Under Netherland conditions, Wind (1955) calculated from field measurements that at 10, 15, 20, and 30 centimeter depths practically all movement of water was via soil and only very little water was transported by the roots of forages. At depths less than 10 centimeters the flow of water through roots became important. Obviously there were no water absorbing roots at depths below 10 centimeters. Wesseling and Van Wijk (1955) found that no shortage of water was likely to occur in case of deep drainage (130 centimeters deep or more) in heavy clay soil under Dutch weather conditions.

Retention of excess soil moisture within the root zone may have a detrimental effect on the nutrition and health of plants. Thom and Smith (1938), Russel (1952) and Lowton (1945) point out that the anaerobic decomposition of organic matter frequently produces substances toxic to plant roots.

Boynton (1941) found that the fluctuations of ground water in relatively fine-textured soils were usually well correlated with

fluctuations in oxygen and carbon dioxide percentages of the soil air, particularly in the strata of soil just above the water table. Russell (1952) stated that aeration conditions influence the water economy of plants. Toxic concentrations of carbon dioxide presumably reduce the root permeability through their lethal action of root cells.

Gilbert and Chamblee (1959) working with the effect of depth of water table with and without surface watering on yields of Ladino clover, orchardgrass and tall fescue under North Carolina conditions have shown that without surface watering, the average yields from the lower water tables as compared with the 6-inch depth were 20, 54 and 71 percent higher for Ladino clover, orchardgrass, tall fescue, respectively. The addition of water to the surface resulted in a large increase in yields with orchardgrass and tall fescue grown above the 12-inch, 6- to 20-inch and 20-inch water tables, but a depression in yields above 6-inch water table. Ladino clover had a significant increase in yield from surface watering at all water table depths.

Boehle et al. (1961) stated that alfalfa alone and alfalfa-orhcardgrass made the best use of available subsoil moisture while orchardgrass alone made very poor use of subsoil moisture.

Studies have shown that species of grass vary in rooting depth (Gist et al., 1948), nitrogen requirements, and root penetration (Oswalt, et al., 1950) and slipping decreased moisture use by forages (Doss et al., 1959). Botanical composition changed with different soil moisture regimes (Lorenz et al., 1961).

Influence of Cutting Frequency, Irrigation, and Nitrogen Fertilization on Production and Quality of Grass-Forage

Information is inadequate in this area. Many workers have tried this combination on the yield and botanical composition of grasses and grass mixtures. Mineral uptake by the grasses under the fertilization x clipping x irrigation treatment combinations is yet to attract the attention of researchers.

Robinson and Sprague (1952) found that the oven dry herbage yields on plots receiving neither nitrogen nor irrigation and cut to simulate rotational grazing generally averaged only 2,950 pounds per acre. Nitrogen fertilization greatly increased yields both on irrigated and non-irrigated plots. Either nitrogen fertilizer alone or irrigation alone doubled the yield. There was an increase of yield due to irrigation both under high nitrogen and low nitrogen fertilization. Annual yields on plots receiving both irrigation and nitrogen fertilization, increased to 8,050 pounds per acre.

Schumaker et al. (1961) working with western wheatgrass found that maximum yields resulted with the combination of frequent irrigations and high rates of N-fertilization. Improved water management and nitrogen applications resulted in hay yields considerably higher than under flood management, common in practice. Increased nitrogen rate, increased the nitrogen content of hay on all moisture levels.

Nielson and Robins (1957) showed that the greatest yields per acre were obtained from irrigating at a midsummer frequency of 7 to 11 days, and clipping at a 12-inch height, as compared with midsummer

irrigation frequencies of 15 to 20 or 20 to 30 days, and clipping at a 6-inch level. For a 3-year period, total yield increased with nitrogen fertilizer rates, and conversely the clover percentage decreased. The most frequently irrigated treatments produced the highest percentage of clover in the pasture mixtures. No difference in botanical composition was obtained between the 6- and 12-inch clipping treatments. Application of fertilizer containing 50 pounds of nitrogen per acre in April produced more grass and clover for the season than did a similar application made in June.

Alder (1954) working with a lucerne-grass mixture under British conditions came to the conclusion that crude protein percentage of lucerne showed little response to nitrogen application, while the actual yield was increased one year and depressed the next. Similarly Ridgman et al. (1955) found no difference in percentage nitrogen in nine cuts, but the tenth showed some increase.

Russell et al. (1961) stated that yields of forage doubled with 40 pounds of nitrogen per acre and low moisture level and tripled with 80 pounds of nitrogen per acre and high moisture levels. Frequent clipping reduced the total yield of all treatments at low, medium and high moisture levels.

Blaser and Brady (1950) found that nitrogen fertilizers increased the growth of grasses and decreased that of leguminous plants. As the growth of grasses increased, the amount of potassium removed by the grasses increased. Hence, the concurrent and/or after effect of nitrogen in reducing the leguminous associates was attributed to competition for potassium.

Robinson and Sprague (1952) found that although irrigation markedly increased the orchardgrass yield when well fertilized, it produced high yields during May and June, even without irrigation. Moreover, the growth rate of orchardgrass declined rapidly in last August and September regardless of nitrogen fertilization or irrigation. Thus the main increase in yield from irrigation of nitrogen fertilized orchardgrass was confined to July and August. Nitrogen fertilization of non-irrigated orchardgrass greatly increased the efficiency of water utilization during the dry part of the season.

Brown and Rouse (1953) indicated that based on total potassium removed by five clippings, the grass removed more potassium than clover except where no nitrogen was given. This may be due to either greater soil coverage by their fibrous root system or they are able to absorb potassium from sources that are less available to clover.

Waddington et al. (1965) working on the growth and chemical composition of three grass species affected by the soil aeration concluded that the level of plant nutrients in the root-zone has been observed to affect the ability of plants to withstand poor aeration. Woodford and Gregory (1948) found that growth of plants in unaerated solutions was increased when the nutrient concentration was four times that required for plants grown in aerated solutions. Cline and Erickson (1959) reported that increased fertilizer rates particularly reduced the effects of low oxygen supply.

METHODS AND MATERIALS

This experiment was conducted at the Greenville Experimental Farm, Logan, Utah, during the period of 1960 to 1964.

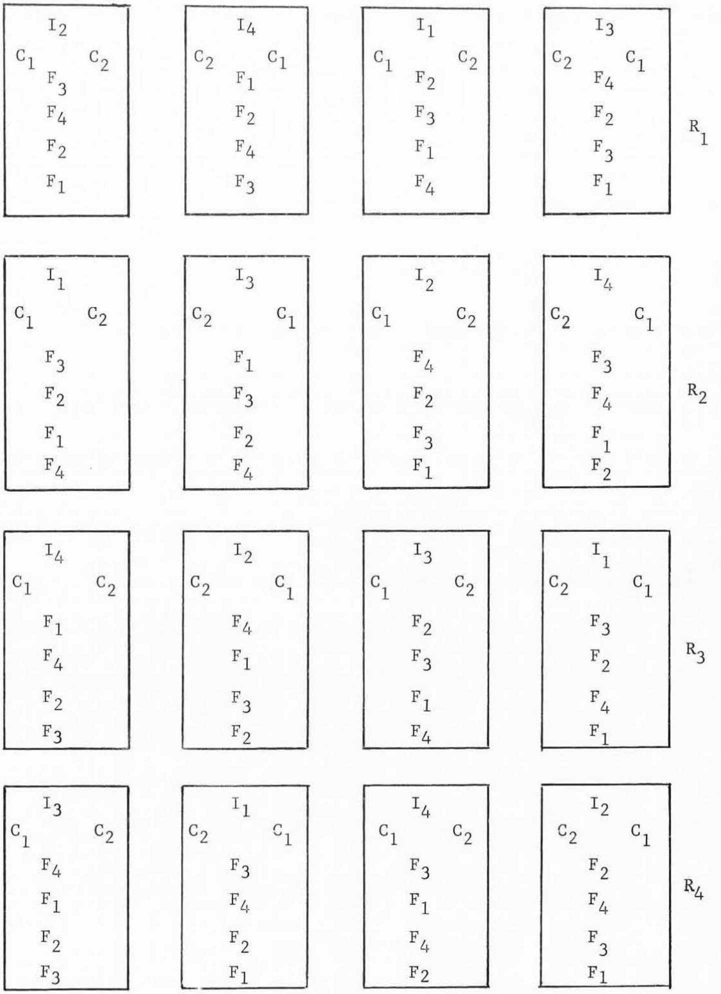
The soil is a Millville silt loam that occurs on an alluvial fan, is well-drained, and has about 1 percent surface slope. The soil is high in potash and phosphorus, and is alkaline, having a pH of 7.9-8.2. It has 2.41 percent organic matter, 2.41 equivalent percent of calcium and magnesium 12.7 parts per million sodium bicarbonate extractable phosphorus, 13.3 milliequivalents per 100-grams base exchange capacity, and .4, .51 and 12.4 milliequivalents per 100-grams exchangeable cations of sodium, potassium and calcium and magnesium, respectively.

The average rainfall for the period of April to September for 1961, 1962, 1963 and 1964 was .85, 1.24, 1.96 and 1.93 inches, respectively.

Experimental Design

The experiment was set up in a factorial arrangement (modified split plot design) in which the whole plots consisted of four moisture intervals with four replications arranged in a latin-square design. The sub-plots were four levels of nitrogen fertilization. The sub-sub-plots were two frequencies of clipping, and the sub-sub-sub-plots were six pasture mixtures. The plan of the layout is given in Figure 1. Size of the smallest experimental unit was 6 x 23 feet.

Plots were seeded April 13-14, 1960. During the establishment year, the plots were uniformly sprinkler irrigated and were clipped twice to control weeds. No treatments were started that year.



The treatment designation is as follows:
R - Replication, I - Irrigation, C - Clipping, F - Fertilization

Figure 1. Design showing replication, irrigation, clipping and fertilization treatments.

The treatments were applied and data were obtained starting in 1961. For convenience, letters were used to designate the different treatments. ("I" for irrigation; "F" for fertilization, and "C" for clipping.)

Irrigation

Water was supplied to the experimental plots with a perforated pipe sprinkler irrigation system. The system was designed to supply approximately one inch of water per hour.

At the start of the 1961 season all of the plots were irrigated uniformly with three inches of water during the period May 8 to May 10. Thereafter, for 1961, water was applied to each of the treatments as follows:

Symbol	Interval	Irrigation number	Dates	Water applied inches
I-1	Long	5	May 8 to May 10, June 1, June 30, July 28, August 21,	18.5
I-2	Medium	6	May 8 to May 10, June 2, June 25 July 13, July 30 August 18	19.0
I-3	Medium short	10	May 8 to May 10, May 24, June 3, June 13, July 6, July 16, July 28, August 7, August 17, August 30	21.0
I-4	Short	19	May 8 to May 10, May 17, June 3, June 7, June 14, June 20, June 29, July 7, July 11, July 16, July 21, July 25, July 29, August 6, August 10, August 13, August 17, August 21, August 27	26.0

In the case of I-1, the number of days between two irrigation dates ranged from 24 to 29 days, whereas for I-2, I-3, and I-4, the interval range was 17 to 22, 10 to 13, and 4 to 6 days, respectively.

Treatments I-1 received approximately four inches of water at each irrigation and I-2, I-3, and I-4 treatments received 3 to 3 1/2, 1 1/2 to 2, and 1 to 1 1/4 inches, respectively.

Soil moisture tension was measured by means of plaster of Paris resistance blocks. They were placed at 6-, 12-, 18-, 24-, 30-, 42-, and 54-inch depths. The tension was read on a Bouyoucos moisture meter calibrated in atmospheres.

Nitrogen Fertilization

Four levels of nitrogen fertilization were used. They included 0, 50, 100, and 200 pounds of nitrogen per acre applied as ammonium nitrate. One hundred and 200 pounds of nitrogen were used as aplit applications in 50-pound increments. The fertilizer was spread with a small three-foot wide Gandi spreader. Approximate dates of application for each of the treatments were as follows:

Symbol	Treatment	Number and dates of application			
	N/A	1	2	3	4
F-1	0	--	--	--	--
F-2	50 pounds	April 20	--	--	--
F-3	100 pounds	April 20	May 29	--	--
F-4	200 pounds	C-1 April 20	May 29	July 1	August 5
		C-2 April 20	May 29	June 26	July 20

In the case of the F-4 treatment, dates of the third and fourth applications were different for the C-1 and C-2 clipping frequencies.

Harvest dates were different for these treatments and the nitrogen fertilizer was applied soon after the forage was harvested.

To assure that sufficient phosphorus was available to the plants, 100 pounds per acre of phosphate (P_2O_5) were broadcast over the entire experimental area in the spring of 1961 and 1963.

Clipping Frequency

Two clipping frequencies were included in the study. Under one clipping treatment, the plots were harvested four times during the season, whereas under the other clipping frequency, the plots were harvested five times. Forage was clipped at the heading stage and to the height of 2 inches at each harvest. The approximate harvest dates under each treatment were as follows:

Symbol	Treatment	Dates of harvest
C-1	4-harvests	May 26 to May 27; June 28 to June 30, August 2 to August 3; September 11 to September 12.
C-2	5-harvests	May 26 to May 27; June 23 to June 24, July 18 to July 19; August 14 to August 15; September 11 to September 12.

Pasture Mixture

Out of six mixtures which were included in the original experiment, only the grass mixture was used for the chemical studies. This was designated as M-6 and consisted of commercial orchardgrass (Dactylis glomerata) and Manchar bromegrass (Bromus inermis).

Yield Data

The forage was cut with the Milbradt plot mower, which had a three-foot sickle bar. Prior to each harvest, the alley-ways were blocked out. Then a swath the width of the mower and 20 feet long was harvested through the middle of each plot for an area of 60 square feet. The total herbage harvested from each strip was weighed green. A sample of 1,000 grams of the cut material was taken in a bag for dry weight, nitrogen, phosphorus, potassium, calcium, copper, iron, manganese, and zinc analysis. The samples were dried in a forced hot-air oven and then reweighed. Resulting data were used to compute the percentage dry weight.

Chemical Analysis

For chemical analysis, all the plots of two replications were sampled for each harvest except the first one. In this first harvest, 48 plots representing all treatments as explained above were sampled for the analysis.

The dried samples were finely ground in a Wiley mill. A one-gram sample was used to determine the total nitrogen, and another one-gram sample to phosphorus, potassium, calcium, copper, iron, manganese, and zinc contents. The nitrogen, phosphorus, potassium and calcium data were determined in percent and copper, iron, manganese, and zinc were in parts per million (ppm).

Procedures for chemical analysis

Nitrogen. A modified Kjeldahl method currently being used at Utah State University was used for nitrogen analysis. Reagents in-

cluded concentrated sulfuric acid, sodium hydroxide solution (40 to 45 percent NaOH by weight), standard 0.0715 N H_2SO_4 and 20 mesh granular zinc.

The digestion mixture used was prepared by mixing copper sulfate (anhydrous powder), sodium sulfate (anhydrous powder), and powdered selenium in a 5:10:0.5 ratio.

The indicator solution was a mixture of brome cresol green.

The ammonia was distilled in two percent boric acid solution and the contents titrated with 0.0715 N H_2SO_4. The procedure followed was essentially the same as given by Jackson (1958).

Phosphorus. Phosphorus was determined with a Beckman, model-B spectrophotometer.

Potassium, calcium, copper, iron, manganese, and zinc. These were determined with a Perkin-Elmer atomic absorption spectrophotometer-303.

The digestion and reading procedures of the above two mentioned instruments for the determination of phosphorus, potassium, calcium, copper, iron, manganese and zinc were as follows:

Digestion procedures

1. Weigh 1 gram of dried 40 mesh plant material into 100 ml volumetric flask.

2. Add 20 ml of concentrated HNO_3, 4 ml of 70-72 percent perchloric acid and 3 ml of concentrated sulfuric acid.

3. Heat the sample on a hot plate under a protected hood until the solution becomes colorless, (1 to 2 ml solution remaining) the flask must not become dry.

4. Cool the flask, add deionized water up to the mark, shake thoroughly, and hold for about eight hours. To eliminate silica, filter the solution through #2 Whatman filter paper.

Phosphorus reading

1. An ammonium-metavanadate-molybdate reagent is required to give the color for reading the Beckman model-B spectrophotometer. This is prepared as follows:

Solution 1: Dissolve 45 grams of ammonium molybdate $(NH_4)_6MO_7O_{24}.4H_2O$ in 800 ml of distilled water and heat to bring into solution; cool.

Solution 2: Dissolve 2.5 grams of ammonium vanadate (meta) NH_4VO_3 in 600 ml of boiling water, cool, add 500 ml of concentrated HNO_3, and cool again.

Pour solution 1 into solution 2 and dilute to 2 liters. Mix these thoroughly.

2. Pipette a 10 ml aliquot, from digestion procedure #4 above into a 50 ml beaker,

3. Add 30 ml of distilled water, and stir with glass rod,

4. Add 10 ml of mixed ammonium vanadate-molybdate reagent; stir,

5. Read on the Beckman, model-B spectrophotometer exactly 30 minutes after adding the reagent. Use No. 440 blue filter.

6. First setting on the spectrophotometer should be obtained with a blank using only reagents known to be pure.

7. Standard curves were obtained by using 0.5, 1, 2, 3, 4, and 5 ml of standard phosphorus solution (50 ppm 0.2196 gram KH_2PO_4 [potassium monophosphate] per liter).

Potassium reading

1. Pipette a 10 ml aliquot from digestion procedure #4 above into a 100 ml volumetric flask and dilute with distilled water to mark.

2. Run directly on the Perkin-Elmer atomic absorption spectrophotometer-303, using standard solutions for reference and the tube prescribed in their machine manual (dilution factor-1000).

Calcium reading

1. A lanthanum chloride reagent is required. This is prepared as follows:

Dissolve 50.9 grams of 2 percent lanthanum chloride ($LaCl_3 6H_2O$) in 1000 ml of distilled water.

2. Pipette a 5 ml aliquot from 1 under potassium above into a 5 ml beaker.

3. Add 5 ml of lanthanum chloride reagent.

4. Mix with glass rod and run on Perkin-Elmer atomic absorption spectrophotometer-303, using standard solutions for reference and a tube as prescribed in their machine manual (dilution factor-2000).

Copper, iron, manganese, and zinc reading

1. Run the aliquot #4 in digestion procedure directly on Perkin-Elmer atomic absorption spectrophotometer-303, using standard solutions for reference and tubes for each one of these elements respectively, as prescribed in their machine manual, (dilution factor-100).

Computing Procedure

Three standard solutions having known concentrations of the metal to be determined in the same solvent as that of samples were prepared. These standard concentrations bracketed the expected concentration in the sample.

Percent absorption was read from the spectrophotometer as described in the machine manual, for the sample and each of the three

standard solutions in the following sequence: standards, sample, standards, sample, standards. The readings for each standard were averaged and converted from the average percent absorption to absorbance using Table III in the machine manual. The working curve of absorbance versus concentration was plotted. The readings for the sample were averaged and converted to absorbance. The concentration of each sample was determined with the working curve.

EXPERIMENTAL RESULTS AND DISCUSSION

Experimental results and discussion of the dry matter yield and mineral composition of the orchardgrass-bromegrass pasture mixture as influenced by clipping frequency, nitrogen fertilization and irrigation regimes for the years 1961, 1962, 1963, and 1964 will be presented in the following order: average dry matter yield in tons per acre, nitrogen, phosphorus, potassium and calcium in percent and copper, iron, manganese and zinc in parts per million for the C-1 and C-2 frequencies.

The analyses of variance for the above studies are given in the appendix in Tables 45 through 62. Tables 45 and 46 contain the analyses of variance for dry matter yield within C-1 and C-2 frequencies, respectively. Tables 47 to 54 contain the analyses of variance for nitrogen, phosphorus, potassium, and calcium contents and Tables 55 to 62 contain the analyses of variance for copper, iron, manganese and zinc, respectively.

Average Dry Matter Yield as Influenced by the Different Treatments and Their Combinations

The analyses of variance for average seasonal dry matter yield given in Tables 45 and 46 of the appendix for the C-1 and C-2 frequencies, respectively, show that the "F" values for all the main effects, viz. years, irrigations, nitrogen fertilizations and harvests were highly significant. Some first order and second order interactions were also significant or highly significant. The third order interaction, viz.

year x irrigation x nitrogen fertilization x harvest was nonsignificant within both clipping frequencies.

Response to years

The response of the orchardgrass-bromegrass pasture mixture to years on seasonal dry matter yield is presented in Table 1. The yields were significant at .05 level within C-1 and at .01 level within the C-2 frequency.

In the years 1961 and 1964 the dry matter yields were higher than in 1962 and 1963, under both frequencies. The year 1963 was lowest in dry matter production. The amounts were 2.20 and 2.05 tons per acre within C-1 and C-2 frequencies, respectively. The dry matter yields were higher every year within the C-1 than within the C-2 frequency, which shows the influence of number of cuttings per year on yield of forage. Allred (1965), while working with grasses, found that there was a tendency for four clippings per year to give higher yields than five clippings per year. Everson (1966) observed a progressive decrease in yield of tops when clipped many times. In this experiment, the C-2 frequency had less yield in the years 1962, 1963, and 1964 than the yields for the same years under C-1. The differences were .22, .15 and .15 tons per acre, respectively.

Response to irrigation

The effect of irrigation on over-all dry matter production of the grass pasture mixture is shown in Table 2. The results are graphed in Figure 2. The yield differences within each irrigation level were highly significant under both clipping frequencies. Treatment I-4 (most frequent irrigation) gave the highest yields. On the other hand

Table 1. Effect of years on average dry matter yield for C-1 and C-2 clipping frequencies (1961-1964)

Year	Tons per acre C-1	C-2	Ave.
1961	2.48	2.45	2.47
1962	2.32	2.10	2.21
1963	2.20	2.05	2.13
1964	2.40	2.25	2.38
Ave.	2.35	2.21	
LSD: 5% - 0.044	5% - 0.041 1% - 0.057		

Table 2. Effect of irrigation on the average dry matter yield for C-1 and C-2 clipping frequencies (1961-1964)

Irrigation	Interval	Tons per acre C-1	C-2
1	Long	2.08	1.90
2	Medium	2.16	2.15
3	Medium-short	2.52	2.25
4	Short	2.68	2.55
	Ave.	2.36	2.21
		(2.28)	
	LSD: 5% - 0.04 1% - 0.06		5% - 0.04 1% - 0.05

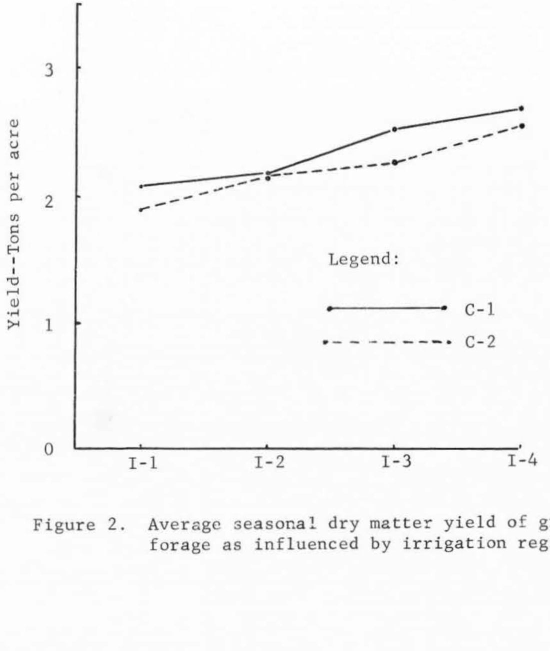


Figure 2. Average seasonal dry matter yield of grass forage as influenced by irrigation regime.

I-1 (irrigation at long intervals) gave the lowest production. There was also a significant difference between the I-1 and I-2 or I-2 and I-3 treatments. I-4 within C-1 produced .60 and within C-2, .65 tons per acre higher dry matter yields than the I-1 treatment. Kilmer et al. (1960) observed that grasses are less responsive to irrigation levels than legumes. However, the growth response was as much as twice in yield production when the grasses were provided with 7.24 inches of water over the grasses provided with only 2.64 inches. Bennett et al. (1964) showed that yields of dry matter increased as the available moisture increased in sweet sudangrass, Starr millet and Sart sorghum forages.

Response to nitrogen fertilization

The influence of nitrogen fertilization on the average dry matter yield is shown in Table 3. The results are graphed in Figure 3. It will be seen from Figure 3 that the dry matter production increases with the increase in nitrogen fertilizer. The highest yields were obtained when the plots were fertilized with 200 pounds of nitrogen (F-4). These results are the same under both clipping frequencies. When 100 pounds (F-3) and 200 pounds (F-4) of nitrogen were applied, however, the difference in forage yields increased to 1.40 and 1.25 tons per acre under C-1 and C-2 frequencies, respectively. With the increment of 50 pounds of nitrogen per acre, a significant increase in overall production of forage was obtained. With no nitrogen (F-1), the dry matter yields obtained were 1.08 and 1.20 tons per acre within C-1 and C-2 frequencies, respectively. Nitrogen fertilization showed slightly higher response at all the levels within the C-1 than within the C-2 frequency.

Table 3. Effect of nitrogen fertilization on average dry matter yield for C-1 and C-2 clipping frequencies

Fertilization	Tons per acre		
	C-1		C-2
F-1	1.08		1.20
F-2	1.88		1.80
F-3	2.48		2.30
F-4	3.88		3.55
Ave.	2.33		2.21
		(2.27)	
LSD: 5% - 0.04 1% - 0.05		5% - 0.03 0.04	

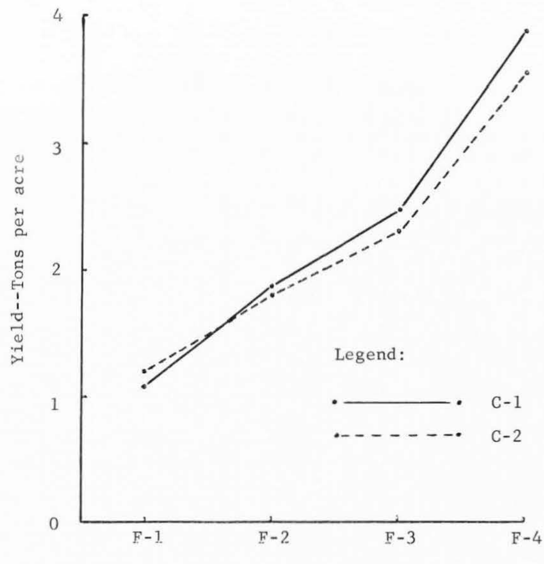


Figure 3. Average seasonal dry matter yield of grass forage as influenced by nitrogen fertilization.

Walter et al. (1954) estimated that grasses could utilize all the available nitrogen up to 300 pounds per acre and that while two-thirds of this nitrogen may be harvested, the other third was utilized in building up the root system of grasses. Dorvat (1960) concluded that grasses were not able to produce a maximum yield under a high fertilizer regime without the presence of added potassium. MacLeod (1965) showed that timothy was the highest yielding grass at all nitrogen fertilization rates followed by the orchardgrass and bromegrass. Dry matter yield of each species was increased significantly by nitrogen fertilization. All these results show a similar trend to that obtained in this study.

Response to different harvests

The response of forage production to different harvests appears in Table 4. The results are presented in Figure 4. Under C-1 the yields were higher at all harvests than under the C-2 frequency. A consistent decrease in yield was noted from first to fourth harvest under C-1. This was also true under C-2. Van Riper and Smith (1959) observed a similar decrease in dry matter yields with advance in maturity of grasses. They have shown that the yield of dry matter was higher during the spring than during summer at each stage of growth. Bromegrass produced only 21 percent as much dry matter during the summer as during the spring. Biswell et al. (1933), Cook and Stoddart (1953) Dwyer et al. (1963) and many other workers observed that the yields of forages and plant nutrients are inversely related to the frequency and intensity of defoliation. Results of the studies of Conrad (1954), Cook and Stoddart (1958), Justus and Thurman (1955) and Wagner (1952) showed that the more frequent and severe the defoliation treatment, the greater the reduction of dry matter yield.

Table 4. Effect of different harvests on the dry matter yield for C-1 and C-2 clipping frequencies

Harvests	Tons per acre C-1	Tons per acre C-2
1	0.98	0.83
2	0.95	0.54
3	0.44	0.39
4	0.32	0.30
5	--	0.14
Ave.	0.67	0.44
LSD: 5% - 0.032 1% - 0.042		5% - 0.03 1% - 0.04

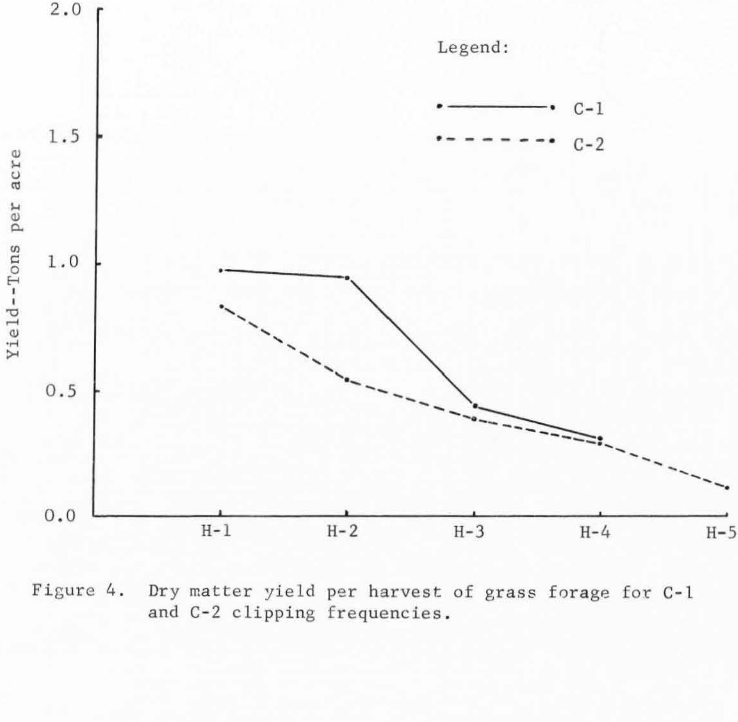


Figure 4. Dry matter yield per harvest of grass forage for C-1 and C-2 clipping frequencies.

Interaction of year x nitrogen fertilization

The effect of this interaction on the dry matter production appears in Table 5. The results are presented in Figure 5 for C-1 and Figure 6 for C-2. This interaction was highly significant under C-2, whereas, it was significant at the 5 percent level under C-1. F-4 (200 pounds of nitrogen per season) gave the highest increase in dry matter production, under both C-1 and C-2 for all four years. This increase was followed by F-3 (100 pounds of nitrogen per season) and F-2 (50 pounds of nitrogen per season). F-1 (no fertilizer) gave very small yields for all four years. The difference in dry matter yields between F-4 and F-1 was 2.56 tons per acre in 1961 and 3.28 tons per acre in 1964, respectively. F-2 and F-3 were intermediate. Under C-2, F-4 decreased the dry matter production in 1961. All fertilizer levels slightly depressed the yield during 1962 and 1963 as compared to the yields during 1961. At F-1, the dry matter yields progressively decreased over years. At F-2, F-3, and F-4, the dry matter yields decreased in 1962 as compared to 1961 but increased in 1963 and 1964 under both the frequencies. These trends were similar to the results found by Allred (1965) and MacLeod (1965).

Interaction of year x harvest

The influence of the interaction of year x harvest on dry matter production is shown in Table 6. The results are presented in Figures 7 and 8. This interaction was highly significant under both C-1 and C-2. It will be seen from Figures 7 and 8 that H-1 gave the highest yields all four years under both C-1 and C-2. The lowest yields were obtained for H-4 under C-1 and for H-5 under C-2. H-2 gradually

Table 5. Average dry matter yield as influenced by year and nitrogen fertilization for C-1 and C-2 clipping frequencies

	Tons per acre									
	C-1					C-2				
Year	F-1	F-2	F-3	F-4	Ave.	F-1	F-2	F-3	F-4	Ave.
1961	1.32	2.04	2.72	3.88	2.49	1.30	2.20	2.70	2.50	2.18
1962	1.04	1.72	2.48	3.96	2.30	1.20	1.55	2.05	3.55	2.09
1963	1.00	1.72	2.36	3.76	2.21	1.20	1.50	2.15	3.45	2.08
1964	0.92	2.04	2.44	4.20	2.40	1.10	1.85	2.35	3.75	2.26
Ave.	1.07	1.88	2.50	3.95	2.35	1.20	1.78	2.31	3.31	2.15

Table 6. Average Dry matter yield per year as influenced by harvest for C-1 and C-2 clipping frequencies

	Tons per acre										
	C-1					C-2					
Year	H-1	H-2	H-3	H-4	Ave.	H-1	H-2	H-3	H-4	H-5	Ave.
1	1.12	0.54	0.44	0.35	0.62	1.21	0.50	0.31	0.22	0.20	0.49
2	0.83	0.63	0.44	0.41	0.58	0.60	0.52	0.51	0.33	0.13	0.42
3	0.86	0.66	0.40	0.29	0.55	0.57	0.65	0.37	0.34	0.13	0.41
4	1.13	0.54	0.49	0.24	0.60	0.95	0.49	0.38	0.32	0.11	0.45
Ave.	0.99	0.59	0.44	0.33	0.59	0.83	0.54	0.39	0.30	0.14	0.44

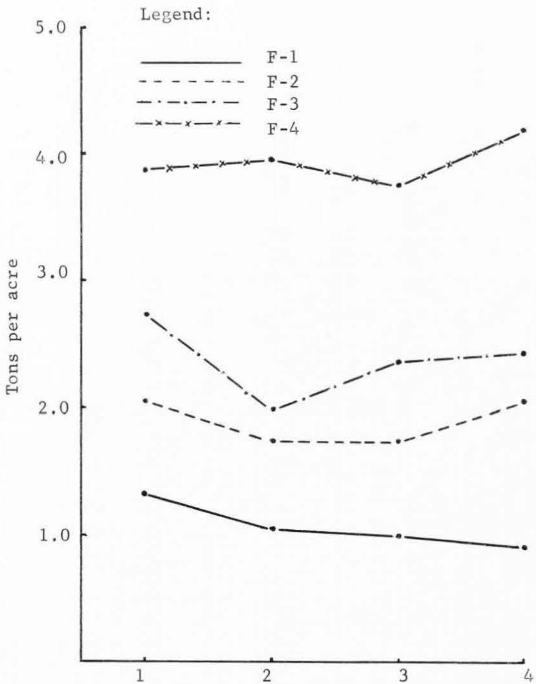


Figure 5. Average dry matter yield per year as influenced by nitrogen for the C-1 clipping frequency.

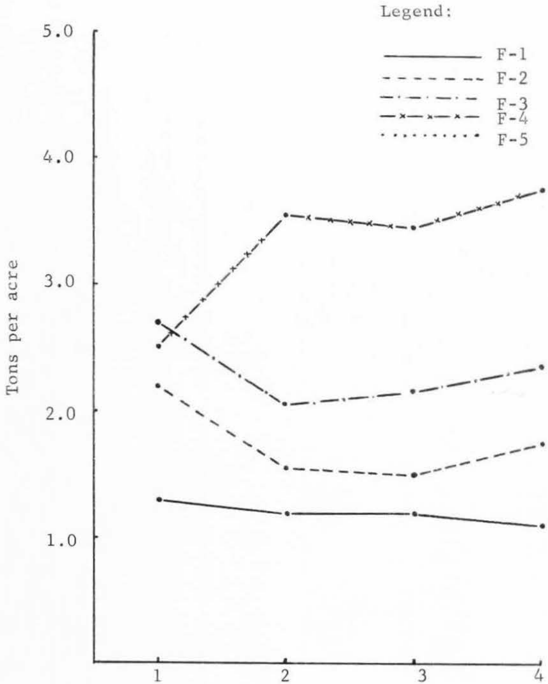


Figure 6. Average dry matter yield per year as influenced by nitrogen for the C-2 clipping frequency.

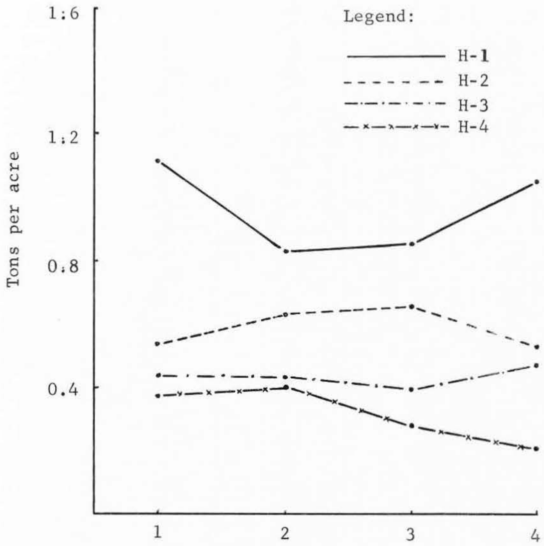


Figure 7. Average dry matter yield per year as influenced by the different harvests for the C-1 clipping frequency.

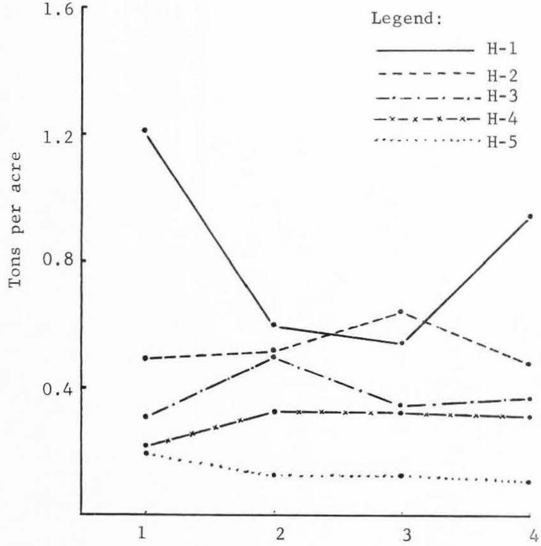


Figure 8. Average dry matter yield per year as influenced by the different harvests for the C-2 clipping frequency.

increased for the first three years for both C-1 and C-2 but dropped the fourth year. H-3 maintained yields for the first three years and increased the fourth year under C-1, whereas it did not show any trend under C-2. H-4 showed a similar trend to H-2 under C-1 and a gradual increase in all four years under C-2. To repeat it breifly again H-1 decreased the second year and increased subsequently. H-4 increased the second year and decreased the next three years. H-2 and H-3 differences over years were small. The main source of the interaction in both C-1 and C-2 appeared to be the differences between H-1 and H-4. Burton et al. (1963) working with coastal bermudagrass showed that the annual dry matter yield of bermudagrass increased for 12 weeks and decreased afterwards. No data showing the influence of season on dry matter production is available. Some references however, are available to show the effect of stage of maturity in a season on dry matter production. Under Wisconsin conditions Van Riper and Smith (1959) concluded that the most favorable time to harvest grasses in order to obtain an optimum yield of desirable nutrients and a minimum yield of undesirable nutrients, generally occurred when forages approached 1/10 bloom stage of growth during both spring and summer periods.

Interaction of nitrogen fertilization x harvest

The average dry matter yield as influenced by this interaction is shown in Table 7. The results are graphed in Figures 9 and 10. It will be seen from Figures 9 and 10 that F-4 (200 pounds of nitrogen per season) greatly increased dry matter yield at all harvests. The increase was followed by F-3 (100 pounds nitrogen per season) and F-2 (50 pounds of nitrogen per season). F-1 (no fertilizer) gave the lowest yields at

Table 7. Average dry matter yield per harvest as influenced by nitrogen fertilization for C-1 and C-2 clipping frequencies

	Tons per acre									
	C-1					C-2				
Harvest	F-1	F-2	F-3	F-4	Ave.	F-1	F-2	F-3	F-4	Ave.
1	0.46	1.15	1.11	1.21	0.98	0.45	0.96	0.97	0.95	0.83
2	0.22	0.35	0.87	0.94	0.60	0.26	0.35	0.75	0.79	0.54
3	0.22	0.24	0.36	0.96	0.45	0.21	0.24	0.34	0.79	0.40
4	0.16	0.16	0.16	0.84	0.33	0.18	0.15	0.18	0.70	0.30
5	--	--	--	--	--	0.10	0.08	0.08	0.32	0.15
Ave.	0.27	0.48	0.63	0.99	0.59	0.24	0.36	0.46	0.71	0.44

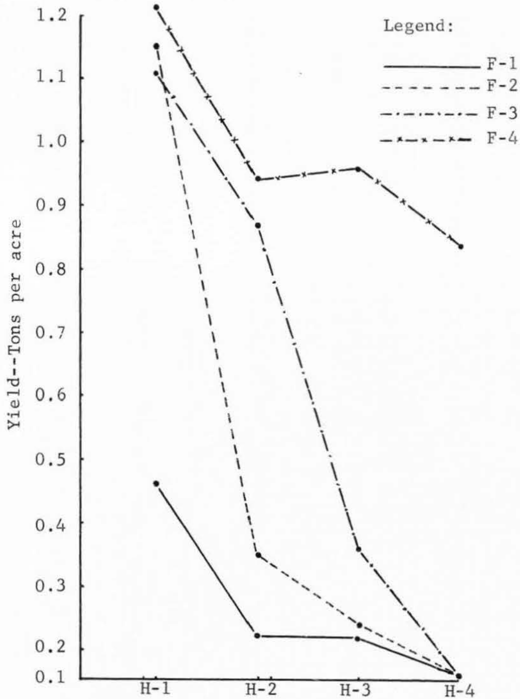


Figure 9. Average dry matter yield per harvest as influenced by nitrogen fertilization for the C-1 clipping frequency.

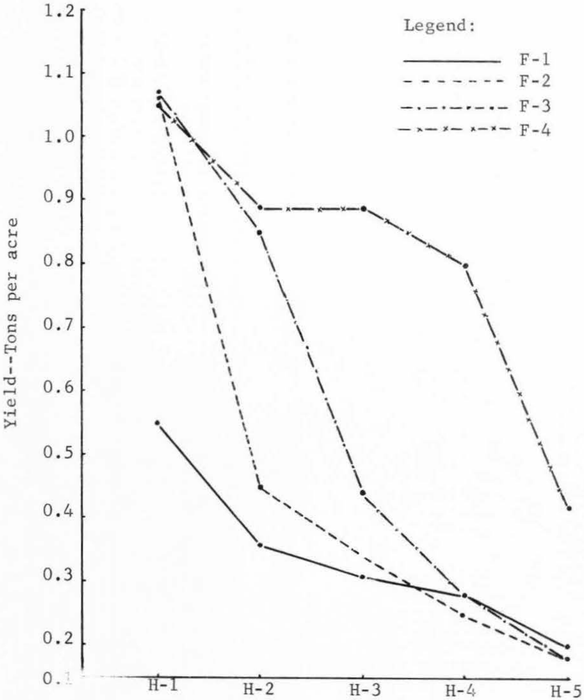


Figure 10. Average dry matter yield per harvest as influenced by nitrogen fertilization for the C-2 clipping.

every harvest. At F-4, the dry matter production decreased for H-2, maintained through H-3 and again decreased for H-4 and H-5. This trend was similar under both C-1 and C-2. At F-3, F-2 and F-1 there was a gradual decrease in dry matter production at the subsequent harvests. The dry matter production at F-2 and F-3 was even lower than F-1 for H-5 under the C-2 frequency. Allred (1965), and Schmidt and Tenpas (1965) reported a 35 percent increase in grass forage yield after receiving heavy doses of nitrogen if harvested at the same time. MacLeod (1965) indicated that, nitrogen, especially at higher rates, increased the competition index of bromegrass at each harvest. However, he also cautioned to restrict harvests to four per season in order to get economic yields.

Interaction of year x irrigation x harvest

Only two of the second order interactions were highly significant under both clipping frequencies. One of them was year x irrigation x harvest. In addition to irrigation, the factors involved in this interaction are the same as those just discussed, and therefore it may be appropriate to discuss it at this place. The average dry matter yields as influenced by this interaction are presented in Table 8. The results show that dry matter of grass forage increased progressively for all years and for all harvests as the frequency of irrigation was increased under both C-1 and C-2. The point to be noted here is that the grass pasture mixture gave higher yields for C-1 than C-2 for all years and all harvests. The highest yields were obtained for H-1 in the first year and when the plots were irrigated at five-day intervals (I-4). They were 1.34 and 1.40 tons per acre for C-1 and C-2, respectively. The dry matter production decreased sharply despite short intervals of irrigation, as the stand of grass

Table 8. Average dry matter yield per harvest as influenced by year, irrigation for C-1 and C-2 clipping frequencies

Harvest	Year	Tons per acre C-1 I-1	C-1 I-2	C-1 I-3	C-1 I-4	C-2 I-1	C-2 I-2	C-2 I-3	C-2 I-4
H-1	1	1.01	1.06	1.06	1.34	1.07	1.23	1.14	1.40
	2	.76	.81	.87	.87	.50	.63	.59	.68
	3	.67	.80	1.00	.98	.49	.58	.58	.66
	4	1.10	1.12	1.22	1.07	.94	.96	1.02	.90
		.89	.95	1.04	1.07	.75	.85	.83	.91
H-2	1	.38	.56	.48	.75	.39	.46	.54	.63
	2	.55	.63	.67	.66	.45	.52	.56	.53
	3	.68	.63	.67	.66	.63	.70	.63	.63
	4	.56	.45	.63	.54	.44	.51	.51	.51
		.54	.57	.61	.65	.48	.55	.56	.58
H-3	1	.49	.35	.37	.56	.22	.45	.19	.36
	2	.30	.43	.55	.48	.45	.40	.55	.65
	3	.31	.33	.45	.50	.36	.32	.40	.42
	4	.40	.46	.52	.59	.25	.29	.49	.51
		.58	.39	.47	.53	.32	.37	.41	.49
H-4	1	.25	.27	.44	.57	.15	.15	.24	.32
	2	.30	.31	.50	.52	.31	.28	.31	.43
	3	.29	.19	.37	.30	.30	.28	.35	.42
	4	.20	.22	.26	.26	.32	.33	.35	.27
		.26	.25	.39	.41	.27	.26	.31	.36
H-5	1	--	--	--	--	.17	.19	.20	.25
	2	--	--	--	--	.06	.11	.15	.21
	3	--	--	--	--	.07	.14	.17	.16
	4	--	--	--	--	.06	.07	.10	.21
						.09	.13	.16	.21

mixture became old and harvesting was continued up to either 4 under C-1 or 5 under C-2. The lowest yields were obtained for H-5 for all the years and for all irrigation intervals under C-2 as compared to the yields of same treatments under C-1.

Interaction of year x nitrogen fertilization x harvest

This is the second interaction which was highly significant under both C-1 and C-2. The data for this interaction are presented in Table 9. The dry matter production progressively increased each year and each harvest as the nitrogen fertilization was increased. It was the highest for all years and for all harvests when the nitrogen was applied at the rate of 200 pounds per season (F-4). Production was fairly uniform from one year to the next year under similar treatments. The highest yields were obtained for 1961 and 1964 when the plots were fertilized with 200 pounds of nitrogen and cut the first time (H-1), for C-1 and C-2, respectively. The yields decreased progressively as the stand of grass mixture became old for each harvest in spite of nitrogen fertilization. The lowest yields were obtained at all nitrogen fertilizer levels and in all years when the plots were cut five times (H-5) under C-2.

The other first order, second order and third order interactions were non-significant within both C-1 and C-2. The dry matter yield as influenced by year x irrigation x nitrogen fertilization x harvest are presented in appendix Tables 63 and 64 within C-1 and C-2 frequencies, respectively. These data show, how the distribution of dry matter production was spread throughout the four seasons under different treatment combinations.

Table 9. Average dry matter yields per harvest as influenced by years, and nitrogen fertilization for C-1 and C-2 clipping frequencies

		Tons per acre							
		C-1				C-2			
Harvest	Year	F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
	1	.61	1.25	1.21	1.40	.68	1.42	1.37	1.37
	2	.38	1.0	.98	.95	.29	.68	.75	.67
H-1	3	.50	.98	.95	1.02	.38	.64	.63	.64
	4	.42	1.36	1.29	1.46	.45	1.11	1.12	1.15
	1	.24	.29	.82	.82	.22	.32	.73	.74
	2	.19	.35	.97	1.02	.29	.34	.69	.75
H-2	3	.23	.40	.97	1.05	.28	.44	.93	.95
	4	.23	.36	.70	.89	.24	.32	.65	.75
	1	.24	.25	.42	.86	.14	.20	.30	.58
	2	.25	.19	.33	.99	.30	.27	.38	1.11
H-3	3	.19	.24	.32	.84	.19	.23	.34	.73
	4	.22	.26	.36	1.13	.20	.24	.34	.75
	1	.25	.24	.25	.79	.12	.15	.17	.42
	2	.24	.19	.18	1.00	.20	.16	.17	.81
H-4	3	.10	.11	.11	.83	.27	.13	.18	.78
	4	.74	.72	.08	.72	.14	.15	.20	.79
	1	--	--	--	--	.13	.12	.14	.42
	2	--	--	--	--	.14	.11	.07	.21
H-5	3	--	--	--	--	.07	.06	.09	.33
	4	--	--	--	--	.05	.03	.05	.31

Influence of Treatments on Nitrogen Content of Pasture Mixture Within C-1 and C-2 Frequencies

The data for nitrogen percentage of the orchardgrass-bromegrass mixture were analyzed separately under C-1 and C-2 frequencies. The analyses of variance for the C-1 and C-2 frequencies are given in Appendix Tables 47 and 48, respectively.

The analyses of variance show that the "F" values for main effects, viz. years, irrigations, nitrogen fertilizations, and harvests were highly significant. The "F" values of some of the first order and second order interactions were also significant to highly significant under both C-1 and C-2.

Response to years

The nitrogen content of the grass pasture mixture under both C-1 and C-2 is given in Table 10. The differences were highly significant. Results in C-2 show that for each year the nitrogen content was higher than in the C-1 frequency. This indicates that yields of forage and nitrogen content are inversely related to the frequency and intensity of defoliation. Similar results were obtained by Harlan (1960), Holscher (1945), Neiland (1956) and Pond (1961). Under the C-1 frequency the forage was clipped at an interval of 35 days, whereas, under the C-2 frequency, it was clipped at an interval of 28 days. The difference between 1961 and 1964 was not significant but it was highly significant between 1961 and 1962, 1961 and 1963, and 1962 and 1963. This trend was the same under both C-1 and C-2. The highest

Table 10. Effect of year on average nitrogen content for C-1 and C-2 clipping frequencies

Year	C-1	C-2	Ave.
1961	2.28	2.56	2.42
1962	2.39	2.69	2.54
1963	2.49	2.82	2.65
1964	2.29	2.58	2.43
Ave.	2.36	2.66	
LSD: 5% - 0.066 1% - 0.093	0.0699 0.0981		

nitrogen content was found in 1963 under both clippings. The amounts were 2.49 and 2.82 percent respectively. Newell and Keim (1947) showed that the tissues that regrow after defoliation have a high percentage of crude protein. These and many other workers' results show a similar trend for nitrogen content as found in these studies.

Effect of irrigation on nitrogen content

The overall influence of irrigation on nitrogen content of forage within the C-1 and C-2 frequencies is given in Table 11. The results are presented in Figure 11. The "F" values of this main effect were highly significant under both C-1 and C-2. From Figure 11 it can be seen that the effect of high soil moisture regime on nitrogen content is not very favorable. The nitrogen content of grass plants generally decreased under wet conditions. These results are similar to the results of Thomas and Heilman (1967). Janes (1948), Nelson (1925) working with snap beans and Thomas et al. (1942) working with tomatoes, indicated that the nitrogen content of the leaves of these crops was reduced when the moisture regimes were increased. Similar observations were also made by Emmert (1936) on tomato leaves. The nitrogen content was the highest at I-1 under both C-1 and C-2. The amounts were 2.43 and 2.74 percent, respectively. The lowest nitrogen content was at I-4. The amounts were 2.28 and 2.58 percent for C-1 and C-2, respectively. The content of nitrogen was higher at all the irrigation levels under C-2 than under C-1. This is attributed to the effect of short intervals between harvests under C-2 which will be seen in more detail under the harvest treatment.

Table 11. Effect of irrigation on the average nitrogen content for C-1 and C-2 clipping frequencies

Irrigation	Percent	
	C-1	C-2
I-1	2.43	2.74
I-2	2.37	2.68
I-3	2.37	2.67
I-4	2.28	2.58
Ave.	2.36	2.67
LSD: 5% - 0.066		0.07
1% - 0.093		0.10

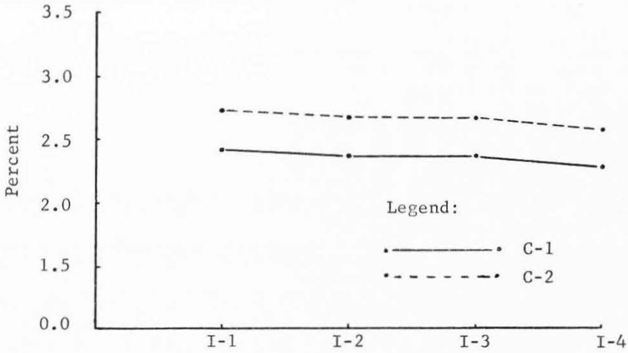


Figure 11. Average nitrogen content of grass forage as influenced by irrigation regimes for the C-1 and C-2 clipping frequencies.

Effect of nitrogen fertilization on nitrogen content

This main effect is represented in Table 12. The results are graphed in Figure 12. Figure 12 shows that under C-2 the nitrogen content of grass plants was higher than under C-1. This again indicates the effect of short intervals in cutting forage. These results are similar to Allred's (1965). The data in Table 12 show that there was a decrease in nitrogen content as the nitrogen fertilization increased up to 100 pounds per acre. Whereas, when the plots were fertilized with 200 pounds per acre (F-4), the nitrogen content increased by .13 and .16 over the F-3 level (100 pound per acre), under both C-1 and C-2, respectively. MacLeod (1965) observed that application of 200 pounds of nitrogen increased the nitrogen content in the grass plants by over 30 percent. Timothy showed the lowest percentage of total nitrogen at all but the highest rate of nitrogen fertilization but it was slightly higher than orchardgrass. Under these studies, the lowest nitrogen content was obtained for F-3. This was true for both C-1 and C-2. The amounts were 2.24 and 2.58 percent under C-1 and C-2, respectively. This trend was similar to the results obtained by Carey et al. (1952).

Effect of different harvests on nitrogen content

The nitrogen content as influenced by different harvests is presented in Table 13. The results are graphed in Figure 13. The "F" value for this main effect was highly significant under both clipping frequencies. Here again the nitrogen content was higher for each harvest under the C-2 than the C-1 frequency. The nitrogen content increased at each succeeding

Table 12. Effect of nitrogen fertilization on average nitrogen content for C-1 and C-2 clipping frequencies

Fertilization	Percent		
	C-1		C-2
F-1	2.43		2.67
F-2	2.41		2.66
F-3	2.24		2.58
F-4	2.37		2.74
Ave.	2.36	(2.51)	2.66
LSD: 5% - 0.075			0.07
1% - 0.100			0.09

Table 13. Effect of different harvests on the nitrogen content for C-1 and C-2 clipping frequencies

Harvests	Percent	
	C-1	C-2
1	1.97	2.30
2	2.30	2.50
3	2.46	2.68
4	2.72	2.93
5	--	2.92
Ave.	2.36	2.67
LSD: 5% - 0.058		0.05
1% - 0.076		0.07

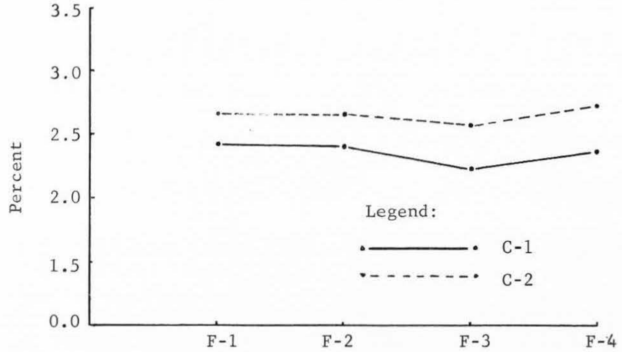


Figure 12. Average nitrogen content of grass forage as influenced by nitrogen fertilization for the C-1 and C-2 clipping frequencies.

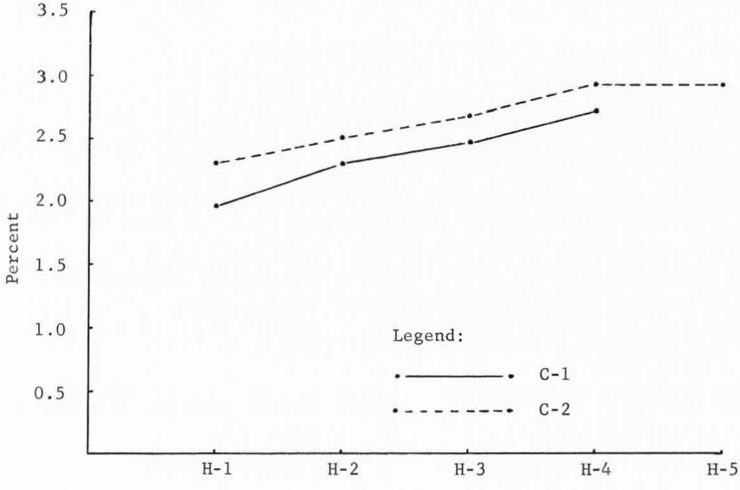


Figure 13. Average nitrogen content per harvest of grass forage the C-1 and C-2 clipping frequencies.

harvest. The lowest values were obtained for H-1. The nitrogen contents for H-1 were 1.97 and 2.30 percent under C-1 and C-2, respectively.

Effect of interaction of year x harvest on nitrogen content

The influence of the year x harvest interaction on nitrogen percentage under the C-1 and C-2 frequencies is shown in Table 14. The results are graphed in Figures 14 and 15 for C-1 and C-2, respectively. These figures show that nitrogen content increased until 1963 except for H-2. They decreased in 1964 at all harvests under both frequencies. H-1 showed a sharp decrease in 1964 under both C-1 and C-2. H-2 gradually increased for the first two years, and dropped in 1963, and again increased slightly in 1964. H-3 increased for all four years under C-2. H-4 showed a similar trend to H-1 with overall higher nitrogen content than H-1, for both clippings. H-5 for C-2 produced the higher nitrogen content in 1962 and 1963, than H-4 in the same years. However, it had a similar trend to H-2. These results show that the fourth harvest was better in nitrogen content for all four years. The influence of seasons on the nitrogen content of forages has not yet attracted the interest of research workers. However, some results are available on the influence of maturity of grass forages on chemical content. Van Riper and Smith (1959) found that bromegrass grown with alfalfa was noticeably higher in percentage of protein during the summer than during the spring. Adam et al. (1967) working with bermudagrass indicated that the percentage nitrogen in forage was higher at the July harvest than the June harvest, declined at the August harvest and increased again at the October harvest. Further, they concluded that the higher nitrogen content in July was probably influenced by the weather conditions resulting in accelerated nitri-

Table 14. Average nitrogen content per year as influenced by harvest for C-1 and C-2 clipping frequencies

	Percent										
	C-1					C-2					
Year	H-1	H-2	H-3	H-4	Ave.	H-1	H-2	H-3	H-4	H-5	Ave.
1	1.90	2.22	2.32	2.68	2.28	1.85	2.43	2.68	3.03	2.84[d]	2.57
2	1.94	2.44	2.50	2.67	2.37	2.50	2.60	2.50[d]	2.85[d]	2.99	2.69
3	2.30	2.20	2.57	2.90	2.49	2.86	2.46[d]	2.77	3.00	3.04	2.83
4	1.75	2.33	2.45	2.64	2.29	1.98[d]	2.52	2.76	2.85[d]	2.80[d]	2.58
Ave.	1.97	2.30	2.46	2.72	2.36	2.30	2.50	2.68	2.93	2.92	2.67

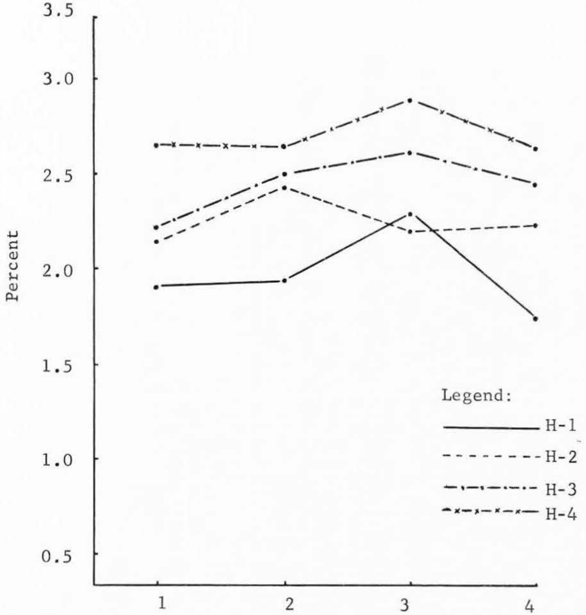


Figure 14. Average nitrogen content per year as influenced by the different harvests for the C-1 clipping frequency.

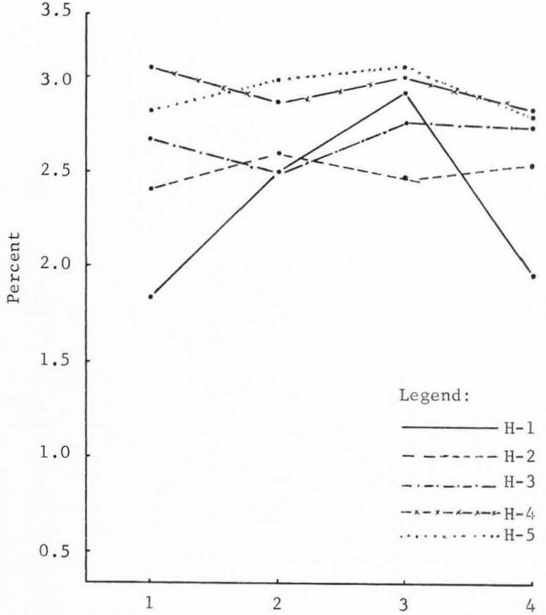


Figure 15. Average nitrogen content per year as influenced by the different harvests for the C-2 clipping frequency.

fication and rapid growth.

Effect of the interaction of irrigation x nitrogen fertilization on nitrogen content

This interaction was nonsignificant under C-1 and highly significant under the C-2 frequency. The results of the interaction for the C-2 frequency are presented in Table 15 and graphed in Figure 16. Figure 16 shows that nitrogen content decreased for F-1 (no fertilizer) and I-2 (medium irrigation interval) and later maintained at I-3 (medium short) and I-4 (short irrigation interval). F-2 (50 pounds of nitrogen per season) followed a similar trend to F-1. On the other hand, F-3 and F-4 maintained the nitrogen content at I-1, I-2 and I-3, and decreased at I-4 (short irrigation interval). Kilmer et al. (1960) indicated that the concentration of nitrogen in forage plants was not significantly affected by variation in the soil moisture supply. Wadleigh and Richards (1951) stated that most experimental evidence shows that for a given level of fertility, decreasing soil moisture supply is associated with a definite increase in nitrogen content of the plant tissue. Jenne et al. (1958) showed no effect of soil moisture stress on nitrogen of whole corn plants. Bennett et al. (1964) showed that the percentage of nitrogen in the above ground portion of the sudangrass, Starr millet and Sart sorghum decreased as the available moisture increased.

Effect of interaction of nitrogen fertilization x harvest on nitrogen content

The results of the interaction between nitrogen fertilization x harvest are presented in Table 16 and graphed in Figure 17 and 18 for C-1 and C-2, respectively. It will be seen from these figures that

Table 15. Average nitrogen content as influenced by irrigation and nitrogen fertilization for C-1 and C-2 clipping frequencies

Irrigation	Percent									
	C-1					C-2				
	F-1	F-2	F-3	F-4	Ave.	F-1	F-2	F-3	F-4	Ave.
I-1	2.44	2.44	2.25	2.59	2.43	2.79	2.69	2.62	2.85	2.74
I-2	2.37	2.35	2.34	2.44	2.38	2.62	2.63	2.63	2.82	2.68
I-3	2.51	2.39	2.23	2.35	2.37	2.63	2.68	2.62	2.76	2.67
I-4	2.42	2.45	2.15	2.10	2.28	2.65	2.66	2.46[d]	2.55[d]	2.58
Ave.	2.44	2.41	2.24	2.37	2.37	2.67	2.67	2.58	2.75	2.67

Table 16. Average nitrogen content per harvest as influenced by nitrogen fertilization for C-1 and C-2 clipping frequencies

Harvest	Percent									
	C-1					C-2				
	F-1	F-2	F-3	F-4	Ave.	F-1	F-2	F-3	F-4	Ave.
1	1.91	2.06	1.93	2.00	1.98	2.21	2.34	2.34	2.30	2.30
2	2.41	2.21	2.25	2.33	2.30	2.47	2.38	2.53	2.62	2.50
3	2.57	2.50	2.28	2.50	2.46	2.72	2.66	2.46	2.87	2.68
4	2.84	2.86	2.52	2.66	2.72	2.95	2.91	2.70	3.17	2.93
5	--	--	--	--	--	3.01	3.02	2.89	2.76	2.92
Ave.	2.43	2.41	2.25	2.37	2.37	2.67	2.66	2.58	2.74	2.67

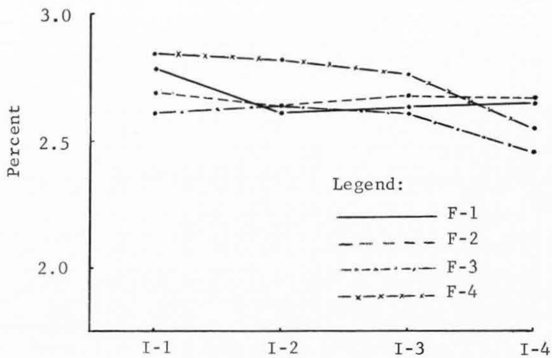


Figure 16. Average nitrogen content of grass forage as influenced by irrigation and nitrogen fertilization for C-2 clipping frequency.

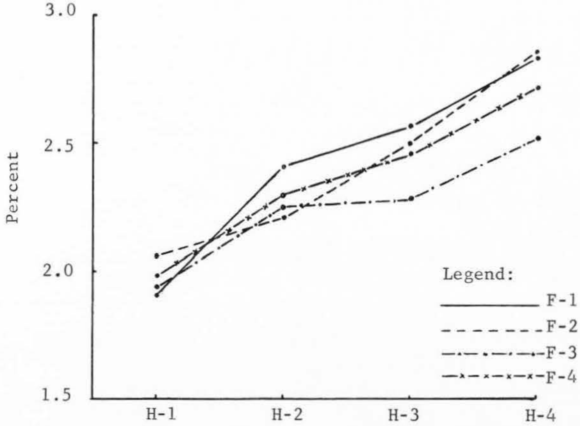


Figure 17. Average nitrogen content per harvest as influenced by nitrogen fertilization for the C-1 clipping frequency.

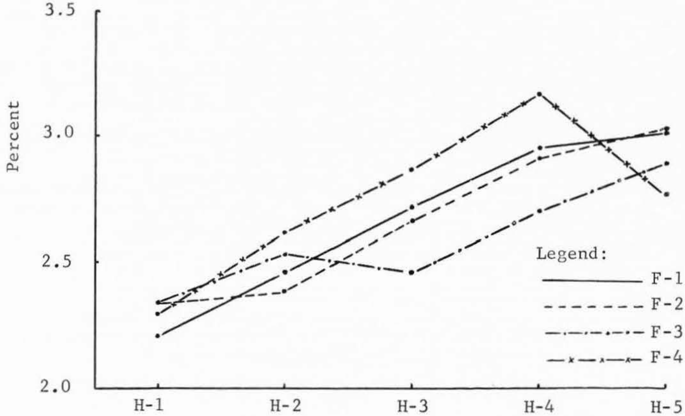


Figure 18. Average nitrogen content per harvest as influenced by nitrogen fertilization for the C-2 clipping frequency.

the nitrogen content for F-1 gradually increased for all harvests. The trend was similar to both clippings. F-2 showed a similar trend to F-1 for both C-1 and C-2. F-3 showed a similar trend to F-1 and F-2 except that the increase was very gradual for C-1 and a small drop at H-3 for C-2. F-4 showed a similar trend to H-1 under C-1. Under C-2, it increased gradually until H-4 giving higher nitrogen content than other fertilizer treatments but dropped sharply for H-5. Fuellman (1948), Rather and Harrison (1939), Comstock and Law (1948) and Churchill (1947) showed that both the height and frequency of cutting influence the yield and nitrogen content of the herbage produced.

The main effect, viz. irrigation, and the other first order, second order, and third order interactions were nonsignificant under C-1 and highly significant under C-2 frequency. On the other hand, only the first order interaction of year x nitrogen fertilization was significant at 0.01 level under C-2 and nonsignificant under C-1.

No second or third order interactions were significant under both C-1 and C-2. The nitrogen percentages as influenced by year x irrigation x nitrogen fertilization x harvest are presented in appendix Tables 65 and 66 for C-1 and C-2, respectively. These show, how the distribution of nitrogen percentage was spread throughout the four seasons under different treatment combinations.

Influence of Treatments on Phosphorus Content of Grass Pasture Mixture

The data for phosphorus percentage of orchardgrass-bromegrass pasture mixture were analyzed separately under the C-1 and C-2 clipping frequencies. The analyses of variance within C-1 and C-2 treatments are given in appendix Tables 49 and 50, respectively.

The analyses of variance show that the "F" values for main effects, viz. years, nitrogen fertilizations, and harvests were highly significant under both C-1 and C-2. Whereas, irrigation was nonsignificant under C-1 and highly significant under C-2. The "F" values of some of the first order and second order interactions were also significant to highly significant under both clippings.

Response to years

The phosphorus content of grass pasture mixture under the C-1 and C-2 frequencies is presented in Table 17. The "F" value of this main effect was highly significant under both C-1 and C-2. For each year, the phosphorus content increased significantly over the previous year. This was the same for both frequencies. The average values for phosphorus content under C-1 were .321, .387, .416 and .433 percent, whereas, under C-2 they were .364, .373, .448 and .467 percent for 1961, 1962, 1963 and 1964, respectively. The highest phosphorus content was obtained in 1964 and the lowest in 1961 under both C-1 and C-2. Adam et al. (1967) found a similar trend for phosphorus content in grasses in their studies under Georgia conditions.

Effect of nitrogen fertilization on phosphorus content

The influence of nitrogen fertilization on phosphorus content of grass forage within C-1 and C-2 is shown in Table 18. The results are graphed in Figure 19. From Figure 19, it will be seen that the phosphorus content in grass forage was not much affected by nitrogen fertilization up to 100 pounds per season but with 200 pounds of nitrogen, the phosphorus content decreased. MacLeod (1965) found that

Table 17. Effect of year on average phosphorus content per C-1 and C-2 clipping frequencies

	Percent		
Year	C-1	C-2	Average
1961	0.321	0.364	0.342
1962	0.387	0.373	0.380
1963	0.416	0.448	0.432
1964	0.433	0.467	0.450
Ave.	0.389	0.413	
LSD: 5% - 0.026 1% - 0.037	5% - 0.0168 1% - 0.0236		

Table 18. Effect of nitrogen fertilization on average phosphorus content for C-1 and C-2 clipping frequencies

	Percent		
Fertilization	C-1	C-2	Average
F-1	0.419	0.422	.421
F-2	0.398	0.425	.411
F-3	0.408	0.438	.423
F-4	0.331	0.366	.399
Average	0.389	0.413	
	(0.401)		
LSD:	5% - 0.018 1% - 0.023	5% - 0.018 1% - 0.024	

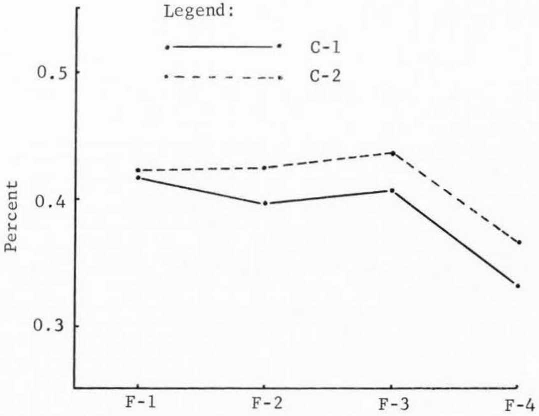


Figure 19. Average phosphorus content of grass forage as influenced by nitrogen fertilization.

in grasses, phosphorus content decreased from 0.32 with zero nitrogen to a low of 0.18 percent with 200 pounds nitrogen treatment. Adam et al. under Georgia conditions, found that although the total phosphorus removed in the forage increased with increasing fertility levels, the percent recovery declined generally as the rate of fertilization increased.

Effect of different harvests on phosphorus content

The phosphorus content as influenced by different harvests is presented in Table 19. The "F" value of this effect was highly significant under both C-1 and C-2. The phosphorus content of grasses varied widely with the date of harvest in the manner similar to nitrogen content. The phosphorus content was highest at H-4 under both C-1 and C-2. The amounts were .555 and .510 percent respectively. At each subsequent harvest, the phosphorus content of forage increased, except at H-5 under C-2. For this harvest, the phosphorus content was lower than for H-4. Adam et al. (1965) working with bermudagrass and orchardgrass found that the phosphorus content of these grasses was higher in the July harvest than in adjacent harvests in June or August. They indicated that the climatic factors which appeared to influenced the growth of bermudagrass and orchardgrass were more optimum for nitrient uptake during the period of June 10 to 15.

Effect of interaction of year x harvest on phosphorus content

The phosphorus percentages as influenced by the year x harvest interaction are shown in Table 20. The results are graphed in Figures 20 and 21 for C-1 and C-2, respectively. It will be seen from Figures 20 and 21 that the phosphorus content of the grass pasture mixture

Table 19. Effect of different harvests on the phosphorus content for C-1 and C-2 clipping frequencies

Harvest	Percent C-1	Percent C-2
1	0.299	0.330
2	0.388	0.392
3	0.413	0.398
4	0.555	0.510
5	--	0.432
Average	0.414	0.413
LSD: 5% - 0.017 1% - 0.023	0.015 0.019	

Table 20. Average phosphorus content per year as influenced by harvest for C-1 and C-2 clipping frequencies

	Percent										
	C-1					C-2					
Year	H-1	H-2	H-3	H-4	Ave.	H-1	H-2	H-3	H-4	H-5	Ave.
1	0.221	0.284	0.400	0.379	0.321	0.232	0.296	0.368	0.432	0.471	0.364
2	0.293	0.414	0.390	0.452	0.387	0.323	0.405	0.353	0.480	0.304	0.373
3	0.366	0.389	0.376	0.532	0.416	0.398	0.387	0.360	0.394	0.304	0.409
4	0.315	0.466	0.494	0.458	0.433	0.348	0.505	0.501	0.533	0.448	0.467
Ave.	0.299	0.388	0.415	0.455	0.389	0.330	0.398	0.396	0.460	0.432	0.403

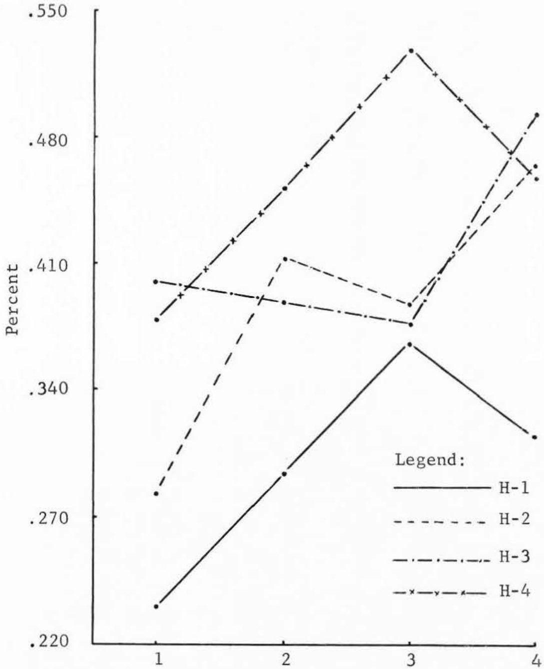


Figure 20. Average phosphorus content per year as influenced by the different harvests for the C-1 clipping frequency.

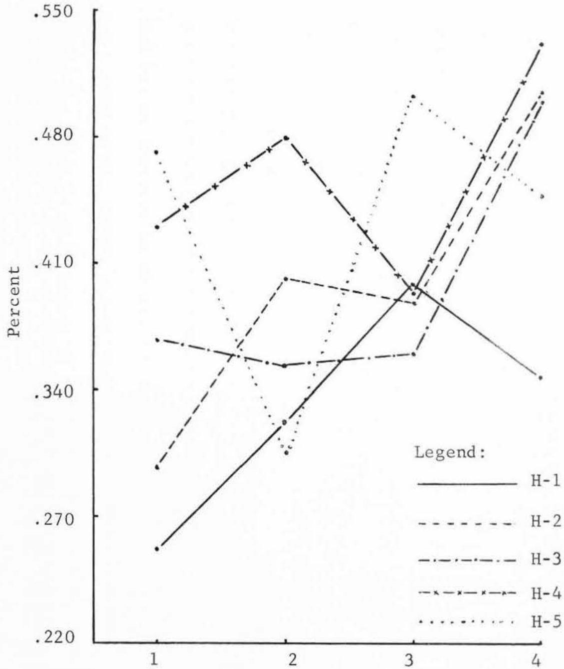


Figure 21. Average phosphorus content per year as influenced by the different harvests for the C-2 clipping frequency.

increased for both C-1 and C-2 for H-1 and decreased sharply the fourth year. H-2 increased for the second and fourth year but was depressed the third year. H-3 gradually decreased the second and third year and increased sharply the fourth year. These trends were similar for both C-1 and C-2. H-4 showed a similar trend to H-1 for C-1. H-4 was also similar to H-2 for C-2. H-5 did not show a trend. However, it had the lowest phosphorus content for 1962, and the highest for 1963. H-1 and H-4 had a progressive increase in phosphorus content the first three years, but a sharp reduction the fourth year. By contrast, H-2 and H-3 had an increase in phosphorus content the fourth year in C-1.

Adam et al. (1967) showed that the phosphorus content of bermudagrass was significantly higher in July than in adjacent harvests in June or August under Georgia conditions. Dotzenko and Ahlgren (1951) indicated that on a percentage basis phosphorus content of the herbage of smooth bromegrass decreased with increased maturity. Their work was mostly confined to the maturity of grasses in a particular season and not the age of stand of grasses as was studied in this experiment.

Effect of the interaction of nitrogen fertilization x harvest on phosphorus content

The influence of this interaction on the phosphorus content of the grass pasture mixture is presented in Table 21. The results are graphed in Figures 22 and 23 for C-1 and C-2, respectively. It will be seen from these figures that there was a gradual decrease in phosphorus content of the forage associated with an increase in nitrogen fertilization for H-1 under both C-1 and C-2. At the F-3 (100 pounds of nitrogen per season) there was a sharp increase in phosphorus content

Table 21. Average phosphorus content per harvest as influenced by nitrogen fertilization for C-1 and C-2 clipping frequencies

	Percent									
	C-1					C-2				
Harvest	F-1	F-2	F-3	F-4	Ave.	F-1	F-2	F-3	F-4	Ave.
1	0.312	0.295	0.300	0.288	0.299	0.324	0.328	0.326	0.325	0.330
2	0.460	0.419	0.348	0.324	0.388	0.416	0.422	0.375	0.381	0.399
3	0.428	0.431	0.455	0.346	0.415	0.425	0.421	0.405	0.330	0.395
4	0.474	0.447	0.530	0.362	0.455	0.516	0.525	0.592	0.406	0.510
5	--	--	--	--	--	0.412	0.431	0.494	0.389	0.432
Ave.	0.419	0.398	0.408	0.332	0.389	0.422	0.425	0.438	0.366	0.413

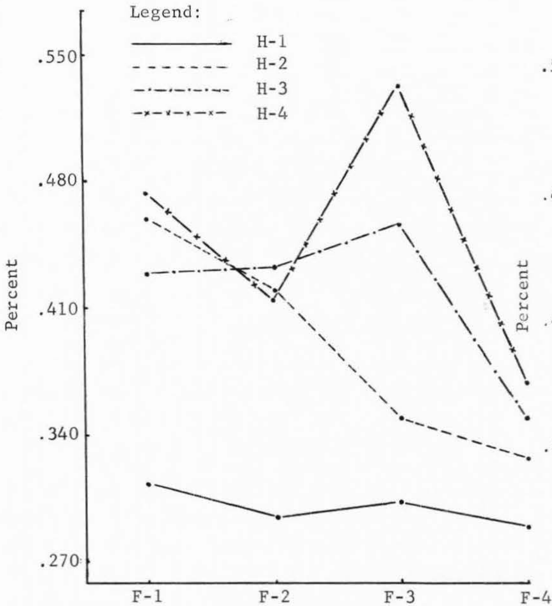


Figure 22. Average phosphorus content as influenced by nitrogen fertilization and the different harvests for the C-1 clipping frequency.

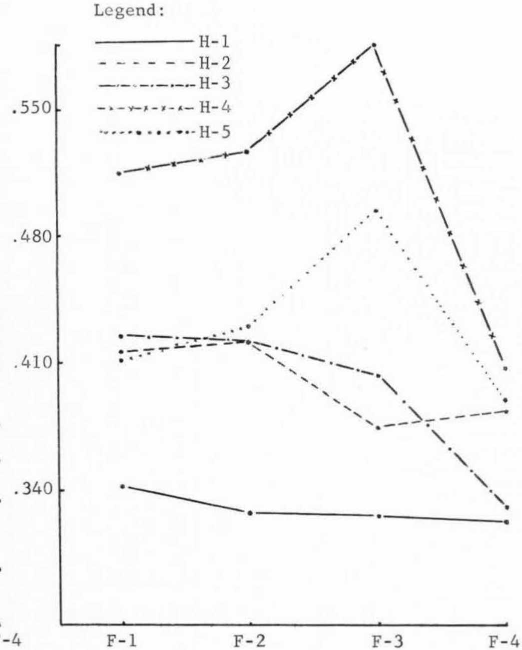


Figure 23. Average phosphorus content as influenced by nitrogen fertilization and the different harvests for the C-2 clipping frequency.

for H-3 and H-4 under C-1 and H-4 and H-5 under C-2. Thomas and Heilman (1967) working with sweet peppers found that total phosphorus uptake increased in plants as the nitrogen fertilizer increased on both non-phosphated and phosphated soils. The percentage of total phosphorus absorbed from the fertilizer also increased with addition of nitrogen fertilizer. On the other hand, MacLeod (1965) working with alfalfa and grasses found that in grasses the phosphorus content decreased from 0.32 with 0 nitrogen to a low of 0.18 percent with 200 nitrogen treatment. Reid et al. (1967) observed no apparent effect of higher nitrogen levels on the concentration of phosphorus.

The main effect, viz. irrigation; the first order interactions, viz. year x irrigation, irrigation x nitrogen fertilization; the second order interactions, viz. year x irrigation x harvest and year x nitrogen fertilization x harvests were nonsignificant under C-1 and highly significant under C-2 frequency.

The other first order, second order, and third order interactions were nonsignificant under both C-1 and C-2.

The phosphorus percentage as influenced by the third order interaction, viz. year x irrigation x nitrogen fertilization x harvest is presented in appendix Tables 67 and 68 for C-1 and C-2, respectively. These tables show how the distribution of phosphorus percentage was spread throughout the four seasons under the different treatment combinations.

Influence of Treatments on Potassium Content of Grass Pasture Mixture

The data for potassium percentage of the orchardgrass-bromegrass pasture mixture were analyzed separately under C-1 and C-2. The analyses of variance within C-1 and C-2 treatments are given in appendix Tables 51 and 52 respectively.

The analyses of variance show that the "F" values for main effects for years and harvests were highly significant under both C-1 and C-2. The main effect of irrigations was nonsignificant under both C-1 and C-2. On the contrary, main effect of nitrogen fertilization was non-significant under C-1 and significant at .05 level under C-2. Only the first order interactions viz. year x harvest was highly significant, whereas all other interactions were nonsignificant under both C-1 and C-2.

Response to years

The potassium content of grass pasture mixture under C-1 and C-2 is given in Table 22. The data indicate that the differences between the years were highly significant. In fact, only small differences were required to provide a highly significant effect. The percentage of potassium generally decreased with advance in age of stand of grass pasture mixture. In 1962, however, there was a higher potassium percentage than in 1961. There was a gradual reduction in potassium content over years, except for 1962 which gave the highest amount. This trend was found for both C-1 and C-2.

The influence of age of stand on the potassium content of grasses has not been reported previously. However, some results are available on the maturity of grass forage in a season.

Table 22. Effect of year on average potassium content for C-1 and C-2 clipping frequencies

	Percent		
Year	C-1	C-2	Ave.
1961	1.49	1.48	1.48
1962	1.70	1.60	1.65
1963	1.49	1.44	1.47
1964	1.27	1.32	1.30
Ave.	1.49	1.46	
LSD:	5% - 0.05 1% - 0.07	5% - 0.046 1% - 0.064	

Effect of nitrogen fertilization
on potassium content

The results of this interaction are presented in Table 23 and graphed in Figure 24. The "F" value of this effect was nonsignificant within C-1 and significant at .05 level within C-2. Figure 24 shows that the potassium content was not consistent under the nitrogen fertilization treatments. The overall response of nitrogen fertilization was higher for C-1 than for C-2 except for F-3 (100 pounds of nitrogen per season) which was slightly better in potassium content for C-2 than for C-1. The differences between other fertilization treatments were nonsignificant. Griffith (1964) observed that nitrogen applications on grasses caused a potassium deficiency during July and August growth periods. Further, the potassium content dropped to 1.6 and 1.4 percent, respectively, for the medium and high nitrogen levels where potassium was withheld. This depression was associated with a marked increase in asparagine content of grass.

Effect of different harvests
on potassium content

The influence of this main effect on the potassium content of grass pasture mixture is shown in Table 24. The results are graphed in Figure 25. It will be seen from Figure 25 that the potassium content gradually increased for the first three harvests and sharply dropped for the fourth harvest for both clipping frequencies. For H-5 under C-2, there was a slight increase in potassium content. The potassium content dropped about 22 and 18 percent at H-4 for C-1 and C-2, respectively. The lowest potassium content was obtained for H-4 under both C-1 and C-2.

Table 23. Effect of nitrogen fertilization on average potassium content for C-1 and C-2 clipping frequencies

Fertilization	Percent	
	C-1	C-2
F-1	1.47	1.46
F-2	1.50	1.46
F-3	1.48	1.49
F-4	1.49	1.43
Ave.	1.49	1.46
	(1.48)	
	5% - 0.04	

Table 24. Effect of different harvests on potassium content for C-1 and C-2 clipping frequencies

Harvests	Percent	
	C-1	C-2
1	1.53	1.58
2	1.55	1.59
3	1.61	1.55
4	1.25	1.27
5	--	1.30
Average	1.49	1.53
LSD: 5% - 0.051 1% - 0.067	5% - 0.05 1% - 0.06	

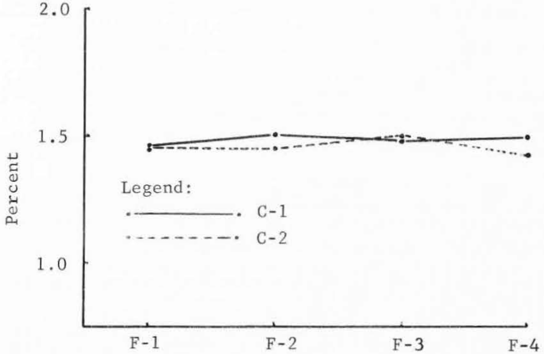


Figure 24. Average potassium content of grass forage as influenced by nitrogen fertilization for the C-1 and C-2 clipping frequencies.

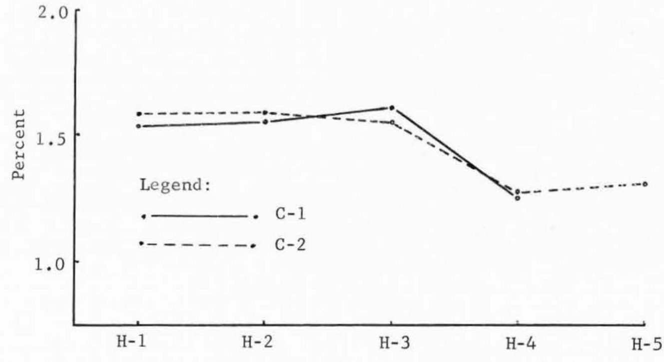


Figure 25. Average potassium content per harvest of grass forage for the C-1 and C-2 clipping frequencies.

Dotzenko and Ahlgren (1951) concluded that the 1/2 bloom stage gave the maximum quality grass forage. This quality was measured through the mineral contents of the grass forage.

Effect of the interaction of year x harvest on potassium content

The results of this interaction are presented in Table 25 and graphed in Figures 26 and 27 for C-1 and C-2, respectively. These figures show that the potassium content increased for both C-1 and C-2 for H-1 except that a decrease occurred the third year. H-2 gradually increased for the first three years for both C-1 and C-2, but dropped sharply the fourth year for both C-1 and C-2. H-3 increased during the intermediate years, but dropped sharply the fourth year for both C-1 and C-2. For H-4 there was a gradual decrease in potassium content the first three years for both C-1 and C-2, but a slight increase the fourth year. H-5 was similar to H-4 in potassium content during all four years under the conditions of this study. Salmon et al. (1925) Van Riper and Smith (1959) and Dawson et al. (1940) working with forages indicated that the percentages of phosphorus and potassium in alfalfa and other forage species declined with maturity. Reid et al. (1967) observed similar results.

The main effect viz. irrigation, and the other first order, second order and third order interactions were nonsignificant under C-1 and C-2.

The potassium percentage as influenced by the third order interaction are presented in appendix Tables 69 and 70 to show the general distribution of potassium content throughout the four seasons under

Table 25. Average potassium content per year as influenced by harvest for C-1 and C-2 clipping frequencies

	Percent										
	C-1					C-2					
Year	H-1	H-2	H-3	H-4	Ave.	H-1	H-2	H-3	H-4	H-5	Ave.
1	1.15	1.72	1.47	1.59	1.48	1.16	1.76	1.47	1.50	1.52	1.48
2	1.70	1.76	2.20	1.15	1.70	1.84	1.76	1.74	1.25	1.43	1.60
3	1.51	1.85	1.55	1.05	1.49	1.52	1.83	1.72	1.06	1.05	1.44
4	1.77	0.87	1.22	1.23	1.27	1.82	1.00	1.29	1.29	1.18	1.32
Ave.	1.53	1.55	1.61	1.26	1.59	1.59	1.59	1.56	1.28	1.30	1.46

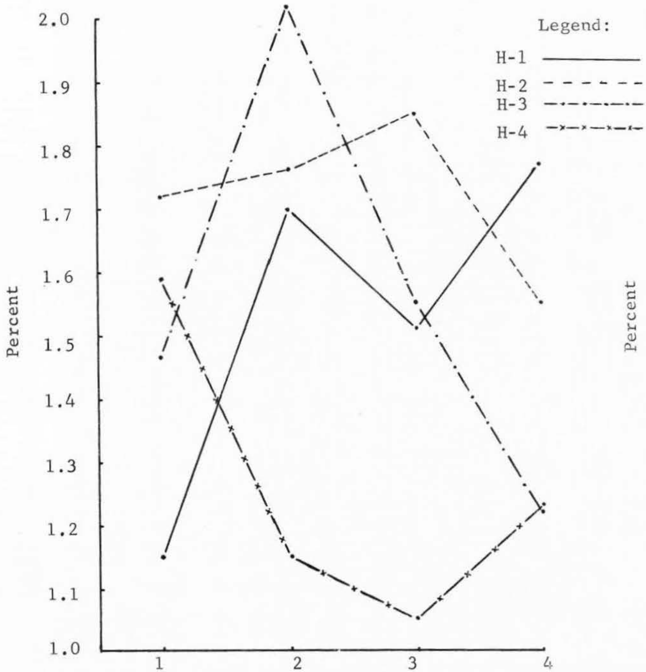


Figure 26. Average potassium content per year as influenced by the different harvests for the C-1 clipping frequency.

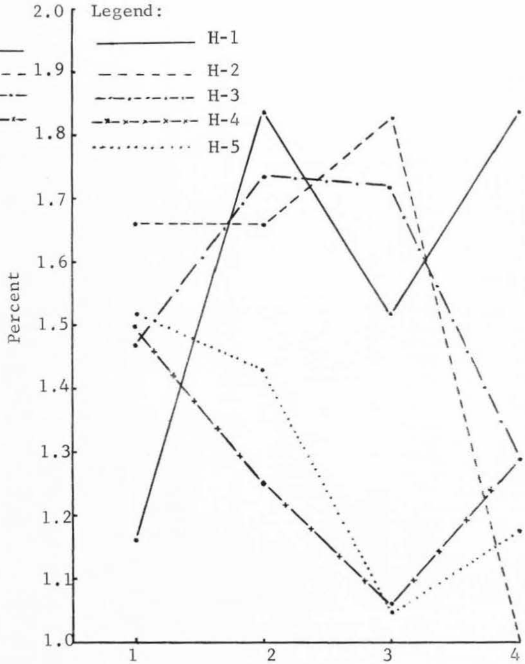


Figure 27. Average potassium content per year as influenced by the different harvests for the C-2 clipping frequency.

the different treatment combinations.

Influence of Treatments on Calcium Content of Grass Pasture Mixture

The data for calcium percentage of orchardgrass-bromegrass pasture mixture were analyzed separately under C-1 and C-2 clipping frequencies. The analyses of variance for the C-1 and C-2 treatments are given in appendix Tables 53 and 54, respectively.

The analyses of variance show that the "F" values for the main effects, viz. years, nitrogen fertilizations and harvests were highly significant within the C-1 and C-2 frequencies. The "F" values of a few first order, and second order interactions were also significant or highly significant under both frequencies.

Response to years

The calcium content of the grass pasture mixture within C-1 and C-2 frequencies, is presented in Table 26. The differences among the years were highly significant. The highest calcium content was obtained for 1961 under both C-1 and C-2. The amounts were 1.27 and 1.32 percent, respectively. The lowest amounts, viz. .73 and .70 percent were obtained for 1964 for C-1 and C-2, respectively. The intermediate years did not show any particular trend. For 1963 the calcium content was slightly higher than for 1962.

Table 26. Effect of year on average calcium content for C-1 and C-2 clipping frequencies

Year	Percent C-1	Percent C-2	Percent Ave.
1961	1.27	1.32	1.30
1962	0.82	0.87	0.85
1963	1.08	1.08	1.08
1964	0.73	0.79	0.76
Ave.	0.98	1.02	

LSD: 5% - 0.096   5% - 0.054
1% - 0.135   1% - 0.076

Effect of nitrogen fertilization on calcium content

The influence of nitrogen fertilization on calcium content of grass forage within the C-1 and C-2 frequencies is shown in Table 27 and graphed in Figure 28. It will be seen from Figure 28 that calcium gradually decreased as the levels of nitrogen fertilizer increased. The lowest calcium contents were obtained from the highest nitrogen level (F-4). This trend was similar for both C-1 and C-2. Reid, Jung, and Murray (1966) working with orchardgrass showed that the calcium content decreased as the nitrogen fertilizer levels were increased. Reid, Odhuba and Jung (1967) concluded that there was no apparent effect of higher nitrogen levels on the concentration of calcium in grasses.

Effect of different harvests on calcium content

The calcium content as influenced by different harvests is presented in Table 28. The results are graphed in Figure 29. The data show that calcium gradually increased during the season. The lowest calcium contents were obtained for H-1 and the highest for H-4 under C-1 and for H-5 under C-2. The amounts were 1.09 and 1.22 percent, respectively. For H-3 and H-4 the calcium content was slightly higher for C-1 than C-2. This may be attributed to the large intervals between cuttings under C-1. There appears to be an influence of period of cuttings on the calcium content. Ririe and Toth (1952) considered calcium to be an immobile element. As there is less calcium in the lower leaves than in upper, the harvest of forage has an influence on the calcium. Van Riper and Smith (1959) and Beeson (1952) obtained similar results for grasses grown as pure species but could not establish a trend when legumes were included in the mixture.

Table 27. Effect of nitrogen fertilization on average calcium content for C-1 and C-2 clipping frequencies

Fertilization	Percent C-1	C-2	Average
F-1	1.17	1.22	1.19
F-2	1.06	1.02	1.04
F-3	0.92	0.95	.93
F-4	0.75	0.86	.81
Average	.98 (1.06)	1.01	
LSD: 5% - 0.078 1% - 0.106		5% - 0.05 1% - 0.06	

Table 28. Effect of different harvests on the calcium content for C-1 and C-2 clipping frequencies

Harvests	Percent C-1		C-2
1	0.81		0.93
2	0.93		0.93
3	1.06		0.95
4	1.09		1.04
5	--		1.22
Average	0.97		1.01
LSD: 5% - 0.056 1% - 0.075		5% - 0.05 1% -.0.07	

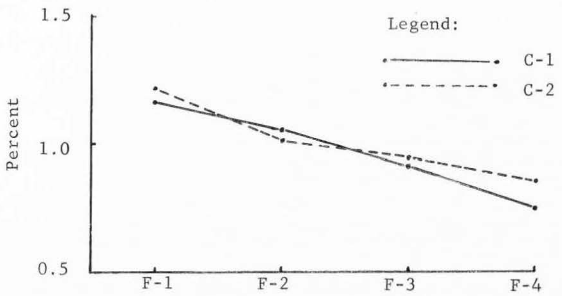


Figure 28. Average calcium content of grass forage as influenced by nitrogen fertilization for the C-1 and C-2 clipping frequencies.

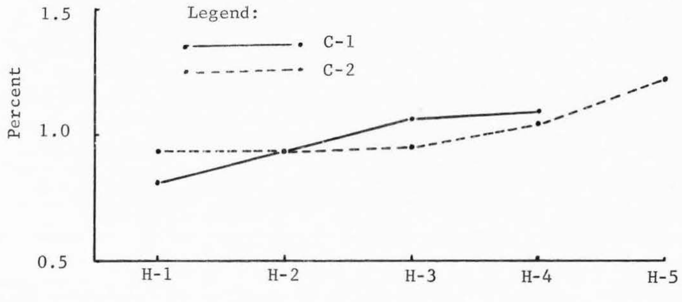


Figure 29. Average calcium content per harvest of grass forage for the C-1 and C-2 clipping frequencies.

Effect of year x harvest on calcium content

The influence of the interaction of year x harvest on calcium content of grass forage within C-1 and C-2 is shown in Table 29. The results are presented in Figures 30 and 31, respectively. These figures show that the calcium content for H-4 decreased sharply the second and fourth years under C-1 and C-2. The first and third years showed a high calcium content in pasture plants. H-2 and H-4 showed similar trends to H-1 under both C-1 and C-2. H-3 decreased sharply the second year and gradually increased the third and fourth years for both clipping frequencies. H-5, under C-2 decreased the second year, maintained for the third year and sharply increased the fourth year. It will be seen from the data that the initial year, and third year, gave higher calcium contents than the second and fourth years. The fourth year was lowest in calcium percentage in all harvests except at H-5 under C-2. The data on the effect of age of stand on calcium content of forage is very meager. However, some work has been done on the maturity of the forage in a given season. Van Riper and Smith (1959) stated that a general trend for percentage of calcium with advance in maturity was not clearly indicated during a growth period. The literature differs on the trend of calcium in forage plants with advance in maturity. Calcium percentage increased in alfalfa with advance in maturity. Calcium percentage increased in alfalfa with advanced maturity in studies by Woodman et al. (1933), while the calcium percentage was higher in the initial bloom stage than in the later stages of growth in studies by Dawson et al. (1940).

Table 29. Average calcium content per year as influenced by harvest for C-1 and C-2 clipping frequencies

	Percent										
	C-1					C-2					
Year	H-1	H-2	H-3	H-4	Ave.	H-1	H-2	H-3	H-4	H-5	Ave.
1	1.20	1.13	1.31	1.43	1.27	1.60	0.98	1.25	1.41	1.37	1.32
2	0.53	0.76	0.83	1.14	0.82	0.57	0.88	0.68	1.11	1.10	0.87
3	0.96	1.13	1.07	1.17	1.08	1.06	1.17	0.98	1.08	1.11	1.08
4	0.57	0.71	1.03	0.63	0.74	0.52	0.70	0.88	0.56	1.31	0.80
Ave.	0.81	0.93	1.06	1.09	0.98	0.93	0.93	0.95	1.04	1.22	1.02

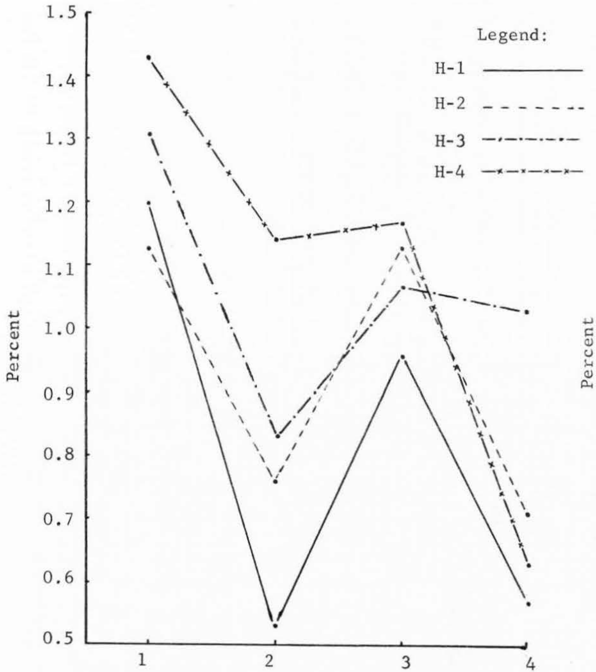


Figure 30. Average calcium content per year as influenced by the different harvests for the C-1 clipping frequency.

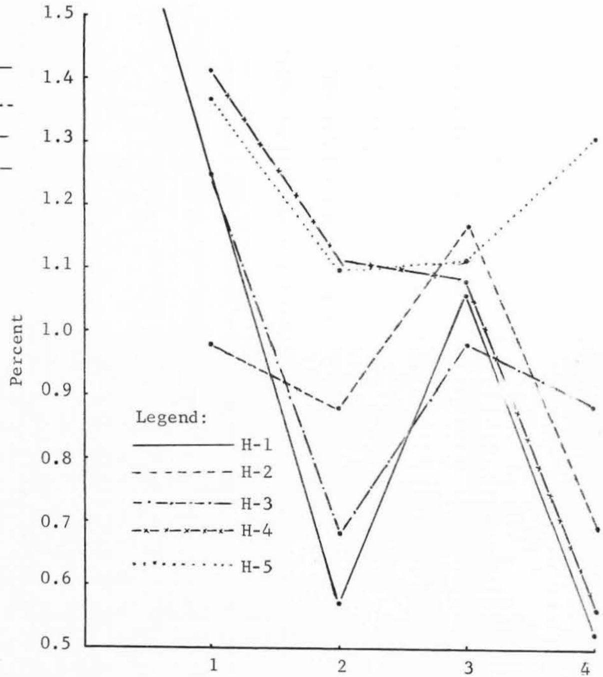


Figure 31. Average calcium content per year as influenced by the different harvests for the C-2 clipping frequency.

The main effect of irrigation and second order interaction of year x nitrogen fertilization x harvest was nonsignificant under C-1 and significant at .05 level under C-2. The other first order, second order and third order interactions were nonsignificant under both C-1 and C-2 clippings.

The calcium percentage as influenced by year x irrigation x nitrogen fertilization x harvest is presented in appendix Table 71 and 72 for C-1 and C-2, respectively. These tables show how the distribution of calcium percentage was spread throughout the four seasons under the different treatment combinations.

Influence of Treatments on the Copper Content of Grass Pasture Mixture

The data for the copper content of orchardgrass-bromegrass pasture mixture were analyzed separately under C-1 and C-2, clipping frequencies. The analyses of variance for the C-1 and C-2 treatments are given in appendix Tables 55 and 56 for C-1 and C-2, respectively.

The analyses of variance show that the "F" values for main effects, viz. years, and harvests and the first order interaction, viz. year x harvest were highly significant under both C-1 and C-2. The other main effects, the first order interactions, second order interactions and third order interaction were nonsignificant under both clipping frequencies.

Response to years

The copper content of the grass pasture mixture under both C-1 and C-2 is given in Table 30. The data show that the copper content

Table 30. Effect of year on average copper content for C-1 and C-2 clipping frequencies

Year	Parts per million C-1	C-2	Average
1961	10.4	12.2	11.3
1962	7.9	7.4	7.6
1963	7.2	7.8	7.5
1964	5.6	6.0	5.2
Average	7.8	8.4	
LSD: 5% - 0.981	1.064		
1% - 1.37	1.492		

decreased as the grass forage stand became old. The difference between 1961 and 1962 were the biggest as compared to the differences between other years. However, the differences between 1962 and 1963 were non-significant. The lowest copper contents were obtained for 1964, for both C-1 and C-2. The overall copper contents were higher for C-2 than C-1 showing the influence of shorter intervals between harvests.

Effect of different harvests
on copper content

The copper content as influenced by the different harvests is presented in Table 31 and graphed in Figure 32. Figure 32 shows that the copper content decreased for H-2 and shraply increased for H-3 and H-4 for both C-1 and C-2. There was a sharp rise in copper content for H-4 over H-2 and H-3 under both clippings. H-5 dropped slightly under C-2. There was no appreciable difference in copper content between C-1 and C-2. This might suggest that there was no influence of the shorter intervals between harvests on the copper content of the grass forage. Loper and Smith (1961) indicated that the parts per million of micro elements generally decreased quite rapidly during successive stages of growth under Wisconsin conditions.

Effect of interaction of year x
harvest on copper content

The influence of this interaction on copper content of grass pasture mixture within the C-1 and C-2 clipping frequencies is shown in Table 32 and graphed in Figures 33 and 34. These figures show that the copper content for H-1 decreased sharply in the second and fourth year. Whereas, it was quite high for the first and third years. This

Table 31. Effect of different harvests on the copper content for C-1 and C-2 clipping frequencies

Harvests	Parts per million C-1	C-2
1	7.9	7.7
2	6.5	6.4
3	7.2	7.3
4	10.1	10.6
5	--	9.7
Average	7.9	8.3
LSD: 5% - 0.28 1% - 0.37	5% - 0.3 1% - 0.4	

Table 32. Average copper content per year as influenced by harvest for C-1 and C-2 clipping frequencies

	Parts per million										
	C-1					C-2					
Year	H-1	H-2	H-3	H-4	Ave.	H-1	H-2	H-3	H-4	H-5	Ave.
1	12.1	7.3	8.4	13.7	10.4	12.1	6.7	9.7	16.3	15.9	12.1
2	4.9	6.4	6.4	13.8	7.9	4.5	6.0	5.8	12.8	7.8	7.4
3	10.5	6.9	7.0	6.5	7.7	9.9	7.2	7.3	6.6	7.9	7.8
4	4.0	5.1	6.9	6.3	5.6	4.1	5.5	6.5	6.6	7.1	6.0
Ave.	7.9	6.4	7.2	10.1	7.9	7.7	6.4	7.3	10.6	9.7	8.3

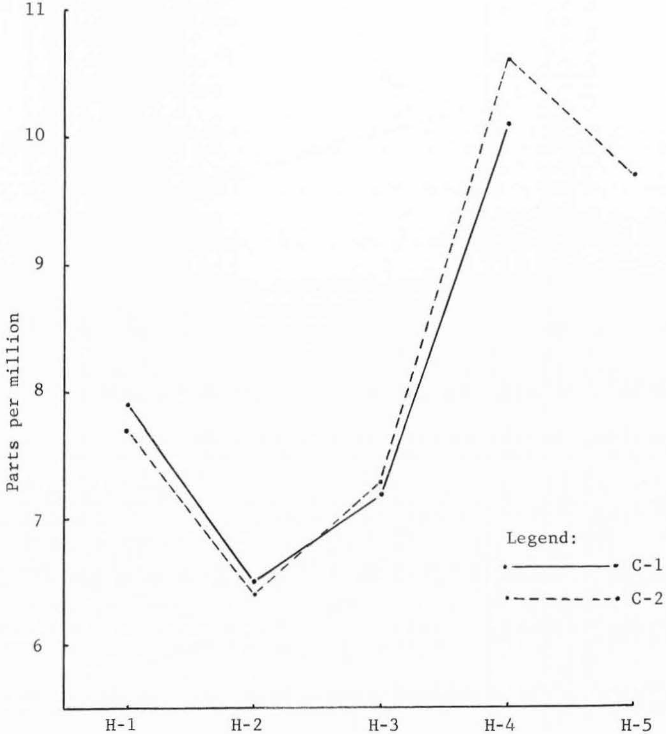


Figure 32. Average copper content per harvest of grass forage for the C-1 and C-2 clipping frequencies.

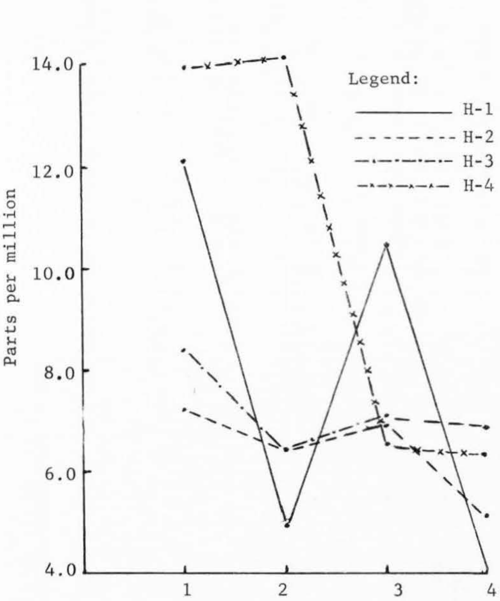


Figure 33. Average copper content per year as influenced by the different harvests for the C-1 clipping frequency.

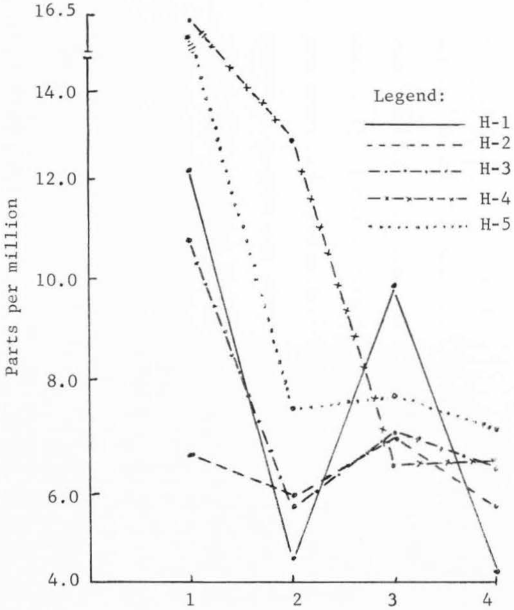


Figure 34. Average copper content per year as influenced by the different harvests for the C-2 clipping frequency.

trend was the same for both C-1 and C-2. H-2 was similar to H-1 for both frequencies, except the decrease for the second and fourth years was not so sharp as that for H-1. H-3 dropped slightly the second year but increased gradually the third and fourth years under C-1, whereas it behaved similar to H-1 and H-2 with less reduction the fourth year under C-2. H-4 maintained the copper content the first and second years and dropped very sharply the third year under C-1. There was a progressive reduction the first three years in H-4 in C-2. H-3 for C-2 was similar to H-2. H-4 for C-1 and H-4 and H-5 for C-2 gave higher copper contents than other harvests for all years except the third year. Adam et al. (1956), Riceman and Jones (1957) working on forages in relation to maturity in a given season showed that copper concentration in forage usually decreases with advancing maturity. Thomas et al. (1952) and Reid et al. (1957) found insignificant changes in copper in some grasses like tall fescue with advance in maturity. Beeson and MacDonald (1951) also found similar results in some legumes. Loper and Smith (1961) reported a marked decrease in copper content with maturity in bromegrass, under Wisconsin conditions.

The main effects of irrigation and nitrogen fertilization, the other first order, second order and third order interactions were nonsignificant under C-1 and C-2.

The copper content as influenced by the highly complex interaction, viz. year x irrigation x nitrogen fertilization x harvest is presented in appendix Tables 73 and 74 for C-1 and C-2, respectively. These give the copper content of the forage for the four seasons under different treatment combinations.

Influence of Treatments on Iron Content of Grass Pasture Mixture

The data for iron content of orchardgrass-bromegrass pasture were analyzed separately within the C-1 and C-2 frequencies. The analyses of variance for the C-1 and C-2 treatments are given in the appendix Tables 57 and 58, respectively.

The analyses of variance show that the "F" values for main effects, viz. years, and harvests were highly significant within both the C-1 and C-2 frequencies. The main effect of irrigations was nonsignificant under C-1 and significant at .05 level under C-2. The reverse was true for the nitrogen fertilizations. It was significant at .01 level under C-1 and nonsignificant under C-2. The "F" values of some first order and second order interactions were significant or highly significant within both C-1 and C-2.

Response to years

The iron content of grass pasture mixture within the C-1 and C-2 frequencies is presented in Table 33. The "F" value of this main effect was highly significant under both clippings. The differences in iron content between 1961 and 1962, and 1963 and 1964 were highly significant. On the contrary, the difference between 1962 and 1963 or 1962 and 1964 were nonsignificant for both C-1 and C-2. The iron content was highest in 1961, amounting to 154 and 174 parts per million for both C-1 and C-2. The iron content decreased rapidly as the stand of grass pasture mixture became old, giving the lowest amount of iron for 1964. This was true for both C-1 and C-2. In general, there was not a very large difference in iron content between the C-1 and C-2 frequencies except for 1961.

Table 33. Effect of year on average iron content for C-1 and C-2 clipping frequencies

Year	Parts per million		
	C-1	C-2	Average
1961	154	174	164
1962	116	113	114
1963	107	105	106
1964	96	97	96.5
Average	118	122	
LSD: 5% - 17.93 1% - 25.12	15.25 29.93		

Effect of nitrogen fertilization
on iron content

The influence of nitrogen fertilization on iron content of grass forage within the C-1 and C-2 clipping frequencies is shown in Table 34. The results are graphed in Figure 35. It will be seen from this figure that there was a continuous drop in iron content as the nitrogen fertilization levels were increased, for C-1. The lowest amount of iron content was obtained for F-4 (200 pounds of nitrogen per season) amounting to 103 ppm. For C-2, the trend was not consistent. F-1 and F-3 had a low iron content compared to F-2 and F-4 under C-2. There was a large difference in iron content between C-1 and C-2 at F-1, F-3 and F-4 levels, whereas at F-2 the iron content was almost the same. In general, the iron content was higher for C-2 than C-1, except for no fertilizer treatment, (F-1). This may be due to the shorter intervals between harvests for the C-2 frequency.

Reid et al. (1967) revealed that analysis for iron did not show any definite trend associated with nitrogen fertilization.

Effect of different harvests
on the iron content

The iron content as influenced by different harvests is presented in Table 35 and graphed in Figure 36. It will be seen from Figure 36 that the iron content increased in a linear manner from the first to the fourth harvest under C-1. Whereas, there was a slight drop for H-3 and H-4 and a sharp increase again for H-5 for C-2. The highest amounts of iron were obtained for H-4 and H-5 under C-1 and C-2 respectively. However, C-2 showed a similar trend to C-1. One interest-

Table 34. Effect of nitrogen fertilization on average iron content for C-1 and C-2 clipping frequencies

Fertilization	Parts per million		
	C-1		C-2
F-1	132		124
F-2	126		129
F-3	105		115
F-4	103		121
Ave.	118	(120)	122
LSD: 5% - 10.38 1% - 13.84	5% - 16.0 1% - 21.0		

Table 35. Effect of different harvests on the iron content for C-1 and C-2 clipping frequencies

Harvests	Parts per million	
	C-1	C-2
1	88	85
2	109	118
3	128	112
4	148	117
5	---	179
Average	118	122
LSD: 5% - 10.43 1% - 13.47	5% - 15.0 1% - 19.0	

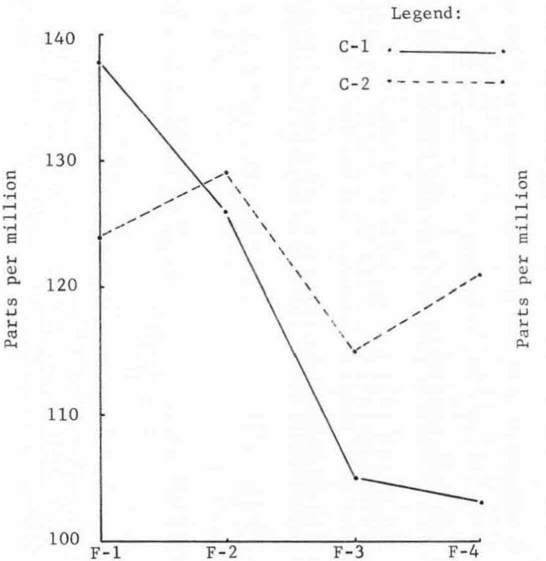


Figure 35. Average iron content of grass forage as influenced by nitrogen fertilization for the C-1 and C-2 clipping frequencies.

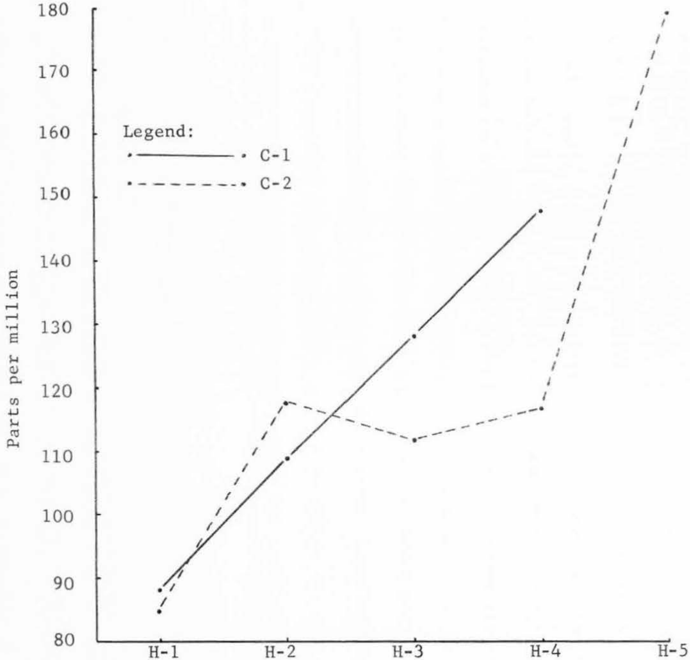


Figure 36. Average iron content per harvest of forage for the C-1 and C-2 clipping frequencies.

ing thing to note is that the differences between any two harvests for C-1 were highly significant whereas they were nonsignificant between H-2 and H-3 and H-3 and H-4, for C-2. Thomas et al. (1952) observed decreases in iron concentration during successive young stages of growth. Iron concentration in their studies dropped from 30 to 50 percent during the very young stages of alfalfa, alsike clover, black medic, and sainfoin with no significant changes thereafter. Loper and Smith (1961) concluded that accumulation of iron in pounds per acre increased in nearly all species from early growth until the fifth or sixth (final) growth stages.

Effect of interaction of year x harvest on iron content

The iron content as influenced by the interaction of year x harvest is given in Table 36. The results are presented in Figures 37 and 38. These figures show that the iron content for H-1 decreased the second year and maintained about the same level the third and fourth years, under C-1, whereas, the trend was generally downward under C-2. H-2 was similar to H-1 for C-1 and C-2, except that the iron content was higher than H-1. H-3 and H-4 gradually decreased for all years under both clippings. H-5 decreased sharply for intermediate years but increased the fourth year, under C-2. The overall iron content for H-5 was higher than the other treatments. No specific literature showing the influence of the age of stand of pasture forages on the content of different minerals in the forage plants is available. However, some work has been done on the maturity of forages in a given season. Moxon et al. (1951) found wide variations in iron

Table 36. Average iron content per year as influenced by harvest for C-1 and C-2 clipping frequencies

	Parts per million										
	C-1					C-2					
Year	H-1	H-2	H-3	H-4	Ave.	H-1	H-2	H-3	H-4	H-5	Ave.
1	123	134	144	215	154	110	162	159	157	283	174
2	75	89	136	163	116	76	117	93	127	151	113
3	74	101	124	127	107	96	86	100	114	126	104
4	77	111	102	87	96	58	108	97	70	155	98
Ave.	87	109	128	148	118	85	118	112	117	179	122

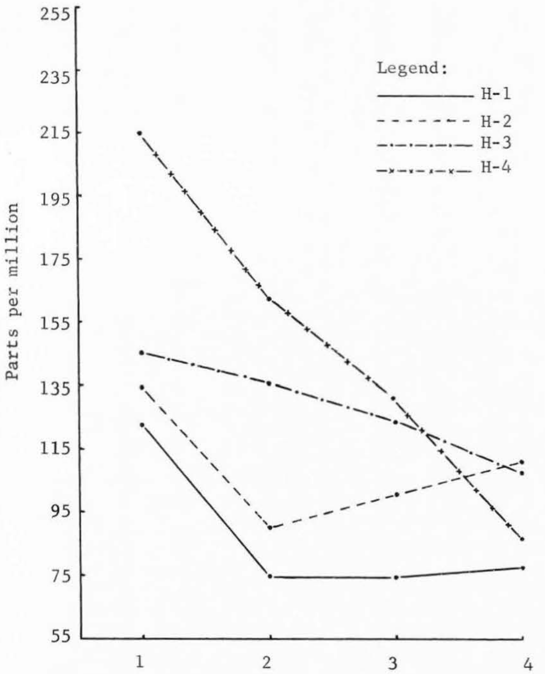


Figure 37. Average iron content per year as influenced by the different harvests for the C-1 clipping frequency.

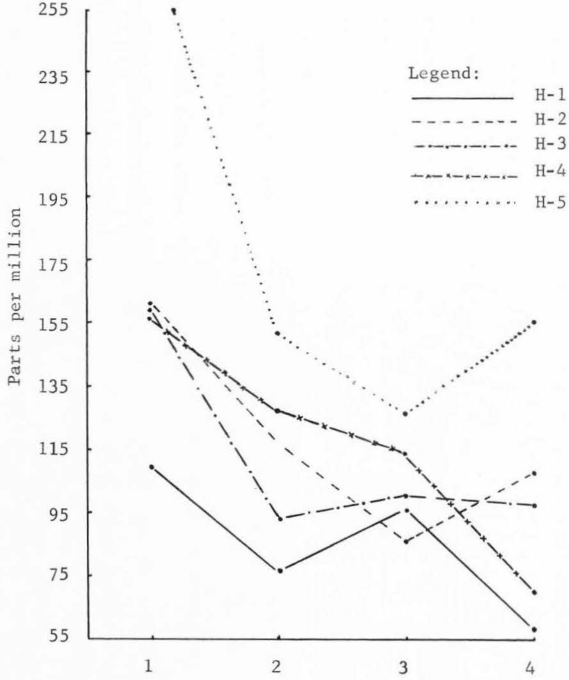


Figure 38. Average iron content per year as influenced by the different harvests for the C-2 clipping frequency.

concentration at various stages of growth in western wheatgrass, although bluegrama grass increased in iron concentration from the shooting stage to maturity. Kirchgessner (1957) reported no significant effect of stage of maturity on iron concentration of meadow hay species in Germany. Beeson and MacDonald (1951) found that the parts per million of iron in alfalfa, birdsfoot trefoil, ladino clover and timothy increased as the plants matured with most of the increase in the leaves. In contrast, Thomas et al. (1952) observed a decrease in iron concentration during successive young stages of growth.

The main effect of irrigations and the first order interaction of irrigation x harvest were nonsignificant under C-1 and significant at .05 level under C-2. On the contrary, the first order interaction of nitrogen fertilization x harvest and the second order interaction for year x irrigation x harvest were significant at .05 level under C-1 and at .01 level under C-2, respectively.

The other first order, second order and third order interactions were nonsignificant under both the clippings.

The iron content as influenced by most complex interaction, viz. year x irrigation x nitrogen fertilization x harvest are presented in appendix Tables 75 and 76, for C-1 and C-2, respectively. These tables give the iron content for the four seasons under different treatment combinations.

Influence of Treatments on Manganese Content of Grass Pasture Mixture

The data for the manganese content of the orchardgrass-bromegrass pasture mixture were analyzed separately under C-1 and C-2 clipping frequencies. The analyses of variance for the C-1 and C-2 treatments

are given in appendix Tables 59 and 60, respectively.

The analyses of variance show that the "F" values for main effects, viz. years, nitrogen fertilizations and harvests were highly significant within the C-1 and C-2 frequencies. Some of the first order interactions and second order interactions were significant to highly significant.

Response to years

The manganese content of grass pasture mixture as influenced by the main effect of hears is presented in Table 37. The "F" value of this effect was highly significant under both clipping frequencies. Table 37 shows that the manganese content decreased as the stand of the grass pasture became old. This trend was similar for both C-1 and C-2. The highest manganese content i.e. 125 and 122 parts per million for the year 1961 and the lowest i.e. 50 and 39 parts per million for the year 1964 were obtained for the C-1 and C-2 frequencies, respectively. The intermediate years did not show any particular trend. The third year however, showed an increase by 18, and 10 parts per million over the second year for C-1 and C-2, respectively.

Effect of nitrogen fertilization on manganese content

The manganese content of the grass pasture mixture as influenced by this main effect is presented in Table 38. The results are graphed in Figure 39. It will be seen from this figure that the manganese content gradually decreased as the nitrogen fertilization increased. This trend was similar for both C-1 and C-2. The lowest manganese content was obtained for F-4 (200 pounds of nitrogen per season). The amounts were 76 and 79 parts per million for C-1 and C-2, respectively.

Table 37. Effect of year on average manganese content for C-1 and C-2 clipping frequencies

Year	Parts per million		
	C-1	C-2	Ave.
1961	125	122	123.5
1962	81	84	82.5
1963	99	94	96.5
1964	50	39	44.5
Ave.	89	85	
LSD: 5% - 10.74 1% - 15.06	5% - 8.0 1% - 11.0		

Table 38. Effect of nitrogen fertilization on average manganese content for C-1 and C-2 clipping frequencies

Fertilization	Parts per million	
	C-1	C-2
F-1	102	92
F-2	92	87
F-3	85	83
F-4	76	79
Average	89	85
LSD: 5% - 10.94 1% - 14.60	5% - 6.5 1% - 8.6	

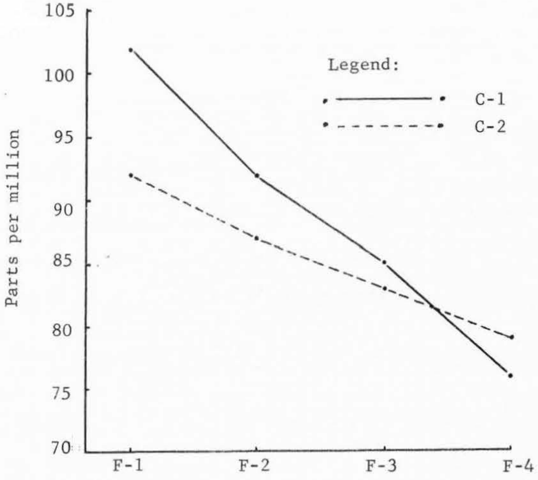


Figure 39. Average manganese content of grass forage as influenced by nitrogen fertilization for the C-1 and C-2 clipping frequency.

On the other hand the highest manganese content was obtained for the first year. The amounts were 102 and 92 parts per million for C-1 and C-2, respectively. There was no marked difference for manganese content between C-1 and C-2 at any fertilizer level. Reid et al. (1959) found similar results.

Effect of different harvests on manganese content

The influence of this main effect on the manganese content is shown in Table 39 and graphed in Figure 40. It will be seen from this figure that the manganese content increased sharply for the first three harvests and decreased with almost the same sharpness for H-4 for both C-1 and C-2. H-3, however, had a gradual increase over H-2 for both clippings. The lowest manganese content was obtained for H-4 for both C-1 and C-2. The amounts were 55 and 84 parts per million, respectively. H-5 for C-2 showed a slight increase over H-4. The highest manganese content was obtained for H-3 for both C-1 and C-2. They were 113 and 104 parts per million, respectively. The dates of third harvest (H-3) were August 2 and 3 for C-1 and July 18 and 19 for C-2. Moxon et al. (1951) and Loper and Smith (1961) while working with forage maturity and its influence on mineral assimilation, found that manganese in bromegrass decreased to about heading stage and then increased. They also indicated that bromegrass contained the largest manganese content in the leafblades.

Effect of an interaction of nitrogen fertilization x harvest on manganese content

The influence of the interaction is shown in Table 40. The results are graphed in Figures 41 and 42. These figures show that manganese

Table 39. Effect of different harvests on the manganese content for C-1 and C-2 clipping frequencies

Harvests	Parts per million	
	C-1	C-2
1	52	50
2	104	94
3	113	104
4	55	84
5	---	91
Average	81	85
LSD:	5% - 9.35 1% - 12.29	5% - 6.1 1% - 8.0

Table 40. Average manganese content per harvest as influenced by nitrogen fertilization for C-1 and C-2 clipping frequencies

Harvest	Parts per million									
	C-1					C-2				
	F-1	F-2	F-3	F-4	Ave.	F-1	F-2	F-3	F-4	Ave.
1	57	55	49	47	52	50	48	51	50	50
2	136	110	84	87	104	112	96	84	84	94
3	123	118	113	98	113	118	102	97	99	104
4	91	84	94	72	85	87	87	89	74	84
5	---	---	---	---	---	90	95	94	87	92
Average	102	92	85	76	89	91	86	83	79	85

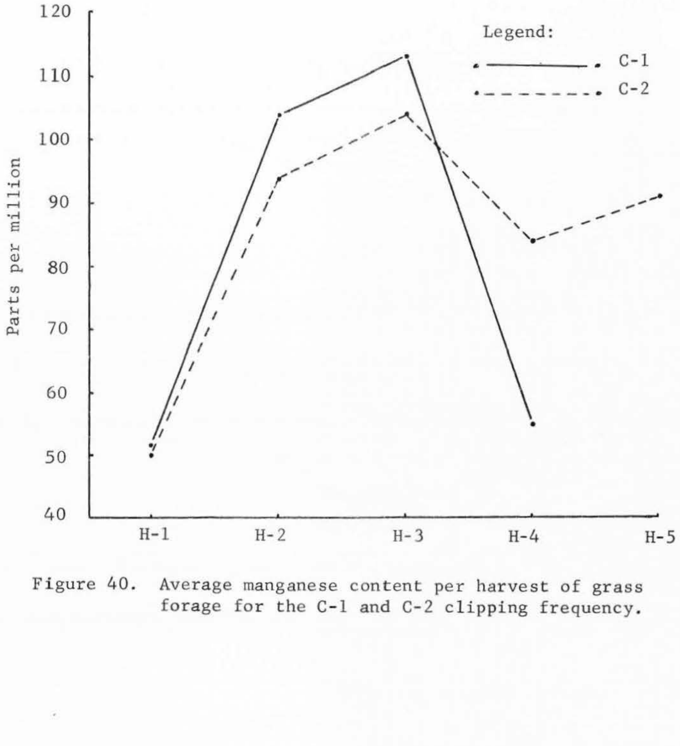


Figure 40. Average manganese content per harvest of grass forage for the C-1 and C-2 clipping frequency.

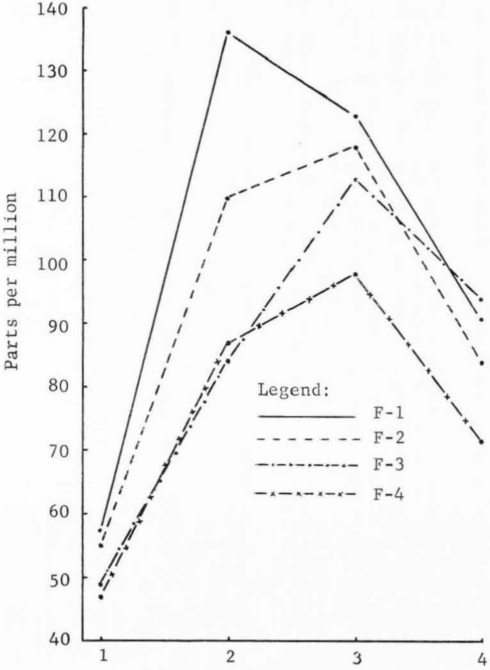


Figure 41. Average manganese content per harvest as influenced by nitrogen for the C-1 clipping frequency.

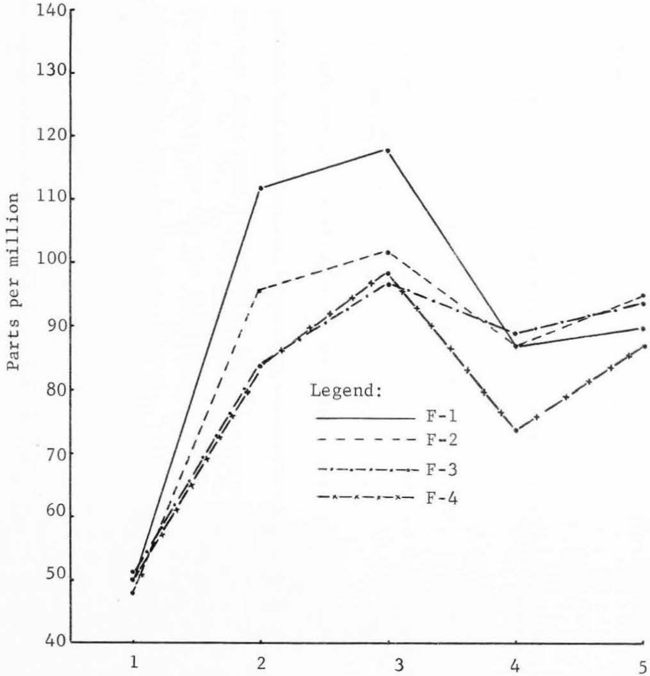


Figure 42. Average manganese content per harvest as influenced by nitrogen fertilization for the C-2 clipping frequency.

content decreased as the nitrogen fertilizer level increased. F-1 increased sharply for H-2 and gradually decreased for H-3 and H-4 under C-1. Wheras, it gradually increased for the first three harvests and decreased for H-4 and H-5 under C-2. F-2 showed a similar trend to F-1 for both C-1 and C-2. F-3 showed a steep increase the first three harvests and decreased for H-4 and in C-1. Although the trend of F-3 for C-2 was similar to C-1, the increase for the first three harvests was not as steep as it was within C-1. F-4 also showed a gradual increase for the first three harvests and sharp decrease for the H-4 under both C-1 and C-2. The manganese content at H-5 was larger than at H-4 for all fertilizer levels under C-2. Manganese contents for all fertilizer levels were higher at H-2 than other harvests. For H-4 the manganese content was depressed at all fertilizer levels for both C-1 and C-2. F-1 (no fertilizer) had higher manganese percentages than other fertilizer levels for all harvests. Reid et al. (1967) reported that the content of manganese and other minor elements did not show any definite association either with fertilization or with stage of maturity of tall fescue. Loper and Smith (1961) noted a general decline in the level of manganese with advanced stages of growth of forages.

Effect of an interaction of year x harvest on manganese content

The influence of this interaction on manganese content is shown in Table 41. The results are graphed in Figures 43 and 44 for C-1 and C-2, respectively. It will be seen from these figures that the manganese contents for H-1 for C-1 and C-2 gradually increased for the first three years and dropped sharply the fourth year. The manganese content was

Table 41. Average manganese content per year as influenced by harvest for C-1 and C-2 clipping frequencies

	Parts per million										
	C-1					C-2					
Year	H-1	H-2	H-3	H-4	Ave.	H-1	H-2	H-3	H-4	H-5	Ave.
1	51	162	128	160	125	43	163	122	155	126	122
2	55	78	122	68	81	60	62	104	72	120	84
3	75	102	144	73	99	75	102	146	72	76	94
4	26	75	57	40	50	21	50	44	49	42	41
Ave.	52	104	113	85	89	50	94	104	87	91	85

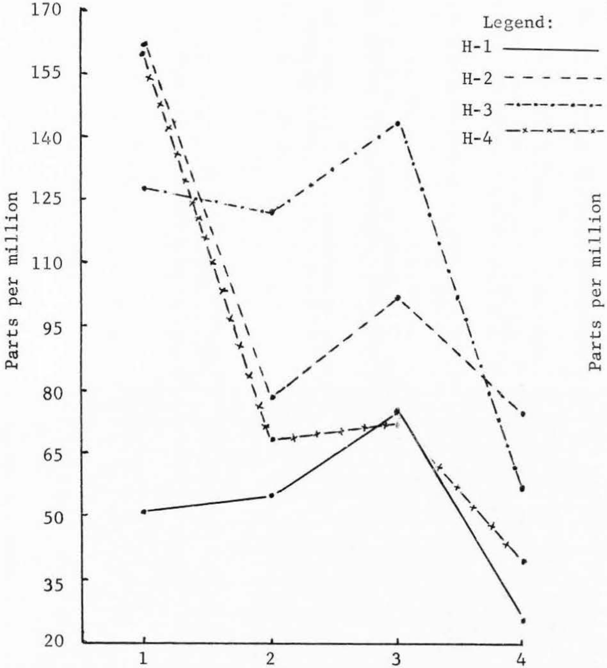


Figure 43. Average manganese content per year as influenced by different harvests for the C-1 clipping frequency.

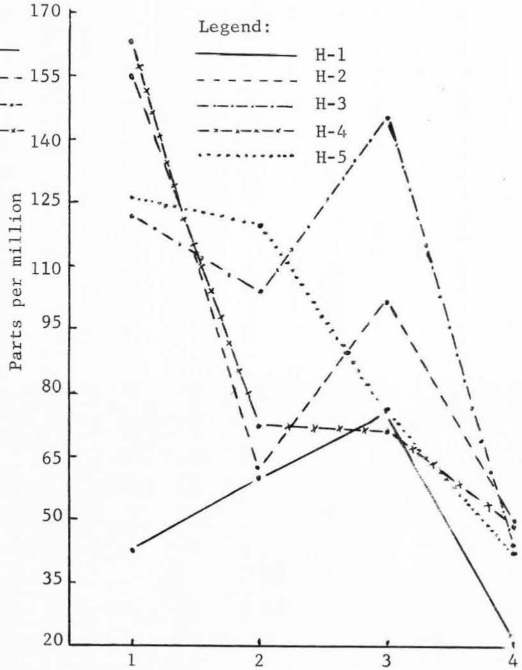


Figure 44. Average manganese content per year as influenced by different harvests for the C-1 clipping frequency.

high for H-2 for 1961, and dropped sharply for 1962, showed a slight increase for 1963 and finally decreased for 1964. H-3 and H-4 for C-1 and H-3 and H-5 for C-2 gave similar trends at H-1 and H-2 for both C-1 and C-2. The manganese content was high in 1961 and 1963 for all harvests under both frequencies. Williams and Moore (1952) found that the manganese content in Algerian oats depended on soil pH. It was higher in alkaline soils and increased with the age of grasses especially during early growth. Kirchgessner (1957) reported no definite trend in manganese concentration with the maturity in meadow grass hays and golden oatgrass.

The first order interaction for irrigation x harvest was nonsignificant for C-1 and significant at .05 level for C-2. Similarly, the second order interaction for year x nitrogen fertilization x harvest was nonsignificant for C-1 and highly significant for C-2.

The main effect of irrigations, the other first order, second order and third order interactions were nonsignificant under both the C-1 and C-2 frequencies.

The third order interaction, viz. year x irrigation x nitrogen fertilization x harvest was also nonsignificant under both C-1 and C-2. The influence of this interaction is presented in appendix Tables 77 and 78 for C-1 and C-2.

Influence of Treatments on Zinc Content of Grass Pasture Mixture

The data for zinc content of the orchardgrass-bromegrass pasture mixture were analyzed separately within the C-1 and C-2 frequencies. The analyses of variance for C-1 and C-2 treatments are given in

appendix Tables 61 and 62, respectively.

The analyses of variance show that the "F" values for main effects of years and harvests were highly significant within the C-1 and C-2 frequencies. The nitrogen fertilization effect was nonsignificant under the C-1 and significant at .05 level under C-2. The "F" values of some of the first order and second order interactions were significant within both C-1 and C-2.

Response to years

The zinc content of grass pasture under the C-1 and C-2 frequencies is given in Table 42. The "F" value of this main effect was highly significant. It will be seen from Table 42 that the zinc content in 1962 was about half of what it was in 1961. This lower level persisted for 1963 and 1964, and was true for both C-1 and C-2. The highest zinc content was obtained for the initial year of the stand of the grass, i.e. 1961. The amounts were 27.0 and 32.7 parts per million for C-1 and C-2, respectively. If the slight increase for 1963 over 1962 was neglected, one can visualize that there was a gradual drop in zinc content in pasture plants as their stand became old.

Effect of different harvests on zinc content

The zinc content of grass pasture mixture as influenced by different harvests is presented in Table 43. The results are graphed in Figure 45. It will be seen from Figure 45 that the zinc content dropped sharply the second harvest. There was a slight increase the third harvest over the second harvest. At H-4 there was a marked increase in zinc content for both C-1 and C-2. H-5 for C-2 dropped sharply

Table 42. Effect of year on average zinc content for C-1 and C-2 clipping frequencies

Year	Parts per million		
	C-1	C-2	Ave.
1961	27.0	32.7	29.85
1962	16.0	16.5	16.25
1963	21.4	22.4	21.90
1964	16.9	17.5	17.20
Ave.	20.3	22.3	
LSD: 5% - 2.00 1% - 2.81	1.636 2.294		

Table 43. Effect of different harvests on the zinc content for C-1 and C-2 clipping frequencies

Harvests	Parts per million	
	C-1	C-2
1	21.4	26.6
2	18.7	19.8
3	19.1	20.4
4	22.3	24.1
5	--	20.4
Average	20.30	22.26
LSD: 5% - 1.40 1% - 1.84	1.55 2.04	

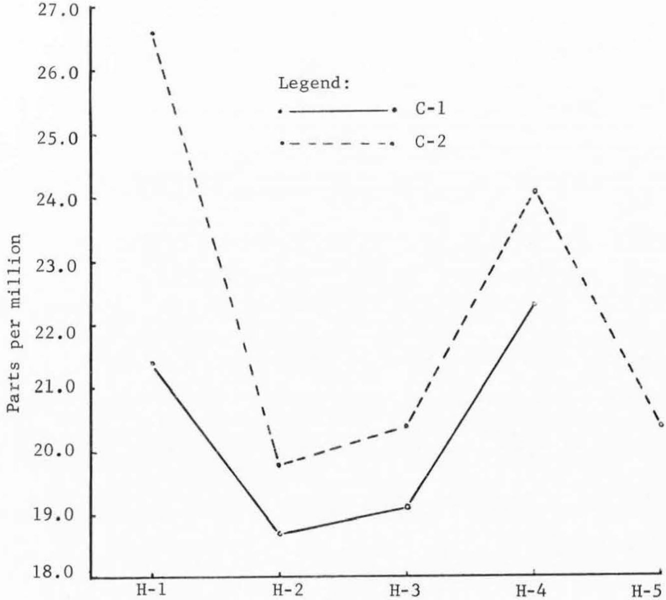


Figure 45. Average zinc content per harvest of grass forage the C-1 and C-2 clipping frequencies.

again giving a zinc content equal to H-3. For H-2 and H-3 the difference in zinc content was smaller than the difference between H-1 and H-2 or H-3 and H-4. This trend was similar for both C-1 and C-2. The highest zinc content for C-2 was obtained for H-1 which was 26.6 parts per million. Loper and Smith (1961) showed that the most rapid decrease in zinc content came in the youngest stage of growth of forages. Riceman and Jones (1957) grew subterranean clover in nutrient solutions containing various concentrations of zinc. In treatments where zinc deficiency symptoms did not develop, zinc concentration increased at first, then dropped sharply. Plants that developed early zinc deficiencies decreased in zinc to minimum of 12.5 to 8.1 parts per million. On the contrary, Kirchgessner (1957) found that zinc in golden oatgrass was not affected by plant development.

Effect of interaction year x harvest on zinc content

The zinc content as influenced by year x harvest is given in Table 44. The results are presented in Figures 46 and 47 for C-1 and C-2, respectively. These figures indicate that the zinc content for H-1 under C-1 and C-2 decreased very sharply for 1962, increased with the same sharpness for 1963 and dropped in 1964. H-2 and H-3 were similar to H-1 for both C-1 and C-2, except that the increase for 1963 was gradual. H-4 showed a gradual decrease the first three years and a slight increase the fourth year, i.e. 1964. This trend was similar to both frequencies. H-5 for C-2 was similar to H-2.

The main effect of nitrogen fertilizations, the first order interactions of year x nitrogen fertilization, irrigation x harvest, and

Table 44. Average zinc content per year as influenced by harvest for C-1 and C-2 clipping frequencies

	Parts per million										
	C-1					C-2					
Year	H-1	H-2	H-3	H-4	Ave.	H-1	H-2	H-3	H-4	H-5	Ave.
1	23.6	27.2	25.4	32.0	27.1	42.8	28.9	28.3	35.9	27.4	32.7
2	11.9	16.0	16.0	20.3	16.1	12.0	14.7	16.5	21.2	18.3	16.5
3	33.9	15.7	18.5	17.7	21.5	46.0	18.9	20.9	18.0	18.1	24.4
4	16.0	15.9	16.3	19.4	16.9	15.7	16.8	16.0	21.4	17.9	17.6
Ave.	21.4	18.7	19.1	22.4	20.4	29.1	19.8	20.4	24.1	20.4	22.8

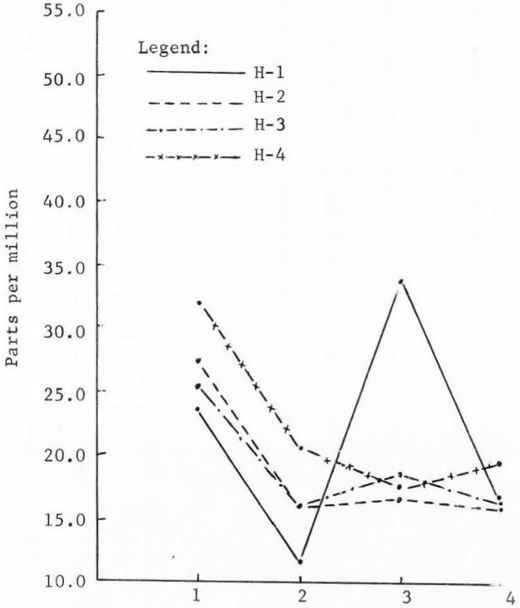


Figure 46. Average zinc content per year as influenced by the different harvests for the C-1 clipping frequency.

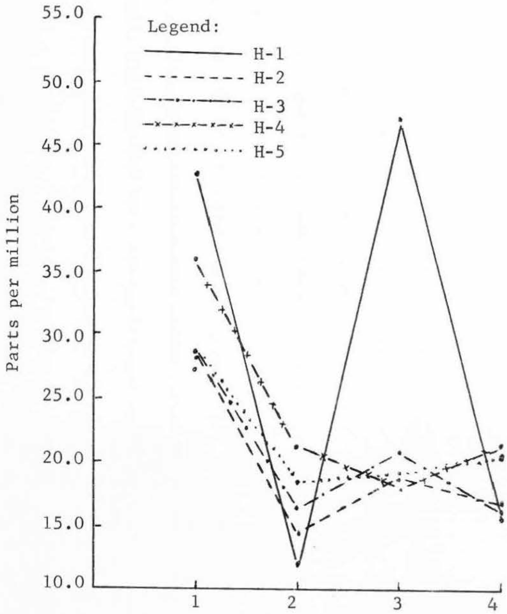


Figure 47. Average zinc content per year as influenced by the different harvests for the C-2 clipping frequency.

nitrogen fertilization x harvest; the second order interactions for year x irrigation x harvest and year x nitrogen fertilization x harvest were nonsignificant under the C-1 and highly significant under the C-2 frequency. On the contrary, the second order interaction for irrigation x nitrogen fertilization x harvest was highly significant under the C-1 and nonsignificant under the C-2 frequency. The third order and most complex interaction was highly significant under the C-1 and significant at .05 level under the C-2 frequency.

The irrigation as a main effect, the other first order, second order interactions were nonsignificant under both clipping frequencies.

The zinc content as influenced by the third order interaction for year x irrigation x nitrogen fertilization x harvest are presented in appendix Tables 79 and 80 for C-1 and C-2, respectively.

SUMMARY AND CONCLUSIONS

The field experiment was conducted at the Greenville Experimental Farm in North Logan, Utah, from 1961 to 1964. The soil is a Millville silt loam that occurs on an alluvial fan, well drained, and has about 1 percent surface slope. The soil is high in potash and phosphorus, and is alkaline having a pH of 7.9 to 8.2.

The study was conducted to evaluate the influence of two clipping frequencies, four nitrogen fertilization levels, and four irrigation intervals on the forage yield and forage quality shown through the content of nitrogen, phosphorus, potassium, calcium, copper, iron, manganese, and zinc in the forage of an orchardgrass-bromegrass pasture mixture.

On the basis of the results obtained, the following conclusions were drawn.

Only a small difference was noted between the amount of forage produced by the grass mixture when harvested four times (C-1) as compared to five times (C-2). The tendency, however, was toward higher yields with the fewer harvests (C-1). This was especially true on plots receiving the higher rates of nitrogen fertilization, and frequent irrigations.

Nitrogen, phosphorus, calcium, copper, iron and zinc content was higher with five harvests (C-2). On the contrary, potassium and manganese content was higher with four harvests (C-1).

Yields of forage increased as available soil moisture increased, producing the highest yields for short intervals of irrigation (I-4).

The second highest yields were obtained for the medium short intervals of irrigation (I-3).

In general, nitrogen, copper, iron, and zinc content decreased with increasing soil moisture. There was a slight increase of phosphorus, calcium, and manganese content with increasing the soil moisture. On the other hand, there was a variable effect of increasing soil moisture on potassium percentage.

Nitrogen fertilization increased the dry matter yield of forage significantly. Two hundred pounds of nitrogen per acre (F-4) gave the highest yields of dry matter.

Percentage nitrogen decreased as nitrogen fertilization increased up to 100 pounds per acre (F-3) but slightly increased with 200 pounds per acre (F-4). There appeared to be no consistent trend of increasing nitrogen fertilization on phosphorus, potassium, and copper content. Zinc content slightly increased with the increase of nitrogen fertilization. On the contrary, calcium, iron and manganese content showed a decrease with increase in nitrogen level.

The dry matter yield decreased as the age of stand of forage increased. However, a small difference was noted between the amount of forage produced for different years.

Percentage nitrogen and phosphorus increased with the increasing age of stand. Copper, iron and manganese content decreased with the increased age of stand of forage. Potassium, calcium, and zinc content showed a general decrease with the increasing age of forage, but there was a fluctuating tendency in their content for different years.

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APPENDIXES

Appendix A

Working Principle of Atomic Absorption Spectrophotometer

The phenomenon of light absorption by chemical elements has been long recognized. As soon as astronomers examined the spectrum of light from the sun and other planets, they noted the distinct absence of certain light frequencies.

This indicates certain elements present absorbed light as these wave lengths. The method is still useful in today's space age.

The use of atomic absorption as an analytical tool was developed by Dr. A. Walsh of Commonwealth Scientifica and Industrial Research Organization (CSIRO) just ten years ago. Its application to biological material analysis was first made by J. F. Allan of the Department of Agriculture, Rukuhia Research Station, Hamilton, New Zealand, and D. J. David of CSIRO, Austrailia in 1958. Instruments for such analyses have been available only during the past three to four years.

The atmoic absorption spectrophotometer is designed to measure the amount of light absorbed by a given chemical element. Because each element has absorption bands separate and distinct from all other chemical elements, this technique is a valuable tool for analyzing unknown samples.

Normally a test sample is dissolved and the solution is atomized into a flame. A light source of the characteristic wavelength of element being examined is directed through the flame.

The light that is not absorbed is measured by a photoelectric cell. For example, if zinc were being determined, the light source

would be heated cathode made of zinc. In this way, only the light characteristic of the element zinc would be emitted.

As this light passes through the flame, it can be absorbed only by zinc atoms. The greater the number of zinc atoms placed in the light path, the greater the absorption of light and the smaller will be the light recovered by the photoelectric cell.

Atomic absorption depends upon the absorption of light by an element in the "ground" state. That is, the element need not be excited to a higher energy level.

Flame photometry, an older system of chemical analysis, depends upon the emission of light by excited atoms that are heated to high temperatures.

In emission, flame photometry, interference is common because other elements in the sample may also become excited and emit light that is very close in wavelength to the light of the element being tested. Also, only a small fraction of the light of the sample becomes sufficiently excited to emit light. Thus, atomic absorption is much more accurate and sensitive in most cases than flame photometry, and is much more free of interference.

Appendix B

Tables

Table 45. Analysis of variance for dry matter yield within the C-1 clipping frequency, (1961-1964)

Source	DF	SS	MS	'F' values
Years	3	.336623	.112208	4.1696*
Replications	1	.000488	.000488	.01814
Years x Reps	3	.043479	.014493	.5385
Irrigation	3	1.999935	.666645	24.7726**
Years x Irr	9	.860479	.095608	3.5528*
Error (A)	12	.322927	.026910	
Fertilizers	3	35.04978	11.68326	576.3500**
Irr x Fert	9	.359011	.039890	1.9678
Year x Fert	9	.394136	.043792	2.1603*
Year x Irr x Fert	27	.427532	.015834	.7811
Error (B)	48	.973006	.020270	
Harvests	3	31,44761	10.48254	608.2100**
Irr x Harvest	9	.147729	0.16414	.9523
Fert x Harvest	9	11.42831	1.269812	73.6760**
Irr x Fert x Harv	27	.398175	.014747	.8556
Year x Harvest	9	32.71742	3.635269	210.9240**
Year x Irr x Harv	27	1.026495	.038018	2.2052**
Year x Fert x Harv	27	1.459119	.054414	3.1355**
Year x Irr x Fert x Harv	81	1.013406	.012511	.7259
Error (C)	192	3.309100	.017235	
Total	511	94.267090	.184475	

*Significant at 5%.
**Significant at 1%.
NSNon-significant.

Table 46. Analysis of variance for dry matter yields within the C-2 clipping frequency, (1961-1964)

Source	DF	SS	MS	'F' values
Years	3	.5515000	.1838333	6.654**
Replications	1	.0104000	.0104000	.376
Years x Reps	3	.1243900	.0414633	1.501
Irrigations	3	1.313370	.4377900	15.847**
Years x Irr	9	.3039900	.0337766	1.223
Error (A)	12	.3315200	.0276266	
Fertilizers	3	19.56223	6.520743	401.73**
Irr x Fert	9	.3635200	.0403911	2.488*
Year x Fert	9	.4973000	.0552555	3.404**
Year x Irr x Fert	27	.4176600	.0154688	NS
Error (B)	48	.7791100	.0162314	
Harvests	4	35.02672	8.756680	576.974**
Irr x Harvest	12	.1876800	.0156400	NS
Fert x Harvest	12	9.071230	.7559358	49.808**
Irr x Fert x Harv	36	.4655900	.0129330	NS
Year x Harvest	12	43.79243	3.64926	240.488**
Year x Irr x Harv	36	1.134070	.03150194	2.076**
Year x Fert x Harv	36	2.008000	.0557777	3.675**
Year x Irr x Fert x Harv	108	2.116550	.0195976	1.291
Error (C)	256	3.285280	.01517688	
Total	639	88.23519	.1380832	

*Significant at 5%.
**Significant at 1%.
NS Non-significant.

Table 47. Analysis of variance for nitrogen content within the C-1 clipping frequency, (1961-1962)

Source	DF	SS	MS	'F' values
Years	3	3.702242	1.234081	20.659**
Replications	1	1.726309	1.726309	28.899**
Years x Reps	3	.211985	.080661	1.350NS
Irrigations	3	1.425506	.475169	7.955**
Years x Irr	9	.750159	.083310	1.395NS
Error (A)	12	.716809	.059734	
Fertilizers	3	2.641723	.880574	9.952**
Irr x Fert	9	3.84629	.427365	4.830**
Year x Fert	9	1.331529	.147948	1.672NS
Year x Irr x Fert	27	1.839065	.0681135	.770NS
Error (B)	48	4.247110	.0884814	
Harvests	3	37.88069	12.62690	225.52**
Irr x Harvest	9	.869336	.096592	1.752NS
Fert x Harvest	9	2.499556	.2777284	4.960**
Irr x Fert x Harv	27	1.452494	.0537960	.961NS
Year x Harv	9	41.613890	4.623766	82.583**
Year x Irr x Harv	27	2.313644	.0256905	1.530NS
Year x Fert x Harv	27	2.528084	.0936327	1.672*
Year x Irr x Fert x Harv	21	3.705976	.0457528	.817NS
Error (C)	192	10.74984	.0559887	
Total	511	89.62706	.175395	

*Significant at 5%.
**Significant at 1%.
NS Non-significant.

Table 48. Analysis of variance for nitrogen contents within the C-2 clipping frequency, (1961-1964)

Source	DF	SS	MS	'F' values
Years	3	6.948400	2.316133	23.125**
Replications	1	1.274500	1.274500	15.476**
Years x Reps	3	.129600	.043200	NS
Irrigations	3	1.926600	.66220	8.041**
Year x Irr	9	1.327800	.147533	1.791
Error (A)	12	.988200	.082350	
Fertilizers	3	2.094700	.698233	7.542**
Irr x Fert	9	1.810400	.201155	2.173*
Year x Fert	9	3.169000	.352111	3.803**
Year x Irr x Fert	27	2.657300	.098418	1.063NS
Error (B)	48	4.443800	.092591	
Harvests	4	38.03930	9.509825	198.732**
Irr x Harvest	12	2.003100	.166925	3.488**
Fert x Harvest	12	7.011300	.584275	12.210**
Irr x Fert x Harv	36	1.724000	.047888	NS
Year x Harvest	12	54.199800	4.516650	94.387**
Year x Irr x Harv	36	3.982200	.110617	2.312**
Year x Fert x Harv	36	2.956300	.082119	1.716**
Year x Irr x Fert x Harv	108	6.084400	.053874	1.168NS
Error (C)	256	12.250200	.047852	
Total	639	118.978200	.186194	

*Significant at 5%.
**Significant at 1%.
NSNon-significant.

Table 49. Analysis of variance for phosphorus contents within the C-1 clipping frequency, (1961-1964)

Source	DF	SS	MS	'F' values
Years	3	.9325944	.3108642	33.233*
Replications	1	.2665869	.2665869	28.499**
Years x Reps	3	.0092065	.0030688	.328NS
Irrigations	3	.0501132	.0167044	1.785NS
Years x Irr	9	.0480574	.0053397	.571NS
Error (A)	12	.1122481	.0093540	
Fertilizers	3	.5897211	.1965737	39.774**
Irr x Fert	9	.0328579	.0036508	.738NS
Year x Fert	9	.0990113	.0110013	2.226*
Year x Irr x Fert	27	.0882187	.0032674	.661NS
Error (B)	48	.2372269	.0049422	
Harvests	3	1.687341	.5624468	113.652**
Irr x Harvests	9	.0264631	.0029409	.594NS
Fert x Harvest	9	.4500352	.0500039	10.104**
Irr x Fert x Harv	27	.0985494	.0036499	.737NS
Year x Harv	9	2.261085	.2512317	50.765**
Year x Irr x Harv	27	.1010745	.0037435	.756NS
Year x Fert x Harv	27	.1997464	.0073980	1.494NS
Year x Irr x Fert x Harv	81	.4027566	.0049723	1.004NS
Error (C)	192	.9501736	.0049488	
Total	511	7.005845	.0137100	

*Significant at 5%.
**Significant at 1%.
NSNon-significant.

Table 50. Analysis of variance for phosphorus content within the C-2 clipping frequency, (1961-1964)

Source	DF	SS	MS	'F' values
Years	3	1.318777	.439592	92.088**
Replications	1	.387892	.387892	81.285**
Years x Reps	3	.014545	.004849	NS
Irrigations	3	.150839	.050280	10.533**
Year x Irr	9	.123274	.013697	2.869*
Error (A)	12	.057283	.004774	
Fertilizers	3	.491371	.163790	24.529**
Irr x Fert	9	.136857	.0152063	2.277**
Year x Fert	9	.119153	.013239	1.983NS
Year x Irr x Fert	27	.215291	.007974	1.194NS
Error (B)	48	.320515	.006677	
Harvests	4	2.187000	.546750	155.359**
Irr x Harvest	12	.051979	.0043315	NS
Fert x Harvest	12	.520755	.043397	12.331**
Irr x Fert x Harvest	36	.136567	.003793	NS
Year x Harvest	12	3.476424	.289707	82.320**
Year x Irr x Harvest	36	.251500	.006986	1.985**
Year x Fert x Harvest	36	.218847	.006079	1.727**
Year x Irr x Fert x Harv	108	.477898	.004425	NS
Error (C)	256	.900929	.003519	
Total	639	9.521597	.014900	

*Significant at 5%.
**Significant at 1%.
NSNon-significant.

Table 51. Analysis of variance for potassium content within the C-1 clipping frequency, (1961-1964)

Source	DF	SS	MS	'F' values
Years	3	11.86438	3.954793	118.894**
Replications	1	.0500070	.0500070	1.503NS
Years x Reps	3	.3477790	.1159263	3.485*
Irrigations	3	.0416664	.0138888	.417NS
Years x Irr	9	.1975416	.0219491	.659NS
Error (A)	12	.3991580	.0332621	
Fertilizers	3	.0524257	.0174752	.443NS
Irr x Fert	9	.2740502	.0304500	.772NS
Year x Fert	9	.4263132	.0473681	1.201NS
Year x Irr x Fert	27	.6639547	.024590	.624NS
Error (B)	48	1.891781	.0394121	
Harvests	3	9.819270	3.273090	76.706**
Irr x Harvest	9	.1716765	.01907517	.447NS
Fert x Harvest	9	.1325415	.0147268	.345NS
Irr x Fert x Harv	27	1.1566270	.0428380	1.003NS
Year x Harv	9	47.48436	5.276040	123.647**
Year x Irr x Harv	27	.8525914	.0317996	.745NS
Year x Fert x Harv	27	.5988198	.0221785	.519NS
Year x Irr x Fert x Harv	21	3.175595	.0392048	.912NS
Error (C)	192	8.192675	.04267018	
Total	511	78.02161	.1526842	

*Significant at 5%.
**Significant at 1%.
NSNon-significant.

Table 52. Analysis of variance for potassium content within the C-2 clipping frequency, (1961-1964)

Source	DF	SS	MS	'F' values
Years	3	6.770000	2.256667	64.784**
Replications	1	.090000	..090000	NS
Years x Reps	3	.631000	..210333	6.038**
Irrigations	3	.197000	.065667	NS
Years x Irr	9	.414000	.046000	NS
Error (A)	12	.418000	.034833	
Fertilizers	3	.295000	.098333	2.954*
Irr x Fert	9	.352000	.039111	NS
Year x Fert	9	.716000	.079555	2.390*
Year x Irr x Fert	27	.702000	.026000	NS
Error (B)	48	1.598000	.033291	
Harvests	4	13.115000	3.278750	91.693**
Irr x Harvest	12	.238000	.019833	NS
Fert x Harvest	12	.709000	.059083	NS
Irr x Fert x Harv	36	1.658000	.046055	NS
Year x Harvest	12	42.970000	13.58083	100.141**
Year x Irr x Harv	36	1.540000	.042777	NS
Year x Fert x Harv	36	1.569000	.043583	NS
Year x Irr x Fert x Harv	108	2.941000	.027231	NS
Error (C)	256	9.154000	.035757	
Total	639	73.163000	.114496	

*Significant at 5%.
**Significant at 1%.
NSNon-significant.

Table 53. Analysis of variance for calcium content within the C-1 clipping frequency, (1961-1964)

Source	DF	SS	MS	'F' values
Years	3	23.03096	7.676987	61.406**
Replications	1	.9782500	.9782500	7.825*
Years x Reps	3	.3913600	.1304533	1.043NS
Irrigations	3	.1313600	.0437866	.350NS
Years x Irr	9	.7969900	.0285544	.708NS
Error (A)	12	1.500230	.1250192	
Fertilizers	3	12.39177	4.130590	41.007**
Irr x Fert	9	1.194470	.1327189	1.317NS
Year x Fert	9	.8458100	.0939788	.933NS
Year x Irr x Fert	27	1.463710	.05421148	.538NS
Error (B)	48	4.834890	.1007269	
Harvests	3	6.190280	2.063427	38.057**
Irr x Harvest	9	.6298900	.0699877	1.290NS
Fert x Harvest	9	2.282720	.2536356	4.678**
Irr x Fert x Harv	27	1.391210	.0515263	.950NS
Year x Harv	9	12.37288	1.374764	25.355**
Year x Irr x Harv	27	.9139600	.0332503	.624NS
Year x Fert x Harv	27	2.107270	.0780470	1.439NS
Year x Irr x Fert x Harv	81	4.206340	.0519301	.957NS
Error (C)	192	10.40997	.0542186	
Total	511	82.00540	.1604802	

*Significant at 5%.
**Significant at 1%.
NSNon-significant.

Table 54. Analysis of variance for calcium content within the C-2 clipping frequency, (1961-1964)

Source	DF	SS	MS	'F' values
Years	3	26.80699	8.935662	178.545**
Replications	1	.796650	.796650	15.918**
Years x Reps	3	.314446	.104813	2.094NS
Irrigations	3	.825696	.275232	5.499*
Years x Irr	9	.893329	.099258	NS
Error (A)	12	.600563	.050047	
Fertilizers	3	11.36065	3.786883	93.698**
Irr x Fert	9	.638421	.070935	NS
Year x Fert	9	2.956277	.328475	8.127**
Year x Irr x Fert	27	1.819774	.067399	NS
Error (B)	48	1.939960	.040416	
Harvests	4	8.009442	2.002360	44.857**
Irr x Harvest	12	.785121	.065426	NS
Fert x Harvest	12	5.826863	.485572	10.178**
Irr x Fert x Harv	36	2.446426	.067956	NS
Year x Harvest	12	27.441100	2.286750	51.228**
Year x Irr x Harv	36	2.246893	.0624137	NS
Year x Fert x Harv	36	9.069276	.251924	5.544**
Year x Irr x Fert x Harv	108	5.206792	.048211	NS
Error (C)	256	11.427280	.044637	
Total	639	114.228200	.178761	

*Significant at 5%.
**Significant at 1%.
NS Non-significant.

Table 55. Analysis of variance for copper content within the C-1 clipping frequency, (1961-1964)

Source	DF	SS	MS	'F' values
Years	3	1485.000	495.0001	38.155**
Replications	1	21.82140	21.82140	1.682NS
Years x Reps	3	7.14670	2.38223	.183NS
Irrigations	3	88.29210	29.43070	2.268NS
Years x Irr	9	144.3139	16.03488	1.236NS
Error (A)	12	155.6791	12.97326	
Fertilizers	3	13.30820	4.366067	.294NS
Irr x Fert	9	54.07280	6.008089	.398NS
Year x Fert	9	66.80970	7.423300	.492NS
Year x Irr x Fert	27	135.9124	5.034015	.334NS
Error (B)	42	723.5166	15.07326	
Harvests	3	943.1398	314.3799	24.011**
Irr x Harvest	9	68.53750	7.615278	.581NS
Fert x Harv	9	181.4732	20.16369	1.540NS
Irr x Fert x Harv	27	294.9642	10.92460	.834NS
Year x Harv	9	2847.245	316.3605	24.162**
Year x Irr x Harv	27	445.8624	16.51342	1.2612NS
Year x Fert x Narv	27	526.1398	19.48666	1.488NS
Year x Irr x Fert x Harv	81	748.6771	9.242927	.7059NS
Error (C)	192	2513.891	13.09318	
Total	511	10610.96	20.76509	

*Significant at 5%.
**Significant at 1%.
NSNon-significant.

Table 56. Analysis of variance for copper content within the C-2 clipping frequency, (1961-1964)

Source	DF	SS	MS	'F' values
Years	3	3418.004	1139.335	59.683**
Replications	1	31.1522	31.1522	NS
Years x Reps	3	69.6016	23.2005	NS
Irrigations	3	80.1361	26.7120	NS
Years x Irr	9	325.4768	36.1641	NS
Error (A)	12	229.0736	19.0894	
Fertilizers	3	10.4169	3.4723	NS
Irr x Fert	9	148.9333	16.5481	NS
Year x Fert	9	194.4430	21.6048	NS
Year x Irr x Fert	27	470.3133	17.4190	NS
Error (B)	48	929.1105	19.3565	
Harvests	4	1563.962	390.9905	25.274**
Irr x Harvest	12	150.2643	12.5220	NS
Fert x Harvest	12	324.0892	27.0074	1.746NS
Irr x Fert x Harv	36	499.3964	13.8721	NS
Year x Harvest	12	3800.722	316.726	20.486**
Year x Irr x Harv	36	584.1254	16.2257	1.049NS
Year x Fert x Harv	36	699.4086	19.4280	1.256NS
Year x Irr x Fert x Harv	108	1738.953	16.1014	NS
Error (C)	256	3960.402	15.4703	
Total	639	17744.16	27.7686	

*Significant at 5%.
**Significant at 1%.
NSNon-significant.

Table 57. Analysis of variance for iron content within the C-1 clipping frequency, (1961-1964)

Source	DF	SS	MS	'F' values
Years	3	247767.1	82589.03	19.078**
Replications	1	6125.800	6125.800	1.415NS
Years x Reps	3	20925.60	6975.200	1.611NS
Irrigations	3	54742.70	18247.57	4.215NS
Years x Irr	9	4053.100	450.3444	.104NS
Erros (A)	12	51946.40	4328.867	
Fertilizers	3	107502.2	35836.07	20.896**
Irr x Fert	9	7291.700	810.1889	.472NS
Years x Fert	9	8349.400	927.7111	.541NS
Years x Irr x Fert	27	47548.00	1761.037	1.027NS
Error (B)	48	82316.30	1714.923	
Harvests	3	256654.7	85551.57	47.2911**
Irr x Harvest	9	15834.50	1759.389	.972NS
Fert x Harvest	9	39135.30	4348.367	2.403*
Irr x Fert x Harv	27	39467.60	1461.763	.8080NS
Year x Harv	9	352184.0	39131.56	21.631**
Year x Irr x Harv	27	139321.6	5160.059	2.852**
Year x Fert x Harv	27	51212.50	1896.759	1.048
Year x Irr x Fert x Harv	81	163339.6	2016.538	1.1147
Error (C)	192	347335.4	1809.039	
Total	511	1841148.0	3603.030	

*Significant at 5%.
**Significant at 1%.
^{NS}Non-significant.

Table 58. Analysis of variance for iron content within the C-2 clipping frequency, (1961-1964)

Source	DF	SS	MS	'F' values
Years	3	597115.7	199038.6	50.774**
Replications	1	200.1	200.1	NS
Years x Reps	3	12244.3	4081.4	NS
Irrigations	3	54563.2	18187.7	4.640*
Year x Irr	9	50287.2	5587.4	NS
Error (A)	12	47040.6	3920.1	
Fertilizers	3	15267.2	5089.1	NS
Irr x Fert	9	52258.2	5806.4	NS
Year x Fert	9	68275.7	7586.2	NS
Year x Irr x Fert	27	107814.0	3993.1	NS
Error (B)	48	231879.2	4830.8	
Harvests	4	607544.6	151886.2	42.744**
Irr x Harvest	12	93844.2	7820.4	2.201*
Fert x Harvest	12	35665.8	2972.2	NS
Irr x Fert x Harv	36	121331.9	3370.3	NS
Year x Harv	12	806555.6	68879.67	19.385**
Year x Irr x Harv	36	164871.2	4579.56	NS
Year x Fert x Harv	36	124026.1	3445.17	NS
Year x Irr x Fert x Harv	108	461863.2	4276.51	NS
Error (C)	256	909647.8	3553.31	
Total	639	4009315.0	6274.44	

*Significant at 5%.
**Significant at 1%.
NS Non-significant.

Table 59. Analysis of variance for manganese content within the C-1 clipping frequency, (1961-1964)

Source	DF	SS	MS	'F' values
Years	3	387386.4	129128.8	83.056**
Replications	1	2614.549	2614.549	1.682NS
Year x Reps	3	6093.301	2031.100	1.306NS
Irrigations	3	4404.396	1468.132	.944NS
Years x Irr	9	10735.87	1192.875	.767NS
Error (A)	12	18656.62	1554.718	
Fertilizers	3	44524.52	14841.51	7.812**
Irr x Fert	9	12916.28	1435.142	.755NS
Year x Fert	9	15577.13	1730.792	.911NS
Year x Irr x Fert	27	44916.62	1663.579	.876NS
Error (B)	48	91194.66	1899.889	
Harvests	3	283200.7	94400.24	64.843**
Irr x Harvest	9	18663.13	2073.681	1.424NS
Fert x Harvest	9	33271.07	3696.785	2.539**
Irr x Fert x Harv	27	33448.36	1238.828	.851NS
Year x Harv	9	485316.7	53924.08	37.040**
Year x Irr x Harv	27	46615.90	1726.515	1.186NS
Year x Fert x Harv	27	46112.06	1707.854	1.173NS
Year x Irr x Fert x Harv	81	123419.9	1523.702	1.047NS
Error (C)	192	279520.4	1455.835	
Total	511	1709792.0	3345.973	

*Significant at 5%.
**Significant at 1%.
NSNon-significant.

Table 60. Analysis of variance for manganese content within the C-2 clipping frequency, (1961-1964)

Source	DF	SS	MS	'F' values
Years	3	566626.20	188875.40	189.79**
Replications	1	392.19	392.19	NS
Year x Reps	3	1416.26	472.08	NS
Irrigations	3	1325.83	441.94	NS
Year x Irr	9	7590.30	843.33	NS
Error (A)	12	11941.58	995.13	
Fertilizers	3	13923.22	4641.07	5.546**
Irr x Fert	9	9591.21	1065.69	1.274NS
Year x Fert	9	10012.54	1112.50	NS
Year x Irr x Fert	27	14399.31	533.31	NS
Error (B)	48	40164.87	836.77	
Harvests	4	219914.40	54978.60	88.084**
Irr x Harvest	12	13970.44	1164.20	1.865*
Fert x Harvest	12	18003.24	1500.27	2.403**
Irr x Fert x Harv	36	28968.86	804.70	NS
Year x Harv	12	519121.00	43260.08	69.309**
Year x Irr x Harv	36	24335.25	675.98	NS
Year x Fert x Harv	36	40613.84	1128.o6	1.808**
Year x Irr x Fert x Harv	108	71986.52	666.54	NS
Error (C)	256	159783.60	624.15	
Total	639	1555492.00	2434.26	

*Significant at 5%.
**Significant at 1%.
NS Non-significant.

Table 61. Analysis of variance for zinc content within the C-1 clipping frequency, (1961-1964)

Source	DF	SS	MS	'F' values
Year	3	9779.050	3259.683	60.207**
Replications	1	23.16000	23.16000	.428NS
Years x Reps	3	34.01100	11.33700	.209NS
Irrigations	3	147.6500	49.21667	.909NS
Years x Irr	9	330.1390	36.68211	.678NS
Error (A)	12	649.6880	54.14067	
Fertilizers	3	230.9120	76.97067	1.507NS
Irr x Fert	9	356.3990	39.59989	.775NS
Year x Fert	9	409.0990	45.45544	.890NS
Year x Irr x Fert	27	1169.639	43.31996	.848NS
Error (B)	48	2451.367	51.07015	
Harvest	3	1200.673	400.2243	12.255**
Irr x Harvest	9	489.0410	54.33789	1.664NS
Fert x Harvest	9	354.1920	29.35533	1.205NS
Irr x Fert x Harv	27	1541.358	57.08733	1.742**
Year x Harv	9	9258.489	1028.721	31.501**
Year x Irr x Harv	27	1086.090	40.22556	1.232NS
Year x Fert x Harv	27	1338.122	49.56007	1.518NS
Year x Irr x Fert x Harv	81	4730.488	58.40109	1.788**
Error (C)	192	6270.089	32.65671	
Totals	511	40796.65	79.83689	

*Significant at 5%.
**Significant at 1%.
NSNon-significant.

Table 62. Analysis of variance for zinc content within the C-2 clipping frequency, (1961-1964)

Source	DF	SS	MS	'F' values
Years	3	26107.90	8702.63	192.825**
Replications	1	2.8354	2.8354	NS
Years x Reps	3	67.6486	22.5495	NS
Irrigations	3	216.6867	72.2289	NS
Years x Irr	9	1241.2660	137.9185	3.056*
Error (A)	12	541.5870	45.1322	
Fertilizers	3	2390.0310	796.6770	28.797**
Irr x Fert	9	474.0653	52.6739	NS
Year x Fert	9	4227.3270	469.7030	16.978**
Year x Irr x Fert	27	1192.4740	44.1657	1.596NS
Error (B)	48	1327.9130	27.6648	
Harvests	4	4516.7860	1129.1970	28.270**
Irr x Harvest	12	1413.9720	117.8310	2.950**
Fert x Harvest	12	5315.0930	442.9244	11.089**
Irr x Fert x Harv	36	2053.1690	57.0325	1.429NS
Year x Harvest	12	15269.77	1272.481	31.857**
Year x Irr x Harv	36	5039.8190	139.9950	3.505**
Year x Fert x Harv	36	15744.91	437.3586	10.950**
Year x Irr x Fert x Harv	108	5723.2870	52.9934	1.327*
Error (C)	256	10225.29	39.9425	
Total	639	98791.720	154.6036	

*Significant at 5%.
**Significant at 1%.
NS Non-significant.

Table 63. Average dry matter yields for harvest as influenced by year, irrigation, and nitrogen fertilization for C-1 clipping frequency

		Tons per acre							
		I-1				I-2			
Harvest	Year	F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
	1	.57	1.13	.98	1.35	.56	1.27	1.21	1.21
	2	.37	.81	.93	.92	.34	.96	.95	.97
H-1	3	.37	.74	.76	.84	.34	1.05	.86	.96
	4	.33	1.31	1.23	1.55	.38	1.34	1.40	1.35
	1	.14	.25	.53	.59	.16	.29	.85	.96
	2	.15	.28	.29	.88	.13	.28	1.03	1.09
H-2	3	.18	.49	.95	1.12	.19	.42	.97	.95
	4	.20	.38	.74	.93	.13	.31	.64	.72
	1	.21	.25	.50	.99	.13	.21	.33	.74
	2	.16	.12	.20	.70	.26	.20	.34	.93
H-3	3	.13	.18	.16	.77	.11	.20	.35	.67
	4	.14	.17	.25	1.04	.14	.24	.51	.97
	1	.14	.11	.21	.56	.11	.14	.19	.63
	2	.14	.07	.09	.90	.28	.13	.13	.70
H-4	3	.05	1.00	.05	.96	.05	.07	.15	.51
	4	.04	.06	.60	.66	.35	.05	.09	.72

Table 63. Continued

		Tons per acre							
		I-3				I-4			
Harvest	Year	F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
	1	.46	1.18	1.23	1.39	.84	1.44	1.41	1.66
	2	.39	1.19	1.01	.92	.42	1.04	1.05	.98
H-1	3	.74	1.13	1.04	1.12	.57	1.01	1.17	1.18
	4	.59	1.42	1.34	1.56	.37	1.36	1.17	1.40
	1	.20	.25	.79	.70	.44	.38	1.14	1.04
	2	.25	.48	1.01	1.03	.24	.38	.94	1.08
H-2	3	.30	.32	1.02	1.06	.24	.40	.95	1.06
	4	.39	.34	.87	.94	.20	.41	.56	.98
	1	.15	.21	.40	.74	.47	.34	.47	.97
	2	.35	.25	.46	1.16	.26	.20	.34	1.12
H-3	3	.30	.24	.42	.93	.28	.36	.35	1.01
	4	.38	.24	.32	1.14	.23	.41	.36	1.37
	1	.24	.26	.31	.98	.47	.47	.31	1.0
	2	.25	.27	.34	1.13	.29	.32	.19	1.29
H-4	3	.18	.07	.14	1.09	.14	.23	.09	.77
	4	.18	.05	.09	.73	0.04	.14	.09	.79

Note:

I = Irrigation levels (1,2,3,4. 1=long, 2=medium, 3=medium short, 4=short).
F = Nitrogen fertilization (1=0, 2=50, 3=100, 4=200 pounds per acre).
C = Clipping frequency (1=4 harvests for season, 2=5 harvests per season).
H = Harvest.
Years = (1=1961, 2=1962, 3=1963, 4=1964).

Table 64. Average dry matter yield per harvest as influenced by year, irrigation, and nitrogen fertilization for the C-2 clipping frequency

		Tons per acre							
		I-1				I-2			
Harvest	Year	F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
H-1	1	.58	1.15	1.19	1.35	.80	1.69	1.25	1.20
	2	.18	.50	.72	.60	.32	.78	.73	.69
	3	.36	.60	.51	.45	.44	.72	.63	.54
	4	.43	1.08	1.07	1.21	.44	1.15	1.16	1.10
H-2	1	.15	.26	.54	.59	.18	.28	.65	.72
	2	.19	.32	.64	.67	.24	.32	.75	.79
	3	.20	.44	.94	.96	.34	.47	.99	1.00
	4	.21	.29	.61	.65	.21	.35	.75	.72
H-3	1	.07	.11	.26	.44	.16	.35	.50	.78
	2	.20	.21	.29	1.12	.15	.18	.32	.96
	3	.16	.25	.31	.72	.18	.17	.28	.64
	4	.13	.16	.21	.51	.12	.22	.29	.54
H-4	1	.08	.08	.12	.32	.10	.17	.17	.18
	2	.23	.07	.23	.71	.14	.14	.11	.75
	3	.60	.06	.02	.46	.12	.16	.18	.68
	4	.08	.12	.09	.98	.07	.17	.21	.88
H-5	1	.07	.04	.11	.46	.10	.15	.16	.36
	2	.04	.03	.04	.15	.10	.10	.08	.19
	3	.03	.02	.02	.22	.07	.07	.08	.35
	4	.03	.02	.02	.18	.01	.02	.03	.23

Table 64. Continued

Harvest	Year	I-3 F-1	I-3 F-2	I-3 F-3	I-3 F-4	I-4 F-1	I-4 F-2	I-4 F-3	I-4 F-4
		Tons per acre							
H-1	1	.61	1.24	1.51	1.22	.74	1.61	1.55	1.70
	2	.37	.56	.71	.72	.31	.89	.83	.68
	3	.29	.60	.66	.78	.45	.67	.73	.78
	4	.39	1.13	1.27	1.28	.53	1.09	.98	1.10
H-2	1	.25	.37	.84	.71	.30	.36	.91	.94
	2	.26	.37	.82	.81	.48	.35	.56	.72
	3	.30	.39	.89	.95	.28	.45	.89	.90
	4	.29	.32	.74	.71	.28	.32	.52	.91
H-3	1	.09	.09	.20	.41	.25	.26	.25	.69
	2	.24	.34	.44	1.12	.61	.37	.45	1.18
	3	.20	.28	.40	.75	.22	.23	.38	.84
	4	.27	.25	.46	.98	.30	.35	.40	.99
H-4	1	.10	.10	.19	.58	.21	.26	.22	.62
	2	.17	.14	.15	.20	.26	.29	.20	1.97
	3	.16	.12	.21	.92	.19	.19	.25	1.08
	4	.22	.13	.24	.84	.19	.18	.25	.48
H-5	1	.12	.12	.15	.43	.22	.21	.13	.42
	2	.08	.15	.09	.27	.37	.17	.08	.25
	3	.08	.05	.45	.41	.10	.09	.11	.34
	4	.12	.02	.03	.22	.05	.05	.11	.63

Note: For abbreviations see footnote of Table 63.

Table 65. Average nitrogen content per harvest as influenced by year, irrigation, and nitrogen fertilization for C-1 clipping frequency

		Percent							
		I-1				I-2			
Harvest	Year	F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
	1	1.66	1.96	1.85	2.12	1.66	1.95	1.85	2.12
	2	1.83	2.15	1.95	2.30	1.90	1.92	2.09	1.95
H-1	3	2.63	3.02	2.25	2.37	2.05	2.32	2.20	2.19
	4	1.73	1.75	1.96	2.08	1.60	1.68	1.82	1.85
	1	2.31	2.01	2.53	2.40	2.12	2.05	2.40	2.26
	2	2.51	2.16	2.13	2.40	2.75	2.18	2.34	3.15
H-2	3	2.17	2.14	2.05	2.54	2.18	1.97	2.40	2.09
	4	2.37	2.27	2.23	2.32	2.57	2.26	2.40	2.41
	1	2.37	2.37	2.26	2.43	2.45	2.30	2.15	2.31
	2	2.72	2.64	2.31	2.99	2.64	2.53	2.33	2.43
H-3	3	2.82	2.85	2.40	2.86	2.62	2.55	2.61	2.75
	4	2.65	2.52	2.31	2.78	2.37	2.40	2.37	2.63
	1	2.75	2.97	2.63	3.04	2.86	3.26	2.76	2.51
	2	3.06	2.61	2.30	2.63	2.70	2.44	2.61	3.00
H-4	3	2.82	3.15	2.57	3.27	2.82	3.05	2.80	2.77
	4	2.61	2.49	2.34	3.01	2.46	2.71	2.39	2.70

Table 65. Continued

Harvest	Year	Percent							
		I-3				I-4			
		F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
	1	1.66	1.95	1.85	2.12	1.66	1.95	1.85	2.12
	2	1.80	1.78	1.80	2.00	1.91	2.19	1.94	1.68
H-1	3	2.59	2.56	2.43	1.98	2.31	2.18	1.95	1.86
	4	1.92	1.71	1.52	1.73	1.63	1.86	1.54	1.65
	1	2.26	2.29	2.23	2.28	2.22	2.15	2.02	2.07
	2	2.41	2.48	2.23	2.16	3.29	2.46	2.41	2.08
H-2	3	2.37	2.11	2.78	2.32	2.17	2.13	2.10	2.24
	4	2.44	2.35	2.19	2.41	2.43	2.38	2.13	2.15
	1	2.43	2.67	2.23	2.71	2.21	2.36	2.04	1.91
	2	2.75	2.47	2.34	2.35	2.64	2.54	2.19	2.16
H-3	3	2.66	2.46	2.34	2.57	2.63	2.56	2.22	2.24
	4	2.62	2.45	2.30	2.60	2.51	2.41	2.09	2.26
	1	2.89	2.72	2.47	2.29	2.37	3.04	2.27	2.09
	2	3.18	3.02	2.38	2.35	2.82	3.14	2.40	2.11
H-4	3	3.32	2.77	2.61	3.04	3.16	3.12	2.72	2.40
	4	2.93	2.48	2.51	2.83	2.73	2.82	2.65	2.64

Note: For abbreviations, see footnote of Table 63.

Table 66. Average nitrogen content per harvest as influenced by year, irrigation, and nitrogen fertilization for the C-2 clipping frequency

		Percent							
		I-1				I-2			
Harvest	Year	F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
	1	1.75	1.80	1.90	1.96	1.75	1.80	1.90	1.96
	2	2.41	2.20	2.63	2.56	2.32	2.68	2.58	2.51
H-1	3	2.83	3.05	3.03	3.23	2.99	2.84	2.78	2.74
	4	1.89	2.36	1.98	1.79	1.66	1.87	1.97	2.10
	1	2.25	2.16	2.63	2.63	2.40	2.46	2.73	3.20
	2	2.54	2.80	2.62	2.86	2.57	2.52	2.65	2.64
H-2	3	3.44	2.47	2.32	2.80	2.40	2.26	2.34	2.36
	4	2.50	2.35	2.39	2.57	2.44	2.25	2.70	2.90
	1	2.67	2.77	2.66	3.14	2.55	2.49	2.48	3.22
	2	3.01	2.80	2.36	2.48	2.55	2.53	2.45	2.56
H-3	3	3.04	2.71	2.37	3.49	2.75	2.80	2.48	2.86
	4	2.94	2.93	2.48	3.37	2.86	2.77	2.75	3.31
	1	2.90	2.79	3.28	3.21	3.00	3.08	3.12	3.27
	2	3.30	2.97	2.60	3.16	2.78	2.81	2.67	2.95
H-4	3	3.63	3.11	2.76	3.16	2.84	2.91	2.75	3.46
	4	2.88	2.91	2.70	3.12	2.76	2.84	2.73	3.24
	1	3.02	2.92	3.18	3.10	3.11	3.02	2.99	2.65
	2	2.81	3.11	3.12	2.91	3.09	2.89	2.85	2.53
H-5	3	3.02	2.99	2.78	2.67	2.94	3.17	3.00	3.02
	4	2.91	2.55	2.35	2.80	2.68	2.68	2.69	3.01

Table 66. Continued

Harvest	Year	I-3 F-1	I-3 F-2	I-3 F-3	I-3 F-4	I-4 F-1	I-4 F-2	I-4 F-3	I-4 F-4
		Percent							
H-1	1	1.75	1.80	1.90	1.96	1.75	1.80	1.90	1.96
	2	2.33	2.63	2.81	2.47	2.75	2.47	2.48	2.29
	3	2.71	2.86	2.83	2.87	2.88	3.28	2.45	2.36
	4	1.80	2.07	2.25	2.02	1.80	1.98	2.07	2.11
H-2	1	2.23	2.37	2.48	2.53	2.21	2.15	2.24	2.17
	2	2.30	2.67	2.52	2.62	2.75	2.46	2.55	2.64
	3	2.45	2.44	2.63	2.47	2.43	2.04	2.41	2.16
	4	2.34	2.28	2.78	2.69	2.39	2.42	2.52	2.77
H-3	1	2.56	2.79	2.56	3.41	2.35	2.36	2.33	2.52
	2	2.67	2.12	2.11	2.21	2.83	2.53	2.16	2.13
	3	2.88	2.57	2.74	2.96	2.89	2.75	2.32	2.67
	4	2.67	2.51	2.44	2.90	2.42	2.54	2.29	2.65
H-4	1	2.91	3.02	2.84	3.60	2.67	3.04	2.36	3.35
	2	2.98	3.22	2.66	2.79	3.04	2.77	2.07	2.89
	3	2.80	2.89	2.77	3.41	2.95	2.83	2.64	3.13
	4	3.06	2.59	2.63	3.22	2.70	2.88	2.68	2.78
H-5	1	2.92	3.08	2.53	2.60	2.74	2.77	2.59	2.30
	2	3.08	3.24	2.93	2.73	3.30	3.69	2.93	2.70
	3	3.17	3.07	3.19	2.94	3.35	2.40	3.11	2.88
	4	3.14	2.73	2.78	2.81	2.87	3.07	3.21	2.50

Note: For abbreviations, see footnote of Table 63.

Table 67. Average phosphorus content per harvest as influenced by year, irrigation, and nitrogen fertilization for C-1 clipping frequency

		Percent							
		I-1				I-2			
Harvest	Year	F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
	1	.216	.260	.207	.200	.216	.260	.207	.200
	2	.293	.293	.283	.299	.284	.317	.287	.297
H-1	3	.434	.274	.327	.288	.398	.341	.361	.404
	4	.379	.333	.335	.284	.345	.291	.301	.294
	1	.247	.264	.256	.209	.304	.327	.236	.224
	2	.545	.355	.317	.321	.420	.439	.378	.342
H-2	3	.490	.405	.319	.360	.480	.377	.321	.299
	4	.517	.464	.402	.352	.582	.482	.421	.421
	1	.433	.493	.411	.348	.486	.387	.356	.313
	2	.393	.333	.395	.278	.392	.446	.430	.307
H-3	3	.321	.327	.501	.262	.362	.369	.397	.300
	4	.513	.555	.563	.318	.533	.495	.605	.385
	1	.499	.227	.418	.380	.385	.373	.413	.256
	2	.438	.428	.572	.291	.458	.468	.482	.389
H-4	3	.552	.520	.480	.492	.545	.544	.631	.497
	4	.427	.534	.547	.322	.525	.462	.591	.350

Table 67. Continued

Harvest	Year	I-3 F-1	I-3 F-2	I-3 F-3	I-3 F-4	I-4 F-1	I-4 F-2	I-4 F-3	I-4 F-4
		Percent							
H-1	1	.216	.260	.207	.200	.216	.260	.207	.200
	2	.259	.271	.292	.274	.352	.297	.304	.289
	3	.249	.370	.513	.452	.460	.292	.333	.360
	4	.345	.278	.294	.293	.331	.325	.343	.277
H-2	1	.289	.286	.274	.253	.366	.391	.293	.322
	2	.546	.431	.409	.401	.491	.543	.369	.312
	3	.498	.419	.335	.293	.485	.447	.345	.350
	4	.528	.534	.413	.359	.583	.548	.481	.369
H-3	1	.335	.375	.342	.368	.358	.502	.513	.390
	2	.403	.428	.446	.325	.453	.453	.430	.329
	3	.427	.373	.359	.504	.406	.370	.366	.377
	4	.505	.485	.587	.341	.534	.507	.573	.400
H-4	1	.439	.240	.547	.278	.429	.389	.424	.371
	2	.415	.519	.547	.430	.498	.390	.541	.363
	3	.496	.565	.629	.371	.557	.553	.626	.448
	4	.454	.488	.552	.294	.473	.462	.483	.366

Note: For abbreviations, see footnote of Table 63.

Table 68. Average phosphorus content per harvest as influenced by year, irrigation and nitrogen fertilization for the C-2 clipping frequency

		Percent							
		I-1				I-2			
Harvest	Year	F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
	1	.213	.220	.293	2.80	.213	.220	.293	.280
	2	.303	.377	.301	.341	.347	.278	.318	.329
H-1	3	.403	.346	.356	.385	.427	.273	.445	.305
	4	.353	.348	.318	.320	.379	.352	.332	.330
	1	.251	.327	.234	.267	.303	.306	.233	.286
	2	.336	.415	.234	.393	.433	.401	.430	.427
H-2	3	.407	.383	.358	.404	.443	.399	.437	.333
	4	.545	.547	.465	.480	.477	.613	.514	.421
	1	.320	.367	.358	.323	.287	.415	.328	.280
	2	.343	.341	.306	.303	.380	.519	.223	.329
H-3	3	.300	.350	.354	.248	.440	.335	.468	.293
	4	.491	.478	.590	.417	.550	.627	.619	.368
	1	.313	.359	.366	.327	.451	.414	.427	.486
	2	.415	.447	.626	.386	.341	.507	.579	.410
H-4	3	.569	.536	.601	.471	.730	.693	.794	.495
	4	.549	.590	.657	.473	.623	.647	.655	.363
	1	.432	.450	.485	.332	.417	.454	.644	.420
	2	.278	.284	.357	.280	.277	.279	.333	.314
H-5	3	.477	.493	.494	.431	.560	.593	.647	.492
	4	.380	.447	.506	.395	.348	.430	.614	.373

Table 68. Continued

		Percent							
		I-3				I-4			
Harvest	Year	F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
	1	.213	.220	.293	.280	.213	.220	.293	.280
	2	.289	.304	.342	.340	.321	.366	.320	.300
H-1	3	.499	.425	.424	.362	.524	.619	.234	.348
	4	.383	.334	.337	.519	.387	.351	.325	.406
	1	.281	.279	.271	.270	.410	.413	.228	.373
	2.	.380	.392	.406	.454	.441	.396	.414	.434
H-2	3	.393	.476	.363	.351	.418	.437	.351	.343
	4	.540	.558	.422	.389	.594	.510	.548	.470
	1	.373	.402	.392	.349	.470	.440	.389	.300
	2	.399	.299	.414	.323	.386	.388	.370	.325
H-3	3	.417	.360	.393	.312	.423	.404	.321	.334
	4	.523	.514	.467	.353	.608	.551	.492	.428
	1	.441	.370	.555	.357	.520	.609	.632	.282
	2	.491	.445	.578	.492	.575	.540	.589	.370
H-4	3	.561	.581	.712	.429	.609	.614	.623	.482
	4	.501	.534	.638	.344	.581	.514	.440	.430
	1	.431	.432	.491	.273	.534	.611	.585	.440
	2	.291	.314	.355	.327	.279	.293	.309	.302
H-5	3	.486	.493	.577	.417	.495	.429	.479	.504
	4	.421	.467	.521	.389	.493	.435	.508	.440

Note: For abbreviations, see footnote of Table 63.

Table 69. Average potassium content per harvest as influenced by year, irrigation and nitrogen fertilization for C-1 clipping frequency

		Percent							
		I-1				I-2			
Harvest	Year	F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
H-1	1	1.13	1.16	1.14	1.17	1.13	1.16	1.14	1.17
	2	1.65	1.71	1.75	1.78	1.62	1.58	1.73	1.68
	3	1.54	1.54	1.65	1.45	1.54	1.60	1.50	1.50
	4	1.74	1.87	1.55	1.79	1.69	1.85	1.82	1.74
H-2	1	1.13	1.47	1.61	1.79	1.74	1.62	1.87	1.75
	2	1.51	2.12	1.79	1.82	2.00	1.92	1.43	1.89
	3	1.81	1.83	1.89	1.88	1.95	2.00	1.69	1.83
	4	0.81	1.15	0.82	0.76	1.18	0.83	0.79	1.16
H-3	1	1.34	1.56	1.41	1.69	1.43	1.42	1.32	1.55
	2	2.46	1.98	1.93	2.05	2.08	.238	.245	2.23
	3	1.66	1.68	1.31	1.60	1.59	1.68	1.74	1.55
	4	1.23	1.04	1.23	1.20	1.06	1.22	1.02	1.20
H-4	1	1.47	1.75	1.67	1.59	1.52	1.49	1.54	1.60
	2	1.15	1.12	1.16	1.16	1.13	1.13	1.13	1.14
	3	1.03	1.03	1.26	1.05	1.03	1.04	1.03	1.05
	4	1.20	1.25	1.25	1.18	1.24	1.22	1.25	1.23

Table 69. Continued

		Percent							
		I-3				I-4			
Harvest	Year	F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
H-1	1	1.13	1.16	1.14	1.17	1.13	1.16	1.14	1.17
	2	1.60	1.76	1.63	1.80	1.71	1.56	1.66	2.02
	3	1.64	1.40	1.40	1.47	1.39	1.59	1.57	1.38
	4	1.72	1.87	1.77	1.53	1.81	1.87	1.82	1.88
H-2	1	1.76	1.86	1.82	1.83	1.56	1.72	1.78	1.84
	2	1.90	1.76	1.59	1.64	1.58	1.21	2.13	1.90
	3	1.77	1.97	1.52	1.83	1.91	1.94	1.95	1.89
	4	0.81	0.82	0.81	0.75	0.82	0.82	0.81	0.81
H-3	1	1.21	1.42	1.45	1.62	1.06	1.50	1.50	1.45
	2	2.44	2.17	2.18	2.10	2.06	2.35	2.22	2.20
	3	1.23	1.63	1.56	1.48	1.38	1.73	1.66	1.41
	4	1.41	1.41	1.24	1.18	1.45	1.21	1.43	1.05
H-4	1	1.56	1.57	1.57	1.89	1.45	1.55	1.77	1.53
	2	1.19	1.20	1.17	1.17	1.18	1.14	1.16	1.40
	3	1.03	1.03	1.04	1.00	1.04	1.04	1.02	1.07
	4	1.22	1.23	1.24	1.07	1.37	1.23	1.22	1.30

Note: For abbreviations, see footnote of Table 63.

Table 70. Average potassium content per harvest as influenced by year, irrigation and nitrogen fertilization for the C-2 clipping frequency

		Percent							
		I-1				I-2			
Harvest	Year	F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
H-1	1	1.16	1.14	1.17	1.16	1.16	1.14	1.17	1.16
	2	1.54	2.13	1.83	1.78	1.88	1.96	1.90	1.92
	3	1.48	1.44	1.44	1.60	1.59	1.48	1.49	1.51
	4	1.83	1.79	1.97	1.89	1.88	1.83	1.98	1.63
H-2	1	1.61	1.52	1.82	1.77	1.75	1.92	2.00	1.79
	2	1.83	1.58	2.21	1.65	1.54	2.05	2.18	1.45
	3	1.93	1.85	1.72	1.90	1.86	1.84	1.93	1.79
	4	1.19	1.19	.84	.83	.84	1.11	1.25	.81
H-3	1	1.50	1.28	1.58	1.44	1.32	1.36	1.54	1.70
	2	1.53	1.74	1.56	1.79	1.77	1.74	1.48	1.88
	3	1.82	1.76	1.73	1.63	1.78	1.81	1.83	1.63
	4	1.47	1.25	1.20	1.12	1.25	.94	1.51	1.17
H-4	1	1.34	1.38	1.34	1.46	1.39	1.56	1.59	1.70
	2	1.22	1.20	1.20	1.22	1.17	1.19	1.52	1.18
	3	1.05	1.04	1.03	1.04	1.06	1.07	1.06	1.04
	4	1.35	1.36	1.33	1.40	1.35	1.34	1.23	1.24
H-5	1	1.48	1.47	1.50	1.36	1.63	1.67	1.74	1.75
	2	1.17	1.40	1.41	1.55	1.27	1.16	1.47	1.59
	3	1.05	1.07	1.04	1.06	1.08	.98	1.07	1.06
	4	1.21	1.17	1.25	1.00	1.12	1.26	1.35	1.00

Table 70. Continued

Harvest	Year	Percent							
		I-3				I-4			
		F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
	1	1.16	1.14	1.17	1.16	1.16	1.14	1.17	1.16
	2	1.56	1.85	1.62	1.68	1.90	2.12	2.00	1.61
H-1	3	1.68	1.61	1.61	1.48	1.40	1.43	1.61	1.48
	4	1.89	1.91	1.88	1.75	1.85	1.89	1.81	1.36
	1	1.70	1.67	1.79	1.77	1.90	1.58	1.97	1.64
	2	1.59	1.59	1.64	1.56	1.97	1.70	2.06	1.56
H-2	3	1.95	1.83	1.95	1.85	1.94	1.91	1.79	1.32
	4	.84	1.19	.81	.79	1.20	.82	1.19	1.19
	1	1.47	1.42	1.67	1.44	1.49	1.48	1.44	1.46
	2	1.75	1.60	1.87	1.74	1.73	1.92	1.90	1.87
H-3	3	1.69	1.74	1.68	1.56	1.74	1.66	1.72	1.74
	4	1.23	1.44	1.41	1.24	1.78	1.67	1.24	1.41
	1	1.43	1.41	1.48	1.60	1.47	1.59	1.57	1.73
	2	1.21	1.20	1.21	1.23	1.53	1.22	1.22	1.23
H-4	3	1.05	1.02	1.05	.99	1.33	1.04	1.02	1.07
	4	1.32	1.35	1.32	1.15	1.36	1.30	1.17	1.15
	1	1.50	1.28	1.48	1.27	1.54	1.56	1.51	1.58
	2	1.52	1.57	1.56	1.70	1.32	1.48	1.12	1.70
H-5	3	1.06	1.04	1.06	1.05	1.07	1.05	1.03	1.04
	4	1.15	1.25	1.31	1.01	1.30	1.11	.96	1.48

Note: For abbreviations, see footnote of Table 63.

Table 71. Average calcium content per harvest as influenced by year, irrigation, and nitrogen fertilization for C-1 clipping frequency

		Percent							
		I-1				I-2			
Harvest	Year	F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
	1	1.35	1.15	1.11	1.19	1.35	1.15	1.11	1.19
	2	0.61	0.52	0.35	0.32	.57	.63	.42	.45
H-1	3	1.26	.87	.89	.76	.99	.83	.77	.74
	4	.50	.51	.44	.51	.43	.54	.49	.49
	1	1.26	1.76	1.06	0.92	1.32	1.06	2.19	0.79
	2	1.03	0.75	0.50	0.43	.93	.65	.70	1.01
H-2	3	1.13	.99	.99	1.04	1.35	1.19	.94	1.03
	4	.93	.75	.69	.63	.81	.65	.65	.67
	1	1.65	1.03	1.55	0.71	1.70	1.51	1.38	0.96
	2	1.32	0.81	0.50	0.66	1.06	1.00	.86	.48
H-3	3	.99	1.18	1.19	.83	.95	1.12	1.19	.97
	4	1.19	.97	1.29	.81	1.00	1.12	.94	.80
	1	1.62	1.71	1.38	0.97	1.80	1.60	1.33	1.07
	2	1.43	1.34	1.03	0.69	1.08	1.22	1.31	.78
H-4	3	1.31	1.48	.95	.81	1.33	1.42	1.20	.82
	4	.77	.68	.57	.41	.65	.73	.55	.44

Table 71. Continued

Harvest	Year	I-3 F-1	I-3 F-2	I-3 F-3	I-3 F-4	I-4 F-1	I-4 F-2	I-4 F-3	I-4 F-4
		Percent							
H-1	1	1.35	1.15	1.11	1.19	1.35	1.15	1.11	1.19
	2	1.06	.54	.43	.41	.62	.76	.55	.32
	3	1.27	1.26	.81	.77	1.51	1.06	.90	.65
	4	1.01	.43	.52	.62	1.10	.56	.47	.52
H-2	1	1.30	1.00	0.85	0.89	1.07	1.14	0.74	0.72
	2	.83	.86	.66	.68	1.22	.79	.60	.57
	3	1.41	1.28	.87	1.05	1.41	1.42	1.07	.98
	4	.83	.72	.53	.66	.77	.79	.76	.62
H-3	1	2.06	1.54	1.33	0.88	1.07	1.40	1.11	1.06
	2	1.30	.86	.62	.54	1.07	1.05	.64	.53
	3	1.46	1.18	1.03	.99	1.16	1.02	1.06	.82
	4	1.30	1.07	.97	.77	1.22	1.26	1.04	.72
H-4	1	1.55	1.76	1.56	0.95	1.58	1.83	1.14	1.12
	2	1.62	1.21	1.21	.64	1.38	1.64	1.14	.50
	3	1.42	1.24	1.12	.74	1.42	1.43	1.41	.71
	4	.84	.61	.61	.56	.75	.76	.81	.40

Note: For abbreviations, see footnote of Table 63.

Table 72. Average calcium content per harvest as influenced by year, irrigation and nitrogen fertilization for the C-2 clipping frequency

		Percent							
		I-1				I-2			
Harvest	Year	F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
	1	2.79	1.12	1.15	1.32	2.79	1.12	1.15	1.32
	2	1.08	.38	.55	.49	.45	.53	.45	.34
H-1	3	1.49	1.23	.65	.94	1.56	.71	.83	.77
	4	.50	.52	.54	.45	.46	.45	.56	.48
	1	1.12	1.31	.97	.92	1.37	.95	.61	.85
	2	1.00	.99	.42	.50	1.29	1.13	.50	1.00
H-2	3	1.42	.97	.87	1.02	1.37	1.11	1.04	.92
	4	.80	.77	.56	.62	.75	.54	.55	.65
	1	1.31	.99	1.35	1.58	1.80	1.37	1.13	.67
	2	.85	.65	.54	.47	.60	.61	1.39	.35
H-3	3	1.08	.87	.68	1.08	.96	.97	1.02	.92
	4	1.07	.76	.84	.84	.80	.72	.92	.92
	1	1.34	1.28	1.23	1.09	1.82	1.42	1.53	1.17
	2	1.34	1.26	.96	.65	1.56	1.15	1.00	1.12
H-4	3	1.06	1.01	1.03	1.87	1.04	1.03	1.04	.85
	4	.51	.51	.43	.65	.50	.50	.67	.40
	1	1.56	1.46	1.48	1.34	1.29	1.07	1.05	.86
	2	.73	1.21	1.15	1.02	1.33	.87	1.01	.88
H-5	3	1.15	1.10	1.18	.94	1.17	1.14	1.10	.84
	4	1.35	1.40	1.22	.91	1.57	1.29	1.30	.99

Table 72. Continued

Harvest	Year	I-3 F-1	I-3 F-2	I-3 F-3	I-3 F-4	I-4 F-1	I-4 F-2	I-4 F-3	I-4 F-4
		Percent							
H-1	1	2.79	1.12	1.15	1.32	2.79	1.12	1.15	1.32
	2	.82	.62	.74	.46	.67	.43	.48	.63
	3	1.58	.83	.86	.92	1.46	.96	1.09	1.06
	4	.58	.51	.54	.66	.47	.47	.57	.53
H-2	1	1.23	1.15	.85	.84	.82	1.18	.60	.90
	2	.93	.97	.92	.88	1.08	.85	.90	.80
	3	1.44	.97	1.31	1.16	1.80	1.48	.89	.90
	4	.84	.66	.65	.62	.83	.80	.86	.79
H-3	1	1.41	1.33	.86	1.39	1.30	1.16	1.15	1.12
	2	.68	1.16	.54	.66	.84	.71	.49	.42
	3	1.11	1.03	1.20	1.04	1.02	.87	1.96	.91
	4	1.05	.95	.69	.91	.95	1.01	1.08	.61
H-4	1	1.67	1.89	1.31	1.14	1.66	1.62	1.36	1.06
	2	1.29	1.38	1.14	.65	1.35	1.24	1.05	.63
	3	1.42	1.16	1.14	.87	1.16	1.37	1.29	1.04
	4	.70	.51	.52	.42	.57	1.69	.74	.62
H-5	1	1.56	2.06	1.42	1.70	1.48	1.34	1.29	1.02
	2	1.44	1.23	1.14	1.02	1.48	1.32	1.08	.77
	3	1.21	.96	1.24	.83	1.33	1.46	1.35	.81
	4	1.60	1.39	1.23	.95	1.65	1.71	1.72	.75

Note: For abbreviations, see footnote of Table 63.

Table 73. Average copper content per harvest as influenced by year, irrigation and nitrogen fertilization for C-1 clipping frequency

		Parts per million							
		I-1				I-2			
Harvest	Year	F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
	1	9.9	14.0	11.7	12.9	9.9	14.0	11.7	12.9
	2	4.3	4.8	3.9	5.1	4.8	3.5	4.2	4.8
H-1	3	28.7	11.8	14.1	12.0	9.9	7.8	7.1	6.8
	4	3.8	3.4	4.1	4.4	4.1	4.2	3.8	4.0
	1	6.9	2.2	24.5	6.2	7.7	6.4	9.8	4.1
	2	3.7	5.4	8.5	5.7	5.4	5.3	10.1	5.0
H-2	3	6.6	5.8	6.9	6.6	7.4	5.1	7.3	8.5
	4	4.8	5.7	5.1	5.4	6.1	4.9	5.5	6.0
	1	8.2	11.5	4.7	10.9	10.0	7.7	6.4	7.9
	2	6.0	5.8	5.4	6.4	6.7	6.6	6.6	9.6
H-3	3	6.4	8.1	6.8	9.0	9.8	5.6	6.1	7.0
	4	7.0	7.2	6.1	7.7	7.1	6.2	7.8	7.3
	1	15.7	15.1	13.8	18.7	16.4	9.9	9.2	15.5
	2	12.0	12.5	17.2	12.8	19.0	21.1	13.7	13.1
H-4	3	6.3	6.5	6.0	7.1	5.8	6.5	6.6	6.8
	4	6.6	6.1	5.8	6.4	6.7	6.8	6.3	7.4

Table 73. Continued

		Parts per million							
		I-3				I-4			
Harvest	Year	F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
	1	9.9	14.0	11.7	13.0	9.9	14.0	11.7	12.9
	2	7.0	4.4	3.7	7.5	5.6	4.4	4.5	5.4
H-1	3	13.7	7.4	7.6	8.5	6.0	9.6	7.4	9.6
	4	8.4	4.2	4.1	3.5	4.1	5.7	4.0	3.8
	1	10.8	8.6	6.3	7.5	3.1	3.7	5.7	4.3
	2	5.5	9.4	7.2	5.0	5.3	10.3	6.3	5.4
H-2	3	5.9	5.8	6.8	8.9	6.0	7.1	8.1	8.4
	4	4.8	4.9	5.0	5.1	4.9	4.4	4.6	4.8
	1	4.6	10.4	11.6	7.6	8.7	8.4	7.9	7.8
	2	6.4	6.7	5.6	6.9	5.7	6.8	5.4	5.9
H-3	3	6.0	6.5	6.9	7.7	7.3	7.9	5.9	6.0
	4	7.2	7.0	6.7	7.8	6.2	5.9	5.7	7.4
	1	16.2	9.5	14.0	14.0	19.0	9.4	11.2	12.5
	2	12.5	12.0	13.6	13.3	11.2	13.8	10.2	13.8
H-4	3	6.9	6.0	5.9	7.3	7.4	6.8	5.4	6.9
	4	6.7	5.8	6.5	6.3	5.9	5.6	4.3	7.3

Note: For abbreviations, see footnote of Table 63.

Table 74. Average copper content per harvest as influenced by year, irrigation and nitrogen fertilization for the C-2 clipping frequency

		Parts per million							
		I-1				I-2			
Harvest	Year	F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
H-1	1	10.5	12.9	12.3	12.9	10.5	12.9	12.3	12.9
	2	4.5	5.5	3.9	4.6	3.8	4.5	4.8	3.7
	3	3.9	8.5	12.8	9.4	6.4	6.8	8.7	15.2
	4	3.9	4.0	4.0	4.2	5.2	3.7	4.5	4.0
H-2	1	6.6	5.8	9.0	5.6	3.5	2.1	9.9	5.3
	2	5.4	4.9	5.7	9.5	4.7	5.5	5.9	8.8
	3	7.6	6.4	7.7	6.7	6.3	7.4	8.6	8.2
	4	6.2	6.4	4.9	4.7	4.7	6.2	6.6	5.2
H-3	1	11.0	8.2	8.5	10.7	7.2	7.5	12.2	11.5
	2	6.0	5.5	4.4	6.2	6.2	6.4	3.7	5.6
	3	7.7	8.4	9.5	7.3	9.9	8.4	7.4	7.5
	4	5.2	7.3	6.8	8.1	6.6	6.1	6.4	8.0
H-4	1	13.7	11.6	17.3	15.8	17.0	17.3	17.3	13.1
	2	12.4	11.8	15.3	14.5	12.0	12.9	12.9	12.5
	3	6.7	6.3	6.2	6.8	5.9	7.0	6.4	8.0
	4	7.0	5.8	7.2	7.1	5.7	5.6	8.4	7.9
H-5	1	18.0	11.6	15.9	17.8	10.4	12.2	10.1	10.7
	2	4.3	7.0	8.0	6.3	8.3	7.1	9.8	6.2
	3	7.1	8.5	7.4	7.9	8.0	7.3	8.0	8.2
	4	7.7	5.7	7.9	7.4	7.0	7.0	6.6	8.5

Table 74. Continued

Harvest	Year	I-3 F-1	I-3 F-2	I-3 F-3	I-3 F-4	I-4 F-1	I-4 F-2	I-4 F-3	I-4 F-4
		Parts per million							
H-1	1	10.5	12.9	12.3	12.5	10.5	12.9	12.3	12.9
	2	4.0	5.3	4.2	5.2	4.0	4.9	8.9	4.3
	3	10.2	18.4	8.4	14.4	6.9	12.7	10.2	8.8
	4	3.6	4.1	4.1	4.0	4.1	4.4	4.4	4.0
H-2	1	7.1	6.9	7.5	7.1	13.1	4.7	11.1	18.5
	2	4.6	5.4	4.4	5.9	5.5	9.5	6.4	4.5
	3	6.3	5.9	7.3	6.9	6.1	6.3	9.1	9.1
	4	5.0	6.6	5.2	5.2	5.4	5.2	6.1	5.3
H-3	1	7.8	8.2	11.1	7.8	11.5	12.0	13.4	9.8
	2	6.3	5.1	6.5	6.9	5.0	5.4	5.7	7.7
	3	6.6	6.0	4.9	7.0	5.4	7.1	5.5	8.8
	4	7.0	6.9	6.1	6.1	5.8	6.6	5.8	5.6
H-4	1	15.7	15.6	16.1	18.4	14.5	18.8	18.2	20.9
	2	11.5	15.8	11.9	12.3	11.7	13.2	11.7	12.7
	3	6.4	5.9	6.6	8.0	6.2	6.5	6.1	6.9
	4	5.7	6.2	5.9	7.0	6.1	7.2	6.9	6.8
H-5	1	15.3	12.0	12.5	12.9	5.7	15.2	13.2	12.6
	2	11.3	8.7	9.0	7.1	6.7	9.9	7.0	7.8
	3	8.1	8.4	8.7	8.2	7.6	8.1	7.9	7.9
	4	7.4	6.9	6.7	8.4	6.4	6.4	7.7	6.5

Note: For abbreviations, see footnote of Table 63.

Table 75. Average iron content per harvest as influenced by year, irrigation and nitrogen fertilization for C-1 clipping frequency

		Parts per million							
		I-1				I-2			
Harvest	Year	F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
	1	139	103	121	131	138	103	121	131
	2	76	120	69	96	69	42	73	46
H-1	3	197	88	48	83	82	61	47	43
	4	80	68	93	61	75	43	36	249
	1	169	281	205	139	175	202	56	90
	2	82	135	90	84	95	87	79	72
H-2	3	113	106	88	81	124	109	92	84
	4	182	165	123	102	152	107	101	100
	1	296	162	150	124	199	126	122	115
	2	161	150	96	116	196	204	192	130
H-3	3	137	189	162	123	146	128	99	117
	4	143	143	120	99	100	112	91	109
	1	226	181	172	170	226	252	232	197
	2	281	169	175	218	115	177	144	117
H-4	3	132	164	67	97	257	240	113	95
	4	120	115	101	72	107	94	72	66

Table 75. Continued

		Parts per million							
		I-3				I-4			
Harvest	Year	F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
	1	139	103	121	131	139	103	121	131
	2	89	78	77	75	85	51	74	88
H-1	3	93	133	45	48	63	48	48	67
	4	112	50	57	71	73	66	53	52
	1	83	89	99	145	127	120	87	84
	2	134	112	62	59	70	99	96	67
H-2	3	119	128	95	101	125	93	83	79
	4	99	108	88	81	121	97	81	78
	1	185	161	171	83	85	111	114	107
	2	121	126	99	73	152	178	104	88
H-3	3	122	90	110	134	128	102	108	87
	4	117	112	95	79	117	103	110	83
	1	227	225	191	167	302	252	127	260
	2	201	144	169	127	181	148	126	115
H-4	3	117	116	124	83	116	111	121	88
	4	84	95	84	69	113	78	75	47

Note: For abbreviations, see footnote of Table 63.

Table 76. Average iron content per harvest as influenced by year, irrigation and nitrogen fertilization for the C-2 clipping frequency

		Parts per million							
		I-1				I-2			
Harvest	Year	F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
H-1	1	107	115	95	123	107	115	95	123
	2	64	90	82	87	71	63	70	90
	3	96	96	103	104	97	72	86	105
	4	61	78	46	51	55	54	59	58
H-2	1	214	411	189	204	173	102	66	136
	2	111	71	103	559	84	89	98	67
	3	106	85	88	84	107	83	79	72
	4	146	134	95	92	102	91	96	103
H-3	1	137	112	180	207	159	152	142	137
	2	109	93	98	98	113	102	36	89
	3	111	115	75	108	98	111	104	107
	4	95	88	128	116	93	97	104	82
H-4	1	157	159	114	135	105	101	117	284
	2	158	121	117	114	178	136	135	109
	3	124	124	146	121	122	116	101	117
	4	73	65	64	101	66	61	86	57
H-5	1	314	259	257	306	186	263	246	223
	2	227	180	240	218	105	154	111	116
	3	156	148	131	106	148	103	115	91
	4	177	138	179	129	133	190	173	220

Table 76. Continued

		Parts per million							
		I-3				I-4			
Harvest	Year	F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
	1	107	115	95	123	107	115	95	123
	2	64	79	71	61	101	65	102	54
H-1	3	228	178	62	92	84	63	89	81
	4	53	44	59	62	81	36	66	68
	1	174	191	130	131	94	189	65	121
	2	84	81	66	116	85	118	89	54
H-2	3	87	88	94	83	77	88	78	88
	4	105	106	113	89	126	129	118	85
	1	165	146	155	162	151	261	160	121
	2	91	113	93	87	100	91	90	89
H-3	3	133	108	67	80	94	85	105	102
	4	106	105	94	78	108	112	73	55
	1	123	135	107	113	137	538	86	107
	2	164	118	138	92	90	110	125	135
H-4	3	106	124	102	97	90	127	121	96
	4	66	75	60	51	70	70	80	73
	1	348	380	308	266	284	262	316	319
	2	167	159	155	167	119	109	95	93
H-5	3	137	138	136	91	115	118	191	98
	4	154	161	124	135	122	138	205	102

Note: For abbreviations, see footnote of Table 63.

Table 77. Average manganese content per harvest as influenced by year, irrigation and nitrogen fertilization for C-1 clipping frequency

		Parts per million							
		I-1				I-2			
Harvest	Year	F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
	1	59	49	50	45	59	49	50	45
	2	72	54	59	51	67	32	60	29
H-1	3	126	83	46	78	63	81	72	56
	4	23	26	175	33	18	28	34	32
	1	216	200	156	149	239	179	120	128
	2	40	133	81	70	116	99	47	70
H-2	3	133	80	75	87	139	101	95	96
	4	70	38	48	49	59	62	48	43
	1	161	83	107	96	206	176	178	96
	2	132	116	95	106	130	153	140	96
H-3	3	163	154	118	144	203	153	138	166
	4	97	80	53	48	89	55	80	54
	1	181	191	192	155	175	110	160	165
	2	62	74	82	55	86	77	81	57
H-4	3	86	71	65	59	86	80	85	64
	4	38	49	45	31	52	45	45	29

Table 77. Continued.

Harvest	Year	I-3 F-1	I-3 F-2	I-3 F-3	I-3 F-4	I-4 F-1	I-4 F-2	I-4 F-3	I-4 F-4
		Parts per million							
H-1	1	59	49	50	45	59	49	50	45
	2	63	56	58	48	92	41	72	33
	3	54	177	42	62	46	49	74	93
	4	26	20	29	28	27	33	16	31
H-2	1	168	170	123	142	174	186	132	117
	2	125	107	49	44	52	79	82	76
	3	96	112	111	104	128	88	75	111
	4	59	67	53	70	368	58	57	56
H-3	1	128	118	126	67	133	104	149	122
	2	133	143	109	117	132	161	103	92
	3	90	146	154	141	121	150	171	100
	4	11	42	59	58	33	54	37	67
H-4	1	180	120	166	110	184	167	165	142
	2	57	64	76	55	67	58	82	51
	3	62	81	77	59	72	68	97	65
	4	32	53	52	33	41	37	38	30

Note: For abbreviations, see footnote of Table 63.

Table 78. Average manganese content per harvest as influenced by year, irrigation and nitrogen fertilization for the C-2 clipping frequency

		Parts per million							
		I-1				I-2			
Harvest	Year	F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
	1	29	56	42	46	29	56	42	46
	2	43	58	64	66	78	59	54	82
H-1	3	69	63	73	74	51	70	67	90
	4	13	111	29	27	26	12	25	16
	1	196	182	145	149	223	116	121	132
	2	74	56	104	80	42	72	65	42
H-2	3	114	97	84	96	138	87	85	95
	4	48	41	52	47	61	50	39	52
	1	135	52	85	138	177	119	87	101
	2	112	112	116	99	134	144	21	99
H-3	3	136	146	136	126	167	171	164	136
	4	64	25	57	20	70	34	24	61
	1	131	141	140	132	165	117	154	157
	2	63	71	93	69	57	77	82	58
H-4	3	80	71	84	64	65	81	76	66
	4	40	38	46	27	46	43	71	32
	1	173	165	120	120	70	119	98	78
	2	158	146	131	89	132	68	88	117
H-5	3	80	85	81	71	81	81	84	69
	4	25	40	39	57	30	42	28	58

Table 78. Continued

Harvest	Year	Parts per million							
		I-3				I-4			
		F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
H-1	1	229	56	42	46	29	56	42	46
	2	45	67	39	339	98	51	91	39
	3	173	57	59	80	59	49	89	70
	4	17	23	34	14	20	27	22	30
H-2	1	220	156	135	125	206	189	123	135
	2	50	47	40	63	78	99	74	33
	3	124	114	94	103	108	100	86	107
	4	65	46	55	55	49	58	49	35
H-3	1	140	120	132	129	113	147	154	129
	2	132	67	129	77	94	111	116	100
	3	171	158	108	145	122	170	139	143
	4	63	43	24	41	59	24	62	35
H-4	1	170	161	152	136	177	174	170	146
	2	68	72	82	59	90	70	86	58
	3	75	73	69	95	99	70	64	48
	4	33	41	40	25	37	36	27	45
H-5	1	140	129	136	147	110	160	173	88
	2	140	133	163	124	97	108	116	114
	3	78	23	81	72	74	62	75	70
	4	38	55	27	76	22	48	41	51

Note: For abbreviations, see footnote of Table 63.

Table 79. Average zinc content per harvest as influenced by year, irrigation and nitrogen fertilization for C-1 clipping frequency

Harvest	Year	Parts per million							
		I-1				I-2			
		F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
	1	23.1	23.9	23.5	23.9	23.1	23.9	23.5	23.9
	2	10.7	13.0	12.0	13.7	10.7	12.4	12.5	6.8
H-1	3	18.2	68.6	24.6	61.7	34.2	31.2	21.2	21.3
	4	14.3	17.4	14.6	20.2	12.1	16.1	14.6	15.0
	1	24.9	37.7	35.7	28.3	29.0	29.0	19.2	26.9
	2	9.6	12.6	15.3	16.5	17.5	15.5	17.7	15.3
H-2	3	18.1	15.4	16.7	14.9	12.9	12.3	15.6	15.2
	4	15.7	14.4	17.2	15.9	14.9	16.7	16.9	15.8
	1	27.6	18.3	23.2	24.0	30.2	26.5	30.5	25.8
	2	13.4	15.5	16.4	15.8	16.2	14.4	14.6	18.7
H-3	3	18.9	16.6	16.3	22.7	17.5	17.9	18.2	22.6
	4	16.2	17.4	16.3	17.0	16.6	18.1	21.8	19.8
	1	40.0	30.4	27.0	43.7	26.8	30.8	30.2	34.2
	2	24.5	18.9	21.2	19.4	20.9	21.6	18.1	21.3
H-4	3	15.9	16.3	21.2	19.2	17.5	17.5	17.0	17.5
	4	18.3	20.0	17.5	20.4	18.4	16.6	20.5	20.7

Table 79. Continued

Harvest	Year	I-3 F-1	I-3 F-2	I-3 F-3	I-3 F-4	I-4 F-1	I-4 F-2	I-4 F-3	I-4 F-4
		Parts per million							
H-1	1	23.1	23.9	23.5	23.9	23.1	23.7	23.5	23.9
	2	13.9	12.4	18.1	10.9	12.9	10.0	11.4	9.0
	3	50.2	27.5	14.7	26.8	11.4	43.5	38.0	45.4
	4	16.3	13.8	12.5	15.1	28.1	17.1	17.0	12.6
H-2	1	17.8	20.2	25.6	29.0	34.0	26.0	26.6	25.1
	2	13.7	16.5	18.4	15.1	19.1	23.0	15.5	14.4
	3	17.1	13.3	16.8	18.3	17.7	17.6	14.0	16.0
	4	14.9	16.1	15.7	15.4	16.0	16.6	15.4	17.8
H-3	1	30.7	31.3	23.4	20.3	15.3	24.9	26.1	29.2
	2	15.1	17.0	17.4	16.0	17.3	15.9	15.0	15.9
	3	18.1	14.1	19.7	21.5	17.2	19.9	17.3	18.1
	4	9.4	14.9	14.8	20.1	14.8	13.5	13.9	16.8
H-4	1	35.1	36.1	27.9	27.5	34.8	31.3	21.8	40.3
	2	23.3	19.5	18.5	19.6	17.6	18.8	22.5	19.1
	3	15.9	16.1	16.4	18.5	17.6	17.3	15.4	24.8
	4	22.7	18.4	21.3	26.7	19.4	19.8	18.5	17.7

Note: For abbreviations, see footnote of Table 63.

Table 80. Average zinc content per harvest as influenced by year, irrigation and nitrogen fertilization for the C-2 clipping frequency

		Parts per million							
		I-1				I-2			
Harvest	Year	F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
H-1	1	21.3	18.9	84.9	46.3	21.3	18.9	84.7	46.3
	2	8.2	11.4	13.4	13.7	11.9	10.5	13.5	15.8
	3	15.6	68.1	42.3	27.3	45.2	37.7	38.9	70.0
	4	18.1	11.1	15.4	15.9	15.7	14.7	14.0	13.7
H-2	1	26.5	48.8	27.3	30.0	24.8	18.7	19.3	28.4
	2	14.5	11.8	14.6	18.2	11.3	14.4	18.3	16.0
	3	17.4	18.6	19.9	20.2	17.8	16.3	17.6	18.9
	4	18.8	20.0	17.2	16.3	16.8	20.5	16.8	16.9
H-3	1	21.1	12.5	26.1	39.8	32.3	32.2	23.6	20.1
	2	16.0	16.0	14.4	18.3	20.1	17.0	14.7	16.1
	3	21.8	19.1	27.1	20.4	22.2	22.6	21.1	21.3
	4	15.6	16.8	18.1	22.0	12.8	18.1	12.0	20.2
H-4	1	41.1	40.9	50.1	45.3	27.3	29.2	34.3	27.8
	2	18.6	20.0	26.3	22.9	18.1	19.4	24.0	21.3
	3	17.3	16.0	15.6	19.5	17.8	17.4	14.4	20.1
	4	21.4	20.8	20.3	17.7	21.0	27.0	23.0	22.1
H-5	1	35.7	28.6	29.7	33.6	20.9	22.5	16.9	37.9
	2	14.6	16.6	21.1	17.8	21.2	14.4	18.2	15.4
	3	17.4	18.6	16.5	18.6	18.3	18.1	17.8	18.8
	4	16.9	17.4	16.2	16.9	17.3	21.3	19.1	17.2

Table 80. Continued

		Parts per million							
		I-3				I-4			
Harvest	Year	F-1	F-2	F-3	F-4	F-1	F-2	F-3	F-4
	1	21.3	18.9	84.9	46.2	21.3	18.9	84.9	46.3
	2	10.2	12.6	10.3	10.9	13.1	12.2	15.4	9.0
H-1	3	28.0	44.0	35.9	71.4	14.3	13.4	11.7	18.0
	4	15.2	17.1	16.2	19.2	16.6	16.9	17.8	13.0
	1	28.2	34.3	28.1	37.1	18.6	36.6	19.1	36.4
	2	16.7	14.9	14.1	14.0	14.7	16.1	16.7	12.2
H-2	3	13.7	17.2	17.3	18.6	14.1	18.8	16.6	40.8
	4	15.0	16.8	16.5	16.6	16.8	14.4	17.2	12.2
	1	22.3	23.5	27.7	42.8	29.2	27.5	34.0	39.0
	2	15.7	17.4	16.5	17.8	15.2	16.7	14.9	17.6
H-3	3	19.1	19.2	13.3	23.0	11.5	29.9	16.2	26.1
	4	13.6	16.1	13.7	17.3	11.4	14.5	14.7	19.2
	1	29.5	32.0	30.1	39.4	35.3	33.4	38.7	40.2
	2	18.4	25.9	19.5	22.1	22.4	20.5	19.3	20.6
H-4	3	15.8	16.3	16.7	22.3	20.8	16.0	16.3	25.6
	4	18.2	24.9	21.2	24.3	19.8	22.9	19.3	19.2
	1	25.6	31.0	23.3	28.1	27.9	27.4	25.6	25.0
	2	15.2	21.8	19.4	19.6	17.1	27.8	15.7	16.8
H-5	3	18.3	18.2	20.2	18.7	17.9	17.0	17.5	18.2
	4	16.6	18.1	16.2	18.5	25.0	15.0	18.4	16.9

Note: For abbreviations, see footnote of Table 63.

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