SOYBEAN (*GLYCINE MAX*) WEED CONTROL SYSTEMS AND THE EFFECTS OF HERBICIDES AND DEPTH OF PLANTING ON SOYBEAN INJURY

By

ROBERT BRENT WESTERMAN

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Thesis Approved:

Don S. Murray
Thesis Adviser

Howard A. L. Greer

Eddie Basler

Norman N. Durham
Dean of the Graduate College

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Each of the two parts of this thesis is a separate manuscript to be submitted for publication in *Weed Science*, the journal of the Weed Science Society of America.

PART I

SOYBEAN (*GLYCINE MAX*) WEED CONTROL SYSTEMS

SOYBEAN (GLYCINE MAX) WEED CONTROL SYSTEMS

Abstract. Field experiments were conducted during 2 growing seasons to evaluate chemical systems of weed control in soybeans (*Glycine max* L.). The first series of experiments conducted in 1983 involved weed control systems with preplant incorporated (PPI) and postemergence (POST) combinations, and multiple postemergence combinations. In 1984 all of the studies were combined into a single large field experiment. The experimental site contained uniform stands of pigweed (*Amaranthus* spp.), morningglory (*Ipomoea* spp.), common cocklebur (*Xanthium strumarium* L.), and large crabgrass [*Digitaria sanguinalis* (L.) Scop.] except in one experiment in 1983 where the common cocklebur stand was too erratic for visual ratings. The data collected for both years included visual weed control ratings, visual soybean injury, soybean stand counts, and soybean yields. Supplemental irrigation was used throughout the growing season. In all three experiments conducted during the 1983 growing season, full-season weed control was not obtainable when only postemergence herbicide applications were utilized. Preplant incorporated and preemergence herbicide applications of trifluralin [2,6-dinitro-N,N-dipropyl-4-(trifluoromethyl)-benzenamine] and metribuzin [4-amino-6-(1,1-dimethylethyl)-3-(methylthio)-1,2, 4-triazin-5(4H)-

one] in conjunction with a postemergence herbicide were necessary to control the broad spectrum of weeds for the entire growing season. The same general control results were also observed during the 1984 growing season. Soybean yields were reduced during both growing seasons by uncontrollable wet weather which delayed mechanical harvesting.

Additional index words. Common cocklebur, sequential herbicide applications, herbicide combinations.

INTRODUCTION

Soybeans are grown extensively throughout the mid-western and southeastern United States. Over 93,000 hectares of Oklahoma farmland and over 25 million hectares nationwide were in soybean production in 1983 and 1984. With such a substantial quantity of agronomic land in soybean production it is essential that an effective weed management system be utilized by the producer to obtain the optimum yields possible. Weeds can cause soybean yield reductions of 10 to 100% (8, 9, 10, 14, 22, 23, 30) depending on factors such as environmental conditions, weed species, and the density of weed infestation. Because of this yield reduction an effective weed control system is an essential element of a properly managed soybean production program (7, 20).

Over the past few years a number of new herbicides have been developed for the control of broadleaf and grassy weeds. Recent emphasis of herbicide development has been toward postemergence weed control systems as a total weed control program without including preemergence herbicides measures. Traditional weed management programs in soybeans have primarily utilized soil-applied herbicides to control annual grasses and small-seeded broadleaf weed species. These preemergence or preplant incorporated herbicide treatments collectively have been referred to as preventative treatments. Preventative herbicide treatments alone can be inadequate for full-season weed control and proper timing of application of the postemergence herbicide treatments can be difficult.

Recently the competitive influence of weeds on the growth and seed production of soybeans has received much attention. With production costs of soybeans increasing, better weed control is needed to maintain or increase soybean production profits (18). Important factors which affect the competitiveness of a weed infestation on a soybean crop are weed species (24, 25), weed densities (26, 29), and crop row spacing (27, 28). Weeds have been recognized as the most economically important pest problem for soybean producers (16). Traditionally hand hoeing was used to overcome weed infestations in crop production areas. Because of this high labor requirement needed to maintain a weed free crop production environment, producers have included chemical weed control management into their crop production systems. Miller (20) reported that in order to avoid soybean yield reductions caused from weed infestations an effective weed control program must be included into the soybeans production system.

Soil-applied herbicides used in soybean production can be termed as preventative treatments and can consist of either preplant incorporated or preemergence applications. Preventative herbicide treatments alone have proven insufficient in many cases for full-season weed control. Parker et al. (21) reported that the control of morning-glories and common cocklebur with the soil-applied herbicides alachlor [2-chloro-N-(2,6-diethylphenyl)-N-(methoxymethyl) acetamide], trifluralin, linuron [N'-(3,4-dichlorophenyl)-N-methoxy-N-methylurea], and metribuzin was not adequate. They also indicated that of these soil-applied herbicides treatments, trifluralin plus metribuzin controlled these large-seeded broadleaf weeds best, but even this treatment was inconsistent. Because of the ability of the large-seeded broadleaf weed species to germinate and emerge from deeper in the soil profile than grasses and small-seeded broadleaf species and their ability to emerge through treated soil makes broadleaf weeds especially difficult to manage with soil-applied herbicides alone (4).

Robinson et al. (23) reported that soybean weed control in plots treated with a preemergence application of metribuzin at 0.42 kg/ha was satisfactory for the first 3 weeks, then competing weeds invaded the soybeans and caused lower soybean yields. They also concluded that weeds had to be controlled in soybeans for 90% of the growing season to avoid a yield loss. The soybean yield with only a preemergence treatment of metribuzin at 0.42 kg/ha was approximately 40% lower when compared to plots treated with metribuzin plus a postemergence treatment and plots treated with only postemergence applications. Barker et al. (2) reported that maximum yields of soybeans were obtained when weeds were removed early in the growing season. Johnson (12) reported that herbicides applied as a single application to soybeans prior to or at planting failed to control broadleaf weeds throughout the growing season and; therefore, either cultivation or additional herbicides are required to control weeds for the remainder of the growing season. Vernolate [S-propyl dipropylcarbamothioate] was the only herbicide applied preplant that consistently controlled broadleaf weeds early in the growing season. The data also indicated that with treatments of vernolate alone the weed populations increased to an unacceptable level within 5 weeks after planting the crop. Soybeans treated with nitralin [4-(methylsulfonyl)-2,6-dinitro-N,N-dipropylaniline] were slow to emerge, plants were severely injured, and the injury was pronounced until maturity. The soybean stand and yield components were significantly reduced when the plots were treated with nitralin as compared with the soybean stand and yields from the plots treated with trifluralin or vernolate.

Because of the inadequate full-season weed control obtained from using preventative soil-applied herbicides it is necessary that other weed control measures be used. It has been reported that a large improvement in weed control was obtained when a postemergence tretment was included after the use of a preemergence treatment (8). Gebhardt and Minor (8) conducted soybean production experiments involving a 2x2x2x2 factorial experiment where the treatment levels were planting date (1 May vs. 1 June): row spacing (38 vs. 76 cm); weed control (preemergence herbicides vs. preemergence + postemergence herbicides); and seedbed preparation (conventional vs. no-till). Results indicated that over a 5 year period, average weed control was 18, 12, and 31% higher with conventional tillage, June planting, and herbicides applied preemergence and postemergence than with their counterparts. They also reported that a large improvement in weed control with a postemergence herbicide application was observed each year.

Chemical weed control in soybeans often involves multiple applications of the same or different herbicides (11). In many instances a selective postemergence herbicide following a preventative treatment is necessary to obtain full-season weed control. Johnson (11) conducted an experiment involving the effects of repeated applications of herbicides on soybeans and found that repeated postemergence applications of chloroxuron [N'-[4-(4-chlorophenoxy)phenyl]-N,N-dimethylurea], linuron, or dinoseb [2-(1-methylpropyl)-4,6-dinitrophenol] could be applied to soybeans without severe foliage injury. The plots receiving multiple applications of chloroxuron, linuron, or dinoseb did not affect seed yields.

Parker et al. (21) reported that control of broadleaf weed species with the postemergence herbicides bentazon [3-(1-methyethyl)-(1H)- 2,1,3-benzothiadiazin-4(3H)-one 2,2-dioxide] and acifluorfen [5-[2-chloro-4-(trifluoromethyl) phenoxy]-2-nitrobenzoic acid] equaled or exceeded the control obtained with the soil applied herbicides linuron and metribuzin. The timing of application of bentazon and acifluorfen showed that early applications provided better broadleaf weed control than late applications. Martin and Rieck (17) also reported that the utilization of post-emergence herbicides may be warranted by time and stage of application of these treatments in double-cropped soybeans.

Sequential herbicide treatments have resulted in an increase in weed control throughout the growing season. An experiment conducted by Dowler and Parker (6) showed that trifluralin or alachlor applied as a preemergence treatment followed by a postemergence treatments of chloroxuron, dinoseb, or linuron controlled weeds nearly as well as did cultivation plus hand hoeing. Hauser et al. (10) and Johnson (12) reported that timely postemergence herbicide treatments and cultivation were valuable components of a weed control program. Barker et al. (1) reported that low soybean injury, higher morningglory control, and greater soybean seed yields were obtained with over-the-top herbicide applications at 4 weeks after planting than at 6 weeks after planting. Also tank mixtures of bentazon at 0.28 and 0.56 kg/ha with acifluorfen at 0.28 and 0.56 kg/ha applied to five annual morningglory species gave 90% or better control.

During the past few years a number of chemical and cultural weed control systems have been developed for conventional tillage, minimum-tillage, and no-tillage soybean production (5, 6, 7, 8, 9, 10, 13, 15, 18, 19, 21, 23, 31). Kapusta (13) reported that complex herbicidal systems including a contact herbicide, one or two preemergence herbicides, and a postemergence herbicide may be required for good weed control in minimum and no-till soybean production operations. Robinson et al. (23) conducted experiments involving three weed control regimes on no-till and tilled soybeans and indicated that preemergence treatments alone were not sufficient for full-season weed control and should be used in combination with a postemergence treatment. They also indicated that soybean yields were higher under no-till than conventionally tilled management in two of three years.

Cultural and environmental factors interact to affect soybean stand, vegetative development, and yield (8). Gebhardt and Minor (8) indicated that planting date, row spacing, weed control, and seedbed preparation interact to cause either additions or reductions in soybean yields.

Dowler and Parker (6) compared eight weed control systems in soybeans using numerous combinations of the herbicides trifluralin, alachlor, dinoseb, chloroxuron, and linuron with or without cultivation to cultivation alone and cultivation plus hand hoeing. They concluded that the soybean weed control systems involving herbicides or herbicides plus cultivation controlled more weeds than a system involving only three cultivations.

Hauser et al. (9) used nine systems of weed control in soybeans which compared intensive cultivation, cultivation plus herbicides, and intensive herbicides applications for the control of yellow nutsedge (Cyperus esculentus L.) and common cocklebur. Cultivation treatments included rotary hoeing and sweep cultivation and the herbicide treatments included vernolate at 2.2 kg/ha injected 7.5 cm deep at planting, chloroxuron at 1.1 kg/ha sprayed over-the-top of soybeans and weeds, dinoseb at 1.67 or 3.34 kg/ha applied as a directed spray, and linuron at 0.56 or 1.11 kg/ha applied as a directed spray. Results indicated that cultivation controlled 85 to 93% of the common cocklebur and that any weed control system involving herbicides, or herbicides plus cultivation, controlled 99 to 100% of the common cocklebur. Yellow nutsedge was suppressed satisfactorily by all of the weed control systems. Similar experiments conducted by Hauser et al. (10) revealed that systems containing only cultivation controlled 84 to 98% of the Florida beggarweed [Desmodium tortuosum (SW.)DC.].

Systems involving herbicide applications satisfactorily controlled yellow nutsedge and 99 to 100% control of the common cocklebur. However, there was no significant yield difference among the weed control systems in their 3 year averages.

Gebhardt (7) evaluated cultural and chemical weed control systems in soybeans involving herbicides applied preemergence and postemergence in combination with or without cultivation. Data showed that soybean yield and weed control were both improved when cultivation supplemented the preemergence and postemergence herbicide applications. Burnside and Colville (3) evaluated herbicides, hand-weeding, tillage, and narrow row spacing in systems of weed control in soybeans and found that soybean yield was increased as each of these components was added to the system. They indicated that combinations of these weed control treatments gave more dependable results than any of these treatments used alone.

Lunsford (15) conducted an experiment involving weed control systems in soybeans for the control of sicklepod (Cassia obtusifolia L.), common cocklebur, Florida beggarweed, and redroot pigweed (Amaranthus retroflexus L.) in which 60 herbicide treatment comparisons were evaluated. Numerous systems of weed control were developed and these programs could be divided into three categories; postemergence over-the-top, preemergence followed by a postemergence over-the-top, and early postemergence followed by a postemergence directed sprays. All of these systems caused good weed control but the type of system utilized depends upon the equipment and management ability of the farmer.

Zarecor et al. (31) conducted experiments involving fluchloralin [N-(2-chloroethyl)-2,6-dinitro-N-propyl-4-(trifluoromethyl)benz-enamine] and bentazon in a systems approach to soybean weed control. Fluchloralin was applied at the label rate to the soil for grass control and bentazon was applied at different growth stages for broadleaf weed control. Cultural practices included; 1) non-cultivated standard rows, 2) cultivated standard rows, 3) solid seeded rows spaced 25 cm or less, 4) broadcast application, and 5) row application. Results indicated that when common cocklebur was the dominant weed species, early treatments of bentazon gave excellent weed control in solid seeded and standard seeded rows which were cultivated. Late applications of bentazon were less effective than early or split applications and resulted in a decrease in soybean yields of 67.4 to 134.8 kg/ha in standard rows with cultivation. Solid seeded soybeans had the highest yields but the bentazon timing was more critical than in standard seeding row seeding techniques.

Dowler (5) conducted an experiment involving weed control systems in soybeans with acifluorfen and pendimethalin [N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine] applied preemergence or with cultivation. The data showed that the timing of the acifluorfen application was essential for control of some weeds. Cultivation increased the control of Texas panicum (*Panicum texanum* Buckl.), crowfootgrass [*Dactyloctenium aegyptium* (L.) Willd.], sicklepod, and Florida beggarweed. Postemergence applications of acifluorfen alone always resulted in a lower soybean yield when compared to the weed-free check. However, an added cultivation following an application of acifluorfen resulted in an increase of approximately 337 kg/ha in the soybean yield.

Mathews et al. (19) conducted experiments involving alternate systems for weed control in soybeans. They evaluated the effectiveness of various compatible chemical combinations and mechanical methods of weed control. Data indicated that the chemical combinations resulted in average to good weed control and that several effective mechanized weed control systems were available to the soybean producers in Arkansas.

The objectives of these field experiments were to compare and evaluate soybean weed control systems. These systems consisted of preventative treatments of soil-applied herbicides, single and tank mixtures of postemergence applied herbicides, and combinations of soil-applied and postemergence applied herbicides.

MATERIALS AND METHODS

Field experiments were conducted in the summer of 1983 and 1984, at the Oklahoma State University, Agronomy Research Station near Stillwater, on a Port silt loam (fine-silty, mixed, thermic Cumulic Haplustolls) to evaluate weed control systems in soybeans. Herbicides were applied preplant incorporated (PPI), preemergence (PRE), postemergence over-the-top (POST), and as a postemergence directed spray (PDS). Treatments in all experiments were arranged in a randomized complete block design with four replications. Soil fertility was tested by the Soil, Water, and Plant Analysis Laboratory at Oklahoma State University and all nutrients were considered adequate. The soil pH at this site was 6.5 and there was 0.7 percent organic matter. Supplemental irrigation by an over-head side roll system was available and was used throughout the duration of the experiments; however, rigid irrigation schedules were not followed. Precipitation data for Stillwater, Oklahoma during 1983 and 1984 can be found in the Appendix, Table 9 and Table 10 respectively. Experiments in this manuscript will be described as weed control systems and these will be described more fully under the preceding sub-headings.

Individual plots were 4 rows, each 9.2 m long. Soybeans were planted on a flat-bed culture with a row spacing of 91 cm. In 1983 the right two rows were maintained weed-free throughout the growing season but this practiced was not repeated in 1984. In 1983 the soybean cultivar was Essex and in 1984 the soybean cultivar was

Forrest. The weed infestations for the experimental area included natural stands of large crabgrass, pigweed spp., morningglory spp., and common cocklebur. All weed species were present in all experiments in sufficient quantities for visual ratings except in a single field study, Weed Control Systems with PPI and POST combinations, in 1983 when the common cocklebur stand was too erratic for visual observations. All the treatments were applied using a tractor mounted compressed air sprayer. The carrier volume for the PPI and PRE treatments was 141 l/ha. The carrier volume for the POST and PDS treatments was 282 l/ha. All of the PPI treatments were incorporated with a tandem disk two times to a depth of approximately 6 cm within 15 minutes after application of the herbicide. The PRE treatments were applied immediately after planting in all experiments unless indicated otherwise.

Data collected from all of the weed control systems field studies included visual weed control and visual soybean injury. Ratings were made on a scale of 0 to 10 and converted to percent control or injury. Soybean stand counts and yields were also taken. Soybean plots were harvested in 1983 on November 17 (Essex) and the 1984 field study (Forrest) was not harvested until January 3, 1985 due to uncontrollable environmental factors.

Weed control systems with PPI and POST combinations (1983). Single and sequential herbicide applications were applied as PPI, PRE, POST, and PDS treatments. A complete treatment list showing all herbicides and rates is shown in Table 1. The PPI and PRE herbicide treatments were applied as previously mentioned. Rainfall of 3 cm was recorded 2 days after the application of the soil applied herbicides. POST treatments were applied over-the-top to V4 soybeans 25 days after planting (DAP). At this time the large crabgrass was 8 cm tall, pigweed spp. 10 cm, and the morningglory spp. were 8 cm tall. POST treatments were also applied to V5 soybeans 34 DAP. The large crabgrass was 10 cm, pigweed spp. 15 cm, and the morningglory spp. were 10 cm tall. PDS treatments were also applied at the V5 soybean growth stage and the same weed growth stages.

Weed control systems with POST combinations (1983). Trifluralin and metribuzin were applied PPI and PRE, respectively, as standard preventative herbicide treatments for the comparison of POST, POST combinations, and PDS herbicide treatments. A complete treatment list is shown in Table 3. The PPI and PRE treatments were applied as previously mentioned with the same rainfall event of 3 cm occurring 2 days after application. The POST treatments were applied over-the-top to V4 soybeans 25 DAP. The weed heights were as follows: large crabgrass 10 cm, pigweed spp. 20 cm, common cocklebur 5 to 25 cm, and the morningglory spp. 5 cm. POST treatments were also applied to V5 soybeans 34 DAP. The weed heights were as follows: large crabgrass 13 cm, pigweed spp. 30 cm, common cocklebur 5 to 30 cm, and the morningglory spp. 7.5 cm tall.

Effect of application sequence on weed control efficiency (1983). The final study established in 1983 involved various sequences of postemergence herbicide treatments. A complete treatment list is shown in Table 5. Trifluralin and metribuzin were utilized as preventative standard treatments. The PPI and PRE treatments were applied as previously mentioned with the same rainfall event of 3 cm occurring two days after application. The first POST herbicide treatments were applied over-the-top to V4 soybeans 25 DAP. The weed heights were as follows: large crabgrass 5 cm, pigweed spp. 15 cm, common cocklebur 5 cm, and the morningglory spp. 10 cm tall. POST herbicide treatments were also applied to V5 soybeans 35 DAP. The weed heights were as follows; large crabgrass 15 to 30 cm, pigweed spp. 30 cm, common cocklebur 10 cm, and the morningglory spp. were 15 cm tall.

Weed control systems in soybeans (1984). In 1984 all of the treatments from 1983 were combined into a single experiment. A complete treatment list is shown in Table 7. The PPI, PRE, POST, and PDS herbicide applications were all applied as stated earlier. Rainfall occurred after incorporation of the PPI herbicides and planting was delayed 6 days. The PRE treatments were applied immediately after planting and the following day 5 cm of rainfall was recorded. POST herbicide application were made at the V1, V2, and V3 to V4 soybean growth stages. The V1 POST treatments were applied 10 DAP. The weed heights were as follows: pigweed spp. 1 cm, large crabgrass 3 cm, common cocklebur 5 cm. and the morningglory spp. were 3 cm tall. The V2 POST treatments were applied 18 DAP. The weed heights were as follows: pigweed spp. 10 to 15 cm, large crabgrass 8 cm, common cocklebur 10 to 15 cm, and the morningglory spp. were 8 to 10 cm tall. The V3 to V4 postemergence treatments were applied 24 DAP. The weed heights were as follows: pigweed spp. 1 to 31 cm, large crabgrass 15 cm, common cocklebur 10 to 15 cm, and the morningglory were 1 to 15 cm tall. PDS herbicide treatments were also applied at the V3 to V4 soybean growth and the same weed heights.

RESULTS AND DISCUSSION

Weed control systems with PPI and POST combinations (1983). PPI applications of trifluralin at 0.83 kg/ha followed by PRE treatments of metribuzin at 0.56 kg/ha controlled 90 to 93% of the pigweed throughout the growing season (Table 1). Additional POST applications of acifluorfen at 0.28 kg/ha tank mixed with bentazon at 0.56 kg/ha or a POST application of bentazon at 0.83 kg/ha increased pigweed control to 95%. PPI applications of trifluralin at 0.83 kg/ha in conjunction with a POST application of bentazon at 0.83 kg/ha or tank mixtures of acifluorfen at 0.28 kg/ha plus bentazon at 0.56 kg/ha, bentazon at 0.56 kg/ha plus 2,4-DB at 0.07 kg/ha, or acifluorfen at 0.28 kg/ha plus

2,4-DB at 0.07 kg/ha resulted in inadequate full-season pigweed control of 23 to 35%. PPI applications of trifluralin at 0.83 kg/ha followed by PDS applications of linuron at 0.56 kg/ha or linuron at 0.56 kg/ha plus 2,4-DB 0.56 kg/ha were tank mixed and applied PPI (Table 1). Treatments including PPI applications of trifluralin followed by a PRE of metribuzin resulted in large crabgrass control from 75 to 98%. All other plots not receiving a PRE application of metribuzin resulted in full-season large crabgrass control of 48 to 78%.

Sufficient full-season morningglory control was not obtained with PPI and PRE applications of trifluralin and metribuzin, respectively, when used separately or in combination (Table 1). Average morningglory control, 53 to 73%, was obtained when POST applications of bentazon at 0.83 kg/ha, bentazon at 0.56 kg/ha plus 2,4-DB at 0.07 kg/ha, or acifluorfen at 0.28 kg/ha plus 2,4-DB at 0.07 kg/ha were applied in sequence with a PPI application of trifluralin at 0.83 kg/ha. All other treatments resulted in 0 to 30% full-season morningglory control.

The highest soybean injury occurred from POST applications applied following PPI trifluralin at 0.83 kg/ha (Table 2). Acifluorfen at 0.42 kg/ha, bentazon at 0.83 kg/ha, and a tank mixture of acifluorfen at 0.28 kg/ha plus bentazon at 0.56 kg/ha all resulted in 23 to 28% soybean injury. Bentazon at 0.56 kg/ha plus 2,4-DB at 0.07 kg/ha and acifluorfen at 0.28 kg/ha plus 2,4-DB at 0.07 kg/ha resulted in similar crop injury. Glyphosate applied POST at 0.10 kg/ha resulted in the highest crop injury of 38%.

Differences were not observed between the soybean stand counts in the weedy or weed-free rows in any of the treatments when compared to the check (Table 2). Soybeans yields ranged from 150 kg/ha in the weedy check to 1066 kg/ha in the treatment containing PPI trifluralin at 0.83 kg/ha, PRE metribuzin at 0.56 kg/ha, and a POST application of acifluorfen at 0.28 kg/ha plus bentazon at 0.56 kg/ha (Table 2). All treatments including a PPI trifluralin application followed by a PRE metribuzin application yielded higher than the majority of the other treatments. A similar trend occurred in the weed-free soybeans rows. Treatments including PPI trifluralin followed by a PRE metribuzin application generally resulted in the highest soybeans yields.

Weed control systems with POST combinations (1983). The treatments including PPI trifluralin at 0.83 kg/ha and PRE metribuzin at 0.56 kg/ha resulted in excellent pigweed control of 90 to 98%. Less than average full-season pigweed control was obtained when POST and PDS treatments were used alone (Table 3). The highest full-season pigweed control obtained from a single POST application was from bentazon at 0.28 kg/ha tank mixed with 2,4-DB at 0.07 kg/ha resulting in 45% control.

Treatment including trifluralin and metribuzin provided excellent large crabgrass control of 95 to 100%

(Table 3). Adequate large crabgrass control was also not obtainable utilizing only a POST herbicide application. Fluazifop at 0.28 kg/ha was not effective due to the dense broadleaf canopy which covered the large crabgrass resulting in 28% control at the end of the growing season.

Excellent full-season common cocklebur control of 95% was obtained with a PPI trifluralin application at 0.83 kg/ha followed by a PRE metribuzin application at 0.56 kg/ha and a POST application of bentazon at 0.56 kg/ha (Table 3). Tank mixtures of acifluorfen at 0.28 kg/ha plus bentazon at 0.56 kg/ha or acifluorfen at 0.28 kg/ha plus 2,4-DB at 0.56 kg/ha applied POST also resulted in 95% season long common cocklebur control. All other treatments resulted in less control.

Excellent morningglory control was obtained using a PPI application of trifluralin at 0.83 kg/ha followed by a PRE application of metribuzin at 0.56 kg/ha (Table 3). A POST application of bentazon at 0.56 kg/ha was added to the sequence and a 100% control of morningglory was obtained. POST treatments of tank mixed acifluorfen at 0.28 kg/ha plus 2,4-DB at 0.56 kg/ha or bentazon at 0.28 kg/ha plus 2,4-DB at 0.07 kg/ha resulted also resulted in 100% morningglory control.

Significant soybean injury occurred from all POST herbicide treatments except fluazifop at 0.28 kg/ha and the low rate of bentazon applied at 0.56 kg/ha (Table 4). The highest soybean injury occurred from tank mixtures of acifluorfen at 0.28 kg/ha plus 2,4-DB 0.56 kg/ha, bentazon at 0.28 kg/ha plus 2,4-DB at 0.07 kg/ha, and acifluorfen at 0.28 kg/ha plus bentazon at 0.56 kg/ha plus 2,4-DB at 0.07 kg/ha resulting in 33, 38, and 35% crop injury, respectively.

No significant differences occurred in the soybean stand counts in the weedy or the weed-free rows in any of the treatments when compared to the check (Table 4). The soybean yields in the weedy rows were higher in all instances where preventative weed control measures were utilized. Treatments of only POST applications in the weedy rows yielded much less. The weedy check plot yielded 131 kg/ha compared to the best treatment containing PPI, PRE, and POST applications which yielded 969 kg/ha. The same trend was indicated in the weed-free rows with the treatments containing preventative applications having higher soybean yields than the treatments with only POST or PDS applications.

Effect of application sequence on weed control efficiency (1983). Pigweed control of 83 to 88% was obtained when PPI trifluralin and PRE metribuzin were used as preventative herbicide treatments (Table 5). Adequate full-season pigweed control was not obtained with POST and sequential POST herbicide applications. The highest pigweed control from a POST treatment resulted in only 35% control at the end of the growing season.

The preventative herbicide treatments resulted in 85 to 98% large crabgrass control (Table 5). Sequential POST applications were not effective in the control of large crabgrass. A POST bentazon application at 0.83 kg/ha in sequence with a POST application of fluazifop at 0.28 kg/ha resulted in the highest full-season large crabgrass control of only 48%.

POST applications of bentazon only at 0.83 kg/ha or a tank mixture of bentazon at 0.56 kg/ha plus acifluorfen at 0.28 kg/ha applied POST in sequence with preventative applications or following POST applications of fluazifop at 0.28 kg/ha resulted in 70 to 78% morningglory control (Table 5). All other treatments resulted in less control.

Adequate common cocklebur control was not obtained with PPI trifluralin and PRE applications of metribuzin. A POST application of either bentazon, acifluorfen, or tank mixtures of bentazon plus acifluorfen provided good to excellent season long common cocklebur control (Table 5).

Soybean injury range from 3 to 25% with herbicide applications; however, no differences were observed in the soybean stand counts between the weedy or the weed-free rows when compared to the check (Table 6). Soybean yields from the weedy rows containing preventative herbicide applications ranged from 670 to 717 kg/ha compared to treatments using only POST herbicides which yielded from 30 to 150 kg/ha. Essex soybean yields from the weed-free rows containing PPI and PRE treatments yielded 737 to 977 kg/ha. Soybean yields in the weed-free rows utilizing only POST herbicides yielded 303 to 677 kg/ha.

Weed control systems in soybeans (1984). As in the previous year, excellent full-season pigweed control was obtained when preventative herbicide treatments were used (Table 7). However early postemergence applications of acifluorfen, bentazon, or tank mixtures of acifluorfen and bentazon resulted in pigweed control of 83% or less. Single POST treatments resulted in less than 50% visual pigweed control (Table 7).

Preventative applications of PPI trifluralin and PRE metribuzin resulted in excellent large crabgrass control (Table 7). Likewise, POST treatments of fluazifop at 0.28 kg/ha applied 10 DAP or 18 DAP resulted in good to excellent large crabgrass control of 83 to 100%.

Excellent morningglory control was obtained from PPI trifluralin at 0.83 kg/ha in sequence with a PRE application of metribuzin at 0.56 kg/ha (Table 7). Where trifluralin was the only preventative herbicide treatment, additional POST applications of acifluorfen, bentazon, naptalam plus dinoseb, and tank mixtures of acifluorfen plus bentazon, acifluorfen plus 2,4-DB, and bentazon plus 2,4-DB provided 83 to 100% morningglory control. A PDS application of linuron at 0.56 kg/ha or a tank mixture of linuron at 0.56 kg/ha plus 2,4-DB at 0.22 kg/ha in addition to the PPI trifluralin provided good to excellent control of morningglory. A single PRE application of metribuzin at 0.56 kg/ha resulted in 90% control.

Excellent common cocklebur control was obtained using preventative applications of PPI trifluralin followed by PRE metribuzin (Table 7). A single PRE application of metribuzin at 0.56 kg/ha provided 93% common cocklebur control. Additional POST applications of acifluorfen plus bentazon tank mixtures, naptalam plus dinoseb, or acifluorfen plus 2,4-DB increased common cocklebur control to 100%. Early postemergence treatments of bentazon, bentazon plus acifluorfen, or naptalam plus dinoseb applied 10 DAP also provided 100% control of common cocklebur.

The highest soybean injury occurred from early postemergence applications of fluazifop at 0.28 kg/ha plus acifluorfen at 0.42 kg/ha and fluazifop at 0.28 kg/ha plus bentazon at 0.56 kg/ha plus acifluorfen at 0.28 kg/ha resulting in 83 and 67% injury respectively (Table 8). However after 24 days little or no soybean injury was observed. Early postemergence applications of glyphosate at 0.012 and 0.024 kg/ha resulted in 37 and 23% injury, respectively. In general, most treatments did not cause excessive crop injury.

There were no differences in soybean stand counts in any of the treatments when compared to the weedy or the weed-free check (Table 8). Soybean yields could only be harvested from plots containing both PPI and PRE herbicide applications. A single PPI application of trifluralin did not provide enough weed control to permit mechanical harvesting. POST applications alone also failed to exhibit sufficient weed control to allow for mechanical harvesting. The most effective weed control system for a broad spectrum of weed control includes utilizing PPI trifluralin followed by PRE metribuzin. If needed a POST application of bentazon, acifluorfen, acifluorfen plus bentazon tank mixture, or naptalam plus dinoseb can be used to control escaping pigweed, morningglory, and common cocklebur.

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Table 1. Visual ratings for weed control systems with preventative and postemergence combinations (1983).

	Treatment	Rate	Method of application[1]	Control								
				Pigweed spp.			L. Crabgrass			Morningglory spp.		
				6/29	7/11	8/16	6/29	7/11	8/16	6/29	7/11	8/16
		(kg/ha)		%								
1.	trifluralin	0.83	PPI	88	60	5	98	88	63	48	58	13
2.	trifluralin + metribuzin	0.83+0.56	PPI	90	73	80	95	98	90	23	35	0
3.	trifluralin + metribuzin / metribuzin	0.83+0.28/ 0.28	PPI/ PRE	100	95	91	98	73	80	55	8	3
4.	trifluralin / metribuzin	0.83/0.56	PPI/PRE	99	100	90	95	80	85	48	8	13
5.	trifluralin / metribuzin	0.83/0.56	PPI/PRE	98	98	93	98	90	75	70	43	13
6.	trifluralin / metribuzin / acifluorfen	0.83/0.56/ 0.42	PPI/PRE/ POT	98	98	70	100	75	93	33	13	0
7.	trifluralin / metribuzin / acifluorfen + bentazon	0.83/0.56/ 0.28+0.56	PPI/PRE/ POT	98	98	94	100	95	78	75	50	30
8.	trifluralin / metribuzin / bentazon	0.83/0.56/ 0.83	PPI/PRE/ POT	100	98	95	100	98	98	65	63	18
9.	trifluralin / acifluorfen	0.83/0.42	PPI/POT	81	93	48	83	85	78	33	78	18
10.	trifluralin / bentazon	0.83/0.83	PPI/POT	78	80	35	85	88	60	23	95	73
11.	trifluralin / acifluorfen + bentazon	0.83/0.28+ 0.56	PPI/POT	88	63	23	98	83	58	60	48	0
12.	trifluralin / linuron	0.83/0.56	PPI/PDS	85	50	30	95	68	63	63	65	0
13.	trifluralin / linuron 2,4-DB + AG-98	0.83/0.56+ 0.22+1/2%	PPI/PDS	78	48	28	88	65	73	30	45	23
14.	trifluralin / bentazon + 2,4-DB	0.83/0.56+ 0.07	PPI/POT	86	75	30	93	68	48	50	78	53
15.	trifluralin / acifluorfen + 2,4-DB	0.83/0.28+ 0.07	PPI/POT	80	83	35	85	88	68	43	88	58
16.	trifluralin / naptalam + dinoseb	0.83/1.11+ 0.56	PPI/POT	85	70	50	80	85	65	25	48	23
17.	trifluralin / glyphosate	0.83/0.10	PPI/POT	80	75	53	80	88	73	70	100	68
18.	metribuzin	0.56	PRE	100	85	58	85	48	50	43	20	0
19.	check	----	----	0	0	0	0	0	0	0	0	0
	LSD 0.05			11	27	36	11	34	39	NSD[2]	45	39
	cv(%)			9	24	48	9	31	40	NSD	63	129

[1]PPI is preplant incorporated, PRE is preemergence, POT is postemergence, and PDS is postemergence directed spray.
[2]NSD is no significant difference.

Table 2. Soybean injury, counts, and yields for weed control systems with preventative and postemergence combinations (1983).

	Treatment	Rate	Method of application[1]	Soybean injury 6/29	Soybean injury 7/11	Stand Counts Weedy 7/8	Stand Counts Weed-free 7/8	Yields Weedy 11/17	Yields Weed-free 11/17
		(kg/ha)		-----%-----		#/1.5 m		(kg/ha)	
1.	trifluralin	0.83	PPI	15	5	26	26	359	771
2.	trifluralin + metribuzin	0.83+0.56	PPI	15	5	30	26	615	917
3.	trifluralin + metribuzin / metribuzin	0.83+0.28/ 0.28	PPI/ PRE	18	8	25	22	769	1041
4.	trifluralin / metribuzin	0.83/0.56	PPI/PRE	20	13	22	20	843	855
5.	trifluralin / metribuzin	0.83/0.56	PPI/PRE	18	3	21	25	785	923
6.	trifluralin / metribuzin / acifluorfen	0.83/0.56/ 0.42	PPI/PRE/ POT	15	8	31	24	756	976
7.	trifluralin / metribuzin / acifluorfen + bentazon	0.83/0.56/ 0.28+0.56	PPI/PRE/ POT	23	0	27	19	1066	867
8.	trifluralin / metribuzin / bentazon	0.83/0.56/ 0.83	PPI/PRE/ POT	13	0	25	19	925	907
9.	trifluralin / acifluorfen	0.83/0.42	PPI/POT	8	23	34	28	915	1028
10.	trifluralin / bentazon	0.83/0.83	PPI/POT	8	25	25	25	503	830
11.	trifluralin / acifluorfen + bentazon	0.83/0.28+ 0.56	PPI/POT	25	28	21	24	388	851
12.	trifluralin / linuron	0.83/0.56	PPI/PDS	20	3	30	22	648	1029
13.	trifluralin / linuron 2,4-DB + AG-98	0.83/0.56+ 0.22+0.1/2%	PPI/PDS	20	3	27	23	580	621
14.	trifluralin / bentazon + 2,4-DB	0.83/0.56+ 0.07	PPI/POT	13	23	25	24	463	711
15.	trifluralin / acifluorfen + 2,4-DB	0.83/.28+ 0.07	PPI/POT	13	28	24	25	438	545
16.	trifluralin / naptalam + dinoseb	0.83/1.11+ 0.56	PPI/POT	10	15	28	29	567	844
17.	trifluralin / glyphosate	0.83/0.10	PPI/POT	18	38	26	31	472	753
18.	metribuzin	0.56	PRE	10	0	31	31	486	800
19.	check	----	----	0	0	0	23	150	547
	LSD 0.05			NSD[2]	9	NSD	NSD	322	322
	cv(%)			NSD	54	NSD	NSD	31	31

[1]PPI is preplant incorporated, PRE is preemergence, POT is postemergence, and PDS is postemergence directed spray.
[2]NSD is no significant difference.

Table 3. Visual ratings for weed control systems with postemergence combinations (1983).

	Treatment	Rate	Method of application[1]	Control: Pigweed spp. 7/12	Pigweed spp. 8/16	Pigweed spp. 9/2	L. Crabgrass 7/12	L. Crabgrass 8/16	L. Crabgrass 9/2	Cocklebur 7/12	Cocklebur 8/16	Cocklebur 9/2	Morningglory spp. 7/12	Morningglory spp. 8/16	Morningglory spp. 9/2
		(kg/ha)		%											
1.	trifluralin / metribuzin	0.83/0.56	PPI/PRE	98	96	90	100	93	100	93	80	70	100	100	100
2.	trifluralin / metribuzin bentazon	0.83/0.56/ 0.56	PPI/PRE/ POT	98	95	95	98	85	95	80	100	95	98	100	100
3.	trifluralin / metribuzin / bentazon	0.83/0.56/ 0.83	PPI/PRE/ POT	100	98	98	98	93	96	55	73	73	100	100	78
4.	acifluorfen	0.42	POT	40	8	5	55	30	25	83	58	63	100	100	78
5.	bentazon	0.83	POT	20	10	13	40	43	28	73	83	78	68	75	68
6.	glyphosate	0.05	POT	20	25	8	73	45	33	83	70	70	75	100	60
7.	glyphosate	0.10	POT	60	45	28	58	18	10	63	65	50	88	75	63
8.	fluazifop	0.28	POT	15	20	3	38	35	8	50	45	25	25	40	25
9.	acifluorfen + bentazon	0.28+0.56	POT	65	8	5	33	20	0	75	95	95	88	100	75
10.	acifluorfen + 2,4-DB	0.28+0.56	PDS	75	28	5	63	20	25	100	100	95	100	100	100
11.	bentazon + 2,4-DB	0.28+0.07	POT	60	55	45	35	20	3	98	98	88	88	100	100
12.	acifluorfen + bentazon + 2,4-DB	0.28+0.56+ 0.07	POT	80	43	20	35	5	0	100	78	70	95	100	75
13.	naptalam + dinoseb	1.11+0.56	POT	40	8	3	48	43	35	90	88	75	100	100	60
14.	linuron + 2,4-DB	0.56+0.22	PDS	5	0	3	33	10	38	73	75	53	100	100	65
15.	check	----	POT	0	0	0	0	0	0	0	0	0	0	0	0
16.	check	----	PDS	0	0	0	0	0	0	0	0	0	0	0	0
	LSD 0.05			21	30	24	36	32	28	44	40	46	35	30	46
	cv(%)			31	63	64	51	65	64	45	41	51	32	25	49

[1] PPI is preplant incorporated, PRE is preemergence, POT is postemergence, and PDS is postemergence directed spray.

Table 4. Soybean injury, counts, and yields for weed control systems with postemergence combinations (1983).

	Treatment	Rate	Method of application[1]	Soybean injury 6/29	Soybean injury 7/12	Stand Counts Weedy 7/8	Stand Counts Weed-free 7/8	Yields Weedy 11/17	Yields Weed-free 11/17
		(kg/ha)		-----%-----		#/1.5m		(kg/ha)	
1.	trifluralin / metribuzin	0.83/0.56	PPI/PRE	2	5	22	24	786	819
2.	trifluralin / metribuzin bentazon	0.83/0.56/ 0.56	PPI/PRE/ POT	1	5	22	17	777	970
3.	trifluralin / metribuzin / bentazon	0.83/0.56/ 0.83	PPI/PRE/ POT	1	5	22	23	969	1128
4.	acifluorfen	0.42	POT	-	15	21	22	330	659
5.	bentazon	0.83	POT	-	13	19	21	281	430
6.	glyphosate	0.05	POT	-	15	21	21	237	500
7.	glyphosate	0.10	POT	-	18	22	21	187	447
8.	fluazifop	0.28	POT	-	5	22	24	393	852
9.	acifluorfen + bentazon	0.28+0.56	POT	-	20	18	22	387	875
10.	acifluorfen + 2,4-DB	0.28+0.56	PDS	-	33	18	18	350	329
11.	bentazon + 2,4-DB	0.28+0.07	POT	-	38	17	17	273	436
12.	acifluorfen + bentazon + 2,4-DB	0.28+0.56+ 0.07	POT	-	35	20	20	420	714
13.	naptalam + dinoseb	1.11+0.56	POT	-	28	19	19	330	455
14.	linuron + 2,4-DB	0.56+0.22	PDS	-	5	19	18	158	493
15.	check	----	POT	-	0	20	15	213	642
16.	check	----	PDS	-	0	17	19	131	470
	LSD 0.05			NSD[2]	12	NSD	NSD	305	305
	cv(%)			NSD	58	NSD	NSD	44	44

[1]PPI is preplant incorporated, PRE is preemergence, POT is postemergence, and PDS is postemergence directed spray.
[2]NSD is no significant difference.

Table 5. Visual ratings for the effect of application sequence on weed control efficiency (1983).

	Treatment	Rate	Method of application[1]	Control											
				Pigweed spp.			L. Crabgrass			Cocklebur			Morningglory spp.		
				7/12	8/16	9/2	7/12	8/16	9/2	7/12	8/16	9/2	7/12	U/16	9/2
			(kg/ha)	%											
1.	trifluralin / metribuzin	0.83/0.56	PPI/PRE	93	86	85	96	90	85	60	38	25	48	58	68
2.	trifluralin / metribuzin / bentazon	0.83/0.56/ 0.83	PPI/PRE/ POT	98	86	88	98	93	98	28	45	65	60	43	55
3.	trifluralin / metribuzin / bentazon + acifluorfen	0.83/0.56/ 0.56+0.28	PPI/PRE/ POT	95	88	83	99	95	88	48	65	58	83	75	78
4.	fluazifop + acifluorfen	0.28+0.83	POT	43	10	18	45	15	18	83	30	43	75	70	23
5.	fluazifop + acifluorfen	0.28+0.42	POT	63	40	35	48	43	8	85	23	13	95	88	58
6.	fluazifop + bentazon + acifluorfen	0.28+0.56+ 0.28	POT	38	8	0	20	35	40	93	88	75	73	100	28
7.	fluazifop / bentazon	0.28/0.83	POT/POT	20	20	13	23	33	28	98	90	100	88	75	75
8.	fluazifop / acifluorfen	0.28/0.42	POT/POT	48	13	5	43	40	5	93	75	55	65	100	33
9.	fluazifop / bentazon + acifluorfen	0.28/0.56+ 0.28	POT/POT	25	23	3	25	45	10	95	98	98	90	90	70
10.	bentazon / fluazifop	0.83/0.28	POT/POT	18	8	3	33	30	48	93	63	50	65	80	50
11.	acifluorfen / fluazifop	0.42/0.28	POT/POT	40	10	8	38	20	20	80	60	50	65	75	8
12.	bentazon + acifluorfen / fluazifop	0.56+0.28/ 0.28	POT/ POT	50	38	33	38	20	0	98	70	68	50	93	50
13.	check	----	----	0	0	0	0	0	0	0	0	0	0	0	0
	LSD 0.05			27	25	NSD[2]	40	36	36	32	50	53	48	49	NSD
	cv(%)			40	50	NSD	61	59	73	30	61	69	53	47	NSD

[1]PPI is preplant incorporated, PRE is preemergence, POT is postemergence.
[2]NSD is no significant difference.

Table 6. Soybean injury, counts, and yields for effects of application on weed control efficiency (1984).

	Treatment	Rate	Method of application[1]	Soybean injury 6/29	Soybean injury 7/12	Stand Counts Weedy 7/8	Stand Counts Weed-free 7/8	Yields Weedy 11/17	Yields Weed-free 11/17
		(kg/ha)		-----%-----		#/1.5m		(kg/ha)	
1.	trifluralin / metribuzin	0.83/0.56	PPI/PRE	23	10	19	21	670	737
2.	trifluralin / metribuzin / bentazon	0.83/0.56/ 0.83	PPI/PRE/ POT	20	10	22	21	706	977
3.	trifluralin / metribuzin / bentazon + acifluorfen	0.83/0.56/ 0.56+0.28	PPI/PRE/ POT	15	3	27	26	717	904
4.	fluazifop + acifluorfen	0.28+0.83	POT	-	15	21	20	96	444
5.	fluazifop + acifluorfen	0.28+0.42	POT	-	25	22	20	150	491
6.	fluazifop + bentazon + acifluorfen	0.28+0.56+ 0.28	POT	-	23	22	22	84	381
7.	fluazifop / bentazon	0.28/0.83	POT/POT	-	15	18	21	57	343
8.	fluazifop / acifluorfen	0.28/0.42	POT/POT	-	18	18	22	97	464
9.	fluazifop / bentazon + acifluorfen	0.28/0.56+ 0.28	POT/POT	-	20	21	24	30	303
10.	bentazon / fluazifop	0.83/0.28	POT/POT	-	18	21	19	64	360
11.	acifluorfen / fluazifop	0.42/0.28	POT/POT	-	23	22	25	47	461
12.	bentazon + acifluorfen / fluazifop	0.56+0.28/ 0.28	POT/ POT	-	23	23	30	136	677
13.	check	----	----	0	0	19	19	85	434
	LSD 0.05			NSD[2]	13	NSD	NSD	234	234
	cv(%)			NSD	58	NSD	NSD	43	43

[1]PPI is preplant incorporated, PRE is preemergence, POT is postemergence.
[2]NSD is no significant difference.

Table 7. Visual ratings for weed control systems in soybeans (1984)[1].

Treatment	Rate	Method of application[1]	Control							
			Pigweed spp.		L. Crabgrass		Cocklebur		Morningglory	
			7/6	7/30	7/6	7/30	7/6	7/30	7/6	7/30
	(kg/ha)		%							
1. trifluralin	0.83	PPI	100	95	100	97	32	30	93	100
2. trifluralin + metribuzin	0.83+0.56	PPI	100	87	100	83	83	70	73	93
3. trifluralin + metribuzin / metribuzin	0.83+0.28/ 0.28	PPI/ PRE	100	100	97	100	100	90	60	97
4. trifluralin / metribuzin	0.83/0.56	PPI/PRE	100	100	100	100	100	95	97	98
5. trifluralin / metribuzin / acifluorfen[2] + bentazon	0.83/0.56/ 0.42+0.83	PPI/PRE/ E. POT	100	100	100	100	100	100	87	100
6. triflualin / metribuzin / acifluorfen[2] + bentazon	0.83/0.56/ 0.28+0.56	PPI/PRE/ E. POT	100	67	100	100	100	100	90	83
7. trifluralin / metribuzin / acifluorfen[2] + bentazon	0.83/0.56/ 0.28+0.56	PPI/PRE/ E. POT	100	97	100	100	100	93	90	92
8. trifluralin / metribuzin / acifluorfen[2] + bentazon	0.83/0.56/ 0.42+0.83	PPI/PRE/ E. POT	100	100	100	100	100	100	93	100
9. trifluralin / metribuzin/ naptalam + dinoseb	0.83/0.56/ 1.11+0.56	PPI/PRE/ E. POT	100	100	100	100	100	100	93	100
10. trifluralin / metribuzin / acifluorfen[2]	0.83/0.56/ 0.56	PPI/PRE/ L. POT	100	100	100	100	100	90	60	100
11. trifluralin / metribuzin / acifluorfen[2] + 2,4-DB	0.83/0.56/ 0.56+0.07	PPI/PRE/ L. POT	100	100	100	100	100	100	93	100
12. trifluralin / metribuzin / naptalam + 2,4-DB	0.83/0.56/ 0.83+0.025	PPI/PRE/ L. POT	100	97	100	100	100	97	93	100
13. trifluralin / acifluorfen[2]	0.83/0.42	PPI/E. POT	100	100	100	100	73	60	60	83
14. trifluralin / bentazon	0.83/0.83	PPI/E. POT	100	97	100	100	87	100	97	100
15. trifluralin / acifluorfen[2] + bentazon	0.83/0.28+ 0.56	PPI/E. POT	100	83	97	80	87	100	80	100
16. trifluralin / linuron[2]	0.83/0.56	PPI/PDS	100	93	100	100	0	53	57	87
17. trifluralin / linuron + 2,4-DB[2]	0.83/0.56+ 0.22	PPI/PDS	100	97	100	100	0	20	67	97
18. trifluralin / bentazon + 2,4-DB	0.83/0.56+ 0.07	PPI/E. POT	100	97	100	100	87	93	80	88
19. trifluralin / acifluorfen[2] + 2,4-DB	0.83/0.28+ 0.07	PPI/E. POT	100	93	100	100	83	92	97	97
20. trifluralin / naptalam + dinoseb	0.83/1.11+ 0.56	PPI/E. POT	100	93	100	100	90	83	87	87
21. trifluralin / glyphosate[3] + AG-98	0.83/0.024+ 1/2%	PPI/E. POT	100	100	100	97	7	3	90	83
22. metribuzin	0.56	PRE	100	97	100	93	97	93	93	90

[1]Table 7 continued.

Table 7. Continued.

	Treatment	Rate	Method of application[1]	Control: Pigweed spp. 7/6	Pigweed spp. 7/30	L. Crabgrass 7/6	L. Crabgrass 7/30	Cocklebur 7/6	Cocklebur 7/30	Morningglory 7/6	Morningglory 7/30
		(kg/ha)		%							
23.	acifluorfen[2]	0.42	E. POT	100	77	83	50	83	67	23	37
24.	bentazon	0.83	E. POT	90	26	53	17	87	100	43	73
25.	glyphosate[3] + AG-98	0.012+1/2%	E. POT	0	0	33	40	0	67	0	67
26.	glyphosate[3] + AG-98	0.024+1/2%	E. POT	0	0	0	43	0	93	0	17
27.	fluazifop[4]	0.28	E. FOT	0	3	63	100	0	50	20	50
28.	acifluorfen[2] + bentazon	0.28+0.56	E. POT	100	33	67	10	100	100	0	43
29.	acifluorfen[2] + 2,4-DB	0.28+0.07	E. FOT	100	67	100	27	97	90	63	63
30.	bentazon + 2,4-DB	0.56+0.07	E. POT	43	20	33	47	97	100	43	100
31.	acifluorfen[2] + bentazon + 2,4-DB	0.28+0.56+ 0.07+1/2%	E. POT	100	40	97	67	97	93	50	97
32.	naptalam + dinoseb	1.11+0.56	E. FOT	43	20	0	53	40	100	47	73
33.	acifluorfen[2]	0.83	L. FOT	0	17	7	33	0	60	7	70
34.	fluazifop[4] + bentazon +	0.28+0.83+	E. FOT	40	0	53	100	90	100	50	100
35.	fluazifop[4] + acifluorfen2	0.28+0.42	E. FOT	100	83	100	90	97	63	3	63
36.	fluazifop[4] + bentazon + acifluorfen[2] + AG-98	0.28+0.56+ 0.28+1/2%	E. FOT	97	67	100	100	90	97	53	50
37.	fluazifop[4] / bentazon	0.28/0.83	E. POT/POT	17	7	20	100	0	100	0	100
38.	fluazifop[4] / acifluorfen[2]	0.28/0.42	E. FOT/FOT	0	20	67	93	0	53	0	17
39.	fluazifop[4] / bentazon + acifluorfen[2]	0.28/0.56+ 0.28	E. FOT/POT	0	40	100	97	0	97	3	63
40.	bentazon / fluazifop[4]	0.83/0.28	E. FOT/FOT	80	20	0	83	90	100	76	40
41.	acifluorfen[2] / fluazifop[4]	0.42/0.28	E. FOT/FOT	100	57	100	87	80	73	30	30
42.	bentazon + acifluorfen[2] / fluazifop[4]	0.56+0.28/ 0.28	E. POT/ POT	97	33	100	100	83	100	30	63
43.	check (weedy)	----	----	0	0	0	0	0	0	0	0
44.	check (weed-free)	----	----	100	100	100	100	100	100	100	100
	LSD 0.05			21	31	36	27	25	30	41	38
	cv(%)			17	30	28	20	23	23	44	30

[1]PPI is preplant incorporated, PRE is preemergence, E. POT = applied 10 dap, POT = applied 18 dap, L. POT = applied 24 dap, PDS is postemergence directed spray.

[2]added 1/4% v/v AG-98 surfactant.

[3]reduced carrier volume 70 l/ha.

[4]added crop oil concentrate to all fluazifop treatments at 2.7 l/ha.

Table 8. Soybean injury, counts, and yields for weed control systems in soybeans (1984)[1].

	Treatment	Rate	Method of application[1]	Soybean injury 7/6	Soybean injury 7/30	Stand Counts 7/17	Yields 1/3
		(kg/ha)		-----%-----		#/3m	(kg/ha)
1.	trifluralin	0.83	PPI	10	0	25	0
2.	trifluralin + metribuzin	0.83+0.56	PPI	10	3	24	763
3.	trifluralin + metribuzin / metribuzin	0.83+0.28/ 0.28	PPI/ PRE	0	0	27	1152
4.	trifluralin / metribuzin	0.83/0.56	PPI/PRE	20	3	22	1378
5.	trifluralin / metribuzin / acifluorfen[2] + bentazon	0.83/0.56/ 0.42+0.83	PPI/PRE/ E. POT	30	10	25	1132
6.	triflualin / metribuzin / acifluorfen[2] + bentazon	0.83/0.56/ 0.28+0.56	PPI/PRE/ E. POT	37	3	21	1215
7.	trifluralin / metribuzin / acifluorfen[2] + bentazon	0.83/0.56/ 0.28+0.56	PPI/PRE/ E. POT	33	3	19	734
8.	trifluralin / metribuzin / acifluorfen[2] + bentazon	0.83/0.56/ 0.42+0.83	PPI/PRE/ E. POT	30	7	24	1086
9.	trifluralin / metribuzin/ naptalam + dinoseb	0.83/0.56/ 1.11+0.56	PPI/PRE/ E. POT	23	3	19	1202
10.	trifluralin / metribuzin / acifluorfen[2]	0.83/0.56/ 0.56	PPI/PRE/ L. POT	23	7	18	508
11.	trifluralin / metribuzin / acifluorfen[2] + 2,4-DB	0.83/0.56/ 0.56+0.07	PPI/PRE/ L. POT	17	27	14	763
12.	trifluralin / metribuzin / naptalam + 2,4-DB	0.83/0.56/ 0.83+0.025	PPI/PRE/ L. POT	20	13	28	1036
13.	trifluralin / acifluorfen[2]	0.83/0.42	PPI/E. POT	27	13	26	0
14.	trifluralin / bentazon	0.83/0.83	PPI/E. POT	3	3	25	1068
15.	trifluralin / acifluorfen[2] + bentazon	0.83/0.28+ 0.56	PPI/E. POT	13	3	26	1031
16.	trifluralin / linuron[2]	0.83/0.56	PPI/PDS	33	3	22	0
17.	trifluralin / linuron + 2,4-DB[2]	0.83/0.56+ 0.22	PPI/PDS	7	0	23	0
18.	trifluralin / bentazon + 2,4-DB	0.83/0.56+ 0.07	PPI/E. POT	7	0	22	698
19.	trifluralin / acifluorfen[2] + 2,4-DB	0.83/0.28+ 0.07	PPI/E. POT	33	13	22	1043
20.	trifluralin / naptalam + dinoseb	0.83/1.11+ 0.56	PPI/E. POT	13	0	24	526
21.	trifluralin / glyphosate[3] + AG-98	0.83/0.024+ 1/2%	PPI/E. POT	3	10	21	0
22.	metribuzin	0.56	PRE	13	0	22	640

[1]Table 8 continued.

Table 8. Continued.

	Treatment	Rate	Method of application[1]	Soybean injury 7/6	Soybean injury 7/30	Stand Counts 7/17	Yields 1/3
		(kg/ha)		-----%-----		#/3m	(kg/ha)
23.	acifluorfen[2]	0.42	E. POT	17	10	24	0
24.	bentazon	0.83	E. POT	10	0	17	0
25.	glyphosate[3] + AG-98	0.012+1/2%	E. POT	7	37	15	0
26.	glyphosate[3] + AG-98	0.024+1/2%	E. POT	0	23	16	0
27.	fluazifop[4]	0.28	E. POT	7	17	13	0
28.	acifluorfen[2] + bentazon	0.28+0.56	E. POT	23	10	17	0
29.	acifluorfen[2] + 2,4-DB	0.28+0.07	E. POT	10	23	14	0
30.	bentazon + 2,4-DB	0.56+0.07	E. POT	7	17	20	0
31.	acifluorfen[2] + bentazon + 2,4-DB	0.28+0.56+ 0.07+1/2%	E. POT	23	7	26	0
32.	naptalam + dinoseb	1.11+0.56	E. POT	13	13	18	0
33.	acifluorfen[2]	0.83	L. POT	0	40	25	0
34.	fluazifop[4] + bentazon +	0.28+0.83+	E. POT	20	3	24	0
35.	fluazifop[4] + acifluorfen[2]	0.28+0.42	E. POT	83	7	25	0
36.	fluazifop[4] + bentazon + acifluorfen[2] + AG-98	0.28+0.56+ 0.28+1/2%	E. POT	67	0	24	0
37.	fluazifop[4] / bentazon	0.28/0.83	E. POT/POT	10	37	22	0
38.	fluazifop[4] / acifluorfen[2]	0.28/0.42	E. POT/POT	7	47	18	0
39.	fluazifop[4] / bentazon + acifluorfen[2]	0.28/0.56+ 0.28	E. POT/POT	0	10	19	0
40.	bentazon / fluazifop[4]	0.83/0.28	E. POT/POT	10	0	20	0
41.	acifluorfen[2] / fluazifop[4]	0.42/0.28	E. POT/POT	20	3	19	0
42.	bentazon + acifluorfen[2] / fluazifop[4]	0.56+0.28/ 0.28	E. POT/ POT	13	10	24	0
43.	check (weedy)	----	----	0	0	17	0
44.	check (weed-free)	----	----	0	0	19	793
	LSD 0.05			22	19	8	368
	cv(%)			77	120	22	59

[1]PPI is preplant incorporated, PRE is preemergence, E. POT = applied 10 dap, POT = applied 18 dap, L. POT = applied 24 dap, PDS is postemergence directed spray.

[2]added 1/4% v/v AG-98 surfactant.

[3]reduced carrier volume 70 l/ha.

[4]add crop oil concentrate to all fluazifop treatments at 2.7 l/ha.

APPENDIX

Table 9. Precipitation data (0.1 cm quantities or more) - Agronomy Research Station, Stillwater, Oklahoma. (January 1 - December 31, 1983).

Date	Centimeters	Date	Centimeters	Date	Centimeters
January 19	0.4	May 11	0.7	September 26	0.2
January 22	0.5	May 13	3.4	October 4	0.3
February 1	4.1	May 14	3.4	October 7	0.9
February 5	0.3	May 18	2.6	October 8	0.4
February 20	1.8	May 21	3.0	October 11	0.9
February 21	0.8	May 28	1.7	October 12	0.4
February 22	0.6	May 29	2.7	October 17	0.9
March 4	1.7	May 31	1.4	October 18	0.1
March 5	0.5	June 6	0.2	October 19	1.1
March 20	0.5	June 11	2.9	October 20	6.1
March 23	0.3	June 14	0.7	October 21	8.2
March 24	0.3	June 18	0.2	November 1	0.2
March 26	3.1	June 25	0.3	November 2	0.3
March 27	0.5	June 26	0.6	November 7	0.4
March 29	0.2	June 27	1.5	November 9	0.5
March 30	0.9	June 29	2.9	November 10	0.2
April 2	0.4	August 20	2.2	November 19	1.6
April 4	0.7	September 5	0.2	November 23	1.7
April 5	2.2	September 13	2.8	November 27	0.8
April 8	0.1	September 14	0.1	December 3	0.4
April 13	0.2	September 16	0.5	December 19	0.6
April 22	0.3	September 20	1.5		

Table 10. Precipitation data (0.1 cm quantities or more) - Agronomy Research Station, Stillwater, Oklahoma. (January 1 - December 31, 1984).

Date	Centimeters	Date	Centimeters	Date	Centimeters
January 10	0.2	April 30	0.1	September 28	1.4
January 15	0.1	May 7	2.4	October 10	0.5
January 17	0.2	May 20	1.6	October 14	0.2
February 9	0.8	May 26	2.1	October 16	1.5
February 27	0.9	May 27	0.6	October 21	1.3
March 4	0.9	June 12	2.0	October 25	2.1
March 12	1.0	June 19	0.6	October 27	6.5
March 17	0.3	June 20	2.7	October 28	0.3
March 19	0.9	June 21	0.6	November 1	1.3
March 23	3.8	June 26	5.4	November 17	1.7
March 24	2.6	June 28	1.2	November 18	2.2
March 28	2.0	June 29	0.9	November 27	0.4
March 29	0.2	July 12	1.0	December 5	1.1
March 31	1.3	July 27	0.3	December 13	0.1
April 3	0.2	August 8	0.2	December 14	2.2
April 8	2.4	August 11	1.5	December 15	2.2
April 10	0.2	August 22	0.5	December 16	4.0
April 11	1.3	August 30	0.3	December 19	0.1
April 16	1.3	September 3	0.5	December 21	0.2
April 20	0.4	September 16	0.3	December 29	0.1
April 21	0.9	September 18	0.3	December 31	0.1
April 27	1.7	September 27	0.6		

PART II

EFFECTS OF HERBICIDES AND DEPTHS OF PLANTING ON SOYBEAN (*GLYCINE MAX*) INJURY

EFFECTS OF HERBICIDES AND DEPTHS OF PLANTING ON SOYBEAN (GLYCINE MAX) INJURY

Abstract. A field study was initiated in the spring of 1984 near Perkins, OK, to evaluate the effect of four herbicides, three rates of application, and two depths of planting on soybean (*Glycine max* L.) injury. The herbicides used in this study were chlorimuron (ethyl 2-[[[[(4-chloro-6-methoxypyrimidin-2-yl)amino]carbonyl] amino]sulfonyl]benzoate), imazaquin (2-[4,5-dehydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2yl]-3-quinolinecarboxylic acid), dimethazone (2-(2-chlorophenyl) methyl-4, 4-dimethyl-3-isoxazolidinone), and metribuzin (4-amino-6-(1,1-dimethylethyl)-3-(methylthio)-as-triazine-5(4H)-one). Depth bands were attached to the planter units to allow the soybean seed to be placed at a 1.9 or 3.8 cm depth in the soil. Data collected included visual weed control, visual soybean injury, and soybean stand counts. Adequate annual pigweed (*Amaranthus spp.*) and annual grass control were obtained when the high rate of these herbicides were used. Early in the growing season no significant difference in soybean injury between depths within a treatment was observed. However, significant soybean injury did occur between treatments. Three weeks

later there was a significant difference between depths of planting within treatments with the soybeans planted at the 3.8 cm depth visually having significantly less soybean injury. In general soybean stand counts were higher when planted at the 3.8 cm depth.

Additional index words. depth of planting, soybean injury, soybean stand counts, chlorimuron, dimethazone, imazaquin, metribuzin.

INTRODUCTION

The control of broadleaf weeds has been one on the most difficult objectives to achieve in a soybean production system. Four herbicides which show activity on a broad spectrum of broadleaf weeds are chlorimuron (ethyl 2-[[[[(4-chloro-6-methoxypyrimidin-2-yl)amino]carbonyl] amino] sulfonyl]benzoate), dimethazone (2-(2-chlorophenyl) methyl-4, 4-dimethyl-3-isoxazolidinone), imazaquin (2-[4,5-dehydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-3-quinolinecarboxylic acid), and the standard herbicide metribuzin (4-amino-6-(1,1-dimethylethyl)-3-(methylthio)-as-triazine-5(4H)-one). Preliminary data from Oklahoma and other southern states have shown excessive soybean injury from one or more of these herbicides. Some of the possible reasons for crop injury occurring in soybeans are; soil type, organic matter percentage, soybean variety, method of application, rate of application, and other environmental factors. Factors such as herbicide rate, rainfall after treatment, and soybean cultivar have been cited as important factors in determining the degree of injury to the soybean crop from metribuzin application (1). Sommerville and Wax (6) found that soybean injury increased with increasing depth of incorporation of 3.4 kg/ha chloramben. In field trails involving soybean stand establishment and yield as affected by herbicide and planting practices it was found that the herbicides metribuzin or vernolate (S-propyl dipropylcarbamothioate) had only minor effects on stand establishment and seed yield (2). Johnson (2) found that cultural variables such as seedbed condition, seed qualtity, and minor differences in sowing depth are often the major variables causing stand problems.

Greenhouse investigation of the tolerance of corn (Zea mays L.). on preemergence applications of pendimethalin (N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine) as affected by planting depth showed that no phytotoxic symptoms were observed at the 3.8 and 5.1 cm planting depths however phytotoxic symptoms were observed in corn planted at the 1.3 cm depth and slight injury was observed at the 2.5 cm planting depth (5). Narsaiah and Harvey (4) conducted experiments under growth chamber conditions to study the influence of depth of planting and temperature on alachlor injury to corn seedlings and in two seperate studies found that the maximum injury was observed when the corn was planted at the 2 or 2.5 cm depth and little or no injury was observed at the 8.0 cm depth. Jolley and Murray (3) conducted experiments involving the relationships of planting depths to control from soil applied herbicides and found that preemergence applications of metribuzin at the recommended rate gave no crop injury at the 2 or 6 cm planting depths. The objective of this research was to evaluate the effects of four herbicides, three rates of application, and two depths of planting on soybean injury and to evaluate visual weed control obtained from these herbicides.

MATERIALS AND METHODS

A field experiment was conducted in 1984 near Perkins in northcentral Oklahoma on a Teller fine sandy loam (fine-loamy, mixed, thermic, Udic Argiustoll) to evaluate the effects of herbicides and depths of planting on soybean injury. Treatments in the experiments were arranged in a 2x2 factorial design with four replications. Soil fertility was tested by the Soil, Water, and Plant Analysis Laboratory at Oklahoma State University and all nutrients were considered adequate. The soil pH at this site was 6.9 and there was 0.6 percent organic matter. Supplemental irrigation by an over-head side roll system was available and was used throughout the duration of the experiment; however, rigid irrigation schedules were not followed. Precipitation data for Perkins, Oklahoma during 1984 can be found in the Appendix, Table 3.

Individual plots were four rows, each 7.5 m long. Forrest soybeans were planted on a flat-bed culture with a row spacing of 91 cm with two rows planted at 1.9 cm and the other two rows planted at 3.8 cm. The weed infestation for the experimental area included annual pigweed spp. and annual grass spp.. Herbicides were applied preemergence (PRE) with a tractor mounted compressed air sprayer. A complete treatment list showing all herbicides and rates is shown in Table 1. The carrier volume for the PRE treatments was 141 l/ha. The PRE treatments were applied immmediately after planting. Rainfall of 0.64, 2.72, and 0.56cm was recorded 4, 5, and 6 days, respectively, after the herbicide application. Metribuzin was utilized as a standard for the comparison of chlorimuron, dimethazone, and imazaquin.

Data collected from the study included visual weed control and visual soybean injury. Ratings were made on a scale of 0 to 10 and converted to percent control or injury. Soybean stand counts were also taken.

RESULTS AND DISCUSSION

All rates of chlorimuron, dimethazone, imazaquin, and metribuzin gave excellent pigweed control of 95 to 100% 18 days after treatment (DAT) except the low rate of dimethazone at 0.56 kg/ha (Table 1). At 40 DAT only the two highest rates of chlorimuron, imazaquin, and metribuzin provided sufficient pigweed control with all rates of dimethazone providing inadequate control. All rates of dimethazone and imazaquin provided excellent annual grass control of 93 to 100% 18 DAT (Table 1). Only the 0.42 and 0.56 kg/ha rates of metribuzin provided sufficient grass control of 93 to 100%, respectively. In most instances chlorimuron treatments provided significantly less grass control than the other treatments 18 DAT. All rates of imazaquin, dimethazone at 1.12 and 1.68 kg/ha, and metribuzin at 0.56 kg/ha provided good to excellent annual grass control of 83 to 95% 40 DAT. In most cases all rates of chlorimuron provided significantly less annual grass control, 33 to 38%, compared to the other treatments.

Visual ratings for soybean injury 18 DAT indicated that no significant difference occurred between depths of planting within treatments so the values were pooled and analyzed together (Table 1). All herbicide treatments showed significant soybean crop injury 18 DAT at the 0.05 level. The highest crop injury of 40% occurred from metribuzin applied at 0.56 kg/ha. Visual soybean crop injury ratings taken 40 DAT showed a significant difference in soybean injury due to depth of planting (Table 2). In all cases soybean injury at the 3.8 cm planting depth was significantly less than or equal to the injury occurring from the 1.9 cm planting depth. Within the shallow planting depth (1.9 cm) the least amount of crop injury, 3 to 13%, occurred from all rates of dimethazone. In contrast, a significantly greater amount of crop injury, 33 to 43%, occurred from all imazaquin herbicide applications. At the deep planting depth (3.8 cm) the least amount of crop injury, 0 to 3%, also occurred from applications of dimethazone. The greatest amount of crop injury at the 3.8 cm planting depth, 24 to 38% occurred from imazaquin herbicide applications.

Statistical analysis revealed that there was a significant difference in soybean stand counts between depths of planting within treatments (Table 2). Within all treatments there were an equal or significantly greater number of soybean plants/3 m of row at the 3.8 cm planting depth. Within the 1.9 cm depth of planting the largest stand reduction occurred from 0.42 and 0.56 kg/ha of metribuzin. Within the 3.8 cm planting depth metribuzin at 0.42 and 0.56 kg/ha again resulted in the largest amount of stand reduction but was not significantly different from the check treatments.

In summary all treatments provided excellent pigweed control 18 DAT except the low rate of dimethazone. AT 40 DAT only the two highest rates of chlorimuron, imazaquin, and metribuzin provided satisfactory pigweed control. Excellent grass control 18 DAT was obtained with all rates of dimethazone, imazaquin, and the 0.42 and 0.56 kg/ha rates of metribuzin. Excellent grass control 40 DAT was obtained with dimethazone at 1.12 and 1.68 kg/ha and all rates of imazaquin. Early in the growing season, 18 DAT, no significant difference occurred between depths of planting within treatments. In contrast, 40 DAT, depth of planting was significant with the highest injury at both planting depths occurring from applications of imazaquin. Within all treatments soybean stand counts were equal to or significantly greater at the 3.8 cm planting depth.

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Table 1. Visual ratings for weed control and soybean injury with preemergence applications (1984).

	Treatment	Rate	Method of application[1]	Control				Soybean injury
				Pigweed spp.		Grass spp.		
				7/3	7/25	7/3	7/25	7/3
		(kg/ha)		%				
1.	chlorimuron	0.017	PRE	98	80	30	33	21
2.	chlorimuron	0.022	PRE	100	98	70	38	31
3.	chlorimuron	0.034	PRE	98	100	63	35	31
4.	dimethazone	0.56	PRE	48	20	93	63	21
5.	dimethazone	1.12	PRE	95	55	98	90	18
6.	dimethazone	1.68	PRE	98	73	100	93	24
7.	imazaquin	0.14	PRE	100	85	95	95	38
8.	imazaquin	0.28	PRE	100	100	100	90	15
9.	imazaquin	0.56	PRE	100	100	98	90	25
10.	metribuzin	0.28	PRE	98	55	73	50	25
11.	metribuzin	0.42	PRE	100	88	93	68	35
12.	metribuzin	0.56	PRE	100	93	100	83	40
13.	check (weedy)	----	---	0	0	0	0	0
14.	check (weed-free)	----	---	100	100	100	100	0
	LSD 0.05			8	27	25	37	14
	cv(%)			6	26	22	39	60

[1]PRE is preemergence application.

Table 2. Visual ratings for soybean injury with preemergence applications (July 25, 1984).

	Treatment	Rate	Method of application[1]	Soybean injury[2] Depth 1.9cm	Soybean injury[2] Depth 3.8cm	Stand Counts[2] Depth 1.9cm	Stand Counts[2] Depth 3.8cm
		(kg/ha)		------%	------	#/3m of row	
1.	chlorimuron	0.017	PRE	13	8**	21	29**
2.	chlorimuron	0.022	PRE	20	5*	23	30**
3.	chlorimuron	0.034	PRE	15	10**	27	29
4.	dimethazone	0.56	PRE	13	3**	18	31**
5.	dimethazone	1.12	PRE	3	0*	22	28*
6.	dimethazone	1.68	PRE	5	0**	19	28**
7.	imazaquin	0.14	PRE	40	24**	20	34**
8.	imazaquin	0.28	PRE	33	30*	27	29
9.	imazaquin	0.56	PRE	43	38**	22	27**
10.	metribuzin	0.28	PRE	13	5**	23	25
11.	metribuzin	0.42	PRE	23	18**	15	20**
12.	metribuzin	0.56	PRE	15	15	17	17
13.	check (weedy)	----	---	0	0	11	18**
14.	check (weed-free)	----	---	0	0	13	22**
	LSD 0.05			9	9	7	7
	LSD 0.01			11	11	10	10
	cv(%)			63	63	32	32

[1]PRE is preemergence application.

[2] * and ** denote a significant difference at the 0.05 and 0.01 level, respectively, between depths within a treatment.

APPENDIX

Table 3. Precipitation data (0.1 cm quantities or more) - Agronomy Research Station, Perkins, Oklahoma. (January 1 - December 31, 1984).

Date	Centimeters	Date	Centimeters	Date	Centimeters
January 10	0.7	May 5	0.1	September 28	0.7
January 15	0.3	May 7	2.5	October 10	0.4
January 17	0.2	May 14	0.1	October 13	0.4
February 9	0.5	May 19	0.3	October 14	0.1
February 18	0.3	May 20	5.7	October 15	0.2
February 26	0.2	May 27	0.6	October 16	1.1
February 27	1.8	May 28	0.2	October 20	0.9
March 4	0.3	June 10	2.2	October 21	1.0
March 12	1.3	June 11	0.3	October 25	2.2
March 17	0.4	June 19	0.8	October 26	0.1
March 18	0.5	June 20	0.3	October 27	4.2
March 19	0.3	June 21	0.3	October 28	0.1
March 23	4.7	June 22	0.2	November 1	1.0
March 24	3.6	June 26	5.0	November 17	1.5
March 28	1.9	June 28	0.8	November 18	3.0
March 29	0.1	June 29	0.6	November 19	0.2
March 31	1.8	July 27	0.1	November 26	0.4
April 1	0.3	August 5	0.5	December 5	0.6
April 2	0.2	August 9	1.7	December 13	0.5
April 3	0.3	August 10	0.1	December 14	2.8
April 8	2.7	August 13	0.3	December 15	2.9
April 10	0.3	August 28	0.9	December 16	5.3
April 11	1.3	August 30	0.5	December 21	0.5
April 21	3.6	September 2	1.0	December 29	0.3
April 27	0.2	September 3	0.5	December 30	0.7
April 30	0.4	September 9	0.6	December 31	2.1
May 2	0.1	September 18	0.3		
May 3	0.2	September 27	0.5		

VITA 2

Robert Brent Westerman

Candidate for the Degree of

Master of Science

Thesis: SOYBEAN (GLYCINE MAX) WEED CONTROL SYSTEMS AND THE EFFECTS OF HERBICIDES AND DEPTH OF PLANTING ON SOYBEAN INJURY

Major Field: Agronomy

Biographical:

Personal Data: Born in Hobart, Oklahoma, December 24, 1959, the son of Dr. and Mrs. Robert Lee Westerman. Married Connie Kirk on May 17, 1986 in Lawton, Oklahoma.

Education: Graduated from Stillwater High School, Stillwater, Oklahoma, in May, 1978; received a Bachelor of Science degree from Oklahoma State University, Stillwater, Oklahoma, with a major in Mechanized Agriculture, December, 1982; and completed the requirements for the Master of Science degree in Agronomy, May, 1988.

Experience: Student worker in the Agronomy Department at the Oklahoma State University Agronomy Research Farm, Stillwater, Oklahoma, May 1976 to December 1982 during which time I was involved in soybean variety testing, peanut variety and row spacing evaluation, and soil fertility evaluation on small grains and forage crops; and Senior Agriculturalist in row crop weed science under Dr. Don S. Murray, Oklahoma State University, Stillwater, Oklahoma, December, 1982, to the present.

Professional Memberships: Southern Weed Science Society.