RESPONSES OF EASTERN RED CEDAR

(*JUNIPERUS VIRGINIANA* L.) TO

VARIOUS CONTROL PROCEDURES

By

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CHAPTER I

INTRODUCTION

The use of herbicides for brush control on Oklahoma rangeland has resulted in an increase in grass production on land previously infested with brush. However, as we are able to control some brush species, species not susceptible to the herbicide may result in infestation levels which warrant control measures.

On the other hand, some species may increase to infestation levels in areas where brush had not previously been a problem. Eastern red cedar (*Juniperus virginiana* L.) (36) is a native species increasing on Oklahoma prairie rangeland. This increase, apparently, is partially due to improper range management. Mann (21) found more cedar trees on rangeland in poor condition than on rangeland in good condition.

A county survey of the magnitude of eastern red cedar infestation in Oklahoma was conducted over the entire state in 1968. This survey indicated that approximately 350,000 acres of rangeland was infested with eastern red cedar. The main areas of infestation were found in the Northcentral to Northeastern portion of the state. The infestation in the Southeastern part of the state was minor, since eastern red cedar was unable to compete with hardwoods.

The objective of this study was to evaluate the responses of eastern red cedar to various control methods. Chemical, mechanical, and burning were the control methods studied.

CHAPTER II

LITERATURE REVIEW

Growth Habits

Eastern red cedar (*Juniperus virginiana* L.) (36) belongs to the pine family and is the most widely distributed conifer, being found in every state east of the 100th meridian (38). The wide distribution range of eastern red cedar clearly indicates its ability to grow under varying climatic conditions. It has a wide adaptation to moisture, temperature, and light conditions (14, 38).

This tree generally occurs as a mixture with other tree species in a forest type. However, pure stands do occur and are found throughout the range, particularly on abandoned farmland. It is also a major component of three additional forest types: (1) the Eastern Red Cedar-Pine type occurs throughout the southern half of its range, (2) the Eastern Red Cedar-Hardwood type occurs throughout the central part of its range, and (3) the Eastern Red Cedar-Pine-Hardwoods (38).

Eastern red cedar is a slow growing evergreen which has small inconspicuous flowers that are borne in the spring. The flowers are unisexual and are usually borne on separate plants. The male flowers are yellow and form a short catkin; the greenish female flowers are composed of three to eight pointed scales, some or all of which bear one to two ovules. The scales gradually become fleshy and unite into a berrylike cone with one or two small seeds which mature each season (39).

Ecological Factors

The wide range of distribution of eastern red cedar indicates that it grows under a variety of soil conditions. Maximum growth is obtained on deep, moist, well drained alluvial soils where its height after 50 years, may have reached 55 to 60 feet. However, they are most frequently found on shallow soils with limestone and dolomite outcrops, or other dry rocky sites where hardwoods are unable to compete with them (1, 2). The hardwoods are more serious competitors on deeper soils and eastern red cedar is often eliminated.

This species is adapted to a rather wide range of soil pH's. Natural stands have been found where the pH values ranged from 4.7 to 7.8 (2). Although it grows on slightly alkaline soil, it is not particularly alkali tolerant. In fact, in alkali tolerance tests it is rated in the least tolerant class (37). It is believed that eastern red cedar causes a change in the soil's pH. It was found that soils under dense stands were less acid than those under open stocked stands (2, 34). The pH under natural stands ranged from slightly acid to neutral while under open fields outside the natural dense stand, the pH was 5.4 and 5.0 at depths of 0 to 3 inches and 3 to 6 inches, respectively (2). Therefore, it is believed that the neutral to alkaline soil found under the natural stands are the result rather than the cause of the occurrence of eastern red cedar.

The annual precipitation within its growing region varies from 16 inches in the west to 60 inches in the south. The temperature varies considerably over its ecological range. Likewise, its growing season varies from 120 to 250 days (38).

Eastern red cedar produces a good seed crop every two or three years with light crops in the intervening years (8, 38). Many small mammals and birds feed on the fruit and aid in its dispersal and germination (2, 27). The natural germination of the seed generally occurs in the early spring of the second year after dispersal. This delay in germination is due to a dormant embryo and partially to an impermeable seed coat (38, 39). The passage of the seed through the digestive tract of birds may enhance the germination; however, this is dependent upon the bird species. Parker (27) found that seeds fed to doves were entirely destroyed by the digestive action. On the other hand, berry eating birds like thrushes, starlings, and waxwing did not destroy the seed coats but merely scarified the seed, thereby hastening or improving germination.

Embryo dormancy can be overcome by stratification at a low temperature. It has been found that eastern red cedar seeds require a stratification period of 2 to 3 months at $5^{\circ}C$ for optimum germination (5, 26). This stratification period is known as after-ripening. Pack (24) reported that after-ripening occurs at temperatures between 0 to $10^{\circ}C$, but it occurs most rapidly at $5^{\circ}C$. In addition to stratification, the seeds must have a fairly low temperature ($50-59^{\circ}F$) for the germination process to occur (7, 25).

Competitiveness

Eastern red cedar is not an aggressive competitor with hardwoods on deep soil sites. However, due to its penetrating taproot and relatively small leaf surface, it is a relatively drought tolerant species and grows on shallower soil sites where hardwood growth is sparser.

During the seedling stage, it develops a long fibrous root system without much top growth (38). It is relatively intolerant to reduced light intensity during this stage. In the Southern Piedmont area, red cedar seedlings under open-canopy stands survived better than those under closed-canopy stands (28).

Effects of Fire

Eastern red cedar is a pioneer species that invades old fields and pastures (1, 2, 3, 4, 38). It is believed that the successful invasion by eastern red cedar on these areas coincides with the reduced burning of grassland (6). This species is unable to maintain itself in areas that burn over frequently due to its inability to resprout and its thin bark. The bark is so thin (rarely more than .3 inch thick) that heat from one surface fire may even kill mature trees (3). However, burning is not an effective control on poor range sites due to the lack of grass for fuel.

Dalrymple (9) reported that small trees were controlled by fire but large trees were more difficult to control. Martin and Crosby (23) found that the effect of fire on cedar kill decreased with increasing height of the trees. They attributed the lessened mortality of the taller trees to the increased tree crown volume and decreased grass for fuel.

Jameson (15) reported a kill of 70 to 100% of 4 ft, 30 to 40% of 5 to 6 ft, and 60 to 90% of 8 to 10 ft trees of one-seed juniper (*Juniperus monosperma*) by fire. The reduction in kill of the 6 ft trees was due to much less fuel under the tree than the 10 ft trees.

Eastern red cedar was found to be more susceptible to burning than American elm (*Ulmus americana*), wild plum (*Prunus americana*), crab (*Pyrus ioensis*), and hawthorn (*Crataegus mollis*) (19). The weather conditions at the time of burn also influenced the effectiveness. The greater the percent moisture in the fuel, the more reduced was the heat intensity of the fire.

Mowing

Mowing is a mechanical means of controlling brush, especially non-sprouting species. Heavy-duty mowers or brush cutters can be used for initial clearing and cutting sprout growth with stem diameters not exceeding 3 to 4 inches. Costs of initial mowing may range from 3 to 7 dollars or more per acre (12).

Chemical Control

The most commonly used herbicide for the control of hardwoods is 2,4,5-T (2,4,5-trichlorophenoxy acetic acid). However, it has been reported that 2,4,5-T and 2,4-D (2,4-dichlorophenoxy acetic acid) are ineffective in controlling eastern red cedar (13). However, new chemicals have been developed and a very limited number have been tried in experimental work for the control of eastern red cedar. Picloram

(4 amino-3,5,6-trichloropicolinic acid) aerially applied at the rate of one pound per acre resulted in only 2% control of redberry juniper (*Juniperus pinchote*) (30).

Kirch and Esposito (18) reported that a 2,4-D/2,4,5-T invert emulsion system plus picloram applied at 4 + 4 + .75 pounds acid equivalent (ae) per acre, respectively, in 16 gallons total volume resulted in 80% kill of eastern red cedar 27 months after application. The 2,4-D/2,4,5-T invert emulsion plus dicamba (2-methoxy-3,6-dichlorobenzoic acid) applied at 6 + 6 + 9 pounds ae, respectively, was ineffective. Cedars did not respond to the 2,4-D/2,4,5-T invert emulsion applied at 3 + 3 pounds ae per acre, respectively, in 10 gallons total volume (17).

Norbak, a swellable polymeric material suited for reducing drift, reduced the effectiveness of Tordon 101 (picloram .54 pound + 2,4-D 2 lbs/gal) at the rate of 4 gallons per acre in 15 gallons total volume (22). However, Warren (40) reports that Norbak with 1 to 2 gallons of Tordon 101 per acre in 25 gallons total volume gave good to excellent control of western red cedars (*Juniperus occidentalis*).

The method generally used in treating brush along roads, rights-of-way, and fence rows is a foliar leaf-stem spray. Power spray equipment is generally used with an adjustable hand gun. All foliage, twigs, and terminal limbs are wetted thoroughly with a dilute herbicidal spray. The treatments are made in the spring when the leaves are fully grown.

Meek, Eastin, and Palmer (24) found that a 1.3 percent solution of diethanolamine salt of 6 hydroxy-3-(2H) pyridazinone (MH) and a 0.5 percent solution of N-dimethyl-amino succinamic acid were both ineffective in inhibiting the growth of cedars. Picloram effectively controlled ground junipers with 0.4 pound active ingredient (ai) per 100 gallons (aihg) of water while 2,4,5-T with 4 pounds aihg of water was ineffective (32).

Watson and Wiltse (41) reported that picloram at one pound aihg of water completely killed eastern red cedar. Dalrymple (9) stated that ammonium sulfamate at 75 pounds aihg of water gave a 77% kill of ashe cedar (*Juniperus ashe* Buckh.), 15 months after treatment. Picloram + paraquat (1,1-dimethyl-4,4'-bipyridinium) 0.5 + 0.5 pounds aihg respectively, resulted in 87% kill. Paraquat at 1, picloram at 1, and dicamba at 2 pounds aihg all caused less than 50% kill of ashe cedar, 15 months after treatment. All of the above treatments caused greater than 90% defoliation of eastern red cedar 3 months after treatment. Paraquat at 0.5 pounds aihg in combination with each of the following herbicides resulted in greater than 85% defoliation of eastern red cedar 3 months after treatment: ammonium sulfamate, amitrol-T (3-amino-1,2,4-triazole + NH_4SCN), picloram, silvex [2(2,4,5-trichlorophenoxy) propionic acid], dicamba, 2,4-D and 2,3,6-TBA (2,3,6-trichlorobenzoic acid).

The injection of herbicides is a slow and laborous method of nonfoliar application. However, it gives a greater assurance of kill on most species if the herbicide and carrier are selected correctly and treatment is administered properly. Injection is done with the aid of an injector tool, which is a 2 inch cylinder 4 feet in length with a slightly convex bit on one end and a valve. This tool may be filled with a herbicide or a herbicide and carrier. After a tree is selected, the bit is thrust into the trunk and enough solution is released to fill the incision. Generally one incision is made per inch tree diameter at breast height (DBH) and the incisions are made as near the soil surface as possible (29). The most common injection treatment for hardwood control is to apply 2,4,5-T ester 4 pounds ae diluted 1:9 with diesel oil (12, 20, 35). No research has been reported using the injection procedure on eastern red cedar.

Granular herbicides are commonly used on noncropland for controlling weeds and brush species. However, experiments have been conducted evaluating granular herbicides in the control of cedars.

An experiment conducted by Johnsen (16) in which the herbicide application rate per tree trunk was equivalent to that amount of active material in one tablespoon of 25% fenuron pellets. He found that fenuron and the sodium salt of 2,3,6-TBA were effective in controlling alligator juniper (Juniperus deppeana) 4 to 6 ft tall. Silvex, PBA (polychlorobenzoic acid), dalapon (2,2, dichloropropionic acid), and 2,4-D were ineffective as granular treatments.

Broadcast applications of fenuron (3-phenyl-1, 1-dimethyl urea) and monuron [3-(p-chlorophenyl)-1, 1-dimethyl urea] at rates up to 6 pounds per acre were ineffective in controlling redberry juniper (Juniperus pinchote) (10). However, it is susceptible to basal trunk applications of 4-8 grams of fenuron per stem. Shipman (33) reported that red cedar was susceptible to fenuron pellets at the rate of one teaspoon per inch stem diameter. Preliminary data also indicated it is susceptible to soil ground application of 2,3,6-TBA (11).

Dalrymple (9) reported that Tordon 10K, as a broadcast application on ashe cedars at 15, 30, and 45 pounds per acre caused 37, 55, and 76% kill, respectively, 16 months after treatment. Tordon beads

(2% ai) at 220 pounds per acre resulted in a 58% kill. Fenuron at 100 pounds per acre caused a 47% kill. Hyvar (5-bromo-3-sec-butyl-6-methyluracil) was ineffective in controlling ashe cedar.

Aerial application of picloram (10% ai) at 2 and 4 pounds per acre resulted in 81% juniper control with the 4 pounds per acre rate and 70% control with the 2 pound rate (30). Picloram (10%) pellets applied at the rate of 75 pounds per acre was found to control junipers (42, 31).

Due to the very limited amount of research reported on the control of eastern red cedar, further investigations were necessary with various control procedures. Chemical, mechanical, and burning procedures were selected for this study.

CHAPTER III

METHODS AND MATERIALS

The site selected for this study was located in Payne County, 3 miles east of the Oklahoma State University Agronomy Research Station, Perkins, Oklahoma. The topography of the land was classified as rolling upland with a shallow soil depth. Soil type was a Darnell Stephenville Complex. The first treatments were made in the winter of 1967, and the last readings reported were made in June, 1969.

Chemical, mechanical, and burning procedures were selected as control methods for eastern red cedar. Laboratory experiments were also conducted on the effect water-extracts of eastern red cedar seed, fresh foliage, and partially decomposed foliage had on the germination and coleoptile length of wheat (Triticum aestivum L.) and two native grasses, switchgrass (Panicum vergatum L.), and little bluestem (Andropogon scoparius L.).

A rating scale of 0-10 (0 = no dessication, ranging up to 10 = complete dessication) was used as a measure of the effectiveness of topkill on eastern red cedar. Feathering and regrowth of the treated trees were taken into consideration at the time of each rating. The greater the regrowth the more reduced was the dessication rating. At the final rating, counts were taken of the trees with complete topkill and are expressed as percent topkill for each treatment. Statistical analysis was used in analyzing the effectiveness of chemicals as a control method for eastern red cedar.

The following experiments were conducted in evaluating different control methods for eastern red cedar.

Experiment I: Date of Injection and Herbicide Formulation on Topkill of Eastern Red Cedar

The objective of this experiment was to determine the influence date of injection and herbicide formulation had on the topkill of eastern red cedar. Injection treatments were applied in the winter of 1967 and the spring and summer of 1968. The treatments were arranged as a split-plot in a randomized block design, replicated 10 times, each replication consisting of one tree. The incisions were made and the chemicals applied in 2 independent operations. The incisions were made with a water filled "Ruell Little" injector at a 45° angle around the base of each tree, approximately 2 inches above the soil line. One incision was made per inch DBH (diameter breast height). The desired amount of chemical was then inserted into each incision with an automatic syringe. The tree size ranged from 4-6 inches DBH.

The propylene glycol butyl ether ester formulation of 2,4-D and 2,4,5-T; the triethylamine salt of 2,4-D and 2,4,5-T; and the potassium salt of picloram were applied at the following rates per incision:

(1) 2,4,5-T ester undiluted 1 and 3 ml.

(2) 2,4,5-T amine undiluted 1 and 3 ml.

(3) 2,4,5-T amine in water at the ratio of 1:4, 1 ml.

(4) 2,4,5-T ester in diesel oil at the ratio of 1:4 and 1:9, 1 ml.

(5) 2,4,-D amine in water at the ratio of 1:4, 1 ml.

(6) 2,4,-D ester in diesel oil 1:9 and 1:4, 1 ml.

(7) 2,4,-D amine undiluted 1 and 3 ml.

(8) 2,4-D ester undiluted 1 and 3 ml.

(9) Picloram undiluted 0.5, 1 and 3 ml.

The three treatment dates were December 20 and 21, 1967, March 25 and 26, 1968, and August 1, 1968. The trees were then evaluated at equal time intervals after application.

Experiment II: Date of Granular Herbicide Applications and Topkill of Eastern Red Cedar

Early spring and summer treatments of granular herbicides were applied as a split-plot arranged in a randomized block design, replicated 10 times, each replication consisting of one tree. Treatments were applied as teaspoons of commercially formulated granular herbicides per inch DBH. The herbicide was placed by hand on all sides of the tree trunk, within a 12 inch radius. The tree size ranged from 4 to 6 inches DBH with the approximate average height being 12 feet.

The following granular herbicides and rates were applied:

(1) Picloram, potassium salt, 2% ai beads at 1, 3, and 6 tsp.

(2) Picloram, potassium salt, 10% ai at 1, 3, and 6 tsp.

(3) Dicamba, dimethylamine salt, 10% ai at 1, 3, and 6 tsp.

(4) Fenuron 25% ai at 1, 2, and 3 tsp.

(5) MonuronTCA [3-(p-chlorophenyl)-1,1-dimethylurea trichloroacetate], 11% ai at 3, 6, and 9 tsp.

(6) Fenac (2,3,6-trichlorophenylacetic acid) sodium salt 10% ai at 3, 6, and 9 tsp.

The spring date of application was March 28, 1968, and the summer application date was August 5, 1968. The average percent soil mositure in the 6 inch surface layer was 11% for the spring application and 2% for the summer application. The trees were evaluated at equal time intervals after treatment.

Experiment III: Tree Size and Topkill of Eastern Red Cedar by Foliar Treatments

This experiment was performed to determine the influence tree size had on the topkill of eastern red cedar with herbicides and herbicide combinations used as ground applied foliar sprays. The tree sizes selected for this study were 3 to 4 ft tall which were considered small trees and those 7 to 8 ft tall were considered large trees. The treatments were applied as a split-plot in a completely randomized design, replicated 10 times, each replication consisting of one tree. Treatment rates are given as pounds aihg of water total spray volume.

An adjustable hand gun nozzle with a hose attached to a tractor mounted piston type sprayer was used in the application of the spray solutions. Application pressure was 30 psi. The spray solution was applied to each tree until the foliage was saturated to the point of run-off with the spray solution.

The following herbicides and rates were used:

(1) 2,4,5-T propylene glycol butyl ether (PGBE) ester 2, 4, and 6 lbs rates in an equal volume of diesel oil in an oil-water emulsion.

(2) 2,4,5-T PGBE ester plus ammonium thiocyanate at 3 + 0.75, 3 + 1.5, and 3 + 2.0 lbs aihg in an equal volume of diesel oil in an oil-water emulsion.

(3) 2,4,5-T PGBE ester plus paraquat methyl sulfate salt at 2+0.5, 4+0.5, and 4+0.25 lbs aihg, respectively, in an equal volume of diesel oil in an oil-water emulsion.

(4) Paraquat methyl sulfate salt at 1, 2, and 4 lbs aihg plus ½% by volume HDD (alkyl phenoxy ethoxy) surfactant.

(5) Dicamba, dimethylamine salt at 1.5, 3, and 6 lbs aihg of water.

(6) 2,4,5-T triethylamine salt plus dimethylamine salt of dicamba at 4+1, 4+2, and 2+1.5 lbs aihg of water.

(7) 2,4,-D propylene glycol butyl ether ester at 2, 4, and 6 lbs aihg in an equal volume of diesel oil in an oil-water emulsion.

(8) Butoxyethanol esters of 2,4-D propionic acid and 2,4-D acetic acid formulated as a (1:1 ratio) mixture (Brush Killer 170) at 2+2, 4+4, and 8+8 lbs aihg of water.

(9) Amitrole + NH_4SCN formulated as 1:1 mixture (Amitrol-T) at 1+1 and 3+3 lbs aihg.

(10) Ammate-X (ammonium sulfamate) at 50 and 75 lbs aihg of water.

(11) Picloram, potassium salt at 0.75, 1.5, and 4.5 lbs aihg of water.

(12) Trispropanolamine salts of picloram and 2,4,-D formulated as 1:2 mixture (picloram 212) at 1+2, 3+6, and 6+12 lbs aihg of water.

(13) Triethylamine salts of picloram and 2,4,5,-T formulated as 1:1 mixture (picloram 225) at 2+2, 4+4, and 6+6 lbs aihg of water.

The treatments were applied June 7-10, 1968. The weather conditions ranged from cloudy to partly cloudy. The average air temperature for the application period was 82°F, 12 p.m. The wind velocity was 7-12 mph from the southeast to the northwest. The percent soil moisture in the surface 6 inches of soil was 13%.

Experiment IV: Topkill of Eastern Red Cedar as Influenced by Different Foliar Applications

The objective of this experiment was to evaluate chemicals as to their possible use as aerial applications and to see if certain additives had any herbicidal properties on eastern red cedar. The experiment was conducted as a completely randomized design. Each treatment consisted of 10 replications with one tree per replication.

The treatments were applied with a compressed air hand sprayer with 40 pounds per square inch (psi) pressure. Each tree was enclosed in a metal frame, 4 x 4 feet, the sides of which were covered with polyethylene film, and the spray solution applied over the top of each tree. Fourteen mls of spray solution were applied per tree which was equivalent to 10 gpa. The chemicals were applied as pounds ai per acre.

The following chemicals and rates were used:

(1) Amitrole at 0.75 and 1.5 lbs per acre.

(2) Ammate-X at 6 lbs per acre.

(3) Ammonium thiocynate at 0.75 and 1.5 lbs per acre.

(4) 2,4,5-T triethylamine salt plus NH_4SCN at 2 + 0.75 and 2 + 1.5 lbs per acre.

(5) 2,4,5-T triethylamine salt plus picloram potassium salt at 2 + 0.5, 2 + 1, and 2 + 2 lbs per acre.

(6) 2,4,5-T triethylamine salt plus dimethylamine salt of dicamba at 2 + 1.5 and 4 + 2 lbs per acre.

(7) Endothall (3,6-endoxohexahydropthalate) disodium salt at 2.5 and 5.0 lbs per acre.

(8) Paraquat methyl sulfate salt at 0.75 and 1.5 lbs per acre.

The treatments were made on June 6, 1968. The weather conditions ranged from cloudy to partly cloudy with an air temperature of 80°F at 12 p.m. The soil moisture was 12% in the surface 6 inches. The trees at the time of treatment had put on new growth.

Experiment V: Mowing for Controlling Small Eastern Red Cedar

The purpose of this experiment was to evaluate a shredder type brush cutter as a mechanical method of controlling small eastern red cedars on rangeland. Five plots with 10 trees per plot were selected for this experiment. The basal diameters of the trees ranged from 0.50 to 1.25 inches with an approximate average height of 3 feet. A tractor mounted shredder was used to destroy the trees 6 inches above the soil line on February 4, 1968. Sixteen months after the date of treatment a count was taken of the number of basal stump sprouts.

Experiment VI: The Influence of Tree Size on Stump Sprouting of Eastern Red Cedar

This experiment was conducted to see if tree size influenced stump sprouting of eastern red cedar. Twenty trees each of 4 different sizes (0.25 to 0.75, 0.75 to 1.5, 1.5 to 3.0, 3.0 to 6.0 inches in diameter) were chosen at random. A chain saw was used to cut the trees off

4 inches above the surface of the soil. This was done July 12, 1968, and 10 months later a count was taken of the eastern red cedar stumps which had sprouted for each of the 4 different sizes.

Experiment VII: The Effect of Fire on Eastern Red Cedar

Two sites were chosen for this experiment. Site I was the same location as the previous experiments. Site II was located 3 miles northwest of the Agronomy Research Station, Perkins, Oklahoma. Both sites were approximately .5 acre each and were similar in that they were both poor range sites. Site I was shallow soil while Site II was of medium depth. The predominant grass on Site I was *Agrostis* spp. and the predominant grass on Site II was little bluestem (*Andropogon scoparious*). The trees on both sites were grouped in 3 size groups: less than 1.5 feet, 1.5 to 3 feet, and 3 to 6 feet.

Forage yield samples were obtained from both sites to determine the amount of dry forage available for fuel. Samples were collected at random from the plots and oven dried for 24 hours in order to determine the dry forage yield per acre.

The percent moisture in the leaf and stems of the trees at the time of burning was also determined. Leaf-stem samples 8 to 12 inches in length were removed from the apex of randomly selected branches of randomly selected trees of varying heights. The samples were oven dried for 72 hours before the percent moisture was determined. Soil moisture samples were taken from the surface 6 inch layer at both burn sites the day of burning, prior to burning.

Site I was burned on March 28, 1968, and Site II was burned on April 17, 1968. Dessication ratings were made on both sites at equal time intervals after burning. The weather on the day of burning Site I was clear with a temperature of 68°F at 10 a.m. The wind direction was from the southwest to the northeast at 5 to 10 mph. The weather on the day of burning Site II was partly cloudy with an air temperature of 60°F at 9 a.m. The wind direction was from the southwest to the northeast at 15 to 20 mph.

The vegetation on Site I had not broken dormancy at the time of burning, but it had broken dormancy on Site II at the time of burning.

Experiment VIII: The Effect of Water-Extracts of Eastern Red Cedar Seed and Foliage on Germination and Coleoptile Length of Wheat and Native Grasses

This experiment was conducted to see if the seed, fresh foliage, or partially decomposed foliage of eastern red cedar had an inhibitory effect on germination and growth of wheat, switchgrass, and little bluestem seedlings. The treatments were arranged as a split-plot in a completely randomized design with 4 replications, each germination box consisting of 25 seeds was considered a replication.

The fresh foliage and seed were collected from trees in January, 1969. The partially decomposed foliage was collected from the ground beneath the trees the same date. The fresh foliage was allowed to air dry 7 days before it was soaked in distilled water. Fifty grams of a sample were soaked in 500 mls of distilled water 48 hours before the water-extract was removed by filtering through cheesecloth.

Twenty mls of the water-extract were applied to a layer of absorbent material in each germination box. Twenty-five seeds of a particular species were placed in each of 4 germination boxes. Distilled water was used as a check treatment.

The germination boxes were placed in a germinator with a 75-85^{o}F temperature range and a 12 hour day length. The pH of the water-extract of each treatment was measured with a Beckman pH meter.

Germination counts and coleoptile measurements of the various species were made 5 days after being placed in the germinator.

CHAPTER IV

RESULTS AND DISCUSSION

Experiment I: Date of Injection and Herbicide Formulation on Topkill of Eastern Red Cedar

The formulation of the phenoxy herbicides and the date of their application caused significant differences on the topkill of eastern red cedar (Tables I and II). The ester formulation of 2,4,5-T had no significant influence at any date of application. The ester formulation of 2,4,-D as the concentrate and the 2,4,5-T amine formulation were most effective when applied in the spring (3/25). These responses were significantly different from the other dates of application throughout the rating period. There was relatively little difference between the 5 and 10 month ratings of the 2,4,5-T amine concentrate treatments. However, at the 14 month rating, the 1 ml rate showed slightly less dessication while the 3 ml rate showed an increase. The high rate of 2,4,-D ester formulation applied in the spring showed the greatest topkill at the 5 month rating. At the 10 and 14 month ratings it showed a slight decrease in dessication.

The 2,4-D amine formulation as the concentrate was most effective when applied in the winter and this date was significantly different from the other dates of applications throughout the rating period. The greatest topkill with this treatment occurred at the 5 month rating.

TABLE I

INFLUENCE OF DATE OF INJECTION ON TOPKILL OF EASTERN RED CEDAR
5 AND 10 MONTHS AFTER TREATMENT

		Rate	5 Month Rating*				10 Month Rating*			
		(ml/in)	Date of Treatment				Date of Treatment			% Topkill
Herbicides	Dilution	DBH	12/20	3/25	8/1	Avg.	3/25	8/1	Avg.	8/1
2,4,5-T ester	conc	1	0.1e**	0.7e	0.0f	0.3f	0.1d	0.1d	0.1f	0
2,4,5-T ester	conc	3	0.0e	0.8e	0.6de	0.5f	0.0d	0.5d	0.3f	0
2,4,5-T ester	1:9	1	0.0e	1.7e	1.3cde	1.0f	0.1d	0.2d	0.2f	0
2,4,5-T ester	1:4	1	0.0e	0.8e	0.5e	0.4f	0.9d	0.4cd	0.7f	0
2,4,5-T amine	conc	1	2.7cd	6.1bc	2.2bcd	3.6d	6.3b	2.0bc	4.2c	0
2,4,5-T amine	conc	3	3.6cd	7.5b	2.9bcd	4.6c	7.6b	3.0b	5.3c	0
2,4,5-T amine	1:4	1	0.1e	1.8e	0.6de	0.8f	0.0d	0.9cd	0.5f	0
2,4-D ester	conc	1	0.1e	0.9e	0.8de	0.6f	0.7d	0.5d	0.6f	0
2,4-D ester	conc	3	1.2de	4.2d	0.7de	2.1e	3.9c	0.9cd	2.4c	0
2,4-D ester	1:9	1	0.0e	1.1e	0.2e	0.4f	0.0d	0.0d	0.0f	0
2,4-D ester	1:4	1	0.1e	0.9e	0.0e	0.3f	0.0d	0.1d	0.1f	0
2,4-D amine	conc	1	4.0c	1.3e	3.6b	2.9de	1.3d	3.5b	2.4e	0
2,4-D amine	conc	3	7.5b	5.2cd	3.6b	5.4c	4.6c	3.1b	3.8d	0
2,4-D amine	1:4	1	0.1e	0.2e	0.9de	0.4f	0.8d	1.0cd	0.9f	0
Picloram K-salt	conc	0.5	7.2b	7.6b	8.7a	7.8b	7.5b	9.2a	8.4b	30
Picloram K-salt	conc	1	7.6b	9.6a	9.5a	8.9a	9.7a	9.8a	9.8a	80
Picloram K-salt	conc	3	9.8a	9.5a	10.0a	9.7a	10.0a	10.0a	10.0a	100
Check	--	-	0.0e	0.0e	1.3cde	0.4f	0.7d	0.2d	0.5f	0

*Ratings 0 to 10 scale
**Duncan's multiple range test, 5% significant level

TABLE II

INFLUENCE OF DATE OF INJECTION ON TOPKILL OF EASTERN RED CEDAR 14 AND 18 MONTHS AFTER TREATMENT

			Ratings*					
			14 Months				18 Months	
Herbicides	Dilution	Rate (ml/in) DBH	12/20	3/25	Avg.	% Topkill 3/25	12/20	% Topkill 12/20
2,4,5-T ester	conc	1	0.0g**	0.4e	0.2f	0	0.4e	0
2,4,5-T ester	conc	3	0.0g	0.4e	0.2f	0	0.0e	0
2,4,5-T ester	1:9	1	0.0g	0.1e	0.1f	0	0.0e	0
2,4,5-T ester	1:4	1	0.0g	0.0e	0.0f	0	0.1e	0
2,4,5-T amine	conc	1	2.2def	5.9c	4.1f	10	2.8d	0
2,4,5-T amine	conc	3	2.5de	8.4ab	5.5c	20	3.1d	0
2,4,5-T amine	1:4	1	0.0g	0.0e	0.0f	0	0.1e	0
2,4-D ester	conc	1	0.2g	0.9e	0.5f	0	0.2e	0
2,4-D ester	conc	3	0.9efg	3.6d	2.3e	0	1.0e	0
2,4-D ester	1:9	1	0.0g	0.4e	0.2f	0	0.2e	0
2,4-D ester	1:4	1	1.0efg	0.4e	0.7f	0	0.9e	0
2,4-D amine	conc	1	3.6d	1.1e	2.3e	0	3.1d	0
2,4-D amine	conc	3	6.0c	3.6d	4.8cd	0	5.6c	0
2,4-D amine	1:4	1	0.0g	0.4e	0.2f	0	0.2e	0
Picloram K-salt	conc	0.5	7.1bc	8.1b	7.6b	10	7.1b	20
Picloram K-salt	conc	1	8.8ab	9.7ab	9.3a	70	9.5a	60
Picloram K-salt	conc	3	9.9a	10.0a	10.0a	100	10.0a	100
Check	—	-	0.5fg	0.2e	0.3f	0	0.1e	0

*Ratings on a 0 to 10 scale

**Duncan's multiple range test, 5% significant level

At the 14 and 18 month ratings, there was a slight decrease in dessication. The injection treatments of the phenoxy herbicides diluted with water or diesel oil had no apparent effect on eastern red cedar.

Picloram was the most phytotoxic herbicide in the experiment and its activity was not affected by date of application. The low rate of picloram ($\frac{1}{2}$ ml) applied in the summer (8/1) gave better topkill at the 5 and 10 month ratings than the other 2 dates of application. The 1 ml rate of picloram applied during the winter (12/20) gave less topkill at the 5 month rating than the other dates of application. However, this treatment showed an increase in dessication throughout the rating period and there was little difference in response between dates of application at the final rating. All of the trees treated at the high rate (3 ml) exhibited complete topkill at the time of the final rating. The 1 ml rate yielded approximately 70% topkill at all dates of application. The 3 ml rate of 2,4,5-T amine formulation applied in the spring was the only injected phenoxy herbicide treatment which still gave good dessication at the end of the rating period.

All of the trees which were dessicated but not killed were beginning to feather from the outer end of the branches at the time of the final rating. The high rating of some of the checks at different rating dates is attributed to the result of cold weather, since these particular ratings were made during the late winter.

Experiment II: Date of Granular Herbicide Applications and Topkill of Eastern Red Cedar

The results of this experiment (Table III) showed that picloram (10%), fenac, and fenuron gave the best topkill, regardless of the date of application. For picloram (10%) and fenac, the best responses were at the 2 higher rates. Fenuron showed the best response at the highest rate.

The topkill results indicated that these herbicides applied in the spring (3/28) were more effective than when applied in the summer. Picloram (10%) at the 3 teaspoon rate applied in the spring resulted in 70% topkill while the summer application (8/5) resulted in only 40% topkill. This difference may possibly be attributed to the time interval after treatment. The topkill rating of the summer application date was made 10 months after treatment while the percent topkill of the spring treatment was made 13 months after treatment. The trees of the summer treatments were still showing response at the 10 month rating. While the trees of the spring treatments which were dessicated but not killed were feathering from the outer end of the branches at the time of the 13 month rating.

Dicamba caused good topkill only at the high rate, when applied as a summer treatment. However, due to the large amount of variation within the experiment there was no statistical significant difference between dates of application. MonuronTCA and picloram (2%) were not effective in controlling eastern red cedar.

The high ratings of the check of the summer treatment at the 5 month rating and the check of the spring treatment at the 10 month rating is attributed to the result of cold weather since these ratings were made during the late winter.

TABLE III

THE INFLUENCE OF GRANULAR HERBICIDES ON TOPKILL OF EASTERN RED CEDAR RATED VARIOUS INTERVALS AFTER TREATMENT

		Ratings*								
	Rates	5 Months			10 Months				13 Months	
Herbicides	(tsp/in) DBH	3/28	8/5	Avg.	3/28	8/5	Avg.	%Topkill 8/5	3/28	%Topkill 3/28
Picloram (2%)	1	0.3e**	0.1de	0.2f	0.2e	0.2f	0.2h	0	0.1d	0
Picloram (2%)	3	1.6e	1.4de	1.5ef	1.0de	1.6ef	1.3efg	0	2.4cd	10
Picloram (2%)	6	2.4de	1.7de	2.0ef	1.7cde	3.7cdef	2.7efgh	0	2.4cd	0
Picloram (10%)	1	6.7ab	4.8abcd	5.7c	4.2cd	6.7abc	5.5bc	20	6.9a	20
Picloram (10%)	3	8.4a	7.3a	7.8a	9.1ab	9.3a	9.2a	40	9.1a	70
Picloram (10%)	6	7.9a	5.5abc	6.7bc	8.7ab	7.7ab	8.2a	20	9.0a	70
Dicamba	1	2.0de	0.1de	1.0ef	1.7cde	0.3f	1.0fgh	0	0.9d	0
Dicamba	3	0.9e	0.6de	0.7f	0.0e	1.0f	0.5gh	0	0.2d	0
Dicamba	6	1.6e	3.5bcde	2.6de	0.1e	6.1abcd	3.1defg	20	0.2d	0
Fenuron	1	2.8de	1.7de	2.2e	2.6cde	4.0cde	3.3cdef	10	3.6c	10
Fenuron	2	2.6de	2.1cde	2.3e	3.6cde	3.6cdef	3.6cdef	10	3.7c	10
Fenuron	3	6.4ab	2.6bcde	4.5cd	8.6ab	5.7abcd	7.2ab	30	7.4a	40
Fenac	3	4.6bcd	1.6de	3.1de	4.5cd	2.3def	3.4cdef	10	4.7bc	0
Fenac	6	6.2abc	4.7abcd	5.4c	5.5bc	4.9bcde	5.2bcd	10	7.5a	50
Fenac	9	8.9a	5.7ab	7.3ab	9.4a	6.7abc	8.1a	30	8.8a	60
MonuronTCA	3	3.2cde	0.0de	1.6ef	4.3cd	1.2ef	2.8efgh	0	4.0c	10
MonuronTCA	6	2.6de	0.4de	1.5ef	2.4cde	1.3ef	1.9efgh	0	4.0c	10
MonuronTCA	9	2.5de	1.8de	2.1ef	2.9cde	2.4def	2.7efgh	0	3.7c	10
Check	-	0.0e	1.5de	0.8f	0.7de	0.1f	0.4gh	0	0.0d	0

*Ratings on a 0 to 10 scale
**Duncan's multiple range test, 5% significant level

Experiment III: Tree Size and Topkill of Eastern Red Cedar by Foliar Treatments

The results of this experiment (Table IV) indicated that tree size (3-4 ft and 7-8 ft) did not influence the response of eastern red cedar to foliar treatments. Amitrole + NH_4SCN, 2,4,5-T, and 2,4-D were ineffective in killing the tops of eastern red cedar. However, 2,4-D and 2,4,5-T in combination with other chemicals yielded good topkill. The low rates of paraquat ($\frac{1}{4}$, $\frac{1}{2}$ aihg) plus 2,4,5-T resulted in good dessication of the treated trees 2 months after treatment. There was a gradual increase in dessication of the treated trees throughout the rating period. At the time of the final rating the trees exhibited 90% topkill. Dicamba + 2,4,5-T caused good topkill, but the response was not greater than dicamba alone. Dicamba at 1.5 pounds aihg gave as good dessication as dicamba + 2,4,5-T at 1.5 + 2.0 pounds aihg, throughout the rating period.

Picloram, alone or in combination with 2,4-D or 2,4,5-T was effective at all rates. Paraquat and Ammate-X also gave excellent topkill. All of the above treatments caused complete dessication 7 months after treatment. None of the treated trees were feathering at the time of the final rating.

Dicamba, and 2,4-D + 2,4-DP at high rates showed good potential response in controlling eastern red cedar. The low rate of 2,4-DP + 2,4-D(2 + 2 lbs aihg) showed greatest dessication at the 7 month rating. At the 12 month rating there was a decrease in dessication which was due to feathering that was occurring at the outer end of the branches. The dessication of trees treated with the higher rates of 2,4-DP + 2,4-D remained relatively constant throughout the rating period. The

TABLE IV

THE INFLUENCE OF TREE SIZES (3-4 FT AND 7-8 FT) ON TOPKILL OF EASTERN RED CEDAR BY FOLIAR TREATMENTS

Herbicides	Rate (aihg)	Ratings at Various Months after Treatment*										
		2 Months			7 Months			12 Months				
		Small	Large	Avg.	Small	Large	Avg.	Small	Large	Avg.	% Topkill Small	% Topkill Large
2,4,5-T	2	1.4h**	—	—	3.2ij	—	—	0.7j	—	—	0	—
2,4,5-T	4	3.8g	4.5g	4.1gh	4.4g	4.0d	4.2e	3.6h	3.7e	3.7f	0	0
2,4,5-T	6	6.9e	6.7f	6.8f	7.2ef	5.8c	6.5c	6.3f	5.9cd	6.1d	0	0
2,4,5-T+NH_4SCN	3.0+0.75	3.7g	3.5g	3.6h	3.4hi	2.8d	3.1f	2.5i	1.2f	1.9h	0	0
2,4,5-T+NH_4SCN	3.0+1.5	3.8g	3.9g	3.9h	3.9gh	3.3d	3.6ef	2.6i	3.0e	2.8g	0	0
2,4,5-T+NH_4SCN	3.0+2.0	4.9e	—	—	6.6f	—	—	3.9h	—	—	0	—
2,4,5-T+paraquat	2.0+0.5	9.1ab	—	—	9.8a	—	—	9.9ab	—	—	90	—
2,4,5-T+paraquat	4.0+0.25	9.2ab	8.9abcd	9.0bcd	9.7a	9.6a	9.6a	10.0a	10.0a	10.0a	100	100
2,4,5-T+paraquat	4.0+0.5	9.6a	9.0abcd	9.3abc	9.9a	9.8a	9.8a	9.9ab	10.0a	10.0a	90	100
Paraquat + HDD	1.0+0.5%	9.8a	—	—	10.0a	—	—	10.0a	—	—	100	—
Paraquat + HDD	2.0+0.5%	10.0a	9.8ab	9.9a	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a	100	100
Paraquat + HDD	4.0+0.5%	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a	100	100
Dicamba	1.5	7.9cd	—	—	8.5bcd	—	—	9.0bc	—	—	30	—
Dicamba	3.0	9.7a	9.3abc	9.5ab	9.4ab	9.4a	9.4a	10.0a	9.8a	9.9a	100	100
Dicamba	6.0	9.6a	9.7ab	9.7ab	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a	100	100
Dicamba + 2,4,5-T	1.5+2.0	8.3bc	8.1cde	8.2ef	7.9de	8.0b	8.2b	8.5cd	8.6b	8.6b	30	0
Dicamba + 2,4,5-T	1.0+4.0	4.5fg	—	—	8.4cd	—	—	4.9g	—	—	0	—
Dicamba + 2,4,5-T	2.0+4.0	9.1ab	7.7de	8.4def	9.8a	9.5a	9.6a	9.6ab	9.5a	9.6a	60	50

*Ratings on a 0 to 10 scale
**Duncan's multiple range test 5% significant level

TABLE IV (continued)

Herbicides	Rate (aihg)	Ratings at Various Months after Treatment* 2 Months Small	Large	Avg.	7 Months Small	Large	Avg.	12 Months Small	Large	Avg.	% Topkill Small	Large
2,4-D	2.0	1.4h**	—	—	2.3jk	—	—	1.2j	—	—	0	—
2,4-D	4.0	5.3f	4.8g	5.0g	6.5f	4.3d	5.4d	5.2g	5.1d	5.2e	0	0
2,4-D	6.0	8.2bc	7.3ef	7.8f	9.3abc	6.8bc	8.0b	7.7de	6.8c	7.3c	0	0
2,4-DP + 2,4-D	2.0+2.0	7.1de	—	—	8.3d	—	—	7.2e	—	—	10	—
2,4-DP + 2,4-D	4.0+4.0	8.9ab	8.5bcde	8.7cde	9.8a	9.0ab	9.4a	9.8ab	9.2a	9.5a	80	30
2,4-DP + 2,4-D	8.0+8.0	9.8a	9.0abcd	9.4abc	9.8a	9.9a	9.8a	9.8ab	9.9a	9.9a	80	90
Amitrole+NH_4SCN	1.0+1.0	0.4i	—	—	2.6ijk	—	—	1.5j	—	—	0	—
Amitrole+NH_4SCN	3.0+3.0	2.3h	1.7h	2.0i	3.2ij	2.4d	2.8f	2.7i	2.7e	2.7g	0	0
Ammate-X	50.0	9.5a	—	—	10.0a	—	—	10.0a	—	—	100	—
Ammate-X	75.0	9.9a	9.7ab	9.8a	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a	100	100
Picloram	0.75	9.6a	—	—	10.0a	—	—	10.0a	—	—	100	—
Picloram	1.5	10.0a	9.8ab	9.9a	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a	100	100
Picloram	4.5	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a	100	100
Picloram + 2,4-D	1.0+2.0	10.0a	—	—	10.0a	—	—	10.0a	—	—	100	—
Picloram + 2,4-D	3.0+6.0	10.0a	9.8ab	9.9a	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a	100	100
Picloram + 2,4-D	6.0+12.0	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a	100	100
Picloram + 2,4,5-T	2.0+2.0	10.0a	—	—	10.0a	—	—	10.0a	—	—	100	100
Picloram + 2,4,5-T	4.0+4.0	10.0a	9.9a	9.9a	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a	100	100
Picloram + 2,4,5-T	6.0+6.0	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a	100	100
Check	—	0.0i	0.0i	0.0i	2.0k	1.8e	2.1g	0.0k	0.0g	0.0i	0	0

*Ratings on a 0 to 10 scale
**Duncan's multiple range test 5% significant level

high rates of dicamba (6 lbs aihg) caused complete dessication of the treated trees 7 months after treatment.

Some of the chemicals had adverse effects on vegetation in the treated area. Picloram, paraquat, and Ammate-X at all rates had adverse effects on vegetation. At the time of the final rating, no vegetation was growing within an approximate 2.5ft radius of the center of the treated tree, even though vegetation had been growing there prior to treatment. Amitrole + NH_4SCN, 2,4,5-T, 2,4-D, the low rates of 2,4-DP + 2,4-D and dicamba had no adverse effects on the vegetation.

The dessication of the checks at the 7 month rating is attributed to the result of the cold weather, since this rating was made during the winter. All treated trees which were dessicated but not killed were beginning to feather from the outer end of the branches at the time of the final rating.

Experiment IV: Topkill of Eastern Red Cedar as Influenced by Different Foliar Applications

Eastern red cedar did not respond to all the treatments (Table V). Ammonium thiocynate, amitrole, endothall, Ammate-X, and 2,4,5-T were ineffective in controlling eastern red cedar. The amine formulation of 2,4,5-T in combination with ammonium thiocynate or dicamba caused poor dessication of the treated trees.

Picloram + 2,4,5-T and paraquat were the most phytotoxic treatments in the experiment. The highest rate of picloram + 2,4,5-T (2 + 2 lbs/A) caused the highest percent topkill. The treated trees showed an increase in dessication at the 8 month rating in comparison to the

TABLE V

EFFECT OF FOLIAR APPLICATIONS FOR THE CONTROL OF EASTERN RED CEDAR RATED AT VARIOUS INTERVALS AFTER TREATMENTS

Herbicides	Rate (lb/A)	Ratings*			
		2 Mos.	8 Mos.	12 Mos.	12 Mos. % Topkill
Amitrole	0.75	0.1f**	0.6gh	1.1efg	0
Amitrole	1.5	0.0f	0.9gh	0.9fg	0
Ammate-X	6.0	1.4de	0.8gh	2.1ef	0
NH_4SCN	0.75	0.0f	0.0h	0.0g	0
NH_4SCN	1.5	0.0f	0.1h	0.3g	0
2,4,5-T + NH_4SCN	2.0+0.75	0.3ef	0.1h	0.1g	0
2,4,5-T + NH_4SCN	2.0+1.5	0.2ef	0.1h	0.2g	0
2,4,5-T + picloram	2.0+0.5	6.7b	6.7b	6.2c	20
2,4,5-T + picloram	2.0+1.0	7.4b	9.3a	9.2a	30
2,4,5-T + picloram	2.0+2.0	8.2a	9.9a	9.8a	80
Endothall	2.5	1.7cd	1.0gh	1.9ef	0
Endothall	5.0	2.8cd	1.7gh	2.4e	0
2,4,5-T + dicamba	2.0+1.5	1.7cd	3.6f	2.2ef	0
2,4,5-T + dicamba	4.0+2.0	2.2cd	5.2e	4.1d	0
Paraquat	0.75	7.4b	7.8cd	7.6b	40
Paraquat	1.5	6.4b	8.5bc	8.7ab	50
Check	—	0.0f	1.7g	0.0g	0

*Ratings on a 0 to 10 scale
**Duncan's multiple range test, 5% significant level

2 month rating. However, at the 12 month rating there was relatively little difference between the 8 and 12 month ratings. At the final rating, this treatment showed an apparent 80% topkill. Paraquat (1.5 lbs/A) was not as effective as the highest rate of picloram + 2,4,5-T. Paraquat caused a 50% topkill at the final rating in comparison to an 80% topkill for picloram + 2,4,5-T. The trees treated with paraquat and picloram + 2,4,5-T which were not completely killed at the time of the final rating were beginning to feather from the outer end of the branches.

The dessication of the check at the 8 month rating is again attributed to the effect of cold weather on the trees, since the rating was made in February, 1969. None of the treatments had an adverse effect on the grass in the treated zone. Paraquat did dessicate the grass at the time of treatment, but at the time of the 14 month rating there was no visible effects of paraquat on the grass.

Experiment V: Mowing for Controlling Small Eastern Red Cedar

Twenty-two percent of the mowed off stumps (0.5-1.25 inch basal dia) had resprouted 16 months after mowing. The results of the influence tree size had on stump sprouting of eastern red cedar (Experiment VI, Chapter III) indicated that 18% of the 0.25-0.75 inch diameter stumps had resprouted, 10 months after being cut with a chain saw. There was no resprouting of the stumps of the other 3 size groups (0.75-1.5, 1.5-3.0, 3.0-6.0 inch diameters). There was no sprouting from the root zone of any of the stumps in both experiments.

Experiment VI: The Effect of Fire on Eastern Red Cedar

The field data collected prior to burning indicated relatively little difference between the sites of both burn dates. The leaf-stem moisture at Sites I and II prior to burning were 42 and 43%, respectively. Soil moisture in the 6 inch surface layer at Site I was 12% and Site II was 10%. Dry forage yields prior to burning at Sites I and II were 2,000 pounds and 2,800 pounds per acre, respectively. The approximate distance between burn sites was 5 miles.

The data (Figure 1) indicates that date of burning did not greatly influence the final response of eastern red cedar to burning. However, 2 weeks after initial burning, there was a significant difference in the responses between the 2 burn dates. The date I burn (March 28, 1968) yielded greater dessication with all tree sizes over date II burn (April 17, 1968).

As the interval of time after burning increased, the dessication at date II increased on all tree sizes, while date I dessication of trees less than 3 ft remained relatively constant. Fourteen months after burning there was relatively little difference between dessication of trees less than 3 ft at both dates.

The dessication of the large trees (3-6 ft) of date II burn was less than that of date I at the initial evaluations. However, the trees treated on date II continued to dessicate throughout the rating period while that of date I decreased the first 5 months and then remained constant. The higher percent dessication of the 3-6 ft tree size of date II burn is attributed to the fact that more grass was found beneath the trees of date II burn (Site II) than that of date I (Site I) burn.

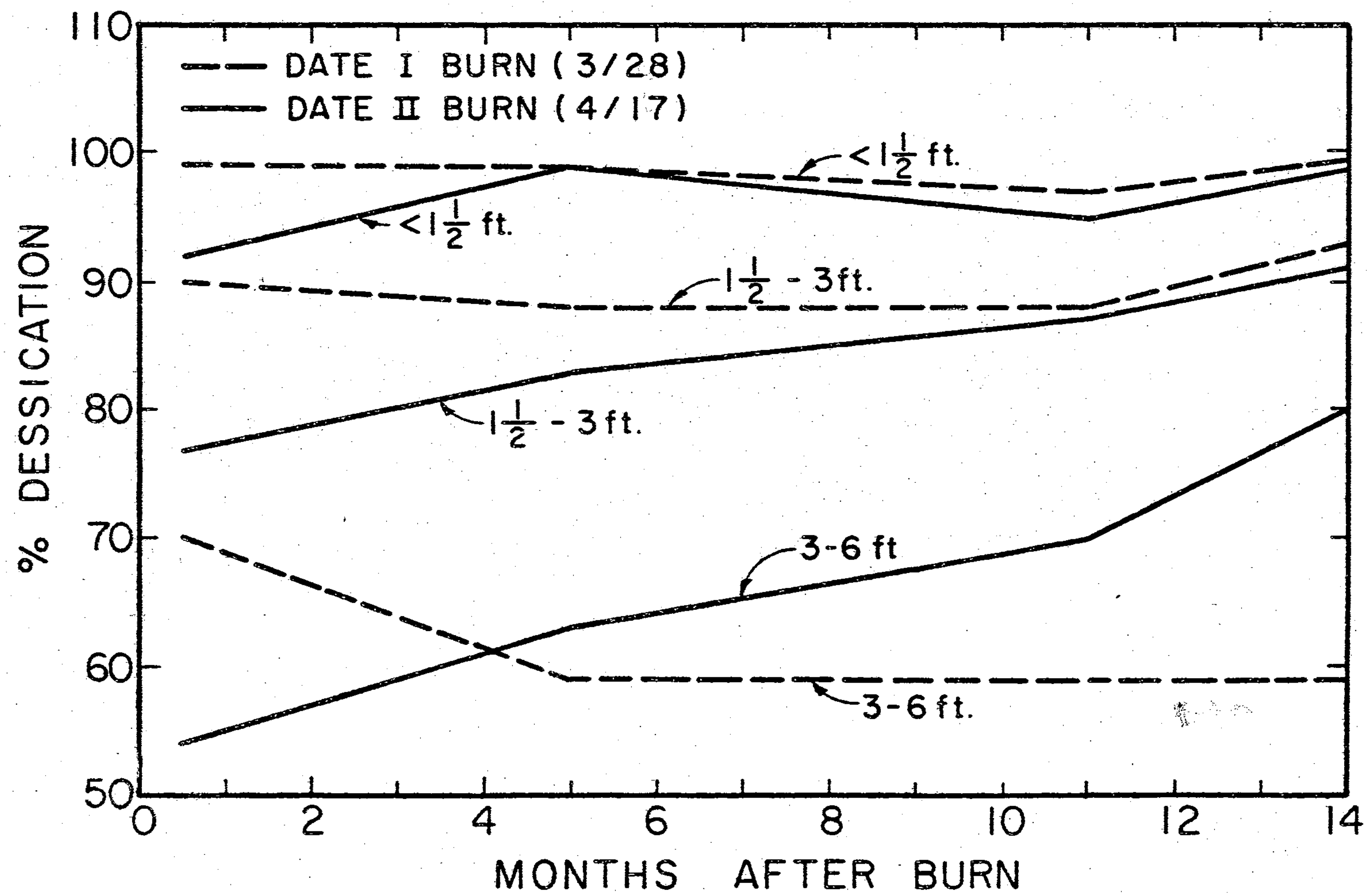

Figure 1. The Effect of Date of Burning on Different Sizes of Eastern Red Cedar

The data also indicated that tree size is an influencing factor in the response of eastern red cedar to burn. The smaller the trees the higher the percent dessication of trees at both dates.

Experiment VII: The Effect of Water-Extracts of Eastern Red Cedar Seed and Foliage on Germination and Coleoptile Length of Wheat and Native Grasses

The results (Table VI) indicated that the pH of the water-extracts were below that of distilled water (pH 7.2). The pH of the water-extracts of fresh seed, fresh foliage, and partially decomposed foliage were 4.1, 4.3, and 5.3, respectively.

The effects of the different water-extracts on germination and coleoptile length varied with the individual species. Wheat germination was not affected by any of the water-extracts, while little bluestem germination was inhibited by all of the water-extracts. Switchgrass germination was enhanced by the water-extracts of fresh seed and partially decomposed foliage.

The water-extracts had a greater effect on coleoptile length of the larger seed species (wheat) than the smaller seed species (little bluestem and switchgrass). Water-extracts of fresh seed and fresh foliage which had the lower pH's inhibited the growth of wheat coleoptiles.

Coleoptile growth of little bluestem was inhibited by all the water-extracts. However, the fresh foliage water-extracts caused the greatest inhibition. Switchgrass coleoptile growth was not significantly affected by any of the water-extracts.

The results of this study indicated that foliar, injection and

TABLE VI

THE EFFECT OF WATER-EXTRACTS OF EASTERN RED CEDAR SEED AND FOLIAGE ON GERMINATION AND COLEOPTILE LENGTH OF THREE GRASSES

		Wheat		Little Bluestem		Switchgrass	
Treatment Extracts	pH	% Germ.	Col. Length*	% Germ.	Col. Length	% Germ.	Col. Length
Distilled water	7.2	85a**	1.3a	75a	0.294a	59b	0.32a
Fresh seed	4.1	75a	0.412c	58b	0.248ab	81a	0.239a
Partially decomposed foliage	5.3	78a	1.356a	61ab	0.229ab	80a	0.287a
Fresh foliage	4.3	79a	0.591b	62ab	0.191b	61b	0.247a

*Coleoptile length (inches)
**Duncan's multiple range test, 5% significance level

granular applications of picloram effectively controlled eastern red cedar. Foliar applications of picloram in combination with 2,4-D or 2,4,5-T caused good topkill. Foliar applications of picloram in combination with 2,4-D or 2,4,5-T caused excellent topkill response. Foliar applications of paraquat alone, or, at low rates ($\frac{1}{4}$, $\frac{1}{2}$ aihg), in combination with 2,4,5-T yielded excellent response in killing the tops of eastern red cedar. However, 2,4-D and 2,4,5-T as foliar or injection treatments were ineffective. The amine formulation of 2,4,5-T at the high rate was the only injected phenoxy herbicide which yielded good dessication at the time of the final rating. Amitrole, alone, or in combination with ammonium thiocynate applied as foliar treatments were ineffective.

Dicamba, alone or in combination with 2,4,5-T showed good topkill as a foliar spray. However, as a granular treatment it was ineffective. Granular applications of fenuron and fenac at high rates caused good dessication of eastern red cedar. MonuronTCA as a granular application was ineffective. Dates of application of granular herbicides had no significant effect on their activity.

Burning showed good control of small (less than 3 ft) eastern red cedars. The smaller trees were more susceptible to burning than the larger (3-6ft) trees. Mowing as a mechanical method of controlling small (0.5-1.25 inch basal dia) eastern red cedars resulted in 22% re-sprouts. The results of cutting different size diameters of trees showed that trees with larger than 0.75 inch diameters did not re-sprout. More experimental work with the mowing of various tree diameters is necessary to substantiate the size range at which resprouting does occur.

CHAPTER V

SUMMARY

Various control methods for eastern red cedar were investigated. Chemical, mechanical, and burning procedures were studied. A laboratory study was also conducted on the effect water-extracts of eastern red cedar seed, fresh foliage, and partially decomposed foliage had on the germination and coleoptile length of wheat and two native grasses, switchgrass and little bluestem.

It was found that mowing of small eastern red cedar, as a mechanical control method, resulted in 22% of the stumps sprouting. Tree size had an influencing effect on the response obtained from burning eastern red cedar. The smaller trees (less than 3 ft) were more susceptible to burning than the larger trees (3-6 ft).

Various chemical application methods were used in investigating chemical control of eastern red cedar. The injection method was used with 3 dates of application. The spring application date of 2,4,5-T amine at the high rate was the only phenoxy herbicide which yielded good topkill. Picloram caused excellent response at 1 and 3 ml rates with no difference between dates of application. Picloram (10%), fenuron, and fenac applied as granular herbicides were effective in controlling eastern red cedar at both dates of application. MonuronTCA and picloram (2%) were ineffective.

Foliar application of picloram, alone or in combination with

2,4-D or 2,4,5-T, caused good topkill. Dicamba, Ammate-X, and 2,4-DP + 2,4-D (Brush Killer 170) at high rates yielded good response. Amitrole + NH_4SCN, 2,4-D and 2,4,5-T were ineffective as foliar applications. However, 2,4,5-T in combination with low rates of paraquat ($\frac{1}{4}$, $\frac{1}{2}$ aihg) caused good topkill. Dicamba + 2,4,5-T at high rates yielded good response. There was no difference in topkill between tree sizes. Picloram + 2,4,5-T applied at the high rate in 10 gallons total spray volume per acre yielded good topkill of eastern red cedar.

The results of the laboratory experiment on the effect water-extracts of eastern red cedar seed, fresh foliage, and partially decomposed foliage had on the germination and coleoptile length of wheat, switchgrass, and little bluestem, were variable. The distilled water treatment was used as standard for comparison. Wheat germination was not affected by any of the water-extracts, while little bluestem germination was inhibited by all of the water-extracts. Switchgrass germination was enchanced above that of the distilled water treatment with the water-extracts of fresh seed and partially decomposed foliage.

The water-extracts of fresh seed and fresh foliage inhibited the growth of wheat coleoptiles. The coleoptile growth of little bluestem was inhibited by all the water-extracts, but the fresh foliage had the greatest inhibition. Switchgrass coleoptile growth was not affected by any of the water-extract treatments.

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