THE EVALUATION OF VARIOUS HERBICIDES AND WILT FUNGUS (*CEPHALOSPORIUM DIOSPYRI*, CRANDALL) FOR CONTROL OF PERSIMMON (*DIOSPYROUS VIRGINIANA*, L.)

By

KENNETH LEE FAILES

Bachelor of Science

Oklahoma State University

Stillwater, Oklahoma

1966

Submitted to the faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the degree of
MASTER OF SCIENCE
May, 1970

THE EVALUATION OF VARIOUS HERBICIDES AND WILT FUNGUS (*CEPHALOSPORIUM DIOSPYRI*, CRANDALL) FOR CONTROL OF PERSIMMON (*DIOSPYROUS VIRGINIANA*, L.)

Thesis Approved:

Paul W. Santelmann
Thesis Adviser

J. O. Lynd

Eddie Basler
Dean of the Graduate College

N. Dunham

ACKNOWLEDGEMENTS

The author is sincerely thankful to his wife, Marcia, for kind encouragement and assistance. Deep appreciation is extended to his parents, Mr. and Mrs. Robert Failes, for their encouragement and concern throughout his entire scholastic career.

The author is grateful to his major adviser, Dr. Paul W. Santlemann, and to Mr. Harry M. Elwell for their constructive criticism, time and valuable training during this study. Thanks are extended to the other members of the author's graduate committee, Dr. J. Q. Lynd, Dr. Eddie Basler, and Dr. Glen Todd, for suggestions and advice during the course of his graduate program.

Also, appreciation is extended to Mr. Benny Eaton and Mr. Normie Buehring for their services and suggestions while establishing these experiments. Gratitude is extended to Mr. Sewell Skelton of Stillwater, Oklahoma, who consented to allow use of his property for the experiments.

The author is indebted to Mrs. Ronald Yeck for typing the final copy of this thesis.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

Common persimmon, Diospyrous virginiana L. is one of the principal woody invaders of pastures and idle cropland in Southeastern and Northeastern United States. Gould (21) states that persimmon occurs in Texas in the eastern one-half of the state on Gulf prairie and post oak-blackjack oak savanna sites. In Oklahoma, the plant mainly occurs in the eastern one-half of the state, but also occurs in widely scattered areas in western Oklahoma.

This undesirable woody plant often occurs in thickets which are referred to as groves. It grows mainly on sandy soils, but is also found growing on loam and clay soils of low productivity. The plant varies from a large shrub to small or large trees, depending upon environmental conditions. It has a stoloniferous root system including a taproot, according to Van Dersal (43). The plant will withstand considerable abuse in handling and is considered drought resistant. Ranchers in the Jennings, Oklahoma, community have found the fruit toxic to livestock and causes weight loss and poor animal performance.

Persimmon competes with grasses for moisture, plant nutrients, sunlight and space. This warrants its classification as a weedy plant by the rancher who is trying to produce grass for his livestock.

CHAPTER II

LITERATURE REVIEW

Foliage Treatments For Persimmon Control

The recommended foliage treatment for control of persimmon in Oklahoma is one pound per acre (lb/A) of low volatile ester of 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) in three gallons of diesel oil-water emulsion as the carrier with retreatments as necessary (22). Ray (36) states persimmon has shown a high degree of resistance to aerial application of two lb/A of 2,4,5-T as a low volatile formulation with one gallon of diesel oil and three and one-half gallons of water per acre as carrier. Ester and amine formulations of 2,4-D (2,4-dichlorophenoxyacetic acid) and 2,4,5-T at one and two lb/A gave ineffective control of mature plants under East Texas conditions according to Frey (19). It appears that persimmon is not equally controlled by the same treatments in different locations.

All the above foliage treatments were applied with less than forty gallons per acre of carrier solution. Another method of applying herbicides to the foliage is the wetting spray method. In this method the herbicide is further diluted in the carrier and applied to the foliage until the spray runs off the leaves. Elwell (17) reports that .50, .75, 1.00, 1.50 and 2.00 pounds of 2,4,5-T ester in one hundred gallons of water per acre applied as a wetting spray all produced about 75% control. Peters and Stritzke (35) found dicamba (dimethylamine salt

of 2-methoxy-3,6-dichlorobenzoic acid) to be superior to 2,3-6-TBA (2,3,6-trichlorobenzoic acid) as a wetting spray treatment. Behrens et al. (2) states this method of application is only practical when a large supply of water is readily available and it is usually used only on small treatment areas.

Some research workers (17, 20) have reported an increase in control of persimmon by using phenoxy compounds in combination with picloram (4-amino-3,5,6-trichloropicolinic acid). Hamaker et al. (26) found picloram to be highly toxic to broadleaf plants but only moderately toxic to grasses. Watson and Wiltse (39) state that picloram produces less resprouting when used on persimmon than 2,4,5-T and is more effective at low concentrations. Wiltse (42) found picloram to be readily translocated in plants and is rapidly absorbed by both roots and leaves. Good defoliation of persimmon with picloram has been reported by Peters and Stritzke (34). Nation and Lichy (31) found picloram to be superior to 2,4,5-T for persimmon control.

Persimmon susceptibility to phenoxy compounds is apparently quite variable. Klingman and Shaw (27) report that persimmon shows poor susceptibility to 2,4-D and 2,4,5-T and only fair susceptibility to silvex (2-(2,4,5-trichlorophenoxy) propionic acid). Elwell (14) found persimmon generally not killed with 2,4,5-T aerial applications but it was defoliated with 2,4-D or 2,4,5-T.

Growth conditions of the plant and environmental conditions effect the results of foliar sprays. Peevy (33) states that foliar sprays are more effective soon after full leaf development in the spring and become less effective soon afterward. Elder and Dreessen (12) found that good soil moisture periods which caused active plant growth

resulted in better defoliation by herbicides; also, foliar applications of 2,4-D or 2,4,5-T caused quick leaf drop, usually with little effect on the plants. Elwell (16) states oaks (Quercus spp.) are easier killed when the plants are recovering from drought stress and when they occur on upland or droughty soils. Woody plants recovering from a recent fire are not effectively controlled with 2,4,5-T in foliar applications. In addition, he found that persimmon with leaf diseases have not been controlled satisfactorily with 2,4,5-T. Miller and Starr (30) reported that it is necessary for woody plant roots to be in a stage of meristematic activity before herbicides will be effective.

Herbicide formulations also have an effect on control of persimmon by foliar spray. Leonard and Harvey (28) found the ester formulations of phenoxy herbicides are usually superior to oil soluble or water soluble amine formulations. Also woody plants are less sensitive when growth is stopped due to exhaustion of soil moisture. Fisher (18) reported a dormant wetting spray of 2,4,5-T at six to eight lb/A as having promising results on persimmon.

Injection Treatment For Persimmon Control

This method was carried out by placing the herbicide in notches or cuts made at the base of the tree. For every inch DBH (diameter at breast height) one notch was made. An injector is a hollow tube with a cutting edge used to make these treatments. The chemical is placed in the tube.

Peevy (33) suggests that four pounds of 2,4,5-T in nineteen gallons of diesel oil with eight ml per inch diameter should be used for persimmon control by the injection method. Elwell (15) obtained good

control of persimmon using 2,4,5-T ester in a ratio of one gallon of 2,4,5-T to nine gallons (1:9) of kerosene or diesel oil. Using undiluted 2,4-D amine Cech and Mulder (3) report only 57% defoliation.

Injection treatments can be made throughout the year, but are usually more effective from late fall through early summer (17, 38). Greer (22) suggests using 2,4,5-T in a ratio of 1:9 in diesel oil with five ml per injection or one ml of undiluted 2,4-D. Peevy (33) found that the injection should be spaced no more than one inch apart and to a depth of three to four inches in trees of adequate diameters.

Basal Bark Treatments For Persimmon Control

This method is accomplished by spraying the bark around the base of the tree until the point of saturation is reached, usually treating the basal twelve inches of the trunk. Behrens et al. (2) reported that this method is usually the most effective way to kill brush and small trees. Elwell (16) states that twelve pounds of 2,4,5-T per one hundred gallons of diesel oil used this way will control hard-to-kill species such as persimmon.

Nichols (32) working in Missouri showed that 2,4,5-T at four pounds per one hundred gallons of diesel oil, on trees less than two inches in diameter, resulted in good control of persimmon. Martin (29) recommended basal bark treatments rather than foliar spray application due to resprouting.

Darrow and Frey (10) found 2,4,5-T superior to 2,4-D for control of persimmon by the basal bark method. Elder and Gassaway (13) reported that twenty pounds of 2,4,5-T per one hundred gallons of diesel oil gave 100% top kill when applied to persimmon as a basal bark treatment.

Zahnley and McCall (44) used one hundred gallons of diesel oil with sixteen to thirty-two pounds of 2,4,5-T to obtain good persimmon control. Dicamba was superior to 2,4,5-T in basal bark treatments for persimmon control (25, 34).

When persimmons are cut down and herbicides applied to the cut stump surface similar results are obtained. Frey (19) found dormant treatments of 2,4,5-T applied to the cut stump more effective than during the growing season. Davis (11) reported that basal applications of 2,4,5-T are more effective when painted on cut stumps than on the bark.

Soil Treatments For Persimmon Control

Three general methods of applying herbicides to brush by this treatment method are used; namely, broadcasting granular materials, applying granules at the base of the tree and applying liquid materials at the base of the tree.

Dicamba granules used at one and two teaspoons per inch DBH gave excellent kill for Haas et al. (25) and was superior to 2,4,5-T and fenuron (3-phenyl-1,1-dimethylurea), when applied during late winter. Peters and Stritzke (34, 35) found that dicamba liquid sprayed at the base of the tree on the soil surface at eight and sixteen lb/A gave good control of persimmon.

Picloram pellets used at seven and one-half lb/A gave good defoliation of brush according to Wiltse (42). Peters and Stritzke (34) used picloram pellets at 1.25, 2.50, 5.00 and 10.00 lb/A and found defoliation of persimmon to be 60, 85, 94, and 99% respectively.

Darrow et al. (9) found little control of persimmon by using six

lb/A of fenuron. Cech and Mulder (3) reported that 3.4 lb/A of fenuron was ineffective for persimmon control. Elwell (17) reported poor results when using fenuron at 6, 8, 12, and 15 lb/A on persimmon.

Persimmon Wilt For Persimmon Control

Persimmon wilt, caused by Cephalosporium diospyri Crandall, is a fast-killing vascular wilt of the common persimmon and was first reported by Crandall and Davidson (8), from central Tennessee in 1936.

From this first report the wilt fungus has swept across several counties in Tennessee, practically eliminating persimmon in some areas. Later the disease was found in Mississippi, Alabama, Georgia, South Carolina, Florida, Texas and Oklahoma (1, 5). Chester (4) states that the disease appeared to be established in Oklahoma in 1939 near Cushing and Stillwater in Payne County. Chester found visual symptoms of the dying trees to be similar to those reported by Crandall in Tennessee, except that no spores were produced by the mycelium.

Wilting apparently occurs when gums are produced by the tree in the water-conducting vessels (xylem). These gums could be produced as a result of irritation by the fungus or in response to an irritant produced by it. This disease, which stops the upward movement of water and nutrients in the vessels of the tree, is characterized internally by fine brownish-black streaks throughout the wood of the outer annual rings.

Wilson (41) was able to isolate and identify this disease from infested persimmon trees in northwestern Arkansas in 1968, but the landowner indicated that he had observed persimmons dying in a similar manner for the past ten years.

Toole and Lightle (37) observed the disease in abundance in Pontotoc County, Oklahoma in 1960. They further stated that their observations showed no presence of the disease in Alabama, Arkansas, Louisiana, Mississippi, and Tennessee since 1952, even in areas where it was formerly common. Toole and Lightle (37) found that in parts of Tennessee, where the disease was first reported, wilt has practically eliminated the host as a dominant species. Except for some locations in Tennessee and possibly Oklahoma, wilt does not appear to have affected the prevalence of persimmon.

External symptoms of the disease are the wilting of the foliage from the terminal part of the plant then extending to the main part of the plant. This is followed by a foliar yellowing and then rapid defoliation, two months often being enough time from injection of the disease into the plant till death of the entire plant. A less common symptom of a tree that was infected late in the previous season is the appearance of small, chlorotic leaves. A tree so affected often lives one or two years after these symptoms first appear.

In culture, Crandall (6) found the mycellium to be fluffy and pinkish white in color. Best laboratory cultural temperature is 30° C., with a narrow range, according to Crandall (6).

The disease attacks only the common persimmon Diospyrous virginiana L. according to Crandall (6). The Asiatic persimmons D. lotus and D. kakiare are highly resistant to Cephalosporium diospyri, although not immune (7).

Wilson (40) states that the use of persimmon wilt fungus as a biological control of persimmon has advantages over the use of herbicide. Among these advantages are: the fungus can be increased rapidly

in the laboratory, it is relatively stable and resistant to adverse environmental conditions, the disease develops rapidly and the fungus will invade the root system of an infected tree and kill subsequent sprouts.

Griffith (23, 24) found the best method of inoculation was by using one petri dish of the mycelium growth diluted in one quart of distilled water and then three to five drops of the media placed in incisions made one to two inches into the wood of persimmon trees. He further states that trees with a diameter of three to ten inches are resistant to persimmon wilt longer than those with a diameter of one to four inches. Griffith also states that the best time of inoculation is two weeks before the buds open on the persimmon trees.

CHAPTER III

METHODS AND MATERIALS

The research field work was conducted on the Sewell Skelton Farm fifteen miles east of Stillwater, Oklahoma, unless otherwise indicated. This area is an upland tall-grass prairie that has scattered groves of persimmon. Soils of the area belong mainly to the Collinsville series, which are shallow to very shallow lying over noncalcareous sandstone and sandy shale.

Winter Injection Treatments

This experiment was designed to evaluate certain herbicides for persimmon control by the injection method and to determine the most effective dilution of the herbicides. Using the R. W. Little tree injector one notch was made per inch DBH to a depth of approximately one-half inch into the wood. The herbicides were then injected into these notches at a rate of one ml per notch with an automatic syringe. The herbicides were used undiluted or were diluted either in water or diesel oil. Treatments were made on February 3, 1966, with ten replications per treatment in a randomized block design. The air temperature was 42° C. and the soil temperature was 28° C. at the time of treatment. The persimmon trees were dormant when the herbicides were applied.

The treatments used were: picloram (4-amino-3,5,6-trichloro-

picolinic acid) undiluted, diluted in water in ratios of 1:9[1], 1:18, 1:36 and 1:72; a commercial mixture of picloram and 2,4-D (which contained .54 lb. of picloram as the potassium salt and 2.00 lbs. of 2,4-D as the triisopropanolamine salt as acid equivalents per gallon) undiluted and diluted in water at 1:9 and 1:18; cacodylic acid (dimethylarsinic acid) undiluted and diluted in water to 1:9; dicamba (2-methoxy-3,6-dichlorobenzoic) undiluted and diluted in water to 1:9 ratio; 2,4-D amine (dimethylamine salt of 2,4-D) undiluted and diluted in water at 1:9 and 1:18 ratios; 2,4-D oil soluble amine (N-oleyl-1; 3-propylenediamine salt of 2,4-D) undiluted and diluted in water at the 1:9 and 1:18 ratios; and 2,4,5-T ester (propylene glycol butyl ether esters) diluted in diesel oil in ratios of 1:9 and 1:18.

Broadcast Granular Soil Treatments

Granular applications of four herbicides at various rates were applied to the soil in persimmon groves as a uniform ground coverage by hand broadcasting. Each treatment was applied to an area of one-sixtyforth (.0156) acre with three replications. The persimmon trees were quite dense with an average of 2.9 square feet per tree or 1446 trees per acre. The trees were approximately fifteen feet in height with diameters of two to four inches. The persimmon trees were approximately one-half in bud stage at time of treatment on April 4, 1966.

The treatments were as follows: picloram (10K pellets) at 1, 2 and 3 lbs. active ingredient per acre (lb ai/A); fenuron (25% pellets) at 3 and 6 lb ai/A; dicamba (25% granules) at 6 and 9 lb ai/A; Niagara

---

[1] A ratio of one part by volume of the herbicide to nine parts by volume of the carrier.

11092 (1,1-dimethyl 3-3-(N-tert-butylcarbamyloxy) phenyl urea) (formulated as 5% granules) at 15 lb ai/A.

Basal Bark And Individual Tree Granular Treatments

This experiment was designed to evaluate basal bark treatments for persimmon control. The herbicides were applied in three ways:

1. Dicamba 25% granules at rates of one and two tablespoons per inch DBH were placed in a six inch radius around the base of ten randomly selected persimmon trees with one inch of soil covering the herbicide.

2. Basal bark application of 2,4,5-T (propylene glycol butyl ether ester) in a ratio of 1:9 with diesel oil, applied with a hand sprayer.

3. Basal bark application of dicamba liquid, applied with a hand sprayer to the basal six inches of the persimmon trees at rates of 4 and 8 pounds per one hundred gallons of water.

The second and third methods each were applied at one pint of the spray mix per tree. In all treatments ten random selected trees were treated. Application date was May 19, 1967, when the air temperature was 72° F. and the soil temperature was 70° F. at the time of treatment. The plants were in full leaf stage.

Foliage Spray Treatments - I

Twelve herbicidal treatments were applied to persimmon as a foliar spray treatment. This experiment was designed to evaluate the defoliation of persimmon when using 2,4,5-T alone and in combination with other herbicides.

The herbicides were applied to ten randomly selected trees of four to six feet in height using ten gallons per acre of carrier. The ten gallons per acre was applied by using a stop watch to determine the spray volume necessary. A hand sprayer using a fan type nozzle was used to apply the herbicides to the trees which were enclosed in a four feet square frame covered with polyethylene plastic to prevent drift. Application date was June 8, 1966, when the air temperature was 70° F. The persimmon trees were in full leaf stage.

Treatments were as follows: 2,4,5-T (formulated as the propylene glycol butyl ether esters) at .25 and .75 lb/A; picloram at .25 lb/A; 2,4,5-T at .75 lb/A plus picloram at .25 lb/A and .13 lb/A; 2,4,5-T at .25 lb/A plus picloram at .25 lb/A; 2,4,5-T at .25 lb/A plus Niagara 11092 (an experimental chemical compound of Niagara Chemical Company) at .25 and .50 lb/A; 2,4,5-T at .75 lb/A plus Niagara 11092 at .25 lb/A; 2,4,5-T at .25 lb/A plus amitrol-T (3-amino-1,2,4-triazole) at .10 and .20 lb/A; 2,4,5-T at .75 lb/A plus amitrol-T at .20 lb/A.

Foliage Spray Treatments - II

This experiment was designed to evaluate combinations of various herbicides with 2,4,5-T for control of persimmon. The treatments were applied to five trees using a hand sprayer in an enclosure as in the previous experiment, using a total volume of ten gallons per acre. The trees were four to six feet in height and in full leaf. The experiment was located on the Maxwell Farm two miles west and three miles south of Stillwater, Oklahoma. The treatments were applied on July 6, 1966, with an air temperature of 86° F. and a wind velocity of 8 to 15 mph. Treatments are shown in Table I.

TABLE I

FOLIAGE SPRAY TREATMENTS - II

Herbicide(s)	Pounds a.e. per acre	Carrier
amitrol-T	.25	water
amitrol-T	.50	water
NH_4SCN	.25	water
NH_4SCN	.50	water
amitrol-T + NH_4SCN	.25 + .25	water
amitrol-T + NH_4SCN	.50 + .50	water
2,4,5-T	1.00	water
2,4,5-T	1.00	oil-water
2,4,5-T + amitrol-T	1.00 + .25	water
2,4,5-T + NH_4SCN	1.00 + .25	water
2,4,5-T + amitrol-T + NH_4SCN	1.00 + .25 + .25	water
2,4,5-T + amitrol-T + NH_4SCN	1.00 + .50 + .50	water
2,4,5-T + amitrol-T + NH_4SCN	1.00 + .50 + .50	oil-water
2,4,5-T + NH_4SCN + triton Gr 7	1.00	water
2,4,5-T + NH_4SCN + triton Gr 7	1.00	oil-water
2,4,5-T + picloram	1.00 + .25	water
2,4,5-T + picloram	1.00 + .13	water

Foliage Spray Treatments - III

Several herbicides alone and in combinations were applied to small trees one to three feet tall. Plots of ten feet by fifty feet were sprayed with a tractor using a ten foot boom with fan type Teejet 8003 nozzles. Two plots per treatment were randomly selected and treated July 26, 1967. Ten gallons of carrier was used per acre. Each plot contained an average of thirty-two plants that were one to three feet in height. The persimmon plants were in full leaf at treatment date. Treatments are shown in Table II.

Seedling Foliage Spray Treatments

This experiment was designed to determine the effect of 2,4,5-T dicamba, paraquat (1,1-dimethyl-4,4'-bipridinium as salts) and picloram as foliage spray treatments on greenhouse-grown seedlings of persimmon. The treatments were applied to persimmons that were germinated in March of 1967 and grown in six inch plastic pots in a greenhouse until treatment date of August 9, 1967. An enclosed spray chamber using forty gallons per acre of carrier was used to apply the herbicides to the plants. After treatment the plants were placed out-of-doors and watered regularly until September 30, 1967, when they were placed in the greenhouse until evaluation on December 16, 1967.

The treatments were: dicamba at 1, 2 and 5 lb/A; 2,4,5-T (propylene glycol butyl ether ester) at .50 and .75 lb/A; picloram at .06, .13, .25 and .50 lb/A; paraquat at .13, .25 and .50 lb/A; paraquat at .13, .25 and .50 plus a surfactant at 1% of the total spray volume.

TABLE II

FOLIAGE SPRAY TREATMENTS - III

Herbicide(s)	Pounds a.e. per acre	Carrier
picloram	.06	water
picloram	.13	water
picloram	.25	water
picloram + 2,4,5-T	.06 + 1.00	water
picloram + 2,4,5-T	.13 + 1.00	water
picloram + 2,4,5-T	.25 + 1.00	water
picloram + 2,4,5-T[1]	.13 + 1.00	oil-water
picloram + 2,4,5-T[1]	.25 + 1.00	oil-water
2,4,5-T	.50	water
2,4,5-T	.75	water
dicamba	1.00	water
dicamba + 2,4,5-T	1.00 + 1.00	water
dicamba + 2,4,5-T	2.00 + 1.00	water
2,4,5-T	1.00	water
2,4,5-T[1]	1.00	oil-water
NH_4SCN[2] + amitrol-T	.25 + .25	water
NH_4SCN[2] + amitrol-T	.50 + .50	water
amitrol-T + 2,4,5-T	.25 + 1.00	water
NH_4SCN[2] + 2,4,5-T	.25 + 1.00	water
amitrol-T + 2,4,5-T + NH_4SCN	.50 + 1.00 + .50	water
2,4,5-T[1]	1.00	water

[1] Also contained extra emulsifiers + NH_4SCN.
[2] Ammonium thiocyanate.

Persimmon Wilt

In working on the persimmon wilt fungus, a culture of the organism was obtained from the Samuel Roberts Noble Foundation of Ardmore, Oklahoma. The Foundation had received their culture from the American Type Culture Collection of Washington, D. C. This original culture was increased in petri dishes containing yeast-malt agar. One petri dish was then diluted in one quart of distilled water and three to five drops of mycellium-water media were placed in incisions made by hatchet for inoculation purposes. One cut approximately one inch deep was made by the hatchet per tree.

Another means of isolating the disease was by collecting streaked wood and gum from a natural infestation of the disease. This infestation occurred on the Sewell Skelton Farm fifteen miles east of Stillwater, Oklahoma. The wood was collected and cut into pieces approximately one-eighth inch by one-forth inch by one-half inch. The gum was collected and smeared into the hatchet cuts of the persimmon trees. The inoculated trees that had the black vascular streaking of the wood were considered to possess the disease organism.

Percent of Grove Inoculation Study

This experiment was designed to inoculate a certain percentage of persimmon trees in a grove with the mycelium-water media produced in the laboratory and then record the number of trees that had the disease after one and two growing seasons. Levels of 20, 40 and 80% were used on groves containing forty trees each. The grove that had 20% of the 40 trees inoculated contained 8 inoculated trees, whereas, 16 and 32 trees were inoculated in the 40 and 80% inoculated groves respectively.

All 40 trees in these three groves were evaluated for the presence of the disease at 22 and 68 weeks after treatment on April 10, 1967. The treatments were not replicated and treated when the buds had opened on the persimmon trees.

Effect of Tree Size on Wilt Inoculated Persimmons

This experiment was designed to evaluate the effect of tree size on the number of persimmons contracting the disease after inoculation. The same method as used in the previous experiment was employed for distribution of the persimmon wilt mycelium. Trees of 2 to 4 inches and 4 to 6 inches DBH were inoculated on April 10, 1967 and evaluated 22 and 68 weeks later. Ten trees of each of the three average DBH (1.4, 3.8 and 5.6 inches) were inoculated on April 10, 1967 and evaluated 22 and 68 weeks later.

Use of Wood and Gum From Diseased Trees As Inoculation Material

Wood and gum from a natural infestation of persimmon wilt were used to inoculate healthy trees in this experiment. The wood was collected and cut into pieces approximately one-eighth inch by one-forth inch by one-half inch. The gum was collected from the diseased trees and smeared into cuts made by a hatchet into healthy persimmon trees. The wood was placed into hatchet cuts of ten healthy persimmon trees. The size of inoculated trees ranged from two to four inches DBH. Treatments were made August 9, 1967, and evaluated 6 and 52 weeks later.

CHAPTER IV

RESULTS AND DISCUSSION

All herbicidal experiments were evaluated as to percent defoliation of the persimmon plant by visual estimation. The plants were observed individually and then a mean percent defoliation was calculated for each treatment compared to a check of untreated plants.

Duncan's New Multiple Range Test was used as a test criterion for describing statistical differences. Treatments followed by the same letter are not different at the .05 level.

Winter Injection Treatments

The results of winter injection treatments are shown in Table III. Only six of the twenty-two treatments resulted in 80% or more defoliation 131 weeks after treatment. There was no difference in the effect of picloram undiluted or dilutions of 1:9 or 1:18, but greater dilution decreased defoliation. The remaining sixteen treatments had 53% defoliation or less 131 weeks after the herbicides were applied.

The amine formulation of 2,4-D, oil soluble amine of 2,4-D and 2,4,5-T ester treatments resulted in low defoliation of persimmon, which is not in agreement with previous research (15). There was no difference between dilution ratios when using 2,4,5-T ester of 2,4-D oil soluble amine or between the two herbicides.

Water and diesel oil were used as carriers of 2,4-D oil soluble

TABLE III

THE EFFECT OF INJECTED HERBICIDES ON THE PERCENT DEFOLIATION OF PERSIMMON AT THREE INTERVALS AFTER TREATMENT

Herbicide(s)	Dilution	Carrier	% Defoliation 27 weeks	83 weeks	131 weeks
2,4,5-T + dicamba	undiluted	-	92 abc	100 a	100 a
2,4,5-T + dicamba	1:9	water	78 abc	99 a	100 a
picloram	undiluted	-	99 a	100 a	100 a
picloram	1:9	water	88 ab	93 a	95 a
picloram	1:18	water	72 bc	87 a	80 a
picloram	1:36	water	33 de	27 bcde	20 defg
picloram	1:72	water	2 f	4 de	5 fg
picloram + 2,4-D	undiluted	-	84 abc	89 a	90 a
picloram + 2,4-D	1:9	water	15 ef	27 cde	45 bc
picloram + 2,4-D	1:18	water	41 d	41 b	30 cdef
cacodylic acid	undiluted	-	62 c	80 a	53 b
cacodylic acid	1:9	water	10 ef	0 e	0 g
2,4-D amine	undiluted	-	22 def	28 bcde	34 cdef
2,4-D amine	1:9	water	24 def	31 bcd	42 bcd
2,4-D amine	1:18	water	32 def	37	37 bcde
2,4-D OSA[1]	undiluted	-	7 f	9 cde	10 efg
2,4-D OSA[1]	1:9	water	2 f	11 cde	22 defg
2,4-D OSA[1]	1:18	water	2 f	5 de	4 fg
2,4-D OSA[1]	1:9	oil	0 f	29 bcde	28 cdefg
2,4-D OSA[1]	1:18	oil	0 f	0 e	0 g
2,4,5-T ester	1:9	oil	0 f	0 e	0 g
2,4,5-T ester	1:18	oil	0 f	0 e	0 g

[1] Oil soluble amine.

amine with no difference at three evaluation dates. There was difference between 2,4-D amine and 2,4-D oil soluble amine 131 weeks after treatment, but not at 27 and 83 weeks after treatment when water was used as a carrier.

Generally, picloram alone or in combination with 2,4-D treatments increased in % defoliation as time increased after treatment. In comparing treatments of picloram, 2,4-D amine and the combination of these two herbicides, picloram treatments resulted in greater defoliation.

When dicamba and 2,4,5-T were combined in equal volumes the defoliation was 100% or complete death of the persimmon trees, while 2,4,5-T alone showed no defoliation 131 weeks after treatment.

Broadcast Granular Soil Treatments

The defoliation caused by soil applied herbicides is shown in Table IV. These treatments showed that dicamba gave satisfactory control of persimmon at the rates used. Fenuron, a substituted urea herbicide, was not satisfactory in controlling persimmon. The experimental herbicide Niagara 11092 did not defoliate persimmon at the 15 lb a.i./A rate. Picloram treatments at 1, 2 and 3 lb a.i./A resulted in no difference 118 weeks after treatment and apparently would need a higher rate for satisfactory control of persimmon.

Basal Bark Treatments

The results of basal bark treatments and soil applied herbicides are shown in Table V. All treatments gave satisfactory defoliation of persimmon with no difference between herbicides or rates of application.

TABLE IV

THE EFFECT OF SOIL APPLIED GRANULAR HERBICIDES ON PERSIMMON DEFOLIATION AT TWO INTERVALS AFTER TREATMENT

Herbicide	lb a.i./A	% Defoliation 74 weeks	% Defoliation 118 weeks
dicamba	9	82 a	83 a
dicamba	6	80 a	70 a
picloram	3	60 a	46 b
picloram	2	52 a	42 b
picloram	1	31 b	38 b
fenuron	6	19 b	19 c
fenuron	3	12 b	15 c
Niagara 11092	15	30 b	5 c

TABLE V

THE EFFECT OF HERBICIDES APPLIED ON THE SOIL AND BASAL BARK ON PERSIMMON DEFOLIATION 22 AND 62 WEEKS AFTER TREATMENT

Herbicide	Application Rate	% Defoliation 22 weeks	% Defoliation 62 weeks
dicamba	1 Tb/inch DBH	88 a	63 a
dicamba	2 Tb/inch DBH	90 a	88 a
dicamba	4 lb/100 gal. water	94 a	51 a
dicamba	8 lb/100 gal. water	98 a	91 a
2,4,5-T ester	12 lb/100 gal. water	80 a	71 a

Foliage Spray Treatments - I

The results of the first set of foliar spray treatments are shown in Table VI. The combinations of picloram and 2,4,5-T gave better defoliation of persimmon than 2,4,5-T alone, but was not statistically different and not better than picloram alone. The addition of Niagara 11092 or of amitrol-T to 2,4,5-T resulted in control equal to or less than 2,4,5-T alone.

The .25 lb/A rate of 2,4,5-T alone or in combination with picloram or amitrol-T or Niagara 11092 gave better defoliation than 2,4,5-T at .75 lb/A alone or in combinations. Picloram at .25 lb/A gave excellent control of persimmon.

In comparing the two intervals of evaluation, all treatments, except 2,4,5-T at .75 lb/A plus picloram at .13 lb/A, resulted in greater defoliation on the second evaluation date.

Foliage Spray Treatments - II

The defoliation resulting 53 and 102 weeks after foliar treatments with several herbicides at a different location is shown in Table VII. Nine of the seventeen treatments containing 2,4,5-T alone or in combination with other herbicides caused defoliation of 94% or better. In this experiment no additives were needed to increase the action of 2,4,5-T. Treatment without 2,4,5-T gave lower defoliation. Treatments using water versus oil-water emulsion carrier resulted in no difference in defoliation percentages.

TABLE VI

EFFECT OF FOLIAR APPLIED HERBICIDES ON PERSIMMON DEFOLIATION
53 AND 102 WEEKS AFTER TREATMENT

Herbicide(s)	lb/A	% Defoliation	
		53 weeks	102 weeks
picloram	.25	100 a	100 a
2,4,5-T	.75	10 c	80 abc
2,4,5-T	.25	54 a	80 abc
2,4,5-T + picloram	.75 + .25	100 a	100 a
2,4,5-T + picloram	.75 + .13	98 a	90 ab
2,4,5-T + picloram	.25 + .25	100 a	100a
2,4,5-T + amitrol-T	.75 + .20	0 c	38 d
2,4,5-T + amitrol-T	.25 + .20	26 bc	80 abc
2,4,5-T + amitrol-T	.25 + .10	44 b	74 abcd
2,4,5-T + Niagara 11092	.75 + .25	10 c	44 cd
2,4,5-T + Niagara 11092	.25 + .50	54 b	62 bcd
2,4,5-T + Niagara 11092	.25 + .25	14 c	80 abc

TABLE VII

THE EFFECT OF FOLIAR APPLIED HERBICIDES ON PERSIMMON DEFOLIATION 53 AND 106 WEEKS AFTER TREATMENT

Herbicide(s)	lb/A	% Defoliation 53 weeks	% Defoliation 106 weeks
2,4,5-T + NH_4SCN + amitrol-T	1.00 + .50 + .50	100 a	100 a
2,4,5-T + NH_4SCN + amitrol-T	1.00 + .50 + .50[1]	90 a	100a
2,4,5-T + NH_4SCN + amitrol-T	1.00 + .25 + .25	100 a	100a
2,4,5-T + NH_4SCN	1.00 + .25	100 a	100a
2,4,5-T + amitrol-T	1.00 + .25	100 a	100 a
2,4,5-T[2]	1.00	100 a	100 a
2,4,5-T[2]	1.00[1]	98 a	100 a
2,4,5-T	1.00	100 a	100 a
2,4,5-T	1.00[1]	100 a	94 ab
2,4,5-T + picloram	1.00 + .25	94 a	76 abc
2,4,5-T + picloram	1.00 + .13	92 a	56 cd
NH_4SCN + amitrol-T	.50 + .50	64 b	60 bcd
NH_4SCN + amitrol-T	.25 + .25	88 ab	32 de
NH_4SCN	.50	34 cd	10 f
NH_4SCN	.25	46 c	14 ef
amitrol-T	.50	20 d	0 f
amitrol-T	.25	34 cd	0 f

[1] Carrier was an oil-water emulsion.

[2] Contains extra emulsifiers plus NH_4SCN.

Foliar Spray Treatments - III

In Table VIII the results of foliage spray treatments III are shown. In general, this set of treatments resulted in less defoliation at the final evaluation interval than did treatment sets I and II. This could have been the result of several factors: (1) soil moisture content was lower in the third set of treatments, only 11%, while the soil was moist by feel but not determined in sets I and II; (2) in treatment set III the persimmon trees were only one to three feet in height; (3) in treatment set III the herbicides were applied with a tractor and ten foot boom while in sets I and II a hand sprayer was used to treat individual trees.

Six weeks after treatment the defoliation readings of foliar spray treatment III were considerably higher than readings taken 47 weeks after treatment. Only three treatments resulted in satisfactory defoliation 47 weeks after treatment; these were: dicamba at 1 lb/A, dicamba at 1 lb/A plus 2,4,5-T at 1 lb/A and picloram at .25 lb/A plus 2,4,5-T at 1 lb/A. Treatments of picloram alone or 2,4,5-T alone were not satisfactory. Dicamba at 1 lb/A was not different than dicamba at 1 lb/A plus 2,3,5-T at 1 lb/A but was significantly higher in defoliation than 2,4,5-T alone. The only treatment that increased in defoliation between the two evaluation dates was picloram at .25 lb/A.

Treatments that contained diesel oil as a part of the carrier resulted in less defoliation than did treatments with water as a carrier.

Foliage Spray Treatments - Seedling Trees

The defoliation of greenhouse-grown persimmon seedlings is shown in Table IX. Paraquat caused complete defoliation of the seedlings

TABLE VIII

THE EFFECT OF FOLIAR (III) APPLIED HERBICIDES ON PERSIMMON DEFOLIATION 6 AND 47 WEEKS AFTER TREATMENT

Herbicide(s)	lb/A	% Defoliation 6 weeks	% Defoliation 47 weeks
2,4,5-T	1.00	99 a	30 bc
2,4,5-T[2]	1.00	94 a	12 cd
2,4,5-T	.75	86 a	12 cd
2,4,5-T	.50	88 a	22 bc
dicamba	1.00	88 a	77 a
2,4,5-T + dicamba	1.00 + 2.00	99 a	49 b
2,4,5-T + dicamba	1.00 + 1.00	97 a	88 a
picloram	.25	31 b	34 bc
picloram	.13	19 b	17 cd
picloram	.06	19 b	2 d
2,4,5-T + picloram	1.00 + .25	98 a	72 a
2,4,5-T + picloram	1.00 + .25[1]	97 a	46 b
2,4,5-T + picloram	1.00 + .13	93 a	44 b
2,4,5-T[2] + picloram	1.00 + .13	90 a	42 b
2,4,5-T + picloram	1.00 + .06	98 a	30 bc
2,4,5-T + NH_4SCN + amitrol-T	1.00 + .50 + .50	99 a	5 d
2,4,5-T + NH_4SCN	1.00 + .25	97 a	10 cd
2,4,5-T + amitrol-T	1.00 + .25	88 b	15 cd
NH_4SCN + amitrol-T	.50 + .50	16 b	7 d
NH_4SCN + amitrol-T	.25 + .25	13 b	41 b

[1] Carrier was an oil-water emulsion.

[2] Contains extra emulsifiers plus NH_4SCN.

approximately two weeks after treatment but these results of paraquat treatments were only temporary as new foliage was produced by the end of a seventeen week period. The use of a surfactant with paraquat did not increase kill or defoliation of seedling persimmons. Picloram at .25 and .50 lb/A and 2,4,5-T at .50 and .75 lb/A defoliated and killed persimmon seedlings satisfactorily. Picloram at .13 and .06 lb/A resulted in poor defoliation and kill of persimmon seedlings.

TABLE IX

THE EFFECT OF FOLIAR APPLIED HERBICIDES ON DEFOLIATION AND KILL OF GREENHOUSE-GROWN, SEEDLING PERSIMMONS 17 WEEKS AFTER TREATMENT

Herbicide	lb/A	% Defoliation	% Kill
picloram	.50	100 a	100
picloram	.25	83 a	70
picloram	.13	48 b	10
picloram	.06	10 c	0
2,4,5-T	.75	99 a	90
2,4,5-T	.50	98 a	80
paraquat + surfactant	.50	10 c	0
paraquat	.50	0 c	0
paraquat + surfactant	.25	0 c	0
paraquat	.25	0 c	0
paraquat + surfactant	.13	0 c	0
paraquat	.13	0 c	0

Persimmon Wilt - Percent of Grove Inoculation Study

Inoculation of persimmon with laboratory cultured mycelium resulted in the organism developing in these trees. Uninoculated trees in the same grove also showed visual symptoms of the disease (Table X). The uninoculated trees that contained the disease symptoms are reported in the table under the column headed "Number Spread." It appears that the disease is able to withstand the winter climate and continue to control persimmon the following season. Uninoculated trees increased in showing the disease symptoms as the percent of grove inoculation increased from 20 to 40 to 80%.

TABLE X

PERCENT OF PERSIMMON TREES DISEASED 22 AND 68 WEEKS AFTER INOCULATION WITH THE PERSIMMON WILT MYCELIUM FUNGUS AT THREE LEVELS (%) OF GROVE INOCULATION

% inoc.	No. inoc.	Number diseased 22 wks.	68 wks.	Number spread 22 wks.	68 wks.	% Diseased 22 wks.	68 wks.
20	8	4	5	0	2	50	62
40	16	7	8	2	7	44	50
80	32	18	20	5	8	56	62

Effect of Tree Size on Wilt Inoculated Persimmons

In Table XI the results of inoculation of different sized trees with laboratory cultured mycelium wilt fungus are shown. From this data it appears that the larger the tree size the less success of inoculating the disease into persimmon by this inoculation technique. More trees possessed the disease at 68 weeks than at 22 weeks after

treatment. The increase of the disease between the two dates of evaluation could have resulted from the spread of the disease from the diseased trees at 22 weeks after treatment.

TABLE XI

PERCENT AND NUMBER OF PERSIMMON TREES OF VARIOUS SIZES DISEASED FOLLOWING INOCULATION WITH PERSIMMON WILT MYCELIUM

Inches (DBH)	Trees Inoculated	Number Diseased		% Diseased	
		22 wks.	68 weeks	22 wks.	68 wks.
2-4	111	62	80	56	72
4-6	12	2	3	17	25
1.4	10	7	9	70	90
3.8	10	2	3	20	30
5.6	10	1	1	10	10

Use of Wood and Gum From Diseased Trees as Inoculation Material

In Table XII the results of inducing persimmon wilt fungus into trees with wood and gum are presented. Both the wood and gum as inoculate material resulted in disease symptoms appearing in undiseased persimmon trees. The wood was a better inoculate material.

TABLE XII

PERCENT AND NUMBER OF PERSIMMON TREES DISEASED FOLLOWING INOCULATION WITH WOOD AND GUM FROM A NATURAL WILT INFESTATION

Source of organism	Trees inoculated	Number Diseased		% Diseased	
		6 weeks	52 weeks	6 weeks	52 weeks
wood	10	7	8	70	80
gum	10	1	1	10	10

CHAPTER V

SUMMARY AND CONCLUSIONS

Studies were conducted to determine the most satisfactory herbicides or combinations of herbicides and method of treatment to control common persimmon. A biological control agent for control of common persimmon was tried by the use of the persimmon wilt fungus.

The winter injection method of treatment was a satisfactory method of applying herbicides. Picloram and a combination of 2,4,5-T and dicamba resulted in good persimmon control. The use of 2,4-D and 2,4,5-T gave consistently poor control of persimmon. In general, the undiluted herbicides gave better control than dilutions of the herbicides in diesel oil or water.

The use of herbicides as a broadcast granular soil treatment was erratic. Dicamba was the only successful soil herbicidal treatment. Basal bark and soil applied applications of dicamba and 2,4,5-T gave good control of persimmon.

Foliage spray treatments were conducted in three sets of experiments. Results were not consistent among the three sets. Picloram was an effective herbicide for persimmon control if used at .25 lb a.i./A. The addition of dicamba or picloram to 2,4,5-T increased control over 2,4,5-T alone. Amitrol-T and ammonium thiocyanate combinations with 2,4,5-T did not improve the control of persimmon. Paraquat was not a satisfactory foliage contact herbicide treatment.

The biological control of persimmon by the use of the persimmon wilt fungus resulted in some control. The larger the tree size the less successful was the inoculation with wilt disease. The use of laboratory cultured mycelium was a satisfactory method of growing and distribution of this disease. The wood and gum collected from diseased trees and inoculated into healthy trees was another method of distribution of the disease. More research needs to be conducted in this technique for use as a control for persimmon.

LITERATURE CITED

1. Beattii, R. K. and B. S. Crandall. 1939. Disease attacks the persimmon. American Forests 45:120-121.

2. Behrens, R., H. M. Elwell, W. A. Gentner, H. H. Hull, D. L. Kingman, F. A. Peevy, F. L. Timmons and F. H. Tschirley. 1961. Chemical control of brush and trees. USDA Farmers Bul. 2158.

3. Cech, F. and W. J. Mulder. 1964. Control of cull hardwoods by herbicide injection. Proc. S. Weed Conf. 17:240-245.

4. Chester, K. S. 1939. Persimmon wilt fungus found in Oklahoma. U. S. Bur. Pl. Ind. Plant Disease Reporter 23:252.

5. Crandall, B. S. 1940. Known range of persimmon wilt in 1939. U. S. Bur. Pl. Ind. Plant Disease Reporter 24:168-169.

6. _____. 1945. A new species of Cephalosporium causing persimmon wilt. Mycologia 37:495-498.

7. _____ and W. L. Baker. 1950. The wilt disease of American persimmon, caused by Cephalosporium diospyri. Phytopathology 40:307-325.

8. _____ and R. W. Davidson. 1937. Cephalosporium wilt of persimmon. U. S. Bur. Pl. Ind. Plant Disease Reporter 21: 251.

9. Darrow, R. A., W. G. McGully and E. E. Hughes. 1959. Woody plant and grass responses to granular applications of fenuron and chlorinated bensoic acids. Proc. S. Weed Conf. 12:143-146.

10. _____ and W. K. Frey. 1951. Dormant season treatments of persimmon. N. C. Weed Conf. Res. Rept. 8:150.

11. Davis, J. R. 1958. Basal spray with 2,4,5-T for winter hardwood control in East Texas. Jour. of Forestry 56:349.

12. Elder, W. C. and J. Dreessen. 1952. Effect of 2,4-D and 2,4,5-T on persimmon. N. C. Weed Conf. Res. Rept. 9:54.

13. _____ and J. E. Gassaway. 1950. Effect of 2,4-D and 2,4,5-T on persimmon trees. N. C. Weed Conf. Res. Rept. 7:236.

14. Elwell, H. M. 1960. Land improvement through brush control. Soil Conservation 26:56-59.

15. _____. 1963. Brush can be controll on grazing lands. Agron. Abs. Pan Am. Agron. 1963 Meetings, Nov. 1963.

16. _____. 1965. Brush, brambles and weed control with aerial applied herbicides produces more grass and livestock. Proc. of the 5th Okla. Aerial Applicator's Conf.

17. _____. 1967. Unpublished information.

18. Fisher, C. E. 1952. Control of woody plants with herbicides. Agr. Chem. 7(3):49.

19. Frey, W. K. 1953. Effects of herbicidial applications on common persimmon Diospyrous virginiana. Jour. of Range Management 6:437.

20. Gantz, R. L. and E. R. Laning, Jr. 1964. Tordon for control of woody rangeland species in Western United States. Down to Earth 19:10-13.

21. Gould, F. W. 1962. Texas plants - A checklist and ecological summary. Texas Agr. Exp. Sta. Bul. MP-585.

22. Greer, H. A. L. 1968. Weed and brush control on grasslands, 1968. Okla. State Univ. Fact Sheet 2754.

23. Griffith, C. 1966. Personal communications.

24. _____. 1967. Persimmon control with the fungus persimmon wilt Cephalosporium diospyri. Strum Farm 1965-66. Samuel Robert Noble Foundation. Ardmore, Oklahoma.

25. Haas, R. H., R. A. Darrow and S. K. Lehman. 1964. Evaluation of herbicides for the control of common persimmon. Proc. S. Weed Conf. 17:278-283.

26. Hamaker, J. W., H. Johnston, R. T. Martin and C. T. Redemann. 1963. Picolinic acid derivative: a plant growth regulator. Science 141:363.

27. Klingman, D. L. and W. E. Shaw. 1962. Using phenoxy herbicides effectively. USDA Farmers Bul. 2183-1-24.

28. Leonard, O. A. and W. A. Harvey. 1965. Chemical control of woody plants. Calif. Agr. Exp. Sta. Bul. 812.

29. Martin, C. S., J. M. Nichols and D. L. Klingman. 1954. Controlling woody plants with 2,4,5-T; 2,4-D and ammate. Mo. Agr. Exp. Sta. Bul. 615.

30. Miller, W. F. and J. W. Starr. 1962. The relationship between soil moisture and hardwood kill. Proc. S. Weed Conf. 15: 175-180.

31. Nation, H. A. and C. T. Lichy. 1964. Tordon herbicide for brush control in the Southern United States. Proc. S. Weed Conf. 17:287-294.

32. Nichols, J. M. 1957. Control of woody vegetation. Mo. Agr. Exp. Sta. Res. Bul. 638.

33. Peevy, F. A. 1960. Controlling southern weed trees with herbicides. Jour. of Forestry 58:708-710.

34. Peters, E. J. and J. F. Stritzke. 1963. Herbicides and comparisons of application methods for the control of persimmon. N. C. Weed Conf. Res. Rept. 20:106.

35. _____. 1964. Picloram, 2,3,6-TBA and dicamba for the control of persimmon and sassafras. N. C. Weed Conf. Proc. 21:28.

36. Ray, H. C. 1958. Aerial chemical reduction of hardwood brush as a range improvement practice in Arkansas. Jour. of Range Management 11:284-290.

37. Toole, E. R. and P. C. Lightle. 1960. Status of persimmon wilt, 1959. USDA-CRD-ARS Plant Disease Reporter 44(1):45.

38. Watson, A. J. and R. J. Mesler, Jr. 1964. Effect of tordon herbicide as basal frill and tree injection of certain hardwood trees. Down to Earth 19(4):20-23.

39. _____ and M. G. Wiltse. 1963. Tordon for brush control on utility rights-of-ways in the Eastern United States. Down to Earth 19(1):11-14.

40. Wilson, C. L. 1963. Persimmon wilt - friend or foe? Ark. Exp. Sta. Farm Res. 12:5.

41. _____. 1968. Presence of two tree vascular diseases confirmed in Arkansas. USDA-CRD-ARS Plant Disease Reporter 52(1):79.

42. Wiltse, M. G. 1964. Tordon herbicide as a soil treatment for brush control. Down to Earth 19(4):3-6.

43. Van Dersal, W. R. 1938. Native woody plants of the United States. USDA Misc. Pub. 303:117-118.

44. Zahnley, J. W. and G. L. McCall. 1950. Response of persimmon Diospyrous virginiana and certain other species of trees to 2,4-D and 2,4,5-T applied as basal sprays. N. C. Weed Conf. Res. Rept. 7:250.

VITA

Kenneth Lee Failes

Candidate for the Degree of

Master of Science

Thesis: THE EVALUATION OF VARIOUS HERBICIDES AND WILT FUNGUS (CEPHALOSPORIUM DIOSPYRI, CRANDALL) FOR CONTROL OF PERSIMMON (DIOSPYROUS VIRGINIANA, L.)

Major Field: Agronomy

Biographical:

Personal Data: Born at Cherokee, Oklahoma, January 10, 1943, the son of Robert J. and Esther B. Failes.

Education: Attended grade school at Cherokee, Alfalfa County, Oklahoma; graduated from Cherokee High School, Cherokee, Oklahoma, in 1961; attended Northwestern State College, Alva, Oklahoma from 1961-1962; received the Bachelor of Science degree from Oklahoma State University, with a major in Agronomy, in May, 1966.

Professional Experience: Reared and worked on a farm near Cherokee, Oklahoma, until high school graduation and during the following summers until 1966; worked part-time for the United States Department of Agriculture at Stillwater, Oklahoma, from 1966-1968, employed by Kansas State University at the Newton Experiment Field, Newton, Kansas, 1968-1969.