DIFFERENCES, MECHANISM, AND GENETICS OF HERBICIDE RESPONSE AMONG SELECTED CULTIVARS OF COTTON, GOSSYPIUM HIRSUTUM L.

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CHAPTER I

INTRODUCTION

Differences in cultivar response to herbicides have been reported in a considerable number of crops, e.g., corn (Zea mays L.), tomato (Lycopersicon esculentum Mill.), soybeans (Glycine max L.) Southern peas [Vigna unguiculata (L.) Walp.], and sorghum [Sorghum bicolor (L.) Moench].

The evidence for such response in cotton (Gossypium hirsutum L.) is less clear. In some environments, particularly the Mississippi Delta and the High Plains of Texas, significant cotton injury has occurred which appeared to result from herbicide application. Observations suggest that cotton cultivars do respond differently to given herbicide treatments; but the critical, repeatable experiments to demonstrate those differences have yet to be performed. If in fact they do exist, differences in herbicide response may be due to different levels of seed or seedling vigor or to genetic factors, i.e., cultivar characteristics. Virtually nothing is known of the genetics of herbicide response in cotton. Genetic studies have been conducted for certain defoliant-cultivar combinations, and some insecticides are known to differentially affect the earliness and yield of selected cotton genotypes in some environments. Differential responses of cotton cultivars to other types of chemicals such as herbicides would not be unexpected.

The objectives of the research reported herein were to determine if there were differences in herbicide response among selected cultivars of cotton; and if present, to determine the mechanism and genetics for those differences.

CHAPTER II

REVIEW OF LITERATURE

Herbicide effectiveness in row crops is generally based on interspecific selectivity. However, there are also many instances of intraspecific selectivity which can cause poor weed control or crop injury. Intraspecific selectivity has been reported in Canada thistle, Cirsium arvense L. (18); wild oats, Avena fatua L. (19); and other weeds (25). There are also numerous reports of differential response to herbicides among crop cultivars. Intraspecific selectivity has been reported in many crops, e.g., corn (13), tomato (34), soybeans (37), Southern peas (33), and sorghum (24). The identification and characterization of cultivar responses would be helpful in preventing crop injury and in developing more tolerant lines for the future (12).

Differential Response in Several Crops Other than Cotton and in Weed Species

Hardcastle (16) found that 'Coker 102' soybeans treated with 1.68 kg/ha of metribuzin established 62% fewer plants than its untreated check. Chemical names of the herbicides and insecticides mentioned throughout this literature review are listed in Table I. This difference was also significant from other cultivars treated at the same rate. A small, but statistically significant, increase in stand for 'Bienville' treated at 1.12 kg/ha was noted over its own check. They concluded that

TABLE I

CHEMICAL NAMES OF HERBICIDES AND INSECTICIDES MENTIONED IN THIS REVIEW

Common	Chemical
	Herbicides
Diuron	3-(3,4-dichlorophenyl)-1,1-dimethylurea
Trifluralin	α,α,α-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine
Atrazine	2,chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine
Propazine	2-chloro-4,6-bis(isopropylamino)-s-triazine
Dinitramine	N^4,N^4-diethyl-α,α,α-trifluoro-3,5-dinitrotoluene-2, 4-diamine (N^3,N^3-diethyl-2,4-dinitro-6-trifluoromethyl-m- phenylenediamine)
Profluralin	N-(cyclopropylmethyl)-α,α,α-trifluoro-2,6-dinitro- N-propyl-p-toluidine
Penoxalin	N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine
Glyphosate	N-(phosphonomethyl)glycine
Fluometuron	1,1-dimethyl-3-(α,α,α-trifluoro-m-tolyl)urea
Prometryn	2,4-bis(isopropylamino)-6-(methylthio)-s-triazine (2-methylthio-4,6-bis(isopropylamino)-s-triazine)
DSMA	Disodium methanearsonate
C-2059	2(m-trifluoromethylphenyl)-1,1-dimethyl urea
UC 22463	3,4 dichlorobenzyl-N-methylcarbamate
SAN 6706	[4-chloro-5-(dimethylamino)-2-(α,α,α-trifluoro-m- tolyl)-3(2H)-pyridazinone]
Norflurazon	4-chloro-5-(methylamino)-2-(α,α,α-trifluoro-m-tolyl)- 3-(2H-pyridazinone)
Simazine	2-chloro-4,6-bis(ethylamino)-s-triazine
Metribuzin	4-amino-6-tert-butyl-3-(methylthio)-as-triazin-5(4H) one(4-amino-6-(1,1-dimethylethyl)-3-(methylthio)- 1,2,4-triazin-5(4H)-one)
Bentazon	3-isopropyl-1H-2,1,3-benzothiadiazin-4-(3H)-one 2, 2-dioxide
Chloroxuron	3-[p-(p-chlorophenoxy)phenyl]-1,1-dimethylurea
Bromoxynil	3,5-dibromo-4-hydroxybenzonitrile(4-cyano-2,6- dibromophenol)
2,4-DB	4-(2,4-dichlorophenoxy)butyric acid
Linuron	3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea(N^1-(3, 4-dichlorophenyl)-N-methoxy-N-methylurea

TABLE I (Continued)

Common	Chemical
	Herbicides
Dinoseb	2-sec-butyl-4,6-dinitrophenol(2-(1-methylpropyl) -4,6-dinitrophenol)
	Insecticides
Toxaphene	chlorinated camphene containing 67-69% chlorine
DDT	1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane
Methyl parathion	0,0-dimethyl-0-p-nitrophenyl phosphorothioate
Azodrin	Dimethyl phosphate of 3-hydroxy-N-methyl-cis-croton-amide
Endrin	1,2,3,4,10,10-hexachloro-6,7-epoxy,1,4,4a,5,6,7,8,8a-octahydro-1,4-endo-endo-5,8-dimethanonaphthalene
Carbaryl	1-naphthyl-n-methylcarbamate

herbicide by cultiver interactions as indicated by reductions in stand, height, and yield of soybeans were obtained following metribuzin treatment.

Barrentine, Edwards, and Hartwig (5) screened 45 soybean cultivars representing determinate and indeterminate types commonly grown in the U.S. for tolerance to metribuzin. They found two cultivars and one breeding line which showed only slight injury, whereas two cultivars were completely killed. Edwards, Barrentine, and Kilen (14) studied two soybean cultivars, 'Semmes' and 'Hood', which differed in sensitivity to metribuzin by using their F_1, F_2, and backcross F_2 generations to determine the inheritance of metribuzin sensitivity. They found a single recessive gene controlled metribuzin sensitivity, as expressed by the cultivar Semmes.

Wax, Bernard, and Hayes (38) studied the response of several hundred soybean cultivars to postemergence application of four herbicides and evaluated them in the field, greenhouse, and growth chamber in three consecutive years. The observed order of phytotoxicity for the herbicides was 3.4 kg/ha of bentazon < 3.4 kg/ha of chloroxuron < 0.3 kg/ha of bromoxynil = 0.4 kg/ha of 2,4-DB. Of the 338 named U.S. and Canadian cultivars in the USDA soybean germplasm collection, all but one were tolerant to a postemergence application of 3.4 kg/ha bentazon. One U.S. cultivar, 'Hurrelbrink', and 10 introductions from Japan were highly sensitive to bentazon. Those 11 cultivars were also highly sensitive to bromoxynil and 2,4-DB and somewhat sensitive to chloroxuron.

Jeffery, Jackson, and McCutchen (20) conducted a two-year study at two locations in Tennessee using fluometuron on soybeans. They found differences in response between the two locations and hypothesized that soil type, organic matter, sand and silt content, and amount of rainfall immediately after fluometuron application could have been the critical factors. However, it should be noted that two different cultivars, 'Dare' and 'Lee 68', were used at the two locations.

Johnson (21), in testing soybean response to repeated applications of herbicides, found yields significantly reduced with multiple applications of prometryn when compared to plots that received only a single treatment. Multiple applications of linuron, chloroxuron, or dinoseb did not significantly affect seed yield. Burnside (8), in a study of tolerance in soybean cultivars to weed competition and herbicides, demonstrated that cultivar selection was important in reducing yield loss from herbicides as linuron reduced yields from 5% for 'Harosoy 63' to as much as 31% for 'Ford'.

Eastin (13) found no significant differences in growth among untreated plots of six selections from 'GT112' inbred corn. However, treatment with atrazine killed or stunted one selection while the other five were resistant. Miller and Bovey (24) evaluated 40 sorghums for tolerance to herbicides and found two, 'IS 7363' and PI 285042, which were consistently more tolerant regardless of the herbicide applied.

Smallwood, Abernathy, and Miller (33) tested 24 cultivars of Southern peas for tolerance to dinitroaniline, triazine, urea, amide, and glyphosate-type herbicides. Herbicides were applied preplant incorporated, preemergence, or postemergence at rates which ranged from less than normal for some triazine herbicides to as much as eight times recommended rates for the dinitroanilines. Visual ratings indicated that six cultivars were the least tolerant to the herbicides tested, while four showed a wide range of tolerance. One cultivar, 'Purplehull

Whippoorwill', was the only entry showing a high level of tolerance to every group of herbicides. Some intraspecific variability was observed in the response to specific herbicides in most treatments, but the widest range was noted with the urea and amide compounds. Differential cultivar responses were less pronounced with the triazine, dinitroaniline, and glyphosate compounds.

Stephenson, McLeod, and Phatak (34) showed that 15 cultivars of tomato (Lycopersicon esculentum Mill.) varied greatly in tolerance to metribuzin applied at a concentration of 0.5 mg/l in quartz sand nutrient culture at the three-true-leaf-stage. Tolerance increased with seedling age, but acceptable tolerance was observed about six days earlier in the tolerant cultivars compared to the susceptible ones. Differential tolerance was related to the rate of detoxification by metabolism within the tomato leaves. Detoxification rate was approximately two-fold greater in the tolerant cultivars.

Jacobsohn and Andersen (19) evaluated 214 lines of wild oats (Avena fatua L.) for response to two preplant incorporated and one postemergence herbicide. They observed large differences among lines in response to herbicides including some lines that might not be controlled by recommended rates of the herbicides. Frequency distributions of herbicide response suggest that reaction to the herbicides used is quantitatively inherited. Oliver and Schreiber (25) investigated differential selectivity of herbicides on six Setaria taxa and detected the presence of such reactions for several commonly used herbicides.

Differential Effect of Defoliants and Insecticides on Cotton

Peacock and Hawkins (26) found that resistance to chemical defoliation in upland cotton was controlled at a single locus. Two phenotypes were recognized in the F_2 in the ratio of 3 susceptible (Df-):1 resistant to defoliation (dfdf).

Karami and Weaver (22) investigated the effect of two levels of nitrogen, toxaphene plus DDT, methyl parathion, and azodrien and date of planting on earliness of four strains of upland cotton. The final yield of seed cotton for cultivars differed considerably under the different treatments. A relatively larger reduction in yield resulted from application of the organophosphate insecticides on early maturing entries, T59-538 and 'Atlas', than on the late-maturing entry, Coker 413-68. In all three of their experiments, toxaphene plus DDT produced highly significant yield increases over the two organophosphate insecticides.

Roark, Pfrimmer, and Merkl (28) conducted experiments over two years to determine whether certain commercial formulations of methyl parathion and DDT had a direct action on the metabolism of the cotton plant. Measurements taken during the course of their experiments did not reveal any differences between treatments in the rate of accumulation of bolls after square initiation, in boll period, nor in boll size. Thus, the difference in time of initiation of the first fruiting branches and the resultant delay in square and boll production seems to account for nearly all of the observed differences in early seed-cotton yield between plants treated and untreated with methyl parathion.

Consistent differences in growth, morphological characteristics, or yield due to direct action of DDT, toxaphene, or toxaphene plus DDT on the cotton plant were not detected. Roark, Pfrimmer, and Merkl (29) found delayed initiation of fruiting branches and delayed production of floral buds after cotton plants were sprayed during the seedling stage with either of two organophosphate insecticides. A third organophosphate had less effect on initiation of fruiting branches. Spraying with toxaphene, endrin, or carbaryl did not affect initiation of fruiting branches. Corresponding differences were observed in seedcotton yield at first picking.

Weaver and Harvey (39) presented data on the effects of toxaphene plus DDT compared with methyl parathion on 49 cultivars and strains of cotton. The methyl parathion caused a reduction in earliness, lint yield, lint percent, and micronaire. Methyl parathion also resulted in a slower rate of defoliation, an increase in plant height, and a slight increase in staple length and seed index. Differences noted were dependent upon the cultivar or strain.

Differential Response of Cotton Cultivars

Buchanan (7) noted that recommended rates of most currently used cotton pesticides do not have a significant effect on growth and vigor of the cotton plant. However, detrimental interactions have occurred under certain conditions with the substituted urea herbicides and the systemic organophosphate insecticides. He stated that the organophosphate insecticides alone may have a significant effect on the cotton plant, particularly relative to maturity. Herbicide treatments may also affect maturity of cotton which can in turn adversely affect yield. Interactions of pesticide treatment with cultivar can be a severe problem. Baker and Bridge (3) conducted tests over two years on a sandy loam soil with five cultivars and four herbicide treatments (none, diuron, trifluralin, and trifluralin plus diuron applied at recommended rates). Cotton response was determined by measuring dry weight of seedlings three weeks after planting, plant populations, lint yield, and several fiber properties. In one year, rain and low temperatures rendered conditions unfavorable for seedling emergence; and cultivar differences were noted especially in that year. However, there was no indication that herbicide treatments had a significant influence on cultivar performance.

Abernathy and Ray (1,2) conducted a two-year study of 48 cotton cultivars and 20 herbicides. Their greatest response was obtained with herbicides such as atrazine and propazine. They found cotton cultivars which ranged from no injury to 95% injury with the triazine herbicides. The cultivars most tolerant to the triazine herbicides were 'Paymaster 303', 'GSA-71', and 'Auburn M'; most sensitive were 'Lankart 611', 'Lockett 4789', and 'Paymaster 111A'. They reported very few differences in cultivar response for herbicides such as trifluralin, dinitramine, profluralin, and penoxalin applied at normal rates. They did note that several cultivars known to exhibit tolerance to verticillium wilt (Verticillium dahliae Kleb.) also showed increased levels of resistance to herbicide phytotoxicity.

Baker and Bridge (4) studying 12 cultivars sprayed topically, postemergence, with 0.84 kg/ha glyphosate found lint yields of most cultivars were reduced about 50%. However, two cultivars were significantly more susceptible than the others. 'McNair 511' and 'Acala 1517-70' yields were reduced 71 and 63%, respectively. 'Stoneville 603' was the most tolerant cultivar with a reduction of only 43%.

In 1975 field studies, Meredith (23) treated with the recommended rate of fluometuron and found two entries Deso-6 and 'Delcot 277' which exhibited resistance while all others appeared susceptible. He likewise noted that the two resistant cultivars were also resistant to verticillium wilt. An attempt was made to repeat these observations under greenhouse conditions and no differences in response were observed among cultivars.

Davis (9), in testing for resistance to prometryn, found that determining the precise inheritance of differential response was dependent on obtaining an environment nearly uniform for all members of a progeny, a situation which they found very difficult to accomplish. He noted that different rates of germination cause some seedlings to grow faster, absorb herbicide more rapidly, and exhibit more severe symptoms than other plants genetically the same with respect to herbicide tolerance but with less seedling vigor. He theorizes that resistance to a chemical is probably a relative thing; i.e., it is the ability to withstand a heavier dosage of chemical for a longer period of time without showing serious or fatal damage. If this is so, he believes it possible that a dominant resistant factor is present in some cultivars but not in others.

Many scientists have demonstrated that yield reduction and crop injury occur when herbicides are improperly applied (6,11,15,17,27,40). Santelmann, Scifres, and Murray (31) found that application of five postemergence herbicides (diuron, prometryn, DSMA, C-2059, and UC 22463) at recommended rates on five cotton cultivars ('Parrott', 'Acala 4-44', 'Verden', 'Paymaster 101A', and 'Lankart 57') influenced neither the fiber length nor the seed germination after ginning of any of the cultivars. Fiber coarseness and strength were possibly affected in a few instances, but not consistently by any one herbicide. Therefore, the variations were considered due to random chance rather than to herbicide.

Effect of Herbicides on Absorption, Translocation, and Metabolism on Several Crop Species

Strang and Rogers (37) studied the absorption, translocation, and metabolism of SAN 6706 and norflurazon by cotton, corn, and soybeans. Differences in absorption and translocation rates appeared to be major factors determining the tolerance of plants to the two chemicals, with cotton being most tolerant and with soybeans and corn following in that order.

Small and Rogers (32) tested the behavior of fluometuron in a normally glanded vs. a glandless cotton. In culture solution, the 'Stardel' cultivar and an isogenic line (La. Glandless 68-30) which lacked lysigenous glands showed generally similar responses to ^{14}C-fluometuron at concentrations down to 0.25 ppm. The glandless strain translocated a slightly higher percentage of absorbed radioactivity to its foliage than did Stardel, but the difference was thought unlikely to present a problem under field conditions.

Strang and Rogers (35) using microradioautographs and ^{14}C-diuron in root-treated cotton found diuron appeared to move primarily in the apoplast and to be transported acropetally and laterally in the transpiration stream. Radioactivity accumulated in striking concentrations in the lysigenous glands and the trichomes of the plant. This accumulation was postulated to be a major factor in lowering the effective concentration of the herbicide in the leaves of cotton as compared to leaves of more susceptible plants, and thus may be a significant factor in the tolerance of cotton to diuron.

Strang and Rogers (36) using microradioautographs studied ^{14}C-trifluralin absorption by cotton and soybean. Little movement out of the soybean roots was observed, but limited movement of radioactivity into the leaves of cotton, apparently via the metaxylem, was noted. Radioactivity accumulated in the protoxylem of the cotton stem where many elements appeared to be plugged.

Rogers and Funderburk (30) studied the physiological aspects of fluometuron in cotton and cucumber (*Cucumis sativus* L.) and found that fluometuron inhibited their photosynthesis. Differences in absorption and translocation did not adequately account for their differential response, but phytotoxicity experiments indicated that differential ability to degrade fluometuron to less or nonphytotoxic compounds was the primary factor.

Davis, Funderburk, and Sansing (10) tested the absorption and translocation of ^{14}C-labeled simazine by corn, cotton, and cucumber. Simazine or ^{14}C-labeled degradation products moved from the roots to the leaves of cucumber in less than 0.5 hour. The radioactivity was first confined to the veins, but after 8 hours commenced accumulating in the leaf margin and in the interveinal areas. Simazine moved readily into the roots of all three plants. Almost no absorption occurred through the intact leaves; however, simazine did enter when the cuticle was broken. Chloroform-soluble ^{14}C-labeled compounds, simazine and/or degradation products, accounted for approximately half of the total radioactivity in cucumber leaves, one-fourth of that in cotton, and one-twentieth of that in corn.

CHAPTER III

MATERIALS AND METHODS

Cultivars Investigated

In 1974, 70 foreign and domestic cultivars of upland cotton were planted at Perkins, Oklahoma. Eighteen entries representing eight foreigh countries (Chad, Pakistan, Zambia, Thailand, Mali, USSR, Bulgaria, and Uganda) and three continents (Europe, Asia, and Africa) and 52 cultivars representing the United States were included in the original screening portion of this investigation. The cultivars and their countries of origin are listed in Table II.

Experimental Procedures

Field Experiments

The 70 cultivars were planted in a randomized complete-block design with three replications on a Konawa fine sandy loam (1 to 3% slope) classified as a fine-loamy, mixed, Thermic Ultic Haplustalfs. The cultivars were treated with trifluralin (preplant, incorporated); prometryn, fluometuron, and alachlor (preemergence); and MSMA (post-emergence) at their currently recommended rates (X) and twice their recommended rates (2X) for that particular soil type. The herbicide common names, application stages, chemical names, and respective application rates are listed in Table III. Plots were single rows 9 m

TABLE II

CULTIVARS SCREENED AND THEIR COUNTRIES OF ORIGIN

Cultivar	Country of Origin	Cultivar	Country of Origin	Cultivar	Country of Origin
Westburn	USA	Kemp	USA	Deltapine 45A	USA
Westburn 70	USA	Deltapine 25	USA	Lankart 3840	USA
Westburn M	USA	Deltapine SR-1	USA	Coker 312	USA
Lankburn	USA	Deltapine SR-2	USA	Lankart 611	USA
Thorpe	USA	Paymaster 909	USA	Lankart 57	USA
Parrott	USA	Paymaster 111A	USA	De Ridder Red	USA
Coker 310	USA	Paymaster 18	USA	HG 9	Chad
Stoneville 7A	USA	Dunn 118	USA	BJA 592	Chad
Stoneville 213	USA	Dunn 119	USA	Lasani 11	Pakistan
Deltapine 16	USA	HyBee 100A	USA	Albar 627	Zambia
Lankart LX 571	USA	HyBee 200A	USA	SK 32	Thailand
Lockett 4789-A	USA	GSA-71	USA	Allen 333-61	Mali
Paymaster 202	USA	Coker 201	USA	137-F	USSR
Acala 1517-70	USA	Stripper 31A	USA	138-F	USSR
Lockett BXL	USA	Western 44	USA	108-F	USSR
Tamcot 788	USA	Rilcot 90A	USA	152-F	USSR
Stripper Cala-S	USA	Coker 5110	USA	CX 349	USSR
Paymaster 101-B	USA	Prolific Stormproof	USA	4521	Bulgaria
Earlycot 32	USA	Stripper Cala-N	USA	3996	Bulgaria
Earlycot 31	USA	Blanco 3363	USA	3279	Bulgaria
Bayou 70	USA	Gregg 35W	USA	6111	Bulgaria
Delcot 277	USA	Gregg 45E	USA	AH(67)M	Uganda
Verden	USA	Lockett 4789	USA	BP 52/NC 63	Uganda
				BPA 68	Ubanda

TABLE III

HERBICIDE COMMON NAMES, APPLICATION STAGES, CHEMICAL NAMES, AND APPLICATION RATES UTILIZED IN THESE STUDIES

Common Name	Application Stage	Chemical Name	Application Rate(kg/ha) (X) (2X)
Trifluralin	Preplant, Incorporated	α,α,α-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine	0.84, 1.68
Prometryn	Preemergence	2,4-bis(isopropylamino)-6-(methylthio)-s-triazine (2-methylthio-4,6-bis (isopropylamino)-s-triazine)	2.24, 4.48
Fluometuron	Preemergence	1,1-dimethyl-3-(α,α,α-trifluoro-m-tolyl)urea	2.24, 4.48
Alachlor	Preemergence	2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide	2.24, 4.48
MSMA	Postemergence	Monosodium methanearsonate	2.24, 4.48

long with 0.25 m between rows. Planting was accomplished using an experimental planter developed by D. G. Batchelder, an Agricultural Engineer at Okla. State Univ., for use in narrow-row cotton production. Grades were assigned to cultivars based on external symptoms to each herbicide at each rate and were termed as uniformly susceptible, uniformly resistant, or mixtures of plants exhibiting both reactions over all three replications. Since differential cultivar response to the 2X rate of fluometuron appeared to be more clearly expressed than for the other cultivar-herbicide rate combinations, subsequent work was concentrated on that herbicide at the 2X and higher rates. Three susceptible, Lockett 4789-A, Gregg 45E and 6111, and three resistant cultivars, Paymaster 909, Dunn 118 and Coker 312, were chosen from this initial screening for further study. All possible crosses, ignoring reciprocals, were made among the six cultivars in the summer of 1974. Backcrosses and F_2's were made that winter at Iguala, Mexico. In 1975, the parents, F_1's, F_2's, and Bc's were planted at Perkins in a randomized complete-block design with four replications and two replications each were treated with 2X and 3X rates of fluometuron to determine the inheritance of resistance to that herbicide. Also in 1975 the parents were planted in two experiments utilizing a split-plot design with herbicide rates (0X, 1X, 2X, and 3X) as main plots arranged in a complete-block design and subplots (i.e., the six cultivars) completely randomized within main plots. These experiments were conducted at Perkins on the Konawa fine sandy loam and at Chickasha on a Reinach silt loam (0 to 1% slope) classified as a coarse-silty, mixed, Thermic Pachic Haplustolls to determine whether the herbicide response of individual cultivars to different rates of fluometuron early in the season would have significant effects on agronomic and fiber properties at the end of the year. For the measurement of fiber properties, 15 boll samples were randomly harvested from each plot, ginned on an eight-saw laboratory-type gin, and the lint forwarded to the Cotton Fiber Laboratory at Okla. State Univ., Stillwater. From this set of experiments, the following quantitative characters were measured:

1. Lint Yield - Weight of snapped cotton (seedcotton plus bur) per plot in pounds converted into kilograms of lint per hectare,
2. Picked Lint Percent - Ratio of lint to seedcotton expressed as a percentage,
3. Pulled Lint Percent - Ratio of lint to snapped cotton expressed as a percentage,
4. Fiber Length (2.5% Span Length) - Length in inches at which 2.5% of the fibers are of that length or longer as measured on the digital fibrograph,
5. Fiber Length Uniformity Index - Ratio of 50% ot 2.5% span length expressed as a percentage,
6. Fiber Fineness - Fineness as measured on the micronaire and expressed in μg per inch,
7. Fiber Strength (T_1) - Strength of a bundle of fibers as measured on the stelometer with the two jaws holding the bundle separated by a one-eighth inch spacer and expressed in grams per tex (1000 meters of fiber),
8. Fiber Strength (T_0) - Strength of a bundle of fibers as measured on the stelometer with the two jaws holding the

bundle not separated by a spacer and expressed in grams per tex.

<u>Laboratory Experiments</u>

Experiments were conducted at the Controlled Environmental Relations Laboratory of Okla. State Univ. where the parents and 14 of the 15 possible F_2's were studied. F_1 and backcross seed as well as one of the F_2's had been expended in the field inheritance study at Perkins. Two hundred and fifty grams of Konawa fine sandy loam soil were placed in 8-ounce styrofoam cups. Each parent was planted to 15 cups and each F_2 to 65 cups by planting five seed per cup. The cups were subirrigated until the soil surface was moist. They were then sprayed in a spray chamber with fluometuron at a 2½X rate of 5.60 kg/ha. The cups were placed in growth chambers with temperature settings of 95^{o} day - 65^{o} night with a day light intensity of approximately 350 foot candles for 12 hours. All cups were thinned to three plants seven days after planting. Rates for injury symptoms were made at 16, 19, 22, 25, 28, 31, 34, and 37 days after planting on a scale of normal plants (no external symptoms), plants showing injury, and dead plants.

Another laboratory experiment was conducted to determine differences in absorption and translocation rates of fluometuron in a susceptible (Gregg 45E) versus resistant (Coker 312) cultivar. Seed of each cultivar were germinated and grown in nutrient solution for 28 days. Phenotypically uniform plants were then chosen for treatment. Three plants were placed in 600 ml dark bottles with 400 ml of half strength Hoaglands solution treated with 4.0 μc/ml ^{14}C-labeled fluometuron with a specific activity of 10.3 μc/mg. Two μc ^{14}C-labeled fluometuron was added to each bottle. This was done for four replications, three subplots (i.e., plants) per replication, and three removal times; 24 hours after treatment, 24 hours after removal from treatment, and 48 hours after removal from treatment. At 24 hours after treatment, one set of plants were removed and quick frozen. The remaining two sets were removed and grown in non-treated half strength Hoaglands solution for 24 and 48 hours, respectively, at which times they were removed and quick frozen. The plants were then removed from the freezer and lyophilized. The plants were sectioned into leaves, stems, petioles, and roots; and counts were made using a Beckman liquid scintillation counter with normal cocktail solution, 5 g PPO (p-bis-o-methylstyryl)-benzene, 80 g napthalene, 230 ml ethanol, 385 ml p-dioxane, and 385 ml xylene.

CHAPTER IV

RESULTS AND DISCUSSION

Differences of Herbicide Response Among Selected Cultivars

Screening of the cultivars in 1974 demonstrated that all 70 were resistant to the herbicides tested at their recommended rates. When the application rate was doubled, complete resistance was found only for alachlor. Trifluralin at the 2X rate caused all cultivars to grade as mixtures. Prometryn applications at twice the recommended rate allowed three cultivars to be graded as susceptible: Lockett 4789-A, Gregg 45E, and 6111. Resistance was found only for Dunn 118 with prometryn at the high rate. With 2X fluometuron application Lockett 4789-A, Gregg 45E and 6111 were graded susceptible, as they were with prometuron. Resistance to fluometuron was found for Paymaster 909, Dunn 118, and Coker 312 (Table IV). It may or may not be significant that the only glandless cultivar among the 70 tested was susceptible to both prometryn and fluometuron. While prometryn and fluometuron do not belong to the same herbicide family, they are similar in their mode of action, i.e., they cause photosynthetic disruptures; therefore, their similarities in cultivar response are not totally unexpected.

Fluometuron appeared more consistent in its cultivar reactions as to susceptibility vs. resistance in the screening study. Therefore,

TABLE IV

GRADES FOR 70 CULTIVARS BY INDIVIDUAL HERBICIDES AT THEIR RECOMMENDED RATES

Cultivar	Grades by Individual Herbicides			
	Fluometuron	Prometryn	Alachlor	Trifluralin
Westburn	M*	M	R	M
Westburn 70	M	M	R	M
Westburn M	M	M	R	M
Lankburn	M	M	R	M
Thorpe	M	M	R	M
Parrott	M	M	R	M
Coker 310	M	M	R	M
Stoneville 7A	M	M	R	M
Stoneville 213	M	M	R	M
Deltapine 16	M	M	R	M
Lankart LX 571	M	M	R	M
Lockett 4789-A	S	S	R	M
Paymaster 202	M	M	R	M
Acala 1517-70	M	M	R	M
Lockett BXL	M	M	R	M
Tamcot 788	M	M	R	M
Stripper Cala-S	M	M	R	M
Paymaster 101-B	M	M	R	M
Earlycot 32	M	M	R	M
Earlycot 31	M	M	R	M
Bayou 70	M	M	R	M
Delcot 277	M	M	R	M
Verden	M	M	R	M
Kemp	M	M	R	M
Deltapine 25	M	M	R	M
Deltapine SR-1	M	M	R	M
Deltapine SR-2	M	M	R	M
Paymaster 909	R	M	R	M
Paymaster 111A	M	M	R	M
Paymaster 18	M	M	R	M
Dunn 118	R	R	R	M
Dunn 119	M	M	R	M
Hybee 100A	M	M	R	M
Hybee 200A	M	M	R	M
GSA-71	M	M	R	M
Coker 201	M	M	R	M

TABLE IV (Continued)

Cultivar	Grades by Individual Herbicides			
	Fluometuron	Prometryn	Alachlor	Trifluralin
Stripper 31A	M	M	R	M
Western 44	M	M	R	M
Rilcot 90A	M	M	R	M
Coker 5110	M	M	R	M
Prolific Stormproof	M	M	R	M
Stripper Cala-N	M	M	R	M
Balanco 3363	M	M	R	M
Gregg 35W	M	M	R	M
Gregg 45E	S	S	R	M
Lockett 4789	M	M	R	M
Deltapine 45A	M	M	R	M
Lankart 3840	M	M	R	M
Coker 312	R	M	R	M
Lankart 611	M	M	R	M
Lankart 57	M	M	R	M
De Ridder Red	M	M	R	M
HG 9	M	M	R	M
BJA 592	M	M	R	M
Lasani 11	M	M	R	M
Albar 627	M	M	R	M
SK 32	M	M	R	M
Allen 333-61	M	M	R	M
137-F	M	M	R	M
138-F	M	M	R	M
108-F	M	M	R	M
152-F	M	M	R	M
CX 349	M	M	R	M
4521	M	M	R	M
3996	M	M	R	M
3279	M	M	R	M
6111	S	S	R	M
AH(67)M	M	M	R	M
BP 52/NC 63	M	M	R	M
BPA 68	M	M	R	M

*Code: S = all plants susceptible over all three replications, R = all plants resistant, and M = mixtures of plants displaying susceptibility and resistance.

the remaining field studies were concentrated on that herbicide at the recommended and higher rates.

Rainfall persistence delayed application of MSMA until a date undesirable for evaluation. Since that date was after the time a decision had to be made in regard to genetic crosses, further efforts with that herbicide were abandoned.

Mean squares from analyses of variance performed over herbicide rates, cultivars, and locations are reported in Table V for each of the eight characters measured. F-tests indicate that differences among cultivars were significant for all traits at the 0.10 or higher levels of significance. Analyses also showed a significant location difference for all traits. When locations were analyzed separately, Paymaster 909 at Chickasha was the lowest yielding cultivar and was significantly lower than all except Dunn 118. The cultivar 6111 from Bulgaria was more than twice its nearest competitor with a lint yield of 118 kg/ha. At Perkins, no differences in yield were detected among cultivars (Table VI).

Both picked and pulled lint percents exhibited significant differences among cultivars and between locations. Location by cultivar interactions were not detected at the 0.10 probability level for either trait. Significant cultivar by location interactions were detected for 2.5% span length at the 0.01 probability level and for uniformity index at the 0.10 level. There were no significant location by cultivar interactions or any other interactions involving locations for micronaire, T_0, or T_1. Specific comparisons among cultivars over herbicide rates can be made by locations using the data in Table VI.

TABLE V

ANALYSES OF VARIANCE FOR EIGHT TRAITS OVER HERIBCIDE RATES, CULTIVARS, AND LOCATIONS

		Mean Squares							
					Fiber 2.5% Span Length	Length Uniformity Index		Fiber Strength	
Source	df	Lint Yield (kg/ha)	Lint Percent Picked	Lint Percent Pulled	(in)	(%)	Micronaire (μg/in)	T_0 (grams-force/tex)	T_1 (grams-force/tex)
Reps (R)	4	68785	3.94	24.54	0.000883	1.23	0.43	14.59†	4.36
Herb. Rate (H)	3	40422	7.16	4.97	0.001343	1.19	0.07	2.49	2.39
R X H (Error A)	12	31987	6.04	11.33	0.001551	1.12	0.14	2.49	2.06
Cultivar (C)	5	16253†	229.84**	125.93**	0.230053**	170.71**	2.95**	227.21**	58.82**
H X C	15	5157	3.89	6.49	0.001129	1.65	0.08	2.44	3.89*
RHC + RC (Error B)	80	7220	4.17	11.44	0.001350	2.22	0.56	3.70	2.09
Location (L)	1	9309622**	212.63**	241.80*	0.026481†	539.40**	15.35**	124.70*	104.81*
R X L	4	63955	6.76	29.09	0.004468	2.28	0.60	6.63	12.10
L X H	3	27862	2.70	12.27	0.000613	1.75	0.09	4.41	6.63
R X L X H	12	29301	4.56	9.03	0.000921	1.16	0.06	3.85	3.80
L X C	5	25322**	9.85	18.24	0.004652	6.18†	0.15	3.69	1.36
R X L X C	20	4735	4.66	8.87	0.000700	2.66	0.09	3.05	2.74
L X H X C	15	4489	3.39	6.03	0.000542	0.97	0.09	6.75	2.02
RHCL + RCL	80	6305	5.20	10.14	0.000969	2.13	0.07	4.39	2.24

†,*,**Significant mean squares at the 0.10, 0.05, and 0.01 levels of probability, respectively.

TABLE VI

CULTIVAR RESPONSE OVER HERBICIDE RATES BY LOCATIONS

Cultivar	Lint Yield (kg/ha) Chick.	Lint Yield (kg/ha) Perk.	Lint Percent Picked*	Lint Percent Pulled*	Fiber Length: 2.5% Span Length (in) Chick.	Fiber Length: 2.5% Span Length (in) Perk.	Fiber Length: Uniformity Index (%) Chick.	Fiber Length: Uniformity Index (%) Perk.	Micronaire* (µg/in)	Fiber Strength T_0* (grams-force/tex)	Fiber Strength T_1* (grams-force/tex)
Lockett 4789-A	45	445	33.4	24.4	1.050	1.081	45.4	48.1	3.4	42.1	22.5
Paymaster 909	31	405	36.1	25.3	0.985	0.967	47.8	51.5	3.9	42.4	22.6
Dunn 118	35	486	32.3	22.8	1.097	1.129	44.5	48.4	3.4	47.9	25.1
Gregg 45E	44	434	38.1	26.7	0.969	0.980	48.4	51.8	4.0	44.7	22.6
Coker 312	45	484	35.1	24.7	1.122	1.162	43.7	45.8	3.4	43.2	22.6
6111	118	428	31.9	21.7	0.961	0.992	47.5	49.6	3.6	41.5	21.4
Mean	53	447	34.5	24.3	1.031	1.052	46.2	49.2	3.6	43.6	22.8
$LSD_{.05}$	12	-	0.9	1.5	0.026	0.015	1.1	0.7	0.1	0.8	0.7

*Since these traits did not exhibit a significant cultivar by location interaction (refer to Table V), cultivar means were calculated over locations rather than within separate locations.

Main effects for herbicides (Table V) were not significant at the 0.10 or higher probability levels for any trait nor were any of the interactions involving herbicides significant except for the herbicide rate by cultivar interaction for T_1 as illustrated in Figure 1. The lines in Figure I failed to remain parallel from one herbicide rate to the next which does suggest interaction. However, relative overall ranks among the cultivars for T_1 were essentially the same as for T_0; Dunn 118 had the highest strength, 6111 the lowest, and the other four cultivars were essentially equal.

An inescapable conclusion from these results is that the differences in herbicide response in early season among the cultivars studied had little or no effect on their relative performance at the end of the season as measured in these two experiments.

Mechanism of Herbicide Response Among Selected Cultivars

When the resistant cultivar, Coker 312, was compared with the susceptible Gregg 45E, a large number of significant differences were noted in the absorption and translocation of radioactive fluometuron between different plant parts (Table VII). All parts of Gregg 45E contained a significantly greater amount of fluometuron when compared to its corresponding part in Coker 312 at 24 hours after treatment. Forty-eight hours after treatment (and 24 hours after removal from the treatment), the trend was the same as found at the first time period, and all differences were still highly significant. Seventy-two hours after treatment (and 48 hours after removal from the treated solution), the trend remained significant and in the same direction in the leaves

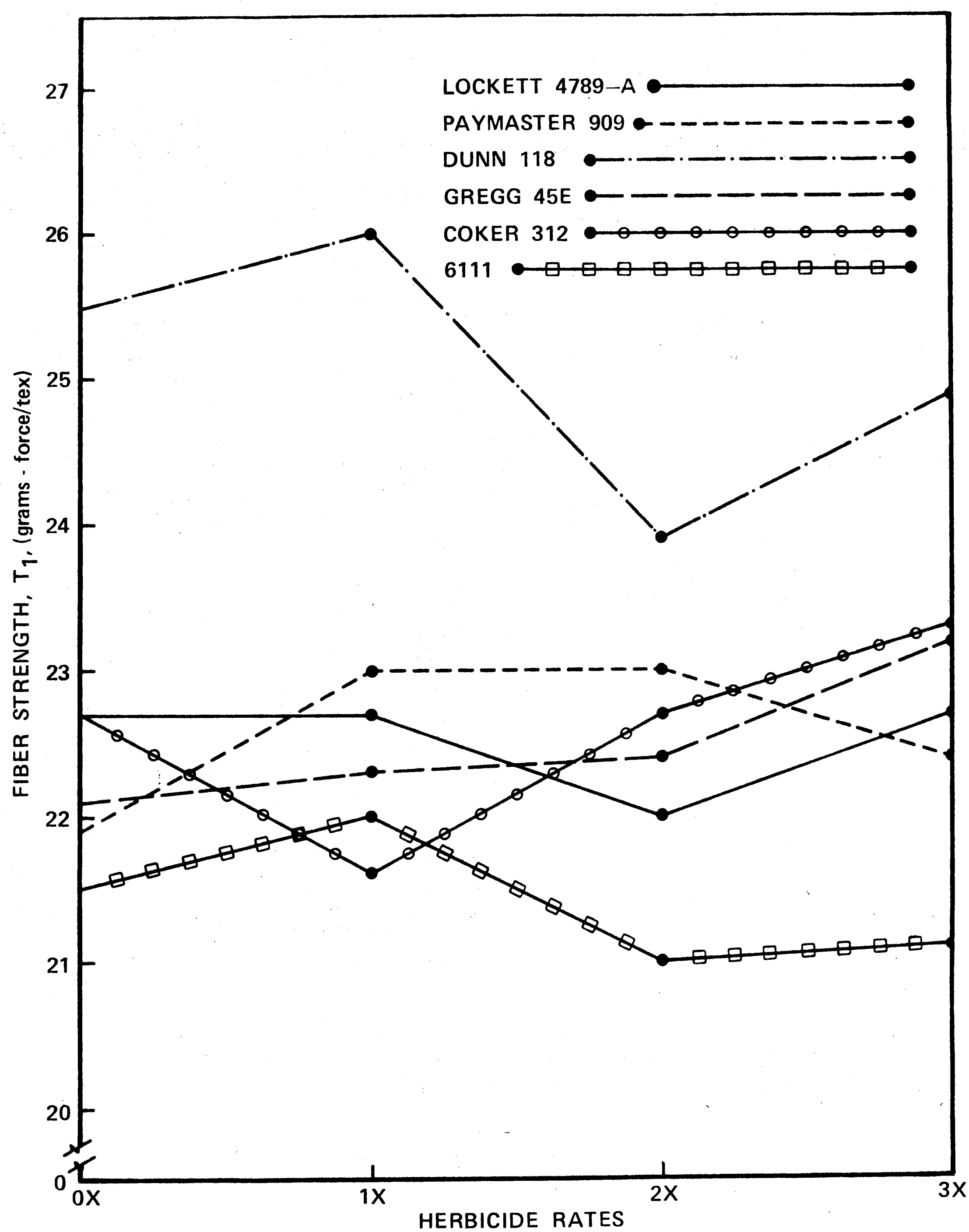

Figure 1. Fiber Strength, T_1, Response to Herbicide Rate by Cultivar

TABLE VII

NANOGRAMS FLUOMETURON PER GRAM OF PLANT MATERIAL 24, 48, AND 72 HOURS AFTER TREATMENT

	24 Hours*		48 Hours**		72 Hours***	
Plant Part	Coker 312	Gregg 45E	Coker 312	Gregg 45E	Coker 312	Gregg 45E
Leaves	1812	2445	1854	3135	1514	2668
Petioles	4558	6773	3400	6948	21389	17693
Stems	2186	5021	2676	6862	3041	4617
Roots	9117	16838	10348	16163	6707	6527
Total	17673	31077	18278	33108	32651	31505

*$LSD_{.05}$ = 231; $LSD_{.01}$ = 491 **$LSD_{.05}$ = 266; $LSD_{.01}$ = 565 ***$LSD_{.05}$ = 133; $LSD_{.01}$ = 282

and stems. However, Coker 312 now had a significantly greater amount of the herbicide in its petioles and in its roots. At 72 hours after treatment, translocation of fluometuron had occurred primarily from the root of both cultivars into the petioles. This suggests that translocation occurred in an acropetiole direction.

After 24 hours, Coker 312 had absorbed only 57% of the labeled fluometuron as had Gregg 45E. After 48 hours, the relative amount absorbed was only 55%; but between two and three days the percentage had climbed to 104%. The overall differences between the two cultivars were significant after 24 and 48 hours, but not after 72. Not only did Coker 312 absorb less of the herbicide over the first 48 hours than did Gregg 45E, but its general distribution in the plant was different. Coker 312 is a normally glanded cultivar, and the labeled fluometuron in autoradiographs appeared to be concentrated in the glands. Gregg 45E is a glandless cultivar, and the labeled herbicide appeared in autoradiographs to be generally distributed throughout any one plant part (Figure 2).

The difference between resistance and susceptibility to high rates of fluometuron in cotton may be partially due to differing absorption rates with the more resistant types being slower to absorb the material. Glanded cottons may have additional protection in that a large part of the absorbed chemical is concentrated in glands where it is largely isolated from other plant tissues, whereas in glandless plants it is generally distributed throughout the plant. The latter explanation can be critically tested only after isogenic glandless lines have been derived on a fluometuron-resistant background.

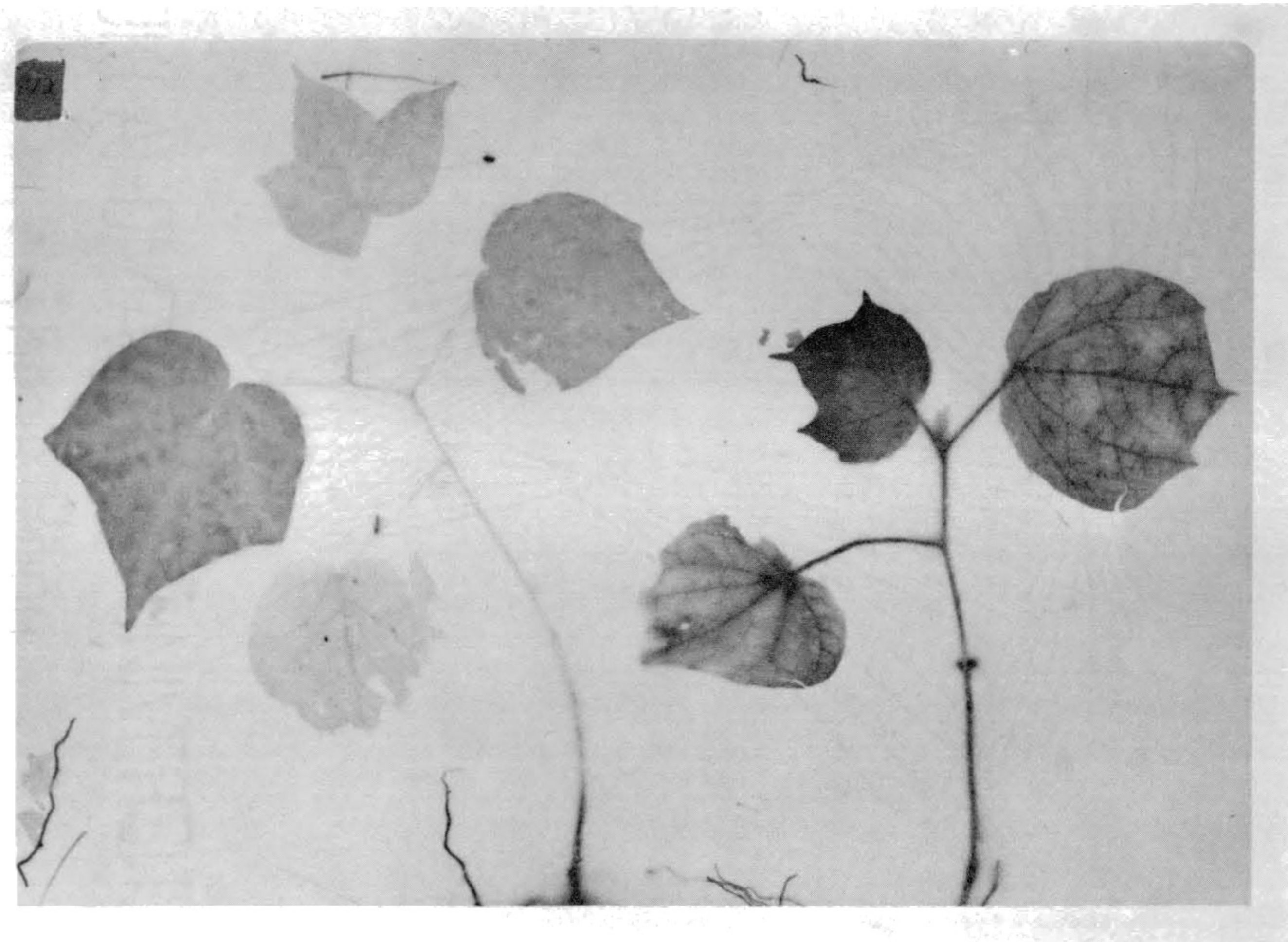

Figure 2. Distribution of ^{14}C-fluometuron 72 Hours After Treatment. Left, Coker 312; Right, Gregg 45E.

Genetics of Herbicide Response Among Selected Cultivars

The effort to determine the inheritance of resistance to fluometuron in the field at Perkins in 1975 using parents, F_1's, F_2's, and backcross seed was abandoned. Symptoms were not generally evident at the 2X rate in that year; and at the 3X rate, the resistant parents appeared to be more susceptible than resistant. Efforts to determine the genetics involved were then transferred to growth chambers. Preliminary screenings of the parents in the chambers suggested that the 2½X rate should be utilized. The F_1, backcross, and one of the F_2's (Dunn X Coker 312) seed had been used in the field studies, and were unavailable for the growth chamber work. The six parents and the remaining 14 of the 15 possible F_2's (ignoring reciprocals) were utilized in the growth chamber studies.

Plants were assigned to three categories: no symptoms; symptoms, but alive; and dead. Since it was observed that most plants which exhibited symptoms eventually died, those two categories were combined for the purpose of testing genetic ratios. Because most plants in the segregating populations died, cups containing three symptomless plants were considered to have received less than their proportionate share of the herbicide; and the plants therein were not counted. If one or more plants displayed symptoms, all plants in that cup were counted. Counts by days after planting for parents and F_2's with Chi-square values for the latter are given in Table VIII.

Most of the F_2's between resistant and susceptible parents did not differ significantly from a 15:1 ratio for susceptibility:resistance.

TABLE VIII

RATIOS OF PLANTS WITH FLUOMETURON INJURY SYMPTOMS TO THOSE WITHOUT SYMPTOMS

Populations	Days After Planting							
	16	19	22	25	28	31	34	37
				Resistant X Susceptible				
1 X 2 F_2	184.02** (134,58)	2.59 (164,5)	6.50* (166,2)	6.50* (166,2)	9.75** (162,0)	2.53 (163,5)	9.76** (162,0)	9.76** (162,0)
1 X 3 F_2	1067.76** (66,120)	2.31 (143,15)	0.37 (156,13)	0.11 (160,9)	0.02 (166,11)	0.01 (168,12)	0.91 (161,7)	0.91 (161,7)
1 X 5 F_2	380.60** (111,77)	0.63 (148,13)	0.10 (156,12)	3.33 (158,4)	6.31* (163,2)	4.80* (162,3)	6.13* (160,2)	1.50 (159,6)
2 X 4 F_2	500.22** (103,87)	100.02** (129,43)	2.69 (162,17)	0.01 (168,11)	2.05 (172,6)	0.75 (173,8)	3.19 (176,5)	0.01 (167,11)
2 X 6 F_2	492.89** (111,89)	2.69 (174,18)	0.96 (179,16)	0.00 (185,13)	0.00 (182,13)	0.01 (183,12)	0.01 (183,12)	1.71 (183,7)
3 X 4 F_2	375.14** (113,77)	0.01 (147,10)	0.34 (157,8)	0.00 (158,10)	0.01 (152,10)	0.73 (155,7)	0.04 (153,9)	0.04 (153,9)
3 X 6 F_2	1242.78** (60,130)	32.08** (141,29)	10.16** (147,21)	0.53 (165,8)	5.16* (168,3)	0.63 (169,8)	3.77 (166,4)	2.64 (165,5)
4 X 5 F_2	343.47** (122,76)	41.37** (150,33)	1.38 (170,16)	0.41 (177,9)	2.41 (180,6)	0.90 (178,8)	0.90 (178,8)	0.90 (178,8)
5 x 6 F_2	654.28** (98,100)	40.14** (138,31)	0.00 (157,11)	3.17 (155,4)	3.68 (164,4)	3.66 (164,4)	4.80* (162,3)	0.04 (153,9)

*,** Does not fit a 15:1 ratio at the 0.05 and 0.01 probability levels, respectively.

TABLE VIII (Continued)

Populations	Days After Planting 16	19	22	25	28	31	34	37
				Susceptible X Susceptible				
1 X 4 F_2	304.20** (121,71)	7.75** (151,20)	3.96* (148,17)	0.15 (153,12)	0.10 (159,9)	0.41 (155,13)	0.15 (153,12)	0.15 (153,12)
1 X 6 F_2	1105.08** (68,124)	9.63** (140,20)	6.09* (152,19)	0.79 (157,14)	0.33 (157,8)	0.01 (151,11)	4.51* (143,17)	3.58 (141,3)
4 x 6 F_2	45.49** (156,35)	2.53 (163,5)	8.03** (164,1)	9.82** (163,0)	2.59 (164,5)	1.67 (163,6)	3.55 (162,4)	3.55 (162,4)
				Resistant X Resistant				
2 X 3 F_2	32.64** (163,32)	0.25 (169,9)	0.01 (166,11)	0.95 (162,7)	0.03 (162,12)	0.00 (160,11)	4.62* (159,3)	0.10 (159,9)
2 X 5 F_2	221.95** (136,64)	0.00 (158,10)	1.27 (153,6)	4.45* (156,3)	3.17 (155,4)	2.11 (154,5)	0.22 (151,8)	1.19 (151,6)
				Parents				
(1) Lockett 4789-A	(31,4)	(33,2)	(33,2)	(32,3)	(33,2)	(35,0)	(35,0)	(35,0)
(2) Paymaster 909	(15,7)	(12,10)	(13,9)	(13,9)	(12,10)	(13,9)	(13,9)	(13,9)
(3) Dunn 118	(30,10)	(39,1)	(38,2)	(38,2)	(38,2)	(37,3)	(37,3)	(37,3)
(4) Gregg 45E	(33,4)	(37,0)	(37,0)	(37,0)	(37,0)	(37,0)	(37,0)	(37,0)
(5) Coker 312	(21,20)	(37,4)	(36,5)	(38,3)	(38,3)	(38,3)	(38,3)	(38,3)
(6) 6111	(25,12)	(34,3)	(36,1)	(36,1)	(36,1)	(37,0)	(37,0)	(37,0)

*,**Does not fit a 15:1 ratio at the 0.05 and 0.01 probability levels, respectively.

From the second date of grading onward, the combinations Lockett 4789-A X Dunn 118, Gregg 45E X Dunn 118, and Paymaster 909 X 6111 fit such a ratio as did Coker 312 X Gregg 45E and Paymaster 909 X Gregg 45E from the third date onward. The combinations Coker 312 X 6111 and Dunn 118 X 6111 were both largely in the same category after the third and fourth dates, respectively, except for a single date in each combination which did not fit the expected ratio. The crosses of Lockett 4789-A with Coker 312 and with Paymaster 909 were largely negative after the fourth and second dates, respectively, with single exceptions in each case. The latter two combinations were tested for fit to a 63:1 ratio on the last four dates, and all did so at the 0.05 probability level. Since Lockett 4789-A was the common factor in the above two crosses, the last two dates of the remaining susceptible X resistant cross involving Lockett 4789-A (i.e., the cross with Dunn 118) were tested against a 63:1 ratio, but neither fit at the 0.05 level of probability.

The above results would be most encouraging were it not for the facts that (a) the susceptible X susceptible crosses after the third date also displayed largely 15:1 ratios, (b) the resistant X resistant crosses after the first date likewise exhibited mainly 15:1 patterns, and (c) none of the resistant parents were phenotypically uniform for resistance (as they were in the 1974 field screenings).

One more encouraging fact is that after the fifth date, all plants (not in groups of three to the cup) of the susceptible parents had died whereas some plants of each resistant parent survived. Therefore, some success may have been achieved in separating susceptible from resistant plants by the screening process used.

General Discussion

The objectives of this research were to determine if there were differences in herbicide response among selected cultivars of cotton; and if present, to determine the mechanism and genetics for those differences.

Differences in herbicide response among cotton cultivars were successfully demonstrated, but it was also shown that those differences were not consistently exhibited in a uniform manner from environment to environment in the field nor from the field to the growth chamber. Differences in mechanism of herbicide absorption between a susceptible and a resistant cultivar were shown. Whether those differences were due to the presence vs. absence of glands in the two cultivars awaits the development of isogenic lines and a genetically resistant background. Somewhat ambiguous results were obtained in the genetic studies whether in the growth chamber or the field, even though all genetic crosses fit a two (15:1) or three gene (63:1) ratio. However, the fact that all plants of the susceptible parents died in the chambers while some of the plants of the resistant parents survived suggests that some success was achieved by the methods used in separating the two reaction types.

Based on the results of these experiments, further work should be conducted in the field to determine more precisely the differences between susceptible and resistant cultivar response to differing herbicide rates for yield and the fiber character. One year and two locations were quite minimal, but necessary under the time limits for this dissertation. Neither of the two tests were conducted under ideal conditions. Neither was under what could be considered a "fair test" to determine response. Additional growth chamber work is also required to better define the environmental conditions optimal for making genetic studies or selections, e.g., temperature, moisture, light quantity, light quality, and day length may all be important factors. Mechanism or mechanisms should be studied further for susceptible vs. resistant cultivars to aid the geneticist or breeder in making his selections, e.g., rate of uptake, metabolic breakdown, or simply chemical storage within the plant should be investigated.

CHAPTER V

SUMMARY AND CONCLUSIONS

The objectives of the research reported herein were to determine if there were differences in herbicide response among selected cultivars of cotton; and if present, to determine the mechanism and genetics for those differences. To achieve those objectives, replicated experiments were conducted in the laboratory and at two locations in Oklahoma.

Initial field screening studies indicated differences among the 70 cultivars tested within certain herbicide-rate combinations, but not within others. All 70 cultivars were resistant to the herbicides tested at their recommended rates. Cotton treated with alachlor at the 2X rate exhibited no external symptoms, while all cultivars treated with trifluralin at the higher rate were graded as mixtures in their reactions. Prometryn and fluometuron at the 2X level were quite similar in their reactions on the cultivars screened. Lockett 4789-A, Gregg 45E, and 6111 were uniformly susceptible to both while Dunn 118 was uniformly resistant to both. Paymaster 909 and Coker 312 were resistant to fluometuron but displayed a mixed reaction to prometryn. The cultivars were not graded for their reactions to MSMA.

Because fluometuron appeared more consistent in its cultivar reactions for resistance vs. susceptibility, subsequent work was concentrated on that herbicide and the six cultivars mentioned above.

Field studies were conducted at two locations to compare agronomic and fiber property reactions to different rates of fluometuron. Location and cultivar differences were found for all characters measured. Location by cultivar interactions were detected for yield, span length, and uniformity index. Herbicide rate differences were not found nor were interactions involving herbicide rates detected for any of the characters studied except for herbicide rate by cultivars for T_1. The differences in herbicide response detected in the early season among these cultivars had little or no effect on their performance at the end of the season, as measured in these two experiments.

A laboratory investigation of the resistant cultivar, Coker 312, and the susceptible Gregg 45E showed a greater absorption of fluometuron in all plant parts of the susceptible cultivar at 24 and 48 hours after treatment. Seventy-two hours after treatment, translocation had occurred primarily from the root into the petioles of both cultivars. The cultivars still exhibited significant differences after 72 hours in their leaves and stems, but the total amount absorbed was now statistically the same as was the amount in the roots. Glanded plants may have additional protection in that a large part of the chemical is concentrated in the glands where it is largely isolated from other plant tissue, whereas in glandless plants it is generally distributed throughout the plant.

Genetic studies in the field were abandoned because symptoms were not evident at the 2X rate in that year; and at the 3X rate, the resistant parents appeared more susceptible than resistant. Genetic studies at the 2½X rate in growth chambers among F_2's derived from resistant by susceptible parents fit a two or three gene ratio in every case. However, the susceptible by susceptible and resistant by resistant crosses also fit a two-gene ratio, and the resistant parents were not phenotypically uniform for resistance (as they had been in the field screenings the previous year). A more encouraging fact is that all plants of the susceptible parents died whereas some plants of each resistant parent survived. Therefore, some success may have been achieved in separating susceptible from resistant plants.

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