THE EVALUATION OF PREEMERGENT HERBICIDES ON WEED CONTROL AND TREE RESPONSE IN BEARING AND NONBEARING PECAN TREES

By

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INTRODUCTION

Control of vegetation in pecan orchards is necessary for maximum growth and yield of pecan trees (Carya illinoensis [Wang] K. Koch). Until recently, vegetation control was by mowing, grazing, or cultivation. The sod-herbicide system used for weed control is now widely accepted. With this system, herbicides are used in tree rows to give a weed-free strip of approximately seven feet on each side of the tree row with a close-mowed sod maintained in row middles. Advantages offered by this method of weed control include reduced spread of crown gall by eliminating mechanical cultivation or mowing close to trees, elimination of mechanical injury to trunks and feeder roots near the soil surface, a smoother orchard floor in a settled condition which is necessary for effective mechanical harvesting of nuts, reduced erosion compared to mechanical tillage, no comtamination of nuts by manure from grazing animals, reduced cost for weed control, control of weeds near irrigation sprinklers or emitters, less soil compaction from equipment during the year, reduced nitrogen immobilization which sometimes occurs when mulching is used to reduce weeds, and usually, an increased yield and grade of pecans through improved weed control and improved moisture infiltration into the soil (17).

An important factor when selecting herbicides for use in pecan orchards is the degradation rates in various soil types when herbicides are used several years in succession. Some of the most persistent herbicides such as oryzalin and diuron applied for a number of years at dosages sufficient to control weeds initially do not appear to affect tolerant woody plants. Since only a small amount of these herbicides persist from one year to the next, there is no serious buildup of residue in the soil. In addition, after two seasons, it is usually possible to decrease the annual dosage. There is little reason to assume that we will sterilize the soils by continuous use of herbicides if carefully selected and wisely used (1).

Losses from pecan insects and diseases are sizeable, but these losses vary from year to year and between geographical locations. Weeds thrive in all areas where pecans are grown and are constant competitors for water and nutrients needed for maximum tree growth and production (29). Klingman (22) has listed weed control cost as being ten times greater than the total cost of insect and disease control on all agriculture land. This cost ratio serves to illustrate the need for weed control research designed to lower this production cost.

The purpose of this study is to determine the effect of some registered and some promising preemergent herbicides on weed control, tree response, and soil persistence and movement in bearing and nonbearing pecan orchards in Oklahoma.

CHAPTER II

LITERATURE REVIEW

Weeds have been a problem for many years. Weed control is one of the most expensive requirements of crop production. Slowly, man has learned to mechanize and use various means of control. The first step was the substitution of a sharpened stick for his fingers; then followed the hoe, which was replaced by the cultivator and plow. The horse was gradually replaced by the tractor. At this time, chemical energy is replacing mechanical energy for weed control (22).

Chemicals such as salts and various industrial by-products such as smelter's waste, have for hundreds of years been applied to roadsides and paths to rid them of vegetation. Chemical weeding, may be considered to have been born in 1896 when Bonnet, a French grape grower, observed that the bordeaux mixture he applied to his vines as protection against downy mildew turned the leaves of yellow charlock (*Brassica kaber*) black. The weed killing properties of ammonia, zinc, iron, and other metals were soon observed. According to Audus (9) and Klingman (22) most selective weed control research evolved since 1935. The first major break through is credited to Zimmerman and Hitchcock when they found 2,4-D [(2, 4-dichlorophenoxy) acetic acid] to be a growth substance. Marth and Mitchell later in 1942 established the selectivity of 2,4-D, when they removed broadleaf weeds from a bermudagrass (*Cynodon dactylon* L.) lawn. Research prior to 1945 was orientated to weed control with chemicals that were either a sterilant or a postemergent. In 1945, Templeman established the preemergence principle of soil treatment for selective weed control. Since then, many chemicals have been evaluated for their preemergence weed control in fruit and nut trees.

Atrazine

Atrazine [2-chloro-4-(ethylamino)-6-(isopropylamino)-S-triazine] a triazine herbicide with a water solubility of 33 ppm has helped establish preemergence weed control with farmers as did 2,4-D (2-4,dichlorophenoxy acetic acid) for postemergence weed control. Many farmers can grow crops in almost complete absence of annual weeds by the use of atrazine. Atrazine does have some limitations in that certain weeds are resistant, dependence upon rainfall for activation, and persistence in the soil (13).

At the Northeastern Louisiana Experiment Station, atrazine has been used as a standard preemergence herbicide, because in the absence of Johnsongrass (Sorghum halepense L.) it usually provides satisfactory season-long control of a broad spectrum of grassy and broadleaf weeds (32). Screening studies done by Fitzgerald, May, and Seldon (20) for chemical weed control in hardwood plantings found atrazine applied preemergent to summer weeds at rates up to 6.70 kg ai/ha to be the most complete and desirable residual weed control without damage to sycamore (Platanus occidentalis L.), yellow poplar (Liriodendron tulipifera L.), and sweetgum (Liquidambar styraciflua L.) seedlings.

Krajicek (23) reported that complete weed control could be achieved by broadcast spraying up to 5.60 kg ai/ha of atrazine without injuring black walnut trees (Juglans nigra L.). Coartney (14) found atrazine, at 3.36 kg ai/ha applied to newly set scotch pine (Pinus sylvestris) was the best treatment in terms of grass control and tree survival. In general, atrazine treatments had no significant effect on tree survival when compared to the untreated trees. However, seedlings with good weed control produced much more terminal growth than untreated seedlings. Hinrichs (21) and Norton (27) applied atrazine at 2.24 kg ai/ha to emerging pecan seedlings in March. Weed counts taken in June found atrazine to adequately control the weed species present.

Soil persistence of triazine herbicides is also of concern to agricultural producers and weed scientists. Savage (30) studied the persistence of atrazine under greenhouse conditions using five soil types which represented a large portion of the southeastern United States agriculture area. Atrazine was incorporated into potting soils and persistence was monitored by periodic bioassays with soybeans (Glycine max L.). It was concluded that the average time required to reduce atrazine toxicity to 50 percent of the initial value was approximately 61 days. Persistence of atrazine residues on soils were studied in field experiments from 1962-1964 by Ashley and Rahn (8). When atrazine was applied to a sandy loam soil at the recommended rate of 2.24 kg ai/ha in late April, the approximate amounts in the soil in October were as much as 0.045 kg ai/ha at 0-10 cm and 0.056 kg ai/ha at 10-20 cm. When the rate of application was increased to 4.48 kg ai/ha, comparable figures were 0.112 kg ai/ha and 0.078 kg ai/ha, respectively. Samples the following March contained no residue from the 2.24 kg ai/ha application, however, 0.078 kg ai/ha remained at 0-10 cm from the 4.48 kg ai/ha application.

In the spring of 1968, Axe, Mathers, and Wiese (10) initiated a study to determine the disappearance and movement of atrazine in a silty clay loam soil. Soil samples were taken shortly after application and at one month intervals for three months. Soil samples were taken at 7.6 cm increments to a depth of 30.5 cm. Analysis five days after application showed that only 33 percent of the material remained in the soil. Herbicide remaining in the soil later was primarily located in the top 7.6 cm. Libik and Romanowski (25) reported on persistence of atrazine applied at 2.24 and 4.48 kg ai/ha on a silt loam soil. Field soil samples were taken during the year of application to a depth of 7.6 cm and bioassayed with cucumber (*Cucumis sativus* L. Wisconsin SMR-18) seedlings. The lower rate of atrazine did not reduce growth beyond 90 days after application. However, the higher rate persisted up to 120 days after application. Buchanan and Hitbold (12) found atrazine to be short-lived with a half-life of 20 days.

Dinoseb

Prior to August 30, 1968, dinoseb [2-sec-butyl-4,6-dinitrophenol] a phenolic herbicide, was the only herbicide approved by the United States Department of Agriculture for weed control in pecan orchards. Dinoseb has limited use in pecan orchards because of its dependence upon critical environmental conditions for activity, its high mammalian toxicity, and its relative short persistence at recommended preemergence rates (33). Norton, Storey, and Madden (29) found that dinoseb's use was prohibitive because it exhibited only four to five weeks of residual control at recommended rates and full-season weed control is usually desired in pecan orchards. Research trials done by Arnold and Aitken (6) found that 11.21 kg ai/ha of dinoseb did not give adequate grass control in pecan orchards.

Diuron

Diuron [3-(3,4-dichlorophenyl)-1,1-dimethylurea] is a urea herbicide with a water solubility of 42 ppm. Diuron is registered for use on pecan trees 3-years and older. Numerous research trials have shown that diuron is suitable for preemergence weed control in pecan orchards. Ahrens (1) has reported that diuron controls most annual weeds and grasses for 2 to 4 months or longer at rates of 1.12 to 3.36 kg ai/ha, but appears to be less active against perennial grasses. In research conducted at Texas A&M University, it was concluded that diuron at 1.68 and 3.36 kg ai/ha controlled the following weeds: redroot pigweed (*Amaranthus retroflexus* L.), foxtail (*Setaria* sp.), barnyardgrass (*Echinochloa crusgalli* L.), thistle (*Cirsium* sp.), cocklebur (*Xanthium* sp.), and crabgrass (*Digitaria* sp.). Bermudagrass and nutsedge (*Cyperus* sp.) were suppressed with diuron at 3.36 kg ai/ha. Johnsongrass was not controlled with rates up to 6.72 kg ai/ha (29).

Aitken (3) applied diuron at 1.79 and 3.59 kg ai/ha to 3-year-old pecan trees in May of 1974 and 1975. Diuron did not adequately control perennial grasses (Johnsongrass and bermudagrass) but provided good control of large crabgrass. Effective broadleaf weed control was obtained with diuron, with the high rate out-performing the low rate. Arnold and Aitken (6) applied diuron at 3.59 kg ai/ha to 7-year-old pecan trees. Evaluations of grass control taken 11 and 23 weeks after application found diuron to be ineffective in controlling the major grass species present (bermudagrass).

Wascom, Young, and Meadows (36) studied diuron at 2.24 kg ai/ha, 3.36 kg ai/ha, and 4.48 kg ai/ha on light, medium, and heavy soils, respectively. The pecan trees consisted of numerous cultivars ranging in age from newly planted through 6-years-old. Diuron was found to be one of the most desirable preemergence chemicals used for the control of annual grasses and weeds, such as pigweed, crabgrass, Johnsongrass, and bermudagrass. No injury was observed at any of the rates. In a study conducted by Hinrichs (21) and Norton (27) at Stillwater, Oklahoma, it was concluded that diuron applied at 1.12 kg ai/ha to emerging pecan seedlings did not give adequate control of weed species present. However, diuron at 2.24 kg ai/ha provided good early season weed control.

Research trials have shown that diuron applied for a number of years at dosages sufficient to control weeds does not adversely affect established pecan trees (1). Two years' results by Norton and Storey (28) have shown that diuron is suitable for preemergence weed control in established pecan orchards. No phytotoxic symptoms were observed in plots treated with annual applications of 3.36 kg ai/ha of diuron. In a pecan tree tolerance test, diuron was applied at 6.72 kg ai/ha around bearing 12-year-old trees on a clay loam soil. No phytotoxicity was observed in this test. Accumulated research results from Texas A&M University found diuron at 3.36 to damage germinating pecan nuts. No phytotoxicity was observed on established trees at rates up to 6.72 kg ai/ha. Increases in tree growth and yield amounting to more than 1.8 kg/tree were obtained at 3.36 kg ai/ha (29). Daniell (16) applied diuron at 4.48 kg ai/ha in the spring and 2.24 kg ai/ha in the fall to mature pecan trees over a four year period. Diuron at this rate effectively controlled the weeds present. Diuron applications also resulted in increased tree diameter, yield, percent shell-out, percent fancy kernels, and nut size compared to the mowed control.

Hexazinone

Hexazinone [3-cyclohexyl-6-(dimethylamino)-1,3,5-triazine-2,4-(1 H, 3 H) dione] is currently being evaluated for use in mature pecan orchards. At the present time, this material is approved only for use in non-crop lands.

Arnold and Aldrich (7) reported in initial studies that hexazinone gave season-long, broad spectrum weed control with both pre- and post-emergence capabilities, when applied at 1.00, 2.02, 4.03 kg ai/ha to pecan trees. Hexazinone's preemergence capabilities were shown to control the germination of summer annuals. Twelve weeks after application a totally weed-free strip was achieved with the 2.02 and 4.03 kg ai/ha rates. After 20 weeks, ratings indicated hexazinone was still effective. At the 2.02 and 4.03 kg/ha rates, total elimination of the weed population remained. The 1.00 kg/ha rate weed control was reduced due to the regrowth of the more persistent perennials. Some leaf injury and subsequent leaf drop occurred at the 4.03 kg/ha rate. However, the trees appeared to rapidly recover with no permanent injury.

Oryzalin

Oryzalin's [3,5-dinitro-N^4,N^4,dipropylsulfanilamide] water solubility (2.5 ppm) and low vapor pressure has permitted its successful use as a surface applied dinitroaniline herbicide (19). Oryzalin should be applied to the soil surface and must be moved into the soil by rainfall or irrigation to be effective. This herbicide, therefore, should be applied during early spring when chances of rain are good. Field observations have shown that approximately 1.27 cm of rainfall is needed for activation of oryzalin and that excess rainfall will not leach this herbicide out of the weed germination zone (18).

Oryzalin is now labelled for use in nonbearing pecan orchards in many states. However, at this time oryzalin is not cleared for bearing pecan orchards. Research trials have found oryzalin to provide good weed control in bearing and nonbearing pecan orchards. Research efforts in the south have been focused on the use of oryzalin in pecan orchards. Edmondson et al. (19) evaluated oryzalin at rates of 2.24, 4.48, and 8.97 kg ai/ha. Oryzalin at 2.24 kg ai/ha provided excellent control of crabgrass, seedling Johnsongrass, and redroot pigweed for a period of 4 to 6 months. Crop evaluations of visible injury, trunk circumference, yield, and nut quality have shown pecans to be tolerant to 8.97 kg ai/ha of oryzalin.

Aitken (2, 3, 4) applied oryzalin at 2.24 kg ai/ha in early May to 3-year-old pecan trees and continued for three consecutive years. Weed control ratings were made 16 weeks after application for overall grass and broadleaf species and predominant weed species. Oryzalin gave good control of most grasses with slightly less control of Johnsongrass. Oryzalin gave fair control of broadleaf weeds and gave excellent control of pigweed.

Simazine

Simazine [2-chloro-4,6-bis(ethylamino)-6-methoxy-S-triazine] is a registered triazine herbicide for weed control in pecan orchards. Since it is stable and relatively insoluble (5 ppm in water) it maintains a herbicide concentration near the surface, killing weeds soon after germination. It should be applied to weed-free soil because it has little effect on established weeds. Simazine requires moisture for activation because it kills the weeds by absorption into the roots. Simazine can damage pecan trees if a substantial amount leaches into the root zone. Damage is more likely to occur to newly planted trees than to established trees (20). Therfore, pecan trees must be established in the orchard at least two years before application (5).

Lagerstedt (24) listed simazine at 4.48 kg ai/ha to be effective in killing most germinating weed seed and providing long residual control in orchards. Ahrens (1) noted that simazine at rates of 2.24 and 3.36 kg ai/ha was effective against a broad spectrum of annual and perennial weeds and grasses from seed for periods of 2 to 6 months. Simazine was least effective at lower rates against annual grasses such as crabgrass. Results obtained in research conducted at Texas A&M University found that simazine applied at 2.24 and 4.48 kg ai/ha to various ages of pecan trees controlled redroot pigweed, foxtail, barnyardgrass, thistle, cocklebur, giant ragweed (*Ambrosia trifida* L.), and crabgrass. Simazine did not control Johnsongrass, bermudagrass, or nutsedge at 2.24, 4.48, or 8.97 kg ai/ha. However, some suppression of bermudagrass was obtained in sandy loam soils treated with 4.48 kg ai/ha. Simazine, applied at 4.48 kg ai/ha, provided residual activity throughout the summer and well into the winter from early spring applications. Treatments of 2.24 kg ai/ha persisted from 2.5 to 3 months (29).

Wascom, Young, and Meadows (36) applied simazine at 2.24, 3.36, and 4.48 kg ai/ha on light, medium, and heavy soils, respectively, to numerous cultivars of pecan trees ranging in age from newly planted through 6-years-old. Simazine was found to be one of the most desirable preemergence chemicals for the control of seedling weeds and grasses present, such as pigweed, crabgrass, Johnsongrass, and bermudagrass. Simazine applied at 8.97 kg ai/ha showed no signs of injury to the trees. Wascom, Young, and Meadows (35) also applied simazine at 2.80 and 5.60 kg ai/ha to 1-year-old pecan trees. Simzaine at both rates resulted in excellent control of the annual weeds and grasses present (crabgrass, cocklebur, and pigweed) when evaluated eight weeks after application. Hinrichs (21) and Norton (27) applied simazine at 2.24 kg ai/ha in March to emerging pecan seedlings. June weed counts showed simazine to be very effective in controlling weed species present.

Two years' results by Norton and Storey (28) have shown that simazine is suitable for preemergence weed control in established pecan orchards. No phytotoxic symptoms were observed in plots treated with annual applications of 4.48 kg ai/ha. In a pecan tree tolerance test, simazine was applied at 8.97 kg ai/ha to 12-year-old pecan trees growing in a clay loam soil. No phytotoxicity was observed in this test. Research conducted at Texas A&M University found that emerging pecan seedlings were damaged with simazine applied at 4.48 kg ai/ha, but 3-year-old transplants were not damaged by this rate. These treatments were superimposed on the same plots the following year, with no phytotoxicity occurring (29). Daniell (16) applied simazine at 4.48 kg ai/ha in the spring and 2.24 kg ai/ha in the fall to mature pecan trees for four consecutive years. Simazine controlled weed growth, increased trunk diameter, yield, percent shellout, percent fancy kernel, and nut size compared to the mowed control.

Research indicates only a small amount of simazine persists from one year to the next, therefore, there is no serious buildup of residue in the soil (1). Slack, Blevins, and Rieck (31) conducted a study to determine the persistence of simazine on a silt loam soil. Simazine at 3.36 kg ai/ha was applied in May of 1975 and 1976. Soil samples were taken from the 0-8 cm layer of the field throughout the season and oats (Avena sativa L. Compact) were used as a bioassay. Oats were harvested three weeks after planting. The results of the bioassay in 1975 showed that soil samples taken at 2, 5, and 8 weeks after application produced oat yields above 50 percent of that of the control and samples taken after 10 weeks showed no persistence of simazine. Soil samples taken at 2, 4, and 6 weeks after application in 1976 again revealed oat yields above 50 percent of the control, while samples collected 12 weeks after application resulted in oat yields of 85 to 99 percent of the control. Ahrens (1) stated that no greater than 20 to 30 percent of granular simazine persisted in the soil a year after application. Lord, Damon, and Gersten (26) studied accumulation of simazine residue under 3-year-old apple trees from 1964-1967. It was concluded that residual simazine was concentrated in the upper 7.6 cm of the soil.

CHAPTER III

MATERIALS AND METHODS

Field Test of Atrazine, Diuron, Simazine, Oryzalin, and Dinoseb

Five preemergent herbicides were evaluated for weed control and tree response in bearing 'Wichita' pecan trees (Carya illinoensis, [Wang] K. Koch) planted in 1969, and nonbearing 'Mohawk' trees planted in 1971. Atrazine, diuron, and simazine at 2.80 and 3.92 kg ai/ha, Oryzalin at 2.24 and 3.36 kg ai/ha, dinoseb at 8.97 and 11.21 kg ai/ha, were applied to the 'Mohawk' plot in 1978. Atrazine, diuron, and simazine at 3.92 kg ai/ha, oryzalin at 3.36 kg ai/ha, and dinoseb at 11.21 kg ai/ha were applied to the 'Wichita' plot in 1978. The same treatments were applied to the 'Wichita' plot in 1979, except dinoseb which was omitted (Table I).

The study was conducted on a Port silty clay loam soil with a zero to one percent slope at the Oklahoma Pecan Research Station near Sparks, Oklahoma. Heavy infestations of weeds, primarily barnyardgrass, cheat (Bromus secalinus L.), cutleaf eveningprimrose (Oenothera laciniata, Hill), giant ragweed, henbit (Lamium amplexicaule L.), Pennsylvania smartweed (Polygonum pensylvanicum L.), purple vetch (Vicia americana, Muhl.), redroot pigweed, stiff thelesperma (Thelesperma ambiguum, A. Gray.), Japanese brome (Bromus

TABLE I

HERBICIDE TREATMENTS

Herbicide	Rate kg ai/ha	Rate kg ai/ha
1. Atrazine (Aatrex)	2.80	3.92
2. Dinoseb (Premerge-3)	8.97	11.21
3. Diuron (Karmex)	2.80	3.92
4. Oryzalin (Surflan)	2.24	3.36
5. Simazine (Princept)	2.80	3.92
6. Check	0.00	0.00

japonieus Thunb.), Johnsongrass, and yellow nutsedge (Cyperus esculentus L.), matured the previous year. This provided reasonable assurance of adequate weed populations in the area selected for study.

No herbicides had been used in this area in the past. Soil management used in this study area until 1978 was summer cultivation with a winter cover crop of native grasses. Tree spacing was 10.7 m x 10.7 m in the 'Mohawk' plot, and 10.7 m x 21.3 m in the 'Wichita' plot.

A randomized complete block design was used for both cultivars. Treatments were replicated six times on 'Mohawk' with two-tree plots and five times on the 'Wichita' with single-tree plots. Fisher's F-test and Duncan's Multiple Range test were used for data analysis.

Herbicides were applied March 19, 1978, and March 15, 1979. The soil was cultivated prior to the herbicide applications. In addition, paraquat [1,1^1-dimethyl-4,4^1-bipyridiniumion] was applied March 21, 1978, to eliminate any weeds which were present. Rainfall followed soon after the herbicide treatments were applied, thus obtaining activiation of the chemicals (Table XI).

All herbicides were surface applied using a carbon dioxide pressurized herbicide sprayer, equipped with a hand held 4-nozzle boom and a 11.36 liter stainless steel tank. At a constant pressure (2.1 kg/sq cm) the herbicide sprayer was calibrated to deliver 205.87 l/ha at a walking speed of 4.8 km/hr.

Weed control ratings were taken in the 'Mohawk' plots by using a transect sampling procedure. A 0.61 m x 1.2 m transect was randomly placed two times in each plot. The weeds within the transects were harvested at ground level, separated by species and dried in a force air oven at 80 C for 72 hours. The weed species were then weighed using an analytical balance, and grouped in one of three categories: broadleaf weeds, grassy weeds, and Johnsongrass. The first weed samples were taken June 1, 1978. Glyphosphate was applied June 6,1978, eliminating all annual and perennial weeds present. The final weed samples were taken September 24, 1978.

Visual weed control ratings were taken on the 'Wichita' plots on May 24, 1978, and May 15, June 23, and September 24, 1979. In addition, in 1979, all weed species were listed at each rating and ranked in order of dominance. A scale of 1 to 10 was used, with 1 = no control and 10 = no weeds present. Glyphosphate [N-(phosphonomethyl) glycine] was applied to the 'Wichita' plots on June 6, 1978, to eliminate all annual and perennial weeds present.

Shoot growth was measured December 21, 1978, on both cultivars and August 22, 1979 on 'Wichita'. Thirty randomly selected terminal shoots were measured around each tree at a height of 2 to 5 meters.

Yield was estimated August 22, 1979, by counting the total number of nuts from 30 randomly selected shoots. Total yield was taken in 1978. Twenty randomly selected nuts from each test plot were analyzed for nut length, diameter, and percent kernel.

Herbicide Persistence and Movement

To determine herbicide persistence and movement within the soil, bioassays were conducted. Soil samples were taken from the 'Mohawk' plots treated with 3.92 kg ai/ha of atrazine, diuron, and simazine, 3.36 kg ai/ha oryzalin, and 11.21 kg ai/ha dinoseb. Soil samples were taken at approximately four week intervals for the first 12 weeks; April 22, May 23, and July 1, 1978. The soil samples were taken using a soil probe. Ten randomly selected soil samples from depths of 0-5, 5-10, and 10-15 cm were taken from each plot. Samples from each plot were ground with mortar and pestle and placed in 5.7 x 5.7 cm plastic pots.

Wheat (Triticum aestivum L., Learned) were utilized as the bioassay indicator plant. The wheat seeds were treated with 5% chlorox solution for three minutes and rinsed with running water for one hour. Five wheat seeds were placed one cm deep in the soil prepared from each test plot. The bioassays were arranged in a randomized complete block design with five subsamples and five replications. The pots were subirrigated in separate containers to prevent leaching of the herbicide and contamination of other samples.

Wheat bioassays conducted on the first soil samples (April 22) were grown in a growth chamber for two weeks. Fluorescent lights were set for a 15 hour day length, from 6:00 a.m. to 9:00 p.m. The light intensity was 3767 luxes. The temperature ranged from 27 to 29 C. Wheat bioassays conducted on the second (May 23) and third (July 1) soil samples were grown in a greenhouse for two weeks. The light intensity was 37674 luxes and the temperature ranged from 21 to 27 C.

Field Test of Oryzalin and Hexazinone

Preemergence herbicides, oryzaline and hexazinone, were evaluated at three rates on 9-year-old 'Mohawk' pecan trees. Rates were 2.24, 3.36, and 4.48 kg ai/ha using oryzalin and 1.12, 2.24, and 3.36 kg ai/ha using hexazinone, plus a control. Each treatment was replicated four times using two-tree plots in a randomized complete block design.

Statistical analysis was by Fisher's F-test and Ducan's Multiple Range test.

Test plots were cultivated April 3, 1979. Herbicides were applied April 9, 1978, using the procedure described previously. Sufficient moisture for herbicide activation occurred soon after application (Table XI).

Visual weed ratings were taken May 15, June 23, and September 15, 1979. A scale of 1 to 10 was used, with 1 = no control and 10 = no weeds present. In addition, all weed species were listed at each rating and ranked in order of dominance. Shoot growth was estimated August 22, 1979, by measuring 30 randomly selected terminal shoots around each tree at a height of 2 to 5 meters.

CHAPTER IV

RESULTS AND DISCUSSION

Effect of Atrazine, Diuron, Simazine, Oryzalin, and Dinoseb on Weed Control and Tree Response

Weed control data obtained June 1, 1978, on the 'Mohawk' pecan trees using the transect sampling procedure is presented in Table II. Results showed that none of the herbicides at any of the rates applied were significantly better in control of the broadleaf, grassy weeds, Johnsongrass, or total weeds than the check plots. The lack of significant weed control may be due to the transect sampling procedure not being able to accurately sample for annual weed control in the presence of more vigorous perennial weeds. The broadleaf and grassy perennial weeds were not distributed equally throughout the study area. Therefore, plots dominated by one or more of the perennial weeds excluded the establishment of less competitive annual weeds. Broadleaf and grassy weeds that were present are listed in Table III.

Visual weed control ratings taken on May 24, 1978, on the non-bearing 'Mohawk' trees and the bearing 'Wichita' trees are presented in Tables II and IV, respectively. The data in these experiments showed that atrazine, diuron, and simazine at 3.92 kg ai/ha were not significantly different in their ability to control weeds. However, they were all significantly better than the control plots, with good

TABLE II

THE EFFECT OF PREEMERGENT HERBICIDES ON WEED CONTROL AND TERMINAL SHOOT GROWTH OF 'MOHAWK' PECAN TREES IN 1978

		Transect Sampling Data					
Herbicide	kg ai/hectare	Grassy Weeds (Annual and Perennial) gm/.72 m^2	Broadleaf Weeds (Annual and Perennial) gm/.72 m^2	Johnsongrass (Seedling and Rhizome) gm/.72 m^2	All Weeds gm/.72 m^2	Visual Weed Control Rating[Y]	Avg. Shoot Growth (cm)
Atrazine	2.80	0.05b[Z]	21.07c	30.72ab	51.72ab	6.67ab	57.05b
Atrazine	3.92	1.50b	17.65c	30.33ab	49.50d	7.05a	51.57b
Dinoseb	8.97	27.42a	149.38b	36.50ab	213.38ab	1.50d	51.38b
Dinoseb	11.21	6.37b	272.90a	55.62	334.88a	2.58cd	53.48b
Diuron	2.80	0.77b	22.47c	102.60ab	125.13cd	5.00abc	73.00b
Diuron	3.92	10.75ab	15.22c	42.67ab	68.63cd	5.83ab	39.96b
Oryzalin	2.24	0.00b	296.65a	0.00	296.75ab	2.75cd	51.89b
Oryzalin	3.36	0.25b	160.23b	27.53ab	188.02cd	2.83cd	39.97b
Simazine	2.80	0.00b	23.75c	56.57ab	80.13cd	4.13bcd	49.44b
Simazine	3.92	0.00b	2.47c	143.48a	145.95cd	6.47ab	55.66b
Check	0.00	17.08ab	61.93bc	14.72ab	93.73cd	1.50d	54.02b

[Z]Means significantly different by Duncan's Multiple Range Test, 5% level.
[Y]Visual Weed Control Rating 1-10; 1=No Weed Control, 10=No Weeds Present.

TABLE III

MAJOR WEED SPECIES PRESENT IN 1978

Common Name[z]	Scientific Name[z]
	Broadleaf Weeds
Carolina geranium	Geranium carolinianum L.
Carolina horsenettle	Solanum carolinense L.
Common cocklebur	Xanthium pensylvanicum Wallv.
Curly dock	Rumex crispus L.
Cutleaf eveningprimrose	Oenothera laciniata Hill.
Giant ragweed	Ambrosia trifida L.
Groundcherry	Physalis sp.
Henbit	Lamium amplexicaule L.
Honeyvine milkweed	Ampelamus albidus Nutt.
Pennsylvania smartweed	Polygonum pensylvanicum L.
Pepperweed	Lepidium sp.
Prickly lettuce	Lactuca scariola L.
Prostrate spurge	Euphorbia supina Raf.
Purple vetch*	Vicia americana Muhl.
Redroot pigweed	Amaranthus retroflexus L.
Stiff thelesperma*	Thelesperma ambiguum A. Gray.
Tall morningglory	Ipomoea purpurea L.
Thistle	Cirsium sp.
Yellow woodsorrel	Oxalis stricta L.
	Grassy Weeds
Barnyardgrass	Echinochloa crus-galli L.
Bermudagrass	Cyndon dactylon L.
Broadleaf uniola*	Uniola latifolia Michx.
Canada wildrye*	Elymus canadensis L.
Cheat	Bromus secalinus L.
Cupgrass*	Eriochloa contracta L.
Fall panicum	Panicum dichotomiflorum Michx.
Japanese brome	Bromus japonieus Thunb.
Johnsongrass	Sorghum hapepense L.
Jointgrass*	Paspalum distichum L.
Large crabgrass	Digitaria sanguinalis L.
Yellow foxtail	Setaria lutescens Weigel.
Yellow nutsedge	Cyperus esculentus L.

[z]Common and scientific names taken from WSSA.
*Common and scientific names taken from Illustrated Flora of the Northern States and Canada.

TABLE IV

THE EFFECT OF PREEMERGENT HERBICIDES ON WEED CONTROL OF 'WICHITA' PECAN TREES IN 1978 AND 1979

Herbicide	Rate kg ai/hectare	Visual Weed Control Rating[Y] May 24 (1978)	May 15 (1979)	June 23 (1979)	Sept. 15 (1979)
Atrazine	3.92	8.0a[Z]	5.7b	3.2cd	2.3bc
Dinoseb	11.21	1.9b	----	----	----
Diuron	3.92	7.5a	8.4a	8.9a	7.6a
Oryzalin	3.36	2.7b	6.2b	5.1bc	3.9bc
Simazine	3.92	7.0a	8.6a	6.1b	4.5b
Check	0.00	1.0b	1.0c	1.0d	1.0c

[Z]Means significantly different by Duncan's Multiple Range test, 5% level.

[Y]Visual Weed Control Rating 1-10; 1=No Control, 10=No Weeds Present.

early season weed control. Visual weed control data in Table II shows that 2.80 kg ai/ha of atrazine and diuron also controlled weeds better than the check plots. There was not a significant difference in weed control between the 2.80 kg ai/ha rate and the 3.92 kg ai/ha rate of atrazine and diuron. Weed control ratings in Table II show that the 8.97 kg ai/ha of dinoseb, 2.24 kg ai/ha oryzalin, and 2.80 kg ai/ha simazine were not significantly different from the check plots. Data in Tables II and IV also show that the 11.21 kg ai/ha of dinoseb and 3.36 kg ai/ha oryzalin failed to reduce the weed populations compared to the check plots.

Season-long weed control ability of these herbicides could not be adequately determined September 24, 1978. After the postemergent herbicide application of glyphosphate on June 6, 1978, weeds did not reestablish due to lack of moisture and high temperatures.

Table IV shows data from May 15, June 23, and September 15 visual weed control ratings taken on bearing 'Wichita' trees in 1979. May 15 weed control data shows that 3.92 kg ai/ha atrazine, diuron, and simazine controlled weeds early in the season. Oryzalin at 3.36 kg ai/ha reduced weeds compared to the check plots. The improved performance of oryzalin may be a result of the decrease in perennial weeds due to the glyphosphate application in 1978. June 23 weed control ratings showed that 3.92 kg ai/ha atrazine no longer controlled weeds significantly better than the control plots. Diuron and simazine at 3.92 kg ai/ha and oryzalin at 3.36 kg ai/ha were significantly better than the check plots, with diuron being significantly better than the other herbicide treatments. Weed control ratings taken September 15 showed that 3.36 kg ai/ha of oryzalin no longer controlled weed growth. However, 3.92 kg ai/ha of diuron and simazine were effective in controlling weeds compared to the check plots, with diuron being significantly better than simazine.

The overall season weed control ability of the four herbicides in Table IV indicates that diuron at 3.92 kg ai/ha gave good season-long weed control. Atrazine at 3.92 kg ai/ha and oryzalin at 3.36 kg ai/ha failed to give season-long weed control. Weed species that were present are listed in Table V.

Tables II and VI shows that the herbicide treatments did not significantly affect terminal shoot growth in any of the experiments conducted over the two years compared to the check plot trees. Yield and nut quality were also determined on bearing trees each year. Table VI shows that the herbicide treatments did not significantly affect yield, percent kernel, nut length or nut diameter in 1978, or the number of nuts per shoot in 1979. These results indicate that no phytotoxicity due to the herbicide treatments occurred over the two year test period.

Herbicide Persistence and Movement

Data from wheat bioassays used to determine the persistence and movement of the herbicide treatments is presented in Table VII. Bioassay data conducted on soil samples taken on April 22 showed that the 0-5 cm soil level contained sufficient herbicide residue of dinoseb and oryzalin to significantly decrease wheat shoot growth compared to the check bioassays. Atrazine, diuron, and simazine did not show any residual activity. This may have been the result of insufficient light intensity in the growth chamber decreasing the

TABLE V

THE EFFECT OF PREEMERGENT HERBICIDES ON WEED SPECIES PRESENT IN 1979

Weed Dominance Rating[z]					
	Treatment kg ai/ha				
	Atrazine 3.92	Diuron 3.92	Oryzalin 3.36	Simazine 3.92	Check 0
	Sampling Date: May 15				
Broadleaf Weeds					
Carolina geranium	---	---	4	---	5
Carolina horsenettle	---	---	4	---	---
Common cocklebur	---	---	4	---	---
Curly dock	---	---	2	---	2
Giant ragweed	---	---	1	2	---
Henbit	---	---	---	---	3
Honeyvine milkweed	2	3	4	---	---
Pennsylvania smartweed	---	---	2	2	1
Pepperweed	---	---	4	---	4
Prickly lettuce	---	---	---	---	5
Purple vetch	---	---	3	---	---
Redroot pigweed	---	---	---	---	1
Stiff thelesperma	---	---	1	---	1
Thistle	---	---	4	---	5
Yellow woodsorrel	---	---	---	---	5
Grassy Weeds					
Broadleaf uniola	---	---	3	---	2
Canada wildrye	---	---	---	---	4
Cheat	---	---	---	---	2
Cupgrass	2	---	---	---	2
Japanese brome	---	2	---	---	2
Johnsongrass	1	2	1	---	---
Large crabgrass	---	---	---	---	4
Yellow foxtail	---	---	---	---	3
Yellow nutsedge	1	1	1	1	2
	Sampling Date: June 23				
Broadleaf Weeds					
Carolina horsenettle	---	3	4	---	3
Common cocklebur	---	---	4	---	---
Curly dock	---	---	3	---	2
Giant ragweed	---	---	2	3	3
Honeyvine milkweed	2	3	4	3	---

TABLE V (Continued)

Weed Dominance Rating[z]					
	Treatment kg ai/ha				
	Atrazine 3.92	Diuron 3.92	Oryzalin 3.36	Simazine 3.92	Check 0
Sampling Date: June 23 (cont'd)					
Broadleaf Weeds (cont'd)					
Pennsylvania smartweed	---	2	1	1	1
Redroot pigweed	2	2	---	2	1
Stiff thelesperma	---	---	1	---	2
Tall morningglory	---	---	---	3	---
Grassy Weeds					
Broadleaf uniola	---	---	3	---	---
Cupgrass	1	2	1	2	1
Johnsongrass	1	2	---	1	---
Jointgrass	2	---	---	3	2
Yellow nutsedge	1	1	1	1	---
Sampling Date: September 15					
Broadleaf Weeds					
Common cocklebur	---	---	5	---	---
Curly dock	---	---	4	---	3
Giant ragweed	---	---	2	3	4
Honeyvine milkweed	3	---	---	4	---
Pennsylvania smartweed	2	1	1	1	1
Prostrate spurge	---	3	5	4	---
Redroot pigweed	3	2	3	2	1
Thistle	---	---	4	---	---
Grassy Weeds					
Barnyardgrass	---	---	---	---	3
Cupgrass	2	2	2	1	2
Fall panicum	1	---	---	1	1
Johnsongrass	2	2	4	1	5
Jointgrass	1	3	5	2	4
Yellow foxtail	---	---	---	---	5
Yellow nutsedge	3	1	1	1	---

[z]Rating Scale 1-5; weed species followed by a 1 are most dominant and by a 5 are least dominant.

TABLE VI

THE EFFECT OF PREEMERGENT HERBICIDES ON TERMINAL SHOOT GROWTH, YIELD, AND NUT QUALITY OF 'WICHITA' PECAN TREES IN 1978 AND 1979

Herbicide	Rate kg ai/hectare	Avg. Shoot Growth (cm) (1978)	Avg. Shoot Growth (cm) (1979)	Yield (kg /Tree) (1978)	Nuts Per Shoot (1979)	Percent Kernel (1978)	Nut Length (mm) 1979	Nut Diameter (mm) 1979
Atrazine	3.92	30.8a[z]	27.3a	8.3a	2.4a	58.3a	43.9a	20.9a
Dinoseb	11.21	22.6a	-----	10.8a	----	56.1a	42.4a	21.3a
Diuron	3.92	30.5a	27.5a	7.0a	2.4a	58.8a	44.1a	20.8a
Oryzalin	3.36	29.2a	29.5a	9.9a	2.3a	58.4a	42.6a	19.9a
Simazine	3.92	24.2a	23.0a	12.6a	2.3a	59.4a	44.1a	20.6a
Check	0.00	25.1a	20.8a	8.4a	1.7a	57.6a	44.2a	21.4a

[z]Means significantly different by Duncan's Multiple Range Test, 5% level.

TABLE VII

SOIL PERSISTENCE AND MOVEMENT OF PREEMERGENT HERBICIDES AS DETERMINED BY WHEAT BIOASSAYS IN 1978

Herbicide	Rate kg ai/ha	Depth (cm)	April 22 Fresh Weight gm/plant	April 22 Dry Weight gm/plant	May 23 Fresh Weight gm/plant	May 23 Dry Weight gm/plant	July 1 Fresh Weight gm/plant	July 1 Dry Weight gm/plant
Atrazine	3.92	0-5	0.120a[z]	0.013a	0.032c	0.006c	0.091a	0.012bcd
Dinoseb	11.21	0-5	0.033a	0.004b	0.115a	0.020a	0.111a	0.018a
Diuron	3.92	0-5	0.081ab	0.008ab	0.043bc	0.008bc	0.076ab	0.010cd
Oryzalin	3.36	0-5	0.041bc	0.006b	0.026c	0.007c	0.041b	0.008d
Simazine	3.92	0-5	0.110a	0.011a	0.082ab	0.010bc	0.101a	0.015abc
Check	0.00	0-5	0.104a	0.012a	0.087ab	0.015ab	0.109a	0.016ab
Atrazine	3.92	5-10	0.126a	0.015a	0.067a	0.010b	0.072abc	0.011abc
Dinoseb	11.21	5-10	0.095a	0.011b	0.094a	0.018ab	0.101a	0.018a
Diuron	3.92	5-10	0.195a	0.011b	0.111a	0.022ab	0.089ab	0.015ab
Oryzalin	3.36	5-10	0.107a	0.013ab	0.115a	0.023a	0.063abc	0.011cd
Simazine	3.92	5-10	0.121a	0.014ab	0.094a	0.017ab	0.058bc	0.009cd
Check	0.00	5-10	0.095a	0.011b	0.079a	0.015ab	0.047c	0.008c
Atrazine	3.92	10-15	0.108a	0.013a	0.100a	0.018a	0.078a	0.013a
Dinoseb	11.21	10-15	0.130a	0.014a	0.103a	0.022a	0.081a	0.014a
Diuron	3.92	10-15	0.115a	0.013a	0.081a	0.016a	0.076a	0.012a
Oryzalin	3.36	10-15	0.117a	0.014a	0.102a	0.020a	0.067a	0.013a
Simazine	3.92	10-15	0.107a	0.012a	0.080a	0.016a	0.085a	0.017a
Check	0.00	10-15	0.109a	0.013a	0.109a	0.022a	0.078a	0.014a

[z]Means significantly different by Duncan's Multiple Range Test, 5% level.

effect of these herbicides, whose main mode of action is photosynthesis inhibition.

The second bioassay conducted on 0-5 cm soil samples collected on May 23 no longer indicated dinoseb's presence. Under the increased light intensity in the greenhouse the wheat bioassays showed atrazine to significantly decrease wheat shoot growth compared to the check plot bioassays. Oryzalin still indicated residual activity eight weeks after herbicide applications.

Data from the July 1 sampling of the 0-5 cm soil samples showed that oryzalin still persisted in the soil. Atrazine did not show any significant residual activity compared to the control twelve weeks after application.

Data collected from bioassays conducted on 5-10 and 10-15 cm soil samples taken on April 22, May 23, and July 1 showed that there was no significant reduction in wheat seedling growth due to any herbicide treatment when compared to the check plot bioassays. The lack of reduction in wheat seedling growth at these lower soil depths indicates that the herbicides used did not move into the 5-10 and 10-15 cm soil zone. All residual activity detected was confined to the 0-5 cm level.

Effect of Oryzalin and Hexazinone on Weed Control and Tree Response

Table VIII shows data obtained from May 15, June 23, and September 15 visual weed control ratings taken on the oryzalin plots. Weed control ratings showed that oryzalin at 2.24 kg ai/ha controlled weeds May 15, but June 23 and September 15 ratings were not significantly better than the check plots. Oryzalin at 3.36 kg ai/ha provided fair

TABLE VIII

THE EFFECT OF DIFFERENT LEVELS OF ORYZALIN ON WEED CONTROL AND TERMINAL SHOOT GROWTH OF 'MOHAWK' PECAN TREES

Herbicide	Rate kg ai/ha	Visual Weed Control Rating[Y] (May 15)	(June 23)	(Sept.15)	Avg. Shoot Growth (cm)
Oryzalin	2.24	4.35b[Z]	2.5bc	1.5b	40.0a
Oryzalin	3.36	5.3ab	6.1a	5.5a	38.9ab
Oryzalin	4.48	7.9a	5.0ab	2.9ab	37.4ab
Check	0.00	1.0c	1.0c	1.0b	33.5b

[Z]Means significantly different by Duncan's Multiple Range test, 5% level.
[Y]Weed Control Rating 1-10; 1=No Control, 10=No Weeds Present.

weed control throughout the season. However, oryzalin at the 4.48 kg ai/ha rate gave fair weed control May 15 with it decreasing as the season progressed. By September 15, oryzalin at the 4.48 kg ai/ha rate did not control weeds significantly better than the check plots. A list of the weeds that were present in oryzalin plots is presented in Table IX.

Terminal shoot growth data in Table VIII shows that oryzalin did not cause any tree phytotoxicity. Oryzalin did not significantly decrease terminal shoot growth when compared to the check plot trees.

May 15, June 23, and September 15 weed control ratings taken on the hexazinone plots are shown in Table X. The weed control ratings demonstrate that hexazinone provided excellent season-long weed control. Hexazinone at the 2.24 and 3.36 kg ai/ha rates kept the plots nearly weed free throughout the season. The 1.12 kg ai/ha rate of hexazinone provided excellent weed control ratings through June 23 with good weed control ratings September 15. Table IX lists the broadleaf and grassy weeds not controlled by hexazinone. This table illustrates that the decrease in visual ratings September 15 of hexazinone at 1.12 kg ai/ha was mainly due to the inability of hexazinone at this rate to control the more resistant grassy weeds, such as Johnsongrass, cupgrass, and yellow nutsedge. Figure 1 illustrates the excellent season-long weed control obtained from hexazinone at 2.24 and 3.36 kg ai/ha. It also illustrates the good weed control demonstrated by hexazinone at 1.12 kg ai/ha September 15, with more resistant grassy weeds no longer being controlled.

TABLE IX

THE EFFECT OF ORYZALIN AND HEXAZINONE ON WEED SPECIES PRESENT

	Weed Dominance Ratings[z]						
	Treatment kg ai/ha						
	Oryzalin			Hexazinone			Check
	2.24	3.36	4.48	1.12	2.24	3.36	0
	Sampling Date: May 15						
Broadleaf Weeds							
Carolina geranium	---	---	---	---	---	---	4
Common cocklebur	4	---	4	---	---	---	---
Curly dock	---	5	---	---	---	---	3
Cutleaf eveningprimrose	4	4	---	---	---	---	5
Giant ragweed	4	2	2	---	---	---	2
Honeyvine milkweed	3	5	4	---	---	---	4
Pennsylvania smartweed	4	---	3	---	---	---	2
Pepperweed	---	4	---	---	---	---	5
Prickly lettuce	---	---	---	---	---	---	4
Purple vetch	---	---	---	---	---	---	5
Redroot pigweed	2	---	4	2	---	---	3
Stiff thelesperma	2	3	1	---	---	---	2
Tall morningglory	---	---	---	2	---	---	5
Yellow woodsorrel	---	5	---	---	---	---	4
Grassy Weeds							
Broadleaf uniola	---	---	---	---	---	---	1
Canada wildrye	---	---	---	---	---	---	1
Cheat	---	---	---	---	---	---	1
Cupgrass	3	4	---	---	---	---	---
Fall panicum	---	---	---	---	---	---	4
Japanese brome	---	---	---	---	---	---	2
Johnsongrass	1	1	2	---	---	---	3
Jointgrass	---	---	---	---	---	---	2
Large crabgrass	4	---	---	---	---	---	---
Yellow foxtail	---	---	---	---	---	---	5
Yellow nutsedge	1	1	1	1	---	---	2
	Sampling Date: June 23						
Broadleaf Weeds							
Carolina geranium	3	---	---	---	---	---	---
Curly dock	3	---	---	---	---	---	4
Cutleaf eveningprimrose	4	---	3	---	---	---	---
Giant ragweed	3	4	---	---	---	---	3

TABLE IX (Continued)

Weed Dominance Ratings							
	Treatment kg ai/ha						
	Oryzalin			Hexazinone			Check
	2.24	3.36	4.48	1.12	2.24	3.36	0
Sampling Date: June 23 (cont'd)							
Broadleaf Weeds (cont'd)							
Ground cherry	---	---	---	3	---	---	---
Honeyvine milkweed	4	---	---	---	---	---	4
Pennsylvania smartweed	---	---	4	---	---	---	2
Pepperweed	4	3	---	---	---	---	---
Prickly lettuce	3	3	---	---	---	---	4
Purple vetch	---	---	3	---	---	---	---
Redroot pigweed	---	---	---	3	---	---	1
Stiff thelesperma	2	3	3	---	---	---	3
Tall morningglory	---	---	3	3	---	---	---
Yellow woodsorrel	---	---	---	3	---	---	---
Grassy Weeds							
Broadleaf uniola	2	2	---	---	---	---	---
Canada wildrye	2	2	2	---	---	---	---
Cheat	2	2	2	---	---	---	---
Cupgrass	---	---	---	2	---	---	1
Japanese brome	2	2	---	2	---	---	---
Johnsongrass	---	3	---	2	---	---	2
Jointgrass	---	---	---	---	---	---	3
Yellow foxtail	4	4	4	---	---	---	---
Yellow nutsedge	1	1	1	1	---	---	3
Sampling Date: September 15							
Broadleaf Weeds							
Carolina horsenettle	---	4	4	---	---	---	---
Common cocklebur	5	---	4	---	---	---	---
Curly dock	5	5	3	---	---	---	3
Giant ragweed	3	2	2	---	---	---	3
Groundcherry	5	5	5	4	---	---	4
Honeyvine milkweed	5	5	4	4	---	---	4
Pennsylvania smartweed	2	2	1	3	---	---	1
Prostrate spurge	4	4	5	---	---	---	---
Redroot pigweed	2	3	2	2	3	2	2
Tall morningglory	---	---	---	4	---	---	---
Yellow woodsorrel	---	5	---	---	---	---	---

TABLE IX (Continued)

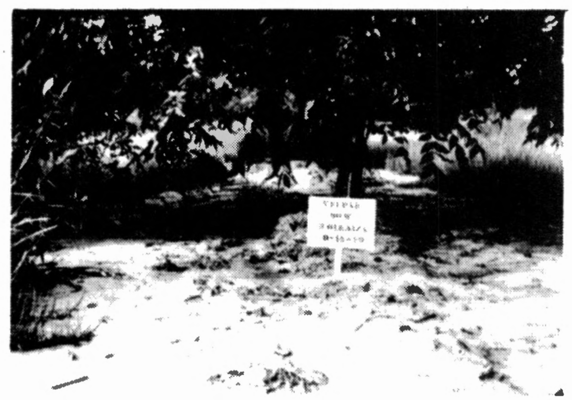
Weed Dominance Ratings							
	Treatment kg ai/ha						
	Oryzalin			Hexazinone			Check
	2.24	3.36	4.48	1.12	2.24	3.36	0
Sampling Date: September 15 (cont'd)							
Grassy Weeds							
Barnyardgrass	---	---	3	3	---	3	4
Bermudagrass	---	---	5	---	---	---	---
Cupgrass	1	2	4	1	1	1	2
Fall panicum	---	3	---	---	2	2	1
Johnsongrass	1	1	1	1	1	1	1
Jointgrass	2	3	---	2	2	2	2
Yellow foxtail	5	5	---	---	---	---	---
Yellow nutsedge	1	1	1	1	2	2	---

[z]Rating Scale 1-5; weed species followed by a 1 are most dominant and by a 5 are least dominant.

Control

Velpar - 90 W
1.12 kg ai/ha

Velpar - 90 W
2.24 kg ai/ha



Velpar - 90 W
3.36 kg ai/ha

Figure 1. Residual Chemical Weed Control 159 Days After Treatment 0, 1, 2, and 3 lbs ai/acre (0, 1.12, 2.24, 3.36 kg ai/ha) of Hexazinone.

Data in Table X shows that the different levels of hexazinone did not significantly differ in the amount of terminal shoot growth produced. However, all of the hexazinone treatments produced significantly more terminal growth than the check trees. Some leaf drop and leaf necrosis were noted on some of the hexazinone-treated plots in late May. These symptoms did not tend to differ between the different levels of hexazinone applied. The symptoms were thought to be phytotoxicity due to the hexazinone treatments, but by mid June the same symptoms were noted on the check plot trees. The causes of the leaf drop and leaf necrosis were not determined. Hexazinone did not directly cause the disorder but the hexazinone treatments did cause this problem to occur earlier in the spring.

TABLE X

THE EFFECT OF DIFFERENT LEVELS OF HEXAZINONE ON WEED CONTROL AND TERMINAL SHOOT GROWTH OF 'MOHAWK' PECAN TREES

Herbicide	Rate kg ai/ha	Visual Weed Control Rating[X] (May 15)	(June 23)	(Sept.15)	Avg. Shoot Growth (cm)
Hexazinone	1.12	9.0b[Z]	8.8a	6.6b	42.2a
Hexazinone	2.24	10.0a	10.0a	9.1a	39.4a
Hexazinone	3.36	10.0a	9.9a	9.5a	38.8a
Check	0.00	1.0[Y]	1.0[Y]	1.0[Y]	33.5b

[Z]Means significantly different by Duncan's Multiple Range test, 5% level.
[Y]Means not used in Duncan's Multiple Range test.
[X]Weed Control Rating 1-10; 1=No Control, 10=No Weeds Present.

CHAPTER V

SUMMARY AND CONCLUSIONS

Weed control ratings showed that atrazine at 3.92 kg ai/ha and oryzalin at 3.36 kg ai/ha gave good early season weed control, but failed to provide season-long weed control. Diuron and simazine at 3.92 kg ai/ha gave good season-long weed control, with diuron providing better overall weed control than simazine. Oryzalin at 3.36 and 4.48 kg ai/ha gave fair early and mid-season weed control. The 3.36 and 4.48 kg ai/ha rates of oryzalin provided significantly better early and mid-season weed control than the 2.24 kg ai/ha rate. Hexazinone at 2.24 and 3.36 kg ai/ha provided nearly complete control of weeds throughout the season. The 1.12 kg ai/ha rate of hexazinone also gave excellent early and mid-season weed control. However, later in the season 1.12 kg ai/ha of hexazinone decreased in its ability to control more resistant grassy weeds. No tree phytotoxicity was observed with any of the herbicides at any of the rates applied. A significant increase in terminal shoot growth was produced by 1.12, 2.24, and 3.36 kg ai/ha of hexazinone compared to the control trees.

Wheat bioassays showed that dinoseb at 11.21 kg ai/ha was persistent in the 0-5 cm soil depth four weeks after application. Atrazine at 3.92 kg ai/ha and oryzalin at 3.36 kg ai/ha showed residual activity in the 0-5 cm soil depth eight weeks after application. Twelve weeks after application oryzalin residue was still detected in the 0-5 cm soil depth. All herbicide residue was confined to the 0-5 cm soil depth, with no detectable movement into the 5-10 and 10-15 cm depths.

LITERATURE CITED

1. Ahrens, J.F. 1966. Herbicides around nut trees. Northern Nut Growers Assoc. Rpt. 57:58-61.

2. Aitken, J.B. 1976. Promising new herbicides for young pecans. So. Weed Sci. Soc. Proc. 29:181-189.

3. _____. 1976. Weed control in young pecans. S.E. Pecan Growers Assoc. Proc. 69:142-147.

4. _____. 1977. Evaluation of oryzalin in young non-bearing pecan trees. So. Weed Sci. Soc. Proc. 30:185-189.

5. Arnold, C.E. 1974. Weed control in Florida pecan orchards. S.E. Pecan Growers Assoc. Proc. 67:43-46.

6. _____, and J.B. Aitken. 1973. Perennial grass control in pecan orchards. So. Weed Sci. Soc. Proc. 26:231-235.

7. _____, and J.H. Aldrich. 1978. Velpar - a season long herbicide. Pecan South. 5(4):160-162.

8. Ashely, R.A., and E.M. Rahn. 1965. Persistance of atrazine and diphenamid soil residues and tolerance of these residues by certain crops. N.E. Weed Control Conf. Proc. 19:362-363.

9. Audus, L.J. 1964. The Physiology and Biochemistry of Herbicides. New York: Academic Press. 608 pp.

10. Axe, J.A., A.C. Mathers, and A.F. Wiese. 1969. Disappearance of atrazine, propazine, and trifluralin from soil and water. So. Weed Sci. Soc. Proc. 22:367.

11. Britton, N.L., and H.C. Brown. 1913. Illustrated Flora of the Northern States and Canada. New York: Charles Seribner's Sons, 2nd Ed. Vol.1-3.

12. Buchanan, G.A., and A.E. Hiltbold. 1973. Performance and persistence of atrazine. Weed Sci. 21:413-415.

13. Burnside, O.C., C.R. Fenster, and G.A. Wicks. 1971. Soil persistence of atrazine. Weed Sci. 19:290-293.

14. Coartney, J.S. 1972. Herbicides as an aid in the establishment of Christmas tree-seedlings. So. Weed Conf. Proc. 25:218.

15. Daniell, J.W. 1972. Use of herbicides for weed control and improved mechanical harvest of pecans. S.E. Pecan Growers Assoc. Proc. 65:75-79.

16. _____. 1974. The effects of chemical weed control on yield and quality of pecans. S.E. Pecan Growers Assoc. Proc. 67:35-38.

17. _____. 1978. Weed control in pecan orchards using Roundup. Pecan South. 5(1):12-15.

18. _____. 1978. Surflan for weed control in nonbearing pecan. Pecan South. 5(4):176-179.

19. Edmondson, J.V., D.A. Addison, R.D. Hicks, W.A. Humphres, J.A. Keaton, and K.E. McNeill. 1976. Oryzalin: a new herbicide for weed control in fruit and nut crops. So. Weed Sci. Soc. Proc. 29:191-193.

20. Fitzgerald, C.H., J.T. May, and C.W. Selden. 1972. Effects of herbaceous weed control in hardwood plantings. So. Weed Conf. Proc. 25:260-269.

21. Hinrichs, H.A. 1968. Studies of pecan research in progress at OSU. Oklahoma Pecan Growers Assoc. Proc. 38:16-23.

22. Klingman, G.C. 1966. Weed Control: As A Science. New York: John Wiley and Sons, Inc. 421 pp.

23. Krajicek, J.E. 1969. Weed control in black walnut plantings. Northern Nut Growers Assoc Rpt. 60:30-35.

24. Lagerstedt, H.B. 1977. Use of herbicides in orchards and small plantings of nut crops. Northern Nut Growers Assoc. Rpt. 68:60-63.

25. Libik, A.W., and R.R. Romanowski. 1976. Soil persistence of atrazine and cyanazine. Weed Sci. 24:627-629.

26. Lord, W.J., R.A. Damon, Jr., and B. Gersten. 1968. Response of 'McIntosh' apple trees to simazine alone and when in combination with hay and black polyethylene mulch and the accumulation of simazine residue under these conditions. N.E. Weed Conf. Proc. 22:224.

27. Norton, J.A. 1976. The effect of pre-emergence herbicides on Western pecan seedlings and control of annual weeds. Masters Thesis, Horticulture Dept., Oklahoma State University. 99 pp.

28. _____, and J.B. Storey. 1969. Use of herbicides in bearing non-bearing pecan orchards. So. Weed Conf. Proc. 22:238.

29. Norton, J.A., J.B. Storey, and G.D. Madden. 1969. Three years of chemical weed control research in Texas pecan orchards. Texas Pecan Growers Assoc. Proc. 48:48-51.

30. Savage, K.E. 1972. Persistence of atrazine, butylate, fluometuron, and nitralin in 15 southeastern soils. So. Weed Sci. Soc. Proc. 25:427.

31. Slack, C.H., R.L. Blevins, and C.E. Rieck. 1978. Effect of soil pH and tillage on persistence of simazine. Weed Sci. 26:145-148.

32. Sloane, L.W., and S.H. Crawford. 1972. Performance of corn preemergence herbicides at St. Joesph. So. Weed Conf. Proc. 25:164.

33. Storey, J.B. 1970. Pecan research by the Texas agriculture experiment station. Oklahoma Pecan Growers Assoc. Proc. 40:34-39.

34. Subcommittee of Weed Science Society of America. 1971. Subcommittee on standardization of common and botanical names of weeds. Weed Sci. 19:435-476.

35. Wascom, B.W., and W.A. Young. 1968. Pecan herbicide studies. S.E. Pecan Growers Assoc. Proc. 61:143.

36. _____, _____, and W.A. Meadows. 1972. A five-year study of weed control in pecan orchards. So. Weed Conf. Proc. 25:277.

TABLE XI

RAINFALL AT OKLAHOMA PECAN RESEARCH STATION
NEAR SPARKS, OKLAHOMA DURING
1978 AND 1979

1978		1979	
Date	Rainfall (cm)	Date	Rainfall (cm)
January 1	0.79	January 1	0.13
		January 11	0.20
		January 21	0.15
		January 26	3.45
February 13	7.11	February 21	1.42
February 15	0.23		
February 20	0.69		
February 28	0.61		
March 8	0.24	March 5	2.03
March 23	0.74	March 19	3.53
March 24	0.08	March 20	0.97
		March 22	1.80
		March 30	0.13
April 4	0.25	April 2	0.86
April 10	1.76	April 4	0.38
		April 11	4.24
		April 18	1.14
		April 24	0.51
		April 30	1.07
May 1	0.90	May 3	3.91
May 3	3.45	May 4	4.60
May 4	0.30	May 7	1.32
May 8	0.76	May 21	5.21
May 17	1.04	May 22	4.88
May 18	0.94	May 23	0.25
May 22	5.13	May 29	0.13
May 30	5.49		
June 2	0.18	June 6	0.74
June 5	0.69	June 7	4.11
June 6	1.04	June 11	9.88
June 19	2.49	June 21	2.24
June 22	2.39	June 25	6.73
		June 26	0.46

TABLE XI (Continued)

1978		1979	
Date	Rainfall (cm)	Date	Rainfall (cm)
July 24	1.47	July 6	3.25
July 31	0.53	July 9	0.23
		July 17	0.51
		July 18	0.43
		July 30	0.23
		July 31	1.93
August 4	0.23	August 11	1.22
August 28	0.13	August 20	2.03
		August 21	0.25
		August 22	2.79
		August 27	0.38
		August 31	2.16
September 6	0.23	September 1	2.41
September 21	0.48	September 6	0.30
September 25	0.89	September 21	0.28
October 9	3.33	October 22	1.25
October 23	0.48	October 30	3.61
November 6	0.89		
November 14	0.31		
November 15	2.03		
November 16	0.84		
November 17	1.73		
November 22	2.26		
Novmeber 27	2.18		

VITA[2]

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