ADSORPTION, DESORPTION, MOVEMENT, AND

DISSIPATION OF TEBUTHIURON

IN SOILS

By

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ACKNOWLEDGMENTS

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CHAPTER I

INTRODUCTION

Tebuthiuron [1-(5-tert-buthy-1,3,4-thiadiazol-2-yl)-1,3-dimethyl-urea] has shown excellent prospects of being a good herbicide for control of herbaceous weeds and brush in pasture and rangeland. Many studies have been conducted on the substituted urea herbicides, but very little information has been published on the activity and fate of tebuthiuron. Most of the substituted urea herbicides are used as soil applied treatments. It is important to know something about the fate of tebuthiuron applied to the soil since this could affect its activity.

The activity of the substituted urea herbicides in soil is affected by many factors and since the activity varies with the individual chemical characteristic of herbicide, it is necessary to evaluate the various environmental and physical factors on each new herbicide being developed. The adsorption and desorption by soil and breakdown by microorganisms, as they are influenced by the soil moisture and the soil temperature are of special concern.

The purpose of this research was to determine the adsorption, desorption, movement, and persistence of tebuthiuron in various soils of Oklahoma.

CHAPTER II

LITERATURE REVIEW

Tebuthiuron (Figure 1) is structurally a substituted urea herbicide (chemical names of herbicides are listed in Table I). It differs from most of the urea herbicides in that it has a thiadiazol group substituted in place of the phenyl group.
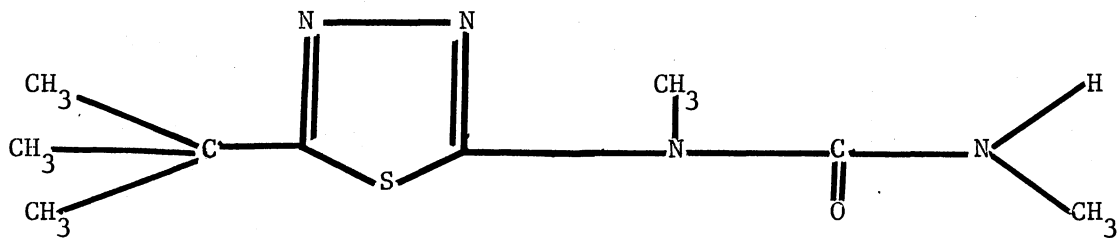
Figure 1. Chemical Structure of Tebuthiuron

Tebuthiuron with a solubility of 2500 ppm at 25° C is much more water soluble than the majority of the phenyl substituted herbicides (Table I). Only fenuron with a solubility of 3850 ppm is more water soluble.

TABLE I

COMMON AND CHEMICAL NAME OF HERBICIDES

Common Name	Chemical Name	Solubility in H_2O ppm
Chlorbromuron	3-(3-chloro-4-bromophenyl)-1-methoxyl-1-methylurea	50
Chloroxuron	3-[4-(p-chlorophenoxy)-phenyl]-1,1-dimethylurea	4 (20°)
Diuron	3-(3,4-dichlorophenyl)-1,1-dimethylurea	42 (25°)
Fenuron	3-phenyl-1,1-dimethylurea	3850 (25°)
Fluometuron	3-(m-trifluromethyphenyl)-1,1-dimethylurea	90 (25°)
Linuron	3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea	75 (25°)
Metobromuron	3-(p-bromophenyl)-1-methoxy-1-methylurea	330 (20°)
Monolinuron	3-(p-chlorophenyl)-1-methoxy-1-methylurea	930 (20°)
Monuron	3-(p-chlorophenyl)-1,1-di-methylurea	230 (25°)
Neburon	3-(3,4-dichlorophenyl)-1-butyl-1-methylurea	5 (24°)
Tebuthiuron	1-(5-tert-butyl-1,3,4-thiadiazol-2-yl)-1,3-dimethyurea	2500 (25°)

Herbicide Adsorption and Desorption in Soils

Adsorption and desorption equilibrium determine the amount of substituted urea herbicides in soil solution and those relate to herbicide activity.

Bailey and White (1964) showed that adsorption of substituted urea herbicides was affected by soil organic matter and clay content. Yuen and Hilton (1962) studied adsorption of monuron and diuron on Hawaiian soil and reported adsorption could be increased by adding carbon. Grover (1975) found that the adsorption of substituted urea herbicides on various soil types correlated with soil organic matter, but not with clay content. However, Hill et al. (1955) found that adsorption of monuron on soil increased as clay content increased. Sheets and Craft (1957) demonstrated that adsorption of substituted urea herbicides increase in following sequence: fenuron, monuron, diuron, and neburon. They found that fenuron was inactivated most rapidly and diuron least rapidly in a large number of California soils. Grover (1975) found about the same trend for adsorption. The order of increasing tendency to be adsorbed was fenuron, monuron, monolinuron, metobromuron, diuron, linuron, and chlorbromuron.

The rate of adsorption of substituted urea herbicides also appears to be related to solubility in water. Wolf et al. (1958) found that the degree of adsorption of fenuron, monuron, diuron, and neburon by soil was inversely related to the order of their water solubility. Bailey et al. (1968) found a direct relationship between water solubility and adsorbability with fenuron, monuron, diuron, and 3-phenylurea in the case of adsorption by the Na-montmorillonite. Grover (1975) worked with seven substituted urea herbicides and he

found that adsorption was inversely related to their solubility. Davidson et al. (1972) found that the nonsingularity between herbicide adsorption and desorption relation was responsible for concentration distribution in soil. The singularity tended to increase the length of soil profile over which the distribution occurred as well as decreased the maximum herbicide solution concentration.

The studies of Hance (1967) on monuron and linuron indicated that the desorption process differed from the adsorption in direction of high retention of these herbicides in soils. Grover (1975) stated that the substituted urea herbicides were readily desorbed by water from low to medium organic matter content, sandy loam and heavy clay soil, but not from a loam soil with high organic matter. Harris and Warren (1964) showed that the monuron was more readily desorbed from bentonite than from muck. It is suggested that substituted urea herbicides can be inactivated more readily in soil with high organic matter.

The adsorption-desorption also has an influence on the amount of herbicide required for phytoxicity. Bailey and White (1964) noted that reduced phytotoxicity occurred with high organic matter and high cation exchange capacity. Dubey and Freemann (1969) found that a 12-fold increase in soil organic matter required 23 times more linuron to induce equal amount of phytoxicity. Weber and Scott (1966) showed reduced monuron phytotoxicity to cucumber when montmorillonite and kaolinite clay were added to model soil system.

Herbicide Movement in Soils

Herbicide movement is affected by solubility of chemical, affinity for soil colloid present, and the amount of water passing through the

soil profile. Davidson and Santelmann (1968) studied the movement of fluometuron and diuron through 250 µ glass bead and Norge loam soil. In the non-adsorbed glass bead, fluometuron was found to be mobile as chloride ion, whereas diuron was less mobile. However, the mobility of fluometuron was less than that of chloride ion in the loam soil. Ashton (1961) found the order of lateral movement of substituted ureas (fenuron, monuron, diuron, and neburon) and the order of their water solubilities to be the same trend. Mobility of monuron and diuron were correlated with solubility and adsorption on soils (Helling 1971). Abernathy and Davidson (1971) found the water required for herbicide movement was correlated to herbicide adsorption, and the more herbicide that was adsorbed, the more water was required to move the herbicide through the soil. Davidson and McDougal (1973) also showed that the mobility of fluometuron was influenced by average pore-water velocity. The tailing noted in a water saturated soil was caused primarily by nonsingularity between adsorption-desorption process. Sherburne et al. (1956) summarized that the movement of monuron in any soil was dependent upon soil type and quantity of water applied. Davidson and Santelmann (1968) found the rate of fluometuron which moved through a water saturated glass bead or uniformly packed soil column was a function of water flux. Wiese and Davis (1964) found that when monuron and diuron were applied to wet soil column, there was a general tendency for the herbicide to move deeper than when applied to dry soil. Upchurch and Pierce (1957) used soil column to study the effect of the quantity, intensity, and frequency of simulated rain on the movement of monuron. Increase amount of rainfall increased leaching but intensity had little effect. Increase frequency also increased the movement.

Ogle and Warren (1954) investigated the soil mobility of monuron applied at 20-40 pound per acre. They found that monuron was readily moved in sand soil, but not in clay soil and in muck peat.

Herbicide Persistence in Soils

The disappearance of substituted urea herbicides from soil is affected by many factors. Microbiological degradation appears to be an important factor affecting the breakdown of the substituted urea herbicides in the soil system. Geissbuler et al. (1963) showed that soil microbial could deactivate N-methylate urea by demethylation to yield the component aniline. Dalton et al. (1966) demonstrated that demethylation was one of the first mechanisms of deactivation of diuron by microorganisms.

Increasing soil temperature resulted in faster disappearance of substituted urea herbicides and Harris et al. (1969) attributed to this microbial activity. Ogle and Warren (1954) demonstrated that monuron toxicity persisted lower at 10° C than at 20° to 30° C. Diuron decomposition in the soil approximately tripled with each 10 degree rise in temperature (McCormick et al. 1966).

Soil moisture has been reported to have a significant effect on herbicide activity. Upchurch (1958) noted that diuron was more phytotoxic to cotton under high moisture condition. This was substantiated by Green and Obien (1969) who found that the phytotoxicity of substituted urea herbicides increased as soil moisture increased. The rate of breakdown can also be decreased if soil moisture is dry. The phytotoxicity of the herbicides as influenced by soil moisture can be confounded if soil moisture is too low since

microbiological breakdown would be decreased. Lousiate et al. (1953) found that monuron at 5 lb/A disappeared in two weeks in soil at field capacity while in dry soil it persisted for ten weeks.

CHAPTER III

METHODS AND MATERIALS

Soils from Stillwater, Perkins, Kingfisher, and Eufaula were used in this study. The properties of these soils are shown in Table II.

TABLE II

CHEMICAL AND PHYSICAL PROPERTIES
OF SOILS USED IN THIS STUDY

Soil Source	Textural Class	Percent			Percent Organic Matter	CEC*	pH
		Sand	Silt	Clay			
Perkins	Sand	95.0	3.0	2.0	0.3	0.6	6.7
Stillwater							
0-4"	Sandy Loam	57.0	30.5	12.5	4.3	13.3	6.1
4-8"	Sandy Loam	58.0	33.8	8.2	1.4	6.7	6.1
Eufaula	Laom	49.0	37.0	14.0	4.8	9.2	6.3
Kingfisher	Clay Loam	30.0	52.2	17.8	4.4	12.4	6.3

*CEC = Meq/100 gm soil

Tebuthiuron Adsorption and Desorption in Soils

Adsorption of tebuthiuron was determined for the soils from Perkins, Stillwater collected from two soil zones, and Eufaula.

Adsorption was determined by mixing a water solution of ^{14}C labeled herbicides with dry soil at a ration of 1 to 1. The isotherm was determined at 26° C. Screw cap pyrex tubes (25 x 20 cm) with teflon seals were used for mixing the herbicides and soils. The radioactive herbicide was diluted with unlabeled herbicide in order to obtain the appropriate count rate and maintain specific herbicide levels. The herbicide concentration of 1, 2, 4, and 8 ppmw were made in 0.01 N $CaCl_2$. A 10 gm soil sample was placed into each tube and a 10 ml quantity of herbicide solution was then added to each tube. Each treatment was replicated four times. The tubes containing soil and herbicide solution were shaken for 12 hours on horizontally set shaker. A preliminary experiment had shown that 12 hours was sufficient time for soil-herbicide equilibrium. After shaking, the tubes were centrifugated at 1800 rpm for 20 minutes to settle the soil particles. A 500 μl sample of the supernatant was transferred into scintillation vials containing 15 ml of scintillation fluid. Each vial was then counted for 10 minutes in a Beckman liquid scintillation counter.

Desorption was determined on the 8 ppmw samples. The supernatant was removed from the centrifugated sample and measured, and replaced with 0.01 N $CaCl_2$ solution. A vibrating stirrer was used to resuspend the soil after centrifugation. The tubes were again shaken for a 12 hour period to establish the new equilibrium, and centrifugated and analyzed for ^{14}C activity. This process was repeated until the

activity leveled. The amount of activity was adjusted to reflect dilution and from this information the amount desorbed was determined.

Herbicide Movement in Soils

Mobility of terbuthiuron was determined by a soil thin-layer chromatography procedure developed by Helling (1971). Fluometuron was included as a herbicide standard. The three soils used (Perkins, Eufaula, and Kingfisher) were passed through a 420 mesh screen and mixed with distilled water until moderately fluid. Soil thin-layer plates of each soil were made by using a conventional thin-layer chromatography making apparatus. The 20 x 20 cm plates were coated and duplicated with a 1 mm thin layer of each soil. No binding agent was added. The plates were air-dried at 25° C for six days. Radioactive herbicides, 2 µl (0.02 µc) were spotted in duplicate 1.5 cm from the bottom of each plate. A line was etched 10 cm above the spots to prevent any water from moving above 10 cm. After spotting, the plates were placed in a conventional thin-layer chromatography developing tank and developed using water as the solvent system. The lower 0.5 cm of each plate was immersed in the water and chromatography developed ascendingly. As the water front reached the 10 cm etched line, the soil plates were removed and air-dried at room temperature for 24 hours. The plates were then covered with polyethylene wrapping and placed in contact with X-ray film (Kodak NS 2T) for 7 days. The film was then developed and the amount of herbicide movement determined from the prints.

Dissipation Studies

Bioassay Analysis

The three plant species tested for possible bioassay were oat (Avena sativa L.), soybean (Glycine max. L.), and corn (Zea mays L.). Various concentrations of tebuthiuron in soils were prepared by mixing known amounts of herbicide with the soils to be studied. These prepared soil samples were then placed into 250 ml styrofoam cups for bioassay. The plant species were seeded into the cups and placed under continuous fluorescent light at 25,200 lux and at a temperature of 25° C. The plants were harvested when differences were noted (usually 14 to 18 days) and the fresh weight determined. The weights were then plotted against the logarithm of the herbicide concentration and GR_{50} determined from the antilogarithm. The GR_{50} is that amount of herbicide that reduces the weight of the plant by 50% when compared to plants growing in no herbicide treated soil.

Effect of Incubation Time, Temperature, and Soil Moisture on Dissipation

Tebuthiuron at 2 ppmw was prepared using soil from Perkins and Eufaula. The treated soil was placed in double plastic bags, and water was added to each bag to bring the desired moisture level to 5% or 15% by weight.

The herbicides were subjected to three storage temperatures of 14°, 25°, and 30° C. At the designated time (0, 10, 20, 40, 80, and 160 days) samples were removed from test condition and frozen for later analysis. Corn seeds were planted into each cup containing 225 g of soil samples

to determine amount of tebuthiuron remaining. The plants were harvested 18 days after planting and fresh weight obtained.

Tebuthiuron Persistence in Bermudagrass Pasture

The experiment was conducted two miles south of Stillwater, Oklahoma. Postemergence treatment ($\frac{1}{4}$, $\frac{1}{2}$, 1 and 2 pounds per acre) of both wettable powder and granule were applied to 15 by 20 feet plots on April 12, 1974. A randomized block design was used with three replications per treatment. At a specific time (60, 120, and 180 days) after application, the soil samples at three different depths (0-4, 4-8, and 8-12 inch) were taken. Two sub-samples per plot were taken. Those samples were frozen for later analysis. The activity of tebuthiuron was determined using an oat bioassay.

Tebuthiuron Persistence in an Oak Climax Area

The experiment was conducted on the Ranch Range west of Eufaula. The tebuthiuron was formulated into large pellets and these pellets were applied to the area on 9 x 9 feet spacing (81 square feet for each pellet). Treatments equivalent of 1, 2, and 4 lb/A were applied on March 30, 1974. Soil samples were taken in the treated spot and 1, 2, and 3 feet down slope from each herbicide-treated spot on July 18, 1974. All soil samples were put into styrofoam cups and were planted with soybean and corn separately to determine the amount of herbicide in the soil.

CHAPTER IV

RESULTS AND DISCUSSION

Tebuthiuron Adsorption and Desorption in Soils

Tebuthiuron adsorption and desorption isotherm are shown in
Table III. The amount of tebuthiuron adsorption onto four soils was
found to be in a linear relationship with equilibrium solution concen-
tration (Figure 2). The line with the steepest slope in Figure 2
indicates the greatest amount of adsorption. In general, adsorption of
herbicide correlated with organic matter, cation exchange capacity, and
clay content. The sand from Perkins adsorbed very little tebuthiuron
whereas loam soil from Eufaula adsorbed a large amount of the herbicide.
It appears that organic matter affects adsorption more than cation ex-
change capacity. The loam soil from Eufaula had lower cation exchange
capacity than the top soil (0-4 inch) from Stillwater, however, the
former soil adsorbed more tebuthiuron. This is accounted for the
higher organic matter content of the loam soil from Eufaula. The effect
of organic matter was also noted in soils collected from Stillwater.
Because the top soil (0-4 inch) from Stillwater had more organic
matter than the subsoil (4-8 inch) the top soil adsorbed more
tebuthiuron.

The desorption of the herbicide from the four soils also showed
in great difference. After six successive desorption extractions, the
loam soil from Eufaula still adsorbed 40% of the initially adsorbed

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herbicide while only less than 1% of the adsorbed herbicide still

adsorbed in sand from Perkins. The soils showing the greatest amount

of herbicide adsorption also showed the least amount of desorption.
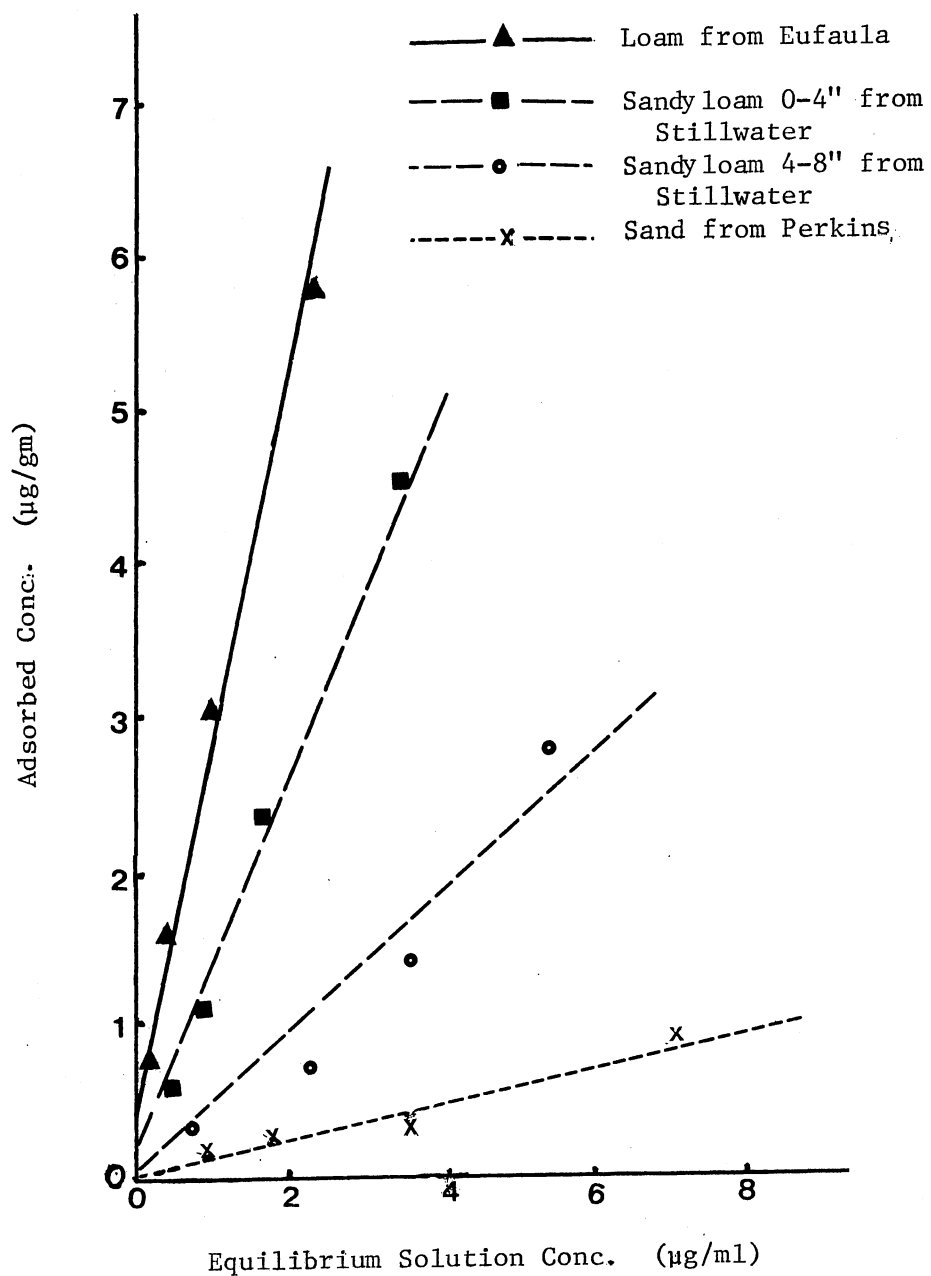
Figure 2.   Adsorption Isotherms of Tebuthiuron
by Four Soils
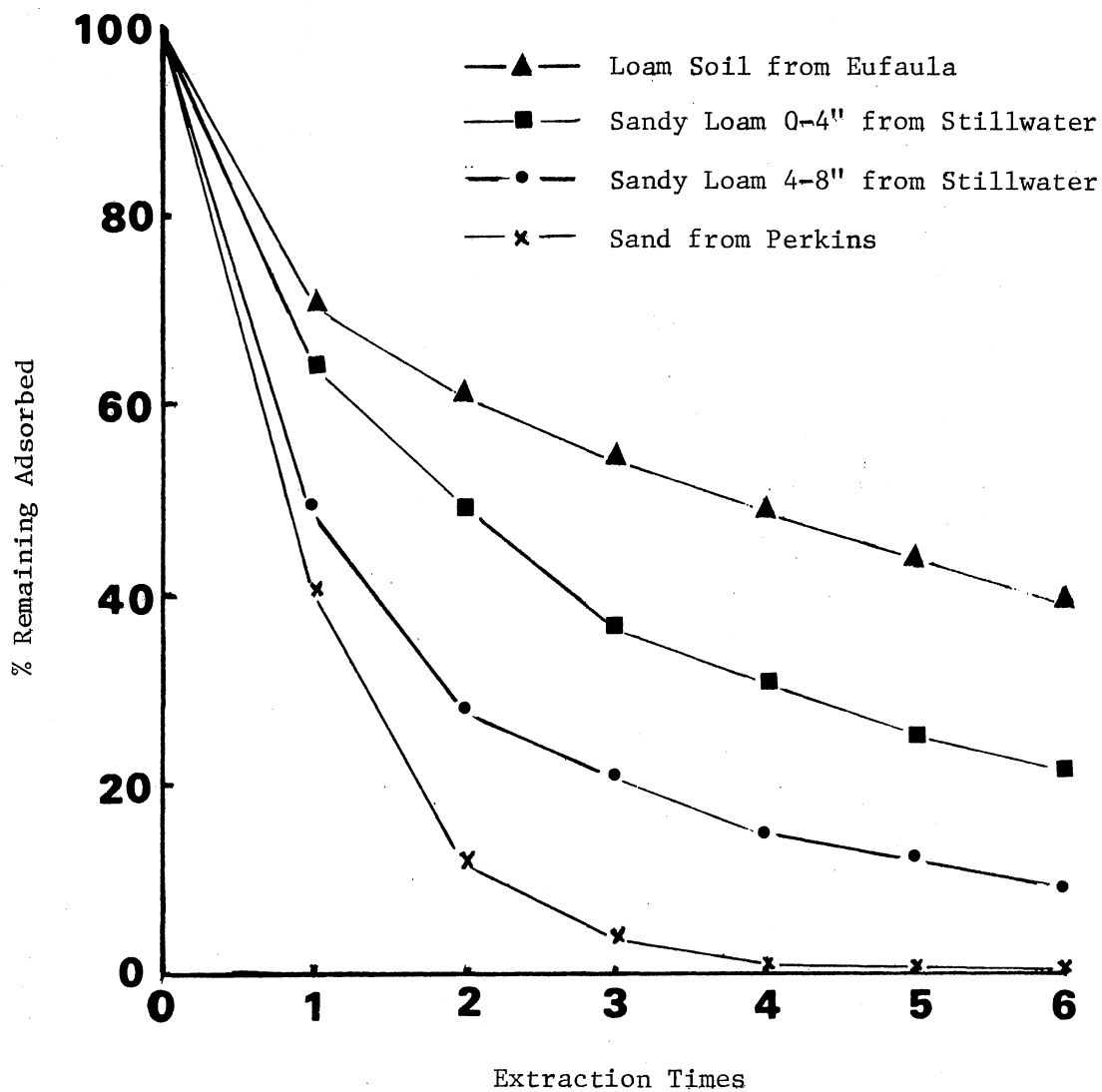
Figure 3. Desorption of Tebuthiuron (8 ppmw) from Four
Soils Expressed as   Percentage of
Remaining Adsorbed after Each Successive
Extraction

TABLE III

ADSORPTION-DESORPTION OF TEBUTHIURON
BY FOUR SOILS

| | Tebuthiuron | | | |
| | Initial Herbicide Concentration (µg/ml) | | | |
Soil Source and Texture	1	2	4	8
Eufaula loam				
Initial ads.	.75	1.59	3.03	5.69
Eq. solution conc.*	.21	.41	.97	2.31
Ads. after 6 ext.	–	–	–	2.26
Total Des.	–	–	–	3.43
% Des.	–	–	–	60.30
Stillwater sandy loam (0-4)"				
Initial ads.	.59	1.19	2.38	4.45
Eq. solution conc.	.41	.81	1.62	3.55
Ads. after 6 ext.	–	–	–	0.94
Total Des.	–	–	–	0.94
% Des.	–	–	–	78.88
Stillwater sandy loam (4-8)"				
Initial ads.	.34	.69	1.36	2.53
Eq. solution conc.	.66	1.31	2.64	5.47
Ads. after 6 ext.	–	–	–	.25
Total Des.	–	–	–	2.28
% Des.	–	–	–	90.12
Perkins sand				
Initial ads.	.12	.27	.43	.90
Eq. solution conc.	.88	1.73	3.57	7.10
Ads. after 6 ext.	–	–	–	.01
Total Des.	–	–	–	.89
% Des.	–	–	–	99.55

*Equilibrium concentration is µg/ml.

Herbicide Movement in Soils

Vertical movements of tebuthiuron and fluometuron, determined by
the soil thin-layer chromatography, are shown in Table IV. The
mobility of both herbicides varied in the three soils. Based on this
study, tebuthiuron would have to be considered a mobile herbicide.
Fluometuron is considered as a mobile herbicide and the R_f value of the
two herbicides have no significant difference. The herbicide had the
least movement in clay loam soil from Kingfisher. In general, the
mobility of the two herbicides decreased as the organic matter cation
exchange capacity and clay content increased. The herbicide mobility
is also correlated with adsorption-desorption characteristics of the
herbicide in soils. Soil with high adsorption and low desorption
showed less amount of herbicide mobility.

TABLE IV

HERBICIDE MOVEMENT IN SOIL USING SOIL
THIN-LAYER CHROMATOGRAPHY

Soil Source and Texture	Herbicide	
	Tebuthiuron	Fluometuron
	R_f Value	
Kingfisher clay	0.58 a*	0.57 a
Eufaula loam	0.66 b	0.65 b
Perkins sand	0.98 c	0.98 c

*Number followed by the same letters are not signifi-
cantly different at the 5% level according to Duncan's
New Multiple Range Test. CV = 2.41.

Dissipation Studies

Bioassay Studies

Three plant species were used as bioassay species for tebuthiuron.
Oat was chosen as the species for low concentration of tebuthiuron,
soybean for moderate concentration, and corn for high concentration.
The bioassay species was then to determine tebuthiuron concentration in
soil by comparing the top growth of the plants grown in the herbicide
treated soil with a standard curve (Figure 4, 5, 6, and 7). The
standard curve was obtained by growing the plant in soil of the known
concentration. The GR_{50} values of the same plant species differ in
different soil type (Table V). It reveals that GR_{50} values are
correlated with adsorption data shown before (Table III). The higher
amount of herbicide is adsorbed to soil the large amount of herbicide
is required to achieve the 50% of growth reduction. Therefore, the
higher adsorption of a herbicide occurs, the less phytotoxicity and the
higher GR_{50} is needed.

Effect of Incubation Time, Temperature, and Soil Moisture on Dissipation

Incubation time, temperature, and soil moisture influence the dis-
sipation of tebuthiuron. As incubation time increased, phytotoxicity
decreased. In other words, the dissipation of tebuthiuron increased
with an increase in incubation time (Table VI). As the incubation
temperature was reduced from 30° to 14° C, the bioassay plants showed
more phytotoxicity (Figure 8). This result indicated a reduced
dissipation rate took place in lower incubation temperature. Soil
moisture over the incubation period also had an influence in herbicide
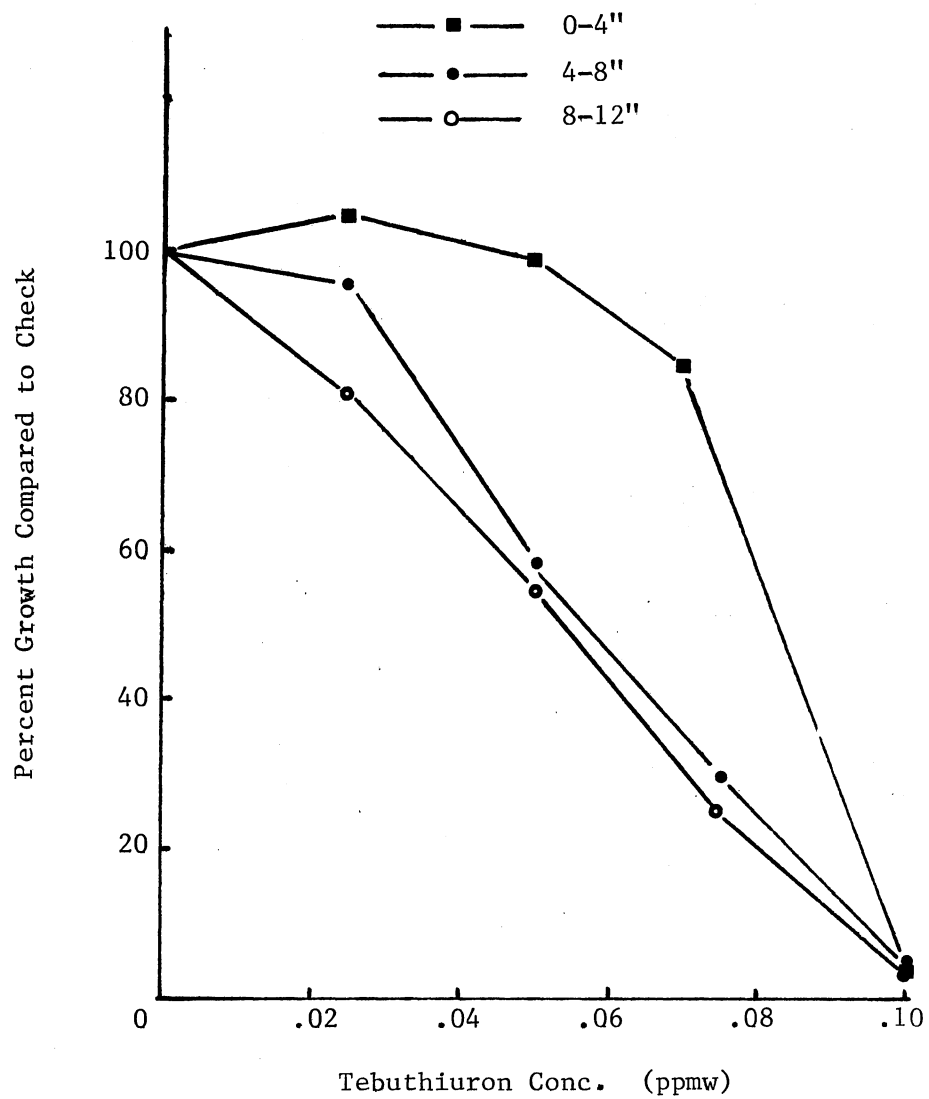
Figure 4. Response of Oat to Various Tebuthiuron
Concentrations in Sand Loam from
Stillwater Sampled at Three Soil
Depths
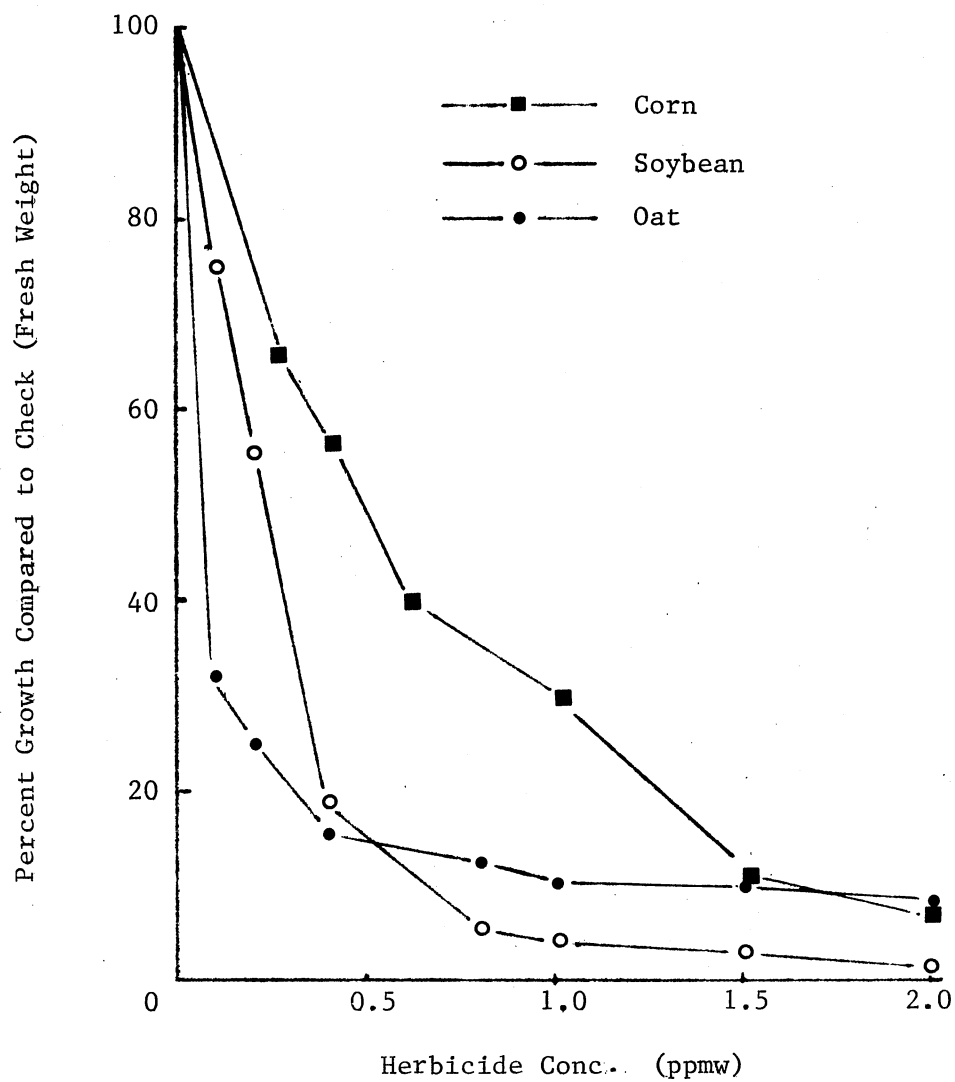
Figure 5. Response of Corn, Soybean, and Oat to
           Various Tebuthiuron Concentrations
           in Sand from Perkins
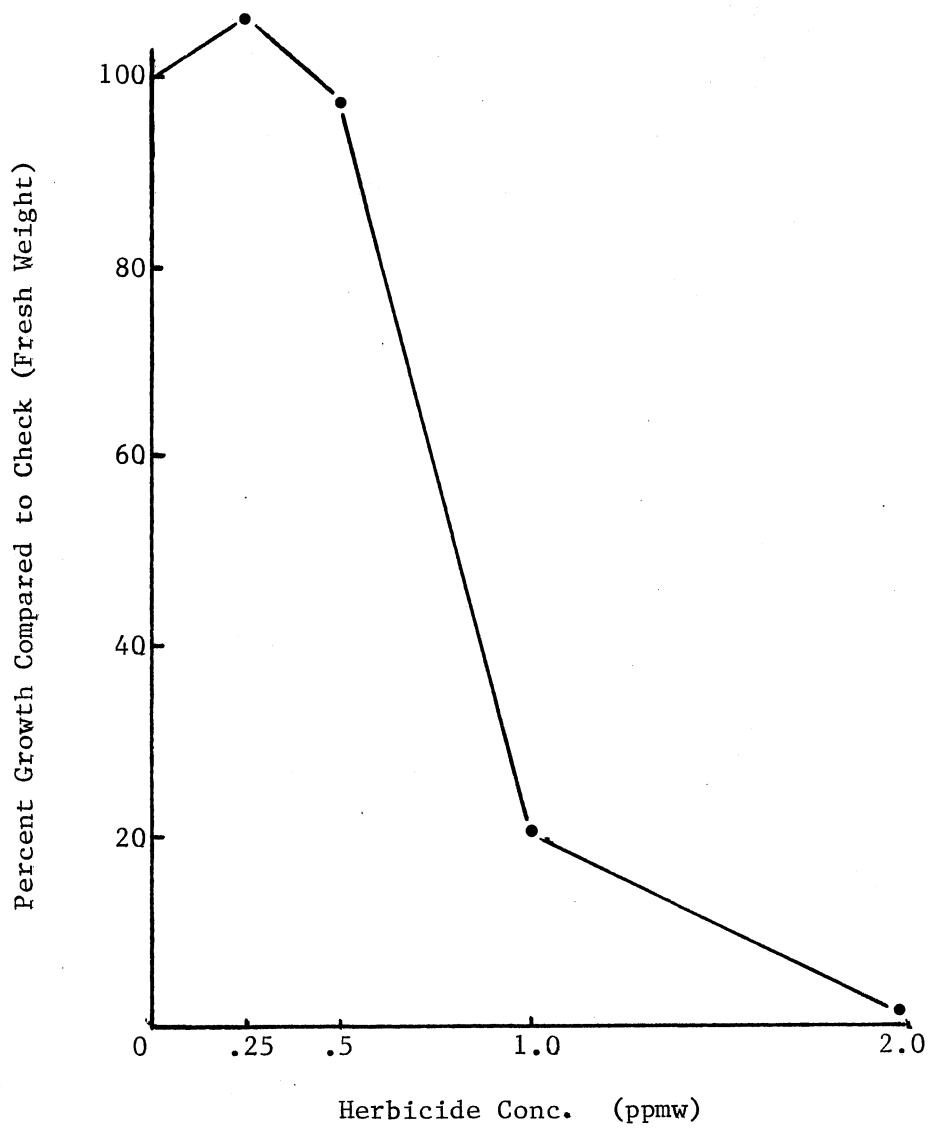
Figure 6. Response of Soybean to Various
            Tebuthiuron Concentrations in Loam
            from Eufaula
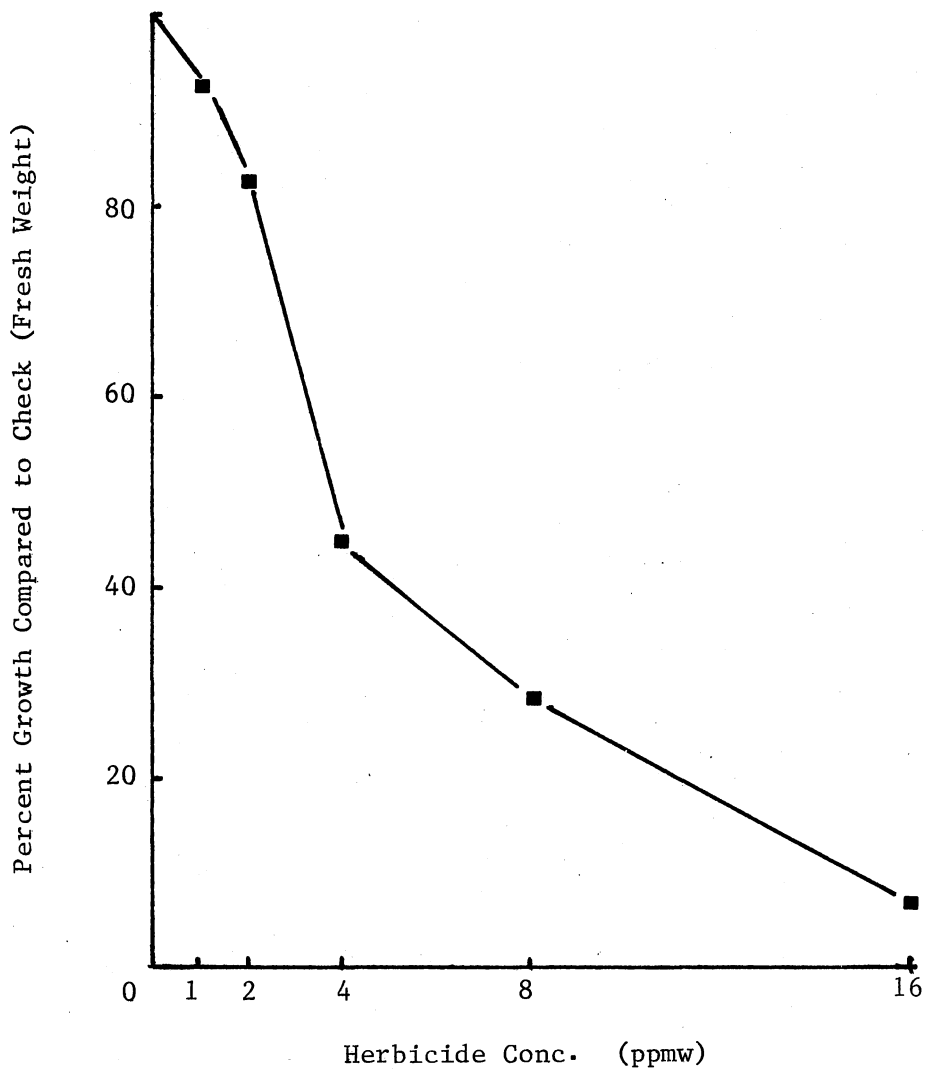
Figure 7. Response of Corn to Various Tebuthiuron
Concentrations in Loam from Eufaula
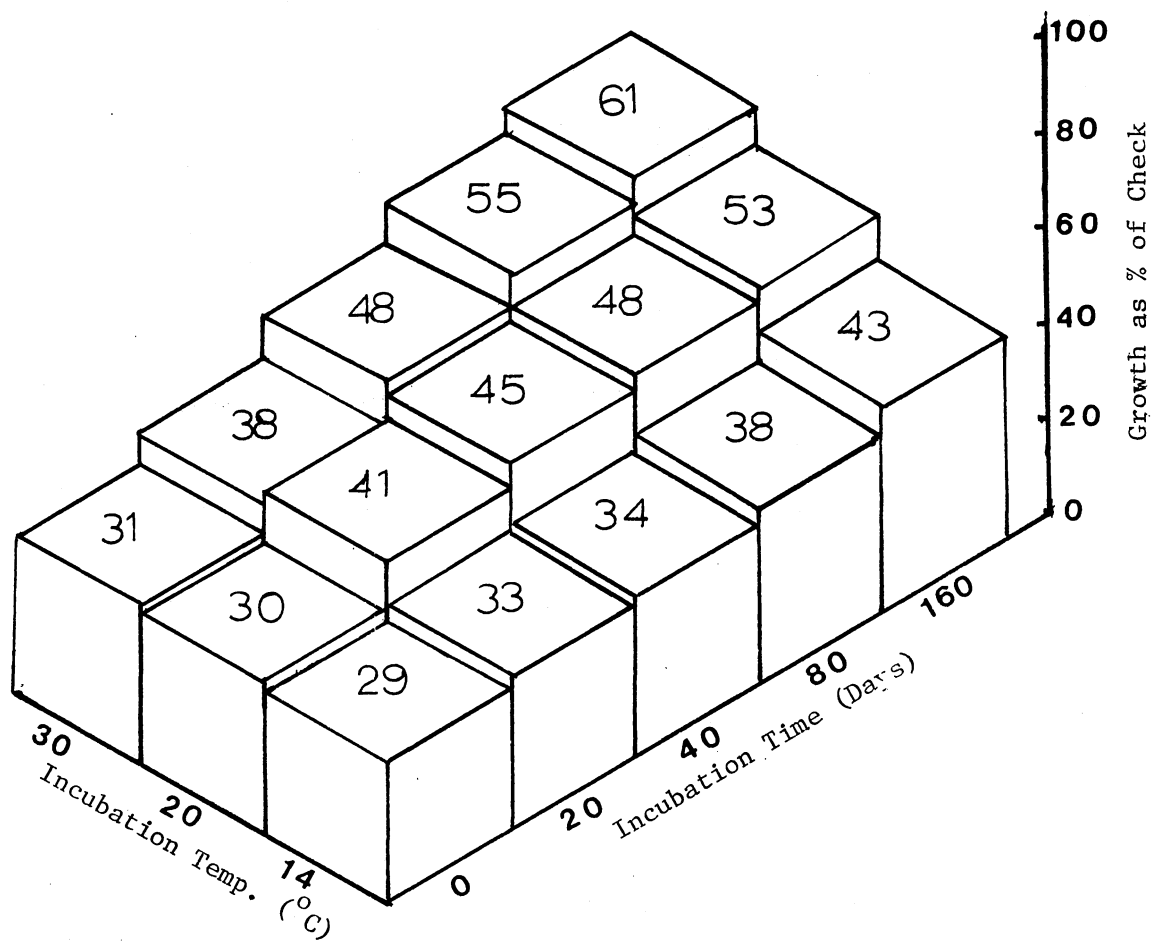
Figure 8. Effect of Incubation Temperature and Incubation Time on Tebuthiuron Dissipation in Loam from Eufaula and Sand from Perkins

TABLE V

GR$_{50}$ VALUE OF TEBUTHIURON FOR THREE PLANT
SPECIES IN VARIOUS SOILS

Soil Sources & Texture	Oat		Soybean		Corn	
	GR$_{50}$[1] (ppmw)	Corr.[2] Coeff.	GR$_{50}$ (ppmw)	Corr. Coeff.	GR$_{50}$ (ppmw)	Corr. Coeff.
Perkins sand	.03	.95	.21	.96	.48	.98
Eufaula loam	–	–	1.03	.86	4.10	.99
Stillwater sandy loam						
0–4"	.09	.72	–	–	–	–
4–8"	.06	.98	–	–	–	–
8–12"	.06	.96	–	–	–	–

[1]Herbicide concentration in ppmw required to reduce plant growth by 50%
when compared to untreated check plants.

[2]Correlation coefficients described the degree of conformity of the
data to GR$_{50}$ value.

TABLE VI

THE EFFECT OF INCUBATION TIME, TEMPERATURE, AND SOIL
MOISTURE ON TEBUTHIURON (2ppmw) DISSIPATION
IN TWO SOILS AS DETERMINED BY FRESH
WEIGH OF CORN

		Soil Type (D)									
Storage Condition		Sand from Perkins					Loam from Eufaula				
Temperature	Moisture	Days Stored (C)					Days Stored (C)				
(A)	(B)	0	20	40	80	160	0	20	40	80	120
14°	5%	11*	15	17	16	22	41	47	49	49	53
14°	15%	11	16	19	24	33	47	53	53	61	64
20°	5%	11	18	20	23	31	47	61	60	61	66
20°	15%	11	19	33	41	40	49	66	70	68	73
30°	5%	12	16	21	36	43	51	57	68	74	71
30°	15%	11	18	32	36	45	50	62	63	76	84

*Value represents the average growth as percent of check of three
 replications.

F value: A = 90.14**.   B = 54.6**.   C = 127.0**.   D = 2865.5**.

A x B = 5.18**, A x C = 9.35**, A x D = 4.10**, B x C = 5.17**,

C x D = 3.57**.

**Significant at 5% level.

dissipation. The increase in soil moisture from 5% to 15% showed a significant increase in herbicide dissipation (Figure 9). The least phytotoxicity was observed when both moisture and temperature were at the higher level (Figure 10). The soil moisture had the same degree of influence as soil temperature to the herbicide dissipation. In Table VI the dissipation of tebuthiuron in loam soil from Eufaula seemed to be greater than what is showed in sand soil from Perkin. . Since loam soil from Eufaula had more organic matter, this indicated that organic matter played an important role in the dissipation of tebuthiuron in soil. The result of this study strongly demonstrated that tebuthiuron dissipation was a result of high incubation tempera-ture and soil moisture. It would be expected that high microbial activity which is enhanced under high temperature and soil moisture increased the chemical breakdown of tebuthiuron. Microbiological decomposition would be decreased when soil was in lower moisture or at lower temperature.

Tebuthiuron Persistence in Bermudagrass Pasture

The experiment was conducted to determine downward movement and dissipation of tebuthiuron by taking soil samples from a bermudagrass pasture. Results of bioassay of soil sampled are listed in Table VII. The natural rainfall data in Stillwater, Oklahoma are shown in Table VIII. Based on photoxicity of oat plants, the herbicide residue was concentrated in the 0-4 inch soil zone comparing to the 4-8 and 8-12 inch soil zone at rates used in this study. This would be explained that tebuthiuron was absorbed readily by the 0-4 inch soil zone which had high organic matter. The high adsorption resulted from
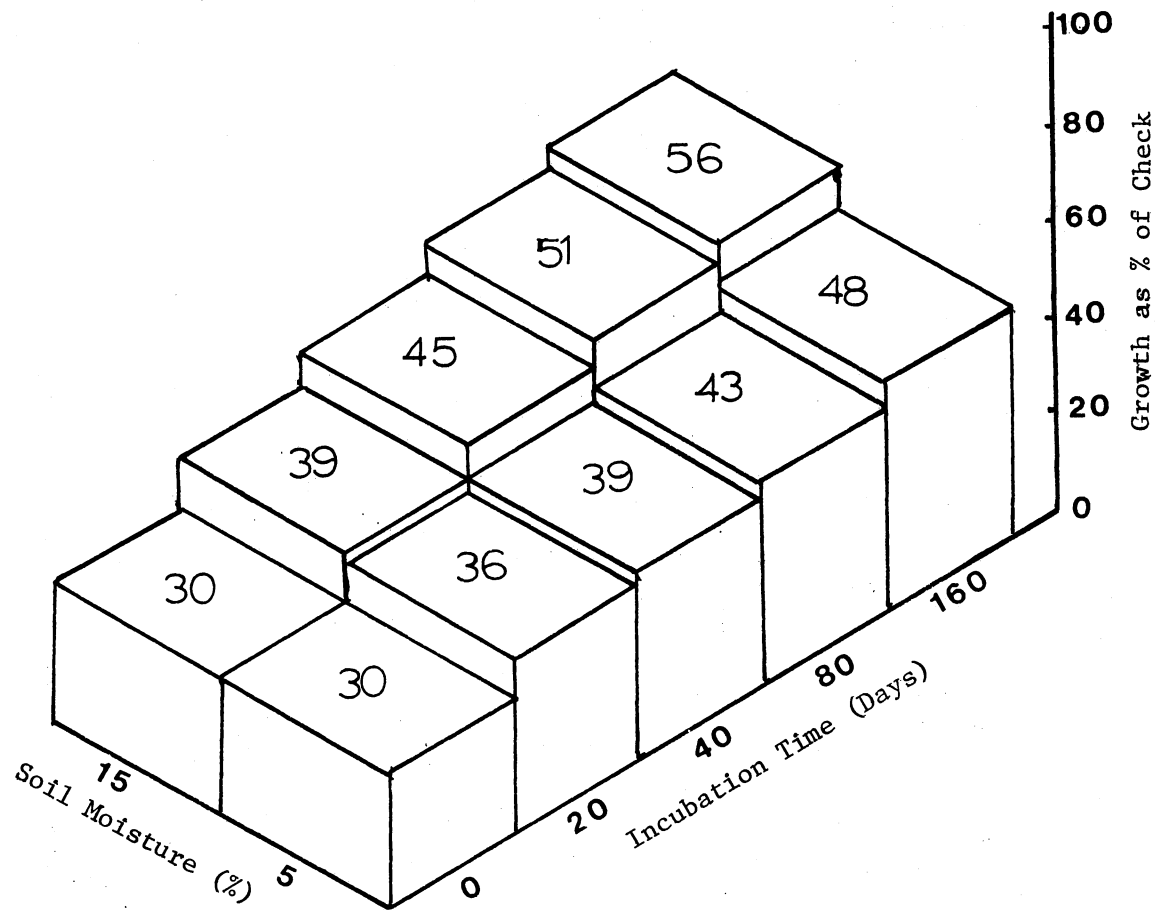
Figure 9. Effect of Incubation Soil Moisture and Incubation Time on Tebuthiuron Dissipation in Loam from Eufaula and Sand from Perkins
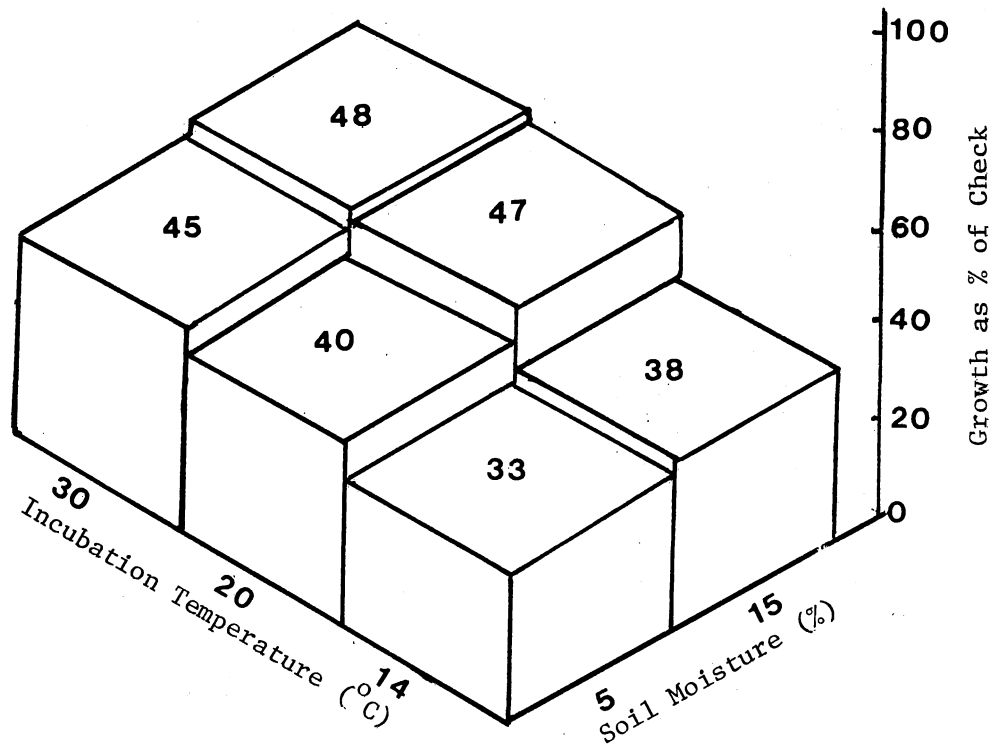
Figure 10. The Interaction Effect of Incubation Temper-
ature and Soil Moisture on Tebuthiuron
Dissipation

TABLE VII

BIOASSAY DETERMINATION OF TEBUTHIURON MOVEMENT
AND DISSIPATION OVER A PERIOD
OF 204 DAYS

Initial Application April 12 Rate lb/A	Percent Growth Compared to Check (Fresh Weight)								
	June 18			September 3			October 17		
	0-4*	4-8	8-12	0-4	4-8	8-12	0-4	4-8	8-12
¼ wp[1]	88	89	88	87	83	85	92	98	101
¼ G[2]	83	88	91	88	87	89	88	100	98
½ wp	59	83	87	76	84	94	85	91	96
½ G	61	83	87	81	76	84	82	95	92
1 wp	47	72	73	68	77	84	81	92	90
1 G	36	64	76	63	76	76	80	89	89
2 wp	20	51	65	42	67	65	60	91	90
2 G	33	59	67	52	59	64	64	82	89

*Inch in soil zone.

[1]Wettable powder.

[2]Granular.

A: Time.   B: Herbicidal level.   C: Soil zone.

F value: A = 81.6**, B = 33.74**, C = 48.72**, A x B = 3.97**,

A x C = 5.29**, B x C = 2.33**, CV = 12.31.

**Significant at 5% level.

TABLE VIII

NATURAL RAINFALL DATA IN STILLWATER, OKLAHOMA
APRIL THROUGH OCTOBER, 1974

Date	Amount (cm)	Date	Amount (cm)
4-30	1.78	8-1	0.10
4-31	2.29	8-5	0.28
5-2	2.79	8-9	4.47
5-21	0.13	8-10	2.19
5-22	0.20	8-11	0.20
5-23	0.86	8-12	0.28
5-24	1.02	8-23	7.92
5-25	5.26	8-24	0.92
5-26	0.81	8-27	0.15
5-31	2.59	8-28	0.66
6-3	0.08	9-3	6.68
6-5	0.81	9-5	1.02
6-6	1.35	9-20	4.47
6-7	2.29	9-21	0.13
6-8	1.45	9-24	0.20
6-16	0.10	9-25	2.74
7-4	1.60	9-25	0.08

high organic matter content reduced the leachability of the herbicide
into the soil profile. The amount of herbicide residue decreased with
an increase of time. By the October sampling, only a small amount of
herbicide was detected. The gradual decline in herbicide concentration
in soil could be attributed to plant uptake, microbiological degrada-
tion, and runoff by rainfall. The rate of dissipation decreased in
the subsoil. The slow rate of dissipation of herbicide in the 4-8 and
8-12 inch soil zone may be resulted from lower organic matter and low
microbial activity in subsoil. The downward movement was significantly
related to the herbicide rate. The higher the applied herbicide
concentration the more downward movement of the herbicide was detected.
No difference was noted between wettable powder and granular formula-
tions (Table VII).

Tebuthiuron Persistence in an Oak Climax Area

The experiment was conducted to determine dissipation and
horizontal movement of tebuthiuron by sampling on 140 days period.
Soil samples were taken from the top 10 cm. Results are listed in
Table IX. The natural rainfall data in Hanna, Oklahoma of this study
are shown in Table X. At 140 days after application, there was a
detectable amount of tebuthiuron in 0, 1, 2, and 3 feet down slope from
the herbicide treated spot. The highest amount of tebuthiuron residue
was found right where the herbicide was treated. The residual herbi-
cide concentration decreased as one went down slope. Runoff was not
significant with broadcast application of 2 lb/A or less but the move-
ment down slope did occur when tebuthiuron was concentrated with the
arid placement. Since soil from Eufaula has high organic matter, this

TABLE IX

BIOASSAY DETERMINATION OF TEBUTHIURON
DISSIPATION IN LOAM SOIL FROM
EUFAULA IN AN OAK CLIMAX
AREA AFTER 140 DAYS

| Rate (B) | Distance from Herbicide Treated Spot (A) | | | | |
lb/A	0	1	2	3	(ft)
1	0.9*	0.5	0.4	0.3	
2	3.2	0.7	0.5	0.4	
4	7.1	2.5	1.3	0.5	

*Tebuthiuron Conc. (ppmw) in soils.

F value: A = 155.0**.   B = 130.5**.   A x B = 42.31**.

CV = 24.26.

**Significant at 5% level.

TABLE X

NATURAL RAINFALL DATA IN HANNA, OKLAHOMA
APRIL THROUGH JULY, 1974

Date	Amount (cm)
4-6	0.15
4-11	1.17
4-12	0.86
4-21	1.14
4-22	1.50
4-30	11.94
5-2	2.13
5-25	3.02
5-26	3.66
5-31	2.60
6-1	0.86
6-4	.51
6-5	5.97
6-8	0.03
6-9	4.12
6-12	0.43
7-4	0.31
7-5	0.18
7-24	1.14

soil could adsorb a considerable amount of herbicide into the soil.

The down slope movement of herbicide was decreased greatly with broad-

cast application of lower rates.

CHAPTER V

SUMMARY

Laboratory, greenhouse, and field studies were conducted to obtain
a better understanding of tebuthiuron adsorption, desorption, movement,
and dissipation in soils.

Soil adsorption and desorption appeared to be affected by organic
matter, cation exchange capacity, and clay content. Loam soil from
Eufaula showed the greatest adsorption while sand from Perkins showed
the least adsorption with tebuthiuron. In sandy loam from Stillwater,
there are different adsorption and desorption between the soil from
0-4 inch soil zone and the soil from 4-8 inch soil zone. After six
successive extractions, less desorption occurred in loam soil from
Eufaula than sandy loam from Stillwater and sand from Perkins.

Mobility of both tebuthiuron and fluometuron were much more in
sand from Perkins than in soil from Eufaula and Kingfisher. Tebuthiu-
ron showed about the same mobility in soil as fluometuron. Tebuthiuron
would have to be considered as a mobile herbicide. Mobility of
tebuthiuron is correlated with adsorption-desorption process.
Tebuthiuron dissipation was greater at two higher temperatures (30° and
20° C) and high soil moisture (15%). At these rates used in the study,
tebuthiuron was readily adsorbed at 0-4 inch soil zone and leached
very little into soil profile in field condition. Some amount of
herbicide still persisted 204 days after broadcast application of both

granular and wettable powder formulations. Down slope movement was not significant with broadcast application of 2 lb/A or less but the movement did occur when tebuthiuron was concentrated with the arid placement.

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