8-1984

# Equipment for application of postemergence directed sprays for weed control in narrow-row no-tillage soybeans

Olakanmi J. Abolarin

To the Graduate Council:

I am submitting herewith a thesis written by Olakanmi J. Abolarin entitled "Equipment for application of postemergence directed sprays for weed control in narrow-row no-tillage soybeans." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Biosystems Engineering Technology.

Fred D. Tompkins, Major Professor

We have read this thesis and recommend its acceptance:

B.L. Bledsoe, Luther Wilhelm, William Hart

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

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

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The Graduate School

# EQUIPMENT FOR APPLICATION OF POSTEMERGENCE DIRECTED SPRAYS FOR WEED CONTROL IN NARROW-ROW NO-TILLAGE SOYBEANS

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Olakanmi J. Abolarin

August 1984

To my Parents, the late MR. & MRS. GEORGE "JEUN-AYO" ABOLARIN for their love, encouragement, and support. May their souls rest in perfect peace.

## ACKNOWLEDGMENTS

The author wishes to express his sincere thanks to the following:

Dr. Fred D. Tompkins, my major professor, who devoted his time and expertise in the editing of this thesis. His excellent leadership and guidance were essential components in this program.

Dr. B. L. Bledsoe, committee member, for his educational counseling and advice during my financially difficult times at The University of Tennessee.

Dr. Luther Wilhelm, committee member, for his advice, editing of this thesis, and assistance during the period of my graduate program.

Mr. William Hart, committee member, for his technical assistance in the set up, calibration, and operation of equipment used in this study. His time spent for collection of field data and suggestions to improve the thesis were very valuable.

Fellow graduate students, Dr. Robert Hayes and the staff at the Milan Experiment Station for their assistance in the collection of data.

My wife, Lucia Adunni, for her understanding and spiritual support during many discouraging times.

Finally, my God for his guidance and blessings throughout my life, especially during the educational programs in the United States of America.

ABSTRACT

A field study was conducted in 1983 at The University of Tennessee Milan Experiment Station to assess the potential for using tractor-mounted postemergence directed spraying equipment for weed control in no-tillage soybeans (Glycine max) planted with 20-inch row spacing in wheat (Triticum aestivum) stubble. Six commercial or experimental directed sprayers either designed exclusively for or adapted to use in 20-inch rows were used to apply a tank mix of linuron and 2,4-DB in 12-inch soybeans.

Crop injury due to both mechanical damage and chemical contact were subjectively assessed for each system. Sprayers producing the most injury (up to 40 percent) had some misaligned machine assemblies or had limited capability for adjustment of row protection shielding. Two shielded sprayers resulted in crop injury ratings of 10 percent or less.

A single herbicide application with any of the sprayers gave good control (80 to 88 percent) of cocklebur (Xanthium pensylvanicum) with no significant differences among applicators. Control of large crabgrass (Digitaria sanguinalis) was poor (40 percent) with all sprayers primarily because the grass was severely drought stressed at the time of application.

Drought conditions during the growing season resulted in abnormally low yields. No significant differences in yields were

shown among the treatments. However, yields in sprayed plots tended to be greater than those from untreated plots.

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# CHAPTER I

## INTRODUCTION

Large-scale production of soybeans [*Glycine max* (L.) Merr.] in the United States of America is due in part to the extensive use of farm machinery, such as tractors and spraying equipment. This equipment has also contributed to increased crop yields (Febre, 1968).

One restricting, and therefore undesirable, factor in the production of food, feed, and fiber is weeds. Weeds compete with crops for water, light, and mineral nutrients. According to Potts (1958), weeds are among the greatest negative influences on production costs for farmers. Losses caused by weeds on farms in the United States in the late 1950's reached an estimated 5 billion dollars per year, with an average grower losing 10 percent of the total value of his products. A survey conducted by Saunders et al. (1962) showed that losses caused by weeds in the United States are believed to equal the combined losses from insects and diseases and to rank second only to those caused by soil erosion. In recent years, Hill (1982) reported that, "if herbicides were not available, almost one-third of the annual production of our major crops would be lost, an economic value of $13 billion."

Various methods of weed control are being practiced throughout the world. For example, in Africa and Asia, weeds are still being controlled mainly by hand hoeing, cultivating, slashing and burning with some limited biological and chemical methods. These weed control methods differ in terms of labor costs, ecological impact, and mechanical and chemical inputs. But in North America (U.S.A. and Canada), chemical weed control is the most extensively used of all methods (Bullock, 1980).

Tillage practices were utilized extensively as integral parts of conventional weed control programs when herbicides were first introduced. But crop production systems employing several tillage operations made land vulnerable to erosion and had high fuel and labor requirements. Thus many agricultural innovators and researchers examined other land and crop management practices, such as no-tillage and double cropping, to reduce these negative impacts.

Many changes in the types and quantities of herbicides being used to control weeds on the farm have occurred over the years. According to Rogers (1973), effective weed control in soybeans often requires the use of postemergence herbicides. Since these herbicides require accurate deposition on the target for optimum results, application equipment that is accurate, precise, and reliable is needed.

Research was initiated in 1983 at The University of Tennessee Milan Experiment Station to evaluate the effectiveness of six post-directed sprayers for weed control in no-tillage narrow-row soybeans according to the following criteria:

A. Determine ease of adaptation of equipment to 20-inch row spacing.

B. Determine the percentage of mechanical and chemical injury to soybeans resulting from use of the directed applicators.

C. Determine the level of weed control afforded by each machine.

D. Determine the overall advantage of the directed applicators in terms of crop yield.

CHAPTER II

# REVIEW OF LITERATURE

## 1. SPRAYING EQUIPMENT DEVELOPMENT

Development of equipment and chemical application techniques to control weeds, insects and fungi started during the second chemical period, 1867 to early 1900's (Akesson and Yates, 1979). During this time, there was an increase in the number of farmers interested in utilizing chemicals to aid in increasing crop yields and obtaining higher quality, more profitable produce. According to Akesson and Yates (1979), another surge of equipment and application technique development occurred after World War I. But during the present chemical period, or since 1939, improvements in sprayers and application techniques have slowed. Drever et al. (1978) and Friesen et al. (1978) in separate reports mentioned that, while drastic changes in chemical availability and recommended usage were occurring, there was relatively little change in the field sprayers being produced. Friesen et al. (1978) commended the addition of boom wheels in the early sixties, which to them was a very important improvement since more constant nozzle height above the target and improved uniformity of application resulted.

Lack of attention given to development of improved sprayers and spraying techniques was world wide. In Britain, during the 1975 British Insecticide, Fungicide and Herbicide Conference, Bals (1975) reported that, while chemicals for pest control became more sophisticated, too little thought had been given to the weapons of delivery, whether they be large missiles or humble bullets. This statement was supported by Taylor and Merritt (1975) British scientists who noted in their report that,

> the cost of developing a successful new herbicide has been stated to be almost 4 million British pounds (about US $ 6 million). While much time and money are spent in searching for new herbicides, the equipment which is used to apply these products has received relatively little attention and has for many years remained essentially unchanged.

## 2. POSTEMERGENCE DIRECTED SPRAY APPLICATION

Postemergence directed spray application can be used if the crop is grown in rows and the crop is taller than the weeds. The spraying nozzles are positioned so that weeds between the crop rows are sprayed while ensuring that little or no herbicide formulation is allowed to contact the crop. Although postemergence directed application is not new, the concept has perhaps been de-emphasized because of the availability of postemergence, over-the-top selective herbicides. According to Fawcett (1983), postemergent herbicides have begun to come into their own because of the discovery of new topical herbicide chemistry.

Wooten and Williford (1971) observed that efficient post-emergence weed control in cotton (Gossypium hirsutum L.) required several factors including: uniformly emerging crop on a smooth seedbed, timeliness in application (since most weeds are more susceptible to chemicals during the early stages of growth), and use of proper equipment correctly adjusted to apply the necessary quantity of material at the right place. There are two general types of postemergence spray applications: topical sprays (those that are applied over the top of crop) and directed sprays (those that are applied under the crop foliage and between crop rows with weeds being the principal target). In comparing the two types, Wooten and Williford (1971) concluded that directed sprays have the following advantages compared to over-the-top broadcast applications: (a) residue problems are minimized, (b) better weed control is obtained, and (c) there is less crop damage. Another difference noted was that a smaller quantity of herbicide was required with the directed sprayer to obtain the same level of weed control as with a topical application.

Overton and Andrews (1966), conducting research in Tennessee, reported that good control of emerged cockleburs (*Xanthium pensylvanicum* Wallr.) in soybeans was obtained with a topical application of 1/8 to 1/4 lb of 2,4-DB applied over-the-top between 10 days prior to blooming and the mid-bloom stage. Directed application of 1/16 to 1/4 lb of 2,4-DB to cockleburs that were 8 inches tall resulted in good control. The lower rates used with directed application were less effective when applied topically. This sug-suggests that post-directed application may save substantial quantities of chemical, thereby making soybean production more profitable.

The height differential between the soybeans and the weeds must be considered in the application of herbicides using postemergence directed techniques. In particular, soybeans must be taller than weeds for effective application of post-directed sprays. If the crop foliage is sprayed, soybean injury may result. Rogers (1973) suggested during an interview about postemergence herbicide application in soybeans with a Weed Today correspondent that good seedbeds should be prepared for the beans to give an early growth advantage over weeds. However, such an advantage may not exist naturally in no-tillage plantings.

Ashburn (1981) recommended that applications of 2,4-DB and linuron, separately or as a tank mix, should be directed toward the base of soybean stems when soybeans are over 8 inches tall. He warned against applying these chemicals over-the-top. He further emphasized that herbicides are most effective on weeds less than 3 inches tall, and that the tank mix combinations provide effective control of small grasses and broadleaves such as morningglory [*Ipomea purpurea* (L.) Roth], cocklebur and pigweed (*Chenopodium album*).

Buchanan and Hoveland (1971) reported that the most effective method of controlling sicklepod (*Cassia obtusifolia* L.) in soybeans has been by using postemergence herbicides. They observed that chloroxuna (Tenoran, Ciba-Geigy) applied when sicklepod was less than 2 inches in height usually was adequate for control. They concluded that directed applications were more effective than over-the-top treatments. Hamilton and Arle (1970), researchers with the

Arizona Agricultural Experiment Station, found that the use of directed applications of low rates of herbicides had the advantages of lower cost of herbicides, safety to cotton, effective weed control, and little herbicide residue in the soil which might affect following crops.

Although postemergence directed sprays require precise application, directing the spray allows the use of non-selective herbicides that might cause excessive injury if applied over the top of soybeans. The non-selective herbicides may be effective against both grasses and broadleaf weeds. Directed treatments can be very effective on late germinating weeds or weeds that have been stunted by soil-applied herbicides. And very favorably, post directing may be the most inexpensive application technique since a selected portion of the field (between the plant rows and base of the beans) is sprayed compared to over-the-top application that requires spraying the entire field (Ashburn, 1983).

## 3. POSTEMERGENCE DIRECTED SPRAY EQUIPMENT

Postemergence directed application was introduced as a technique for extending the use of many herbicides that would cause undue damage if brought in contact with the crop (Akesson and Yates, 1979). Two general types of directed spray applicators in common use are: (1) the parallel-acting shoe and (2) the shield type.

According to Wooten and Williford (1971), the parallel-acting shoe applicator consists of a flat metal skid or shoe that is mounted to the carrier through a parallel-acting linkage. The front of the shoe is curved upward to allow skidding over the soil surface. Spray nozzles are mounted on skids to control height and direction of herbicide application (Overton et al., 1971). The postemergence directed sprayer used by Overton et al. (1971) at Jackson, Tennessee was mounted on the rear of a tractor equipped with a cultivator, while the one used by Wooten and Williford (1971) at Stoneville in Mississippi was mounted on the front of a tractor and used in conjunction with a rear-mounted cultivator. Wooten and Williford also reported that high-clearance versions of this applicator were available, providing clearance for large plants and allowing mid-season application in cotton.

Most of the new directed applicators are equipped with shields. The shield-type applicator is similar to the parallel-acting shoe except the shoe is much shorter and attached to the outside of a row shield (Wooten and Williford, 1971). The shield is usually 6 to 8 inches in height and 2 to 4 feet in length. The purpose of the shield is to prevent the herbicidal sprays from contacting the crop while en route to the target area (Jordan and Barrentine, 1976; Wooten and Williford, 1971; Akesson and Yates, 1979; and Klingman and Ashton, 1982). Although Klingman and Ashton (1982) suggested that since the crop is taller than the weeds, spray shields may not be needed if nozzles that allow little spray drift are chosen. But good application can be achieved only if nozzle height and direction are carefully controlled. Wooten and Williford (1971) emphasized the need for careful consideration in setting nozzles for maximum coverage of grass and weeds with minimum coverage of the crop foliage.

Early postemergence directed applicators used to control weeds in soybeans were designed for two to four rows with a row width of 40 inches (Overton et al., 1971). According to Jordan and Barrentine (1976), applicator nozzles were tilted downward to provide a 16- to 20-inch band of coverage. However, double-cropped, no-tilled soybeans in wheat stubble are usually planted with row spacing of 20 inches or less. Narrow row spacing reduces weed competition due to shading provided by the crop canopy (Jeffery et al., 1980) and enhances yield (Graves et al., 1980). Little information has been reported about the availability and performance of directed spray equipment for use in soybeans grown with 20-inch row spacing.

4. USE OF POSTEMERGENCE APPLICATION IN NO-TILLAGE SOYBEANS

No-tillage systems were introduced for soybean production to reduce land erosion, lower fuel consumption, lessen labor requirements, and make possible the production of two crops within a single growing season. Lewis (1978) and Mitchell et al. (1977) reported other advantages associated with no-tillage, including reduction in seedbed preparation time and earlier planting dates.

Emergence of weeds may be quicker under no-tillage systems than with conventional seedbed preparation (Bullock, 1980). Hence postemergence directed herbicides such as 2,4-DB, linuron, or paraquat should be applied at the correct time after the weeds emerge and before they reach the height of the beans. Bauman and Jordan

(1982) observed that weeds present when the soybeans are in the second to fifth trifoliate leaf stage can be controlled with early post-emergence treatment of Basagran (bentazon, BASF), Blazer (acifluorfen, Rohm & Haas), Hoelon (diclofop, American Hoechst), Vistar (mefluidide, 3-M) or Dyanap (dinoseb & alanap, Uniroyal). They emphasized that the size of the weeds is important when using postemergence herbicides. Early postemergence application of Hoelon will control most annual grasses when the grasses are less than one and one-half inches tall. Hobart (1982) also reported that in fields with an appropriate broad-leaf weed population, timing for the Blazer applications should be about 14 to 21 days after planting. Thus, control will be effected before weeds can reduce potential yields.

Postemergent treatments are also useful on peat or muck soils where soil-applied herbicides may be ineffective (Fawcett, 1983). Certain perennial weeds such as horseweed (*Erigeron canadensis*) and johnsongrass [*Sorghum halepense* (L.) Pers.] have increased in economic importance. They regrow from deep root systems, escaping the effects of many soil-applied herbicides. Fawcett (1983) observed that postemergence herbicides such as Roundup (glyphosate, Monsanto), which translocate or move from the leaves of weeds to root systems, are useful to control perennial weeds. Certain large-seeded annual weeds such as cockleburs may be difficult to control with soil-applied herbicides due to their ability to emerge from depths below the herbicide zone. Postemergent herbicides can be effective on these weeds.

Fawcett (1983), in other postemergent weed control studies, observed that some weeds are difficult to control because they continue to germinate throughout the growing season. He found that postemergent treatments can be used to control weeds that emerge after soil-applied herbicides have degraded. He further noted that new topical postemergent grass control herbicides for soybeans such as Poast (sethoxydim, BASF) and Fusilade (fluozifop, ICI) will be very useful in controlling tough annual weeds such as shatter cane Sorghum bicolor (L.) Moench], wild prosomillet (Panicum miliaceum L.), cupgrass [Eriochloa gracilis (Fourn.) Hitchc], as well as perennial weeds, such as johnsongrass and quackgrass [Agropyron repens (L.) Beauv.].

## 5. SOYBEAN CULTURAL PRACTICES

Soybean yields can be increased with an effective weed control program that includes good cultural practices in addition to timely application of postemergent herbicides. Two practices commonly employed in soybean production by Tennessee farmers are: (1) no-tillage planting in a double cropping system with winter wheat and (2) use of narrow-row spacing to enhance yield.

### Double Cropping

Double cropping involves planting and harvesting two crops in a one-year period. Soybeans in West Tennessee are typically planted in wheat stubble following grain harvest in mid June. Jeffery et al. (1980) reported that successful double cropping requires skilled management and careful planning. Timing is critical, since soybeans must be planted as soon as possible after wheat harvest to obtain highest yields. They suggested that, in planning a double cropping system, such factors as weed population, weed species, water supplying capacity of the soil, and planting equipment must be considered. Graves et al. (1980) concluded from studies comparing single-cropped and double cropped soybeans that yields were reduced 19 percent by double cropping. However, the wheat yields obtained in the double-crop scheme more than offset the yield reduction from soybeans, making double cropping of soybeans and wheat appear to have economic advantages over single-cropped soybeans.

Beale and Langdale (1967) found that differences in soybean yields due to tillage practice in South Carolina were not significant. They further concluded that tillage and residue management had no marked influence on soil temperature and available moisture. Peters (1967) found that Kent, Clark 63, and Hill soybean varieties were the most suitable for double-cropping systems in Tennessee.

## Narrow Row Spacing

Soybeans have traditionally been planted in rows spaced approximately 40 inches apart. However, several studies with certain varieties, including Wayne and Amsoy, have shown increased yields with rows spaced less than 40 inches (Graves et al., 1980; Kapusta, 1982; Wax and Pendleton, 1968). In the Southern states, many farmers who plant soybeans into wheat stubble use narrow rows partly as a weed control practice. As the soil is shaded by the crop canopy, weed establishment is reduced and crop competition is increased.

Kapusta (1982) found that narrow row spacing (7 to 20 inches) resulted in more rapid development of the crop canopy. Canopy closure is very effective in reducing weed problems. He concluded that soybean varieties best adapted for full-season planting also give optimum double-crop yields. Other data collected in Illinois indicated a significant advantage associated with growing soybeans in 20-inch rows as compared with production in 30- or 40-inch rows (Wax and Pendleton, 1968). Yields were higher in the narrower rows. The 20-inch rows had an advantage over 10-inch rows in that they could be mechanically cultivated at least once if necessary. Wax and Pendleton (1968) also reported that weed control by either chemical herbicides or cultivation was more effective in 20-inch rows than in 40-inch rows.

Graves et al. (1980), in Tennessee research between 1974 and 1976, evaluated five soybean varieties for no-till planting. In comparing rows spaced 40 and 20 inches planted following wheat harvest, they found that the average response of all varieties to the closer row spacing was 5 bushels additional yield per acre. A significant response to the closer row spacing was obtained each year. A similar experiment conducted at The University of Tennessee Milan Experiment Station in 1970 and 1972 by Jeffery et al. (1980) revealed that slightly greater yields were obtained from 20-inch rows than from 40-inch rows in the weed-free checks, and that substantially greater yields were obtained with the 20-inch row spacing in the weedy check plots. The latter results were attributed to reduced weed competition due to shading provided by the crop canopy. They concluded that positive yield responses associated with narrow row spacing were even greater in some cases involving use of particular herbicides.

## 6. POSTEMERGENCE DIRECTED HERBICIDES AND WEED CONTROL IN WHEAT-SOYBEAN DOUBLE CROP SYSTEMS

Postemergence herbicides are often required to maintain effective weed control in soybeans over the growing season. This is especially true in fields where soybeans are grown continuously and infestations of broadleaf weeds are common (Rogers, 1973). Rogers (1973) observed that, while preemergence herbicides have given good control of annual grasses, some broadleaf weeds such as cocklebur, morningglory and wild poinsettia [*Euphorbia* *pulcherrima* (Willd.) ex Kl.] have been only partially controlled. He also found that postemergence herbicides applied as directed sprays were effective in controlling these problem weeds while inflicting little or no crop injury.

Two herbicides commonly applied with postemergence directed equipment are 2,4-DB and linuron. Descriptions of modes of actions for these herbicides and results of field studies involving the two chemicals are summarized below.

### 2,4-DB

2,4-DB [4-(d,4-Dichlorophenoxy) butyric acid] applied as a directed spray is recommended for control of cockleburs in soybeans (Muzik, 1970). Application should be made when the soybeans are 8 to 12 inches tall (Graves et al., 1974; Klingman and Ashton, 1982).

The chemical is also recommended for emergency use if the cockleburs form a canopy over the soybeans (Graves et al., 1974).

2,4-DB is absorbed through the plant foliage. According to Ashton and Crafts (1973) and Potts (1958), the cells of cuticular and epidermal layers of the leaf begin breaking down within a few hours. The 2,4-DB rapidly penetrates to the inner cells. When it reaches the inner veins and is carried into the plant system, nucleic acids increase, resulting in unordered expansion growth. Later, development of callus-like tissues in the cortex and pith will result in death and destruction of the weed.

Ashburn (1981) recommended application of 2,4-DB either separately or as a tank mix with other chemicals in a spray directed at the base of soybean stems to control weeds up to 3 inches tall. He suggested that Sencor (metribuzin, duPont) could be used in a tank mix with 2,4-DB to enhance weed control. Ashburn further observed that an appropriate tank mix provides the most effective control of sicklepod. Postemergence applications of 2,4-DB are being recommended by several Southern states for controlling cockleburs in soybeans (Overton et al., 1971).

Rates of 0.125 to 0.2 lb active ingredient (ai) per acre of 2,4-DB were applied to soybean 8 inches or less in height at The University of Tennessee Milan Experiment Station in 1968 and 1969 without severe crop injury and with fair to good cocklebur control (Overton et al., 1971). Overton et al. (1971) observed that soybeans showed tolerance to the 0.2 lb ai/A, which gave better weed control than lower rates. Previous work had shown that directed application of 2,4-DB in combination with cultivation resulted in adequate cocklebur control with minimum injury to soybeans (Overton et al., 1971).

A directed spray application of 2,4-DB to the lower 3 to 4 inches of soybean plants at least 10 to 12 inches tall has given excellent control of 4- to 6-inch cockleburs and morningglory (Rogers, 1973; Weed Science, 1979). The spray gave no control of annual grasses and hemp sesbania [Sesbania exaltala (Raf.) Cory], however.

Linuron

Linuron [3-(3,4-dichloropheny)-1-methoxy-1-methylurea] is a very active postemergence herbicide with some preemergence activity (Buchanan and Hoveland, 1971; Henard, 1970). Linuron applied to the leaf surface penetrates cuticular and epidermal layers to varying degrees (Kearney and Kaufman, 1975). Phytotoxicity of this herbicide can be significantly increased by the addition of surfactants to the spray mixture (Klingman and Ashton, 1982; Kearney and Kaufman, 1975). According to Kearney and Kaufman, a fraction of the compound not only reaches the photosynthesis mesophyll cells, but also the tracheal veins by which it moves in the peripheral and/or acropetal direction. However, there is little or no entry into the phloem system and, therefore, practically no translocation into stem or leaves by the assimilate stream. They also noted that suggestions that surfactants may induce phloem or downward movement have not been substantiated by actual measurements.

Currey and Whitty (1973) reported good control of annual grasses and most broadleaf weeds with linuron, but they strongly discouraged its use on light sandy soils. They also found that linuron plus a surfactant applied as a directed spray to 12-inch soybeans gave excellent control of most broadleaf weeds.

Klingman and Ashton (1982) reported that best results from foliar application are obtained when weeds are young and succulent, temperatures are 70°F or higher, and humidity is high. Postemergence application in corn (*Zea mays* L.), cotton, grain sorghum [*Sorghum bicolor* (L.) Moench], and soybeans should be directed to minimize the amount of linuron received by crop plants.

Linuron gives short-term control of annual weeds on cropland. At recommended application rates, the average persistence of linuron is about four months (Weed Science, 1979; Klingman and Ashton, 1982).

### Linuron and 2,4-DB Combination

Linuron and 2,4-DB in a tank mixture are effective against most soybean weeds in Louisiana (Rogers, 1973). Such a mixture is particularly valuable in fields infested with several species of weeds. Moreover, the necessity of selecting herbicide treatments on a field-to-field basis is eliminated. Rogers (1973) reported that there seems to be an additive effect from mixing the two chemicals since the combination gives better control of some weed species than either herbicide alone. But a report from Frans (1970), who conducted research at the Arkansas Agricultural Experiment Station, indicates that topical application (over-the-top) of mixtures of low concentrations of 2,4-DB and linuron were found to be damaging to the extent of reducing soybean yields. Yield reductions corresponded to increasing 2,4-DB concentrations in the spray.

Graves et al. (1980) found that, with no-till double cropping of soybeans following wheat in Tennessee, a mixture of alachlor (2 lb ai/A) plus linuron (0.75 lb ai/A) plus paraquat (0.5 lb ai/A) plus surfactant consistently gave good to excellent control of annual grasses and common ragweed (*Ambrosia artemisiifolia* L.). They observed that when 1.5 lb ai/A of glyphosate was substituted for paraquat in this mixture, excellent weed control was obtained.

Linuron plus surfactant was evaluated by Overton et al. (1971) at The University of Tennessee Milan Experiment Station and West Tennessee Experiment Station for six years. The mix was applied as a directed spray at rates of 0.125 to 2.0 lb ai/A to soybeans in several stages of growth. Rates of 0.6 lb ai/A and above were injurious in 1964, and yields were consequently lowered. The 0.15 lb ai/A rate gave inadequate weed control, but the 0.3 lb ai/A rate gave excellent control of grasses and broadleaf weeds with only slight injury to 6- to 8-inch tall soybeans. They concluded that the 0.5 lb ai/A rate of linuron with surfactant resulted in effective weed control in 8- to 10-inch soybeans with slight to moderate vigor reduction, but allowed good recovery of the soybeans. In another test, the tank mix of linuron plus 2,4-DB gave high yields and excellent control, although moderate injury occurred (Overton et al., 1971).

# CHAPTER III

# MATERIALS AND METHODS

## 1. PLOT SELECTION AND EXPERIMENTAL DESIGN

A field study was conducted at The University of Tennessee Milan Experiment Station from June through October, 1983. Six equipment systems for application of postemergence directed sprays were evaluated for performance in narrow-row, no-tillage soybeans. The soil in the plot area was classified as Calloway silt loam. Fertilizer having a chemical analysis of 30-60-30 was applied to the soil at a rate of 244 pounds per acre in the fall of 1982 prior to seeding wheat. Each plot consisted of eight 20-inch rows, 30 feet long. A 20-foot alley for turning machinery was located at the end of each block of plots.

The experimental design was a randomized complete block with seven treatments. Treatments consisted of herbicide formulation applied with six directed sprayers and a control where no herbicide was applied. The sprayers are identified in Table 1. Each treatment was replicated four times. Sprayer evaluation was based upon visual assessment of weed control obtained within the treated rows. Data representing mechanical and chemical injuries to the crop and soybean yield were also obtained from each treatment.

Table 1. Directed sprayers used for applying a herbicide tank mix of linuron plus 2,4-DB in no-tillage soybeans seeded in 20-inch rows.

| Treatment | Sprayer |
|---|---|
| 1 | KMC Chemical Cultivator Shielded Sprayer (Kelley Manufacturing Company, Tifton, Georgia) |
| 2 | H & H Crop Guard Sprayer, Model CG-820-PM (H & H Farm Machine Co., Indian Trail, North Carolina) |
| 3 | S & N Sprayer (S & N Sprayer Co., Greenwood, Mississippi) |
| 4 | Brown Shielded Sprayer (Brown Manufacturing Company, Ozark, Alabama) |
| 5 | Roberts Shielded Sprayer (Johnny Roberts, Halls, Tennessee) |
| 6 | Experimental Prototype Directed Sprayer (Milan Experiment Station, Tennessee) |
| 7 | Control (unsprayed plots) |

# 2. EQUIPMENT

## Liquid Supply System

The plumbing system used with all sprayers was connected as shown schematically in Figure 1. The main components were: (1) tank, (2) agitator, (3) roller pump, (4) strainers, (5) reinforced rubber hose, (6) control valves, (7) pressure regulator, and (8) pressure gauge.

A 50-gallon metal tank was mounted on a saddle attached to the front of an International Harvester Model 454 tractor. The PTO-driven Delavan roller pump (Model N7-3110) supplied fluid to the nozzles and the hydraulic agitator. The inlet to the pump was protected by a 50-mesh stainless steel suction strainer connected to the three-quarter-inch suction hose. The discharge side of the pump was connected to an on-off valve. This valve was used to control flow to the nozzles.

A line equipped with a flow control valve connected the pressure side of the system to the hydraulic agitator. This hydraulic agitator was fixed to the bottom of the tank to provide adequate mixing of the chemicals.

The pressure regulator was used to adjust and maintain the desired operating fluid pressure at the nozzles while spraying and to bypass all the flow to the tank when flow to the boom was stopped. The pressure gauge indicated the pressure at a given point in the system and was located between the pressure regulator and the nozzles.

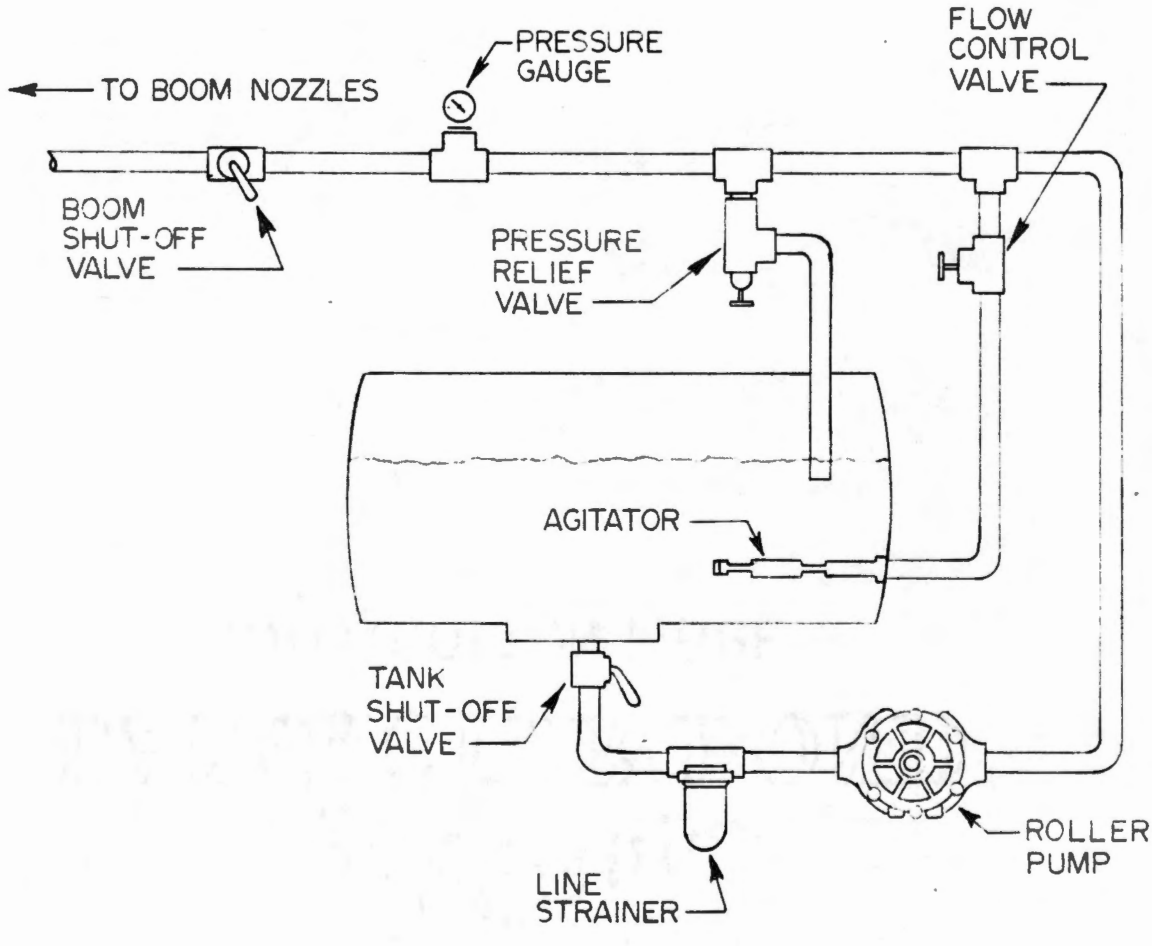


Figure 1. Schematic of the liquid handling system used to supply fluid to each of the directed spray applicators included in the field test.

The pressure gauge was positioned near the operator to allow monitoring of system pressure during chemical application.

Postemergence Directed Applicator Set Up and Calibration

A. Set Up. Some of the sprayers obtained for evaluation were delivered unassembled. The unassembled units were subsequently set up and adjusted in accordance with the manufacturers' or suppliers' instructions. Manufacturers' representatives were not present during the assembly, adjustment, and field testing.

B. Calibration. The spraying systems were checked to ensure that all components were clean and in good working condition. The tractor used to operate all the sprayer units was driven several times over a 200-foot course with ground conditions similar to the test plots. The average time required to travel the 200 feet was recorded. This was approximately 57 seconds. From the above information, the calibration speed of 2.4 miles per hour was calculated.

With each sprayer operating at the desired fluid pressure (25 pounds per square inch) to be used in the field, the volume of water delivered from several randomly selected nozzles was collected in graduated cylinders for a specified time interval (usually 60 seconds). Nozzle delivery rates were then calculated using the quantity of water collected and the measured time. Delivery rate divided by the area covered per unit time determined the application rate. Calculated sprayer unit application rates, in gallons per acre, are shown in Table 2.

Table 2. Nozzle tips used to outfit each directed spray applicator and resultant application rate when the system was operated at 2.4 miles per hour with a fluid pressure of 25 pounds per square inch.

| Sprayer | Spray Nozzles | Actual Application Rate (gpa) |
|---|---|---|
| 1. Kelley | 150-degree flat fan | 21.3 |
| 2. H & H | 80-degree even spray | 19.7 |
| 3. S & N | Flooding | 20.4 |
| 4. Brown | 150-degree flat fan | 21.3 |
| 5. Roberts | 80-degree flat fan | 21.3 |
| 6. Experimental | 80-degree flat fan | 21.3 |

# 3. DESCRIPTION OF APPLICATORS

## KMC Chemical Cultivator Shielded Sprayer

An eight-row (20-inch row spacing) KMC Chemical Cultivator shielded sprayer was provided by Kelley Manufacturing Company of Tifton, Georgia (see Figure 2). The tool bar of the 3-point-hitch-mounted machine was a 2-inch by 5-inch by 3/16-inch thick rectangular steel tube with the 5-inch side oriented vertically. Lateral motion of the sprayer was limited through use of a 21-inch stabilizing coulter mounted at the center of the tool bar. Vertical adjustment of the coulter standard allowed the tool bar to be positioned at the desired operating height.

Shield assemblies for each row middle were independently suspended and were each supported by 4-inch width pneumatic gauge wheels. These gauge wheels were bolted to 2-inch square tubular carrier arms which attached to the tool bar. The arms allowed 16 inches of flotation, 8 inches above and 8 inches below horizontal. Shields constructed of 14-gauge steel sheet enclosed the nozzles on three sides to prevent chemical drift onto the crop row. Shields could be adjusted from ground level to a height of 6 inches in 2-inch increments. A flat bar near the bottom of the shield and immediately behind the gauge wheel was designed to push large weeds forward to insure that the spray pattern of the nozzle was not distorted. Shields were flared in front to funnel plants in the crop row into the protected zone without mechanically damaging limbs and foliage.

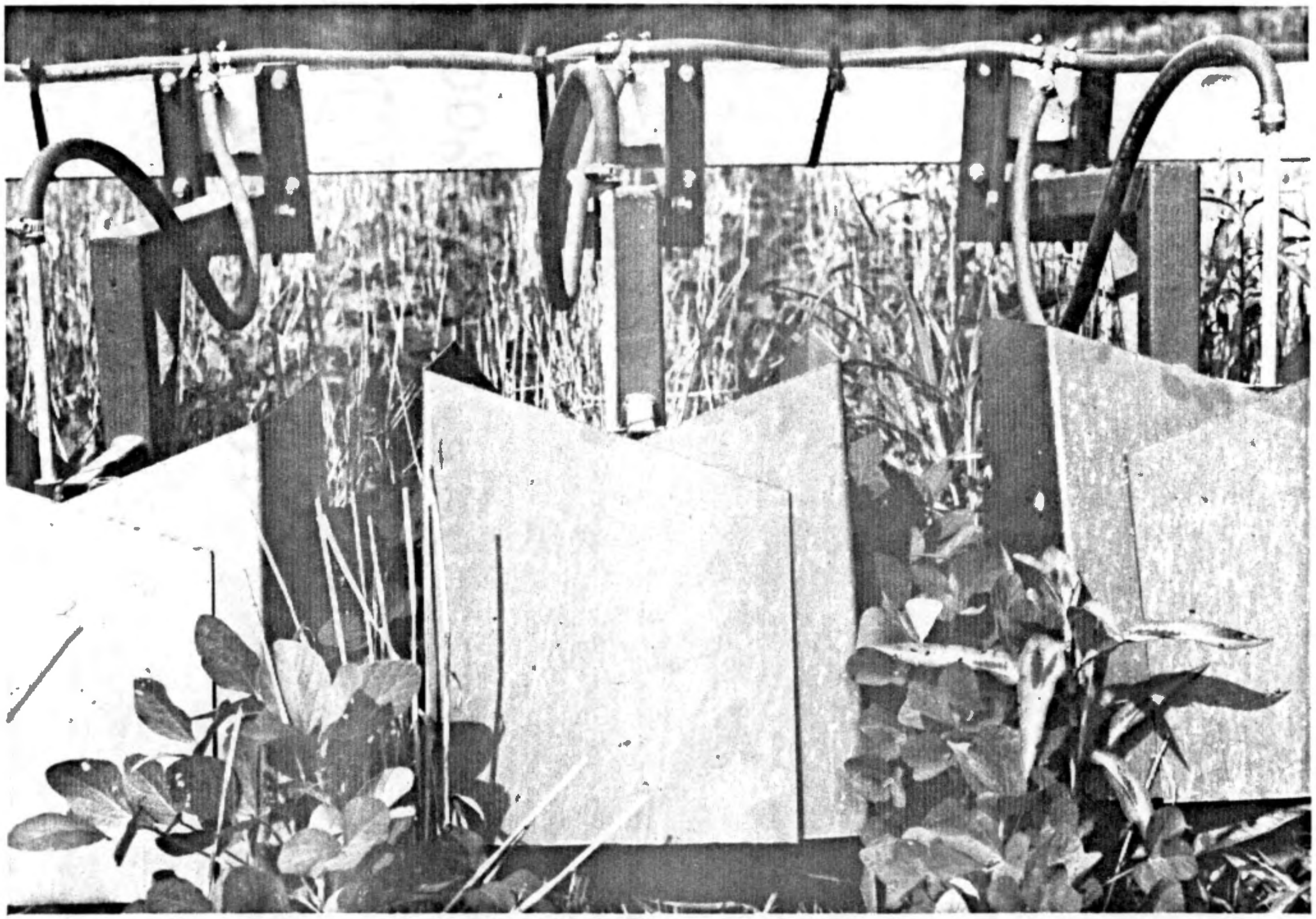

Figure 2. The KMC Chemical Cultivator featured 150-degree flat fan nozzles enclosed on three sides by adjustable metal shields to accommodate various row spacings.

All hoses on the sprayer were 1/2-inch diameter with 200-psi pressure rating. The feeder hose from the pump connected to a lateral hose which lay on the tool bar. Tees in this lateral hose allowed fluid to be delivered to individual row middles. The aluminum spray tube between the delivery hose and nozzle body could readily be adjusted vertically allowing the nozzle to be positioned from ground level up to 16 inches high. All nozzles and tees were constructed of brass. The seven inboard row middle units were equipped with 15002 (Spraying Systems Company) flat fan nozzle tips while the two outside units had similar tips with half the flow capacity.

H & H Crop Guard Sprayer

An H & H Crop Guard Model CG-820-PM sprayer, manufactured by H & H Farm Machine Company of Indian Trail, North Carolina, was set up to accommodate eight 20-inch rows (see Figure 3). The tool bar of the 3-point-hitch-mounted sprayer was a 2-inch by 3-inch by 1/4-inch thick rectangular steel tube with the 3-inch dimension oriented vertically. This tool bar was supported by two pneumatic 4.80 X 8 gauge wheels. To establish the desired tool bar operating height above the ground surface, the gauge wheels were vertically adjustable in 4-inch increments to five positions on the standard.

Shields designed to protect the crop rows from chemical injury were constructed of noncorrosive, high-density polyethylene. These shields, measuring approximately 26.5 inches long by 17.5 inches in height, were supported by a metal framework attached directly to the tool bar. In addition to being adjustable along the tool

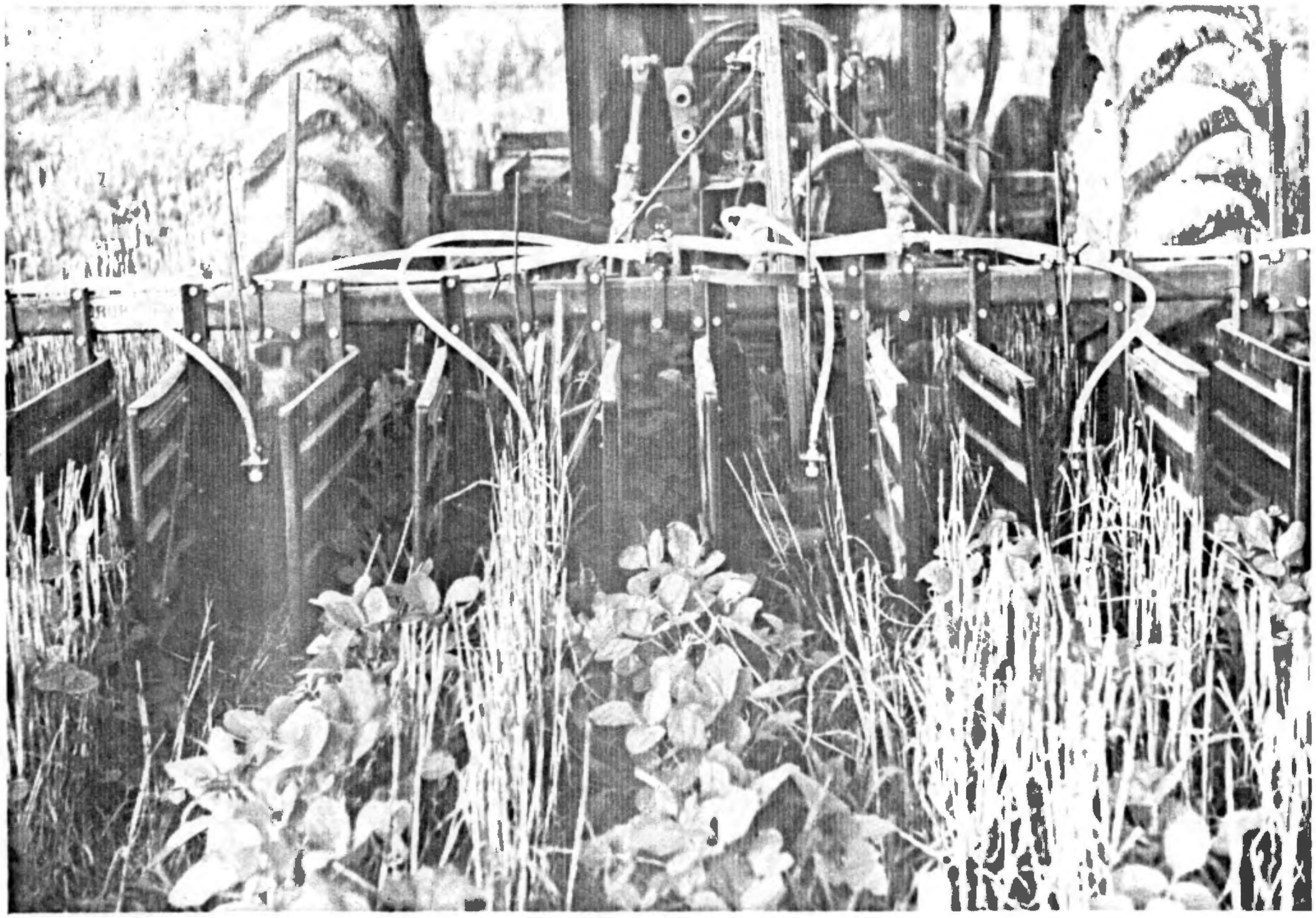

Figure 3. The H & H Crop Guard directed spray applicator equipped with plastic shields to protect the crop from chemical injury. The chemical is applied through even spray nozzle tips.

bar for various row spacings, the shields could also be oriented at angles of up to 25 degrees from vertical to accommodate wide crop canopies while allowing herbicide application close to the base of the plants in the row.

Liquid conduits on the sprayer were clear plastic tubes. A 3/4-inch diameter tube delivered fluid from the tractor-mounted pump to each of two manifolds, one mounted on either side of the center of the tool bar. A 0- to 100-psi pressure gauge was mounted in one of the manifolds. A 3/8-inch diameter tube connected a given manifold to an individual nozzle. Vertical nozzle position was readily adjustable over a 19-inch range. All fittings and fluid-contacting components were fabricated of non-metallic materials.

Each row middle was sprayed with one 8002E (Spraying Systems Company) even spray nozzle centered between two crop rows. The last nozzle on each end of the machine was an OC06 (Spraying Systems Company) off-center tip which sprayed only half the row.

S & N Shielded Sprayer

An eight-row (20-inch row spacing), 3-point-hitch-mounted directed applicator was supplied by S & N Sprayer Company of Greenwood, Mississippi (see Figure 4). The tool bar supporting the row middle units was a 2 3/8-inch diameter steel tube with 1/8-inch wall thickness. Carrier arms of the row middle units each consisted of two 1-inch square steel tubes, one above the other separated by about 3/8 inch. A pneumatic gauge wheel approximately 5 inches wide was mounted in a yoke at the rear of each set of carrier arm tubes.

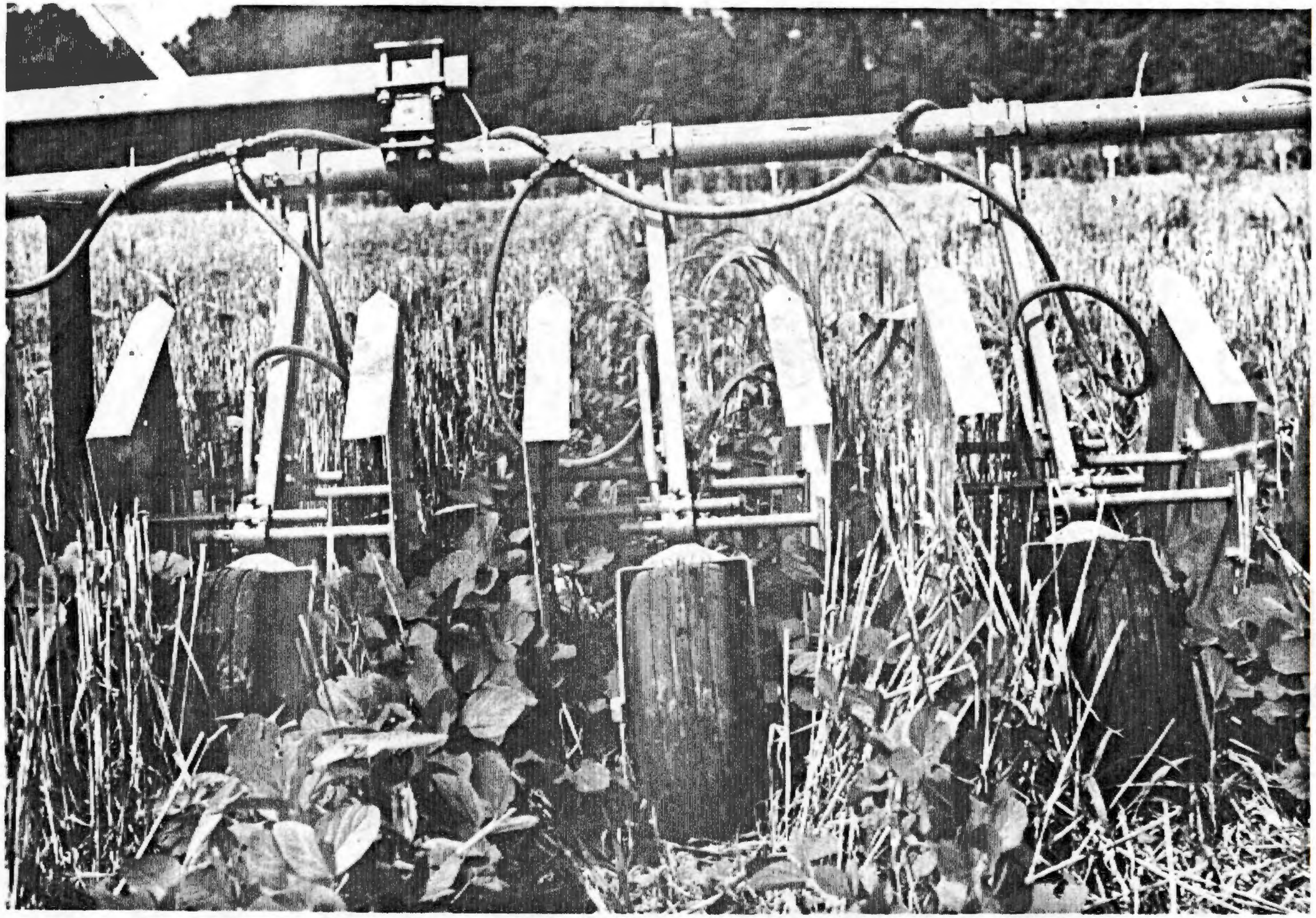

Figure 4. The S & N postemergence directed sprayer featured flooding nozzles and adjustable aluminum shields to protect the crop row against chemical damage.

Two small down-pressure springs assured sustained ground contact by the gauge wheel on the individual units.

Row shields were approximately 14 inches long and 16 inches in height. Fabricated of aluminum sheet, the shields had a slight flare at the front to funnel the crop row into the protected zone. A series of holes provided in the shields allowed vertical adjustment from ground level to several inches high. Lateral adjustment of shields for various row middle widths could easily be made over a range of from 10 to 19 inches.

Flow from the tractor-mounted pump entered the 3/8 inch diameter, 200-psi rated lateral hose near the center of the machine. Tees along the lateral hose allowed delivery of fluid through 1/4-inch diameter hose to the individual nozzles. A 1/4-inch galvanized spray tube between the delivery hose and the nozzle body allowed the nozzle position to be adjusted over a range of 9 1/2 inches. Flooding-type nozzle tips oriented with the axis parallel to the ground surface to create a fan pattern were used. The inboard units were equipped with TK.1 (Spraying Systems Company) tips while the end units had TK0.5 tips. Nozzle tips were situated in front of the gauge wheels.

Brown Manufacturing Company Shielded Sprayer

A four-row, Model LQII/830 directed-spray applicator was provided by Brown Manufacturing Company of Ozark, Alabama (see Figure 5). The tool bar of the 3-point-hitch-mounted unit was a 2 1/2-inch square steel tube with 1/4-inch wall thickness. Carrier arms for

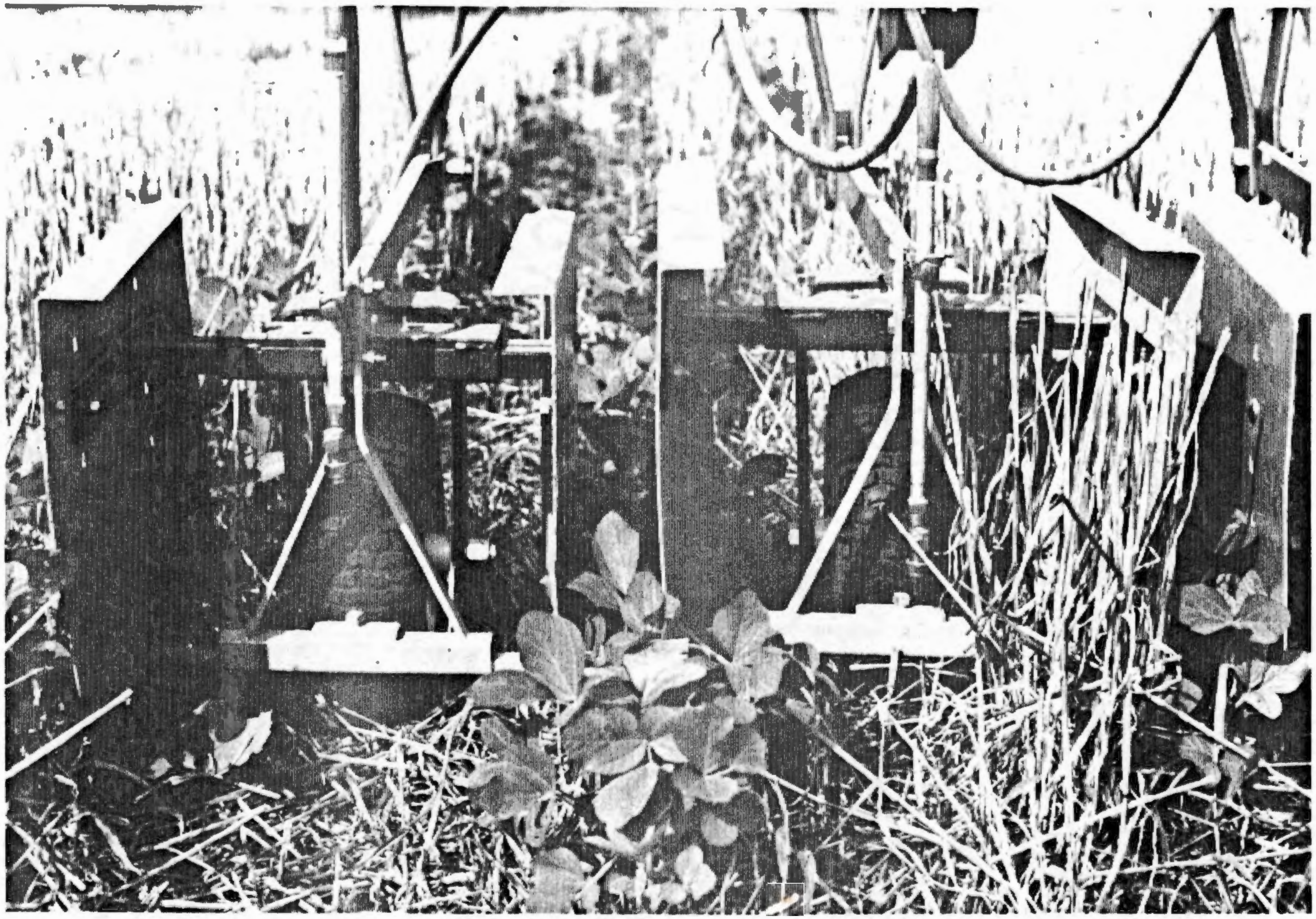

Figure 5. The directed sprayer provided by Brown Manufacturing Company featured a bar designed to knock down the weeds in the row middles as the herbicide formulation was being applied through 150-degree flat fan nozzle tips.

the row middle units were 3/4-inch by 2-inch steel bars. A gauge wheel having a rolling diameter of about 13 inches and a width of 5 inches was mounted in a yoke attached to each carrier arm.

Shields were fabricated from steel sheet and had a flare along the front edge to funnel the crop row between adjacent row units with minimal damage to the vegetation. The shields protected an area about 16 inches high and 16 inches long and could be adjusted to four vertical positions in 2-inch increments beginning at ground level. Since this particular model was not designed for row spacings as small as 20 inches, structural members which supported the shields and allowed adjustment for row spacing and canopy size had to be shortened. With this modification, row middle units were 16 inches wide. A patented feature of the row middle units was a horizontal bar extending between the shields to bend over or knock down tall weeds which might distort the spray pattern from the nozzle. This weed bar was adjustable both fore-and-aft and vertically.

Liquid was supplied to individual row middle nozzles through 3/8-inch hose rated at 200-psi. A 1/4-inch galvanized spray tube between the delivery hose and the nozzle body allowed 11 inches of vertical adjustment of the nozzle tip position. Inboard row middle units were each equipped with a single 15002 (Spraying Systems Company) flat fan nozzle tip. End units were outfitted with 15001 tips to supply half the liquid flow of the inboard units. These tips were located about 2 inches behind the weed bar.

Roberts Shielded Sprayer

A shielded sprayer designed and constructed by West Tennessee farmer Johnny Roberts for directed herbicide application in soybean rows spaced 20 inches apart was included in the evaluation (see Figure 6). The nine-row, 3-point-hitch-mounted unit did not have provision for adjustment to other row spacings. The structural framework supporting the hitch and the row units consisted of two tool bars fabricated from 3-inch square steel tubes with 1/4-inch wall thickness. Lateral stability of the machine was assured by use of two 20-inch disk coulters. Individual row middle units were attached to the tool bar through 4-bar parallel linkages fabricated of 2-inch square tubular steel. These linkages allowed the row shielding to maintain the proper orientation independent of vertical position. Each row middle unit was supported during field operation by a 12-inch diameter by 4-inch width semi-pneumatic gauge wheel.

Shielding was vertically adjustable in 3/4-inch increments over a range of 7 1/2 inches. Nozzles were completely enclosed in pyramid-shaped shields fabricated of 1/8-inch steel sheet. The shield served to knock over tall weeds in the row middle as well as prevent chemical drift onto the crop rows. The sprayed strip between the rows was about 15 inches wide.

A 3/8-inch diameter clear plastic conduit rated at 120-psi distributed the pump output laterally across the machine. A galvanized spray tube between the delivery hose and nozzle body in a row middle unit allowed 3 to 4 inches of vertical adjustment in

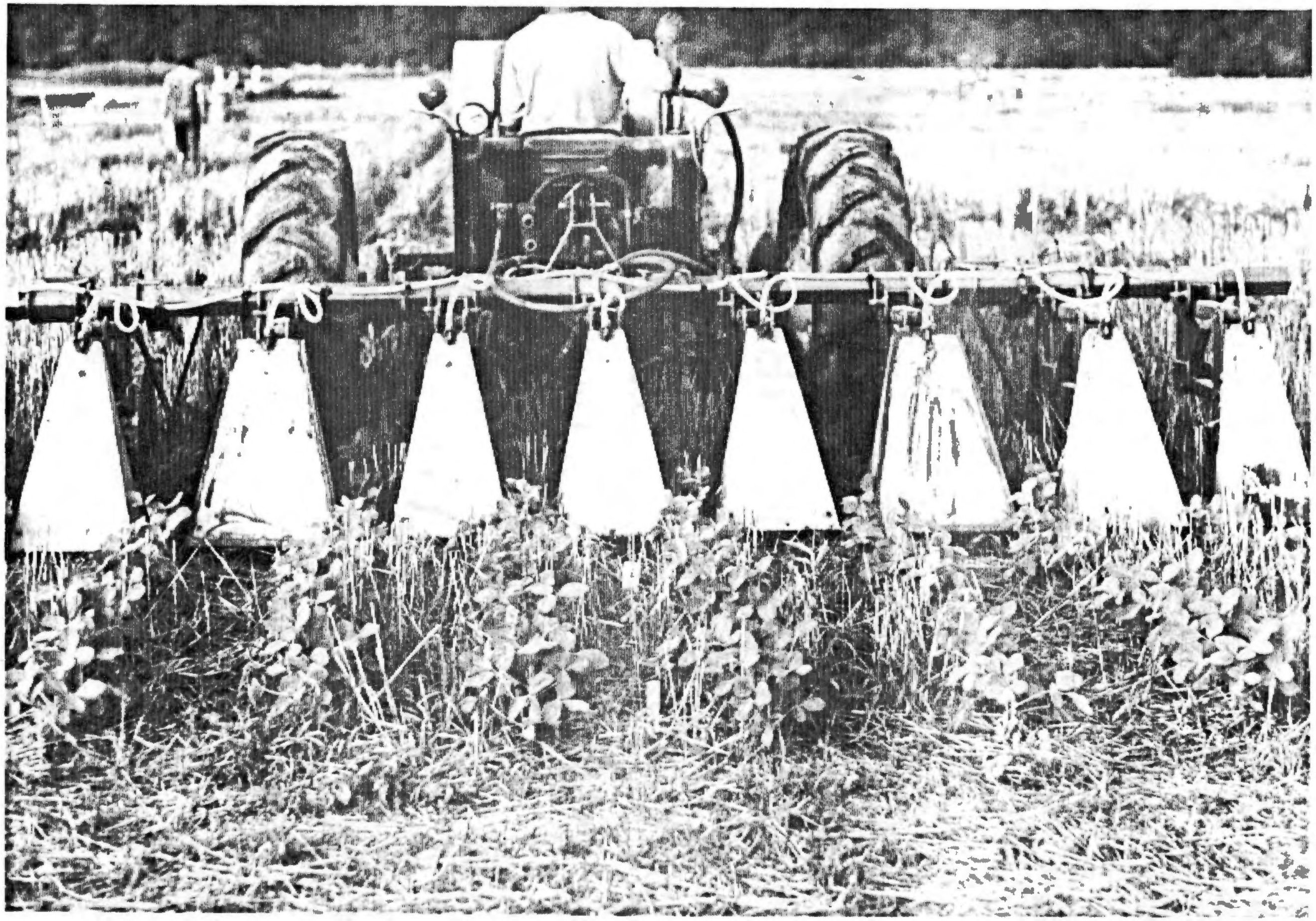

Figure 6. The postemergence directed-spray applicator constructed by farmer Johnny Roberts was a nine-row unit designed to accommodate crop rows spaced 20 inches apart.

nozzle position. The inboard row units were equipped with 8002 (Spraying Systems Company) flat fan spray tips, while the end units had 8001 tips.

Experimental Prototype Directed Sprayer

A 3-point-hitch-mounted, eight-row shielded sprayer was developed by personnel at the Milan Experiment Station specifically for postemergence directed spraying of soybeans planted in 20-inch rows (see Figure 7). There was no provision for adjustment to other row spacings. The tool bar was a 2-inch square steel tube with 3/16-inch wall thickness. A 5/8-inch diameter steel rod was used in a truss arrangement with the tool bar to provide structural rigidity. A standard supporting a stabilizing coulter designed to prevent lateral movement of the machine was attached to the tool bar. Carrier arms for the individual row middle units were fabricated of 1 1/4-inch square steel tubing. A 10 1/2-diameter by 4-inch width gauge wheel attached to each carrier arm supported the row middle unit shielding when the sprayer was operating through the field.

Row shielding consisted of two pieces of 2-inch by 6-inch steel channel configured as an inverted V to prevent chemical drift onto the crop row. The forward side of the channel sections was enclosed with a metal sheet which extended down to about 6 inches above ground level. The lower edge of this front enclosure bent over large weeds to allow spray to reach the outer fringes of the swath and to prevent distortion of the spray pattern.

Figure 7. The experimental prototype directed-spray applicator was outfitted with 80-degree flat fan nozzle tips enclosed in an A-shaped framework constructed specifically for 20-inch rows.

Flow from the tractor-mounted pump entered the 3/8-inch lateral distribution hose near the center of the machine. Tees in the lateral hose allowed distribution to the individual row middle units. Galvanized spray tubes between the hoses and the nozzle bodies allowed vertical adjustment of nozzle position. Flat fan nozzle tips used in the inboard row middle units were 8002 (Spraying Systems Company) while 8001 flat fan tips were used in the two outside, half row units.

## 4. PLOT PREPARATION

Due to wet field conditions and cool weather which delayed maturity, wheat was not harvested from the experimental plots until June 17, 1983. The stubble remaining after combined harvesting was about 9 inches in height.

Soybeans (ASGRO-5774) were no-till planted into the wheat stubble on June 24, 1983. A John Deere "Soybean Special" no-till planter was used to seed the soybeans in 20-inch rows on all plots.

The soil moisture at the time of planting was adequate for germination. Thereafter, there were 0.20-inch, 0.78-inch, 3.0 inches and 2.0 inches rainfall on June 26, 27, 29 and July 2, respectively. No additional rainfall occurred after July 2 until the soybeans had reached harvest maturity.

## 5. HERBICIDE APPLICATION

The set-up and flow rate calibration of the sprayer units was done on July 13, 14, and 26, 1983. A tank mix of linuron (0.5 lb ai/A) plus 2,4-DB (0.2 lb ai/A) plus Surfactant WK (0.5 percent by volume), at label rates, was applied to all plots on the afternoon of July 26, 1983. Relative humidity was between 80 and 90 percent during the herbicide application, while the temperature was in the upper 90's (Fahrenheit). Winds were calm during the spraying period. All sprayer units were calibrated at approximately 20 gallons per acre with a spraying pressure of 25 pounds per square inch (see Table 2, page 25).

## 6. DATA ACQUISITION

### Crop Injury

Crop damage due to herbicide application was estimated on August 3, 1983. Injury ratings were determined by counting soybean plants damaged and killed in randomly selected row segments.

The research plots were evaluated by numerically rating crop injury on a scale of 0 to 100, with zero being equivalent to maximum plant vigor and 100 equivalent to complete kill of the soybean plants.

### Weed Control

Predominant weed species observed in experimental plots included cocklebures, pennsylvania smartweed (*Polygonum penyslvanicum* L.), large crabgrass [*Digitaria sanguinalis* (L.) Scop] and goosegrass

[*Eleusine indica* (L.) Gaertn]. Treated plots were tentatively evaluated on August 3, 1983. Effectiveness of control was determined on August 29, 1983 by counting weed skeletons and subjectively assessing weed regrowth in plots. Cockleburs and large crabgrass were used as indicator weeds for the evaluations. An experienced weed specialist from the West Tennessee Experiment Station evaluated the research plots by numerically rating weed control on a scale of 0 to 100, with zero being equivalent to no weed control and 100 equivalent to complete kill of indicator weeds.

## Soybean Yield

The center four rows of each plot were combine harvested on October 16, 1983. The soybeans averaged 14.2 percent moisture content at the time of harvesting, but yields were computed in bushel per acre (bu/ac) at 13 percent moisture, wet basis.

Dates of the various field operations are presented in Table 3.

Table 3. Dates of various 1983 field operations in the experiment to evaluate directed spray applicators for use in narrow-row no-tillage soybeans.

| Operation | Date |
|---|---|
| 1. Planting | June 24 |
| 2. Sprayer set up and calibration | July 13, 14 and 26 |
| 3. Chemical application | July 26 |
| 4. Ratings: | |
| (a) Crop injury | August 3 |
| (b) Weed control | August 3 and 29 |
| 5. Harvesting | October 26 |

# CHAPTER IV

## RESULTS AND DISCUSSION

### 1. ADAPTATION OF EQUIPMENT TO 20-INCH ROW SPACING

The sprayer units provided by the commercial suppliers were assembled as necessary and adjusted according to the manufacturers' specifications. As indicated earlier, substantive component modification was required only on the Brown Manufacturing Company shielded sprayer, which was actually designed for operation in crop rows with spacings greater than 20 inches. The experimental prototype unit and the Roberts sprayer, which were designed exclusively for use in 20-inch rows, required no adjustment of the structural components.

All six sprayers included in the field evaluation generally operated satisfactorily in the test plots. Operating the machines through crop rows with soybean plants 8 to 12 inches tall presented no particular problem. Both tractor and implement clearance appeared adequate. Alleys maintained between blocks of plots to serve as equipment turn strips were not sufficiently wide. Aligning the tractor equipped with a mounted sprayer to enter the crop rows without damaging the soybean plants was a laborious, time-consuming task. Since some damage to the crop frequently did occur near the point where the equipment entered the plot, crop injury was assessed at randomly selected sites well away from the ends of the crop rows.

## 2. CROP INJURY

Ratings of soybean crop injury resulting from operation of the six postemergence applicators are summarized in Table 4. Tabulated mean values reflect both mechanical damage to the plants due to contact with sprayer components and chemical injury due to inability of the machine to fully protect the crop row from chemical contact. Injury values listed in Table 4 indicate the percentage of plants which were markedly damaged in the process of applying the directed spray treatment with the various machines. Injury ratings by replication are shown in Table A-1 in the Appendix.

Highest levels of crop injury (41 percent) were produced with the Roberts sprayer. Most of the injury with that machine occurred because the dimensions and positioning of the crop protection shields across the width of the sprayer did not precisely conform to the spacing of the crop rows. In particular, there was considerable variation from row to row in the width of the nozzle enclosure. As a result, plants in the crop row were sometimes exposed to chemical contact as well as subjected to mechanical damage. Crop injury levels for this machine could be substantially reduced by maintaining more precise quality control in dimensioning and fabricating crop shielding components.

Crop injury in the plots where the Brown Manufacturing Company sprayer was operated was also quite high (32 percent). Two factors contributed to this level of crop injury. First, equipment modifications made to allow sprayer operation in the 20-inch rows only

Table 4. Soybean plant injury resulting from operation of six post-emergence directed sprayers. Rating values reflect both mechanical damage and chemical injury.

| Sprayer | Mean Crop Injury, Percent |
|---|---|
| 1. KMC Chemical Cultivator | 10 |
| 2. H & H Crop Guard Sprayer | 9 |
| 3. S & N Shielded Sprayer | 14 |
| 4. Brown Shielded Sprayer | 32 |
| 5. Roberts Shielded Sprayer | 41 |
| 6. Experimental Prototype Unit | 20 |
| 7. Control (No Spray Application) | 0 |

reduced the width of the row middle units to 16 inches. Row middle units of this width left only 4 inches of clearance between adjacent shields on either side of the row. Thus tractor operation had to be very precise to prevent damage to plants in the crop row. Secondly, one of the row middle units on the sprayer was not aligned perpendicular to the tool bar due to a component defect. Thus some plant damage occurred because the unit did not track properly.

The least amount of crop injury occurred with the KMC Chemical Cultivator (10 percent) and the H & H Crop Guard Sprayer (9 percent). Both machines allowed the plants in the crop rows to be funneled between adjacent shields without excessive mechanical damage to the foliage. The shield arrangement on both machines effectively protected the crop row from contact with the herbicide formulation being applied.

## 3. WEED CONTROL

Mean percentages of cocklebur and large crabgrass control obtained through one postemergence herbicide application with each of the directed sprayers are listed in Table 5. Cocklebur control by replication for each treatment is summarized in Table A-2 in the Appendix.

Effective control of cocklebur was obtained with each of the six sprayers with mean control levels ranging from 80 to 88 percent. Cocklebur control resulting from use of any of the test machines was significantly ($\alpha = 0.05$) greater than that in the untreated check plot.

Table 5. Mean control of cocklebur (*Xanthium pensylvanicum*) and large crabgrass (*Digitaria sanguinalis*) in no-tillage soybeans planted in 20-inch rows and treated with a single postemergence herbicide application using one of six directed sprayers.

| Sprayer | Mean Percentage Control | |
|---|---|---|
| | Cocklebur | Large Crabgrass |
| 1. KMC Chemical Cultivator | 85 | 40 |
| 2. H & H Crop Guard Sprayer | 85 | 40 |
| 3. S & N Shielded Sprayer | 80 | 40 |
| 4. Brown Shielded Sprayer | 83 | 40 |
| 5. Roberts Shielded Sprayer | 85 | 40 |
| 6. Experimental Prototype Unit | 88 | 40 |
| 7. Control (No Spray Application) | 0 | 0 |

Only about 40 percent control of large crabgrass was obtained with any of the sprayers through the single herbicide application. Grass control obtained with any sprayer was significantly ($\alpha = 0.05$) greater than control in the untreated check plots. The low level of crabgrass control in the sprayed plots can be attributed to the drought stressed condition of the weeds at the time of herbicide application. The herbicide formulation was simply not effective on the very dry grass.

## 4. SOYBEAN YIELD

Mean yields from no-tillage soybean plots treated with each of the six directed spray applicators and from similar untreated control plots are shown in Table 6. Yields by replication for each of the treatments are listed in Table A-3 in the Appendix.

Average yields of all plots were extremely low because of a severe shortage of available moisture during the crop growing season. Numerically, the average yield of any sprayed treatment was greater than that from the untreated control. However, differences were not great enough to be declared significant at the 95 percent level of probability. Note that the two largest numerical yield values are associated with the two applicators which resulted in the least amount of damage to the soybean plants. Similarly, the two lowest yield values among sprayed plots are associated with the two applicators which resulted in the greatest amount of crop damage.

Table 6. Mean yields from no-tillage soybean plots treated with a single postemergence herbicide application using one of six directed sprayers and from untreated control plots.

| Sprayer | Mean Yield, Bushels Per Acre |
|---|---|
| 1. KMC Chemical Cultivator | 8.9 |
| 2. H & H Crop Guard Sprayer | 8.5 |
| 3. S & N Shielded Sprayer | 8.1 |
| 4. Brown Shielded Sprayer | 7.8 |
| 5. Roberts Shielded Sprayer | 7.1 |
| 6. Experimental Prototype Unit | 8.4 |
| 7. Control (No Spray Application) | 6.0 |

## CHAPTER V

## SUMMARY AND CONCLUSIONS

### 1. SUMMARY

Six commercial and experimental directed spray applicators were evaluated for postemergence weed control effectiveness in no-tillage soybeans planted in rows spaced 20 inches apart. Field tests were conducted at The University of Tennessee Milan Experiment Station during 1983. The following applicator models were included in the study: (1) KMC Chemical Cultivator, (2) H & H Crop Guard shielded sprayer, (3) S & N shielded sprayer, (4) Brown Manufacturing Company shielded sprayer, (5) Roberts shielded sprayer, and (6) Milan Experiment Station prototype shielded sprayer.

Soybeans were no-till planted following wheat in a double-cropping system. A preplant application of paraquat and pendimethalin burned existing vegetation and gave some early preemergence control of weeds in the plots. The directed spray formulation was applied with the various machines when the soybeans were approximately 12 inches tall. The postemergence spray formulation was a tank mix of linuron (0.5 lb ai/ac) and 2,4-DB (0.2 lb ai/ac) plus Surfactant WK (0.5 percent by volume).

Ease of adaptation of the applicators for use in crops planted with 20-inch row spacing was noted. Operational characteristics of the applicators in the 20-inch rows were observed. Data collected to evaluate sprayer performance included (1) assessments of crop injury, (2) control ratings of selected grass and broadleaf weeds, and (3) soybean yields.

## 2. CONCLUSIONS

The following conclusions were drawn from this study:

1. All directed spray units included in the evaluation were either designed for or readily adapted to use in 20-inch rows. Furthermore, machine operation in 20-inch rows when the soybean crop height was about 12 inches presented no particular problems. An adequate selection of equipment appropriate for use in making directed spray applications in crops planted in 20-inch rows appears to be presently available on the commercial market.
2. Relatively high levels of crop injury (combination of mechanical damage and chemical injury) produced by some sprayers resulted primarily from misalignment of machine assemblies due to component defects and from improper positioning or adjustment of row shielding.
3. Cocklebur control ratings in plots sprayed with any of the applicators averaged 80 percent or greater with no significant variation among machines. Control of large crabgrass obtained with any of the sprayers was poor (40 percent), probably because the grass was already severely drought stressed at the time of postemergence treatment.

4. Soybean yields were not significantly affected by the spray treatments. Numerically, mean yields of all sprayed treatments were greater than yields from unsprayed plots. Highest yields within the sprayed area tended to be associated with plots with lowest injury ratings and lowest yields with plots having highest injury ratings.
5. Further research is suggested to determine if results would be more definitive in a favorable growing season. The severe drought conditions of 1983 doubtlessly affected the study results reported herein.

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## LITERATURE CITED


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APPENDIX

Table A-1. Crop injury ratings by replication for six postemergence directed spray applicators operated in no-tillage soybeans planted in 20-inch rows.

| Sprayer | Percentage Crop Injury | | | | |
|---|---|---|---|---|---|
| | Replication | | | | |
| | 1 | 2 | 3 | 4 | Mean |
| 1. Kelley | 10 | 10 | 5 | 15 | 10 |
| 2. H & H | 10 | 10 | 10 | 5 | 9 |
| 3. S & N | 10 | 30 | 10 | 5 | 14 |
| 4. Brown | 35 | 40 | 30 | 25 | 32 |
| 5. Roberts | 40 | 40 | 50 | 35 | 41 |
| 6. Experimental | 25 | 15 | 10 | 30 | 20 |
| 7. Control (No Application) | 0 | 0 | 0 | 0 | 0 |

Table A-2. Cocklebur (Xanthium pensylvanicum) control ratings by replication in no-tillage soybean plots treated with a single postemergence herbicide application using one of six directed sprayers.

| Sprayer | Percentage Cocklebur Control | | | | |
|---|---|---|---|---|---|
| | Replication | | | | |
| | 1 | 2 | 3 | 4 | Mean |
| 1. Kelley | 80 | 90 | 90 | 80 | 85 |
| 2. H & H | 80 | 90 | 80 | 90 | 85 |
| 3. S & N | 80 | 80 | 80 | 80 | 80 |
| 4. Brown | 80 | 80 | 90 | 80 | 82 |
| 5. Roberts | 80 | 90 | 90 | 80 | 85 |
| 6. Experimental | 80 | 90 | 90 | 90 | 88 |
| 7. Control (No Application) | 0 | 0 | 0 | 0 | 0 |

Table A-3. Mean yields by replication from no-tillage soybean plots treated with a single postemergence herbicide application using one of six directed sprayers and from an untreated control.

| Sprayer | Yield, Bushels Per Acre | | | | |
|---|---|---|---|---|---|
| | Replication | | | | |
| | 1 | 2 | 3 | 4 | Mean |
| 1. Kelley | 10.4 | 9.7 | 11.1 | 4.3 | 8.9 |
| 2. H & H | 10.0 | 9.0 | 8.6 | 6.5 | 8.5 |
| 3. S & N | 9.0 | 6.5 | 9.3 | 7.5 | 8.1 |
| 4. Brown | 9.3 | 10.0 | 5.8 | 6.1 | 7.8 |
| 5. Roberts | 6.8 | 7.5 | 7.2 | 6.8 | 7.1 |
| 6. Experimental | 10.4 | 9.3 | 7.2 | 6.8 | 8.4 |
| 7. Control (No Application) | 4.7 | 9.7 | 4.3 | 5.4 | 6.0 |

## VITA

Olakanmi J. Abolarin was born on December 11, 1953 in Osun-Ekiti, Ondo State, Nigeria. He obtained a Certificate and Higher Diploma in General Agriculture from the University of Ife, Institute of Agricultural Research & Training, Nigeria, in 1975 and 1979, respectively. He worked as an Agricultural Assistant/Superintendent in both the Western and Ondo States of Nigeria Ministry of Agriculture between 1975 and 1980.

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He is married to the former Lucia Adunni Famuyiwa of Abeokuta in Ogun State of Nigeria. They have two children, Lola and Olaolu, Jr.