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Tolerance of Soybeans and Grain Sorghum to Fluometuron Residue

Alton Wayne Jackson

To the Graduate Council:

I am submitting herewith a thesis written by Alton Wayne Jackson entitled "Tolerance of Soybeans and Grain Sorghum to Fluometuron Residue." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Plant, Soil and Environmental Sciences.

Larry S. Jeffery, Major Professor

We have read this thesis and recommend its acceptance:

L. N. Skold, W. L. Parks

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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W L Parks

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Vice Chancellor
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TOLERANCE OF SOYBEANS AND GRAIN SORGHUM TO FLUOMETURON RESIDUE

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee

Alton Wayne Jackson

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ABSTRACT

Failure to obtain a stand of cotton (Gossypium hirsutum L.) is often a problem. Cotton can be replanted only during a narrow range of recommended planting dates; therefore, alternative crops are sometimes necessary. The selection of an alternate crop is dependent on the herbicides already applied for preemergence weed control in cotton. Fluometuron [1,1-dimethyl-3-(a,a,a-trifluoro-m-tolyl)urea] is a widely used cotton herbicide, which may injure any alternative crop. The objective of this 1973 study was to determine the susceptibility of soybeans [Glycine Max (L.) Merr.] and grain sorghum [Sorghum bicolor (L.) Moench.] to fluometuron residues when grown as alternative crops to cotton on a Memphis silt loam at Milan, Tennessee and on a Sequatchie loam at Knoxville, Tennessee. The four main treatments consisted of fluometuron at the rate of 3.36 kg/ha broadcast, 1.68 kg/ha broadcast, 1.68 kg/ha on a treated area basis restricted to a 50 cm band, and no fluometuron. Each main treatment was divided into three subtreatments consisting of three, six, and nine week intervals from date of application to planting.

At Milan the 1.68 kg/ha band treatment did not significantly affect the number of live soybean plants, plant height, percent vigor reduction or yield of soybeans at any planting date. Fluometuron treatments of 3.36 and 1.68 kg/ha broadcast required a waiting period of nine weeks before soybeans could be grown without injury.

The 1.68 kg/ha band treatment did not cause significant injury or yield reduction of grain sorghum at Milan. Fluometuron treatments of 1.68 and 3.36 kg/ha broadcast required waiting periods of six and nine weeks, respectively, to prevent significant injury and yield reduction of grain sorghum at Milan. Grain sorghum and soybean response and yields and bioassay results showed a decrease in residue with successive planting dates. Grain sorghum exhibited more tolerance to fluometuron residue than did soybeans.

Fluometuron did not cause a significant reduction in the number of live plants, plant height, plant vigor or yield of either soybeans or grain sorghum at any rate at Knoxville. Response to fluometuron was obtained in a secondary experiment at Knoxville. Difference in response between locations was primarily attributable to a higher soil organic matter content at Knoxville.

Results of oat bioassays showed that fluometuron residues were found primarily in the 0-10 cm depth of soil. Sufficient dissipation had occurred by 24 weeks after application to allow normal growth of oats on all except the highest rate of fluometuron. Less phytotoxicity, due to fluometuron, was observed on oats grown in treated Sequatchie than in treated Memphis soil.

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CHAPTER I

INTRODUCTION

The Tennessee Agricultural Extension Service estimated in 1970 that cotton producers used a preplant or preemergence herbicide, or a combination of both on 96 percent of their acreage. Fluometuron, commercially available as "Cotoran" or "Lanex," is the most commonly used preemergence cotton herbicide in Tennessee.

While fluometuron is a very effective cotton herbicide, it is not labeled for use in any other Tennessee crop. Nor can any crop except cotton be replanted on land treated with fluometuron within a year after treatment. This has limited the use of fluometuron treated land for catch crops when cotton stands are not adequate and cannot be replanted.

Inadequate cotton stands are a major problem in Tennessee. Conditions for germination and seedling growth are often adverse as a consequence of the earliness of recommended planting dates (April 20-May 10). This narrow range of recommended planting dates restricts the possibility of replanting cotton in case of poor stands.

Logical catch crops for cotton in Tennessee are soybeans and grain sorghum. Recommended planting dates for soybeans are April 15-June 15 and for grain sorghum are May 1-June 1.

The possibility may exist that soybeans and grain sorghum could be used as catch crops because of their extended dates of planting. A time lapse might allow fluometuron to dissipate sufficiently to allow satisfactory soybean or grain sorghum growth.

The objectives of this experiment were:

1. Determine tolerance of soybeans and grain sorghum to fluometuron residues at two locations in Tennessee.
2. Determine the time interval between fluometuron application and planting which allows sufficient herbicide dissipation to eliminate significant crop injury and yield reduction.
3. Determine effect of band and broadcast application and rates on fluometuron dissipation.
4. Determine location and longevity of fluometuron residue in the soil profile.

CHAPTER II

LITERATURE REVIEW

The herbicidal properties of 1,1-dimethyl-3-(a,a,a-triluoro-m-tolyl)urea were first reported in the United States by Ciba personnel at the 1964 Southern Weed Conference (7). At that time, this compound was coded C-2059 and has since been designated by the common name fluometuron.

Research data were presented from seven different areas of the United States which indicated C-2059 to be particularly promising as a cotton herbicide. It had a wide margin of selectivity. Cotton was tolerant to rates up to 25.8 kg/ha in certain areas. Morningglory (Ipomea spp.), cocklebur (Xanthium spp.), pigweed (Amaranthus spp.), foxtail (Setaria spp.) and lambsquarter (Chenopodium album L.) were controlled at rates as low as .75 kg/ha. Higher rates of 2.24 to 4.48 kg/ha were required to control grasses such as crabgrass (Digitaria spp.) and barnyardgrass [Echinochloa crusgalli (L.) Beauv.].

Evaluation of fluometuron in several crops showed that soybeans were susceptible while grain sorghum tolerated fairly high dosages. The low tolerance of soybeans to fluometuron has been substantiated by Frans (14). The tolerance of grain sorghum to fluometuron has since been noted by Darding and Freeman (8) who, after work to determine suitable plant species for bioassay of fluometuron, suggested the use of grain sorghum when a fluometuron tolerant species is required. Eastin and coworkers (11), reporting on weed control in sorghum, showed that a rate of 1.12 kg/ha of fluometuron in combination with 1.12 kg/ha of propazine [2-chloro-4,6-bis(isopropylamino)-s-triazine] did not reduce grain sorghum yield but control of broadleaf weeds was excellent and control of grasses was good. Fluometuron at the rate of 3.36 kg/ha caused significant yield reduction but gave excellent control of both grasses and broadleaves.

According to a 1970 survey made by the Tennessee Agricultural Extension Service, fluometuron has become the most widely used cotton herbicide in Tennessee. The popularity of fluometuron is probably due to its effectiveness as a cotton herbicide which has been widely reported by researchers in most cotton growing areas (1,2,5,6,15,16).

Soon after the introduction of fluometuron as a cotton herbicide, research was begun on physiological aspects of the herbicide. Rogers and Funderburk (18) found that the basic physiological and herbicidal behavior of fluometuron, which acted as an inhibitor of the photosynthesis system at low rates, was typical of other phenyl substituted urea herbicides. These studies also showed cotton to be somewhat more tolerant than bean (*Phaseolus* spp.) and cucumber (*Cucumis sativus*) to the effects of fluometuron. Fluometuron in concentrations up to 10 ppm did not affect the respiratory system of cotton, bean or cucumber *in vitro*.

Sikka and Pramer (25) also studied the herbicidal properties of fluometuron on unicellular algae. They stated that fluometuron appeared to be selectively toxic to one or more light-mediated biochemical reactions required for the formation and function of photosynthetic pigments and organelles. This statement was based on results showing that fluometuron did not adversely influence respiration or the light-independent reactions that lead to the formation of chlorophyll or chloroplast precursors. It did interfere with the light-dependent or the greening process of chlorophyll synthesis and with photosynthetic oxygen evolution.

Extensive work has also been done to determine the mechanism of fluometuron tolerance in cotton. Rogers and Funderburk (19,20), showed that the resistance of cotton to fluometuron was due to rapid degradation of the herbicide into nontoxic metabolites. They found that 24 hours after application, shoots had degraded more fluometuron into nontoxic analogs and had less toxic analogs as well as less undegraded fluometuron than did the roots. They also delineated a degradation pathway for fluometuron.

Rubin and Eshel (21) studied the phytotoxicity of fluometuron and its derivatives to cotton, foxtail, and redroot pigweed (Amaranthus retroflexus L.). They suggested that differences in response to fluometuron and its metabolites may contribute to the differential response between cotton and weeds. They also suggested that fluometuron was metabolized more readily in cotton than in other species. They concluded that the selective action in cotton may result from differential susceptibility to metabolites in addition to differential metabolism of the herbicide itself and to differential uptake by the roots as a result of depth protection.

Selectivity due to depth protection is highly dependent on a herbicide's interaction with soil. Research has been carried out on the behavior of fluometuron in soil. Eshel (12) showed that fluometuron was leached more than two other commonly used cotton herbicides; however, fluometuron was less phytotoxic when it was taken into cotton plants.

Davidson and Santelmann (10) studied the displacement of fluometuron through saturated glass beads and soil. They found that fluometuron had a relatively high molecular diffusion coefficient and was thus relatively mobile in soil. They also found that fluometuron was not greatly adsorbed by soil. These two properties give an indication of the ability of fluometuron to permeate the soil.

Fickle and Smith (13) found fluometuron movement was related to rainfall intensity. They also found that fluometuron migration in subirrigated soil columns was related to clay content. Migration was 10-12.5 cm in a soil containing 5 percent clay, compared to 7.5-10.0 cm and 5.0-7.5 cm in soils containing 21 and 32 percent clay, respectively.

Darding and Freeman (9) found that ranges of soil organic matter from 1.0 to 5.0 percent caused no difference in phytotoxicity of fluometuron. They further found that inactivation of fluometuron was more rapid in soil having 3.3 percent organic matter than in soil having 7.2 percent organic matter. No explanation of this phenomenon was given by the authors.

Wiese and coworkers (26) also found that fluometuron injury to cotton was inversely related to organic matter in soils. He also noted that up to 46 percent of the fluometuron applied remained in soil after six months.

Savage (23) also studied the persistence of several herbicides including fluometuron. He found the initial toxicity of fluometuron to be highly correlated with soil organic matter. The average time required to reduce fluometuron to 50 percent of the initial rate was 61 days. At the end of 112 days, growth of bioassay plants was reduced by as much as 50 percent in certain soils.

Bozarth and coworkers (3,4) studied the degradation of fluometuron. They observed that fluometuron was degraded at a slow rate over time, that $^{14}CO_2$ was evolved at a slow and constant rate, and that degradation was a function of microbial metabolism. They concluded that the degradation pathway of fluometuron in soil was similar to the degradation pathway found in plants and that the degradation of fluometuron in soil was similar to degradation of other substituted phenyl urea herbicides. In the discussion of their results, Bozarth and Funderburk referred to the proposal made by Sheets (24) in his review of the literature on persistence of phenyl urea herbicides.

Sheets' proposal was that the adsorption-desorption equilibria of substituted phenyl urea herbicides may lie toward the adsorbed state so that the concentration in the soil solution remains low resulting in slow uptake and consequently slow metabolism.

CHAPTER III

METHODS AND MATERIALS

I. FIELD RESEARCH

Main Experiments

This study was conducted at the Milan Field Station (MFS) on a Memphis silt loam soil with a pH of 6.1 and at the Knoxville Plant Science Farm (KPS) on a Sequatchie loam soil with a pH of 6.2. Both soils are suitable for production of cotton, soybeans or grain sorghum. Prior to seedbed preparation, plot areas were fertilized with broadcast applications of 448 kg/ha of 20-15-15 and 560 kg/ha of 6-12-12 at MFS and KPS, respectively.

Recommended cotton seedbed preparation practices were followed in preparing the land for fluometuron application on May 5 at MFS and on May 7 at KPS. Both dates are within the range of recommended planting dates for cotton.

The experimental design was a split plot with four main treatments consisting of fluometuron applied at 0, 1.68 kg/ha on a treated area basis restricted to a 50 cm band, 1.68 kg/ha broadcast, and 3.36 kg/ha broadcast and with subplots within each main treatment consisting of three, six, and nine week planting intervals after fluometuron application. This experiment was replicated three times at each location in 4.06 x 18.35 meter plots and 4.06 x 9.14 meter plots at MFS and KPS, respectively. Replications were separated by 4.57 meter alleys at each location.

Fluometuron was applied in a spray volume of 187 L/ha at 2.0 kg/cm^2 of pressure using a tractor mounted plot sprayer at MFS and a CO_2 pressured back pack sprayer at KPS. Label directions for application were followed.

Approximately 1.88 cm of rain fell during the night following fluometuron application at KPS which, in addition to precipitation for the following four days, accounted for a total of 5.51 cm of precipitation. Precipitation at MFS totaled 3.23 cm for the three days following application. Weather data are given in Appendix Tables A-1 and A-2.

Specified plots were planted as close as permitted by weather to three, six, and nine week intervals after fluometuron application. Planting dates were as follows:

Interval (Weeks)	MFS	KPS
3	May 25	June 5
6	June 15	June 25
9	July 9	July 9

At specified intervals after fluometuron application, plots were prepared for planting by disking 15 cm deep two times followed by smoothing and firming operations. The objective of the disking was to incorporate and dilute the fluometuron. Plots were kept weed free after planting.

Cultivars planted were 'Dare' and 'Lee 68' soybeans and 'AKS 614' and 'Excel' grain sorghum at MFS and KPS, respectively. Grain sorghum was sprayed as needed for insect control at both locations. Planting was done with a 4-row field planter at MFS and with a "Planet Junior" at KPS. Inability to calibrate the "Planet Junior" correctly resulted in erratic grain sorghum populations at KPS. Recommended planting rates were used at MFS.

Plots at each location consisted of four 1.01 meter rows. Two rows on one side of the plot were planted to soybeans and the other two to grain sorghum.

Live plant counts, visual ratings on vigor reduction, plant heights, and yields were used as criteria for measuring crop response to fluometuron residue. Data were obtained from the center 6.10 meters of the inside row of each crop.

Visual ratings of percent vigor reduction were made on a 0 to 100 scale, with 0 being no vigor reduction and 100 being complete kill of all plants. The degree of vigor reduction was based on comparison with the untreated check in the same replication. Observations for each planting date were recorded approximately two weeks after crop emergence at MFS while only one overall observation was made at KPS due to lack of response to fluometuron.

Plant heights were not taken at the same interval after each planting; therefore, plant heights between planting dates were not compared; however, plant heights within planting dates were compared.

Grain sorghum panicles at MFS were manually clipped and taken to Knoxville to be oven dried and threshed. Soybeans were machine harvested at MFS and yields were converted to 13.5 percent moisture.

Grain sorghum and soybeans at KPS were manually harvested, oven dried and threshed.

Secondary Experiment, Knoxville Plant Science Farm

To further investigate the lack of response to fluometuron at KPS, a secondary experiment was initiated on an untreated portion of the plot area. This secondary experiment was a split plot design consisting of main treatments of an untreated check and 3.36 and 1.68 kg/ha broadcast treatments of fluometuron with subplots made up of zero, three, six, and nine week planting intervals after fluometuron application. Treatments were replicated three times in 3 x 3 meter plots. Two adjacent rows of soybeans and two adjacent rows of grain sorghum were planted in 75 cm row widths within each plot. Plots were prepared for planting at each specified interval by rotary tilling approximately 7.5 cm deep two times to incorporate and dilute fluometuron. A "Planet Junior" was used for planting. Plots were kept weed free.

Soybean stands were not adequate for taking yield data at all planting dates; therefore, only sorghum forage was harvested for yield. Sorghum forage was harvested from the center 1.5 meters of the row nearest the center of the plot and oven dried.

II. LABORATORY RESEARCH

Bioassay

Soil samples were taken at various intervals from each location and bioassayed by a standard oat bioassay (22) conducted in a "twincubator" or growth chamber at Knoxville. Field samples were compared against a standard curve of known amounts of fluometuron ranging from 2.0 to .06 parts per million (ppm). Comparisons were made by water use, green weight, dry weight, and visual injury ratings of oat plants.

Preliminary Bioassay

Soil samples for bioassay were taken approximately 8 weeks after fluometuron application from both locations at depth increments of 7.5 cm down to 22.5 cm. Samples were taken at this time only from non-treated plots and plots treated with 3.36 kg/ha of fluometuron.

Secondary Bioassay, Knoxville Plant Science Farm

Soil samples for bioassay were also taken at 10 cm increments to a depth of 40 cm approximately 16 weeks after application from all treatments of the KPS secondary experiment.

Main Bioassay

Soil samples were also taken at harvest (approximately 24-28 weeks after application) from all treatments at both locations at depths of 0-7.5, 7.5-15.0, and 15.0-22.5 cm at MFS and at 10 cm increments down to 40 cm at KPS.

Soil Characterization

Soil samples were taken during the 1973 growing season at the Milan Field Station and at the Knoxville Plant Science Farm.

At Knoxville, samples were taken at 10 cm increments to a depth of 40 cm. Samples from the 0-10 and 10-20 cm depths were pooled as were samples taken from 20-30 and 30-40 cm depths.

At Milan, samples were taken at 7.5 cm increments to a depth of 22.5 cm. Samples from the 0-7.5 and 7.5-15.0 cm depths were pooled.

The samples were air dried, crushed to pass through a 2 mm sieve, and stored in plastic bags. Both soils were characterized during early 1974 in the laboratory.

All laboratory methods used have been previously described by Richards (17). Organic matter was determined by a modification of the Walkley-Black chromic acid method. Bulk density, large and small pore space were also determined. Percentages of textural components were determined by the pipette method. Soil moisture content at several tensions was determined by either the porous plate or the pressure membrane method. Moisture values obtained at 1/3 and at 15 bars tension were used to calculate available water holding capacity.

CHAPTER IV

RESULTS AND DISCUSSION

I. FIELD RESEARCH

Main Experiment, Milan Field Station

Grain Sorghum

Number of live plants. The 3.36 kg/ha broadcast treatment left significantly fewer live plants at the first and second planting dates than did the other three treatments (Table 1). Numbers of live grain sorghum plants within the two 1.68 kg/ha treatments were not significantly different from live plants within the nontreated control for any planting date. The number of live plants within the 3.36 kg/ha broadcast treatment increased significantly with each successive planting date so that no significant differences were found at the nine week planting date. This indicates dissipation of fluometuron over time.

When treatments were averaged within dates the number of live grain sorghum plants increased significantly with each successive planting. This increase was due to significant increases in live plant numbers at each successive planting for the 3.36 kg/ha treatment.

When averaged over all planting dates the number of live grain sorghum plants was reduced significantly by the 3.36 kg/ha broadcast treatment while the two 1.68 kg/ha treatments caused no significant reduction of live plants.

Table 1. Effect of Fluometuron Residue on Survival of Grain Sorghum Planted Three, Six, and Nine Weeks After Herbicide Application, Milan Field Station, 1973

Fluometuron Treatments	Interval Between Application and Planting			
	3 Weeks	6 Weeks	9 Weeks	Average
kg/ha	------number of live plants per 6.1 meter row----			
3.36 Broadcast	9 a*	58 b	78 c	48 r
1.68 Broadcast	69 bc	73 c	77 c	73 s
1.68 Band	68 bc	75 c	78 c	74 s
Check	82 c	73 c	78 c	78 s
Average	57 x	70 y	78 z	

*Values for treatments or averages followed by the same letter within either columns or rows are not significantly different at the 5 percent level, according to Duncan's Multiple Range test.

A highly significant interaction occurred between treatments and dates due to the increase in live plants over planting dates for the 3.36 kg/ha treatment while the other treatments stayed approximately the same.

<u>Vigor reduction</u>. The 1.68 kg/ha band treatment caused no significant vigor reduction of grain sorghum for any planting date. The 1.68 and 3.36 kg/ha broadcast treatments caused vigor reduction of grain sorghum at the first and second plantings although there was a decline in the level of vigor reduction from the first to the second planting date

(Table 2). Fluometuron dissipated sufficiently between the second and the third planting so that no significant vigor reduction occurred at the third planting for any fluometuron treatment.

Table 2. Effect of Fluometuron Residue on Vigor Reduction of Grain Sorghum Planted Three, Six, and Nine Weeks After Herbicide Application, Milan Field Station, 1973

Fluometuron Treatments	Interval Between Application and Planting			
	3 Weeks	6 Weeks	9 Weeks	Average
kg/ha	percent vigor reduction			
3.36 Broadcast	98 d*	65 cd	15 ab	59 r
1.68 Broadcast	70 cd	50 bc	5 a	42 r
1.68 Band	7 a	10 ab	0 a	6 s
Check	0 a	0 a	0 a	0 s
Average	44 x	31 x	5 y	

*Values for treatments or averages followed by the same letter within either columns or rows are not significantly different at the 5 percent level, according to Duncan's Multiple Range test.

When averaged for all dates, the 1.68 kg/ha band treatment was found to cause no significant vigor reduction when compared to the nontreated control while the two broadcast treatments reduced grain sorghum vigor.

When treatments were averaged within dates, the amount of grain sorghum vigor reduction declined significantly for the third planting. Significant decreases in vigor reduction of the two broadcast treatments at the third planting date accounted for the decline in vigor reduction at the third planting date. An interaction occurred between dates and treatments due to fluometuron dissipation in the broadcast treatments over time.

Plant height. At the three week planting date, grain sorghum height was reduced by all fluometuron treatments, regardless of rate or method of application. Grain sorghum planted three weeks after the application of 1.68 kg/ha of fluometuron in a band was significantly taller than grain sorghum planted on an area treated with a broadcast application of either 1.68 or 3.36 kg/ha of fluometuron (Table 3). This indicates

Table 3. Effect of Fluometuron Residue on Height of Grain Sorghum Planted Three, Six, and Nine Weeks After Herbicide Application, Milan Field Station, 1973

Fluometuron Treatments	Interval Between Application and Planting			
	3 Weeks	6 Weeks	9 Weeks	Average
kg/ha	plant height cm			
3.36 Broadcast	1.7 a*	2.3 f	15.8 i	6.6 r
1.68 Broadcast	5.0 a	3.8 fg	20.8 j	10.0 s
1.68 Band	11.3 b	6.3 g	18.8 ij	12.1 st
Check	16.3 c	6.8 g	18.5 ij	13.8 t
Average	8.6	4.9	18.5	

*Values for treatments or averages followed by the same letter within columns are not significantly different at the 5 percent level, according to Duncan's Multiple Range test.

that less fluometuron residue was present when fluometuron was applied as a band treatment. The 3.36 kg/ha treatment caused significant reduction of height of grain sorghum planted six weeks after fluometuron application from that of the band treatment and check although height variations between treatments were visually apparent.

Height variation between grain sorghum plants grown on different fluometuron treatments was observed for both the first and second plantings; however, when compared as a percentage of the nontreated check for each planting, the least variation occurred in the second planting. The reduced variation in height of the second planting as compared to the first planting was probably caused by fluometuron dissipation.

At the nine week planting date, grain sorghum heights were erratic due to drought. The tallest and shortest grain sorghum plants grew on plots treated with 1.68 and 3.36 kg/ha broadcast applications, respectively, and this difference was significant. Fluometuron in amounts injurious to grain sorghum almost had dissipated by the nine week planting period.

When averaged over all planting dates, the 1.68 kg/ha band treatment caused no significant reduction in height. The broadcast treatments caused a significant reduction in grain sorghum plant heights.

Seed yields. The 1.68 kg/ha band treatment of fluometuron did not reduce grain sorghum yields for either the first or second planting date (Table 4). The two broadcast treatments reduced yield of grain

Table 4. Effect of Fluometuron Residue on Seed Yields of Grain Sorghum Planted Three, Six, and Nine Weeks After Herbicide Application, Milan Field Station, 1973

Fluometuron Treatments	Interval Between Application and Planting			
	3 Weeks	6 Weeks	9 Weeks	Average
kg/ha	-----------------seed yields kg/ha-----------------			
3.36 Broadcast	154 a*	1379 ab	1480 ab	1005 x
1.68 Broadcast	3221 bcd	5449 e	4186 cde	4285 y
1.68 Band	5829 e	4682 de	1661 ab	4057 y
Check	5729 e	4663 de	2442 cb	4278 y
Average	3734 k	4043 k	2442 j	

*Values for treatments or averages followed by the same letter within either columns or rows are not significantly different at the 5 percent level, according to Duncan's Multiple Range test.

sorghum planted three weeks after fluometuron application. The 3.36 kg/ha treatment reduced yield significantly more than did the 1.68 kg/ha broadcast treatment.

Sufficient fluometuron residue remained from the 3.36 kg/ha broadcast treatment to cause a yield reduction for grain sorghum planted on the second planting date. The two 1.68 kg/ha treatments did not reduce yield of grain sorghum planted six weeks after fluometuron application.

Grain sorghum yields from the third planting were erratic due to drought. The 3.36 kg/ha broadcast treatment again caused the lowest yield; however, this yield was not significantly different from yields of the nontreated control and the 1.68 kg/ha band treatment. At the nine week planting date the yield on the 1.68 kg/ha broadcast treatment was significantly higher than any other fluometuron treatment.

The erratic yield behavior for the third planting was possibly caused by differential availability of water due to differential weed populations occurring between fluometuron application and planting time. Weed populations were relatively high in the nontreated check and in the plots treated with a 1.68 kg/ha band treatment. Weed populations were relatively low in the 1.68 and 3.36 kg/ha broadcast treatments probably because of the presence of sufficient residue to control weeds. Yields from the 3.36 kg/ha broadcast treatment were lower than yields from the 1.68 kg/ha broadcast treatment possibly because the amount of residue remaining in plots treated with the higher rate of fluometuron was sufficient to cause injury.

When grain sorghum yields were averaged for all dates, the two 1.68 kg/ha treatments caused no significant reduction as compared to the nontreated check. The 3.36 kg/ha broadcast treatment caused a significant yield reduction when averaged over all dates. The average of treatment yields by planting dates showed yields from the third planting date to be significantly lower than the first and second planting dates. Yield reduction by drought at the third planting caused significant interaction among treatments and dates.

Soybeans

Number of live plants. At the first planting, the two broadcast treatments of fluometuron left significantly fewer surviving soybean plants than did the band treatment (Table 5). The band treatment did not reduce soybean plant survival when compared to the nontreated check.

Table 5. Effect of Fluometuron Residue on Survival of Soybeans Planted Three, Six, and Nine Weeks After Herbicide Application, Milan Field Station, 1973

Fluometuron Treatments	Interval Between Application and Planting			
	3 Weeks	6 Weeks	9 Weeks	Average
kg/ha	------number of live plants per 6.1 meter row----			
3.36 Broadcast	0 a*	57 bc	29 ab	29 r
1.68 Broadcast	5 a	152 fg	79 cd	79 s
1.68 Band	136 efg	164 g	110 def	137 t
Check	163 g	179 g	95 cde	145 t
Average	76 x	138 y	78 x	

*Values for treatments or averages followed by the same letter within either columns or rows are not significantly different at the 5 percent level, according to Duncan's Multiple Range test.

At the second planting six weeks after fluometuron application, only the broadcast treatment of 3.36 kg/ha fluometuron reduced the number of surviving soybean plants. The number of surviving soybean plants within plots treated with 1.68 and 3.36 kg/ha broadcast treatments of fluometuron increased significantly from the first to the second planting. This increase indicated fluometuron dissipation with successive plantings. Plants continued to die after counts were taken on areas treated with a 1.68 kg/ha broadcast application of fluometuron. This continued plant death was reflected in yields.

At the third planting, only the 3.36 kg/ha broadcast treatment reduced the number of surviving soybean plants. Soybean survival within all other treatments was less than in the second planting because of drought.

When the numbers of surviving soybean plants were averaged over all dates, fluometuron treatments reduced surviving plants in the order 3.36 kg/ha broadcast > 1.68 kg/ha broadcast > 1.68 kg/ha band = nontreated check.

When the numbers of surviving soybean plants within each date were averaged, significantly more soybeans survived at the second planting than at the first and third plantings. Soybean survival at the first planting was decreased due to severe rates of kill by the two broadcast treatments of fluometuron. Soybean survival for the third planting nine weeks after fluometuron application was reduced due to drought.

Significant interaction occurred among treatments and dates due to drought after the third planting which reduced soybean populations. This was in contrast to the increasing populations from the first to the second planting because of fluometuron dissipation.

<u>Vigor reduction</u>. All fluometuron treatments caused significant soybean vigor reduction at the first planting date (Table 6). At the first planting, the two broadcast treatments reduced soybean vigor significantly more than did the band treatment. Within the second and third planting dates, only the fluometuron broadcast treatments reduced soybean vigor.

Table 6. Effect of Fluometuron Residue on Vigor Reduction of Soybeans Planted Three, Six, and Nine Weeks After Herbicide Application, Milan Field Station, 1973

Fluometuron Treatments	Interval Between Application and Planting			
	3 Weeks	6 Weeks	9 Weeks	Average
kg/ha	-------------percent vigor reduction-------------			
3.36 Broadcast	100 a*	73 ab	50 bc	74 o
1.68 Broadcast	98 a	53 ab	25 bcd	59 o
1.68 Band	38 bc	13 cde	10 de	20 n
Check	0 e	0 e	0 e	0 m
Average	59 x	35 y	21 y	

*Values for treatments or averages followed by the same letter within either columns or rows are not significantly different at the 5 percent level, according to Duncan's Multiple Range test.

The degree of vigor reduction of soybeans within each treatment decreased with each successive planting due to dissipation of the herbicide. When averaged over all dates, soybean vigor reduction resulted from all fluometuron treatments. The 1.68 and 3.36 kg/ha broadcast treatments caused significantly more vigor reduction than did the 1.68 kg/ha band treatment.

When soybean vigor reduction from all fluometuron treatments within planting dates was averaged, it decreased with each successive planting. The second and third plantings had significantly less vigor reduction than did the first planting. This decrease in vigor reduction over planting dates indicated fluometuron dissipation.

No significant interaction occurred because all treatments followed the same trend of decreasing vigor reduction with an increase in interval between fluometuron application and planting.

Plant height. All treatments of fluometuron significantly reduced plant heights of soybeans planted three weeks after fluometuron application (Table 7). The band treatment reduced soybean heights less than the broadcast treatments.

At the second planting, only the fluometuron broadcast treatments reduced soybean plant heights. A wide variation was observed in soybean heights ranging from 3.8 to 6.5 cm for the 3.36 kg/ha treatment and

Table 7. Effect of Fluometuron Residue on Height of Soybeans Planted Three, Six, and Nine Weeks After Herbicide Application, Milan Field Station, 1973

Fluometuron Treatments	Interval Between Application and Planting			
	3 Weeks	6 Weeks	9 Weeks	Average
kg/ha	plant height cm			
3.36 Broadcast	.8 a*	3.8 e	8.8 m	4.5 r
1.68 Broadcast	1.7 a	4.5 ef	11.8 n	6.0 s
1.68 Band	10.5 b	5.5 fg	13.8 o	9.9 t
Check	12.5 c	6.5 g	11.8 n	10.2 t
Average	6.4	5.1	11.5	

*Values for treatments or averages followed by the same letter within columns are not significantly different at the 5 percent level, according to Duncan's Multiple Range test.

nontreated check, respectively. Soybean height tended to reflect the degree of injury of each fluometuron treatment.

Soybean plant height, taken as a percent of the nontreated check, tended to increase from the first to the second planting for each fluometuron treatment. This indicated dissipation of fluometuron with successive plantings.

At the third planting, nine weeks after application, only the 3.36 kg/ha fluometuron treatment reduced soybean plant height. Drought caused plant heights of the third planting to be erratic.

When soybean plant heights are averaged over all dates for each treatment, fluometuron treatments reduced heights in the order 3.36 kg/ha broadcast > 1.68 kg/ha broadcast > 1.68 kg/ha band = nontreated check.

Interaction occurred among treatments and planting dates.

<u>Seed yields</u>. Broadcast treatments of 1.68 and 3.36 kg/ha of fluometuron caused complete kill of all soybeans at the first and second plantings; therefore, no yields were obtained (Table 8). The 1.68 kg/ha band treatment caused no significant reduction in yield of soybeans planted three and six weeks after fluometuron application. Fluometuron treatments caused no significant differences in yields of soybeans planted on the third date regardless of rate of application. Soybean yields of the third planting were adversely affected by drought as noted by the fact that the 1.68 kg/ha band treatment and nontreated check yielded significantly lower for the third planting than for the first

Table 8. Effect of Fluometuron Residue on Seed Yields of Soybeans Planted Three, Six, and Nine Weeks After Herbicide Application, Milan Field Station, 1973

Fluometuron Treatments	Interval Between Application and Planting			
	3 Weeks	6 Weeks	9 Weeks	Average
kg/ha	----------------seed yields kg/ha----------------			
3.36 Broadcast	0 a*	0 a	72 a	24 m
1.68 Broadcast	0 a	0 a	346 a	115 m
1.68 Band	2017 b	2379 b	613 a	1670 n
Check	2877 b	2922 b	381 a	2059 o
Average	1223 x	1327 x	354 y	

*Values for treatments or averages followed by the same letter within either columns or rows are not significantly different at the 5 percent level, according to Duncan's Multiple Range test.

and second planting. When all treatments were averaged within planting dates, the third planting yielded significantly less than the first and second plantings.

Soybean yields averaged over all dates showed a significant reduction in yield by all fluometuron treatments. The two broadcast treatments reduced yields significantly more than the band treatment.

A significant interaction occurred among treatments and dates due to increased treatment yields of second planting over the first followed by a sharp drop in treatment yields because of drought at the third planting.

Knoxville Plant Science Farm

Grain Sorghum

Live plants. Live plant numbers of the first and second plantings were not affected by any fluometuron treatments (Table 9).

For the third planting date, the only difference found was more live plants growing on the 1.68 kg/ha broadcast treated area than on the nontreated area.

No significant difference was found between treatments when averages for all dates were compared.

Table 9. Effect of Fluometuron Residue on Survival of Grain Sorghum Planted Three, Six, and Nine Weeks After Herbicide Application, Knoxville Plant Science Farm, 1973

Fluometuron Treatments	Interval Between Application and Planting			
	3 Weeks	6 Weeks	9 Weeks	Average
kg/ha	--------no. live plants per 6.1 meter row--------			
3.36 Broadcast	89 a*	250 bcd	300 cd	213 n
1.68 Broadcast	94 a	240 bcd	370 d	235 n
1.68 Band	97 a	248 bcd	344 cd	196 n
Check	116 a	230 bc	223 bc	190 n
Average	99 x	217 y	309 z	

*Values for treatments or averages followed by the same letter within either columns or rows are not significantly different at the 5 percent level, according to Duncan's Multiple Range test.

A significant increase in live plants for each successive planting date was due to planter calibration problems.

Vigor reduction. Only the 3.36 kg/ha treatment caused significant vigor reduction which was 10, 8 and 7 percent for the three, six, and nine week planting intervals, respectively (Table 10).

No significant differences were found among treatments or dates.

Table 10. Effect of Fluometuron Residue on Vigor Reduction of Grain Sorghum Planted Three, Six, and Nine Weeks After Herbicide Application, Knoxville Plant Science Farm, 1973

Fluometuron Treatments	Interval Between Application and Planting			
	3 Weeks	6 Weeks	9 Weeks	Average
kg/ha	percent vigor reduction			
3.36 Broadcast	10 c*	8 bc	7 b	8 n
1.68 Broadcast	0 a	0 a	0 a	0 n
1.68 Band	0 a	0 a	0 a	0 n
Check	0 a	0 a	0 a	0 n
Average	3 s	2 s	2 s	

*Values for treatments or averages followed by the same letter within either columns or rows are not significantly different at the 5 percent level, according to Duncan's Multiple Range test.

Plant height. At the first planting, band treatment plant heights were not different from plant heights of any other treatment. Heights of grain sorghum plants grown in plots treated with 3.36 kg/ha of fluometuron were not different at the first planting date from heights of plants grown in the nontreated check (Table 11). Plant heights for these two treatments were significantly lower for the first planting than were heights of plants grown in areas treated with a 1.68 kg/ha broadcast application. This same pattern was found for treatments within the second and third plantings and when treatments were averaged over all dates; however, differences were not significant.

Table 11. Effect of Fluometuron Residue on Height of Grain Sorghum Planted Three, Six, and Nine Weeks After Herbicide Application, Knoxville Plant Science Farm, 1973

Fluometuron Treatments	Interval Between Application and Planting			
	3 Weeks	6 Weeks	9 Weeks	Average
kg/ha	plant height cm			
3.36 Broadcast	68 a*	75 m	76 s	73 v
1.68 Broadcast	88 b	90 m	78 s	85 v
1.68 Band	79 ab	85 m	80 s	81 v
Check	67 a	75 m	71 s	71 v
Average	75	81	76	

*Values for treatments or averages followed by the same letter within columns are not significantly different at the 5 percent level, according to Duncan's Multiple Range test.

The reduced height of plants grown in the check was due to depletion of moisture reserves by the weed population present between application and planting time. Fluometuron residue probably accounted for the reduction in height of plants grown in an area treated with 3.36 kg/ha.

Seed yields. The check yielded significantly lower than the other three treatments within the first planting, probably due to depletion of moisture reserves by the weed population present between application and planting. Treatments within the six and nine week planting dates had no significant effect on yields. Treatments averaged over all dates showed no significant differences in yield (Table 12). The third planting date showed a significant decrease in average yield.

Table 12. Effect of Fluometuron Residue on Seed Yields of Grain Sorghum Planted Three, Six, and Nine Weeks After Herbicide Application, Knoxville Plant Science Farm, 1973

Fluometuron Treatments	Interval Between Application and Planting			
	3 Weeks	6 Weeks	9 Weeks	Average
kg/ha	----------------seed yields kg/ha----------------			
3.36 Broadcast	3150 e*	1825 bcde	1081 abc	2019 n
1.68 Broadcast	2871 e	2051 bcde	339 a	1753 n
1.68 Band	2700 de	2412 cde	745 ab	1952 n
Check	1465 abcd	2040 bcde	280 a	1262 n
Average	2546 x	2082 x	611 z	

*Values for treatments or averages followed by the same letter within either columns or rows are not significantly different at the 5 percent level, according to Duncan's Multiple Range test.

Soybeans

Number of live plants. No significant differences in live plant numbers were noted between treatments within any planting date or between treatments averaged over all planting dates (Table 13).

The third planting date had a significantly higher average number of live plants than did the first and second plantings due to an improperly calibrated planter.

Table 13. Effect of Fluometuron Residue on Survival of Soybeans Planted Three, Six, and Nine Weeks After Herbicide Application, Knoxville Plant Science Farm, 1973

Fluometuron Treatments	Interval Between Application and Planting			
	3 Weeks	6 Weeks	9 Weeks	Average
kg/ha	no. plants per 6.1 meter row			
3.36 Broadcast	61 a*	57 a	198 bcd	105 n
1.68 Broadcast	89 ab	81 a	204 cd	125 n
1.68 Band	60 a	46 a	241 d	116 n
Check	98 abc	76 a	232 d	135 n
Average	77 a	65 a	219 b	

*Values for treatments or averages followed by the same letter within either columns or rows are not significantly different at the 5 percent level, according to Duncan's Multiple Range test.

Vigor reduction. All fluometuron treatments at all dates caused vigor reduction over the nontreated check (Table 14). The 3.36 kg/ha treatment caused more vigor reduction than the two 1.68 kg/ha fluometuron treatments at all three planting dates.

When treatments were averaged over all dates, no differences were found between vigor reduction of the check and 1.68 kg/ha treatments. The 3.36 kg/ha treatment caused more vigor reduction than the other treatments.

No difference in vigor reduction was found between dates of planting.

Table 14. Effect of Fluometuron Residue on Vigor Reduction of Soybeans Planted Three, Six, and Nine Weeks After Herbicide Application, Knoxville Plant Science Farm, 1973

Fluometuron Treatments	Interval Between Application and Planting			
	3 Weeks	6 Weeks	9 Weeks	Average
kg/ha	percent vigor reduction			
3.36 Broadcast	27 f*	27 f	18 e	24 y
1.68 Broadcast	7 c	7 c	13 d	9 xy
1.68 Band	7 c	7 c	3 b	6 x
Check	0 a	0 a	0 a	0 x
Average	10 n	10 n	8 n	

*Values for treatments or averages followed by the same letter within either columns or rows are not significantly different at the 5 percent level, according to Duncan's Multiple Range test.

Plant height. For the first planting date, the 3.36 kg/ha treatment caused significantly more height reduction than any other treatment (Table 15). No height difference was found between plants grown on non-treated areas and areas treated with either 1.68 kg/ha treatment of fluometuron. Plants grown in areas treated with a 1.68 kg/ha broadcast treatment of fluometuron were taller than those grown in areas treated with a band application. Greater plant heights of this treatment could be due to growth stimulation by subherbicidal levels of fluometuron residue.

Table 15. Effect of Fluometuron Residue on Height of Soybeans Planted Three, Six, and Nine Weeks After Herbicide Application, Knoxville Plant Science Farm, 1973

Fluometuron Treatments	Interval Between Application and Planting			
	3 Weeks	6 Weeks	9 Weeks	Average
kg/ha	plant height cm			
3.36 Broadcast	53 d*	45 h	45 m	48 b
1.68 Broadcast	90 f	71 i	45 m	69 b
1.68 Band	74 e	60 i	48 m	60 b
Check	77 ef	64 i	43 m	61 b
Average	74	60	45	

*Values for treatments or averages followed by the same letter within columns are not significantly different at the 5 percent level, according to Duncan's Multiple Range test.

For the second planting date, the 3.36 kg/ha treatment again caused more reduction in plant height than any other treatment. The tallest plants were again found growing in areas treated with the 1.68 kg/ha broadcast application of fluometuron; however, they were not significantly taller than plants grown in the nontreated area or the band treated area.

Treatments caused no significant difference in plant heights at the third planting or when averaged over all dates.

Seed yields. No differences existed among treatment yields within planting dates, or over all planting dates (Table 16).

No difference was found among planting dates.

Table 16. Effect of Fluometuron Residue on Seed Yields of Soybeans Planted Three, Six, and Nine Weeks After Herbicide Application, Knoxville Plant Science Farm, 1973

Fluometuron Treatments	Interval Between Application and Planting			
	3 Weeks	6 Weeks	9 Weeks	Average
kg/ha	seed yields kg/ha			
3.36 Broadcast	619 **	531	938	696
1.68 Broadcast	1176	978	689	948
1.68 Band	702	412	665	593
Check	880	666	578	708
Average	521	647	717	

**All values were nonsignificant.

Knoxville Plant Science Farm, Secondary Field Experiment

When applied at zero and three week intervals after planting, fluometuron at both rates reduced sorghum forage weights (Table 17).

Table 17. Effect of Fluometuron Residue on Forage Yields of Sorghum Planted Zero, Three, Six, and Nine Weeks After Herbicide Application, Knoxville Plant Science Farm, 1973

Fluometuron Treatments	Interval Between Application and Planting				
	0 Weeks	3 Weeks	6 Weeks	9 Weeks	Average
kg/ha	-------------oven dry forage weight kg/ha-------------				
3.36 Broadcast	10,008 a*	6,229 d	2,396 g	476 j	4,777 x
1.68 Broadcast	11,492 a	9,191 d	3,856 g	531 j	6,267 x
Check	15,962 b	10,026 e	3,618 g	1,131 j	7,684 x
Average	12,487 s	8,482 t	3,290 u	713 v	

*Values for treatments or averages followed by the same letter within either columns or rows are not significantly different at the 5 percent level, according to Duncan's Multiple Range test.

Treatments caused no differences in forage weights when intervals of six weeks or greater were allowed between application and planting. There was a nonsignificant trend for fluometuron to reduce forage weights as compared to the check. This trend generally showed that the 3.36 kg/ha treatment caused a greater amount of weight reduction than did the 1.68 kg/ha treatment.

When averaged over all dates, neither treatment caused a reduction of sorghum forage weight when compared to the check.

Forage yields decreased significantly with each successive planting date due to a shorter length of growth between planting and harvest.

II. LABORATORY RESEARCH

Bioassay

Bioassays were conducted with soil samples taken from both locations over the duration of the field experiment. These bioassays delineated the amounts and location in the profile of fluometuron residues. Residues were of a greater magnitude at MFS than at KPS.

Preliminary

Milan Field Station. At Milan, fluometuron residues were found at all depths. The greatest portion was in the 0-7.5 cm depth of soil from plots treated with 3.36 kg/ha of fluometuron eight weeks prior to sampling.

Based on water use by oat plants, green and dry plant weights and visual ratings, residues were approximately 2.0, 0.25 and 0.13 ppm at depths of 0-7.5, 7.5-15.0, and 15.0-22.5 cm, respectively.

Knoxville Plant Science Farm. Residues were found primarily in the 0-7.5 cm depth of soil from plots treated with 3.36 kg/ha of fluometuron broadcast eight weeks prior to sampling.

Based on water use by oat plants, green and dry plant weights, and visual ratings, fluometuron residues were significant and approximately equal to 0.5 ppm.

Phytotoxicity symptoms consisting of whitened leaf tips indicated that traces of fluometuron were present at depths of 7.5 to 15.0 cm; however, they had no significant effect on water use by oats or green and dry plant weights.

Secondary Bioassay, Knoxville Plant Science Farm

Residues were found primarily in the top 0-10.0 cm depth of soil profile treated with 1.68 and 3.36 kg/ha of fluometuron broadcast applied 16 weeks prior to sampling.

Based on water use by oat plants, green and dry plant weights and visual ratings, fluometuron residues were significant and approximately .06 and .25 ppm for the 1.68 and 3.36 kg/ha treatments, respectively.

Phytotoxicity symptoms indicated that traces of fluometuron were present at depths below 10.0 cm of the 3.36 kg/ha treatment. Water use and green and dry plant weights were not affected by residues at these depths.

No phytotoxicity symptoms were observed among oats grown on soil samples taken from 10-40 cm depths of plots treated with a 1.68 kg/ha broadcast treatment of fluometuron.

Main

Milan Field Station. Residues were found primarily in the top 0-7.5 cm depth of soil taken from plots treated with 1.68 and 3.36 kg/ha broadcast applications of fluometuron 24 weeks prior to sampling. Due to problems with growth chambers which caused excessive water use, no significant differences were found in water use between field plot samples and standard curve treatments. Based on green and dry plant weights and visual ratings, fluometuron residues were significant and approximately equal to .13 and .06 ppm for the 3.36 and 1.68 kg/ha broadcast treatments, respectively.

Phytotoxicity symptoms indicated that traces of fluometuron were present at depths from 7.5-22.5 cm in plots treated with 1.68 and 3.36 kg/ha broadcast treatments and at 0-15.0 cm depths of plots treated with a 1.68 kg/ha band treatment. Residues present in these samples did not affect green or dry plant weights.

Knoxville Plant Science Farm. Only samples taken from the 0-10 cm depth of plots treated with 3.36 kg/ha treatments showed a significant reduction in water use, green and dry plant weights, and visual vigor reduction. Residues were approximately equal to .06 ppm.

Phytotoxicity symptoms indicated that traces of fluometuron were present at the 10-30 and 0-10 cm depths of soil treated with 3.36 and 1.68 kg/ha broadcast treatments, respectively. Neither water use nor green and dry plant weights of these samples were significantly reduced.

Soil Characterization

Results of characterization of the Memphis silt loam and Sequatchie loam soils are given in Table 18.

Table 18. Selected Soil Properties of Sequatchie Loam and Memphis Silt Loam Soils

Properties	Memphis Silt Loam 0-15 cm	Memphis Silt Loam 15-22 cm	Sequatchie Loam 0-20 cm	Sequatchie Loam 20-40 cm
Organic Matter (percent)	.81	.79	1.33	.72
Textural Components (percent)				
Sand	5.70	7.20	40.26	36.40
Silt	74.30	70.80	35.39	33.39
Clay	20.00	22.00	24.35	30.21
Large Pores (percent)	9.00	9.16	8.13	9.67
Small Pores (percent)	36.91	40.89	36.65	37.65
Bulk Density	1.46	1.46	1.54	1.50
Moisture @ Field Capacity (percent/W)	20.45	22.57	16.95	19.03
Available Water Holding Capacity (cm/cm)	.232	.252	.171	.186

Memphis silt loam soil contained less organic matter than Sequatchie loam. The lower organic matter content of Memphis silt loam soil was probably responsible for the greater phytotoxicity of fluometuron observed at Milan as compared to that observed at Knoxville. The ability of organic matter contents as low as 1.0 percent to alter the toxicity of fluometuron has been reported (9).

The high silt content of the Memphis silt loam and the high sand content of the Sequatchie loam suggested a great deal of fluometuron mobility in both soils.

Large and small pore space was approximately the same for both soils while the Sequatchie loam had the higher bulk density value of the two soils.

Physical properties of these two soils apparently had little if any effect on fluometuron movement. Bioassay indicated that fluometuron remained in approximately the upper 10 cm of soil at both locations.

CHAPTER V

SUMMARY AND CONCLUSIONS

Research was carried on to:

1. Determine tolerance of soybeans and grain sorghum to fluometuron residues at two locations in Tennessee.
2. Determine time interval between fluometuron application and planting which allows sufficient herbicide dissipation to eliminate significant crop injury and yield reduction.
3. Determine effect of band and broadcast application and rates on fluometuron dissipation.
4. Determine location and longevity of fluometuron residue in the soil profile.

The field experiment was conducted at two locations in 1973 with additional bioassay and soil characterization work also being carried on in the laboratory. Data on plant heights, number of live plants, percent vigor reduction, and seed yields were collected for soybeans and grain sorghum grown at each location.

At Milan, data generally showed that soybeans and grain sorghum could be planted as soon as three weeks after a 1.68 kg/ha band application of fluometuron without significant injury or yield reduction. A nine week waiting period between application and planting was required to prevent significant injury and yield reduction of soybeans grown in areas treated with 1.68 and 3.36 kg/ha of fluometuron applied as a broadcast treatment.

The 1.68 and 3.36 kg/ha broadcast treatments required waiting periods between application and planting of six and nine weeks, respectively, to prevent significant injury and yield reduction of grain sorghum at Milan.

Generally, no significant response to fluometuron residue was shown in injury or yield reduction by either crop at Knoxville although a slight yield reduction occurred in a secondary experiment at Knoxville when grain sorghum was planted zero or three weeks after the 3.36 kg/ha broadcast treatment of fluometuron.

Characterization of the two soils showed that the extreme differences in response between locations were primarily attributable to differences in soil organic matter content.

Bioassay showed that fluometuron remained primarily in the 0-10 cm depth of soil at both locations. Response of oat plants showed toxicity of fluometuron to be approximately three times greater at Milan than at Knoxville. Residues decreased with subsequent sampling dates; however, up to .13 and .06 ppm were present in samples taken from 3.36 kg/ha treatments of fluometuron at Milan and Knoxville, respectively, 24 weeks after application.

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LITERATURE CITED

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APPENDIX

APPENDIX

Table A-1. Rainfall Data for May-October of 1973, Milan Field Station

Date	Month					
	May	June	July	August	September	October
	inches					
1	.06	T		.25		T
2	2.04		.21		.03	.38
3	.15	T				T
4			T			
5	**	.10	.05		T	T
6	.18	.18			.20	
7	.15				1.77	
8	.96		.25		.41	1.45
9					T	
10			.21			
11	.03		.03			
12	.18	1.30		.04		
13		.15		.19	T	
14		.17		1.50	.62	.53
15					T	
16		.03				
17	.09		.17			
18						
19						
20	T	1.01	.03			
21		.36			.24	
22						
23	.26					
24	.38		T			
25			.05		.03	
26			T			
27	2.27		T		.02	
28	.03	.41			.08	.19
29	T			.03	.03	.08
30	T		.19			
31			T	1.23		.15
1973 Total	6.78	3.71	1.20	3.24	3.43	2.78
Monthly Mean	4.22	4.23	4.42	3.54	3.46	2.65

**Date fluometuron applied.

Table A-2. Rainfall Data for May-October of 1973, Knoxville Plant Science Farm

Date	May	June	July	August	September	October
	-----	-----	-----	inches	-----	-----
1		.17	.40	1.28		1.85
2						.04
3	.08					T
4	.37		.08			
5						
6						
7	**		.26			T
8	.77		T			T
9	.68					
10	.01		T	T	.35	
11	.69					
12	.07			.09		
13				.07		T
14	.06		.76	.12	.97	.41
15			.60		.02	
16		1.10	.04			
17	.26	.23		.01		
18		.08			.86	
19			.02			
20	.43			.66		
21		.49				
22		.08				
23	.27					
24	.53		.58			
25	.25		.28	T		
26	.18		.62			
27	.01		.25			
28	2.58	1.29			.08	.82
29	.04				.01	.05
30		.09		T	1.20	T
31			.49	.08		.31
1973 Total	7.28	3.53	4.38	2.31	3.49	3.48
Monthly Mean	3.50	3.33	4.82	3.46	2.54	2.61

**Date fluometuron applied.

Table A-3. Analyses of Variance for Survival, Percent Vigor Reduction, Height, and Yield of Grain Sorghum as Affected by Fluometuron Residue, Milan Field Station

Source of Variation	Degrees of Freedom	Mean Squares	F Values
	Live Plants Per 6.1 Meter Row		
Replications	2	329.53	9.26*
Fluometuron Treatments	3	1,588.99	44.63**
Error A	6	35.60	
Planting Dates	2	1,325.45	24.64**
Interaction	6	882.19	16.40**
Error B	16	53.79	
Total	35		
	Percent Vigor Reduction		
Replications	2	.55	.19
Fluometuron Treatments	3	66.52	22.47**
Error A	6	2.96	
Planting Dates	2	37.10	17.10**
Interaction	6	9.52	4.39**
Error B	16	2.17	
Total	35		
	Plant Heights		
Replications	2	2.72	2.43
Fluometuron Treatments	3	13.84	12.36**
Error A	6	1.12	
Planting Dates	2	94.81	57.11**
Interaction	6	5.20	3.14*
Error B	16	1.66	
Total	35		
	Seed Yields		
Replications	2	445,803	1.50
Fluometuron Treatments	3	8,872,986	29.76**
Error A	6	298,128	
Planting Dates	2	3,312,721	6.37**
Interaction	6	2,434,243	4.68**
Error B	16	520,079	
Total	35		

*Significant at the .05 level of probability.

**Significant at the .01 level of probability.

Table A-4. Analyses of Variance for Survival, Percent Vigor Reduction, Height, and Yield of Soybeans as Affected by Fluometuron Residue, Milan Field Station

Source of Variation	Degrees of Freedom	Mean Squares	F Values
	Live Plants Per 6.1 Meter Row		
Replications	2	315.25	.29
Fluometuron Treatments	3	26,723.29	24.93**
Error A	6	1,071.73	
Planting Dates	2	14,781.00	30.47**
Interaction	6	3,956.26	8.16**
Error B	16	485.03	
Total	35		
	Percent Vigor Reduction		
Replications	2	2.97	1.07
Fluometuron Treatments	3	90.31	32.60**
Error A	6	2.77	
Planting Dates	2	27.25	10.69**
Interaction	6	4.49	1.76
Error B	16	2.55	
Total	35		
	Plant Heights		
Replications	2	.43	2.53
Fluometuron Treatments	3	11.80	69.41**
Error A	6	.17	
Planting Dates	2	21.96	39.93**
Interaction	6	3.98	7.24**
Error B	16	.55	
Total	35		
	Seed Yields		
Replications	2	1.77	1.36
Fluometuron Treatments	3	139.64	107.42**
Error A	6	1.30	
Planting Dates	2	48.29	12.19**
Interaction	6	26.54	6.70**
Error B	16	3.96	
Total	35		

*Significant at the .05 level of probability.

**Significant at the .01 level of probability.

Table A-5. Analyses of Variance for Survival, Percent Vigor Reduction, Height, and Yield of Grain Sorghum as Affected by Fluometuron Residue, Knoxville Plant Science Farm

Source of Variation	Degrees of Freedom	Mean Squares	F Values
	Live Plants Per 6.1 Meter Row		
Replications	2	10,899.20	.51
Fluometuron Treatments	3	16,692.50	.78
Error A	6	21,272.10	
Planting Dates	2	836,809.30	43.34**
Interaction	6	29,495.40	1.53
Error B	16	19,309.50	
Total	35		
	Percent Vigor Reduction		
Replications	2	4.17	1.00
Fluometuron Treatments	3	4.17	1.00
Error A	6	4.17	
Planting Dates	2	.02	1.00
Interaction	6	.02	1.00
Error B	16	.02	
Total	35		
	Plant Heights		
Replications	2	77.08	3.07
Fluometuron Treatments	3	66.29	2.64
Error A	6	25.04	
Planting Dates	2	20.58	5.66*
Interaction	6	7.88	2.17
Error B	16	3.63	
Total	35		
	Seed Yields		
Replications	2	128,592	.74
Fluometuron Treatments	3	401,998	2.30
Error A	6	174,880	
Planting Dates	2	4,666,339	24.21
Interaction	6	230,059	1.19
Error B	16	192,708	
Total	35		

*Significant at the .05 level of probability.

**Significant at the .01 level of probability.

Table A-6. Analyses of Variance for Survival, Percent Vigor Reduction, Height, and Yield of Soybeans as Affected by Fluometuron Residue, Knoxville Plant Science Farm

Source of Variation	Degrees of Freedom	Mean Squares	F Values
Live Plants Per 6.1 Meter Row			
Replications	2	1,866.60	.35
Fluometuron Treatments	3	1,485.60	.28
Error A	6	5,266.87	
Planting Dates	2	87,894.10	28.40**
Interaction	6	893.90	.29
Error B	16	3,094.72	
Total	35		
Percent Vigor Reduction			
Replications	2	.18	.06
Fluometuron Treatments	3	22.50	7.35*
Error A	6	3.06	
Planting Dates	2	.03	.03
Interaction	6	.85	.86
Error B	16	.99	
Total	35		
Plant Heights			
Replications	2	15.44	.61
Fluometuron Treatments	3	110.74	4.40
Error A	6	25.19	
Planting Dates	2	397.19	18.47**
Interaction	6	29.60	1.38
Error B	16	21.50	
Total	35		
Seed Yields			
Replications	2	56,848.30	.40
Fluometuron Treatments	3	77,316.60	.55
Error A	6	140,466.70	
Planting Dates	2	45,688.30	2.80
Interaction	6	43,683.30	2.68
Error B	16	16,290.60	
Total	35		

*Significant at the .05 level of probability.

**Significant at the .01 level of probability.

Table A-7. Analysis of Variance for Sorghum Forage Yields, Secondary Experiment, Knoxville Plant Science Farm

Source of Variation	Degrees of Freedom	Mean Squares	F Values
Replications	2	33,513	.2
Fluometuron Treatments	2	342,128	2.5
Error A	4	132,675	
Planting Dates	3	3,372,933	105.6**
Interaction	6	79,360	
Error B	18	31,916	
Total	35		

*Significant at the .05 level of probability.

**Significant at the .01 level of probability.

VITA

Alton Wayne Jackson was born in Franklin County, Tennessee on January 24, 1948. He was reared on a farm in that county. He attended Broadview Elementary School and graduated from Franklin County High School in June of 1966.

In September of 1966 he entered the University of Tennessee at Knoxville to study in the Institute of Agriculture. He graduated from the University of Tennessee in March of 1970 with a major in Agricultural Education. Upon graduation, he accepted a position teaching Vocational Agriculture at Franklin High School in Williamson County, Tennessee. He taught Vocational Agriculture two years before returning to the University of Tennessee to pursue study toward the Master of Science degree in the Plant and Soil Science Department. He received the Master of Science degree in June of 1974 with specialization in Weed Science.

He is married to the former Linda Wagner of Knoxville and they have one daughter, Jennifer Susan.