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Response of giant ragweed, jimsonweed, common lambsquarters, tall morningglory, and velvetleaf in soybeans to various overtop postemergence herbicides

Kenneth Dale Russell

To the Graduate Council:

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Larry S. Jeffery, Major Professor

We have read this thesis and recommend its acceptance:

L. N. Skold, W. A. Krueger

Accepted for the Council:
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Vice Provost and Dean of the Graduate School

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

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RESPONSE OF GIANT RAGWEED, JIMSONWEED, COMMON LAMBSQUARTERS, TALL MORNINGGLORY, AND VELVETLEAF IN SOYBEANS TO VARIOUS OVERTOP POSTEMERGENCE HERBICIDES

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ABSTRACT

Many broadleaf weeds in soybeans [Glycine max (L.)] are not adequately controlled by currently available preemergence herbicides. Recent studies have shown that several postemergence herbicides, such as bentazon [3-isopropyl-1H-2,1,3-benzothiadiazin-(4)3H-one 2,2-dioxide], chloroxuron [3-[p-(p-chlorophenoxy) phenyl]-1,1-dimethylurea], dinoseb [2-sec-butyl-4,6-dinitrophenol] plus naptalam [N-1-naphthylphthalamic acid], 2,4-DB [4-(2,4-dichlorophenoxy) butyric acid], and RH-6201 [sodium 5-2-chloro-4-(trifluoromethyl)-phenoxy-2-nitrobenzoate], can be applied overtop of soybeans without causing severe injury. The objective of this 1977 study was to determine the efficacy of these herbicides, when applied at different stages of growth, for control of tall morningglory [Ipomoea purpurea (L.) Roth], jimsonweed [Datura stramonium (L.)], giant ragweed [Ambrosia trifida (L.)], common lambsquarters [Chenopodium album (L.)], and velvetleaf [Abutilon theophrasti (Medic.)] in soybeans.

The experiment was conducted on sites where natural infestations of jimsonweed, tall morningglory, common lambsquarters, and velvetleaf occurred. The giant ragweed experiment was seeded. Alachlor [2,-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide] was applied as a preemergence herbicide over each experimental area to control annual grasses. Herbicides were applied overtop of soybeans in late spring and early summer of 1977 as the weeds reached various plant heights, i.e., 3 to 5, 10 to 15, 20 to 25, and 38^{+} cm. tall.

Bentazon effectively controlled giant ragweed less than 15 cm. tall, common lambsquarters less than 10 cm. tall, and velvetleaf less than 30 cm. tall. It did not control tall morningglory but controlled jimsonweed through the 38^{+} cm. height. Chloroxuron effectively controlled common lambsquarters less than 10 cm. tall, velvetleaf less than 15 cm. tall, jimsonweed less than 15 cm. tall, and tall morningglory less than 5 cm. long. Dinoseb plus naptalam effectively controlled giant ragweed less than 15 cm. tall, tall morningglory less than 5 cm. long, velvetleaf less than 15 cm. tall, and jimsonweed at all stages of growth. It did not control common lambsquarters. Giant ragweed less than 30 cm. tall was effectively controlled by 2,4-DB. Common lambsquarters (less than 5 cm. tall) and velvetleaf (less than 15 cm. tall) were also controlled by 2,4-DB. Jimsonweed and tall morningglory (Spring Hill experiment only) were susceptible to 2,4-DB at all stages of growth used in this study, and tall morningglory (Knoxville experiment only) less than 15 cm. in length was also susceptible. The herbicide RH-6201 effectively controlled giant ragweed less than 15 cm. tall, common lambsquarters less than 5 cm. tall, tall morningglory less than 5 cm. in length, velvetleaf less than 5 cm. tall and jimsonweed at all stages of growth.

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CHAPTER I

INTRODUCTION

Growing populations and limited land for cultivation are causing increased concern about world food availability. Food shortages have occurred and will continue to occur. It is imperative that all factors limiting crop production be understood and reduced in severity. One factor which continues to limit crop production is weed control. Effective weed control is basic not only to food production but to human health, water resources, recreational areas, and scenic beauty as well. The problems of weed control are as old as man's effort to till the earth; weed problems were even mentioned in the Old and New Testaments (Jonah 2:5; Matthew 13:24-30).

In 1971, Holm reported that more energy is expended for the weeding of crops than on any other single human task (13). Before the introduction of chemical weed control, the measures employed to eradicate or limit the spread of weeds were primarily manual weeding, crop rotation, mechanical tillage, and various methods of preventing weed seeds from being dispersed in crop seed. The first organic chemical substitute (herbicides) for the hoe was developed in 1932 with the introduction of the first organic herbicide DNOC [2-methyl-4,6-dinitrophenol].

Since that time, weed control has grown into the very modern and technical field of weed science. Today more than 180 different chemicals are available for use as herbicides. Herbicides are effective tools for controlling weeds in crops either by selective or nonselective means.

Several broadleaf weeds, a few of which are giant ragweed [Ambrosia trifida (L.)], jimsonweed [Datura stramonium (L.)], common lambsquarters [Chenopodium album (L.)], tall morningglory [Ipomoea purpurea (L.) Roth], and velvetleaf [Abutilon theophrasti (Medic.)], continue to cause significant soybean [Glycine max (L.)] yield reductions in the southeastern United States. Recently, studies have shown selected herbicides such as bentazon [3-isopropyl-1H-2,1,3-benzothiadiazin-(4)3H-one 2,2 dioxide], chloroxuron [3,[p-(p-chlorophenoxy) phenyl]-1, 1-dimethylurea], dinoseb [2-sec-butyl-4,6-dinitrophenol] plus naptalam [N-1-naphthylphthalamic acid], 2,4-DB [4-(2,4-dichlorophenoxy) butyric acid], and RH-6201 [sodium 5-2-chloro-4-triflouromethyl)-phenoxy-2-nitrobenzoate] can be applied overtop of soybeans without causing severe injury. Definite research data are lacking about the efficacy of these herbicides when applied in specific stages of weed growth.

The objective of this study was to determine the efficacy of bentazon, chloroxuron, dinoseb plus naptalam, 2,4-DB, and RH-6201 when applied at different stages of growth for control of giant ragweed, jimsonweed, common lambsquarters, tall morningglory, and velvetleaf in soybeans.

CHAPTER II

LITERATURE REVIEW

Soybean production in the United States has nearly doubled from approximately 9.43 to 17.22 million hectares[1] in the decade 1960 to 1970. Average yields rarely exceed 2,000 kg/ha; however, it is estimated that the top growers have averages of at least 3,400 kg/ha (10). Uncontrolled weeds are an important factor which limit yields.

In 1975, weeds caused an estimated 10% reduction in the yield and quality of soybeans. This loss amounted to more than 700 million dollars (36). In addition, farmers treated approximately 80% of the planted acreage with herbicides at a cost of more than $400 million, including the cost of application. Farmers also spent more than $550 million for cultural practices of weed control, including seedbed preparation and cultivation. Thus, the losses caused by weeds and the cost of their control, in soybeans alone, amounted to about $1.5 billion in 1975 (36).

The long term use of herbicides specific for grass weeds has contributed to increasing infestations of large-seeded broadleaf weeds such as giant ragweed, velvetleaf, and tall morningglory.

I. WEEDS OBSERVED

Giant Ragweed

Giant ragweed is one of several ragweed species whose pollen causes millions of people to suffer from seasonal respiratory allergies (38).

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[1]All units of measurement have been converted to metric units, regardless of how they appeared in the original source.

Giant ragweed, a member of the Compositae family, is a summer annual that may grow up to 3.7 meters tall (21). Giant ragweed flowers from July to October. It is found in cultivated and waste places, grain fields, pastures, and fence rows and is partial to the rich soil of field margins and marshes (21). Ragweeds are listed in the ten most important weeds in the United States (14).

Jimsonweed

Jimsonweed, also called Thorn-Apple, Jamestown Weed, Devil's Trumpet, and Stinkweed, is a member of the Solanaceae family. It is a summer annual and reproduces only by seed. It has erect, thick, green to reddish branching stems, ranges in height from 0.6 to 1.5 meters and has a distinctive rank or unpleasant odor (21). Jimsonweed, a native of Asia, occurs in barnyards, fence rows, pastures, and waste places throughout Tennessee. The plant is a commercial source of hyoscyamine, atropine, and scopolamine. The seeds and seedlings are poisonous.

Jimsonweed seedlings have emerged from a depth of 15 centimeters, but maximum emergence is usually from 0 to 8 centimeters (37). Jimsonweed seed contamination in soybeans for export could lead to significantly lower prices or even to denial of the commodity by some importing countries (7). In 1973, some shipments overseas contained up to 400 jimsonweed seed/kg (7), thus far exceeding the level considered safe for human consumption. Jimsonweed seed can also cause poisoning when it is a contaminant in bread flour (18).

Common Lambsquarters

Common lambsquarters, a coarse, branching summer annual, is a member of the Chenopodiaceae family. Its erect, smooth stems often are grooved with red or green lines (38). The ragtooth edged leaves are alternate being smooth on the upper surface with grayish green pubescence beneath. A single plant may produce many thousands of seeds (21). Common lambsquarters flowers in the summer and fall and can be poisonous to livestock during drouthy conditions (nitrite poisoning) (21). Plants containing more than 1.5% nitrate may prove lethal to livestock (19). Growth during drought conditions and lessened light tend to promote increased nitrate content in common lambsquarters. The content and form of nitrogen in the soil both before and after fertilization and the kinds and amounts of other ions present determine the capacity of the soil to supply nitrates to accumulating common lambsquarters plants (19). However, common lambsquarters is edible under normal conditions. It is found in cultivated fields, gardens, barnyards, and waste places throughout Tennessee. Common lambsquarters is listed in the ten most important weeds in the United States (14).

Tall Morningglory

Tall morningglory is a member of the Convolvulaceae family. It is a climbing or trailing vine-type plant. Funnel-shaped flowers occur throughout the summer and fall and last for only one day. The seeds are black and irregularly shaped and require some vernalization before germination occurs (38). Tall morningglory may reproduce by cuttings if the soil is moist. It is found in cultivated fields, waste places, gardens, etc., throughout Tennessee. The morningglories are listed among the twenty most important weeds in the United States and have been described as among the ten worst weeds in field crops (14). Season-long competition with soybeans can reduce yields up to 70% (6). The viney growth makes harvest difficult and increases harvesting losses. Achieving acceptable control of tall morningglory in soybeans is difficult because of the apparent tolerance to most of the herbicides which are commonly used in soybean production.

Velvetleaf

Velvetleaf, also called Indian Mallow and False Cotton, is a member of the Malvaceae family (38). It is a summer annual which grows from 1 to 1.8 meters tall and has large, velvety, heart-shaped leaves which taper at the point. The showy, yellow flowers occur from July to September. Velvetleaf, a native of Asia, is commonly found in cultivated fields, barnyards, gardens, and waste places throughout Tennessee. Frans and Oliver (11) showed that velvetleaf must compete between 8 to 10 weeks before it causes a significant soybean yield reduction. Thus, control of velvetleaf during the seedling stage does not appear to be critical from the standpoint of competition. However, from the standpoint of chemical weed control, herbicides should be applied as early as possible because velvetleaf susceptibility decreases as weed size increases.

II. HERBICIDES USED

Bentazon

Bentazon was discovered and tested by BASF A. G., Ludwigshafen/Rhein, West Germany, in the late 1960's. Early greenhouse trials showed that bentazon had certain beneficial properties over 2,4-D [(2,4-dichlorophenoxy) acetic acid] when used to control weed infestations commonly found in European cereal crops (39).

Bentazon is a selective postemergence herbicide used in soybeans for control of specific broadleaf weeds such as common cocklebur (*Xanthium pensylvanicum* Wallr.), giant ragweed, velvetleaf, jimsonweed and others. Soybeans are tolerant to bentazon at all stages of growth; however, they may exhibit some temporary discoloration following treatment (1). Kerr and Royster (17) reported that bentazon at 1.1 to 3.4 kg/ha applied overtop of soybeans and cocklebur in the rapid vegetative growth phase gave excellent cocklebur control except when applied after the cockleburs had started to flower. Soybean plants 25 to 75 cm. tall were not injured by the 3.4 kg/ha rate. Also, Rogers and Crawford (34) reported no observable soybean injury when bentazon was applied at 0.8 kg/ha. They obtained 90% control of morningglory. Bentazon is now registered for use in five additional crops; i.e., corn (*Zea mays* L.), dry beans (*Phaseolus vulgaris* L.), peanuts (*Arachis hypogeae* L.), peas (*Pisum arvense* L.), and rice (*Oryza sativa* L.).

Bentazon should be applied early postemergence when weeds are small and actively growing (29, 35, 39). As a general rule, susceptible weeds should have no more than six true leaves and not be more than 10 cm. tall (39).

Compared to preemergence treatments, bentazon phytotoxicity is less affected by soil type and climatic conditions, although extremely dry, cold, or cool weather can cause unsatisfactory bentazon performance.

Good cultural practices along with proper use of bentazon can provide season-long control of most broadleaf weeds. Two major keys to success are: (1) a good stand of soybeans, and (2) timely cultivation when soybeans are grown in conventional wide rows. Proper cultivation is a must when soybeans are grown in conventional wide rows (more than 50 cm. apart). Problems from late germinating weeds usually occur only in bare spots or where soybeans have germinated unevenly; therefore, another spraying may be needed in these areas. In field research and development programs, cultivation prior to bentazon application has tended to decrease weed control, especially under dry conditions due to a loss in soil moisture (39).

Development of bentazon has allowed revival of an old, but exciting concept; i.e., growing soybeans in narrow or solid-seeded rows (25 cm. or less). Hans von Amsberg (39) reported solid-seeded beans consistently gave higher yields (approximately 5% in the South and 10% in the North) than did conventional wide-row beans. McAvoy and Pearson (24) reported control of velvetleaf and cocklebur increased in fields with row widths of less than 50 cm. indicating that a secondary germination did not occur.

In order to determine the most effective use of bentazon in soybeans, von Amsberg, McAvoy, and Pearson (40, 24) studied several variables and their influence on weed control with bentazon. The variables were: rate, addition or absence of a surfactant, size of soybeans and weeds at the time of treatment, spray volume and type of application (broadcast or band). The size of the soybeans and weeds at the time of application was the most important variable influencing the control of velvetleaf, morningglory, and giant ragweed. Common lambsquarters control was influenced most positively by the addition of surfactant. The rate of bentazon was dependent upon the size of the weed with lower rates required for smaller weeds. Jimsonweed control was influenced most by application rates of bentazon varying from 0.5 to 1.7 kg/ha. Jimsonweed was the only species that appeared to be more completely controlled when a higher spray volume was used. Broadcast application of bentazon was more effective than banded applications for control of velvetleaf, morningglory and common ragweed (Ambrosia artemisiifolia L.).

According to a study by Mathis and Oliver (22), bentazon control was dependent upon the weed species and its stage of growth. Jimsonweed and velvetleaf were the most susceptible species when treated one week after emergence with 100% and 87% control, respectively. Jimsonweed was the most susceptible species when treated two and four weeks after emergence. In a research report, Gossett (12) obtained excellent control of small (less than 15 cm. tall) ragweed and jimsonweed with bentazon applied at 0.6-2.2 kg/ha.

McClelland et al. (25, 26) concluded the most effective control (89%) of tall morningglory was obtained when bentazon (0.6 kg/ha) was applied 14, 18, and 22 days after emergence. Inferior control was obtained if the treatment was delayed until 28 days after emergence. A delay of no longer than four days between the first and second applications of bentazon at the 0.6 kg/ha rate was important for tall morningglory control.

Mathis and Oliver (22, 23) found tall morningglory to be the most resistant weed species included in their 1975 studies. In another study in 1977, bentazon applied at 1.1 kg/ha gave good control of tall morningglory and several other morningglory species. Ivy-leaf morningglory (*Ipomoea hederacea* Jacq.) was the exception. Eastman and Coble (6) obtained excellent control on small red morningglory (*Ipomoea coccinea* L.) but only fair (50-75%) control on other species with bentazon.

Chloroxuron

Chloroxuron is a member of the urea herbicide family and is applied as an early postemergence treatment to selectively control broadleaf weeds in soybeans, strawberries (*Frageria* spp. L.) and carrots (*Daucus carota* L.).

Chloroxuron is most effective when applied after the cotyledons of the weeds have opened, but before the weeds have reached a height of 5 cm.[2] Chloroxuron should be applied at a broadcast rate of 2.2-3.4 kg/ha with a surfactant. The higher rate should be used where tough to control weeds such as cocklebur, velvetleaf, or morningglory are present.

Chloroxuron may cause some temporary yellowing, burning, or small necrotic spots on the crop leaves, but these symptoms usually last for only a short time and the plants resume normal growth. Rogers and Crawford (34) applied chloroxuron at 1.1 kg/ha plus surfactant to soybeans and obtained approximately 10% soybean leaf necrosis. In similar reports, Johnson (15, 16) and Burns, et al. (4) applied chloroxuron at 1.7 kg/ha plus surfactant as a directed postemergence spray to soybeans 25-30 cm. high without severely injuring the soybeans. However, multiple applications, repeated at two to three day intervals until plots had

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[2]Sample Label - Tenoran 50WP - Ciba-Geigy Corporation.

been treated 2, 3, or 4 times with chloroxuron, damaged soybean stems with the degree depending on the number of applications.

Nester and Hurst (28) suggest that chloroxuron be applied when the temperature is above 24° C. for satisfactory weed control. Chloroxuron at 1.1 kg/ha plus surfactant gave good control of cocklebur, morningglory and pigweed (*Amaranthus* spp. L.) when the spray was directed to the base of soybeans 7.6 cm. tall and weeds were less than 5 cm. However, they also suggest that a second application be made five to seven days later.

Baldwin et al. (3) applied chloroxuron at 0.8, 1.7, and 3.4 kg/ha overtop of weed-free Lee soybeans at five different growth stages, i.e., emergence, true leaf, V1, V2, and V3. Initial soybean injury increased as the rate of herbicide increased at each growth stage, ranging from 10-70%. The highest degree of injury was noted at the true leaf and V1 growth stages; however, the yields did not significantly reflect this injury. A trend toward lower yields existed when the 3.4 kg/ha rate of chloroxuron was applied at the true leaf, V1 and V2 stages, but these yields were not significantly lower than those from the untreated plots.

In another experiment, Baldwin et al. (3) applied chloroxuron across rows of cocklebur, prickly sida (*Sida spinosa* L.), pigweed, morningglory, and soybeans. Applications were made at the growth stages noted above. All weed species were most susceptible and most effectively controlled when they were in the cotyledon or emergence growth stage and when treated with the 3.4 kg/ha rate of chloroxuron. Lower rates were also effective depending on the weed species. Morningglory seedlings were effectively controlled with all chloroxuron rates. When the weeds noted above were 10-15 cm. tall, they were very difficult to control; beyond this stage, control was impossible with the rates applied.

It appears that broadleaf weeds may be controlled by topical applications of chloroxuron applied at a very early growth stage. Unfortunately, soybeans also may be injured when chloroxuron is applied at an early growth stage even though no significant soybean yield reductions occurred in studies by Baldwin et al. (3). The susceptibility of soybeans to topical applications during those early growth stages presents some risk.

Dinoseb plus Naptalam

Dyanap, a selective herbicide, is a combination of one part of dinoseb to two parts of naptalam. It controls annual grasses and broadleaf weeds such as crabgrass (*Digitaria sanguinalis* L.), foxtail [*Sorghum halapense* (L.) Pers.], common lambsquarters, tall morningglory, pigweed, jimsonweed, cocklebur, and many others. Dinoseb plus naptalam may be used preemergence or early postemergence. If applied postemergence, dinoseb plus naptalam should be sprayed when weeds are small and succulent. In the southern soybean areas with determinant type soybeans, dinoseb plus naptalam should not be applied after flowering begins.[3]

According to Burns et al. (4), dinoseb plus naptalam should be applied before the first true leaves of soybean seedlings unfold. If application is after this, serious injury may result. The period when this treatment can be applied safely does not usually exceed four to

[3]Sample Label - Dyanap - Uniroyal Chemical Corporation.

five days after planting. Application to wet soil may also result in more serious injury. Dinoseb plus naptalam applied postemergence at 1.7 + 3.4 kg/ha provides excellent control of emerging broadleaves and grasses as well as residual control (4). Residual herbicidal activity may be sharply reduced if dry soil conditions persist after application. Frans (8) concluded that, in instances where application is delayed much past emergence, injury may be severe, being manifested as stunting and excessive necrosis. However, if concentrations are low and growing conditions optimum, soybeans outgrow early injury with little or no effect on final yield.

Rogers et al. (33) obtained 80-100% control of most annual weeds which were less than 5-8 cm. high when dinoseb plus naptalam at 1.1 + 2.2 to 1.7 + 3.4 kg/ha with surfactant was directed postemergence to the lower one-third to one-half of 12^{+} cm. soybean plants. Control of grasses larger than 5 cm. and prickly sida larger than 2.5 cm. was inadequate.

When dinoseb plus naptalam was applied as a single cracking-stage treatment, Mathis and Oliver (23) obtained good control of six morningglory species; however, multi-applications at various intervals caused soybean yield reductions. Frans (9) applied dinoseb plus naptalam overtop of soybeans at 15-20 cm. and 25-30 cm.; when rated eight weeks after application, 75-88% control of tall morningglory was obtained with slight to moderate visual injury to the soybeans.

For weeds such as jimsonweed, morningglory, and velvetleaf under 8 cm. tall, the recommended label rate of dinoseb plus naptalam should be used. If the majority of weeds to be controlled are 8 to 15 cm. tall, a higher rate of dinoseb plus naptalam would be required for adequate control. Also, dinoseb plus naptalam will suppress the growth of cocklebur and morningglory taller than 15 cm., reducing their competition with the soybean crop. Cocklebur and morningglory with up to 20-25 cm. vines were severely stunted or killed when one-third to one-half of each weed was covered with dinoseb plus naptalam at 1.7 to 3.4 kg/ha (31).

2,4-DB

Butoxone, or 2,4-DB is a member of the phenoxycarboxylic herbicide family. It is usually applied as a foliar treatment for contorl of annual broadleaf weeds in soybeans, peanuts, alfalfa (*Medicago sativa* L.), trefoil (*Lotus corniculatus* L.), and clover (*Trifolium* spp. L.). Some control fo grass seedlings may occur, but little or no control of established grass plants occurs. Under normal use, 2,4-DB has low toxicity to man and animals. It is converted within susceptible plants to the acetic-acid form by beta-oxidation; this acetic acid form is herbicidal. Plants incapable of rapid beta-oxidation are not severely injured by 2,4-DB (1).

Soybean foliage should be dark green, indicating nodulation and nitrification are underway before being treated with 2,4-DB. When Rogers and McCormick (32) applied 2,4-DB at 0.2 kg/ha directed postemergence to soybeans at least 25 cm. high, they obtained 70% control of morningglory, whereas the soybeans were tolerant of the 2,4-DB treatment.

Mathis and Oliver (23) showed excellent control of six morningglory species when 2,4-DB was applied postdirected at V4 and V6 stages of soybean growth. Nester and Hurst (29) recommend 2,4-DB by applied as a directed spray to soybeans 20 to 30 cm. high with no more than the lower one-third of the soybean stem sprayed. In a similar report, Ashburn and Jeffery (2) suggest 2,4-DB be applied at 0.2 kg/ha as a directed spray when soybeans are 20 to 30 cm. tall. Also, 2,4-DB may be used as a canopy application for emergency clean-up use to partially save the crop.

In 1971 according to a study by Connell et al. (5), the best systems for cocklebur control in soybeans appeared to be trifluralin [a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine] applied preplant incorporated followed by dyanap as a preemergence treatment followed by 2,4-DB as a postemergence treatment when the burrs are less than 10 cm. tall.

In similar studies, Overton et al. (30, 31) applied 2,4-DB at 0.1 and 0.2 kg/ha to soybeans 20 cm. or less in height without severe injury and with fair to good cocklebur control. The soybeans showed tolerance to the 0.2 kg/ha rate which gave better weed control than lower rates. The results from these studies show that directed applications of 2,4-DB in combination with cultivation can result in adequate cocklebur control with minimum injury to the soybeans.

RH-6201

Presently, RH-6201 is an experimental selective herbicide for preemergence and postemergence control of annual weeds in soybeans. It shows promise on weeds such as seedling johnsongrass, ragweed, pigweed, morningglory, cocklebur, jimsonweed and others. Control of certain grass species may be expected only if applications are made in the one to three leaf growth stage.

The most effective and consistent control of cocklebur, morningglory, and other tough problem weeds has been obtained from postemergence applications of RH-6201. It may be applied postemergence to soybeans from the unifoliolate through the fifth trifoliolate leaf stage at the time weeds are less than 10 cm. Certain highly sensitive weed species such as morningglory, cocklebur, velvetleaf, and others can be controlled at larger growth stages, provided good coverage is obtained.[4]

A spray adjuvant is recommended if the weeds are under stress conditions. When soybeans are treated with RH-6201, injury symptoms such as leaf cupping, crinkling, and speckling may develop on the youngest leaves present. This damage is minor and soybeans usually recover rapidly.

Mangeot et al. (20) directed investigations toward determining the activity of RH-6201 as affected by rate and timing of application. When RH-6201 was applied to soybeans (which were infested with cocklebur, jimsonweed, morningglory, pigweed, velvetleaf, common lambsquarters, and prickly sida) preemergence at 1.1 kg/ha and 2.2 kg/ha, it resulted in yields of 86% and 88%, respectively, of that of the weed free check. Applications at the cracking stage of 0.55, 1.1, and 2.2 kg/ha gave yields of 67%, 94%, and 92%, respectively, of that of the weed free check. Yields of 67, 76, 87, 63, and 66% resulted when 0.55 kg/ha of

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[4]Specimen Label - Blazer 2L - Rohm and Haas Corporation.

RH-6201 was applied at cracking, V1, V2, V4, V6, and V8 soybean growth stages, respectively.

Generally, applications of RH-6201 gave 90-100% control of cocklebur, jimsonweed, morningglory, pigweed, and velvetleaf, regardless of growth stage. However, control of common lambsquarters and prickly sida was dependent on rate and growth stage. These results indicate that RH-6201 has selective activity on many broadleaf weeds in soybeans when applied preemergence or postemergence. Rates of 1.1 kg/ha or higher are required for acceptable weed control. Optimal soybean yields were obtained with RH-6201 at 0.55 kg/ha postemergence during V1 to V4 development stages. The broadest spectrum of weed control resulted when RH-6201 was applied at the smaller growth stages. Murdock et al. (27) conducted field research to evaluate the response of soybeans and weeds to overtop applications of RH-6201 alone, in combination with a surfactant, and with a surfactant-oil blend. Slight to moderate soybean damage resulted, but the plants recovered within 10 to 14 days after treatment. The surfactant and surfactant plus oil blend included herbicidal activity with no significant change in selectivity. Cocklebur and pigweed were very susceptible, regardless of growth stage. Common ragweed, annual morningglory, and annual goosegrass [Eleusine indica (L.) Gaertn.] were moderately susceptible, and only the smaller weeds were controlled. Common lambsquarters proved to be relatively resistant. The most optimum treatment was RH-6201 at 0.55 kg/ha in combination with either the surfactant or surfactant-oil blend.

Good early-season control of six morningglory species was obtained by Mathis and Oliver (23) when RH-6201 was applied preemergence at

1.1 kg/ha; however, control decreased with time resulting in soybean yield reduction from weed competition. The best and most consistent control was obtained when RH-6201 at 0.55 kg/ha was applied to soybeans at the V2 and V4 stages.

CHAPTER III

METHODS AND MATERIALS

I. INTRODUCTION

This research was designed to study the efficacy of various postemergence herbicides applied overtop of soybeans at different stages of growth for control of several weed species.

II. HERBICIDE APPLICATION

The herbicides were applied in late spring and early summer of 1977 as the weeds reached various stages of growth. The experiments were located at four different locations throughout Tennessee. The tall morningglory and jimsonweed experiments were conducted at the Knoxville Plant Science Farm and the Middle Tennessee Experiment Station (Spring Hill). The giant ragweed experiment was located at the Knoxville Plant Science Farm and the common lambsquarters experiment was conducted at the West Tennessee Experiment Station (Jackson). The velvetleaf experiment was located on a private farm near Jackson, Tennessee.

The location of each experiment was determined primarily by the presence of naturally occurring weed infestations at each site; however, the giant ragweed experiment was seeded. Alachlor was applied over the entire experiment at 2.2 kg/ha, as a preemergence herbicide, at each location to control annual grasses.

The soil at each location was fertilized according to soil test for high yields of soybeans. In order to identify accurately responses of the weeds when treated at different growth stages, small coded stakes were placed by the individual plants at the time of treatment. The herbicides were applied with a CO_2-powered back-pack sprayer calibrated to deliver 370 l/ha at 2.8 kg/cm^2. Plots were 3.0 m (three rows) by 6 to 9 m. All data were collected from the center row. Two or three weeks after each application was made, plant counts were taken in each treated plot. The number of living plants per square meter was recorded; the number of dead plants per square meter was recorded. Injury ratings were made on any weeds remaining alive after treatment. The scale used for the injury ratings was from 0 to 10, 0 being no visible injury and 10 being complete kill. An after-harvest visual rating was made to evaluate season-long herbicide performance using a scale of 1 to 5. The injury scale is listed in Table 1. Due to an erratic stand of common lambsquarters and to unfavorable, drouthy growing conditions, percentage control ratings were visually made on the common lambsquarters test.

The plants, which were staked before each treatment was applied, were photographed when ratings were made to ascertain weed control obtained at the various growth stages. Entire plot photographs were also taken to illustrate visually and to compare and contrast the degree of weed control obtained as a result of the treatments being applied at the various growth stages.

To obtain soybean yield response to the herbicides used, yields were determined for the experiments at Knoxville.

Five herbicides were applied at appropriate rates and at various growth stages. Bentazon was applied at 0.8 kg/ha at the 0-5 cm. weed

Table 1. Injury scale for living weeds remaining after treatment.

Scale	Injury Description
0	No effect
1 - 3	Slight effect (1-2) Slight stunting or discoloration; usually no or little stand reduction (3) Weed injury more pronounced, but not lasting
4 - 6	Moderate effect (4) Moderate size reduction, but weeds usually recover by mid-season (5) Weeds about one-half normal size; extended period required for recovery (6) More lasting injury; usually some chlorsis or twisting; extent of recovery in doubt
7 - 9	Severe effect (7) Increasing discoloration, deformity and stand loss; severe injury; recovery requires very favorable conditions; usually some stand loss (8) Weed nearly destroyed; few surviving plants which seldom reproduce (9) Only occassional weeds survive, which are abnormal and do not reproduce
10	Complete kill

growth stage and at 1.1 kg/ha at all other stages. Chloroxuron was applied at 1.1 kg/ha at all growth stages. Butoxone or 2,4-DB was applied at 0.14 kg/ha at all growth stages. Dinoseb plus naptalam was applied at 0.8 + 1.7 kg/ha at the first stage of growth, with 1.7 + 3.3 kg/ha being the rate used for all other growth stages, and RH-6201 was applied at 0.55 kg/ha at all growth stages. The chemicals were chosen primarily because: (1) recent studies have shown them to have few harmful effects on soybeans when applied as overtop treatments; (2) these herbicides give relatively good control of these weeds when applied at early stages of growth (2 to 4 leaf stage); and (3) they may or may not control these weeds when they are larger than the 2 to 4 leaf stage.

A randomized complete block design with three replications was used in each of the experiments. The percent soybean vigor reduction was recorded approximately two to three weeks after each treatment was applied to each experiment. An analysis of variance and a Duncan's Multiple Range test was conducted on all ratings.

CHAPTER IV

RESULTS AND DISCUSSION

I. HERBICIDES

Bentazon

Bentazon gave excellent control of giant ragweed when it was applied at the 10-15 cm. growth stage with no living plants remaining after treatment (Table 2).[1] Partial control was obtained at the 38^{+} cm. stage with only three living plants per square meter remaining, as compared to 11 living plants in the weedy check. This partial control was illustrated, as well, by the injury rating of 5 to the three remaining plants. These plants were about one-half their normal size with an extended period required for recovery (Table 2).

Jimsonweed was effectively controlled at all stages of growth with bentazon at Knoxville and Spring Hill (Table 3). These results compare favorably with studies by Mathis and Oliver (22) and Gossett (12), where jimsonweed was the most susceptible weed species of many tested, when treated with bentazon. When treated at the 38^{+} cm. stage, only six living jimsonweed plants per square meter remained at the Knoxville location, as compared to 109 plants per square meter in the weedy check. The remaining jimsonweed plants showed an injury rating of 3 indicating temporary stunting and leaf burn (Table 3).

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[1]Tables 2 through 6 are located in the appendix to this thesis.

Bentazon gave 100% control of common lambsquarters (up to 10 cm. tall). No differences in common lambsquarters control were observed between bentazon with crop oil or without (Table 4). This contrasts the results of von Amsberg et al. (40) where they found common lambsquarters control to be positively influenced by the addition of a surfactant. Tall morningglory was only partially controlled by bentazon, regardless of growth stage at the time of herbicide application (Table 5). Partial control was exhibited at Spring Hill in the early growth stage with 34 living plants per plot remaining after treatment, as compared to 66 plants in the weedy check (Table 5). Partial tall morningglory control was also obtained at the Knoxville experiment with 21 dead tall morningglory plants per square meter at the 10-15 cm. growth stage, as compared to only 24 living tall morningglory plants in the weedy check (Table 5). The partial tall morningglory control obtained in this study was much less than the morningglory control (90%) obtained by Rogers and Crawford (34). However, this partial control is similar to the control in the studies of Mathis and Oliver (22, 23) where they found tall morningglory to be the most resistant weed species in their studies.

Bentazon controlled velvetleaf effectively up to the 25-30 cm. growth stage (Table 6). At the 38^{+} cm. stage, 17 velvetleaf plants per square meter remained alive after treatment, as compared to 16 plants in the weedy check. However, 20 dead velvetleaf plants per square meter were counted in the same plot indicating partial control was obtained, even at this larger growth stage.

Chloroxuron

Chloroxuron failed to control jimsonweed at Spring Hill, regardless of growth stage (Table 3). Fair to good control was obtained at Knoxville when chloroxuron was applied at the early growth stages (0-5 cm. and 10-15 cm.). At the 0-5 cm. stage of growth, 35 living plants per square meter remained after treatment, as compared to 109 living plants in the weedy check. At the next stage (10-15 cm.), jimsonweed was not as susceptible with 43 living plants per square meter remaining after treatment.

Effective control of common lambsquarters up to 10 cm. tall was obtained with chloroxuron (Table 2). Very little difference in weed control was noted, regardless of whether crop oil was added or not.

At Spring Hill, chloroxuron partially controlled tall morningglory up to 5 cm. tall with 25 tall morningglory plants per plot remaining after treatment, as compared to 66 living tall morningglory plants in the weedy check (Table 3). Tall morningglory control was not obtained at Knoxville, regardless of growth stage at time of application. The poor tall morningglory control obtained in this study contrasts the good morningglory control obtained with chloroxuron by Nester and Hurst (34). Also, Baldwin et al. (4), obtained good control of morningglory less than 10 cm. in length. However, they reported control was impossible beyond this stage with the rates applied.

Chloroxuron controlled velvetleaf effectively when applied at the 10-15 cm. stage of growth (Table 4). Twenty-one velvetleaf plants per square meter survived treatment when treated with chloroxuron at the

25-30 cm. stage of growth, as compared to only 16 velvetleaf plants in the weedy check. However, 41 dead velvetleaf plants per square meter were in the same plot, indicating partial control.

Dinoseb plus Naptalam

Dinoseb plus naptalam gave excellent control of giant ragweed up to the 10-15 cm. stage of growth with no living plants remaining after treatment (Table 2). When dinoseb plus naptalam was applied at the later stages of growth (25-30 cm. and 38^+ cm.), severe injury occurred as evidenced by severe leaf burn and stunting, although few plants were killed (Table 2). An extended period of time was required for recovery of injured giant ragweed.

Dinoseb plus naptalam controlled jimsonweed effectively up to the 10-15 cm. growth stage at both Knoxville and Spring Hill, with no living weeds remaining at Knoxville and only two living weeds per plot remaining after treatment at Spring Hill (Table 3). Also, good control of jimsonweed was obtained at the 38^+ cm. stage at Knoxville with only 10 living plants per square meter remaining after treatment, as compared to 109 jimsonweed plants per square meter in the weedy check. Remaining plants were severely injured, exhibiting symptoms of discoloration, deformity, and slow recovery (Table 3). Some injury to the soybeans was noted after treatment, being manifested primarily as leaf burn and crinkling. The soybeans, however, recovered from this injury by the end of the growing season. This agrees with Frans' (8) conclusions that, if dinoseb plus naptalam concentrations are low and growing conditions optimum, soybeans outgrow early injury with little or no effect on final yield.

Dinoseb plus naptalam did not control common lambsquarters, regardless of stage of growth or the rate of herbicide used at the time of treatment (Table 4). Only 10% of the common lambsquarters were controlled when dinoseb plus naptalam was applied at the 0-5 cm. growth stage.

Dinoseb plus naptalam controlled tall morningglory at the 0-5 cm. growth stage at both Knoxville and Spring Hill (Table 5). At Spring Hill, only eight tall morningglory plants per plot remained after treatment, compared to 66 living tall morningglory plants in the weedy check. At Knoxville, 13 tall morningglories per square meter remained after treatment, as compared to 24 tall morningglories in the weedy check (Table 5). These remaining weeds received an injury rating of 4. At Spring Hill, partial control of tall morningglory was exhibited at the 10-15 cm. growth stage as only 24 living tall morningglories per plot remained after treatment with dinoseb plus naptalam, as compared to 66 in the weedy check (Table 5). Also Knoxville, some partial control was exhibited at the 10-15 cm. stage (Table 5). These results compare favorably with reports by Mathis and Oiver (23) and Frans (9) where they obtained good morningglroy control with dinoseb plus naptalam.

Velvetleaf was partially controlled by dinoseb plus naptalam up to the 10-15 cm. stage of growth, with only nine living plants per square meter remaining after treatment (Table 6). This compared to 16 velvetleaf plants in the weedy check. This control was strongly supported by the number of dead velvetleaf plants (24) per square meter present after treatment. Even though 25 living velvetleaf plants per square meter remained after treatment at the 25-30 cm. stage of growth, 11 dead plants per square meter indicated partial control had been obtained.

2,4-DB

With essentially no control above that stage, 2,4-DB gave excellent control of giant ragweed under 30 cm. tall (Table 2). No giant ragweed plants remained after the treatment was applied at the 25-30 cm. stage of growth, but 10 living weeds were present after treatment at the 38^+ cm. stage of growth. This compared to 11 giant ragweed plants in the weedy check. In addition, these weeds received a rating of only 1 on the injury scale, indicating low herbicidal activity at this semimature stage.

Jimsonweed was controlled effectively by 2,4-DB regardless of growth stage at Knoxville, but at the Spring Hill experiment, jimsonweed was controlled only at the 0-5 cm. growth stage (Table 3). At Knoxville, only seven living jimsonweed plants remained after 2,4-DB treatment at the 38^+ cm. stage of growth, as compared to 109 living jimsonweed plants in the weedy check. The remaining weeds received an injury rating of 4 and were somewhat stunted, but usually recovered by midseason (Table 3). At Spring Hill, only seven living jimsonweed plants per plot remained after treatment at the 0-5 cm. stage of growth, compared to 25 living plants per plot in the weedy check. However, when 2,4-DB was applied either at the 25-30 cm. or 38^+ cm. stages of growth, 34 and 30 living jimsonweed plants per plot remained after each respective treatment, indicating less jimsonweed control with 2,4-DB as jimsonweed matured.

Only at the 0-5 cm. growth stage did 2,4-DB effectively control common lambsquarters. Control was practically nil when 2,4-DB was applied after this stage of growth (Table 4).

At Knoxville, tall morningglory was controlled by 2,4-DB up to the 10-15 cm. growth stage, with partial control up to the 38^+ cm. stage of growth (Table 5). Only five living tall morningglory plants per square meter, as compared to 24 in the weedy check, remained after treatment at the 10-15 cm. growth stage, with 25 dead tall morningglories per square meter. At the 38^+ cm. growth stage, seven living tall morningglories per square meter remained after treatment, with 13 dead tall morningglories per square meter indicating partial tall morningglory control was obtained. Also, this partial control is evidenced by larger numbers (26) of weeds being killed at the 0-5 cm. growth stage, as compared to fewer (13) weeds being killed at the 38^+ cm. stage of growth. The remaining tall morningglories were rated 3 to 4 on the injury scale being manifested as moderate stunting. They recovered by midseason. At Spring Hill, 2,4-DB controlled tall morningglory effectively at all stages of growth (Table 5). No living tall morningglories remained after treatment at the 20-25 cm. growth stage, as compared to 66 tall morningglories per plot in the weedy check. The soybeans were injured by the 2,4-DB but recovered before harvest. When Rogers and McCormick (32) applied 2,4-DB directed postemergence to soybeans at least 25 cm. high, they obtained 70% control of morningglory. The soybeans were tolerant of the 2,4-DB treatment.

Good velvetleaf control was obtained when 2,4-DB was applied, up to the 10-15 cm. stage of growth (Table 6). At the 0-5 cm. and 10-15 cm. growth stages, the number of dead velvetleaf plants per square meter indicates the weed control obtained. After 2,4-DB treatment at the 0-5 cm. growth stage, 51 dead velvetleaf plants per square meter were counted, and 23 were counted after the application at the 10-15 cm. stage of growth indicating some control was obtained. Nineteen living velvetleaf plants per square meter remained after treatment at the 25-30 cm. growth stage, with no velvetleaf control at this more mature stage.

RH-6201

With only one living giant ragweed per square meter remaining after treatment, RH-6201 effectively controlled giant ragweed when applied at the 10-15 cm. growth stage (Table 2). This compared to 11 giant ragweed plants per square meter in the weedy check. Partial control was obtained when RH-6201 was applied at the more mature stages of growth. Only four giant ragweed plants per square meter remained after treatment with RH-6201 at the 25-30 cm. growth stage. Six giant ragweed plants per square meter remained after treatment with RH-6201 at the 38^+ cm. growth stage (Table 2). The surviving weeds after RH-6201 treatment at the 38^+ cm. growth stage received an injury rating of 6. A more lasting injury with some chlorosis and twisting was also noted. When the herbicide was applied at the 25-30 cm. stage, the surviving weeds received an injury rating of 3. This was noted as slight stunting and discoloration. More weeds survived the treatment applied at the larger growth stage.

At both Knoxville and Spring Hill, RH-6201 effectively controlled jimsonweed at all growth stages. This compares to the 90-100% control of jimsonweed obtained by Mangeot et al. (20) when RH-6201 was applied as a preemergence treatment. No plants withstood the treatment applied at the 0-5 cm. growth stage at Spring Hill, and only one jimsonweed remained following this treatment at Knoxville (Table 3). At Spring Hill, only two jimsonweed plants per square meter survived after RH-6201 was applied at the 20-25 cm. growth stage, as compared to 25 per square meter in the weedy check. At Knoxville, 10 living jimsonweed plants per square meter remained after treatment at the 38^+ cm. growth stage, as compared to 109 per square meter in the weedy check, indicating excellent jimsonweed control. An injury rating of 7 was given to these remaining weeds (Table 3). This injury consisted of increasing discoloration and deformity, which required favorable environmental conditions before recovery.

When it was applied at the 0-5 cm. growth stage, RH-6201 controlled 70% of the common lambsquarters (Table 4). When RH-6201 was applied at the 10-15 cm. and 25-30 cm. growth stages, 40% and 50% control, respectively, was obtained. At these larger stages of growth, RH-6201 gave poor lambsquarters control. This is consistent with the results of Mangeot et al. (20) which showed common lambsquarters control to be dependent on growth stage and herbicide rate when treated. Also, Murdock et al. (27) demonstrated common lambsquarters to be relatively resistant to RH-6201.

When it was applied at the 0-5 cm. growth stage, RH-6201 gave good control of tall morningglory. Only eight living tall morningglories per square meter remained after treatment at Knoxville, compared to 24 per square meter in the untreated check (Table 5). At Spring Hill, only 13 living tall morningglories per plot remained after RH-6201 treatment at the 0-5 cm. growth stage, as compared to 66 in the weedy check. Poor control was obtained when RH-6201 was applied at the older stages of growth (Table 5). An injury rating of 4 was assigned to the remaining weeds indicating moderate size reduction and recovery by midseason (Table 5). Tall morningglory control by RH-6201 at the 20-25 cm. or later growth stages was poor (Table 5). Good early-season control of six morningglory species was obtained by Mathis and Oliver (23) when RH-6201 was applied as a preemergence treatment. However, the best and most consistent control was obtained when RH-6201, at 0.55 kg/ha, was applied to soybeans at the V2 and V4 stages.

Fair to good velvetleaf control was obtained with RH-6201 at all growth stages. At the 0-5 cm. growth stage, 12 living velvetleaf plants per square meter survived the treatment, as compared to 16 per square meter in the weedy check, indicating poor control. However, 19 dead velvetleaf plants per square meter in the same plot indicated fair to good control was obtained. Mediocre control was obtained when RH-6201 was applied at or after the 10-15 cm. stage of growth.

CHAPTER V

SUMMARY AND CONCLUSIONS

Research was initiated in the spring of 1977 to determine the efficacy of bentazon, chloroxuron, dinoseb plus naptalam, 2,4-DB, and RH-6201 when applied at different stages of growth for control of giant ragweed, jimsonweed, common lambsquarters, tall morningglory, and velvetleaf in soybeans.

Bentazon effectively controlled giant ragweed which was less than 15 cm. tall, common lambsquarters when less than 10 cm. tall, and velvetleaf that was less than 30 cm. tall. Jimsonweed was susceptible to bentazon at all stages of growth ($0\text{-}38^{+}$ cm. tall). Tall morningglory less than 15 cm. long was partially controlled by bentazon. Giant ragweed taller than 15 cm., common lambsquarters taller than 10 cm., velvetleaf taller than 30 cm., and tall morningglory longer than 15 cm. showed very little or no response to bentazon.

Chloroxuron effectively controlled jimsonweed (Knoxville experiment only) that was less than 15 cm. tall, common lambsquarters which was less than 10 cm. tall, tall morningglory (Spring Hill experiment only) when less than 5 cm. long, and velvetleaf which was less than 15 cm. tall. Jimsonweed taller than 15 cm., common lambsquarters taller than 10 cm., tall morningglory longer than 5 cm., and velvetleaf taller than 15 cm. showed very little or no response to chloroxuron.

Dinoseb plus naptalam effectively controlled giant ragweed when less than 15 cm. tall, tall morningglory that was less than 5 cm. long, and velvetleaf which was less than 15 cm. tall. It effectively controlled jimsonweed (Knoxville and Spring Hill experiments) through the 38^+ cm. stage of growth, common lambsquarters was not effectively controlled by dinoseb plus naptalam, regardless of rate of herbicide or stage of growth. Giant ragweed taller than 15 cm., tall morningglory longer than 5 cm., and velvetleaf taller than 15 cm. showed very little or no response to dinoseb plus naptalam.

Giant ragweed which was less than 30 cm. tall, common lambsquarters that was less than 5 cm. tall, and velvetleaf when less than 15 cm. tall, were effectively controlled by 2,4-DB. It effectively controlled jimsonweed (Knoxville and Spring Hill experiments) and tall morningglory (Spring Hill experiment only) through the 38^+ cm. stage of growth. At the Knoxville experiment, 2,4-DB effectively controlled tall morningglory which was less than 15 cm. in length. Giant ragweed taller than 30 cm., common lambsquarters taller than 5 cm., velvetleaf taller than 5 cm., and tall morningglory (Knoxville experiment only) longer than 15 cm. showed very little or no response to 2,4-DB.

When less than 15 cm. tall, RH-6201 effectively controlled giant ragweed, common lambsquarters which was less than 5 cm. tall, tall morningglory that was less than 5 cm. in length, and velvetleaf when less than 5 cm. tall. It controlled jimsonweed (Knoxville and Spring Hill experiments) through the 38^+ cm. stage of growth. Giant ragweed taller than 15 cm. tall, common lambsquarters taller than 5 cm., tall morningglory longer than 5 cm., and velvetleaf taller than 5 cm. showed very little or no response to RH-6201.

This research has shown that these five herbicides can be used as overtop postemergence treatments to effectively control many broadleaf weeds in soybeans. Relatively good weed control was obtained with all herbicides when applied at early stages of weed growth. However, further research is needed to more fully identify the exact stages of growth where these weeds do not respond to herbicide treatment.

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APPENDIX

Table 2. Response of giant ragweed to postemergence herbicide applications at Knoxville.

Treatment				
Herbicide	Rate (kg/ha)	Stage (cm.)	Live Plants (No/M^2)	Weed** Injury
Bentazon	1.1	10-15	0	-
Bentazon	1.1	25-30	5	1
Bentazon	1.1	38+	3	2
Dinoseb + Naptalam	0.8-1.7	10-15	1	-
Dinoseb + Naptalam	1.7-3.3	25-30	4	5
Dinoseb + Naptalam	1.7-3.3	38+	6	5
2,4-DB	0.14	10-15	0	-
2,4-DB	0.14	25-30	0	2
2,4-DB	0.14	38+	10	1
RH-6201	0.55	10-15	1	-
RH-6201	0.55	25-30	4	3
RH-6201	0.55	38+	6	6
Weedy Check	--	---	11	0

*Counts were made 2-3 weeks after herbicide application.

**Scale used: 0—no visible injury; 10—complete kill.

Table 3. Response of jimsonweed to postemergence herbicide applications at Knoxville and Spring Hill.

Treatment			Spring Hill	Knoxville	
Herbicide	Rate (kg/ha)	Stage (cm.)	Live Plants* (No/Plot)	Live Plants* (No/M^2)	Weed** Injury
Bentazon	0.8	0-5	0	0	--
Bentazon	1.1	10-15	0	3	1
Bentazon	1.1	20-25	1	8	3
Bentazon	1.1	38+	--	6	3
Chloroxuron	1.1	0-5	28	35	2
Chloroxuron	1.1	10-15	20	43	6
Chloroxuron	1.1	33-48	56	--	--
Dinoseb + Naptalam	0.8+1.7	0-5	0	0	--
Dinoseb + Naptalam	1.7+3.3	10-15	2	0	--
Dinoseb + Naptalam	1.7+3.3	20-25	3	11	8
Dinoseb + Naptalam	1.7+3.3	38+	--	10	7
2,4-DB	0.14	0-5	7	3	1
2,4-DB	0.14	10-15	34	5	4
2,4-DB	0.14	20-25	30	7	4
2,4-DB	0.14	38+	--	7	3
RH-6201	0.6	0-5	0	1	--
RH-6201	0.6	10-15	6	17	6
RH-6201	0.6	20-25	2	11	8
RH-6201	0.6	38+	--	10	7
Weedy Check	---	---	25	109	0

*Counts were made 2-3 weeks after herbicide application.

**Scale used: 0—no visible injury; 10—complete kill.

Table 4. Response of common lambsquarters to postemergence herbicide applications at Jackson.

Treatment			Stage	Control*
	Rate			
Herbicide	(kg/ha)	L/ha	(cm.)	%
Bentazon	0.8			100
Bentazon + oil	0.8	3.8	0-3	100
Bentazon	1.1			100
Bentazon + oil	1.1	3.8	5-10	100
Chloroxuron	1.1		0-5	100
Chloroxuron + oil	1.1	3.8	0-5	80
Chloroxuron + oil	1.1	3.8	5-10	100
Dinoseb + Naptalam	0.6+1.1		0-5	10
Dinoseb + Naptalam	1.1+2.2		10-15	20
Dinoseb + Naptalam	1.7+3.3		25-30	25
2,4-DB	1.4		0-5	70
2,4-DB	1.4		10-15	38
2,4-DB	1.4		25-30	57
RH-6201	0.55		0-5	70
RH-6201	0.55		10-15	40
RH-6201	0.55		25-30	50
Control	---		---	0

*Ratings were made 2-3 weeks after herbicide application.

Table 5. Response of tall morningglory to postemergence herbicide applications at Knoxville and Spring Hill.

Treatment	Rate (kg/ha)	Stage (cm.)	Spring Hill Live Plants* (No/M^2)	Knoxville Live Plants* (No/M^2)	Knoxville Weed** Injury
Bentazon	0.8	0-5	34	18	1
Bentazon	1.1	10-15	43	36	2
Bentazon	1.1	20-25	46	27	1
Bentazon	1.1	38$^+$	--	24	2
Chloroxuron	1.1	0-5	25	21	2
Chloroxuron	1.1	10-15	40	23	3
Chloroxuron	1.1	33-48	61	--	-
Dinoseb + Naptalam	0.8+1.7	0-5	8	13	4
Dinoseb + Naptalam	1.7+3.3	10-15	24	17	3
Dinoseb + Naptalam	1.7+3.3	20-25	69	17	2
Dinoseb + Naptalam	1.7+3.3	38$^+$	--	15	2
2,4-DB	0.14	0-5	1	3	1
2,4-DB	0.14	10-15	3	5	4
2,4-DB	0.14	20-25	0	7	4
2,4-DB	0.14	38$^+$	--	7	3
RH-6201	0.55	0-5	13	8	3
RH-6201	0.55	10-15	58	37	4
RH-6201	0.55	20-25	27	22	3
RH-6201	0.55	38$^+$	--	19	2
Weedy Check	---	---	66	24	0

*Counts were made 2-3 weeks after herbicide application.

**Scale used: 0—no visible injury; 10—complete kill.

Table 6. Response of velvetleaf to postemergence herbicide applications at Jackson.

Treatment			Live	Live
Herbicide	Rate (kg/ha)	Stage (cm.)	Plants* (No/M^2)	Plants* (No/M^2)
Bentazon	0.8	0-5	6	12
Bentazon	1.1	10-15	3	7
Bentazon	1.1	25-30	4	24
Bentazon	1.1	38^+	17	20
Chloroxuron	1.1	0-5	3	12
Chloroxuron	1.1	10-15	3	18
Chloroxuron	1.1	25-30	21	41
Dinoseb + Naptalam	0.8+1.7	0-5	12	15
Dinoseb + Naptalam	1.7+3.3	10-15	9	24
Dinoseb + Naptalam	1.7+3.3	25-30	25	11
2,4-DB	0.14	0-5	23	51
2,4-DB	0.14	10-15	10	23
2,4-DB	0.14	25-30	19	--
RH-6201	0.55	00-5	12	19
RH-6201	0.55	10-15	9	11
RH-6201	0.55	25-30	8	12
Weedy Check	---	---	16	0

*Counts were made 2-3 weeks after herbicide application.

VITA

Kenneth Dale Russell was born in Warren County, Tennessee on June 30, 1953. He attended Dibrell Elementary School and graduated from Warren County High School in May of 1971.

In September of 1971, he entered the University of Tennessee, Institute of Agriculture, at Knoxville. He graduated from the University of Tennessee in December of 1975 with a major in Agricultural Education. Upon graduation, he accepted a sales position with the Varsity Company of Nashville, Tennessee. He was a sales manager for Varsity for one year before returning to the University of Tennessee to pursue study toward the Master of Science degree in the Plant and Soil Science Department. He received the Master of Science degree in December of 1978 with specialization in Weed Science.

He is married to the former Joan Marie Elder of Nashville, Tennessee.