June 8, 1973

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# SYSTEMS OF JOHNSONGRASS CONTROL IN SOYBEANS

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A Thesis

Presented to

the Graduate Council of

The University of Tennessee

---

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

---

by

David Keith Glover

August 1973

ACKNOWLEDGMENT

The author wishes to express his sincere appreciation to the following persons:

Dr. Larry S. Jeffery, his major professor, for providing guidance and assistance throughout the course of this study and in preparation of this manuscript.

Mr. Charles R. Graves and Dr. David L. Coffey for their aid and suggestions and for serving on the author's graduate committee.

His fellow graduate students for their aid and fellowship throughout his study.

His wife, Kay, for her patience, encouragement, and support throughout his graduate study.

His mother for her aid and inspiration throughout his college study.

The University of Tennessee Experiment Station for providing financial assistance.



1101047

## ABSTRACT

The objective of this study was to determine an effective combination of herbicides for controlling johnsongrass while growing soybeans. Experiments were conducted at four locations in Tennessee in 1972. Observations were made on the control of seedling and rhizomatous johnsongrass, soybean injury, and the broadleaf weed control. Soybean seed yield from each plot was measured.

A split-block experimental design was used. Main blocks consisted of two preplant foliar treatments for the control of rhizome johnsongrass, viz., dalapon (2,2-dichloropropionic acid) and glyphosate [N-(phosphonomethyl)glycine]. Subblocks consisted of four herbicides to control seedling johnsongrass, i.e., alachlor [2-chloro-2',6'-diethyl-N-(methoxymethyl)acetanilide], nitralin [4-(methylsulfonyl)-2,6-dinitro-N,N-dipropylanilide], trifluralin (a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine), and vernolate (S-propyl dipropylthiocarbamate), plus a weed-free check and a weedy check included in each main treatment of each replication.

Johnsongrass rhizome control was good to excellent at all locations with both dalapon and glyphosate treatments. Significant differences between these two herbicides existed only at the Middle Tennessee Experiment Station. No significant differences among herbicides used for seedling johnsongrass control were found at any location. All treatments gave good to excellent control of most broadleaf species present. All herbicide treatments caused some soybean injury with vernolate causing

the most severe injury. No significant differences existed between soybean seed yields at Ames Plantation. At Mascot and Pulaski, yields from glyphosate treated plots were significantly higher than were those from dalapon treated plots. Dalapon treated plots yielded significantly more soybeans at the Middle Tennessee Experiment Station, probably due to the fact that the glyphosate treated plots were turned after only four days.

CRANES CREST

TABLE OF CONTENTS


| CHAPTER | | PAGE |
|---|---|---|
| I. | INTRODUCTION | 1 |
| II. | LITERATURE REVIEW | 3 |
| | Herbicide Review | 5 |
| | Dalapon | 5 |
| | Glyphosate | 8 |
| | Alachlor | 9 |
| | Nitralin | 10 |
| | Trifluralin | 11 |
| | Vernolate | 13 |
| III. | MATERIALS AND METHODS | 15 |
| | Locations | 15 |
| | Experimental Design | 15 |
| | Herbicides Used in the Experiment | 16 |
| | Herbicide Application | 16 |
| | Cultural Practices | 18 |
| | Data Collection | 19 |
| IV. | RESULTS AND DISCUSSION | 20 |
| | Ames Plantation | 20 |
| | Mascot | 23 |
| | Middle Tennessee Experiment Station | 29 |
| | Pulaski | 31 |

CHAPTER PAGE

V. SUMMARY AND CONCLUSIONS . . . . . 35

LITERATURE CITED . . . . . 38

APPENDIX . . . . . 43

VITA . . . . . 57

CRANE CREST

LIST OF TABLES


| TABLE | | PAGE |
|---|---|---|
| 1. | Herbicides, Application Method, and Rates Used at All Locations for Johnsongrass Control in Soybeans . . . . . | 17 |
| 2. | Average Johnsongrass Rhizome Control Ratings of Treatments at Ames Plantation, 1972 . . . . . | 21 |
| 3. | Ratings of Average Johnsongrass Seedling Control by Treatments Over All Locations . . . . . | 22 |
| 4. | Ratings of Average Soybean Injury Due to Treatments at Each Location . . . . . | 24 |
| 5. | Average Johnsongrass Rhizome Control Ratings of Treatments at Mascot, 1972 . . . . . | 26 |
| 6. | Average Soybean Seed Yields at Each Location by Main Treatment . . . . . | 27 |
| 7. | Average Soybean Seed Yields at Each Location by Combination | 28 |
| 8. | Average Johnsongrass Rhizome Control Ratings of Treatments at Middle Tennessee Experiment Station, 1972 . | 30 |
| 9. | Average Soybean Seed Yields at Each Location by Subtreatment . . . . . | 32 |
| 10. | Average Johnsongrass Rhizome Control Rating of Treatments at Pulaski, 1972 . . . . . | 33 |
| A-1. | Climatological Data for Ames Plantation, Grand Junction, June, 1972 . . . . . | 44 |
| A-2. | Climatological Data for Knoxville, June, 1972 . . . . . | 45 |

TABLE PAGE

A-3. Climatological Data for Middle Tennessee Experiment Station, Spring Hill, June, 1972 . . . . . 46

A-4. Climatological Data for Pulaski, June, 1972 . . . . . 47

A-5. Control Ratings for Broadleaf Weeds at Ames Plantation, 1973 . . . . . 48

A-6. Control Ratings for Broadleaf Weeds at Mascot, 1972 . . . . 48

A-7. Control Ratings for Broadleaf Weeds at Middle Tennessee Experiment Station, Spring Hill, 1972 . . . . . 49

A-8. Control Ratings for Broadleaf Weeds at Pulaski, 1972 . . . 49

A-9. Analyses of Variance Tables for Johnsongrass Rhizome Control Ratings of Treatments at Ames Plantation . . . . 50

A-10. Analyses of Variance Tables for Johnsongrass Rhizome Control Ratings of Treatments at Mascot . . . . . 51

A-11. Analyses of Variance Tables for Johnsongrass Rhizome Control Ratings of Treatments at Middle Tennessee Experiment Station . . . . . 52

A-12. Analyses of Variance Tables for Johnsongrass Rhizome Control Ratings of Treatments at Pulaski . . . . . 53

A-13. Analyses of Variance Tables for Johnsongrass Seedling Control Ratings of Treatments at Each Location . . . . . 54

A-14. Analysis of Variance Table for Soybean Seed Yields Due to Treatments at Ames Plantation . . . . . 55

A-15. Analysis of Variance Table for Soybean Seed Yields Due to Treatments at Mascot . . . . . 55

TABLE PAGE

A-16. Analysis of Variance Table for Soybean Seed Yields Due to Treatments at the Middle Tennessee Experiment Station . . . . . 56

A-17. Analysis of Variance Table for Soybean Seed Yields Due to Treatments at Pulaski . . . . . 56

# CHAPTER I

## INTRODUCTION

Johnsongrass (Sorghum halapense (L.) Pers.) is listed internationally as one of ten worst weeds and occurs in all the major agricultural areas of the warm regions of the world (17). This grass was first introduced into the United States as a potential forage crop in the nineteenth century. It probably came from the Mediterranean region (25). It rapidly became a serious weed because it is extremely difficult to eradicate once it is established. Although johnsongrass can be used for hay, it has become the single most important weed in the state of Tennessee. It is found in almost every crop and causes severe economic losses in soybeans, cotton and corn. Johnsongrass ranks second only to cocklebur (Xanthium spp.) in reducing soybean production in Tennessee by competing with soybeans for nutrients, light, space, and water and by interfering with harvesting efficiency (50).

Weed competition is one of the major factors limiting the yield of soybeans in Tennessee. It is estimated that the control of johnsongrass and cocklebur alone would increase the state average soybean yield by nine bu/A (49) and increase the value by $33,750,000 each year.

Johnsongrass is very difficult to control under present systems. It creates a special problem since it emerges early and grows at the same time as cotton and corn, thus competing with them during their most susceptible stages. Soybeans, on the other hand, may be planted later in the

season and still result in normal yields. This has often been the reason why soybeans are produced in conjunction with attempts to control johnsongrass. Kemp (18) found the best combination of johnsongrass control and crop yield was obtained when soybeans were grown during treatment of johnsongrass with various herbicides.

McWhorter and Hartwig (27) reported up to 80 percent soybean yield loss, or in extreme cases, complete crop failure due to johnsongrass competition. Caviness and Taylor (6) found soybean yield reductions up to 60 percent when johnsongrass was allowed to grow unchecked. They also noted that the first seven weeks after planting was the critical period during which competition caused the greatest yield reduction.

The objective of this experiment was to determine the effectiveness of several combinations of herbicides in controlling both rhizomatous and seedling johnsongrass while producing soybeans.

# CHAPTER II

## LITERATURE REVIEW

A study by McWhorter (26) on johnsongrass growth revealed some of the reasons why this grass is extremely difficult to control. He found that a single johnsongrass plant could produce up to 212 feet of rhizomes and one and one-half pounds of seed in a single growing season. Seeds shatter when ripe, remain viable in the soil for several years, and are capable of producing new rhizomes three weeks after emergence. Research indicated that the period at which johnsongrass is most susceptible to any control measure is the interval from when growth is initiated until just prior to flowering. McWhorter suggested that the reason for this is that glucose and sucrose, the two predominant carbohydrates in the rhizomes, are at their lowest levels during this period. Soon after flowering, the level of sucrose in the rhizomes increases markedly and the most rapid rhizome growth occurs. Maximum rhizome growth of 3.3 feet per day was noted in the month of August.

Prolific seed production and the persistence of viable seed in the soil for several years enable johnsongrass to become reestablished quickly and spread even though the rhizome system has nearly been eradicated. Johnsongrass seed are commonly spread by flood water, birds, cattle, unclean seed, and farm machinery (35). Many workers (14,15,33) have reported that adequate rhizome control could be obtained early in the season, but that reinfestation from seedlings after soybean layby still reduces yields.

Virtually since its introduction, measures have been sought for the control of johnsongrass. Mechanical, cultural and chemical methods as well as various combinations of these methods have been extensively tested.

McWhorter and Hartwig (27) stated that disking ten times at four to six day intervals before planting destroyed up to 90 percent of the johnsongrass rhizomes. Cutting the rhizomes into small pieces promotes dehydration, breaks apical dominance, and causes a more rapid depletion of carbohydrate reserves. Burt and Willard (5) found that plowing in the summer or fall, followed by sufficient tillage to keep the regrowth less than 8-10 inches tall, was effective in reducing the stand of johnsongrass from rhizomes. They noted that one full season must be devoted to cultural practices in order for them to be effective. Hauser and Thompson (12) agreed that cultural control methods are effective, but noted that these methods are usually laborious and expensive and often necessitate the removal of cropland from production for up to two years during treatment.

Repeated clippings of johnsongrass foliage throughout the growing season was found by Sturkie (42) to greatly reduce rhizome production. Defoliation at or before the boot stage was reported to be the most effective treatment in reducing rhizomes. Beasley (4) pointed out that clipping or cultivation may serve to stimulate growth of dormant buds under the cut foliage or adjacent to the cut rhizome. He stated that unless the clipping or cultivation was repeated until stored energy sources are exhausted, a more vigorous stand often results.

Herbicides, alone or in combination with cultural practices, have shown good to excellent results in controlling johnsongrass. Most of the early johnsongrass controlling herbicides were too expensive for general use on cropland. Most of them also acted as soil sterilants to some degree. With the introduction of dalapon (2,2-dichloropropionic acid) in 1952, the first low cost, consistent means of controlling johnsongrass in row crops was found. Dalapon has given effective control of johnsongrass rhizomes while still allowing a crop to be produced on the land. Several arsenical herbicides such as MSMA (monosodium metharsonate) and DSMA (disodium metharsonate) have been shown to be effective in controlling johnsongrass rhizomes, however only a few field crops are tolerant to these compounds and arsenic residues in plant tissue may limit their use on even those crops (29). Burt and Willard (5) found that herbicides used alone were only one-half to two-thirds as effective as those applied after plowing.

Prolific seed production and extended seed viability in the soil make total eradication of johnsongrass a long-term affair even after the rhizome system is controlled. Several herbicides are now available which give effective control of johnsongrass seedlings in soybeans.

## Herbicide Review

Dalapon. Dalapon (2,2-dichloropropionic acid) is a systemic grass herbicide which controls many perennial species such as johnsongrass, bermudagrass, and quackgrass. It is a white to tan free-flowing powder,

soluble in water at 57 grams per 100 milliliters at 20 C, highly hygroscopic and corrosive to metals (7).

Crafts (7) reported that some of the effects of dalapon on grass foliage were fusion, buckling, tubular leaf formation, stunting, excessive tillering, and with sufficient dosage, slow lingering death. Severe discoloration of the leaves with browning or bronzing also will occur. Several days may be required for complete death of the plant to occur.

Klingman (21) found that dalapon may be absorbed into the plant by both the foliage and the roots, but stated that foliar absorption is most important under most circumstances. Absorption continues for at least 48 hours although the first six hours are the most critical. Rain within six hours of application washes the chemical from the leaves and results in less effective control. Hauser and Thompson (12) found that once absorbed, dalapon is readily translocated throughout the plant. Leasure (23) stated that in order to take advantage of dalapon's systemic properties, it should not be applied in sufficient concentrations or in phytotoxic mixtures to cause acute foliage burn. Rapid death of the foliage would retard translocation from the foliage into the roots and rhizomes and result in less effective control. Klingman (21) found that two or three light applications at 5 to 20 day intervals usually gave more control than did one heavy application.

The exact mode of action of dalapon is not known although many effects have been noted. Anderson et al. (1) observed that dalapon caused protein degradation and proposed a basis of species selectivity in that susceptible plants lacked the ability to detoxify the protein breakdown

products. Hilton et al. (16) suggested that dalapon might block pantothenic acid metabolism in susceptible plants. They felt that selectivity was accounted for because plants have different requirements for pantothenate.

Kemp (18) found that the best rhizome control treatment in soybeans was an application of dalapon at 7.4 lb/A when the johnsongrass was 12 inches tall, followed by plowing three days later, plus trifluralin (0.75 lb/A) incorporated into the seedbed. Nation (33) also found that dalapon applied to 8 to 10-inch johnsongrass showed remarkable early season control, but noted that reinfestation by seedlings later in the season may reach 50 percent or more of the original infestation. Kerr et al. (19) found that a program consisting of three years of deep chisel plowing in the fall, dalapon treatment the next spring, followed by chisel plowing and incorporation of trifluralin in the spring nearly eradicated johnsongrass while not affecting soybean yields. Several workers (4,5,19,27) have noted that johnsongrass control by dalapon can be enhanced when the rhizome system is weakened by disking one or more times before application.

Hamilton and Tucker (11) found that various johnsongrass strains or ecotypes differ in their response to dalapon. This may account for survival of some plants after treatment, however improper timing and application techniques are the most common cause of unsatisfactory johnsongrass control by dalapon. Beasley (4) pointed out that inadequate translocation of the phytotoxic agent into the rhizome extremities and/or

nonreceptive state of inactive vegetative buds at the time of treatment are major reasons for the inconsistent johnsongrass control by dalapon.

It is currently recommended that dalapon be applied to young actively growing, 8 to 10-inch johnsongrass when the air temperature is above 70 F and the soil moisture is adequate for rapid growth. The treated area should be plowed within three to five days after treatment. Subsequent applications may be required to control regrowth from missed plants (46).

Glyphosate. Glyphosate [N-(phosphonomethyl)glycine] is a member of a new class of herbicides which has an exceptional degree of herbicidal activity. Several formulations of this acid are being tested. Members of this group of herbicides translocate readily and can kill many perennial weeds with vegetative propagules such as rhizomes as well as most annual weeds (31).

Baird et al. (2) reported that a rate of 1.8 lb/A gave 98-100 percent control of johnsongrass rhizomes within 5-7 weeks. They also noted that glyphosate at 1/4 lb/A was more active on narrow-leaf species than 2,4-D and was slightly more active than 2,4-D on broadleaf species. Glyphosate was also found to be more active than paraquat as a contact foliage killer. McWhorter (24) found that glyphosate at 0.75 to 4.0 lb/A gave excellent control of johnsongrass from rhizomes if applied during the period from April through August. He noted that applications of glyphosate at 1.0 to 2.0 lb/A gave consistently better control than either dalapon at 3.0 to 9.0 lb/A, or MSMA at 1.5 to 16.0 lb/A. Glyphosate

also provided much longer control of johnsongrass rhizomes than did either of the other compounds compared.

Topical applications of glyphosate at rates of 0.75 to 4.0 lb/A caused 65-75 percent injury to soybeans, but the soybeans recovered and produced yields of 30-35 bu/A as compared to the untreated soybeans infested with johnsongrass which produced only 8 bu/A (24). Corn and soybean yields were not adversely affected by preplant applications of glyphosate up to 64 lb/A according to Baird et al. (2). Soybean seed produced were tested for germination and growth and were found to give 100 percent germination and normal growth.

Glyphosate should be applied to young, actively growing plants. Perennial weeds must have adequate leaf area to allow maximum absorption and translocation into the plant tissue and underground parts. The treated area should not be cultivated for 2-3 weeks after application to allow full translocation of the chemical within the plant (32). Tillage of the soil within two weeks or less after treatment of perennial weeds may cause less effective control. Tillage about three weeks or more after application may improve weed control.

Alachlor. Alachlor [2-chloro-2,6-diethyl-N-(methoxymethyl)acetanilide] is recommended for use as a preemergence herbicide for control of many annual grasses and certain broadleaf weeds in soybeans, corn, cotton, and peanuts. Alachlor has been shown to control weeds over a wide range of climatic conditions and soil types. Gossett and Nolan (9) found that broadcast preemergence at rates of 1.5 to 3.0 lb/A, alachlor gave good

control of annual grasses and fair control of broadleaves for 5-6 weeks and that soybean tolerance was acceptable.

Knowledge of alachlor's mechanism of action is incomplete but it has been speculated that alachlor inhibits protein synthesis in susceptible plants. It is absorbed mainly by the germinating plant shoots and secondarily by the roots. Alachlor is also absorbed and translocated by tolerant plants but is almost completely metabolized by the plant within ten days (30).

Microbial breakdown causes 40 percent of the alachlor loss from the soil and chemical breakdown causes 60 percent. Losses due to photodecomposition and/or volatilization are low. At recommended rates, alachlor persists in the soil at herbicidal concentrations from six to ten weeks (30).

It is recommended that alachlor (2 to 3 lb/A) be applied to the soil surface prior to weed or crop emergence since it has no postemergence herbicidal qualities (45).

Nitralin. Nitralin [4-(methylsulfonyl)-2,6-dinitro-N,N-dipropylaniline] is a selective, preplant-incorporated herbicide used in soybeans, cotton, and certain vegetables and horticultural crops for the control of many annual grasses and some broadleaf weeds such as pigweed, lambsquarters, and chickweed (39).

Incorporation by either mechanical means or as the result of rainfall or irrigation is necessary for this compound to be effective. Best results are usually obtained when this herbicide is incorporated to a depth of

one to two inches (39). Orr et al. (34) found that a delay of up to nine days after application before incorporation did not reduce weed control. They also noted that greater crop injury often resulted if nitralin was placed at a four inch depth.

McWhorter and Shepherd (28) achieved 83-85 percent control of johnsongrass seedlings with 1.5 lb/A of nitralin applied either in fall or in the spring. When applied at this rate in both spring and fall the control was increased to 90-94 percent. Soybean stands were not reduced below the untreated check and yields were increased over the untreated check. Rogers et al. (38) agreed that nitralin gave good control of seedling johnsongrass and noted that control generally lasted all season. They also found that nitralin gave good control of many other annual grasses and many small-seeded broadleaf species.

Recommended rates vary with soil types: 0.5 lb/A on sandy soils, to 1.5 lb/A on clay soils. Application and incorporation may be either preplant, postplant, or at layby (45).

Trifluralin. Trifluralin (a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine) is recommended for use on soybeans, cotton, and various vegetable and horticultural crops for the control of most annual grasses, including johnsongrass from seed, and many broadleaf species (8).

The mode of action of trifluralin is not fully understood, however there is evidence that it acts as a mitotic poison. It causes a cessation of cell division in meristematic root tissue. No metabolites have been found in the plant tissue (8). Anatomical studies by Kust and Struckmeyer (22) showed that trifluralin caused enlargement of cortical cells and

multinucleate cells in root meristematic regions. Cell plate formation did not occur and there were disorganized mitotic divisions in root cells treated with trifluralin. Greenhouse studies by Standifer and Thomas (40) indicated that johnsongrass seedlings were killed when the first internode passed through treated soil. Shoots from rhizomes were not killed but lateral root development was inhibited on that portion of stem in contact with treated soil. Barrentine and Warren (3) in a comparison of trifluralin and nitralin, found that trifluralin was more toxic to the shoots of emerging seedlings while nitralin was more toxic to roots. Trifluralin prevented seedling emergence in almost all species tested while nitralin did not prevent emergence of any species but killed most soon after emergence.

Pieczarka et al. (37) reported that soil incorporation of trifluralin greatly increased, four to six times in some cases, the herbicidal activity over surface applications. According to Wiese and Smith (50), trifluralin exhibited maximum phytotoxicity when incorporated to a depth of one inch and was most effective when placed just below the soybean seed. Loss of phytotoxicity due to photodecomposition was clearly shown when trifluralin was applied to the soil surface.

Guse and Schwer (10) reported that trifluralin gave excellent control of johnsongrass seedlings at 0.5 lb/A and there was no reduction in soybean yields when 1.5 lb/A was used. Highly significant reductions in soybean yields were noted when trifluralin was applied at 3.0 lb/A. Higher rates are required on high organic matter soils to achieve satisfactory control.

Kleifeld (20) reported that trifluralin inhibited growth of johnsongrass root systems. Therefore, if trifluralin is applied, fewer applications of herbicides for rhizome control such as MSMA are necessary for eventual control than would have been required had trifluralin not been used.

Recommended rates of trifluralin for the control of seedling johnsongrass are from 0.5 to 1.0 lb/A depending upon soil type. Double rates of trifluralin for the control of rhizomatous johnsongrass has been evaluated and is currently recommended as a promising practice. Two consecutive years at the double rate are required for satisfactory control and repeated disking greatly improves rhizome control. Only tolerant crops may be planted the following season to reduce the danger of residue damage (45).

Vernolate. Vernolate (S-propyl dipropylthiocarbamate), is a preplant incorporated herbicide registered for use on soybeans, peanuts and tobacco for the control of most annual grasses, nutsedge, and many broadleaf weeds including pigweed, lambsquarters, sickle-pod and purslane. Vernolate interferes with normal germination and seedling development and will not control established weeds (41).

Vernolate must be mechanically incorporated to a depth of 2-3 inches immediately after application. Vernolate is lost readily from the soil surface by volatilization when the surface is wet at the time of application (41).

Herron and Phillips (13) recommend vernolate at 3 lb/A, incorporated shallowly at the time of planting for the control of johnsongrass seedlings

and note that application of the herbicide to the rows in bands and cultivation of the middles might be more economical. Parochette and Hawes (36) showed that vernolate at 3-5 lb/A controlled 80 percent of weeds in soybeans ten weeks after application. They also noted that vernolate caused transient injury to the soybeans which disappeared after one month. Talbert (43) stated that vernolate had a high degree of selectivity for controlling johnsongrass seedlings in soybeans.

At recommended rates of 2 to 5 lb/A, vernolate does not persist in the soil more than six to eight weeks and should not leave a toxic residue injurious to sensitive crops grown the following season. Vernolate is rapidly metabolized by tolerant plants to $CO_2$ and other naturally occurring plant constituents. Microbial breakdown and volatilization are significant factors in its loss from the soil (41).

# CHAPTER III

## MATERIALS AND METHODS

This experiment was an attempt to control johnsongrass rhizomes and seedlings in a soybean production system. Several herbicides are available which control either rhizomes or seedlings but there is no single product currently available which will effectively control both in row-crops. The objective of this study was to determine the best combination of herbicides for controlling both types of johnsongrass in a soybean field.

Two herbicides for rhizome johnsongrass control in combination with four herbicides for seedling control were evaluated.

### Locations

This experiment was conducted in 1972 at four Tennessee locations, i.e., Ames Plantation near Grand Junction, Middle Tennessee Experiment Station at Spring Hill, and on private farms near Pulaski and Mascot. One location was thus placed in each of the three main geographical divisions of the state, with two being in the Middle Tennessee area.

A well-established rhizome johnsongrass stand was a prerequisite in the choice of each location.

### Experimental Design

The experimental design was a split-block with the main set of treatments consisting of two herbicides for rhizome control and the

secondary set of blocks consisting of four herbicides for seedling control, a weedy check, and a weed-free check.

Three replications were used at Middle Tennessee Experiment Station and four were used at each of the other locations. Plots were 14 feet wide and 30 feet long at both Pulaski and Mascot, 6 rows wide and 40 feet long at Ames Plantation, and 10 feet by 30 feet at the Middle Tennessee Experiment Station. Plot size was governed by the available area of johnsongrass infestation.

Herbicides Used in the Experiment

All herbicides used in this experiment had been used for johnsongrass control in previous experiments. The herbicides and rates used are shown in Table 1.

Herbicide Application

Dalapon and glyphosate were applied to their respective blocks when the johnsongrass was approximately 8 to 12 inches tall and rapidly growing.

The dalapon treated areas were plowed three to four days after application as recommended by the manufacturer. Glyphosate treated blocks were plowed 12 to 14 days after application as recommended by the manufacturer at all locations except the Middle Tennessee Experiment Station where they were plowed after only a four-day waiting period.

Within one to four days after the glyphosate blocks were plowed, a seedbed was prepared and the preplant herbicides were applied and incorporated by a double disking. 'Lee 68' soybeans were planted at all

TABLE 1

HERBICIDES, APPLICATION METHOD, AND RATES USED AT ALL LOCATIONS FOR JOHNSONGRASS CONTROL IN SOYBEANS

| Herbicide | Application Method | Pounds Active Ingredient/A |
|---|---|---|
| For Rhizome Control | | |
| Dalapon | Preplant, foliar | 6 |
| Glyphosate | Preplant, foliar | 2 |
| For Seedling Control | | |
| Alachlor | Preemerge | 3 |
| Nitralin | Preplant incorporated | 1 |
| Trifluralin | Preplant incorporated | 1 |
| Vernolate | Preplant incorporated | 3 |

locations with the exception of Middle Tennessee Experiment Station where 'York' soybeans were used. Alachlor was applied as a preemerge treatment within three days after planting and before soybean or weed emergence. All treatments used for control of seedling johnsongrass will be called preemergence herbicides throughout this thesis regardless of whether they were incorporated or not.

All herbicides were applied as aqueous sprays with a $CO_2$ powered back-pack sprayer with a four-nozzle boom covering approximately a seven-foot width. All herbicides were applied at 20 gallons per acre using 8002 nozzle tips at 30 pounds per square inch pressure. The manufacturer's recommendations were followed in regard to rates and procedures in order to maximize control. Environmental conditions at the time of herbicide application were considered satisfactory at all locations. Rainfall and temperature data for the treatment period are given in Tables A-1, A-2, A-3, and A-4 in the Appendix.

## Cultural Practices

Weather conditions prevented some scheduled cultivations. All plots at Ames Plantation were cultivated twice and the weed-free plots were hand-hoed twice. Only the weed-free plots were cultivated at Middle Tennessee Experiment Station. Heavy and untimely rains made it impossible to cultivate at either Pulaski or Mascot. All plots except the weedy checks were hand-hoed at Mascot at midseason. No plots were cultivated or hoed at Pulaski and the weed-free checks remained essentially the same as the weedy checks.

Data Collection

Visual weed control ratings were made at each location on two different dates. Ratings of rhizome and seedling johnsongrass control as well as control of broadleaf weeds were made. Soybean injury ratings, vigor reduction and stand reduction, were made at the time of the first weed control rating. Weed control ratings were made on a scale of 0 to 100; with 0 being no control and 100 being complete control. Injury ratings were also made on a scale of 0 to 100 with 0 indicating no injury and 100 being complete death caused by the herbicide. The degree of control or injury in each plot was based on comparison with the nearest untreated check plot. Notes were also taken on items such as animal damage, row skips due to planter malfunction, and varied weed populations.

It became difficult to distinguish between first year seedlings and established rhizome johnsongrass plants as the season progressed. Such things as the angle of shoot emergence and size and vigor of shoots were used to help distinguish seedlings from rhizomes. Many plants were also pulled from the ground for closer examination.

Broadleaf weed infestations varied greatly from location to location and no analysis was performed on these data. Control ratings for each location are shown in Tables A-5, A-6, A-7, and A-8 in the Appendix.

# CHAPTER IV

## RESULTS AND DISCUSSION

The results of this experiment will be discussed by specific location and by observations of the overall experiment.

### Ames Plantation

All herbicide treatments gave good to excellent control of johnsongrass at Ames Plantation (Table 2). Dalapon and glyphosate, used as foliar applied preplant treatments, each controlled 91 percent of the rhizomatous johnsongrass at the first rating. The final rating indicated 96 to 97 percent control by dalapon and glyphosate, respectively. Increased control can be attributed to cultivation between ratings. No significant difference in rhizome control was found between dalapon and glyphosate. There was a significant difference in rhizome control due to the preemergence treatments. Both dalapon and glyphosate gave significantly better control when followed by trifluralin applied as a preplant incorporated treatment (Tables 2 and A-9 in the Appendix).

The preemergence herbicides gave good to excellent control of seedling johnsongrass, although no significant differences existed between herbicide treatments (Tables 3 and A-13 in the Appendix).

No significant differences in either rhizome or seedling control were found due to the interaction of foliar applied herbicides and preemergence treatments (Tables A-9 and A-13 in the Appendix).

TABLE 2

AVERAGE JOHNSONGRASS RHIZOME CONTROL RATINGS OF TREATMENTS AT AMES PLANTATION, 1972

| Treatment | | Pounds Active Ingredient/A | | Ratings* | |
|---|---|---|---|---|---|
| Foliar | Preemergence | Foliar | Preemergence | 7-25-72 | 9-23-72 |
| Dalapon | Alachlor | 6.0 | 3.0 | 85 c | 97 abc |
| Dalapon | Nitralin | 6.0 | 1.0 | 91 abc | 96 abc |
| Dalapon | Trifluralin | 6.0 | 1.0 | 96 ab | 98 ab |
| Dalapon | Vernolate | 6.0 | 3.0 | 91 abc | 93 c |
| Glyphosate | Alachlor | 2.0 | 3.0 | 86 bc | 96 abc |
| Glyphosate | Nitralin | 2.0 | 1.0 | 89 abc | 97 abc |
| Glyphosate | Trifluralin | 2.0 | 1.0 | 97 a | 98 ab |
| Glyphosate | Vernolate | 2.0 | 3.0 | 90 abc | 95 bc |
| Weedy check | | --- | --- | 0 d | 0 d |
| Weed-free check | | --- | --- | 0** | 99 a |

* A rating of 0 indicates no weed control; a rating of 100 indicates complete weed control. Values in individual columns followed by the same letter are not significantly different at the .05 level of probability.

**Ratings were made before cultivation.

TABLE 3

RATINGS OF AVERAGE JOHNSONGRASS SEEDLING CONTROL BY TREATMENTS OVER ALL LOCATIONS

| Treatment | Ames | Pulaski | Mascot | Middle Tennessee |
|---|---|---|---|---|
| Dalapon - Alachlor | 77* | 92* | 96* | 97** |
| Dalapon - Nitralin | 87 | 88 | 95 | 92 |
| Dalapon - Trifluralin | 95 | 90 | 98 | 94 |
| Dalapon - Vernolate | 78 | 88 | 92 | 94 |
| Glyphosate - Alachlor | 95 | 95 | 98 | 98 |
| Glyphosate - Nitralin | 75 | 90 | 95 | 86 |
| Glyphosate - Trifluralin | 90 | 95 | 98 | 98 |
| Glyphosate - Vernolate | 70 | 88 | 94 | 96 |
| Weed-free check | 0*** | 0*** | 0*** | 0*** |
| Weedy check | 0 | 0 | 0 | 0 |

* Average of four replications. No values were significantly different at the .05 level of probability.

** Average of three replications. No values were significantly different at the .05 level of probability.

***Ratings were made before cultivation.

Foliar applied treatments had no significant effect on soybean injury while nearly all preemergence herbicides caused some soybean injury. Alachlor caused little or no injury and was rated as 0. Vernolate caused the most severe injury symptoms with an average vigor reduction of over 20 percent (Table 4). Nitralin and trifluralin both caused slight soybean injury. Only vernolate caused any significant soybean stand reduction; up to 20 percent on certain plots. The interaction of foliar and preemergence herbicides did not cause any significant differences in soybean injury. Injury ratings for treatments over all locations are shown in Table 4.

There was no significant difference in soybean seed yield due to preplant treatments, preemergence treatments, or the interaction of preplant and preemergence herbicides. Yields on both the dalapon and glyphosate treated plots averaged 35.0 bu/A. Yields ranged from 32.4 bu/A for the vernolate treated plots to 36.7 bu/A for alachlor. Plots with the highest yield average were the weed-free checks which gave 38.3 as compared to 29.0 bu/A for the weedy checks.

Mascot

At the Mascot location all herbicide treatments gave good to excellent control of johnsongrass. Dalapon and glyphosate were not significantly different in their control of rhizomatous johnsongrass with 98 and 99 percent control at the first rating. Rhizome control had decreased to 91 and 95 percent for dalapon and glyphosate, respectively, at the final rating. Though there was no significant difference

TABLE 4

RATINGS OF AVERAGE SOYBEAN INJURY DUE TO TREATMENTS AT EACH LOCATION

| Treatment | | Vigor Reduction* | | | | Stand Reduction* | | | |
|---|---|---|---|---|---|---|---|---|---|
| Foliar | Preemergence | Ames | Mascot | MTES | Pulaski | Ames | Mascot | MTES | Pulaski |
| Dalapon | Alachlor | 0** | 15 | 10 | 5 | 0 | 9 | 0 | 6 |
| Dalapon | Nitralin | 9 | 8 | 5 | 13 | 4 | 3 | 0 | 4 |
| Dalapon | Trifluralin | 6 | 10 | 3 | 13 | 0 | 6 | 1 | 11 |
| Dalapon | Vernolate | 23 | 14 | 3 | 31 | 8 | 8 | 0 | 34 |
| Glyphosate | Alachlor | 0 | 9 | 0 | 9 | 0 | 7 | 0 | 5 |
| Glyphosate | Nitralin | 3 | 8 | 8 | 10 | 0 | 3 | 0 | 3 |
| Glyphosate | Trifluralin | 13 | 28 | 0 | 9 | 3 | 18 | 0 | 5 |
| Glyphosate | Vernolate | 26 | 8 | 5 | 30 | 10 | 4 | 0 | 30 |

* All ratings given in terms of percent injury. A rating of 0 indicates no soybean injury; a rating of 100 indicates death or absence of soybean plants.

**Average of all plots receiving each particular treatment.

in control of rhizomatous johnsongrass between foliar treatments (Table A-10, Appendix), there was a consistent trend for glyphosate to rate slightly higher in rhizome control than dalapon (Table 5). Rhizome control was not significantly different regardless of which preemergence herbicide either dalapon or glyphosate were combined with.

No significant difference in seedling johnsongrass control due to the preemergence treatments was found. All treatments controlled over 90 percent of the seedling johnsongrass at this location (Table 3, page 22). The interaction of preplant and preemergence herbicides had no significant effect on either rhizomatous or seedling johnsongrass control.

All herbicide treatments caused some degree of injury to the soybeans (Table 4). Injury symptoms were erratic and varied greatly from replication to replication. In general the trifluralin and vernolate treatments were the most injurious to soybeans at this location. Most evidence of stunting had disappeared by the end of the season and it was estimated that soybean yields were not reduced due to herbicide injury.

Soybean seed yields were significantly different from the dalapon and glyphosate treated plots (Tables 6 and A-15 in the Appendix). The glyphosate treated plots averaged nearly three bushels more per acre than did the dalapon plots. All herbicide treated plots, as well as the weed-free check plots, yielded significantly higher than did the weedy checks (Table 7).

Due to limited space at the Mascot location, replication 1 was placed on an eroded slope of low soybean production potential. Soybeans grown

TABLE 5

AVERAGE JOHNSONGRASS RHIZOME CONTROL RATINGS
OF TREATMENTS AT MASCOT, 1972

| Treatment | | Pounds Active Ingredient/A | | Ratings* | |
|---|---|---|---|---|---|
| Foliar | Preemergence | Foliar | Preemergence | 7-25-72 | 9-23-72 |
| Dalapon | Alachlor | 6.0 | 3.0 | 98 | 88 |
| Dalapon | Nitralin | 6.0 | 1.0 | 99 | 90 |
| Dalapon | Trifluralin | 6.0 | 1.0 | 99 | 98 |
| Dalapon | Vernolate | 6.0 | 3.0 | 97 | 85 |
| Glyphosate | Alachlor | 2.0 | 3.0 | 98 | 98 |
| Glyphosate | Nitralin | 2.0 | 1.0 | 99 | 94 |
| Glyphosate | Trifluralin | 2.0 | 1.0 | 100 | 99 |
| Glyphosate | Vernolate | 2.0 | 3.0 | 98 | 90 |
| Weedy check | | --- | --- | 0 | 0 |
| Weed-free check | | --- | --- | 0** | 99 |

* A rating of 0 indicates no weed control; a rating of 100 indicates complete weed control. No values were significant at the .05 level of probability.

**Ratings were made before cultivation.

TABLE 6

AVERAGE* SOYBEAN SEED YIELDS AT EACH LOCATION BY MAIN TREATMENT

| Treatment | Ames Plantation | Middle Tennessee Experiment Station | Pulaski | Mascot |
|---|---|---|---|---|
| | | bu/A | | |
| Dalapon | 34.6 a** | 18.3 a | 10.2 a | 17.5 a |
| Glyphosate | 35.0 a | 13.1 b | 8.8 b | 20.5 b |

* Average of all plots receiving each particular treatment.

**Values in individual columns followed by the same letter are not significantly different at the .05 level of probability.

TABLE 7

AVERAGE SOYBEAN SEED YIELDS AT EACH LOCATION BY COMBINATION

| Treatment | Ames Plantation | Middle Tennessee Experiment Station | Pulaski | Mascot |
|---|---|---|---|---|
| | | bu/A | | |
| Dalapon + | | | | |
| Alachlor | 38.0 a* | 15.6 bcd | 17.3 a | 18.3 c |
| Nitralin | 34.2 a | 9.0 cde | 11.4 abcd | 20.3 bc |
| Trifluralin | 36.9 a | 17.8 bc | 11.1 bcd | 19.4 bc |
| Vernolate | 33.3 a | 22.0 b | 8.2 cde | 18.2 c |
| Weedy Check | 29.0 a | 10.2 cde | 4.6 e | 8.7 d |
| Weed-free Check | 38.0 a | 35.0 a | 8.9 cd | 20.1 bc |
| Glyphosate + | | | | |
| Alachlor | 35.5 a | 10.4 cde | 16.2 ab | 23.4 ab |
| Nitralin | 37.6 a | 4.9 e | 8.2 cde | 20.4 bc |
| Trifluralin | 35.7 a | 11.0 cde | 13.0 abc | 23.5 ab |
| Vernolate | 31.5 a | 10.9 cde | 7.5 cde | 21.0 bc |
| Weedy Check | 29.0 a | 5.9 de | 5.6 de | 9.0 d |
| Weed-free Check | 38.0 a | 35.2 a | 2.2 e | 25.4 a |

*Values in individual columns followed by the same letter are not significantly different at the .05 level of probability.

in the entire first replication were stunted and skippy. Animal damage, caused mostly by rabbits, was most severe on soybeans which were stunted since they stayed small and tender longer. Herbicide injury was also greater in all treatments in the first replication, probably due to the fact that the soybeans were slow to emerge and weakened.

Middle Tennessee Experiment Station

All treatments used at the Middle Tennessee Experiment Station gave fair to good control of johnsongrass. There was a significant difference in the control given by dalapon and glyphosate. Dalapon was much more effective than glyphosate, especially at the final rating (Tables 8 and A-11, Appendix). This difference was probably because the glyphosate treated plots were plowed under at the same time as the dalapon treated plots, or about ten days earlier than recommended. The herbicide may not have had time to have been fully translocated to the rhizomes, therefore, its effectiveness was greatly reduced.

There were no significant differences in johnsongrass seedling control among any of the herbicide treatments. All treatments gave very good to excellent seedling control (Table 3, page 22).

No significant differences were found in johnsongrass seedling control due to the interaction of preplant and preemergence herbicides. Rhizome control was significantly affected by the interaction of treatments. Vernolate, combined with either dalapon or glyphosate, gave excellent control, especially at the final rating.

Preplant treatments had no significant effect on soybean injury. All preemergence herbicide treatments caused some soybean injury; ranging

TABLE 8

AVERAGE JOHNSONGRASS RHIZOME CONTROL RATINGS OF TREATMENTS AT MIDDLE TENNESSEE EXPERIMENT STATION, 1972

| Treatment | | Pounds Active Ingredient/A | | Ratings* | |
|---|---|---|---|---|---|
| Foliar | Preemergence | Foliar | Preemergence | 7-26-72 | 8-22-72 |
| Dalapon | Alachlor | 6.0 | 3.0 | 88 a | 91 abcde |
| Dalapon | Nitralin | 6.0 | 1.0 | 85 a | 88 bcdef |
| Dalapon | Trifluralin | 6.0 | 1.0 | 92 a | 85 defg |
| Dalapon | Vernolate | 6.0 | 3.0 | 92 a | 94 ab |
| Glyphosate | Alachlor | 2.0 | 3.0 | 88 a | 98 abc |
| Glyphosate | Nitralin | 2.0 | 1.0 | 83 a | 77 h |
| Glyphosate | Trifluralin | 2.0 | 1.0 | 87 a | 78 gh |
| Glyphosate | Vernolate | 2.0 | 3.0 | 92 a | 92 abcd |
| Weedy Check | | --- | --- | 0 b | 0 i |
| Weed-free Check | | --- | --- | 0** | 98 a |

* A rating of 0 indicates no weed control; a rating of 100 indicates complete weed control. Values in individual columns followed by the same letter are not significantly different at the .05 level of probability.

**Ratings were made before cultivation.

from slight with alachlor to moderate with nitralin. No herbicide treatment reduced soybean stand significantly at this location.

Significant differences in soybean seed yields were found due to replication, preplant treatments, and preemergence treatments. Differences due to replications were probably caused by the erratic population of broadleaf weeds. Several species, notably morningglory (Ipomea spp.) and nutsedge (Cyperus esculentus), were not controlled in certain plots and undoubtedly reduced yields. The early plowdown of the glyphosate treatment was the probable cause of the difference between preplant treatments. Dalapon was clearly more effective than glyphosate under these circumstances. Vernolate, with an average yield of 16.7 bu/A was not significantly higher than nitralin with an average of 7.0 bu/A. The weed-free check averaged 35.1 bu/A as compared to 8.1 bu/A for the weedy check and was significantly higher than all other treatments (Table 9).

Pulaski

Johnsongrass rhizome control at Pulaski was excellent with both dalapon and glyphosate. Control by both compounds averaged greater than 90 percent (Tables 10 and A-12, Appendix). There was no significant difference in rhizome control due to preplant treatments, preemergence treatments, or the interaction.

Seedling control ranged from very good to excellent, with no significant differences found between herbicide treatments (Table 2, page 21). Neither preplant treatments, preemergence treatments, nor their interaction caused any significant differences in seedling control.

TABLE 9

AVERAGE SOYBEAN SEED YIELDS AT EACH LOCATION BY SUBTREATMENT

| Treatment | Ames Plantation | Middle Tennessee Experiment Station | Pulaski | Mascot |
|---|---|---|---|---|
| | ----------bu/A---------- | | | |
| Alachlor | 36.8 a* | 13.1 b | 16.8 a | 20.9 a |
| Nitralin | 35.9 a | 7.0 b | 9.7 bc | 20.7 a |
| Trifluralin | 36.3 a | 14.5 b | 12.0 ab | 21.4 a |
| Vernolate | 32.4 a | 16.7 b | 7.8 c | 19.6 a |
| Weedy Check | 29.0 a | 8.1 b | 5.1 c | 8.9 b |
| Weed-free Check | 38.3 a | 35.1 a | 5.6 c | 22.8 a |

*Values in individual columns followed by the same letter are not significantly different at the .05 level of probability.

TABLE 10

AVERAGE JOHNSONGRASS RHIZOME CONTROL RATING OF TREATMENTS AT PULASKI, 1972

| Treatment | | Pounds Active Ingredient/A | | Ratings* | |
|---|---|---|---|---|---|
| Foliar | Preemergence | Foliar | Preemergence | 7-26-72 | 8-23-72 |
| Dalapon | Alachlor | 6.0 | 3.0 | 92 | 97 |
| Dalapon | Nitralin | 6.0 | 1.0 | 93 | 95 |
| Dalapon | Trifluralin | 6.0 | 1.0 | 93 | 98 |
| Dalapon | Vernolate | 6.0 | 3.0 | 94 | 94 |
| Glyphosate | Alachlor | 2.0 | 3.0 | 92 | 98 |
| Glyphosate | Nitralin | 2.0 | 1.0 | 92 | 97 |
| Glyphosate | Trifluralin | 2.0 | 1.0 | 96 | 97 |
| Glyphosate | Vernolate | 2.0 | 3.0 | 90 | 95 |
| Weedy Check | | --- | --- | 0 | 0 |
| Weed-free Check | | --- | --- | 0** | 0** |

* A rating of 0 indicates no weed control; a rating of 100 indicates complete weed control. No values were significant at the .05 level of probability.

**Weather did not permit cultivation of the weed-free checks.

Soybean injury ratings were generally more severe at Pulaski than at any other location (Table 4, page 24). Alachlor was the least injurious with an average vigor reduction of about 7 percent. Vernolate caused soybean vigor reductions of over 30 percent but this condition was only temporary and little permanent damage was done. Vernolate also caused severe stand reduction on some plots. Other treatments caused slight stand reductions.

Soybean seed yields were significantly different due to replication, preplant treatments, and preemergence treatments. Differences due to replication were caused by the differences in harvesting dates. Three weeks of exposure to heavy rains and flooding between the harvest of the first replication and the last two caused a great drop in yield. Glyphosate treated plots averaged almost 2 bu/A more than the dalapon treated plots. Differences due to preemergence treatments probably reflected the excellent broadleaf control given by alachlor. A heavy infestation of pigweed caused lowered yields from the other treatments. Since the weed-free plots at this location were not cultivated due to bad weather, there was no significant difference between the weed-free and weedy checks with 5.5 and 5.1 bu/A respectively. Yields from all plots were reduced due to late harvest and wet field conditions.

# CHAPTER V

## SUMMARY AND CONCLUSIONS

An attempt was made to determine an effective combination of herbicides for controlling johnsongrass while growing soybeans. The experiment was conducted at four locations in Tennessee in 1972. Observations were made on johnsongrass rhizome and seedling control, soybean injury and seed yield, and broadleaf weed control.

At Ames Plantation all herbicide treatments gave good to excellent control of both rhizome and seedling johnsongrass. There was no significant difference in rhizome control due to main treatments. Trifluralin caused a significant increase in rhizome control when combined with either dalapon or glyphosate. The alachlor combinations were rated next in effectiveness with nitralin and vernolate being least effective but still giving good control.

All herbicide treatments caused some soybean injury symptoms. Vernolate and trifluralin were rated as most injurious to soybeans but neither caused severe, long-lasting damage. Soybean yields were not significantly different from any of the treatments.

Broadleaf weed control was good to excellent though there was much variation in species and population from plot to plot. Each herbicide was more effective in controlling certain species than others.

At the Mascot location there was no significant difference in the rhizome control achieved by any of the herbicide treatments. Either dalapon or glyphosate gave excellent control of rhizomatous johnsongrass

regardless with which preemergence herbicide they were combined. No significant differences were found in the degree of seedling control given by any of the herbicide treatments. All herbicide treatments gave excellent control of johnsongrass seedlings at Mascot.

Soybean injury symptoms varied from slight with alachlor to moderate with vernolate and trifluralin. Very little permanent damage was noted from any treatment. Soybean seed yields were found to be significantly different due to replication, preplant treatments, and preemergence treatments. Differences due to replication at Mascot were caused by the fact that replication 1 was placed on an eroded slope because of space limitations. Yields were definitely lower on this replication. Yields were significantly higher on the glyphosate treated plots than on the dalapon treated plots. Alachlor and trifluralin treated plots yielded significantly higher than did nitralin or vernolate treated plots.

All treatments gave good to excellent control of the various broadleaf weeds present though ratings varied with each particular herbicide from species to species.

At the Middle Tennessee Experiment Station a significant difference was found in the degree of rhizome control given by dalapon and glyphosate. Dalapon gave greater control than did glyphosate but it must be pointed out that the glyphosate treated area was mistakenly plowed several days before it was scheduled. This undoubtedly reduced its effectiveness. Control varied from poor to excellent. Johnsongrass seedling control was excellent from all treatments and no significant differences among treatments were found.

Soybean seed yields were highly significantly different due to preplant and preemergence treatments. Differences due to preplant treatments can be explained by the mishandling of the glyphosate treatment. The split-block treatment differences are due primarily to the difference between the weed-free check and the other treatments. Severe broadleaf weed infestations lowered the yields from the uncultivated plots.

Both dalapon and glyphosate gave excellent control of rhizome johnsongrass at the Pulaski location. No significant difference was found due to treatments. Seedling control was good to excellent with no significant differences due to treatments.

Soybean seed yields were significantly affected by replications, preplant treatments, and highly significantly affected by the preemergence treatments. Differences due to replication are due to the differences in harvest dates since the last two replications harvested were exposed to heavy rains and flood waters and were severely damaged at harvest. Glyphosate treated plots were significantly higher than were the dalapon treated plots. Of the preemergence treatments, alachlor resulted in the highest soybean yield due largely to the excellent control of the severe pigweed competition.

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## LITERATURE CITED


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CRANE'S CREST

# APPENDIX

APPENDIX

TABLE A-1

CLIMATOLOGICAL DATA FOR AMES PLANTATION, GRAND JUNCTION, JUNE, 1972

| Date | Temperature F | | Rainfall |
|---|---|---|---|
| | Maximum | Minimum | |
| 1 | 73 | 47 | |
| 2 | 77 | 49 | |
| 3 | 84 | 57 | |
| 4 | 88 | 59 | |
| 5 | 90 | 63 | |
| 6 | 92 | 64 | |
| 7 | 94 | 68 | |
| 8 | 90 | 61 | |
| 9 | 90 | 64 | |
| 10 | 94 | 68 | .01 |
| 11 | 80 | 49 | .06 |
| 12 | 82 | 54 | |
| 13 | 84 | 66 | |
| 14 | 90 | 72 | |
| 15 | 89 | 70 | .61 |
| 16 | 85 | 64 | .23 |
| 17 | 85 | 62 | |
| 18 | 85 | 64 | |
| 19 | 91 | 65 | |
| 20 | 88 | 65 | |
| 21 | 93 | 66 | |
| 22 | 83 | 56 | |
| 23 | 80 | 49 | |
| 24 | 83 | 52 | |
| 25 | 88 | 53 | .72 |
| 26 | 82 | 66 | .25 |
| 27 | 89 | 68 | .10 |
| 28 | 91 | 68 | .85 |
| 29 | 88 | 66 | |
| 30 | 89 | 67 | |

TABLE A-2

CLIMATOLOGICAL DATA FOR KNOXVILLE, JUNE, 1972

| Date | Temperature F | | Rainfall |
|---|---|---|---|
| | Maximum | Minimum | |
| 1 | 69 | 45 | |
| 2 | 73 | 48 | |
| 3 | 80 | 54 | |
| 4 | 86 | 59 | |
| 5 | 85 | 64 | |
| 6 | 92 | 66 | |
| 7 | 87 | 63 | .54 |
| 8 | 83 | 58 | |
| 9 | 86 | 68 | |
| 10 | 81 | 64 | .26 |
| 11 | 76 | 49 | |
| 12 | 76 | 51 | |
| 13 | 82 | 68 | |
| 14 | 86 | 63 | |
| 15 | 89 | 67 | |
| 16 | 90 | 69 | .20 |
| 17 | 82 | 69 | .19 |
| 18 | 81 | 65 | |
| 19 | 86 | 67 | .07 |
| 20 | 82 | 65 | .45 |
| 21 | 80 | 68 | |
| 22 | 80 | 60 | |
| 23 | 73 | 55 | |
| 24 | 77 | 57 | |
| 25 | 84 | 57 | |
| 26 | 85 | 64 | |
| 27 | 85 | 63 | |
| 28 | 87 | 64 | 2.35 |
| 29 | 74 | 64 | 1.14 |
| 30 | 84 | 61 | .14 |

TABLE A-3

CLIMATOLOGICAL DATA FOR MIDDLE TENNESSEE EXPERIMENT STATION, SPRING HILL, JUNE, 1972

| Date | Temperature F | | Rainfall |
|---|---|---|---|
| | Maximum | Minimum | |
| 1 | 68 | 42 | |
| 2 | 75 | 45 | |
| 3 | 81 | 53 | |
| 4 | 86 | 56 | |
| 5 | 90 | 62 | |
| 6 | 91 | 66 | |
| 7 | 93 | 66 | |
| 8 | 87 | 53 | |
| 9 | 88 | 61 | |
| 10 | 93 | 64 | 1.25 |
| 11 | 78 | 50 | |
| 12 | 81 | 58 | |
| 13 | 81 | 65 | |
| 14 | 86 | 66 | |
| 15 | 88 | 70 | .03 |
| 16 | 84 | 65 | .02 |
| 17 | 82 | 67 | |
| 18 | 78 | 68 | |
| 19 | 88 | 62 | |
| 20 | 86 | 66 | |
| 21 | 84 | 62 | |
| 22 | 78 | 54 | |
| 23 | 77 | 52 | |
| 24 | 80 | 49 | |
| 25 | 86 | 57 | |
| 26 | 89 | 62 | |
| 27 | 86 | 63 | .34 |
| 28 | 90 | 67 | .45 |
| 29 | 85 | 65 | |
| 30 | 86 | 59 | |

TABLE A-4

CLIMATOLOGICAL DATA FOR PULASKI, JUNE, 1972

| Date | Temperature F | | Rainfall |
|---|---|---|---|
| | Maximum | Minimum | |
| 1 | 75 | 41 | |
| 2 | 81 | 45 | |
| 3 | 87 | 51 | |
| 4 | 92 | 54 | |
| 5 | 92 | 60 | |
| 6 | 92 | 63 | |
| 7 | 93 | 66 | T |
| 8 | 88 | 57 | |
| 9 | 93 | 59 | |
| 10 | 90 | 64 | .62 |
| 11 | 83 | 49 | |
| 12 | 83 | 62 | |
| 13 | 87 | 66 | |
| 14 | 87 | 71 | |
| 15 | 90 | 71 | |
| 16 | 84 | 67 | .60 |
| 17 | 80 | 68 | .14 |
| 18 | 90 | 67 | .07 |
| 19 | 88 | 63 | |
| 20 | 85 | 69 | |
| 21 | 84 | 66 | |
| 22 | 81 | 56 | |
| 23 | 81 | 51 | |
| 24 | 90 | 50 | |
| 25 | 88 | 61 | |
| 26 | 86 | 67 | .08 |
| 27 | 86 | 64 | .02 |
| 28 | 86 | 66 | .06 |
| 29 | 86 | 63 | .29 |
| 30 | 88 | 63 | |

TABLE A-5

CONTROL RATINGS FOR BROADLEAF WEEDS AT AMES PLANTATION, 1972*

| Species | Alachlor | Nitralin | Trifluralin | Vernolate |
|---|---|---|---|---|
| Morningglory | 41 | 93 | 99 | 14 |
| Prickly Sida | 96 | 65 | 83 | 97 |
| Spurge | 94 | 38 | 84 | 90 |
| Carpetweed | 99 | 97 | 98 | 31 |

*Rated on 7-25-72.

TABLE A-6

CONTROL RATINGS FOR BROADLEAF WEEDS AT MASCOT, 1972

| Species | Alachlor | | Nitralin | | Trifluralin | | Vernolate | |
|---|---|---|---|---|---|---|---|---|
| | 7-27 | 8-18 | 7-27 | 8-18 | 7-27 | 8-18 | 7-27 | 8-18 |
| Pigweed | 98 | 92 | 97 | 76 | 100 | 97 | 87 | 72 |
| Jimsonweed | 93 | 89 | 74 | 92 | 72 | 85 | 76 | 91 |
| Spurge | 99 | 100 | 98 | 92 | 98 | 94 | 99 | 89 |
| Morningglory | 99 | 100 | 96 | 99 | 100 | 98 | 99 | 95 |
| Prickly Sida | 98 | 99 | 99 | 100 | 100 | 97 | 100 | 98 |

TABLE A-7

CONTROL RATINGS FOR BROADLEAF WEEDS AT MIDDLE TENNESSEE EXPERIMENT STATION, SPRING HILL, 1972

| Species | Alachlor | | Nitralin | | Trifluralin | | Vernolate | |
|---|---|---|---|---|---|---|---|---|
| | 7-26 | 8-22 | 7-26 | 8-22 | 7-26 | 8-22 | 7-26 | 8-22 |
| Prickly Sida | 98 | 75 | 87 | 70 | 95 | 95 | 94 | 93 |
| Morningglory | 3 | 88 | 76 | 80 | 70 | 85 | 53 | 83 |
| Y. Nutsedge | 98 | 93 | 93 | 73 | 85 | 73 | 88 | 73 |
| Purslane | 97 | --- | 70 | --- | 67 | --- | 66 | --- |
| Common Ragweed | 78 | 86 | 82 | 83 | 48 | 75 | 62 | 65 |

TABLE A-8

CONTROL RATINGS FOR BROADLEAF WEEDS AT PULASKI, 1972

| Species | Alachlor | | Nitralin | | Trifluralin | | Vernolate | |
|---|---|---|---|---|---|---|---|---|
| | 7-26 | 8-23 | 7-26 | 8-23 | 7-26 | 8-23 | 7-26 | 8-23 |
| Morningglory | 55 | 97 | 86 | 95 | 68 | 96 | 37 | 83 |
| Carpetweed | 100 | --- | 93 | --- | 90 | --- | 96 | --- |
| Spurge | 100 | --- | 96 | --- | 98 | --- | 100 | --- |
| Pigweed | 100 | 100 | 62 | 54 | 86 | 66 | 79 | 63 |
| Prickly Sida | 98 | 97 | 97 | 99 | 86 | 99 | 100 | 86 |
| Copperleaf | 96 | 98 | 81 | 86 | 81 | 81 | 100 | 100 |
| Other Grasses | 100 | --- | 96 | --- | 99 | --- | 97 | --- |

TABLE A-9

ANALYSES OF VARIANCE TABLES FOR JOHNSONGRASS RHIZOME CONTROL RATINGS OF TREATMENTS AT AMES PLANTATION

| Source of Variation | Degrees of Freedom | Mean Squares | F Value |
|---|---|---|---|
| | 7-25-72 | | |
| Replications | 3 | 55.61 | .61 |
| Main Treatments (MT) | 1 | .03 | .0003 |
| Error (a) | 3 | 90.11 | |
| Split-block Treatments (SB) | 3 | 190.11 | 13.34* |
| Error (b) | 9 | 14.25 | |
| MT X SB | 3 | 3.61 | .12 |
| Error (c) | 9 | 28.47 | |
| Total | 31 | | |
| | 8-23-72 | | |
| Replications | 3 | .11 | .04 |
| Main Treatments (MT) | 1 | 3.78 | 1.49 |
| Error (a) | 3 | 2.53 | |
| Split-block Treatments (SB) | 3 | 25.44 | 7.20* |
| Error (b) | 9 | 3.53 | |
| MT X SB | 3 | 4.03 | .62 |
| Error (c) | 9 | 6.44 | |
| Total | 31 | | |

*Significant at the .05 level of probability.

TABLE A-10

ANALYSES OF VARIANCE TABLES FOR JOHNSONGRASS RHIZOME CONTROL RATINGS OF TREATMENTS AT MASCOT

| Source of Variation | Degrees of Freedom | Mean Squares | F Value* |
|---|---|---|---|
| | 7-27-72 | | |
| Replications | 3 | 11.78 | 5.35 |
| Main Treatments (MT) | 1 | 5.28 | 2.40 |
| Error (a) | 3 | 2.20 | |
| Split-block Treatments (SB) | 3 | 6.03 | .81 |
| Error (b) | 9 | 7.39 | |
| MT X SB | 3 | .61 | .43 |
| Error (c) | 9 | 1.41 | |
| Total | 31 | | |
| | 8-18-72 | | |
| Replications | 3 | 47.03 | 1.89 |
| Main Treatments (MT) | 1 | 132.03 | 5.32 |
| Error (a) | 3 | 24.78 | |
| Split-block Treatments (SB) | 3 | 171.86 | 2.74 |
| Error (b) | 9 | 62.72 | |
| MT X SB | 3 | 14.95 | .80 |
| Error (c) | 9 | 18.47 | |
| Total | 31 | | |

*No values were significant at the .05 level of probability.

TABLE A-11

ANALYSES OF VARIANCE TABLES FOR JOHNSONGRASS RHIZOME CONTROL RATINGS OF TREATMENTS AT MIDDLE TENNESSEE EXPERIMENT STATION

| Source of Variation | Degrees of Freedom | Mean Squares | F Value |
|---|---|---|---|
| | Early | | |
| Replications | 2 | 7.39 | .16 |
| Main Treatments (MT) | 1 | 16.67 | .37 |
| Error (a) | 2 | 44.79 | |
| Split-block Treatments (SB) | 3 | 58.33 | .83 |
| Error (b) | 6 | 69.79 | |
| MT X SB | 3 | 8.33 | .53 |
| Error (c) | 6 | 15.62 | |
| Total | 23 | | |
| | Late | | |
| Replications | 2 | 204.54 | 7.23 |
| Main Treatments (MT) | 1 | 560.67 | 19.81* |
| Error (a) | 2 | 28.29 | |
| Split-block Treatments (SB) | 3 | 362.11 | 1.00 |
| Error (b) | 6 | 359.15 | |
| MT X SB | 3 | 297.44 | 4.91* |
| Error (c) | 6 | 60.57 | |
| Total | 23 | | |

*Significant at the .05 level of probability.

TABLE A-12

ANALYSES OF VARIANCE TABLES FOR JOHNSONGRASS RHIZOME CONTROL RATINGS OF TREATMENTS AT PULASKI

| Source of Variation | Degrees of Freedom | Mean Squares | F Value |
|---|---|---|---|
| | 7-26-72 | | |
| Replications | 3 | 36.04 | 1.49 |
| Main Treatments (MT) | 1 | 0.00 | 0.00 |
| Error (a) | 3 | 24.08 | |
| Split-block Treatments (SB) | 3 | 9.87 | .68 |
| Error (b) | 9 | 14.34 | |
| MT X SB | 3 | 18.75 | .89 |
| Error (c) | 9 | 20.94 | |
| Total | 31 | | |
| | 8-23-72 | | |
| Replications | 3 | 24.75 | 9.59* |
| Main Treatments (MT) | 1 | 18.00 | 6.97 |
| Error (a) | 3 | 2.58 | |
| Split-block Treatments (SB) | 3 | 10.25 | .39 |
| Error (b) | 9 | 26.05 | |
| MT X SB | 3 | 3.75 | .75 |
| Error (c) | 9 | 5.00 | |
| Total | 31 | | |

*Significant at the .05 level of probability.

TABLE A-13

ANALYSES OF VARIANCE TABLES FOR JOHNSONGRASS SEEDLING CONTROL RATINGS OF TREATMENTS AT EACH LOCATION

| Location | Source of Variation | Degrees of Freedom | Mean Squares | F Value* |
|---|---|---|---|---|
| Ames | Replications | 3 | 273.04 | 1.06 |
| | Main Treatments (MT) | 1 | 171.13 | .66 |
| | Error (a) | 3 | 256.04 | |
| | Split-block Treatments (SB) | 3 | 628.37 | 3.67 |
| | Error (b) | 9 | 170.95 | |
| | MT X SB | 3 | 558.20 | 2.67 |
| | Error (c) | 9 | 208.79 | |
| Mascot | Replications | 3 | 10.78 | .90 |
| | Main Treatments (MT) | 1 | 3.78 | .31 |
| | Error (a) | 3 | 11.86 | |
| | Split-block Treatments (SB) | 3 | 41.36 | 2.42 |
| | Error (b) | 9 | 17.06 | |
| | MT X SB | 3 | 3.78 | .93 |
| | Error (c) | 9 | 4.08 | |
| Pulaski | Replications | 3 | 49.46 | 2.17 |
| | Main Treatments (MT) | 1 | 21.13 | .92 |
| | Error (a) | 3 | 22.79 | |
| | Split-block Treatments (SB) | 3 | 95.21 | 3.26 |
| | Error (b) | 9 | 29.20 | |
| | MT X SB | 3 | 27.87 | 1.61 |
| | Error (c) | 9 | 17.32 | |
| MTES | Replications | 2 | 163.04 | 2.06 |
| | Main Treatments (MT) | 1 | .04 | .05 |
| | Error (a) | 2 | .79 | |
| | Split-block Treatments (SB) | 3 | 84.93 | .94 |
| | Error (b) | 6 | 90.43 | |
| | MT X SB | 3 | 26.59 | |
| | Error (c) | 6 | 14.84 | 1.79 |

*No values were significant at the .05 level of probability.

TABLE A-14

ANALYSIS OF VARIANCE TABLE FOR SOYBEAN SEED YIELDS DUE TO TREATMENTS AT AMES PLANTATION

| Source of Variation | Degrees of Freedom | Mean Squares | F Value* |
|---|---|---|---|
| Replications | 3 | 130.24 | 5.22 |
| Main Treatments (MT) | 1 | 2.36 | .09 |
| Error (a) | 3 | 24.94 | |
| Split-block Treatments (SB) | 3 | 31.94 | 3.06 |
| Error (b) | 9 | 10.41 | |
| MT X SB | 3 | 14.23 | 1.99 |
| Error (c) | 9 | 7.12 | |
| Total | 31 | | |

*No values were significant at the .05 level of probability.

TABLE A-15

ANALYSIS OF VARIANCE TABLE FOR SOYBEAN SEED YIELDS DUE TO TREATMENTS AT MASCOT

| Source of Variation | Degrees of Freedom | Mean Squares | F Value |
|---|---|---|---|
| Replications | 3 | 29.87 | 23.33* |
| Main Treatments (MT) | 1 | 104.15 | 81.36** |
| Error (a) | 3 | 1.28 | |
| Split-block Treatments (SB) | 5 | 204.91 | 8.68** |
| Error (b) | 15 | 23.60 | |
| MT X SB | 5 | 10.87 | 1.26 |
| Error (c) | 15 | 8.57 | |
| Total | 47 | | |

* Significant at the .05 level of probability.

**Significant at the .01 level of probability.

TABLE A-16

ANALYSIS OF VARIANCE TABLE FOR SOYBEAN SEED YIELDS DUE TO TREATMENTS AT THE MIDDLE TENNESSEE EXPERIMENT STATION

| Source of Variation | Degrees of Freedom | Mean Squares | F Value |
|---|---|---|---|
| Replications | 2 | 34.90 | 42.04* |
| Main Treatments (MT) | 1 | 243.72 | 292.63** |
| Error (a) | 2 | .83 | |
| Split-block Treatments (SB) | 5 | 622.96 | 9.45** |
| Error (b) | 10 | 65.88 | |
| MT X SB | 5 | 20.63 | .79 |
| Error (c) | 10 | 25.99 | |
| Total | 35 | | |

* Significant at the .05 level of probability.

**Significant at the .01 level of probability.

TABLE A-17

ANALYSIS OF VARIANCE TABLE FOR SOYBEAN SEED YIELDS DUE TO TREATMENTS AT PULASKI

| Source of Variation | Degrees of Freedom | Mean Squares | F Value |
|---|---|---|---|
| Replications | 2 | 26.68 | 36.54* |
| Main Treatments (MT) | 1 | 19.15 | 26.23* |
| Error (a) | 2 | .73 | |
| Split-block Treatments (SB) | 5 | 116.22 | 7.94** |
| Error (b) | 10 | 14.62 | |
| MT X SB | 5 | 14.79 | 1.54 |
| Error (c) | 10 | 9.58 | |
| Total | 35 | | |

* Significant at the .05 level of probability.

**Significant at the .01 level of probability.

# VITA

David Keith Glover was born in Giles County, Tennessee, on February 17, 1948. He attended Bodenham High School and was graduated in 1966. He attended Martin Jr. College from 1966 to 1968 where he earned an Associate in Arts degree. In September, 1968, he entered Middle Tennessee State University and in June, 1970, he received the Bachelor of Science degree in Agronomy. In September, 1971, he entered the Graduate School of the University of Tennessee at Knoxville as a graduate research assistant in the Plant and Soil Science Department. He received the Master of Science degree in Plant and Soil Science in August, 1973.

He is married to the former Mary Katheryn McIntosh of Pulaski, Tennessee.