THE EFFECTS OF CARRIER, FORMULATION OF PHYTOCIDE, AND TIME OF TREATMENT ON THE REACTIONS OF CERTAIN WOODY PLANTS TO CHEMICAL SPRAYS

by

Mason C. Carter

Thesis submitted to the Graduate Faculty of the

Virginia Polytechnic Institute

in candidacy for the degree of

MASTER OF SCIENCE

in

Plant Physiology

APPROVED: APPROVED:

Director of Graduate Studies

Head of Department

Dean of Agriculture

Major Professor

August, 1956

Blacksburg, Virginia

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGMENTS

The author wishes to express his sincere appreciation to Dr. W. E. Chappell for his guidance and assistance in the planning, conducting, and reporting of this study. The author also appreciates the advice and constructive criticism he received from Dr. M. G. Hale, Dr. G. M. Shear, Mr. D. V. Smith, and Mr. C. Y. Kramer. The author wishes to thank the following persons who helped to conduct the study and to gather and tabulate the data: Mr. Robert Dowdy, Mr. Furman Walker, and Mrs. Marie Kidd. Special thanks are due Mrs. Ruth B. Carter for her help with the preparation of this paper.

The author is indebted to the F. A. Bartlett Tree Expert Company for a grant in aid which made this study possible, and to the American Chemical Paint Company for supplying the chemicals used in this study.

INTRODUCTION

The use of chemicals to reduce the growth of woody plants has been found to be cheaper and more efficient than hand cutting (Waldron, 1954; Coffey, 1955; Fisher and Meadors, 1955). Chemicals are being used to remove mesquite trees from thousands of acres of potentially good grazing land in the southwestern United States (Fisher and Meadors, 1955; Hull, 1956), and to remove certain trees and shrubs from competition with timber crops (Peevy, 1954). Utility companies are using chemicals to suppress the growth of woody plants on rights-or-way (Waldron, 1954; Coffey, 1955; White, 1955).

2,4-Dichlorophenoxyacetic acid (2,4-D) and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) are the phytocides most commonly used for the control of woody plants (Behrens et al., 1955; Melander, 1948). Different formulations of 2,4-D and 2,4,5-T produce different effects on woody plants and some new formulations appear to give better results than old ones (Meyers et al., 1955). Season of treatment and stage of growth of the plant are also important factors affecting the reactions of woody plants to phytocides (Beatty, 1955; Suggitt, 1952;

Fisher et al., 1956). Recent reports indicate that phytocides are more effective when applied in a carrier consisting of nine parts water and one part diesel oil than when applied in water alone (Beatty, 1955; Bramble, 1955).

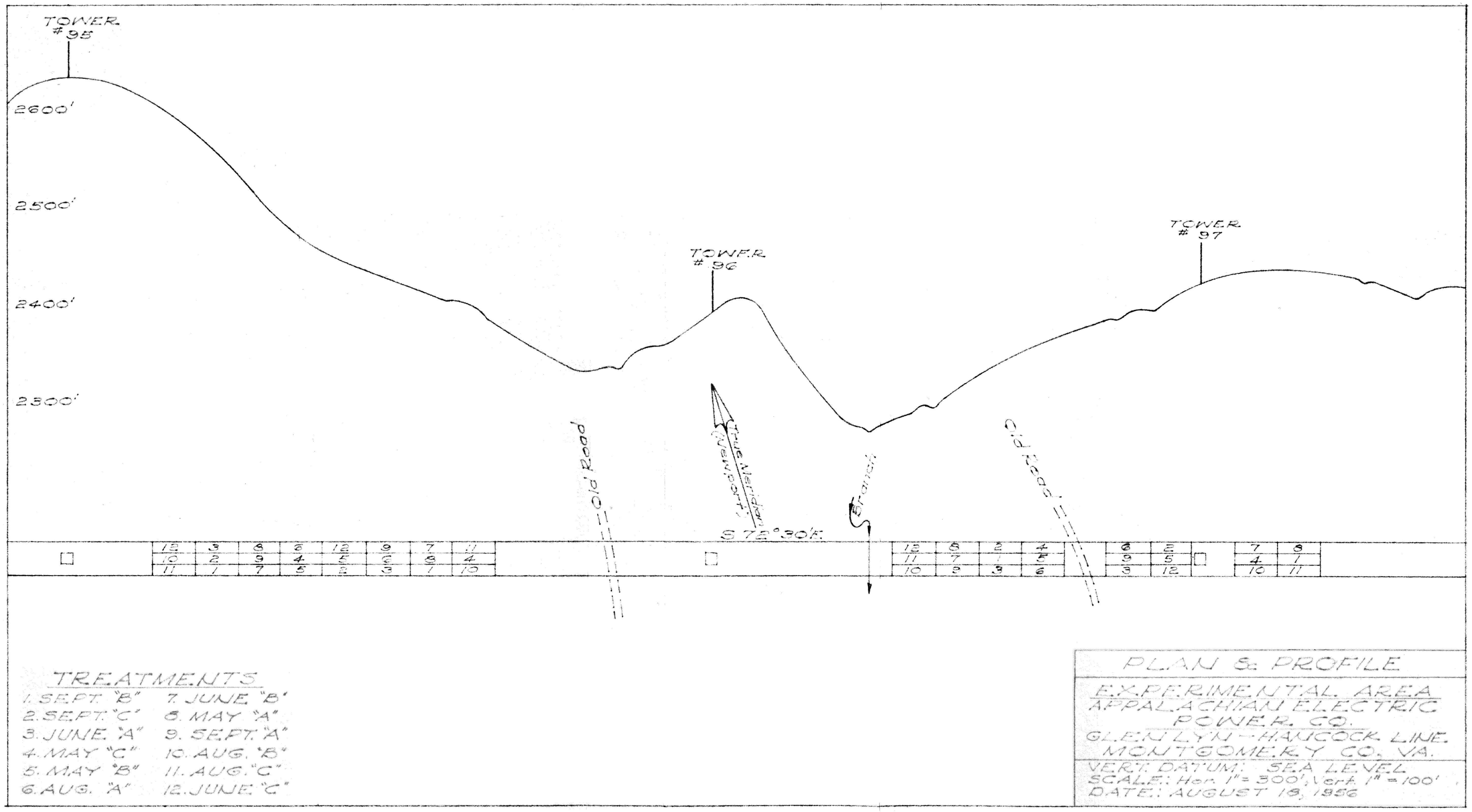
In the present investigation an experiment was designed to compare sprays applied during four different months of the growing season, to compare two different formulations of a phytocide, and to compare a water carrier with an oil-water carrier.

METHODS AND MATERIALS

The experimental area was located on the Appalachian Electric Power Company's Glen Lyn-Hancock transmission line right-of-way in Montgomery County, Virginia, one mile north of the main highway between Blacksburg and Newport. The plots began 264 feet east of tower #95 and extended eastward (Figure 1). The 100-foot right-of-way was divided into three 33-foot strips which were subdivided into 132 foot lengths making each experimental plot 4356 square feet or 1/10th acre in area.

The site of the experiment was an east facing slope and flat area with an average elevation of approximately 2400 feet. The right-of-way was cleared in 1952 by cutting and burning. During the winter of 1952-1953 the area was stump sprayed with a spray mixture consisting of 8 pounds of acid equivalent of a 2,4-D - 2,4,5-T combination per 100 gallons of No. 2 fuel oil. The stump spray was not successful and abundant sprouting occurred. Oak-Hickory is the climax forest type of the area and various stages of succession existed at the time the experiment was begun.

Figure 1 - Drawing of the experimental area showing the plot layout.



In the investigation, an experimental phytocide formulation, ACP-L-578, was compared with a commercial phytocide formulation, Weedone Industrial Brushkiller. These two formulations differed in the kinds and amounts of emulsifying agents and solvents they contained but not in the amount or form of the active ingredients, 2,4-D and 2,4,5-T. Both formulations contained the acid equivalent of 2 pounds of 2,4-D and 2 pounds of 2,4,5-T per gallon in the form of butoxy ethanol esters. An oil-water carrier was compared with a water carrier by applying ACP-L-578 in each of these carriers. The three sprays used were as follows:

"A" - ACP-L-578
6 lbs. acid equivalent in 10 gallons of No. 2 fuel oil and 90 gallons of water.

"B" - ACP-L-578
6 lbs. acid equivalent in 100 gallons of water.

"C" - Weedone Industrial Brushkiller
6 lbs. acid eauivalent in 100 gallons of water.

To compare the differences in time of treatment, the three spray materials were applied in May, June, August, and September of 1955 between the 23rd and 26th of each month.

The sprays were applied with a gasoline powered pump delivering seven gallons per minute at 350 psi. The pump and motor were mounted on a truck (Figure 2) and equipped with 300 feet of hose. Thorough wetting of the aerial parts of all woody plants on the experimental area was accomplished by applying an average of 275 gallons of spray material per acre.

The experiment was originally designed as a 3 x 4 rectangular lattice (Cochran and Cox, 1953) with 12 treatments and four replications making a total of 48 experimental plots. This design was abandoned when it was found that block adjustments were unnecessary and that the 12 treatments had to be considered separately instead of being grouped into months and sprays. The experiment was then considered to be a 3 x 4 factorial in randomized blocks. This design made analysis and interpretation of the results much easier.

The vegetation on the experimental area was sampled by running transects and tagging individual sprouts or sprout clumps on each of the experimental plots. The transects were used to sample the sprouts which were randomly distributed such as the sprouts of all species together or the sprouts of the root suckering species,

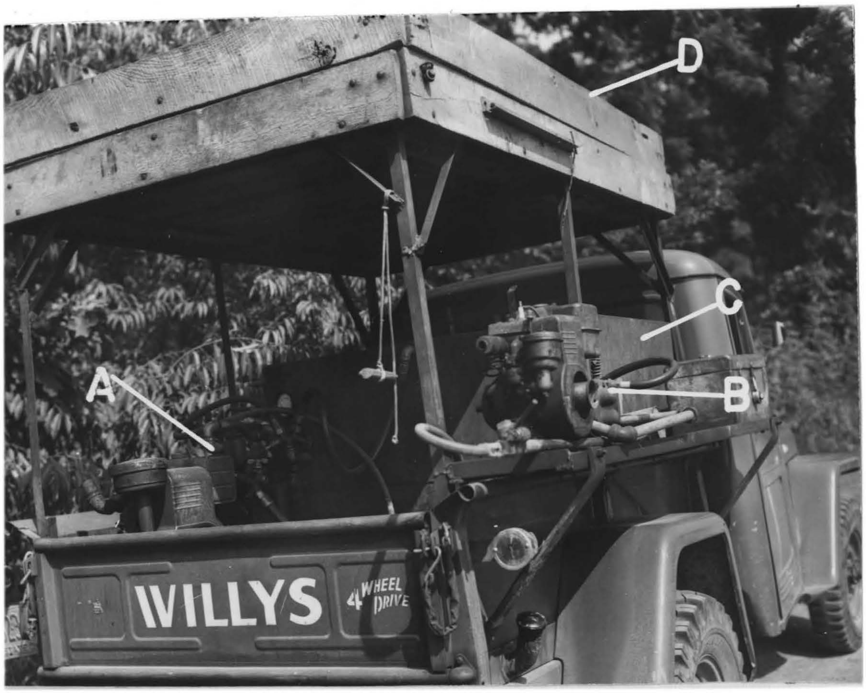


Figure 2 - Photograph of the spray truck showing, A, the spray motor and pump; B, the refill pump; C, the supply tank; and D, the rack for carrying the spray hose.

sassafras and black locust. Sprouts of chestnut oak, red oak, red maple, and black gum which arise principally from the root crown area are clumped rather than randomly distributed and could be sampled more accurately by tagging individual sprouts or sprout clumps. Other species present were few in numbers and were not studied separately.

Transects were formed by placing a stake at each end of a plot and passing a line down the center of the plot between the two stakes. A wooden rod, 3.3 feet long with a metal ring at the center was attached to the line by the ring. The rod was passed along the line between the two stakes and all of the sprouts of tree species growing within the projection of the rod were recorded by species and number. The area in each transect was 1/100th acre or 1/10th the area of each experimental plot. When a transect was completed, the end stakes were replaced with smaller stakes so that the areas could be relocated for future transects. Five sprouts or sprout clumps of chestnut oak, red oak, red maple, and black gum were tagged on each plot with numbered aluminum tags attached with aluminum wires. The frequency and density of the major species on the area appear in Table 1 and a list of all the species recorded on the transects appears in Table 2.

Table 1 - The density and frequency[1] of the major species on the experimental area.

	Density Stems/acre	Frequency %
Chestnut oak (Quercus Prinus)	1050	90
Red oaks (Quercus spp.)	1200	96
Black locust (Robinia pseudoacacia)	840	73
Black gum (Nyssa sylvatica)	1700	96
Sassafras (Sassafras albidum)	2100	100
Red maple (Acer rubrum)	600	70

1 Frequency is the percentage of the 48 transects in which the species occurred.

The transects were run in the summer of 1955 and again in the summer of 1956. The tagging of individual sprouts was done in the summer of 1955 and the tagged sprouts were inspected again in the summer of 1956. Collection of the data was completed on June 23, 1956.

The following information was recorded about the tagged sproute clumps: the species; the number of sprouts; the visually estimated height and diameter of the sprouts; the condition of the sprouts, i.e., living

Table 2 - A list of the species of the woody plants recorded on the transects. Names taken from Gray's Manual of Botany, 8th edition (Fernald, 1950).

COMMON NAME	BOTANICAL NAME
Chestnut oak	*Quercus Prinus*
White oak	*Quercus alba*
Red oaks	*Quercus rubra*, *Q. velutina* *Q. coccinea*
Bear oak, scrub oak	*Quercus ilicifolia*
Sassafras	*Sassafras albidum*
Hickory	*Carya* spp.
Black gum	*Nyssa sylvatica*
Shadbush	*Amelanchier canadensis*
Aspen	*Populus grandidentata*
Pine	*Pinus virginiana*, *P. pungens* *P. ridgida*
Chestnut	*Castanea dentata*
Red maple	*Acer rubrum*
Smooth sumac	*Rhus glabra*
Staghorn sumac	*Rhus typhrina*
Dogwood	*Cornus florida*
Chinquapin	*Castanea pumila*
Sourwood	*Oxydendrum abordum*
Black locust	*Robinia pseudoacacia*

or dead; and the number of resprouts. The condition of a sprout was determined by using a pocket knife and making several cuts at various heights on the sprout through the external tissues into the xylem. If all the tissues exposed by these cuts three inches above ground level were brown and dead, the sprout was recorded as dead. If any of the tissues three inches above the ground appeared green and living, the sprout was recorded as living (Figure 3). Any new growth occurring along the sprout below a point three inches from the ground or from some point on the root system was considered a resprout. On the transects the same definitions of living and dead sprouts and resprouts were used but only the living old sprouts and resprouts were recorded.

The data on red maple and black locust could not be analyzed statistically. Red maple was not present on 10 of the 48 experimental plots and the data on this species were considered insufficient for analysis. Most of the black locust in the plots sprayed in June, August, and September were defoliated by drift from earlier treatments. Since the effect of prior defoliation on the reaction of black locust to the intended treatment could

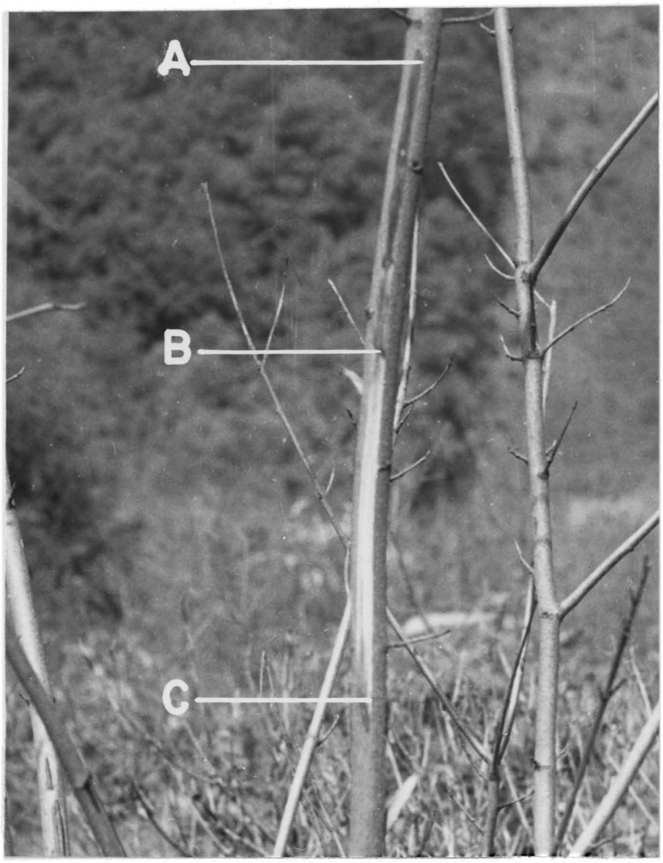


Figure 3 - Photograph of a sprout of red maple (<u>Acer rubrum</u>) showing the tissues exposed by a knife cut. Tissues which appeared as those from A to B were considered dead. Tissues which appeared as those from B to C were considered living. This sprout was considered living because living tissues were found above a point three inches from ground level.

not be determined, no attempt was made to measure the effectiveness of the treatments on this species. Spray drift had no noticeable effect on any other species.

The percentage of the tagged sprouts killed was calculated for chestnut oak, red oaks, and black gum. These calculations consisted of dividing the number of dead sprouts by the number of sprouts before spraying and multiplying by 100. For example, in treatment June "A", first replication, there were 21 sprouts in the five tagged clumps of chestnut oak, of which 5 were dead. The percentage killed was 5/21 x 100 or 24 per cent.

The number of black locust sprouts was subtracted from the total number of sprouts on each transect before the percentages killed were calculated. For example, the transect on treatment May "B", third replication, contained 71 sprouts before spraying of which 5 were black locust; after spraying there were 6 sprouts living of which 3 were black locust. Subtraction of the black locust sprouts gave a before spraying total of 66 and an after spraying total of 3. The percentage killed was 63/66 x 100 or 95 per cent.

All percentages were transformed to arc sine values according to Table 16.8 in Snedecor (1948) before any analyses were made.

The data on percentages killed were analyzed according to the factorial design and significant means were compared by the multiple range and multiple F tests as described by Duncan (1955). A comparison of the number of resprouts per plot could not be made without considering the original number of sprouts per plot. Therefore, the resprout data were analyzed by the analysis of covariance with the number of sprouts before spraying as the X-variable and the number of resprouts as the Y-variable. A multiple range and multiple F test was performed on significant means.

RESULTS

The effects of the treatments on chestnut oak are shown in Table 3. The sprays applied in May and June gave significantly higher kills of this species than the sprays applied in August and September. The resprouting of chestnut oak occurring in the plots sprayed in August and September was sparse due to the poor top kills and was not comparable with the resprouting occurring in the plots sprayed in May and June. The three sprays were not significantly different with respect to the percentage of chestnut oak killed or the number of chestnut oak resprouts.

Table 3 - The percentage of sprouts killed and number of resprouts of chestnut oak for all treatments.

Month of Treatment	No. of Sprouts Before Spraying	Percentage Killed 1/	No. of Resprouts 1/ 2/
May	363	29.0 - a	274 - a
June	462	28.0 - a	443 - a
August	262	6.3 - b	65
September	330	2.4 - b	23

Table 3 - Continued.

Spray	No. of Sprouts Before Spraying	Percentage Killed 1/	No. of Resprouts 1/
"A"	459	16.0 - a	257 - a
"B"	484	17.6 - a	247 - a
"C"	474	15.6 - a	297 - a

1/ Two figures followed by the same letter are not significantly different while two figures followed by different letters are significantly different. Comparisons of significance should be made within the columns and not between the columns.

2/ Figures not followed by letters are not comparable with the other figures in the column.

Significantly higher kills of red oak resulted from the May treatments than from the June, August, and September treatments. Also, the June treatments gave significantly higher kills of red oak than the August and September treatments. The May sprayed plots contained significantly fewer red oak resprouts than the June sprayed plots. No comparisons could be made between the number of red oak resprouts in the May and June sprayed plots and the number in the August and September sprayed plots because of the low percentages killed in the August and September sprayed plots. There were no significant differences in the percentages killed or the amount of resprouting resulting from the three sprays. The effects of treatments on red oak appear in Table 4.

Table 4 - The percentage of sprouts killed and number of resprouts of red oak for all treatments.

Month of Treatment	No. of Sprouts Before Spraying	Percentage Killed 1/	No. of Resprouts 1/ 2/
May	273	86.2 - a	61 - a
June	257	59.8 - b	157 - b
August	312	10.0 - c	32
September	314	2.0 - c	12

Spray	No. of Sprouts Before Spraying	Percentage Killed 1/	No. of Resprouts 1/
"A"	395	38.5 - a	90 - a
"B"	387	36.2 - a	88 - a
"C"	374	43.9 - a	84 - a

1/ Two figures followed by the same letter are not significantly different while two figures followed by different letters are significantly different. Comparisons of significance should be made within the columns and not between the columns.

2/ Figures not followed by letters are not comparable with the other figures in the column.

The percentage of black gum killed in June was significantly higher than the percentages killed in May and September but not significantly higher than the percentage killed in August. Black gum resprouts were found only in the plots sprayed in May and the number there was significantly different from zero. The three sprays were not significantly different with respect to the percentages of black gum killed or the number of black gum resprouts. Table 5 contains the data on black gum.

Table 5 - The percentage of sprouts killed and the number of resprouts of black gum for all treatments.

Month of Treatment	No. of Sprouts Before Spraying	Percentage Killed 1/	No. of Resprouts 1/
May	101	78.3 - b	33 - b
June	113	98.0 - a	0 - a
August	102	88.4 - ab	0 - a
September	102	50.0 - c	0 - a

Table 5 - Continued.

Spray	No. of Sprouts Before Spraying	Percentage Killed 1/	No. of Resprouts 1/
"A"	137	81.3 - a	3 - a
"B"	137	76.5 - a	10 - a
"C"	144	78.1 - a	20 - a

1/ Two figures followed by the same letter are not significantly different while two figures followed by different letters are significantly different. Comparisons of significance should be made within the columns and not between the columns.

May, June, and August sprays were equally effective on sassafras. The percentages of sassafras killed by the September sprays were significantly lower than the percentages killed by the sprays applied earlier in the season. There were no significant differences between the months with respect to the resprouting of sassafras. The three sprays were equally effective on sassafras. Table 6 shows the reactions of sassafras to the different treatments.

Table 6 - The percentage of sprouts killed and the number of resprouts of sassafras for all treatments.

Month of Treatment	No. of Sprouts Before Spraying	Percentage Killed 1/	No. of Resprouts 1/
May	302	100.0 - a	187 - a
June	242	100.0 - a	113 - a
August	208	92.3 - a	264 - ab
September	280	72.0 - b	483 - b

Spray	No. of Sprouts Before Spraying	Percentage Killed 1/	No. of Resprouts 1/
"A"	297	92.3 - a	335 - a
"B"	346	87.5 - a	381 - a
"C"	389	93.3 - a	331 - a

1/ Two figures followed by the same letter are not significantly different, while two figures followed by different letters are significantly different. Comparisons of significance should be made within the columns and not between the columns.

Table 7 shows the effect of treatments on all species. Each month was significantly different from all other months with respect to the percentage of all species killed. The highest percentage killed occurred in May and the lowest occurred in September. There were no significant differences in the number of resprouts in the plots sprayed in the different months.

The three sprays were equally effective on all species together.

Table 7 - The percentage of sprouts killed and number of resprouts of all species except black locust for all treatments.

Month of Treatment	No. of Sprouts Before Spraying	Percentage Killed 1/	No. of Resprouts 1/
May	994	94.1 - a	439 - a
June	929	87.8 - b	393 - a
August	1017	77.5 - c	473 - a
September	1161	63.7 - d	692 - a
Spray	**No. of Sprouts Before Spraying**	**Percentage Killed 1/**	**No. of Resprouts 1/**
"A"	1225	81.8 - a	598 - a
"B"	1432	79.9 - a	696 - a
"C"	1444	80.6 - a	703 - a

1/ Two figures followed by the same letter are not significantly different, while two figures followed by different letters are significantly different. Comparisons of significance should be made within the columns and not between the columns.

A summary of the results of this investigation appears in Table 8. To simplify the interpretation of the data a new set of figures, % Resprout, was used. These figures were derived by dividing the number of resprouts by the number of sprouts before spraying and multiplying by 100.

Table 8 - Summary of the percentages killed
and percentages resprouting by
species for all treatments.

Table 8 - Summary of the percentages killed and percentages resprouting[1] by species for all treatments.

Month of Treatment	Chestnut oak		Red oak		Black gum		Sassafras		All species 2/	
	% Killed	% Resprout	% Killed	% Resprout	% Killed	% Resprout	% Killed	% Resprout	% Killed	% Resprout
May	29.0 - a	75.4 - a	86.2 - a	22.3 - a	78.3 - b	32.6 - b	100.0 - a	61.9 - a	94.1 - a	44.1 - a
June	28.0 - a	95.8 - a	59.8 - b	61.0 - b	98.0 - a	0.0 - a	100.0 - a	46.6 - a	87.8 - b	42.3 - a
August	6.3 - b	24.8	10.0 - c	10.2	88.4 - ab	0.0 - a	92.3 - a	126.9 - ab	77.5 - c	46.5 - a
September	2.4 - b	6.9	2.0 - c	3.8	50.0 - c	0.0 - a	72.0 - b	172.6 - b	63.7 - d	59.6 - a

Spray	Chestnut oak		Red oak		Black gum		Sassafras		All species 2/	
	% Killed	% Resprout	% Killed	% Resprout	% Killed	% Resprout	% Killed	% Resprout	% Killed	% Resprout
"A"	16.0 - a	55.9 - a	38.5 - a	22.7 - a	81.3 - a	2.1 - a	92.3 - a	112.7 - a	81.8 - a	48.0 - a
"B"	17.6 - a	51.0 - a	36.2 - a	22.7 - a	76.5 - a	7.2 - a	87.5 - a	110.1 - a	79.9 - a	48.6 - a
"C"	15.6 - a	62.6 - a	43.9 - a	22.4 - a	78.1 - a	13.9 - a	93.3 - a	85.0 - a	80.6 - a	48.6 - a

Two figures followed by the same letter are not significantly different, while two figures followed by different letters are significantly different. Comparisons of significance should be made within the columns and not between the columns. Figures in the % Resprout columns which are not followed by a letter are not comparable with the other figures in that column due to the low corresponding percentage killed.

1/ Percentage resprouting is derived by dividing the number of resprouts by the number of sprouts before spraying and multiplying by 100.

2/ Except black locust.

DISCUSSION

In the present investigation early season treatment gave better root and top kills than late season treatments, except for the fact that mid-season treatments of black gum gave better results than early or late season treatments. These results support the conclusions of Fisher et al. (1956) and Suggitt (1952) that season of treatment and stage of growth of the plant have a major effect on the reactions of woody plants to 2,4-D and 2,4,5-T. Season of treatment and stage of growth must affect the absorption, translocation, or physiological activity of the phytocides and produce variations in the effectiveness of the phytocides.

2,4-D and 2,4,5-T applied as foliage sprays enter plant leaves principally by passage through the cuticle (Weaver and De Rose, 1946). Therefore, the thickness and composition of the cuticle affect the absorption of the phytocide. Crafts (1953) states that young leaves have a thin cuticle which is very permeable to applied materials, but as leaves mature the cuticle becomes thicker and less permeable. Possibly the cuticles of young, growing leaves possess permeable, immature zones which phytocides can penetrate rapidly (Schieferstein and Loomis, 1956). Differences in the permeability of the leaf cuticle may have resulted in greater absorption of 2,4-D and 2,4,5-T by young leaves than by old, thus bringing about the variations between times of treatment.

Season of treatment and stage of growth may cause variations in the effectiveness of 2,4-D and 2,4,5-T by influencing the movement of carbohydrates. Since 2,4-D and 2,4,5-T are known to move principally in the carbohydrate transport system of the phloem (Mitchell and Brown, 1946; Linder et al., 1949; Weintraub and Brown, 1950), any seasonal variations in the rate or direction of carbohydrate transport would be expected to affect the transport and distribution of applied phytocides. Meyer and Anderson (1952) state that when active growth is occurring, the majority of the carbohydrates produced in plant leaves are transported to the regions of meristematic activity and rapid growth in the root and stem tips and the cambial areas, but when active growth subsides the majority of the carbohydrates are transported downward and accumulate in the stem. The meristematic activity in most woody plants lasts for

46 to 113 days and declines sharply after the middle of August in most temperate regions (Busgen et al., 1929). Therefore, phytocides applied in the early part of the summer should be transported to the regions of merstematic activity while those applied late in the season should accumulate in storage tissues. Fisher et al., (1956) report that maximum translocation of 2,4,5-T in mesquite plants occurs during a period of 50 to 90 days after the first leaves emerge in the spring. Also, young, incompletely differentiated, actively growing tissues are more susceptible to 2,4-D and 2,4,5-T than mature storage cells (Leopold, 1955), and it seems logical that destruction of meristematic tissues would have a greater permanent effect on a plant than destruction of certain storage cells. On the basis of these facts, the high percentages killed by the early season treatments and the low percentages killed by late season treatments are understandable. Black gum which reacted differently from the other species may begin active growth later and continue such growth longer than most of the other species, thus being more susceptible to mid-season treatments than to early or late season treatments.

There was no significant difference in the effectiveness of the oil-water spray, "A", and the water spray, "B", used in this investigation. These findings do not agree with other investigators (Beatty, 1955; Crafts, 1953) who concluded that an oil-water spray was superior to an aqueous spray. Experimental results presented by Bramble (1955) indicated that an oil-water spray gave better results than an aqueous spray, but the oil-water spray used by Bramble contained 6 pounds of 2,4-D and 2,4,5-T in acid form while the water spray contained 4 pounds of 2,4-D and 2,4,5-T in ester form. The advantages of the oil-water spray could have been due to the concentration or form of the phytocide. Gertsch (1953) reported that 2,4-D was more effective when applied in an oil-water emulsion than when applied in water alone. The oil used by Gertsch, however, was a non-phytotoxic horticultural oil which may have produced different results from the No. 2 fuel oil used in the present investigation. Fisher et al., (1956) found that 2,4,5-T applied in a No. 2 fuel oil-water emulsion was not appreciably more effective than 2,4,5-T applied in water alone.

It has been shown that the absorption and translocation of 2,4-D and 2,4,5-T are greater if the phytocides are applied in a straight oil carrier rather than in a water carrier (Penfound and Minyard, 1947; Rice and Rohrbaugh, 1953; Leonard, 1956). Increased absorption is probably due to a saturation of the lipophilic capacity of the leaf cuticle by the oil which leaves the phytocide free to enter the leaf (Crafts, 1953) while the increased translocation may be due to the intercellular creeping of the oil and phytocide independent of the vascular system (van Overbeek, 1956; Leopold, 1955). These reports indicate that an oil carrier is superior to a water carrier for 2,4-D and 2,4,5-T but they do not mean that an oil-water emulsion carrier combines the effectiveness of an oil carrier with the economy of a water carrier. No oil-water emulsion has the affinity for plant surfaces that oil has (Crafts and Reiber, 1948).

In order to be effective, an oil-water carrier must separate rapidly upon reaching a plant surface, leaving most of the 2,4-D and 2,4,5-T in a film of oil (Crafts, 1953). Strong emulsions such as those formed by ACP-L-578 break down slowly, often requiring several hours for complete separation (Carter, unpublished). Also, most of the 2,4-D and 2,4,5-T may not remain with the oil when the emulsion breaks. The esters of 2,4-D and 2,4,5-T are soluble in oil and in the emulsifier used in ACP-L-578, but the emulsifier is only slightly soluble in the oil. When an oil-water emulsion of ACP-L-578 breaks, three separate layers appear - a top layer of oil; a middle layer of a thick, creamy emulsion; a bottom layer of cloudy water (Carter, unpublished). Since most of the emulsifier is probably in the middle layer, most of the 2,4-D and 2,4,5-T may also be in the middle layer and not in the oil. If this occurs, the advantages of an oil carrier are eliminated.

The phytotoxicity of many oils is increased by emulsifying them in water (Dallyn and Sweet, 1951). Since straight No. 2 fuel oil is quite phytotoxic (Crafts and Reiber, 1948), the oil-water emulsion of this oil used in the present investigation may have been so phytotoxic that the conducting tissues of the treated plants were damaged to a point that translocation of the phytocide was impeded.

If an oil-water emulsion is a more effective carrier of 2,4-D and 2,4,5-T than water, the differences in effectiveness are not apparent one year after treatment in the present investigation. The root kill on the plots receiving the oil-water spray may improve until they are significantly better than the root kill on the plots receiving the water spray; however, more work should be done with an oil-water emulsion before it is accepted as superior to water as a carrier for 2,4-D and 2,4,5-T.

Meyers et al. (1955) found that Weedone Brushkiller L-329, a chemical very similar to ACP-L-578, gave better results on certain woody plants than Weedone Industrial Brushkiller. The results of the present investigation do not support the conclusions of Meyers et al., because Weedone Industrial Brushkiller proved equally as effective as ACP-L-578. Weedone Industrial Brushkiller and ACP-L-578 contained equal amounts of the butoxy ethanol esters of 2,4-D and 2,4,5-T and were applied at the same concentrations. The two formulations differed in the types and amounts of additives (such as emulsifying and wetting agents) that they contained. Hull (1956) showed that such additives may either increase or decrease the effectiveness of 2,4,5-T amine depending upon the amount and chemical structure of the additives used. Gertsch (1953) found that each of several emulsifying agents increased the effectiveness of 2,4-D amine, but had no influence on the effectiveness of 2,4-D ester. Leopold (1955) reported that emulsifying and wetting agents, " - - apparently permit the entry of polar acids and salts by normally non-polar pathways" (through the cuticle), - - "such carriers have no beneficial effect upon the absorption of non-polar formulations such as esters of auxins", (2,4-D and 2,4,5-T). On the basis of these findings, the large amounts of emulsifying and wetting agents contained in ACP-L-578 would not be expected to increase the effectiveness of the butoxy ethanol esters of 2,4-D and 2,4,5-T in the formulation.

SUMMARY

The time of treatment greatly influenced the reactions of woody plants to the phytocides used in this investigation. In general, all of the species of woody plants studied were more susceptible to 2,4-D and 2,4,5-T at the time of the May treatments than they were at the time of any other treatments. The only exception to this statement was black gum which appeared to be more susceptible to 2,4-D and 2,4,5-T in June and August than in May.

The oil-water spray, "A", did not prove to be more effective than the water spray, "B", one year after treatment. The two sprays were equally effective at each of the four times of treatment and on each of the species studied.

No differences were apparent between ACP-L-578 and Weedone Industrial Brushkiller. These two formulations gave similar results at each of the times of spraying and on each of the species studied.

Further observations of the experimental area are planned for 1957 and 1958, and the final results of the investigation will be reported elsewhere.

LITERATURE CITED

BEATTY, R. H. 1955. Proc. Chem. Brush Control Conf. Penn. State Uni.:1-7.

BEHRENS, R., C. E. FISHER, AND C. H. MEADORS. 1955. A mesquite seedling test for screening herbicides. Proc. 8th South. Weed Conf.:275.

BRAMBLE, W. C. AND W. R. BYRNES. 1955. Effects of certain common brush control techniques and materials on game food and cover on a power line right-of-way. No. 2. Progress Report No. 135. The Penn. State Uni. Agri. Expt. Sta., University Park, Pa.

BUSGEN, M., E. MUNCH, AND T. THOMSON. 1929. The Structure and Life of Forest Trees. John Wiley and Sons, Inc., New York:98-104.

COCHRAN, W. G. AND G. M. COX. 1953. Experimental Design. John Wiley and Sons, Inc., New York:274-313.

COFFEY, W. J. 1955. Planning and programming and brush control. Down to Earth. Vol. II(1):10-12.

CRAFTS, A. S. 1953. Herbicides, their absorption and translocation. Agri. and Food Chem. Vol. I(1):51-55.

CRAFTS, A. S. AND H. G. REIBER. 1948. Herbicidal properties of oils. Hilgardia. Vol. 18:77-156.

DALLYN, S. L. AND R. D. SWEET. 1951. Theories on the herbicidal action of petroleum hydrocarbons. Am. Soc. Hort. Sci. Vol. 57:347-354.

DUNCAN, D. B. 1955. Multiple range and multiple F tests. Biometrics. Vol. II(1):1-42.

FERNALD, M. L. 1950. Gray's Manual of Botany, 8th Edition. American Book Company, New York.

FISHER, C. E. AND C. H. MEADORS. 1955. Why brush control? Proc. 8th South. Weed Conf.:229-232.

____________________, AND R. BEHRENS. 1956. Some factors that influence the effectiveness of 2,4,5-trichlorophenoxyacetic acid in killing mesquite. Weeds, Vol. IV(2):139-147.

GERTSCH, M. E. 1953. The influence of various carriers upon the inhibitory effectiveness of 2,4-D sprays. Weeds. Vol. II:1:33-42.

HULL, H. M. 1956. Studies on herbicidal absorption and translocation in velvet mesquite seedlings. Weeds. Vol. VL:1:22-42.

LEONARD, O. A. 1956. Effect of additives on the herbicidal effectiveness of 2,4-dichlorophenoxyacetic acid. Abstract. Plant Physiol. Vol. 31, Supplement:xxi-xxii.

LEOPOLD, A. C. 1955. Auxins and Plant Growth. University of California Press, Berkeley:147.

LINDER, P. J., J. W. BROWN, AND J. W. MITCHELL. 1949. Movement of externally applied phenoxy compounds in bean plants in relation to conditions favoring carbohydrate translocation. Bot. Gaz. 110:628-632.

MELANDER, L. W. 1948. Resume of 1948 progress made in research on eradication of woody plants. 5th North Central Weed Conf.:VI.

MEYER, B. S. AND D. B. ANDERSON. 1952. Plant Physiology. D. Van Nostrand Company, Inc., New York:530.

MEYERS, W. A., W. W. ALLEN, AND R. H. BEATTY. 1955. A comparison of field tests of standard and new brushkiller formulations. Proc. 9th Northeastern Weed Conf.:433-438.

MITCHELL, J. W. AND J. W. BROWN. 1946. Movement of 2,4-dichlorophenoxyacetic acid stimulus and its relation to the translocation of organic food materials in plants. Bot. Gaz. 107:393-398.

PEEVY, F. A. 1954. Woody plant control in southern forests. Proc. 7th South. Weed Conf.:261-264.

PENFOUND, W. T. AND V. MINYARD. 1947. Relation of light intensity to effect of 2,4-dichlorophenoxyacetic acid on water hyacinth and kidney bean. Bot. Gaz. 109:231-234.

RICE, E. L. AND L. ROHRBAUGH. 1953. Effect of kerosene on movement of 2,4-dichlorophenoxyacetic acid and derivatives through destarched bean plants in darkness. Bot. Gaz. 115:76-81.

SCHIEFERSTEIN, R. H. AND W. E. LOOMIS. 1956. Wax deposits on leaf surfaces. Plant Physiol. 31:240-247.

SNEDECOR, G. W. 1948. Statistical Methods. The Iowa State College Press, Ames, Iowa:449-450.

SUGGITT, J. W. 1952. Recent research in chemical brush control. Proc. North Central Weed Conf.:59-63.

van OVERBEEK, J. 1956. Absorption and translocation of plant regulators. Ann. Rev. Plant Physiol. Vol. 7:355-372.

WALDRON, C. J. 1954. Right-of-way brush control of REA borrower's pole lines. Proc. 7th South. Weed Conf.:280-283.

WEAVER, R. J. AND H. R. DeROSE. 1946. Absorption and translocation of 2,4-dichlorophenoxyacetic acid. Bot. Gaz. 107:509-521.

WEINTRAUB, R. L. AND J. W. BROWN. 1950. Translocation of exogenous growth regulators in the bean seedling. Plant Physiol. 25:140-149.

WHITE, C. W. 1955. A six year summary of brush control work in the Tennessee Valley Authority. Proc. 8th South. Weed Conf.:237-239.

The vita has been removed from
the scanned document