# The effect of previous cutting on apparent carbohydrate storage and spring growth of perennial grasses with a comparison of methods of determining apparent carbohydrate storage

by Clee S Cooper

A THESIS Submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of Master of Science in Agronomy
Montana State University


Abstract:
This study was made to try to devise a simple indirect method whereby the reserves of plants and their effect on subsequent growth could be measured.

Root samples were taken with a soil tube from three varieties of each of three species of grass. These plots had previously been exposed to three different cutting treatments; (1) cut for seed, (2) cut for hay, (3) cut to simulate pasture. In May of the season preceding this study, one-half of each plot was fertilized at the rate of 500 pounds of NH4SO4/acre. Core samples of bromegrass varieties were taken from both fertilized and unfertilised plots.

Samples taken were subjected to the following methods of treatment to determine the apparent carbohydrate storage; (l) Gores washed, placed in nutrient-free sand in paper containers and grown in greenhouse.

(2) Cores washed, placed in nutrient-free sand in paper containers and grown in darkroom.

(3) Cores placed in river sand in clay pots and grown in greenhouse.

(4) Cores placed in river sand in clay pots and grown in darkroom.

Top growth made by the cores under the above methods of treatment was clipped, oven dried, and the yields expressed as grams of dry matter.

On plots from which core samples had been removed, spring clippings were taken, oven dried, and the yields expressed in pounds per acre.

The results of this study exhibited considerable variability.

Yield averages of cores from the seed treatment plots were higher than yield averages of cores from other cutting treatment plots.

A different factor was being measured by spring clippings than that which was being measured by methods.

Nitrogenous fertilisation apparently had little effect on the response of bromegrass varieties to previous cutting treatments.

# THE EFFECT OF PREVIOUS CUTTING ON APPARENT CARBOHYDRATE STORAGE AND SPRING GROWTH OF PERENNIAL GRASSES WITH A COMPARISON OF METHODS OF DETERMINING APPARENT CARBOHYDRATE STORAGE

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A THESIS

Submitted to the Graduate Faculty

in

partial fulfillment of the requirements

for the degree of

Master of Science in Agronomy

at

Montana State College

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December, 1949

ACKNOWLEDGEMENT

The author wishes to acknowledge the assistance given by Mr. Robert F. Eslick, Associate Professor of agronomy at Montana State College, and Dr. R. E. Stitt, Associate Agronomist of the Bureau of Plant Industry, United States Department of Agriculture, for their assistance throughout the course of this study.

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## ABSTRACT

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# INTRODUCTION

A number of studies have been conducted on the effect of cutting treatments in relation to the storage of food reserves and the subsequent growth of grasses. As a result of these studies we now know there are differences between species and varieties of a species in their response to previous cutting treatments.

The ability of a plant to store reserves has many interesting aspects and offers possibilities for practical application to the field of agronomy. If differences between species and differences between varieties are found to be significant, it might be possible to select those with higher storage coefficients, under like conditions, for breeding purposes, in that these plants should have higher resistance to disease and other plant enemies.

If we can know the storage abilities of different grasses and their subsequent growth recovery, we may be able to rotate pasturing so as to allow for maximum storage by the plant in order to keep it in a highly competitive and vigorous condition. Thus we would have a valuable aid in rotation grazing.

A knowledge of the problem may help in the application of fertilizers. Graber (5) [1] found that frequent and close removals of succulent top growth of grasses having abundant

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[1] Numbers in parentheses refer to Literature Consulted, page .

reserves made for a heavy draft on the supplies of available nitrogen with this element soon becoming the limiting factor of growth. He also found that when regeneration is constantly stimulated by abundant fertilizer, the carbohydrate reserves are rapidly consumed and may become the limiting factor.

If we can determine the periods of growth during which the individual plant stores the largest amount of reserves and those periods in which the least amount of storage takes place, we may be able to regulate applications of fertilizers in order to obtain a more desirable carbohydrate-nitrogen balance within the plant, thereby regulating growth to obtain a maximum yield and storage coefficient.

These points and many others prove the value of a more thorough knowledge of the ability of plants to store food reserves and the subsequent effect on early spring growth and total seasonal production as affected by different cutting treatments. This study was made to try to devise a simple indirect method whereby the reserves of plants and their effect on subsequent growth could be measured.

## REVIEW OF LITERATURE

A number of studies have been conducted on the effect of cutting treatments in relation to the storage of food reserves and the subsequent growth of grasses. The results obtained from these studies indicate conclusively a definite correlation between cutting treatments and the amount of root reserves.

Weaver and Darland (24) found that an excellent test of vigor under conditions favorable for development is that of prompt removal of growth in spring after transplanting. They transplanted blocks of sod of vigorous bluestems, needle grass, and tall panic grass obtained from native prairie in the spring before resumption of growth. These blocks were transplanted in sandy loam soil in boxes ten inches long, ten inches wide, and twenty-four inches deep, with one removable side. Plants which had been clipped four times at weekly intervals had lost much of their vigor. While all controls developed extensive root systems during forty-two days, as revealed by washing away the soil, clipped plants had very few or no roots.

In a similar test using eight species of range grasses, they found the dry weight of tops of weakened plants was 32 to 84 per cent less than that of plants which had good to fair vigor. New roots were always shorter and less branched, and dry weight was 28 to 94 per cent less than that of controls.

Graber (5) states:

"Marked quantitative responses of root, rhizome, and top growth of various grasses grown under field and greenhouse conditions are correlated with cutting treatments which affect the internal environment. It is clearly evident that the productive capacity of grasses is not only dependent upon adequate supplies of available nutrients and moisture combined with favorable light and temperature conditions, but also upon the food reserves of the plant. When photosynthesis is interrupted by frequent removal of top growth the limitations of subterranean development may involve greater susceptibility to drought, lessened absorptive capacity and increased winter and insect injury."

McCarty (13) states, "Grass plants are living organisms and their individual growth requirements must be considered in grazing practices if they are to be maintained on the range, and moderate grazing use is essential to allow for proper carbohydrate food storage."

There is considerable variation between methods employed by workers experimenting with the effect of clipping treatments on various plants. These methods vary as to the frequency, time, and height of cuttings.

Gernert (4) found that clipping native grass more than twice annually did not return enough additional production in the fifth year to pay for the labor. As the number of clippings increased, production declined.

Graber and Ream (9) found in working with bluegrass that the height of clipping greatly influenced any later productivity and concluded that "the photosynthetic parts of plants which remain after cutting are potential sources of reserve foods."

> "In *Stipa pulchra* food deposit was found to be related to low or declining growth velocity and to be dependent upon the amount of leaf area available for its manufacture. The advent of flowers and seed coincided with depression in the growth rate. Accumulation of foods, therefore, is related to low or declining growth velocity and is most active near the close of the annual growth cycle." (19)

D. G. Sturkie (22), working with Johnson grass, found that cutting late in the season reduced the food reserves as much as continuous cutting throughout the season. Cutting discontinued in the middle of the season permitted the Johnson grass to develop forty per cent more rootstalks than continued cutting. Usually the largest yield of top growth was produced when the plants were cut when the seeds were in the late milk stage.

Pierre and Bertram (18) in experiments with kudzu regarding the effect of number of cutting treatments on yields and on the production of reserve foods in the roots brought out the following facts:

(1) The fewer the number of cuttings the greater is the production of root reserves. The roots of plants receiving six cuttings per season decreased in weight during a period of two years, those from plants receiving four cuttings increased approximately 400 per cent, and those from plants receiving one cutting increased about 1,250 per cent.

(2) Yields of tops were found to be dependent on the amount of reserve food stored in the roots. The greater the amount of root storage, the greater is the yield of tops.

(3) The greatest yield of tops was secured with the two-cutting treatment when the roots were of equal size at the beginning of the experiment. Due to the great amount of storage material formed in the roots during the first year from plants cut only once, however, the greatest yield secured the second year was from the one-cutting treatment.

(4) The percentage of reserve starch and nitrogen was found to be less than one-half as much in the roots from plants receiving six cuttings as in the roots of plants receiving four or a less number of cuttings. The percentage of total sugars, however, was found to be greater. This is taken to indicate that a change from starch to sugar is taking place in the roots of plants receiving six cuttings in order to produce new top growth.

McCarty (13) in a study of the carbohydrate content of mountain brome states:

> "Except for the hemicellulose fraction, carbohydrate storage is inversely related to the rate of growth of the herbage, i.e., high growth rate, low carbohydrate storage. Minimum values prevail in the roots and stem bases during the active growth stages of the plant, and evidence indicates the utilization of carbohydrates in excess of their manufacture during the most active growth periods. Maximum storage occurs during the autumn period after current seasonal and secondary herbage growth is completed."

"The carbohydrates and other organic foods cannot be supplied to green plants in a commercial way. The living plant must manufacture them itself. The plant producer can vary treatment so that formation, utilization, storage and destruction of these materials will affect the quantity and quality of the crop produced. Such cultural practices include cutting, grazing, fertilization with nitrogenous fertilizers and limitations of light." (5)

# MATERIALS AND METHODS

Sod samples were selected from plots under cultivation and treatment at the Montana Experiment Station at Bozeman, Montana. These plots were part of an experiment being conducted by Dr. R. E. Stitt, Associate Agronomist, Division of Forage Crops and Diseases, Bureau of Plant Industry, Agricultural Research Administration, U.S. Department of Agriculture, and the Montana Agricultural Experiment Station.

Planting was conducted the latter part of May, 1945, and in September of that season all plots were clipped high. Three different treatments were imposed upon individual plots of each variety in 1946, in 1947, and in 1948. These treatments were (1) cut for seed, (2) cut for hay, (3) cut to simulate grazing. These cutting treatments and the clipping dates of each treatment for each year are given in Tables I, II, and III. (Pages 15, 16, and 17) Previous to this study seed plots were cut a total of three times, hay plots a total of five times, and pasture plots a total of twelve times. Also, in April of 1948, a fertilizer application of five hundred pounds of ammonium sulphate per acre was made to one-half of each plot.

From the above treated plots the following three species and three varieties of each species were selected to be used in this study:

Table I

Clipping dates of cutting treatments in the season of 1946 imposed upon species and varieties used in this study.

| Species & Variety | Seed | Hay | Pasture |
|---|---|---|---|
| *Poa pratensis* | | | |
| P.I. 119684 | 7/11 | 6/6 & 9/3 | 4/25, 5/20, 6/14, 7/8, 7/28, & 9/5 |
| Commercial (F.C.22934) | 7/16 | 6/6 & 9/3 | 4/25, 5/20, 6/14, 7/8, 7/28, & 9/5 |
| Arboretum | 7/16 | 6/6 & 9/3 | 4/25, 5/20, 6/14, 7/8, 7/28, & 9/5 |
| *Dactylis glomerata* | | | |
| Ft. Ellis Strain | 7/22 | 6/28 & 9/20 | 4/25, 5/20, 6/14, 7/8, 7/28, & 9/5 |
| Aberystwyth S-143 (Mont.) | 7/22 | 6/28 & 9/20 | 4/25, 5/20, 6/14, 7/8, 7/28, & 9/5 |
| Maryland (F.C.22883) | 7/22 | 6/28 & 9/20 | 4/25, 5/20, 6/14, 7/8, 7/28, & 9/5 |
| *Bromus inermis* | | | |
| Parkland (Mont.) | 8/5 | 6/28 & 9/20 | 4/25, 5/20, 6/14, 7/8, 7/28, & 9/5 |
| Lincoln | 8/5 | 6/28 & 9/20 | 4/25, 5/20, 6/14, 7/8, 7/28, & 9/5 |
| Utah 13 | 8/5 | 6/28 & 9/20 | 4/25, 5/20, 6/14, 7/8, 7/28, & 9/5 |

Table II

Clipping dates of cutting treatments in the season of 1947 imposed upon species and varieties used in this study.

| Species & Variety | Seed | Hay | Pasture |
|---|---|---|---|
| <u>Poa pratensis</u> | | | |
| P.I. 119684 | 7/14 | 6/16 | 5/20, 6/19, & 8/13 |
| Commercial (F.C.22938) | 7/14 | 6/16 | 5/20, 6/19, & 8/13 |
| Arboretum | 7/14 | 6/16 | 5/20, 6/19, & 8/13 |
| <u>Dactylis glomerata</u> | | | |
| Ft. Ellis Strain | 8/20 | 7/14 | 5/20, 6/19, & 8/13 |
| Aberystwyth S-143 (Mont.) | 8/20 | 7/14 | 5/20, 6/19, & 8/13 |
| Maryland (F.C.22883 | 8/20 | 7/14 | 5/20, 6/19, & 8/13 |
| <u>Bromus inermis</u> | | | |
| Parkland (Mont.) | 8/20 | 7/14 | 5/20, 6/19, & 8/13 |
| Lincoln | 8/20 | 7/14 | 5/20, 6/19, & 8/13 |
| Utah 13 | 8/20 | 7/14 | 5/20, 6/19, & 8/13 |