THE EFFECT OF FIRE ON THE GROWTH

OF *RHUS GLABRA* L. AND

SMILAX BONA-NOX L.

By

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THE EFFECT OF FIRE ON THE GROWTH OF *RHUS GLABRA* L. AND *SMILAX BONA-NOX* L.

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PREFACE

Fire is recognized as an environmental factor that maintains the grassland. Typical studies of fire have dealt with the herbaceous components of the prairie and what effect fire has upon their growth. The intent of this study is concerned with the investigation of what effect fire exerts on the growth of two woody species growing in the prairie.

The author wishes to express his appreciation to his major adviser, Dr. James K. McPherson, for his guidance and assistance throughout this study. Appreciation is also expressed to the other committee members, Dr. Paul Richardson and Dr. Glenn Todd, for their invaluable assistance in the preparation of the final manuscript.

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CHAPTER I

INTRODUCTION

Since the recognition of fire as an environmental factor there have been many studies of its ecological effects including two preliminary studies at OSU. These studies dealt mainly with the prairie grasses and forbs. Observation of the burned grassland plots used for previous studies showed a rank growth of saw greenbriar (*Smilax bona-nox*) and smooth sumac (*Rhus glabra*) (Waterfall, 1969). *Smilax* is a sub-woody vine and *Rhus* is a clone-forming shrub. Since fire has been considered a force which maintains the grassland, it seemed surprising that plots, burned successively for two springs, contained an abundant growth of these woody plants. The purpose of this study, therefore, was to determine the effect of fire upon the growth of *Smilax bona-nox* and *Rhus glabra*.

The removal of the insulative plant material by fire causes an increase in soil surface temperature. Burned fields which were dominated by *Andropogon gerardi* and *Andropogon scoparius* had an increase in soil temperature of 2.2 to 9.8°C (Kucera and Ehrenreich, 1962). In Kansas the temperature was raised by 6°C at a depth of 2.5 cm (Hensel, 1923).

Higher soil temperature has been related to the early emergence of new shoots on a fresh burn. In east central Missouri early growth of *Andropogon scoparius* and *Andropogon gerardi* was attributed to high soil temperature (Koelling and Ducera, 1965). Early growth in a burned prairie in northeastern Iowa was also attributed to the warmer soil. The onset of growth occurred between two and three weeks earlier in the spring (Ehrenreich, 1959).

Burning tends to reduce the soil moisture in a grassland. High soil temperatures and increased evaporation dries the soil (Daubenmire, 1968). In Iowa the top 10 cm of soil was drier in the burned grassland (Ehrenreich and Aikman, 1963). Soil moisture in a burned prairie was reduced to a depth of one meter in eastern Kansas following a burn. Plants growing in the burned area showed definite drought symptoms (Aldous, 1934). Earlier dates of burning in the spring cause a greater reduction of moisture. This is due to a prolonged exposure of the burned soil to evaporation (Anderson, 1965).

In some instances no difference in soil moisture has been detected between burned and unburned areas. In an annual grass stand in California there was no soil moisture difference between burned and unburned sites (Hervey, 1949). According to Daubenmire, 1968, this was probably due to the unusual climatic pattern of the region where grasses grow during the moist winter.

Prairie fires can alter a plant community by changing the flora. This change may be due to the elimination of species by direct injury or to changes in the environment that can open the area for invasion by another species. Species that regrow from underground shoots or produce buds buried in the soil are more apt to survive a fire. Species that produce buds or shoots only above the soil tend to be destroyed. Species such as <u>Andropogon</u> spp. and <u>Sorghastrum nutans</u> can readily survive fire if burned in early spring while they are still dormant

(McMurphy and Anderson, 1965). Species lacking these means to survive a fire will perish, subsequently opening the area for invasion by other species or new individuals of the surviving species.

Prairie fires also affect the productivity of a plant community. Productivity in stands of _A. gerardi_ and _S. nutans_ in Illinois increased two-fold (Hadley and Kieckhefer, 1963). In a native prairie in Iowa productivity also increased after burning (Ehrenreich and Aikman, 1963). However, under some conditions such as dry climates and frequent burning, fire tends to reduce production. In Guthrie, Oklahoma eight years of annual burning reduced production (Elwell et al., 1941).

Most of the information about prairie fires pertains to the herbaceous vegetation. Woody species are commonly associated with the prairie. Sumac, buckbrush, oak, cedar, common greenbriar, and others can be found. Data about shrubs and trees except for fire killed observations are scarce. Forest fire data show an increased growth of shrubs (Martin, 1955) which is probably due to an increase in available nitrates (Lutz, 1956). However, prairie fires kill or damage most woody species which maintains the grassland. All this suggests a need for comparisons of prairie and forest fire effects on shrub species.

Since woody plants are regarded as susceptible to prairie fire it is my belief that the growth of _Rhus glabra_ and _Smilax bona-nox_ would decrease after a fire. Repeated annual burning would presumably cause further reduction of growth of _Rhus_ and _Smilax_. Both field and laboratory studies were utilized to determine the effect of fire on _Rhus_ and _Smilax_. Moisture and water retention studies of the soil in these areas were done to detect any differences between burned treatments. Biomass measurements of both species through the growing season were done to obtain a measure of growth.

CHAPTER II

DESCRIPTION OF STUDY AREA

The area chosen for study was on a gentle south-southeast facing slope on the Oklahoma State University Ecology Preserve. The preserve is located nine miles west of Stillwater, Oklahoma, on the south side of U.S. 51. The general mix of vegetation within the area consisted of *Andropogon gerardi* (Big bluestem), *A. scoparius* (Little bluestem), *Sorghastrum nutans* (Indian grass), *Rhus glabra* (smooth sumac), *Smilax bona-nox* (Saw greenbriar), and some young oaks and cedars.

History of the Study Area

In primeval times savanna was probably the dominating vegetation within the area. Overgrazing during the early 1900's allowed the area to become dominated by a post oak and blackjack oak forest. In 1957 the selective herbicide 2,4,5-T was sprayed onto this forest to make way for more grazing. This spraying was largely, but not totally successful. Most trees were killed, but some trees and understory survived. The Department of Botany and Plant Pathology at OSU acquired the area as part of a preserve in January, 1968. No more grazing by domestic animals was allowed. In the spring of 1969 and 1970 three 25 x 100 meter plots approximately 5 to 20 meters apart were established and burned for previous studies of fire and its effects (Figure 1).

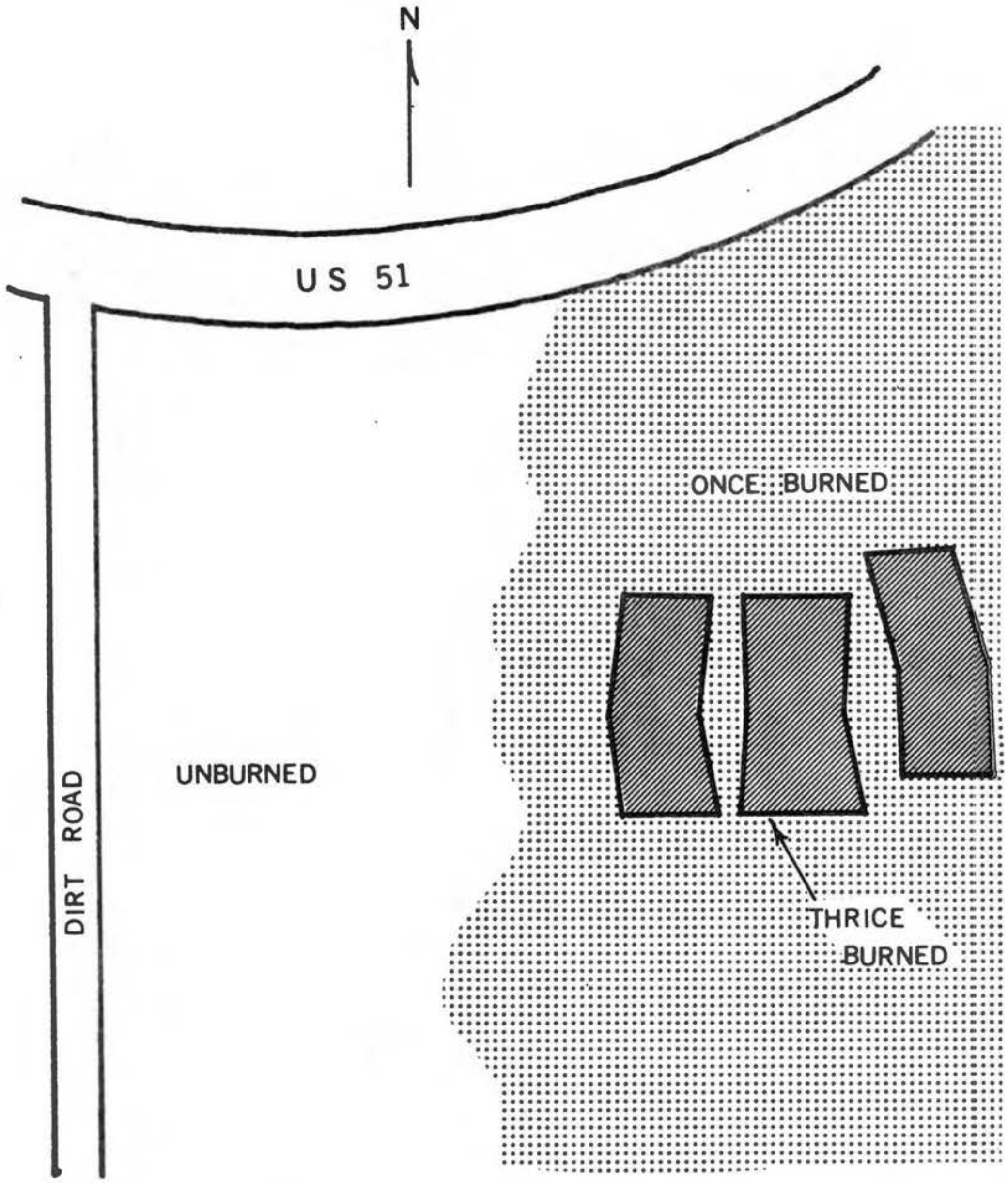

Figure 1. Diagram of Study Area Showing the Unburned Control, Once Burned and Thrice Burned Plots.

Location of Study Plots Within the Area of Study

The previously established plots in 1969 and 1970 were to be used for assessing the results of burning (Figure 1). The immediate area encompassing the three plots was to be used as a once burned area.

CHAPTER III

METHODS

Burning of the Study Area

In the spring prior to the growing seasons of 1969 and 1970 the three 25 x 100 meter plots were burned routinely, with the fires moving against the wind. On March 20, 1971 fires were set in the west plot. After the west plot was burned sudden gusts of wind blew the fire out of control into the surrounding area. The extent of the burn can be seen in Figure 1. The fire mainly burned toward the northeast due to the wind gusting from the southwest. Windward fires burned through the remaining two study plots. Backfires sprang up and burned westward forming a burned area which ended about 100 meters from the west plot.

This accident required some changes in the plan of study. Of the three 25 x 100 meter plots within the study area, the west plot was selected to represent the area burned successively for three springs. It shall be called the thrice burned plot (Figure 1). The area adjacent to the west of the thrice burned plot, for approximately 100 meters, will represent the area burned once during the spring which will be referred to as the once burned area. The unburned area, to be referred to as the control, lies adjacent to the west of the once burned area.

General Observations

Immediate results of the fire and the growth of <u>Rhus</u> and <u>Smilax</u>

were observed to assess general effects of the fire and to detect any differences in the pattern of growth between the control, once burned area, and thrice burned plots.

Soil Moisture

In order to determine if there were differences in soil moisture between burned and unburned sites, regular measurements were made at selected points in *Rhus* and *Smilax* areas. Soil moisture was measured by the gravimetric method (American Society for Testing and Material, 1958).

Twelve soil sampling points were selected in or near stands of *Rhus* and *Smilax* in the study area and were marked by a stake. Of the twelve selected sampling points there were four each in the control, once burned area, and thrice burned plots (Figure 2).

Soil moisture was measured each week during the months of April, June, July, August, September, and October, 1971. Each week two soil core samples were taken at the 2-12 cm soil depth and 12-22 cm soil depth within a meter radius of each sampling point. The top two centimeters of the soil core were discarded. The remainder of the core was separated into two parts, 2-12 cm and 12-22 cm depths. These soil core segments were immediately sealed in aluminum cans and returned to the laboratory for soil moisture determination.

Soil-Water Content Under 15 Bars Tension

Moisture retention measurements of the soil at a specific tension were made at selected points in *Rhus* and *Smilax* areas to determine if any differences occurred between the control and the burned treatments.

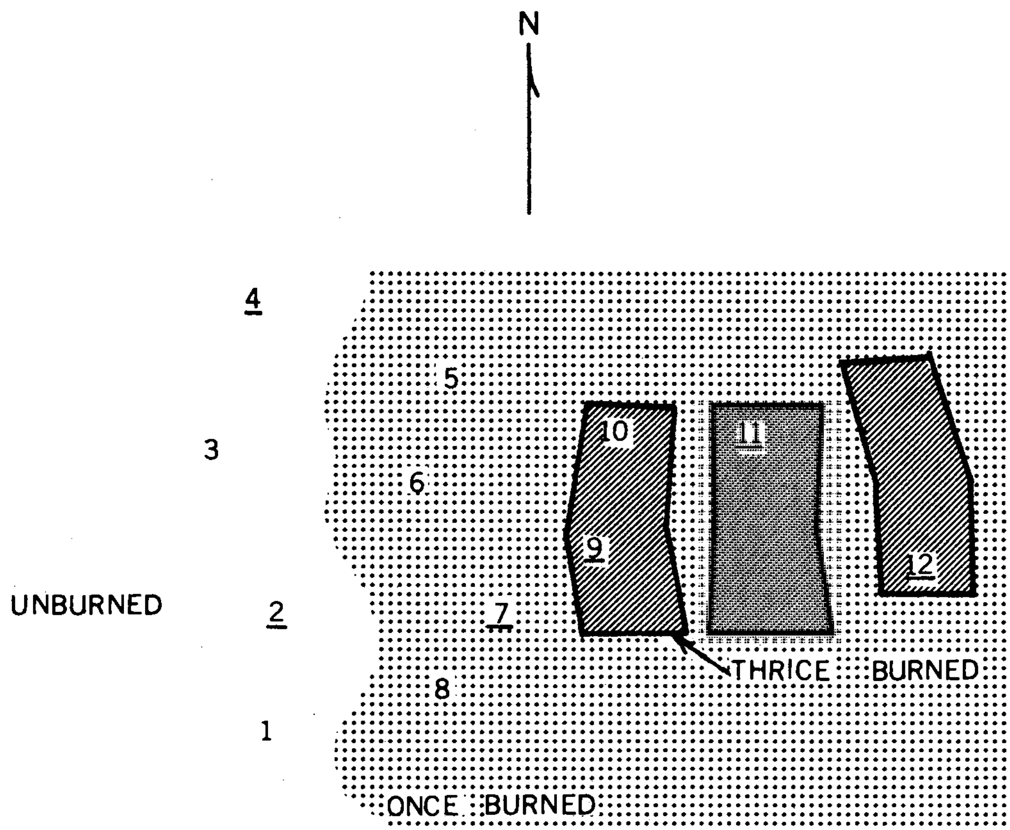

Figure 2. Diagram Showing Locations of Soil Moisture Sampling Stations by Number. Stations with thermocouples are underlined.

Six of the twelve soil sampling stations were also used for measurement of moisture retention of a soil at a specific tension. Two are located in the control, one in the once burned area, and three in the thrice burned plots (Figure 2).

On October 20, 1971, two undisturbed soil core samples were taken at the 2-12 cm and 12-22 cm soil depths. These were obtained by digging with a shovel to the 2-12 cm and 12-22 cm soil depths within a meter radius from the sampling point. When each depth was obtained a two inch diameter soil corer was pounded into the soil with a rubber mallet. Both the soil core and corer were carefully removed. The middle one centimeter segment of soil core was then carefully removed without disturbance and transferred to an aluminum can, sealed, and returned to the laboratory. Upon arrival at the lab soil-water content under 15 bars tension was measured using a porous membrane apparatus as described by Black (1965).

Field Measurement of Water Potential of the Soil

Field measurement of water potential in the soil was done to determine if there were any differences between burned and unburned sites. This method was used along with measurement of % moisture content primarily because during very dry periods in the summer the soil became too hard to sample with a soil corer. Measurement of water potential became a means of determining any moisture differences between burned and unburned sites during the dry periods. Field measurement of water potential in the soil was done by the use of thermocouple psychrometers (Lepco Instruments).

Six soil sampling stations for the measurement of soil-water content under 15 bars tension were used for this method (Figure 2). On May 11, 1971, thermocouples with wire leads were placed in the soil at the 22 cm depth at each station. This was done by taking a core of soil to the 22 cm depth, placing the thermocouple in the bottom of the hole with wire leads coming above the soil surface, and then carefully replacing the soil core into the hole with minimum disturbance to the soil in the core.

After May 18, 1971, weekly measurements were made at each station. Each reading was recorded and converted to bars water potential. October 13, 1971, was the last date for measurement.

Measurement of Growth

Growth of *Rhus glabra* and *Smilax bona-nox* was measured during the growing season to determine if there were any differences between the control, once burned treatment, and thrice burned treatment. Growth was defined as an increase in dry weight over time.

Establishment of Collecting Periods

To determine growth of *Rhus* and *Smilax* the growing season was divided into three periods for measurement of biomass. June 20, 1971 and August 6, 1971 were disignated as the first two collecting periods. The last collection period was when *Rhus* and *Smilax* were about to drop their leaves. For *Rhus* the last collecting period was on September 28, 1971, and for *Smilax* on October 17, 1971.

Collection of Plant Material

To measure growth, plants of *Rhus* and *Smilax* were harvested during the week of each collecting period. Voucher specimens are in the Oklahoma State University Herbarium. During each collecting period ten plants of Rhus were harvested from the thrice burned plot, the once burned area, and the control in that order. Eventually a total of 30 plant specimens of Rhus were collected at each period. After Rhus had been collected Smilax was then collected in the same manner.

To determine which plants of Rhus and Smilax were to be harvested, a randomizing procedure was used. A starting point was established in the northeast corner of the thrice burned plot, the once burned area, and the control. Each plant to be collected was chosen by pacing a randomly selected number of steps west from the starting point and then a randomly selected number of steps south into the study plot or area. A random numbers table was used for determining the number of steps to take each time (Snedecor and Cochran, 1969). At the end of each pacing procedure the plant that was collected was the one nearest to where I stood. This was done ten times for each treatment and the control.

In order to have a constant area to sample from the portion of the plant below the ground, a circular quadrat was placed around each plant to be harvested. The circular quadrat consisted of two half-circles together enclosing an area of approximately 1000 cm^2. The stem(s) of each plant to be harvested was centered within the quadrat. The plant's root system within a cylinder of soil was then dug up and collected (Figure 3). Each plant was immediately bagged and taken to the lab.

Biomass Measurement

At the end of each collecting period plants of Rhus and Smilax were taken to the lab for measurement of biomass. Each plant was cut and

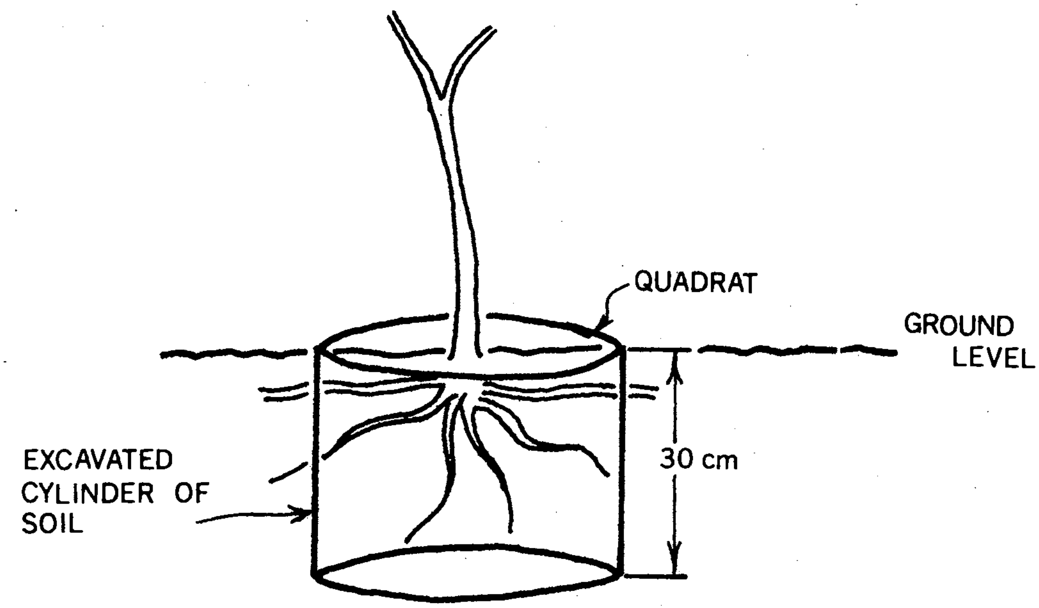

Figure 3. Diagram Illustrating Sample Collecting Scheme.

separated into leaves, above ground stem, underground portion, and inflorescence. Each separation for each plant was bagged and dried in an oven at 90° for 48 hours. After 48 hours in the oven, each bag with its dried contents was weighed to the nearest .01 g. The paper bag was then weighed without its contents and also recorded in grams dry weight. The weight of the bag was then subtracted from the combined weight of the bag and contents to obtain the biomass of the dried plant material.

Calculation of Growth

In order to calculate the growth of *Rhus* and *Smilax* in the burned treatments and control the mean biomass of each species at the first collecting period was subtracted from the mean biomass of each species at the final collecting period.

Statistical Analysis

In order to establish some confidence in the results of biomass measurement a statistical analysis was done. The F-test at the 5 percent confidence level was used to determine the equality of means of total plant biomass and mean growth between the thrice burned plot, once burned area, and the control.

CHAPTER IV

RESULTS AND DISCUSSION

General Observations

Results of the Fire

Almost all the vegetation was burned to the ground. There were occasional fire killed stems of *Rhus* still standing and a few cedar trees remaining. The aerial portion of the vegetation in the burn was mostly consumed.

Growth of *Rhus* and *Smilax*

The regrowth of *Rhus* and *Smilax* was noted through early spring in relation to associated species in both the burn and control. *Rhus* sprouted before *Smilax* within the once and thrice burned plots. This growth was by green suckers which sprouted around the dead fire killed stump. *Smilax* appeared a few days later and had the same pattern of regrowth as *Rhus*. This early growth of *Rhus* and *Smilax* in both burned treatments occurred before *Rhus* and *Smilax* showed any sign of growth in the control. *Rhus* and *Smilax* had an earlier start in above ground growth in both burned treatments even when compared to other species in the same burned area.

Soil Moisture

Soil moisture was measured at two depths to determine if there were any differences between the control and burned treatments. Soil moisture was highest in the control at both the 2-22 cm and 12-22 cm soil depths with few exceptions (Figure 4 and Table I). The lowest moisture readings were generally in the thrice burned treatment at both soil depths. The mean difference between the mean values at both depths between the control and thrice burned treatment was calculated to be 3%. Of the two soil depths soil moisture was lowest at the 12-22 cm depth with few exceptions (Table I).

Moisture content of the soil fluctuated with precipitation received during the growing season (Figures 4 and 5). In some instances when there was a long dry period soil moisture declined steadily until no measurement could be made by the gravimetric method due to the very hard soil.

Burning tended to lead to reduced soil moisture. Repeated annual burns reduced soil moisture more than a single burn. These differences were only slight and probably not significant enough to account for any differences in growth between the control and burned treatments.

Soil Water Content Under 15 Bars Tension

Water content of the soil at 15 bars tension was measured at two depths within the study sites to determine if there were any differences.

The water holding capability of the soil at the 2-12 cm depth was the same within the control and once burned treatment (Table II). However, there was about 1.8% less moisture retained in the thrice burned treatment. The water holding capacity at the 12-22 cm depth in

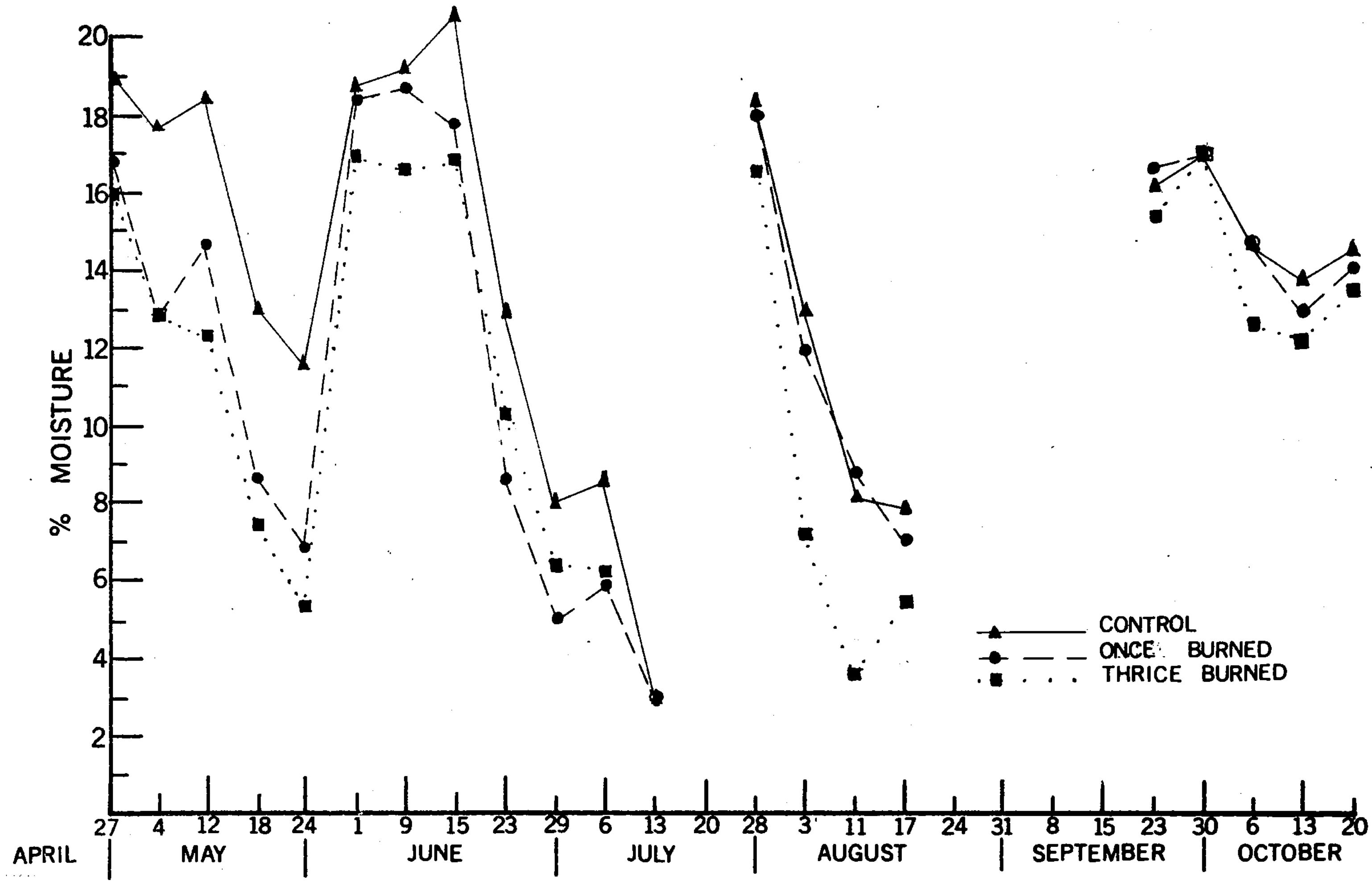

Figure 4. Average Soil Moisture by Weight of the Control, Once Burned and Thrice Burned Plots at the 2-12 cm Soil Depth, April Through October, 1971. Unconnected points indicate when the soil was too dry for sampling.

TABLE I

% SOIL MOISTURE MEAN VALUES IN THREE AREAS AND
TWO DEPTHS, APRIL THROUGH OCTOBER, 1971

DATE		% SOIL MOISTURE: UNBURNED CONTROL 2-12 cm	UNBURNED CONTROL 12-22 cm	1 x ANNUAL BURNED 2-12 cm	1 x ANNUAL BURNED 12-22 cm	3 x ANNUAL BURNED 12-12 cm	3 x ANNUAL BURNED 12-22 cm
April	27	18.9	18.2	16.6	15.2	15.8	14.0
May	4	17.8	16.6	12.8	13.9	12.8	11.9
	12	18.4	16.6	14.4	12.4	12.2	10.2
	18	13.0	12.9	7.6	9.9	6.8	7.0
	24	11.5	11.9	6.8	8.2	5.4	5.5
June	1	18.8	19.2	18.4	16.2	16.8	15.8
	9	19.2	18.0	18.6	16.0	16.5	14.6
	15	20.2	13.8	17.6	16.4	16.6	15.4
	23	12.8	14.1	8.6	10.1	10.3	9.8
	29	7.9	10.2	5.2	5.9	6.4	7.2
July	6	8.6	8.1	6.2	5.6	6.2	5.6
	13	3.2	2.8	3.2	-	-	-
	20	-	-	-	-	-	-
	28	18.0	17.0	17.9	16.1	16.3	14.6
August	3	12.6	11.8	11.7	11.4	9.2	8.4
	11	8.3	9.4	9.2	8.8	3.8	4.6
	17	8.0	8.4	7.1	4.9	5.4	4.4
	24	-	-	-	-	-	-
	31	-	-	-	-	-	-
September	8	9.6	7.1	8.7	5.0	8.3	5.8
	15	-	-	-	-	-	-
	23	16.0	16.6	16.5	15.3	15.5	14.6
	30	16.7	16.0	16.6	15.8	16.6	13.8
October	6	14.8	14.4	14.8	13.7	12.8	11.4
	13	13.6	13.6	13.0	12.5	12.3	9.4
	20	14.5	18.6	20.3	18.0	17.8	16.0

- Soil too hard to take sample core.

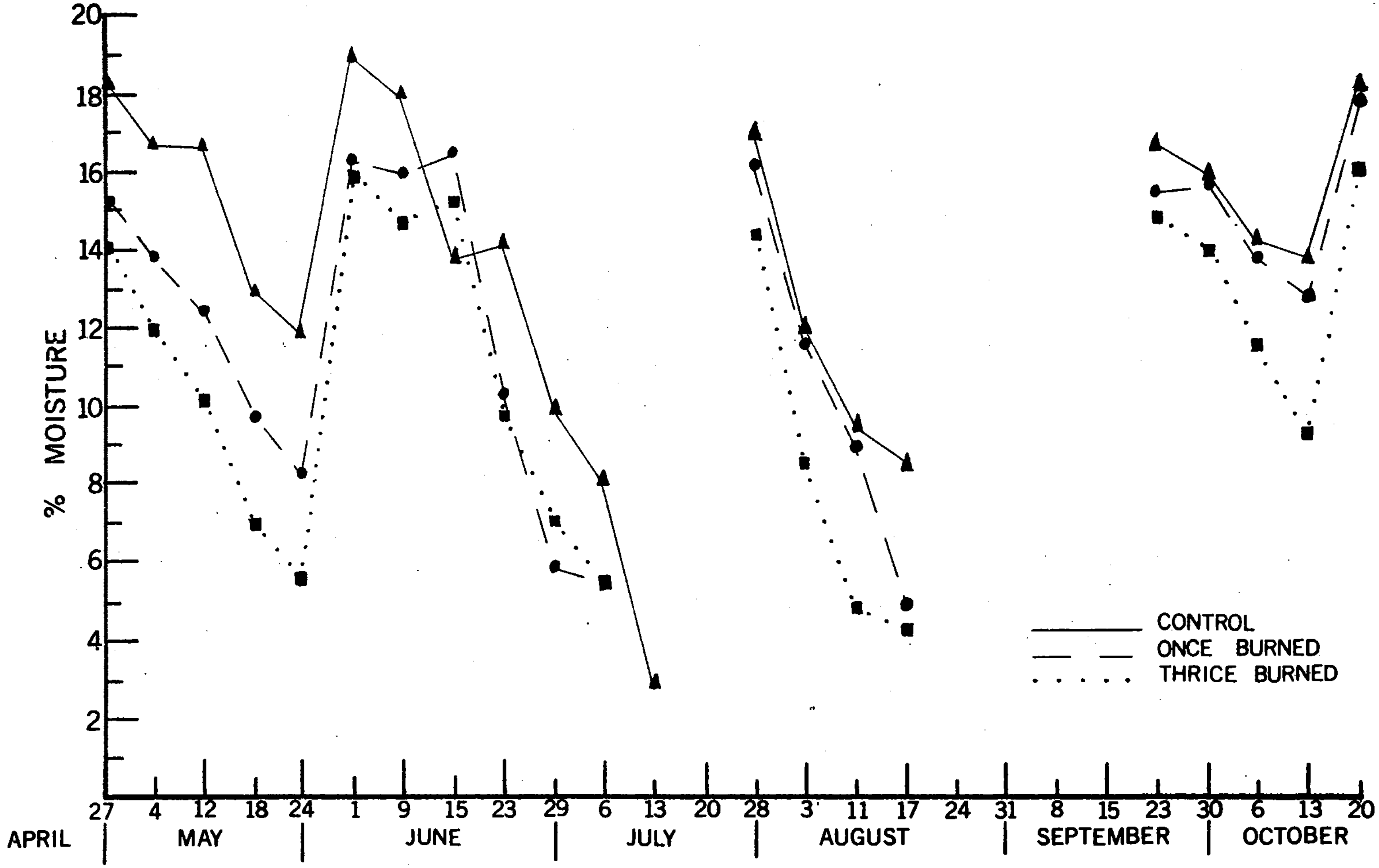

Figure 5. Average Soil Moisture by Weight of the Control, Once Burned and Thrice Burned Plots at the 12-22 cm Soil Depth, April Through October, 1971. Unconnected points indicate when the soil was too dry for sampling.

TABLE II

MEAN % WATER RETENTION OF THE SOIL BY WEIGHT
AT TWO DEPTHS IN THREE AREAS
AT 15 BARS

	% MOISTURE	
	2-12 cm	12-22 cm
UNBURNED CONTROL	4.4	4.4
1 x ANNUAL BURNED	4.4	5.0
3 x ANNUAL BURNED	2.6	2.4

the control was about 0.6% less than the once burned treatment. Soil in the thrice burned treatment retained about 2% less moisture than the control. The greatest difference of moisture retained between the two depths was 0.6%.

Fire frequency appears to decrease soil moisture retention. These differences were only slight and were not important for the purpose of this study.

Field Measurement of Water Potential of the Soil

Field measurement of water potential of the soil was done to determine if any differences existed between the control and both burned treatments. This method was relied upon when percent soil moisture could not be done gravimetrically due to the dry, hard soil.

Some trouble was encountered using the thermocouple psychrometer technique in the field. Nearby storms or overpassing airplanes created electrical interference making it impossible to collect some data.

Water potential within the three study sites fluctuated with rainfall (Table III). After receiving precipitation in the area the water potential would increase (become less negative). In some instances in very moist soil the potential was so high the psychrometer gave a zero reading.

There was high variability of water potential within each study site. Therefore, no mean or average was calculated. Within the control station #2 had the lowest value of water potential of -87.2 bars (Table III). The soil at this station appeared to be high in clay content which probably caused the low reading.

TABLE III

BARS OF WATER POTENTIAL OF THE SOIL IN THREE AREAS
MAY THROUGH OCTOBER, 1971. ALL ARE
NEGATIVE VALUES

		BARS OF WATER POTENTIAL					
		UNBURNED CONTROL		1 x ANNUAL BURNED	3 x ANNUAL BURNED		
DATE		2	4	7	9	11	12
May	18	0.0	1.9	0.9	0.7	*	0.4
	24	1.1	1.4	1.0	2.4	*	0.0
June	1	0.0	0.0	3.6	3.4	1.2	1.6
	9	0.0	0.0	0.6	0.8	0.9	2.8
	15	0.4	0.0	0.4	3.2	0.0	1.1
	23	0.2	**	0.4	2.5	1.0	2.2
	29	0.0	0.8	2.2	1.2	1.2	0.6
July	6	1.0	1.0	4.2	2.8	3.2	1.2
	13	3.8	1.2	13.5	5.9	15.3	9.1
	20	22.6	43.7	22.0	14.2	19.3	17.6
	28	0.0	***	1.1	0.6	0.0	1.1
August	3	1.3	***	1.1	1.6	1.5	***
	11	0.0	***	0.0	0.2	1.5	***
	17	0.0	3.2	1.8	4.0	5.8	***
	24	9.5	0.0	1.4	15.8	21.2	***
	31	*****	32.1	3.2	31.7	31.7	***
September	8	****	9.1	4.9	4.8	2.5	***
	15	****	15.6	4.9	14.2	20.3	***
	23	87.2	0.2	0.2	1.0	0.6	***
	30	****	1.4	0.2	0.2	****	***
October	6	20.2	0.5	0.2	1.5	***	***
	13	15.6	0.8	0.8	0.0	1.5	***

* Thermocouple not yet placed in soil.
** Meter not reading properly.
*** Wire leads to thermocouple cut by animals.
**** Erroneous reading probably due to the thermocouple.

There was little difference between the control and both burned treatments on June 29, 1971. On July 20, 1971 the difference was greater. It was at this time that the soil became very dry, but the differences at other times were not consistent. Questionable readings using this technique made it impossible to determine if any valid differences actually occurred during the dry period between the control and both burned treatments.

Measurement of Growth

Collection of Plant Material

Plants of *Rhus* and *Smilax* were harvested and weighed during the growing season to determine if any differences occurred between the control, once burned area and thrice burned sites. No trouble was encountered while collecting *Rhus*, but some problems occurred when collecting *Smilax*.

It was discovered that *Smilax* had two types of underground growth after the first collection June 20, 1971. One form was rhizomatous and the other a corm-like form with rhizomes. The important difference between the two was biomass. The corm-like form was more massive. It is theorized that the corm-like form was functioning as a storage organ. It would then be the important underground part to measure. Only a few plants of *Smilax* which had the corm-like form were collected during the first collection on June 20, 1971. Thereafter, only plants of *Smilax* that had the corm-like growth were collected during the second and last collecting periods.

Biomass Measurement

Plants of *Rhus* and *Smilax* were separated into leaves, above ground stem, underground portion, and inflorescence at the lab. Each separation was then ovendried and weighed.

Leaf biomass of *Rhus* was always highest in the control (Figure 6). There was an approximate 5 g. per plant decrease from the first to second collection date. This can be attributed to loss of leaves during that dry period plus some insect damage. Leaf biomass in the control was essentially constant through the growing season.

Leaf biomass of *Rhus* in the once burned area was approximately 16 g. per plant lower than that of the control at the first collection date. From then on leaf biomass in the once burned area experienced a steady decrease through the growing season. Conversely, leaf biomass of *Rhus* in the thrice burned plots showed a steady increase through the growing season. By the end of the growing season leaf biomass in the thrice burned plots was approximately 10 g. per plant less than leaf biomass in the control.

Above ground stem biomass of *Rhus* was highest in the control for each collecting date (Figure 7). This is the result of measuring previous year's biomass. There was only a slight gain of biomass for each successive collecting date.

Above ground stem biomass for both burned treatments was considerably lower than the control at the first collection date (Figure 7). Above ground stem biomass values were under 10 g. per plant for both burned treatments for the first collection. Biomass values for both the burned treatments showed a definite increase for the second and last collection dates. Biomass values for the second and last collection

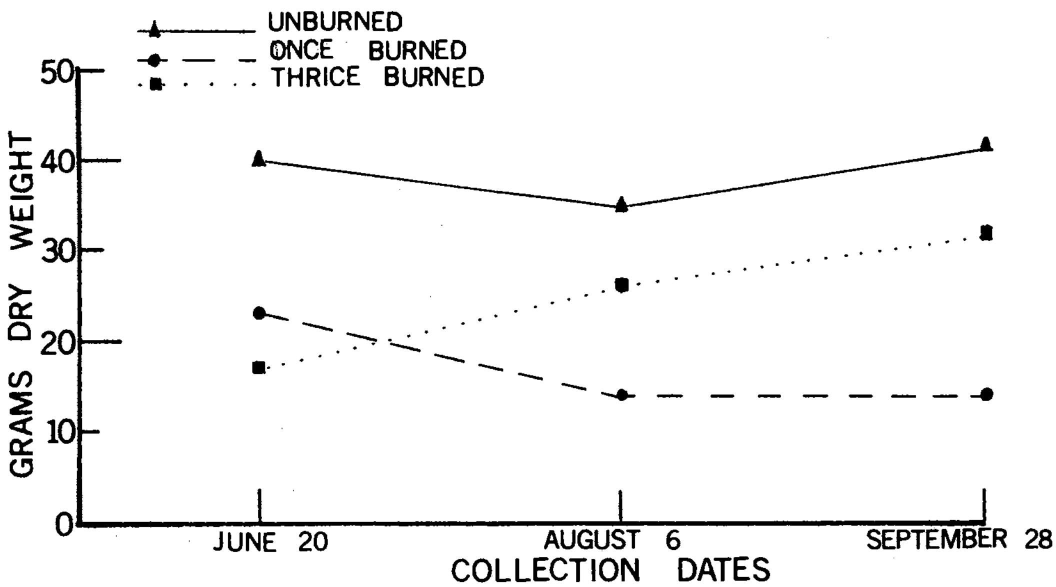

Figure 6. Mean Dry Weights of Leaves of <u>Rhus glabra</u> During the Growing Season.

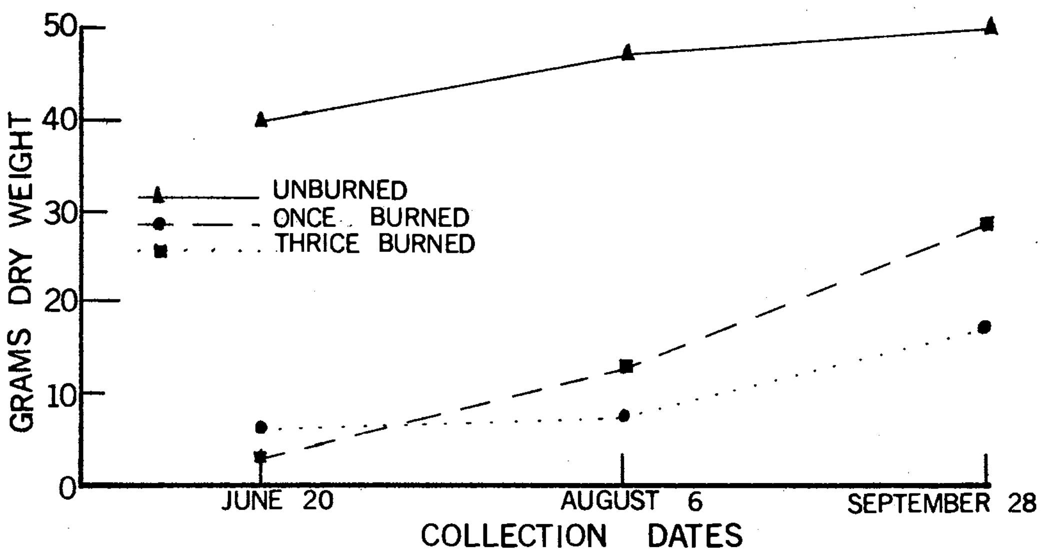

Figure 7. Mean Dry Weights of Above Ground Stem of <u>Rhus glabra</u> During the Growing Season.

dates for above ground stem was higher in the thrice burned plots. This difference was approximately 10 g. per plant at the end of the growing season.

Inflorescences were collected from Rhus plants in the control, but none were collected in burned treatments. Rhus produced no flowers within the treated areas (Figure 8).

Some surprising results were obtained from biomass measurements of the underground portion of Rhus. At the first and second collection dates Rhus plants in the control had the highest biomass (Figure 9). At the last collection date underground biomass of Rhus in the thrice burned plots surpassed the control by approximately 32 g. per plant. Underground biomass in the once burned area was the lowest on all collecting dates.

Total plant weight values of Rhus were highest in the control through the growing season (Figure 10). An increase in total plant biomass was observable in the control after the first collection date. Rhus plants in the once burned area were approximately 20 g. per plant higher in total biomass than those growing in the thrice burned plots at the first collection. After the first collection Rhus growing in the thrice burned plots increased sharply in total biomass. By the end of the growing season Rhus in the thrice burned plots was approximately 6 g. per plant less than those growing in the control. Virtually no increase occurred in the once burned treatment.

To establish some measure of confidence in the results of the total biomass measurements a F-test was conducted. Mean values of total plant biomass for each treatment at each collecting date were significantly different at the 5% confidence level.

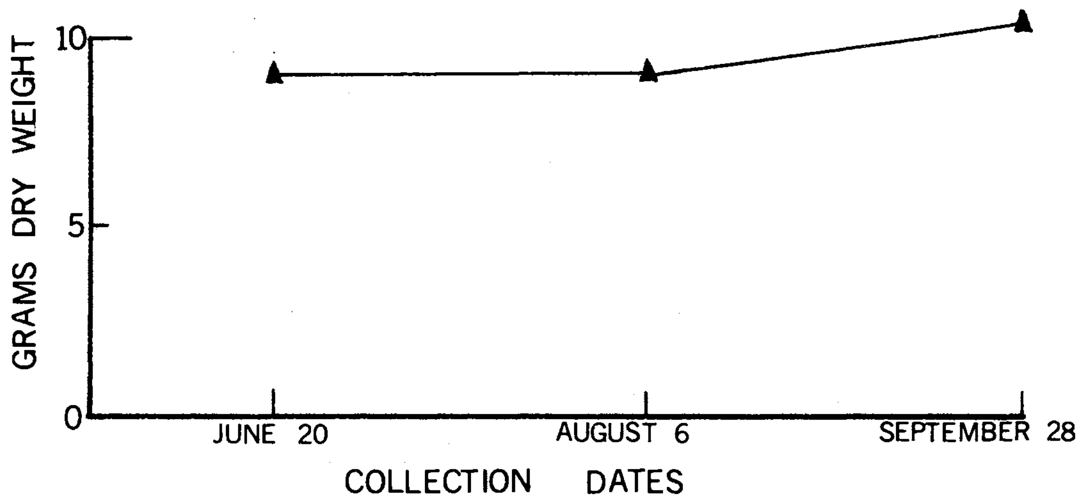

Figure 8. Mean Dry Weight of Inflorescence of *Rhus glabra* in the Control. None were found in either burned treatments.

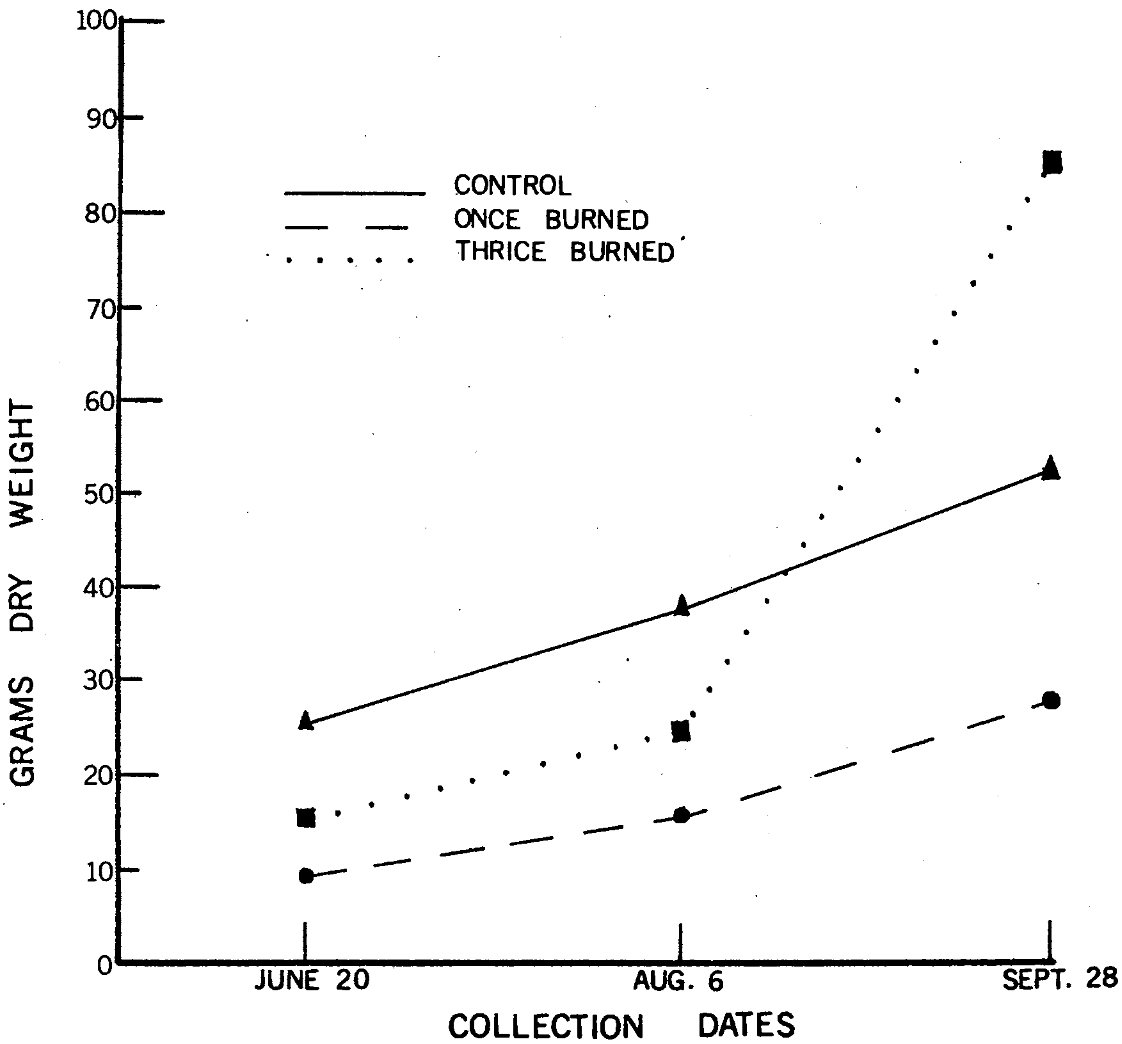

Figure 9. Mean Dry Weights of the Underground Portion of *Rhus glabra* During the Growing Season.

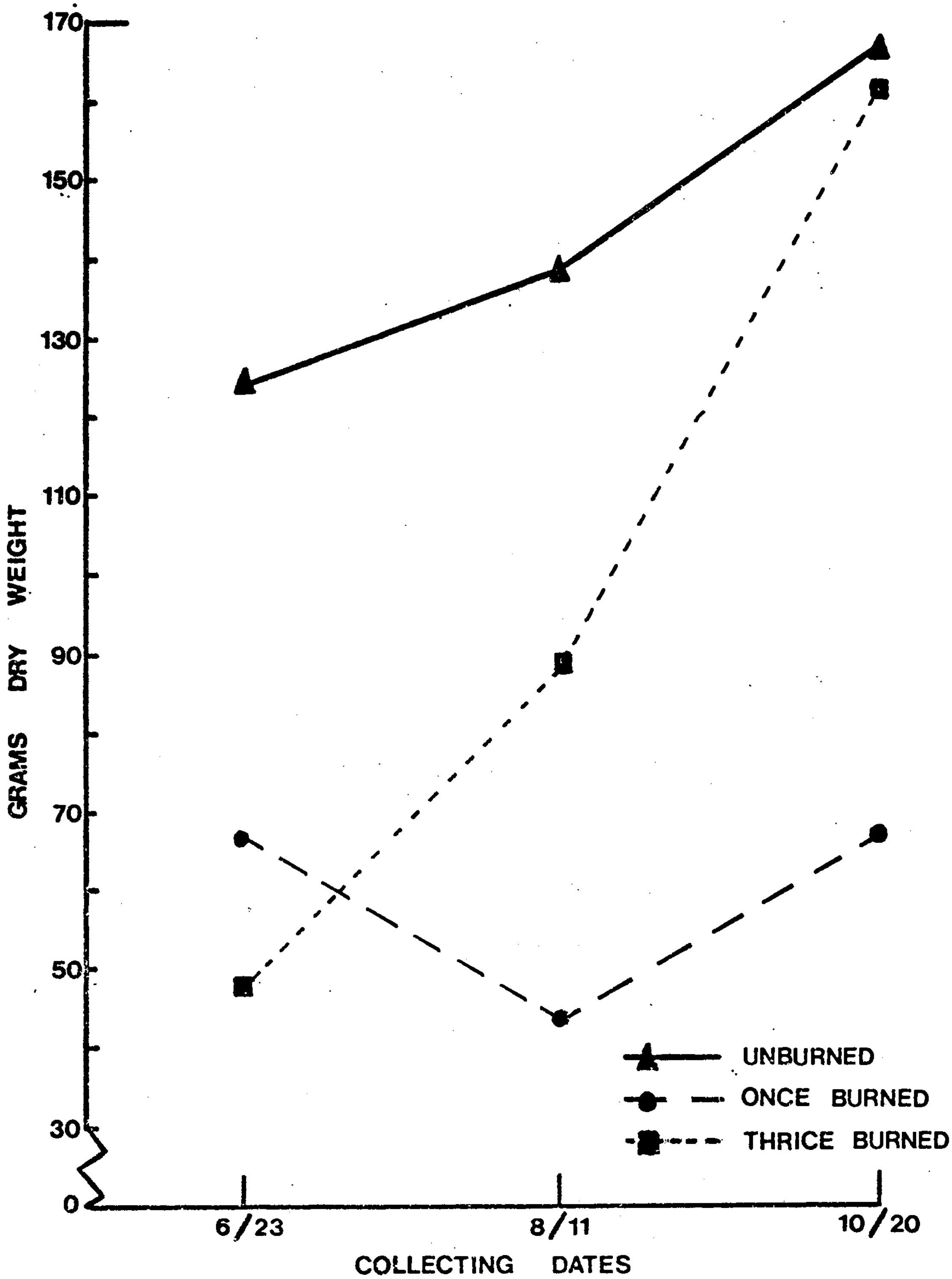

Figure 10. Mean Dry Total Plant Weights of Rhus glabra During the Growing Season.

Biomass values of Smilax leaves was highest in the control, especially at the onset of the growing season (Figure 11). Since Smilax plants in the control were unburned they had more stem available to produce more leaves. Leaf values were higher in the once burned area than those in the thrice burned plots at the onset of the growing season. There was an observable increase in leaf biomass at the second collection date for both burned treatments. However, leaf biomass decreased in the control at that time. Thereafter, not only did leaf biomass in the control decrease, but it also decreased in both burned treatments. Since this decrease happened to the control and both treatments it must not be due to the effect of the fire. Perhaps the dry spell or insect damage affected the Smilax.

Above ground stem values for Smilax was again highest in the control due to the measurement of previous year's biomass (Figure 12). Only a slight increase can be seen in the control through the growing season. Above ground stem values in both burned treatments were essentially the same at the onset of the growing season. Both treatments had an increase in above ground stem values at the second collection date. A very slight increase is observed in the thrice burned plots where a decrease is seen in the once burned area.

Smilax did not produce any inflorescences in the burned treatments. Inflorescence values in the control were essentially the same for the first and second collection dates (Figure 13). A sudden increase in biomass occurred toward the last of the growing season in the control.

At the onset of the growing season biomass values for the underground portion of Smilax was highest in the control (Figure 14). The underground part of Smilax growing in the once burned area was approxi-

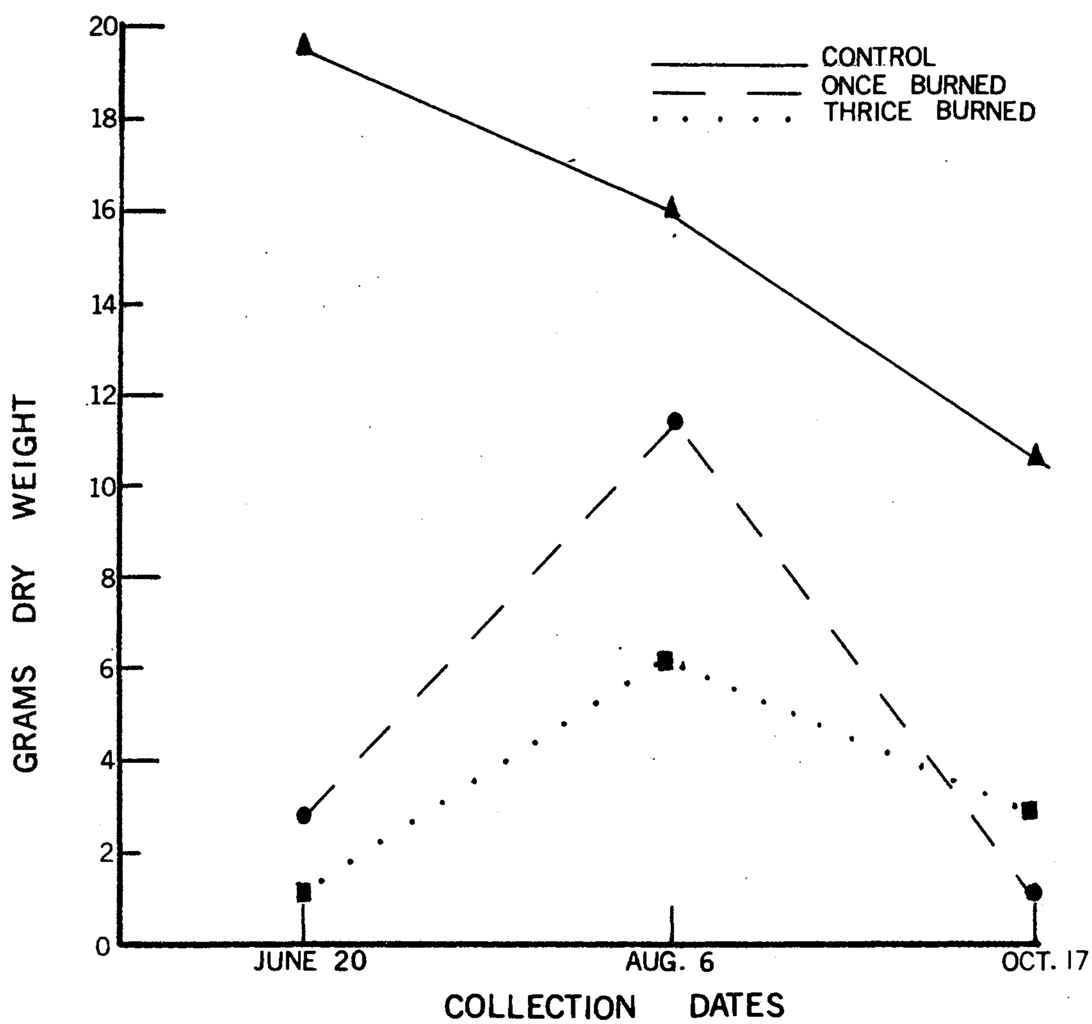

Figure 11. Mean Dry Weight of Leaves of _Smilax bona-nox_ During the Growing Season.

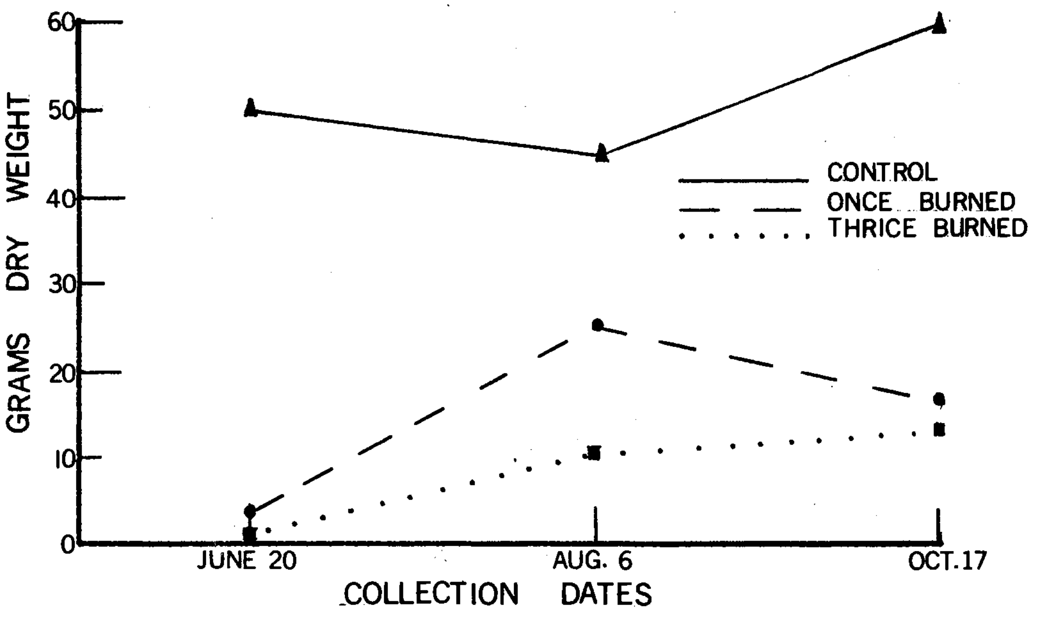

Figure 12. Mean Dry Weights of Above Ground Stem of <u>Smilax bona-nox</u> During the Growing Season.

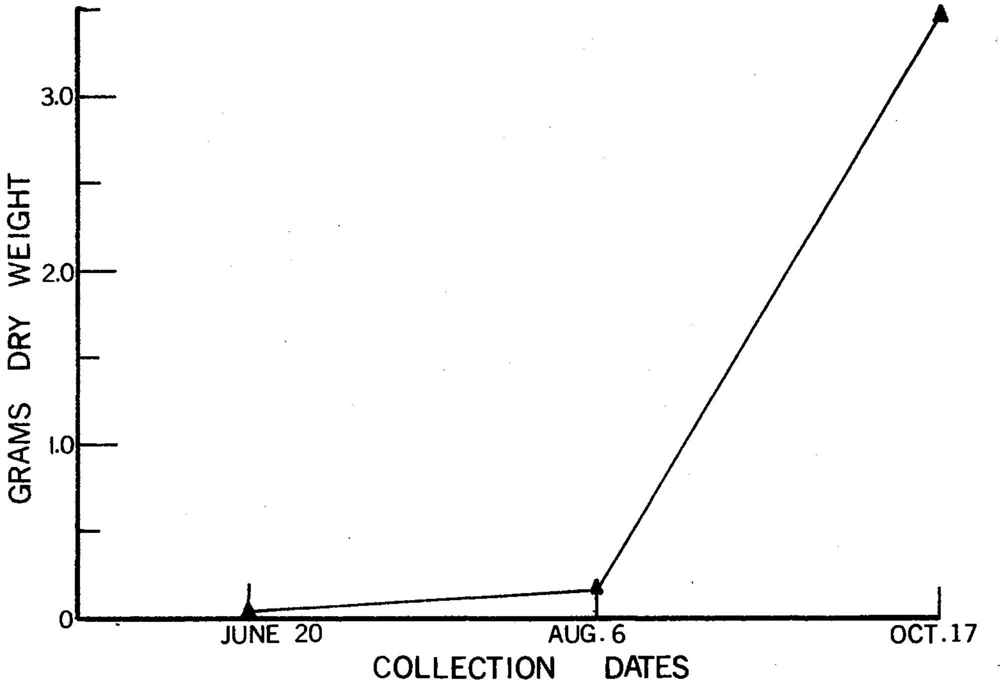

Figure 13. Mean Dry Weight of the Inflorescence of <u>Smilax bona-nox</u> in the Control During the Growing Season. None were found in either burned treatments.

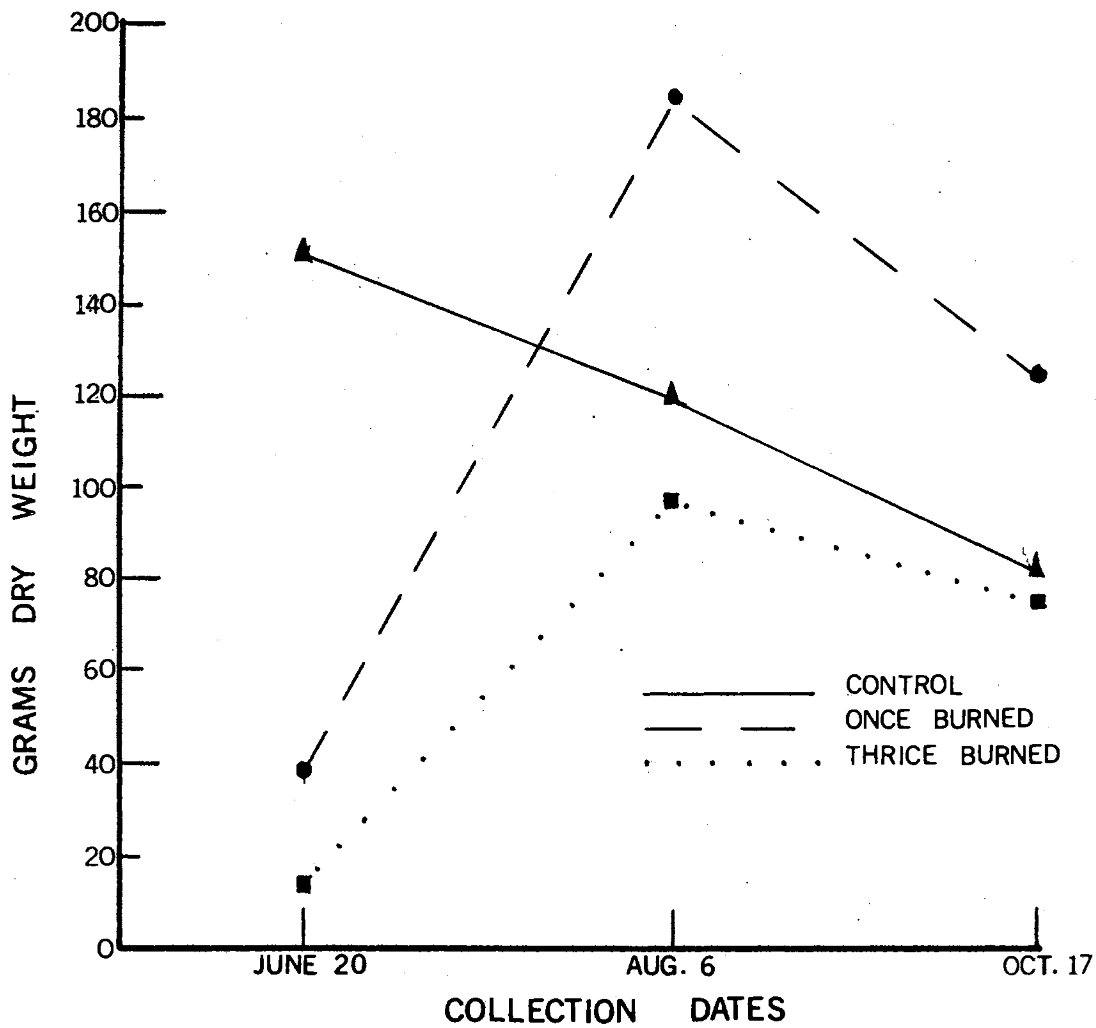

Figure 14. Mean Dry Weight of the Underground Portion of <u>Smilax bona-nox</u> During the Growing Season.

mately 115 g. per plant lower than that of the control. Values in the thrice burned plots was even lower than once burned values. After the first collection date some remarkable changes occurred. Underground biomass values for Smilax in the control decreased at each successive collecting date. Values in both burned treatments increased enough at the second collecting date so that the once burned area was higher than the control. After the second collection date both burned treatments decreased in underground biomass along with the control. The fire clearly altered the dynamics of biomass accumulation in Smilax underground parts.

Total plant biomass of Smilax in the control decreased each successive collecting date (Figure 15). Both burned treatments increased in total biomass from the first to second collecting date with the once burned area increasing more. However, both decreased toward the last of the growing season, as did the control.

The F-test was conducted on total plant values to establish the equality of means. Mean values of plant biomass for each treatment on the first collection date were significantly different at the 5% confidence level. Total plant values of each treatment were not significantly different on the second and last collection dates. These calculated F values were slightly lower than the tabulated F values suggesting that significance might be attained at a lower confidence level.

Calculation of Growth

The mean biomass of each species at the first collecting date was

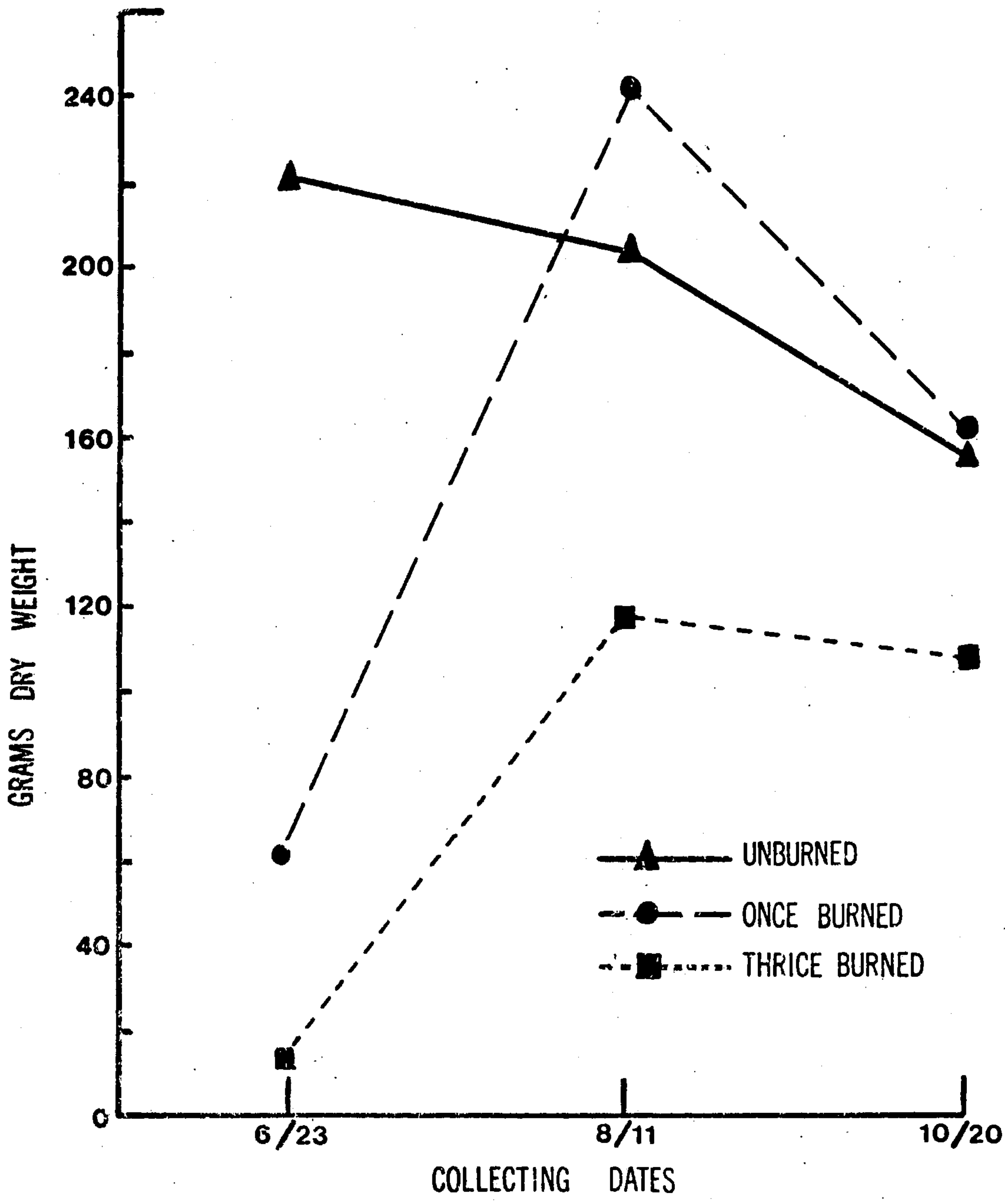

Figure 15. Mean Dry Total Plant Weights of Smilax bona-nox During the Growing Season.

subtracted from the mean biomass of the final collecting date to calculate growth.

Total plant growth of Rhus was highest in the thrice burned plots (Figure 16). This total growth was approximately 60 g. per plant greater than total growth that occurred in the control. The least total growth occurred in the once burned area. Approximately 70% of the total growth is attributed to underground growth of Rhus.

The F-test was conducted to determine the equality of means of growth for Rhus for each treatment. All growth values are significantly different at the 5% confidence level.

In all of the plant parts of Rhus, the most growth occurred in the thrice burned plots with one exception. No growth occurred for the inflorescence. A negative 9.3 g per plant growth for leaves occurred in the once burned area. This is indicative of dropping or insect consumption of leaves.

Total plant growth of Smilax was highest in the once burned area (Figure 17). Total growth in the thrice burned plots was even higher than the control. Most surprising is a negative total growth of Smilax in the control. This loss occurred primarily in the underground portion and leaves.

The F-test was conducted and indicated a significant difference exists between treatments for mean values of total growth of Smilax at the 5% confidence level.

The plant parts of Smilax showed some high values and some negative values for growth. Negative growth occurred in the control for both the underground portion and leaves. Only a slight negative growth occurred for the leaves in the once burned area. All other parts showed some

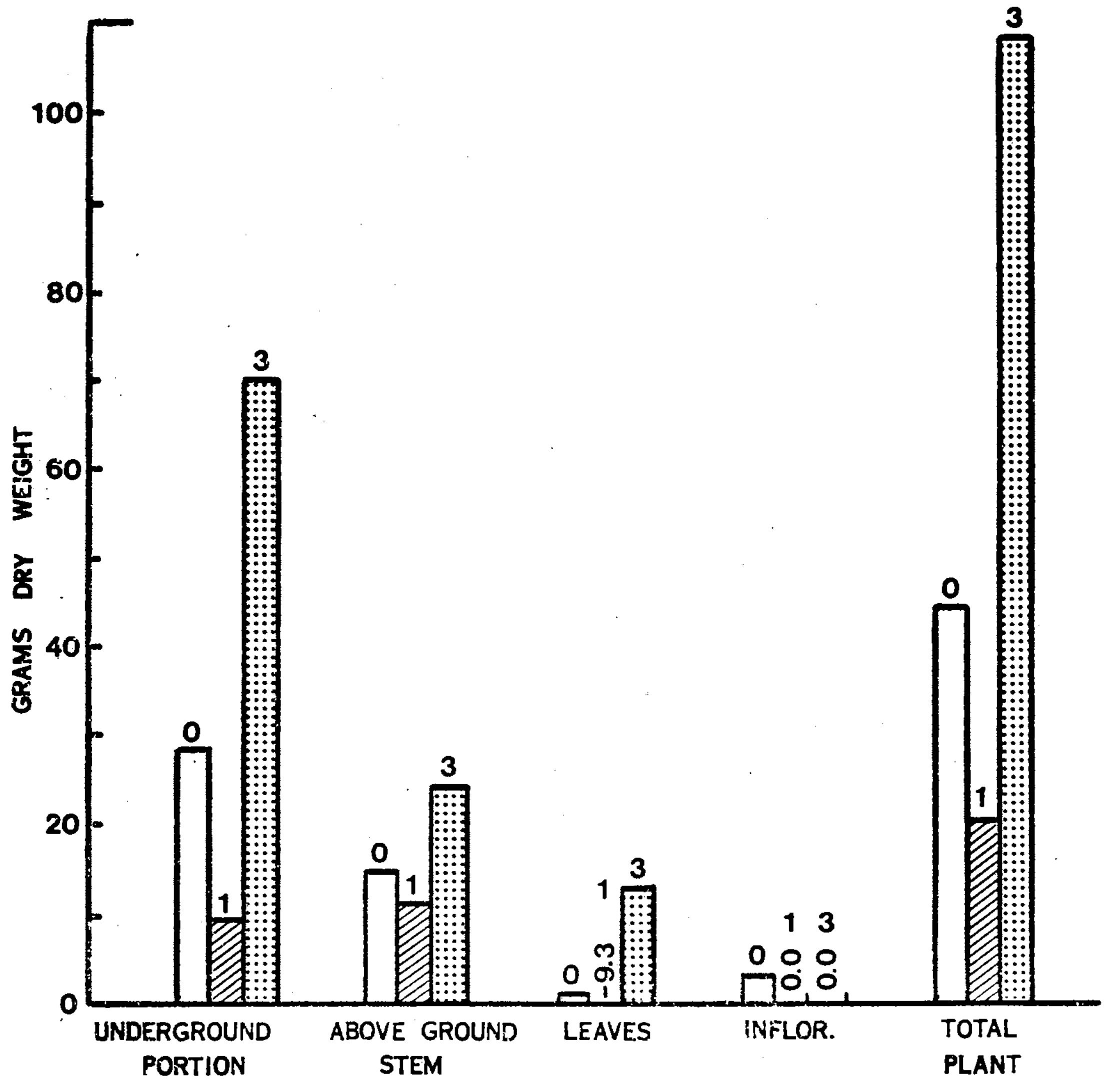

Figure 16. Average Growth of Rhus glabra in the Control (0), the Once Burned (1), and Thrice Burned (3) Treatments.

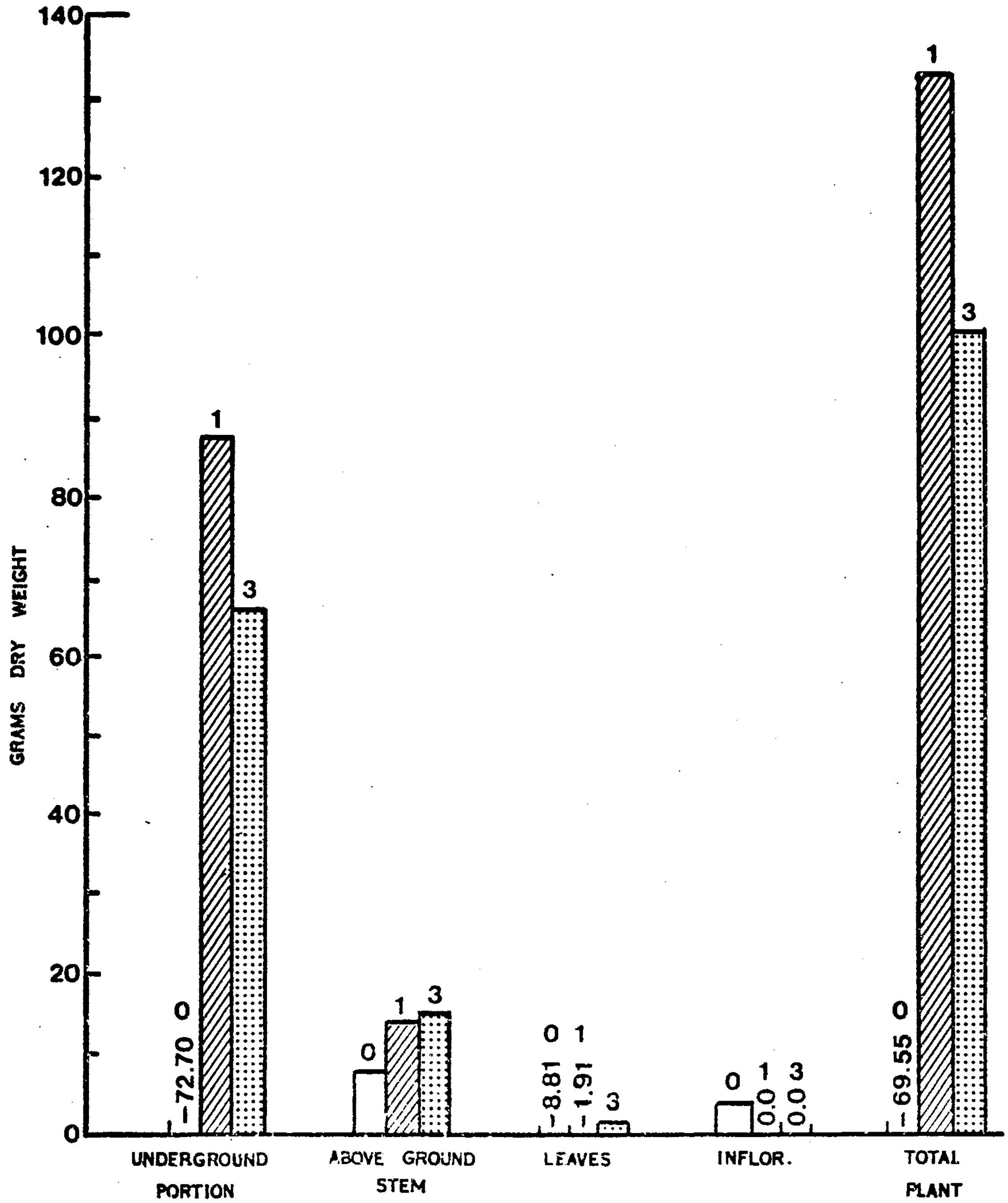

Figure 17. Average Growth of <u>Smilax</u> <u>bona-nox</u> in the Control (0), the Once Burned (1), and Thrice Burned (3) Treatments.

growth with the most growth occurring in the underground portion of *Smilax*. No growth was observed for the inflorescence in either burned treatments.

CHAPTER V

CONCLUSIONS

Fire can exert its effect on vegetation by direct damage to the plant or indirectly by altering the environment in which the plant grows. One aspect of that environment is available moisture to the plant. Daubenmire, 1968, sums it up by saying that a fire can decrease soil moisture in the grassland and thus reduce available moisture to the plant. No important differences were detected after extensive soil moisture measurements in the unburned and burned areas. Therefore, low water availability is probably not a substantial indirect effect of fire in this study.

Biomass measurements and growth calculations indicate that fire does affect the growth of *Rhus* and *Smilax*. *Rhus* is clearly set back after one burn, however, *Smilax* seems to recover rather well after one burn.

It was expected that repeated annual burning would severely cut back the growth of these two woody species. Contrary to this belief *Rhus* that had been burned three successive years grew better than *Rhus* that had not been burned. This suggests that *Rhus* may adapt to repeated burning. *Smilax* performed as hypothesized, that is, repeated fires reduced growth.

The underground portion of both *Rhus* and *Smilax* contributed the majority of growth. Increased root biomass can be due to the removal of competition or to an increase in leaf surface giving more photosynthate (Hadley and Kieckhefer, 1963). If the latter is true, then a beneficial adaptation of plants to fire would be to funnel a large proportion of its photosynthate to the underground portion. This storage accumulation would insure enough energy being available for regrowth after a fire. I believe it is this adaptive feature which enables Rhus to survive repeated burning.

It is my opinion that fire does one other thing which can aid a plant's growth. There was a noteable negative growth of Smilax that was unburned. Smilax that was burned had positive growth. Plants of Smilax that were unburned had a large proportion of non-photosynthetic tissue. Fire can destroy that tissue and the plant starts anew without the respiratory burden of non-green stem tissue. Fire, therefore, may aid Smilax by reducing its respiratory burden.

Another possibility is that Smilax plants in the control are actively spreading underground. They are building new rhizomes and corms by depleting the old ones. Thus, overall growth is positive, but the part measured is negative. In burned sites the plants are stimulated by the loss of the tops to stop the underground spreading process and replenish the reserves in the corms. This gives the positive growth values that were measured.

Studies of fire effects on the herbaceous vegetation of the prairie have shown that Andropogon gerardi and Andropogon scoparious increased flower production after burning (Dix and Butler, 1954). Neither woody species in this study produced flowers after burning. This difference probably merely reflects the difference in the general nature of woody and herbaceous plants.

Fire was expected to reduce the growth of both Rhus and Smilax. Repeated fires were expected to further reduce it. This study produced results contrary to the original hypothesis.

Earlier studies have shown fire to be harmful to most tree species in prairies giving fire the role as the maintainer of the grasslands. This study shows that this role may not be extendable to woody plants other than trees.

Some herbaceous members of the prairie are said to have adaptations which give them the advantage of surviving a fire. This is also true of some woody members such as Rhus.

Fire can also aid a plant by reducing the respiratory burden which can increase that plant's rate of growth or by stimulating the replenishment of reserves of established plants.

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