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Evaluation of BAS 9052 & BAS 9021 for Control of Johnsongrass (Sorghum Halpense) in Soybeans (Glycine Max)

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EVALUATION OF BAS 9052 AND BAS 9021 FOR CONTROL OF JOHNSONGRASS (*SORGHUM HALPENSE*) IN SOYBEANS (*GLYCINE MAX*)

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EVALUATION OF BAS 9052 AND BAS 9021 FOR CONTROL OF JOHNSONGRASS (SORGHUM HALPENSE) IN SOYBEANS (GLYCINE MAX)

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Sheryl Ann Rogers April 1980 34 pages

Directed by: J.P. Worthington, R.E. Johnson, W.C. Normand

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The lack of adequate weed control is one of the major problems encountered in soybean production. Johnsongrass presents one of the most serious weed control problems in the Southeastern United States. Numerous herbicides are used in an effort to control johnsongrass, and research is still being conducted to find new herbicides for this purpose. Two of these herbicides are BAS 9021 [6,6-dimethyl-2,4-dioxo-3-[1-[2-(propenyloxy)amino]butylidene]-cyclohexane] and BAS 9052 [2-(n-ethoxybutyrimidoyl)-5-(2-ethylthiopropyl)-3-hydroxy-2-cyclohexen-1-one].

In 1978, johnsongrass control with BAS 9021 at 1.1 and 1.7 kg/ha in single early postemergence or late postemergence applications, or in each of two split applications, was evaluated using the herbicide alone, with a nonionic surfactant, or a nonphytotoxic crop oil. The split applications gave johnsongrass control ranging from 49% to 83%. Late postemergence applications of 1.7 kg/ha of BAS 9021 were as good as split applications. As a group, the addition of oil or surfactant gave increased control over the herbicide alone.

In 1979 BAS 9021 and BAS 9052 were compared with mefluidide [N-[2,4-dimethyl-5[[(trifluoromethyl)sulfonyl] amino]phenyl]acetamide]and alachlor [2-chloro-2'6'-diethyl-

N-(methoxymethyl)acetamide] for seedling johnsongrass control. The BAS materials were compared with mefluidide, trifluralin [α,α,α-trifluoro-2,6-dinitro-N,N-dipropyl-p-toliuidine], fluchloralin [N-(2-chloroethyl)-2,6-dinitro-n-propyl-4-(trifluoromethyl)aniline] and trifluralin plus vernolate [S-propyl dipropylthiocarbamate] for rhizomic johnsongrass control.

In both experiments BAS 9021 was applied at 1.1 and 1.7 kg/ha in each of two applications. BAS 9052 was applied at rates of 0.6 to 1.1 kg/ha early postemergence, late postemergence or in split applications. Mefluidide was applied at rates of 0.3 to 0.6 kg/ha either early postemergence or in split applications. All postemergence herbicide applications contained an oil concentrate at a rate of 2.4 L/ha.

Alachlor for seedling control was applied preemergence at 3.4 and 4.5 kg/ha. Preplant incorporated applications of trifluralin and fluchloralin were made at rates of 2.2 kg/ha and vernolate at 2.8 kg/ha was combined with 1.1 and 2.2 kg/ha of trifluralin for rhizomic johnsongrass control.

In the seedling area, all BAS treatments gave 88% or better johnsongrass control. In the rhizomic area split applications of BAS 9052 tended to result in the best johnsongrass control. Ratings were taken both 8 and 11 weeks after planting. Soybean yields were generally better with higher johnsongrass control.

Mefluidide caused apparent soybean injury, resulted in poor johnsongrass control and lowered soybean yields. All preplant incorporated treatments gave poor johnsongrass control and low soybean yields. Alachlor gave fair johnsongrass control but resulted in high soybean yields.

INTRODUCTION

The acreage of soybeans produced in the Southeastern United States has increased rapidly in the past few years (43). The value of soybeans is third highest when considering all farm products in Kentucky (46).

Lack of adequate weed control in soybeans is one of the major factors contributing to poor yields (20). Weeds reduce yields through competition for light, nutrients, and moisture, as well as through decreased harvest efficiency and delayed harvest (32).

Johnsongrass presents one of the most serious weed control problems in the growing of soybeans in the Southeastern United States (30). Johnsongrass is difficult to control because it reproduces both from seed and from rhizomes (18,25). Both cultivation and chemical methods are currently being used for johnsongrass control in soybeans.

Dalapon [2,2-dichloropropionic acid] and glyphosate [N-(phosphonomethyl)glycine] are used for johnsongrass control before soybeans are planted (16,38,42). Glyphosate has been found to give better johnsongrass control than dalapon (38).

Double rates of trifluralin and fluchloralin, used for two consectuive years, also provide good control of established johnsongrass (27,28). Single rates of these herbicides are used for annual grass control and seedling johnsongrass control (27.28)

Preemergence applications of alachlor are used to reduce competition from seedling johnsongrass (34). Vernolate as a preplant incorporated treatment also is used for seedling johnsongrass control (36).

Mefluidide, a recently developed plant growth regulator (10), has also been found to give good johnsongrass control (11,15,31). However, mefluidide, which is applied postemergence, often causes soybean injury severe enough to reduce yields (15,31). Glyphosate is being used as a postemergence, directed application in recirculating sprayers for johnsongrass control in soybeans. The recirculating sprayer is needed to prevent glyphosate injury to the crop (30).

Two experimental postemergence herbicides for grass control in soybeans are BAS 9021 (44) and BAS 9052 (2). Both are applied over-the-top of the crop and do not require a height differential between the crop and the weeds as is needed for use of the recirculating sprayer. The BAS 9021 has been found to give good control of giant foxtail (Setaria faberi Herrm.) and quackgrass [Agropyron repens (L.)] (7,3,14). Rhizomic johnsongrass can also be controlled with BAS 9021 (12,41). Control is increased with the addition of a surfactant or an oil concentrate (12,44).

BAS 9052 has excellent activity on annual grasses and johnsongrass (2). The addition of an oil concentrate to

BAS 9052 improved control. Neither BAS 9021 or BAS 9052 has exhibited any soybean injury (2,44).

This study was undertaken to evaluate the effectiveness of BAS 9021 and BAS 9052 for johnsongrass control in soybeans. Varying rates of BAS 9021 and BAS 9052 were applied at differing times and compared with other herbicides for control of johnsongrass. Comparisons were also made for BAS 9021 alone, with a nonionic surfactant, and with a nonphytotoxic crop oil.

REVIEW OF LITERATURE

Soybeans

Soybean acreage has been increasing throughout the Southeastern United States in the past few years (43). In addition, the area of soybean production is moving westward into the Great Plains States (4). Soybeans are a major crop, have the third highest value of all farm products, and have increased in total value more rapidly than any other crop in Kentucky (46).

Many of the pest problems such as insects, diseases, and weeds that afflict other types of crop production programs are also present in soybean production. Losses due to weeds and better methods of weed control are primary concerns of researchers and soybean producers.

Weed Problems in Soybeans

Lack of adequate weed control in soybeans is one of the major factors contributing to low yields (20). Weeds reduce soybean yields by competing with the crop for needed light, nutrients, and moisture. Weeds also decrease harvest efficiency and may delay harvest (32).

Burnside found that weeds reduced yields more from competition than from harvesting problems. Grasses seemed to be more competitive than broadleaf weeds. Overall, weeds reduced soybean yields 53% if no control measures were employed (3). Nave and Wax found that weeds cause some increase in shattering losses, stubble losses, and lodging losses with combine harvesting. Also, soybeans grown in weed-free plots produced 25% more beans per plant than those grown in weedy plots (35).

Various soybean producing areas experience different weed problems. The problems may be caused by grasses, broadleaf weeds or a combination of both. In much of the Southeastern United States, including Kentucky, one of the most problematic weeds in soybeans is johnsongrass.

Johnsongrass

Johnsongrass, considered to be one of the ten worst weeds in the world (17), is apparently native to the Mediterranean area (18,26). In his efforts to establish how and when johnsongrass was introduced into the United States, McWhorter encountered considerable difficulty in trying to prove conclusively that it was present before 1875. However, before this date several names such as guinea grass, Means grass, and bankruptcy grass were used for plants with growth habits indicative of johnsongrass. The exact method of introduction has never been determined (26).

Johnsongrass was spread rapidly throughout much of the United States through its use as a forage, through contaminated hay, and by contaminated crop seed. The Government began recognizing johnsongrass as a problem weed around 1900 (26).

Johnsongrass reproduces both from seed and from rhizomes (18,25). Plants from either seed or rhizomes initiate new rhizome growth 21 (29) to 46 (18) days after emergence. The major portion of rhizome growth takes place after the plant flowers (17,29).

Growth of johnsongrass is most rapid in the warm summer months, with temperatures of approximately 32 C being optimum. Some growth does take place in the cooler seasons of spring and fall (22,33). Temperatures of 24 C greatly reduced growth from that at 32 C. Few differences in growth and development of johnsongrass plants from seeds or rhizomes have been found after the initial two to three weeks of growth when the old rhizome contributes to the plant's food supply (29).

Daylengths for flowering of johnsongrass range from 11 to 14.5 hours according to Keeley and Thullen (22). McWhorter and Jordan found that increased light intensity increased johnsongrass growth. However, rapid growth could still occur at low light levels. Light level adaptability is one reason that johnsongrass is so competitive even when shaded by a crop (33).

McWhorter and Burt have reported the existence of geographical ecotypes of johnsongrass (5,25). When johnsongrass plants from different areas of the United States were studied under the same conditions considerable variation in culm height, number of culms, and plant vigor were noted (5,25). Burt found that latitude seemed to help determine variation in the time required for floral initiation.

Plants from northern areas required approximately seven weeks after emergence to initiate flowering, while those from southern latitudes required nine weeks (5). McWhorter also reported some variation in growth and development of johnsongrass plants collected within a relatively small area (25).

Many factors contribute to the difficulty of johnsongrass control. Reproduction from both seeds and rhizomes is on of the reasons (18,25). Many johnsongrass seeds tend to lie dormant and remain viable in the soil for an extended period of time. Fresh seed have only about 30% germination, and four to five months are required to reach 90% germination (22). Also, the differing ecotypes of johnsongrass may respond differently to herbicides (24).

Johnsongrass Control in Soybeans

Weed control is critical in the first month after soybeans are planted if maximum yields are to be obtained. Control is also needed for the entire growing season since weeds continue to reduce yields as long as they are actively growing (4).

Johnsongrass has been difficult to control and has reduced soybean yields 23% to 41% (32). Cultivation and chemical methods are both used to try to control johnsongrass in soybeans. Preplant incorporated, preemergence, and postemergence herbicide treatments are currently being used for johnsongrass control (16).

Kentucky recommendations list dalapon and glyphosate for postemergence rhizomic johnsongrass control before planting of soybeans. Fluchloralin, profluralin [N-(cyclopropylmethyl)-α,α,α-trifluoro-2,6-dinitro-n-propyl-p-toluidine], trifluralin, and vernolate applied preplant incorporated or alachlor and metolachlor [2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl) acetamide] applied preemerence are recommended for seedling johnsongrass control (16).

Dalapon, a foliar applied herbicide, was released for public use in 1953 (42) and has been used extensively for johnsongrass control since that time. After treatment with dalapon the area must be plowed before soybeans can be planted (36). Glyphosate may be used in much the same manner with better results than those obtained from dalapon (38). A delay of 10 to 14 days is needed between application and plowing to allow for translocation and time for complete kill of johnsongrass by either of these herbicides (36,38). To avoid this delay in planting, preplant incorporated herbicides are used for johnsongrass control.

Label directions indicate the rate of trifluralin for rhizomic johnsongrass control is double that used for annual grasses (9). This double rate of trifluralin has been the most widely used method of controlling johnsongrass in soybeans in the Southeast (27). McWhorter found that double rates of trifluralin gave relatively poor weed control after one treatment. However, the second year of the double rate of herbicide resulted in satisfactory johnsongrass control (27,28).

If trifluralin is used under cool, wet weather conditions crop injury can occur (9). McWhorter found the double rate of trifluralin caused 20% to 30% soybean injury, but still gave yields higher than nontreated weedy plots or those receiving a single rate of trifluralin (28). Parker and Dowler found that trifluralin did reduce soybean yields 10.5% from those of a nontreated weed-free check (36). Hagood and others, however, failed to find reduced yields with rates of trifluralin four times as great as those recommended (13).

Fluchloralin and trifluralin are both in the herbicide group known as the dinitroanilines (1). Comparing trifluralin to fluchloralin, McWhorter found that effect on johnsongrass control, soybean injury, and soybean yields were equal for these herbicides (27). Jacques and Harvey also found trifluralin and fluchloralin to be equivalent when tested for effect on root and shoot length and shoot weight of oats (19).

Vernolate alone or in combination with trifluralin is recommended for seedling johnsongrass control (39). Vernolate alone was found to give good early season weed control but did not last through the growing season. Soybean yields have been found to be reduced 8.6% to 14% by vernolate as compared to a non-weedy check (36).

Alachlor as a preemergence treatment can be used to reduce competition from seedling johnsongrass (34). Alachlor gives good annual grass control (8) and does not cause soybean injury (8,13).

In recent years attention has been turned to postemergence johnsongrass control in soybeans. Glyphosate gives excellent johnsongrass control but also causes soybean injury and reduced yields when applied over-the-top in a growing crop (30). To avoid crop injury a recirculating sprayer has been used. For best results with the recirculating sprayer weeds must be at least 15 cm taller than the crop so as to apply herbicide only to the weeds (30).

Another recently introduced herbicide is mefluidide. Mefluidide acts as a plant growth regulator (10). It has been found to give good control of rhizomic johnsongrass and several other grasses (11,15,31). Mefluidide causes soybean injury, particularly at high rates of application. Some of these reported injuries have been severe enough to cause reduced yields (15,31). Surfactants increase mefluidide activity and decrease the amount of herbicide needed for weed control (11,31).

BAS 9021 and BAS 9052

Two experimental herbicides for grass control in soybeans and several other crops are BAS 9021 (44) and BAS 9052 (2). BAS 9021 is formulated as a 75% soluble powder (44) and BAS 9052 is a 20% emulsifiable concentrate (2). Both are applied postemergence, over-the-top of the crop (2,44).

BAS 9021 has been found to give good control of giant foxtail and of quackgrass (7,8,14). Rhizomic johnsongrass can also be controlled with BAS 9021 (12,14). Control was reportedly better when johnsongrass was 76 cm in height at the time of herbicide application rather than 45 cm in height (12). No soybean injury was apparent at rates of 0.6 to 2.2 kg/ha of BAS 9021 (12). Use of a surfactant or an oil concentrate was found to increase effectiveness of BAS 9021 (12,45).

BAS 9052 has been demonstrated to have excellent activity on both annual and perennial grasses including johnsongrass (2). Low rates, 0.3 to 0.6 kg/ha, of BAS 9052 provided 95% to 100% control of annual grasses. Higher rates, 0.6 to 1.1 kg/ha, were required to obtain control of rhizomic johnsongrass (45).

Split applications of BAS 9052 increased johnsongrass control over that obtained with single applications. The addition of an oil concentrate also improved weed control (45).

BAS 9052 does not injure soybeans and has no effect on broadleaf weeds (45) or nutsedge (*Cyperus spp.*) (2).

MATERIALS AND METHODS

Experiments were conducted on the Western Kentucky University farm at Bowling Green, Kentucky, during the summers of 1978 and 1979. Control of rhizomic johnsongrass was evaluated in 1978, and seedling and rhizomic johnsongrass was evaluated in 1979. All studies were conducted on a Pembroke silty clay loam soil. The experimental design for all studies was a randomized complete block with four replications of each treatment.

All areas were plowed with a moldboard plow and then disked before planting. Mitchell variety soybeans were planted each year. Soybeans were planted in 90 cm row widths on May 30, 1978, and in 75 cm row widths on June 6, 1979.

Plots consisted of two treated rows and one untreated check row. Each plot was 7.5 m long. All herbicide treatments were applied with a hand-held CO_2 sprayer at a rate of 187 L/ha and a pressure of 2.1 kg/cm^2.

1978

In 1978 BAS 9021 was evaluated at varying rates and times of application either alone, with a nonphytotoxic crop oil, or with a nonionic surfactant. BAS 9021 was applied at 1.1 and 1.7 kg/ha early postemergence or late postemergence. Split applications of 1.1 plus 1.1 kg/ha and 1.7 plus 1.7 kg/ha were also made. The surfactant was at 0.25% of total volume and the crop oil rate was 2.4 L/ha. A cultivated check was also included for comparison.

Early postemergence applications were made on June 13 when johnsongrass was 15 cm in height. Late postemergence applications were made on June 27 when previously untreated johnsongrass was approximately 75 cm in height and regrowth in previously treated plots was 8 to 10 cm.

Broadleaf pressure was heavy throughout the area. Bentazon [3-isopropyl-1H-2,1,3-benzothiadiazin-(4) 3H-one 2,2-dioxide] was applied at 1.1 kg/ha to the entire area on July 12 for broadleaf weed control.

Visual ratings for johnsongrass control were made on July 26, eight weeks after planting. All ratings were reported as a percentage of johnsongrass stand controlled. These data were analyzed and means separated as described by Steele and Torrie (40). The analysis of variance tables are in Appendix Table 1.

<u>1979</u>

For rhizomic johnsongrass control BAS 9021 and BAS 9052 were compared with mefluidide, trifluralin, fluchloralin, and trifluralin plus vernolate. The BAS 9021 was applied at rates of 1.1 and 1.7 kg/ha in each of two applications. BAS 9052 was applied at 0.6, 0.8, and 1.1 kg/ha either early postemergence or late postemergence. Split applications of 0.6 plus 0.3 kg/ha and 0.6 plus 0.6 kg/ha were also made.

Mefluidide was applied at 0.3 kg/ha early post-emergence and in split applications of 0.3 plus 0.1 kg/ha and 0.3 plus 0.3 kg/ha. Mefluidide at 0.3 kg/ha was also combined with 0.6 kg/ha of BAS 9052.

Trifluralin and fluchloralin were used at 2.2 kg/ha. Trifluralin at rates of 1.1 and 2.2 kg/ha was also combined with vernolate at 2.8 kg/ha. All of these treatments were preplant incorporated applications.

For seedling johnsongrass control BAS 9021 and BAS 9052 were compared with mefluidide and alachlor. Rates and times of application of the BAS products and mefluidide were the same as previously given for established johnsongrass control. Alachlor was applied preemergence at rates of 3.4 and 4.5 kg/ha.

All early postemergence treatments were applied on June 26, when established johnsongrass was approximately 25 cm in height and seedling johnsongrass was approximately 15 cm in height. Late postemergence applications were made on July 15, when previously untreated rhizomic johnsongrass was 85 cm in height and seedling johnsongrass was 55 cm in height. All postemergence herbicide applications contained a nonphytotoxic crop oil concentrate at the rate of 2.4 L/ha.

Bentazon was applied to the entire area in both experiments at a rate of 1.1 kg/ha on June 29 for broadleaf weed control.

Visual ratings for johnsongrass control were taken on August 1, 8 weeks after planting, and again on August 23, 11 weeks after planting.

Approximately 6 m of one row in each treatment were harvested on October 20. Entire plants were clipped with a sickle-bar mower, bundled, and removed from the area. Each sample was then threshed, screened to remove foreign material, and weighed. Random samples were tested for moisture.

Data were analyzed and means separated by Duncan's multiple range tests according to procedures outlined by Steele and Torrie (40). The analysis of variance tables are in Appendix Tables 2 through 7.

RESULTS AND DISCUSSION

1978 Johnsongrass Control

BAS 9021 in split applications of 1.1 plus 1.1 kg/ha and 1.7 plus 1.7 kg/ha alone, with surfactant, or with crop oil resulted in equivalent johnsongrass control. The control ranged from 49% to 83%. Late postemergence applications of 1.7 kg/ha of BAS 9021 with crop oil or surfactant resulted in control equal to that obtained with split applications (Table 1).

Even though statistical differences were not found, all split applications tended to give somewhat better johnsongrass control than the late postemergence applications. Also, the late applications tended to give better control than the early postemergence treatments.

There were no differences in johnsongrass control between the surfactant and the crop oil when each was added to BAS 9021. The treatments containing surfactant averaged 46% johnsongrass control while those containing crop oil averaged 48%. The addition of either surfactant or crop oil increased control from the 30% given by BAS 9021 aone. The use of an oil concentrate was recommended, but regular crop oil was used. Since this oil was only approximately half the strength of the concentrate better control might have resulted with the concentrate.

Table 1. Evaluation of BAS 9021 for johnsongrass control.

Treatment	Rate[a]	Time of application[b]	Percent johnsongrass control[c]
BAS 9021	1.1	EP	3 g
BAS 9021	1.7	EP	4 fg
BAS 9021	1.1	LP	35 cdefg
BAS 9021	1.7	LP	34 cdefg
BAS 9021	1.1+1.1	EP+LP	49 abcd
BAS 9021	1.7+1.7	EP+LP	58 abc
BAS 9021+crop oil	1.1	EP	33 cdefg
BAS 9021+crop oil	1.1	LP	43 bcdef
BAS 9021+crop oil	1.1+1.1	EP+LP	56 ab
BAS 9021+crop oil	1.7	EP	29 cdefg
BAS 9021+crop oil	1.7	LP	51 abcd
BAS 9021+crop oil	1.7+1.7	EP+LP	76 ab
BAS 9021+surfactant	1.1	EP	9 efg
BAS 9021+surfactant	1.1	LP	40 bcdefg
BAS 9021+surfactant	1.1+1.1	EP+LP	83 a
BAS 9021+surfactant	1.7	EP	20 cdefg
BAS 9021+surfactant	1.7	LP	45 abcde
BAS 9021+surfactant	1.7+1.7	EP+LP	81 ab
cultivation			14 defg

[a] kg/ha active ingredient

[b] EP-early postemergence LP-late postemergence

[c] Means within a column followed by a common letter are not significantly different at the 1% level by Duncan's multiple range test.

The johnsongrass stand was rather uneven over much of the area. Variation in plant size at the time of the early postemergence applications may have allowed smaller plants to escape and result in more regrowth.

Cultivation, a long used method of johnsongrass control, was equivalent to all treatments except the split applications of BAS 9021.

Broadleaf control, although not rated, was poor. This may have been due to the large size of the weeds at the time of bentazon application.

1979 Seedling Johnsongrass Control

In the seedling area all BAS 9052 and BAS 9021 treatments gave approximately 88% or better control of johnsongrass (Table 2). No soybean injury was observed from either BAS 9052 or BAS 9021.

Mefluidide gave much poorer johnsongrass control, as well as causing apparent soybean injury. The observed injury included leaf burn, leaf crinkling, and reduced plant height. The higher rates of mefluidide apparently caused more soybean injury than the lower rates. Alachlor gave better johnsongrass control than mefluidide, but did not perform as well as BAS 9052 and BAS 9021.

All johnsongrass control ratings were as high or higher at the 11-week rating as they were at the 8-week rating. Little regrowth appeared to be taking place after the early treatments.

Yield data (Table 2) were fairly consistent with john-

Table 2. Influence of BAS 9021, BAS 9052, mefluidide, and alachlor on seedling johnsongrass control and soybean yields.

Treatment	Rate[a]	Time[b]	Percent johnsongrass control[c] Week 8	Week 11	Soybean[cd] Yield
BAS 9021	1.1+1.1	EP+LP	88 ab	94 a	2527 abcd
BAS 9021	1.7+1.7	EP+LP	91 ab	94 a	2567 abcd
BAS 9052	0.6	EP	89 ab	96 a	2996 a
BAS 9052	0.8	EP	94 ab	96 a	2663 abc
BAS 9052	1.1	EP	93 ab	98 a	2716 abc
BAS 9052	0.6+0.3	EP+LP	99 a	100 a	2739 ab
BAS 9052	0.6+0.6	EP+LP	100 a	100 a	2604 abcd
BAS 9052	0.6	LP	96 ab	100 a	2510 abcd
BAS 9052	0.8	LP	99 a	100 a	2283 bcd
BAS 9052	1.1	LP	99 a	100 a	2722 abc
BAS 9052+ Mefluidide	0.6+0.3	EP	75 bc	89 ab	2030 d
Mefluidide	0.3	EP	14 g	35	1227 e
Mefluidide	0.3+0.1	EP+LP	30 fg	58	1308 e
Mefluidide	0.3+0.3	EP+LP	53 de	71 c	1465 e
Alachlor	3.4	Pre	40 ef	77 bc	2277 bcd
Alachlor	4.5	Pre	64 cd	73 c	2108 b

[a]kg/ha active ingredient

[b]Time of application. EP-early postemergence LP-late postemergence Pre-preemergence

[c]Means within a column followed by a common letter are not significantly different at the 1% level by Duncan's multiple range test.

[d]kg/ha

songrass control. Better control resulted in higher soybean yields. The greatest differences in control and yields were found for the alachlor treatments. Yields for these treatments were not significantly different from most of the BAS treatments, whereas control ratings were significanlty lower.

The combination of apparent soybean injury and poor johnsongrass control resulted in significantly lower yields for all mefluidide treatments. The combination of BAS 9052 and mefluidide gave better johnsongrass control than mefluidide alone and gave better yields than mefluidide alone. The improvement was probably due to the BAS 9052, while the mefluidide still caused soybean injury.

<u>1979 Rhizomic Johnsongrass Control</u>

In the area with established johnsongrass split applications of BAS 9052 gave better control of johnsongrass than early postemergence treatments (Table 3). Split applications of BAS 9021 and BAS 9052 and late postemergence applications of BAS 9052 resulted in better johnsongrass control than most mefluidide treatments or the preplant incorporated treatments.

Apparent soybean injury was noted from all mefluidide treatments. Trifluralin, fluchloralin, and trifluralin plus vernolate resulted in poor johnsongrass control. Control for these treatments ranged from 5% to 14%.

Control at 11 weeks appeared to be lower than at 8 weeks for the early postemergence applications of BAS 9052

Table 3. Influence of BAS 9021, BAS 9052, mefluidide, trifluralin, fluchloralin, and vernolate + trifluralin on rhizomic johnsongrass control and soybean yields.

Treatment	Rate[a]	Time[b]	Percent johnsongrass control[c] Week 8	Percent johnsongrass control[c] Week 11	Soybean Yield[cd]
BAS 9021	1.1+1.1	EP+LP	81 bcd	75 abc	1803 abcd
BAS 9021	1.7+1.7	EP+LP	86 abc	87 ab	1805 abcd
BAS 9052	0.6	EP	71 de	65 bc	1854 abcd
BAS 9052	0.8	EP	79 cd	68 bc	1746 abcde
BAS 9052	1.1	EP	61 ef	51 cd	1544 bcdef
BAS 9052	0.6+0.3	EP+LP	98 a	97 a	2396 a
BAS 9052	0.6+0.3	EP+LP	100 a	99 a	2247 ab
BAS 9052	0.6	LP	93 abc	99 a	2057 abc
BAS 9052	0.8	LP	95 ab	100 a	1941 abcd
BAS 9052	1.1	LP	95 ab	100 a	2259 ab
BAS 9052+ Mefluidide	0.6+0.3	EP	64 ef	65 bc	1401 cdefg
Mefluidide	0.3	EP	28 g	16 e	811 fg
Mefluidide	0.3+0.1	EP+LP	43 f	30 de	845 fg
Mefluidide	0.3+0.3	EP+LP	53 fg	51 cd	981 fg

continued

Table 3. continued

Treatment	Rate[a]	Time[b]	Percent johnsongrass control[c] Week 8	Week 11	Soybean[cd] Yield
Trifluralin	2.2	PPI	9 i	11 e	1017 efg
Fluchloralin	2.2	PPI	5 i	11 e	1216 defg
Trifluralin+ Vernolate	1.1+2.8	PPI	14 hi	9 e	897 fg
Trifluralin+ Vernolate	2.2+2.8	PPI	9 i	6 e	760 g

[a]kg/ha active ingredient

[b]Time of application. EP-early postemergence LP-late postemergence PPP-preplant incorporated

[c]Means within a column followed by a common letter are not significantly different at the 1% level by Duncan's multiple range test.

[d]kg/ha

and mefluidide. Ratings were approximately the same or somewhat higher at 11 weeks for the late postemergence and split applications of BAS 9052 than they were at the 8-week ratings. Apparently the presence of rhizomes caused regrowth in the plots receiving the earlier treatments.

Soybean yield data for the BAS 9052 and BAS 9021 treatments were generally not significantly different (Table 3). The split applications of either of these treatments did tend to result in somewhat higher yields than the single applications. Apparently the length of time of johnsongrass competition did not have any great effect on soybean yields. Early postemergence and late postemergence treatments gave equal yields.

The split applications of BAS 9052 and BAS 9021 and late postemergence applications of BAS 9052 gave better yields than mefluidide, trifluralin, and trifluralin plus vernolate. Split applications of BAS 9052 gave higher soybean yields than fluchloralin.

1979 General Comments

Although the seedling and rhizomic areas were separate experiments with separate statistical analyses, some comparisons can be made. Areas receiving comparable treatments showed poorer johnsongrass control and lower soybean yields in the rhizomic area than in the seedling area, probably due to the fact that rhizomes are more difficult to control and to greater competition from this johnsongrass.

In both areas the late postemergence applications of BAS 9021 and BAS 9052 tended to result in better johnsongrass control than other treatments. In the seedling area there were fewer differences among the BAS 9052 and BAS 9021 treatments than in the same treatments in the rhizomic area.

Yield data in both areas were fairly consistent with the degree of johnsongrass control. The plots with better johnsongrass control generally produced higher soybean yields.

Mefluidide resulted in poor johnsongrass control and apparently caused soybean injury in both areas. The lowest rate of mefluidide gave the poorest johnsongrass control while still causing apparent crop damage. Mefluidide seemed to slow johnsongrass growth rather than reducing stand.

Bentazon, which was applied to both experimental areas, apparently gave good broadleaf weed control. There was little broadleaf pressure after bentazon application.

From this study it seems that postemergence applications of BAS 9052 or BAS 9021 can give excellent johnsongrass control in soybeans. Since no crop injury was observed from either of these chemicals they can readily be used over-the-top in soybeans.

These herbicides might be used in conjunction with preplant incorporated or preemergence grass herbicides for season-long johnsongrass control. Herbicides effective against broadleaf weeds would also be needed for a total weed control program.

APPENDIX

Table 1. Analysis of variance of the 1978 johnsongrass control ratings.

Source of variation	df	SS	MS	F
Total	75	61,450.00		
Replications	3	1,513.00	504.30	1.57ns
Treatments	18	42,637.50	2,368.80	7.39**
Surf. or oil vs none	1	6,709.37	6,709.37	20.94**
Surf. vs oil	1	33.33	33.33	0.10ns
Error	54	17,299.50	320.40	

Table 2. Analysis of variance of the 1979 8-week seedling johnsongrass control ratings.

Source of variation	df	SS	MS	F
Total	63	51,562.12		
Replications	3	523.05	174.35	1.76ns
Treatments	15	46,568.36	3,104.56	31.25**
Error	45	4,470.70	99.35	

ns-not significant
**Significant at the 1% level.

Table 3. Analysis of variance of the 1979 11-week seedling johnsongrass ratings.

Source of variation	df	SS	MS	F
Total	63	23,404.61		
Replications	3	64.55	21.52	0.49ns
Treatments	15	21,363.86	1,424.26	32.43**
Error	45	1,976.20	43.92	

Table 4. Analysis of variance for 1979 soybean yields from the seedling experiment.

Source of variation		SS	MS	F
Total	63	21,725,403.60		
Replications	3	678.970.10	226,323.40	2.82*
Treatments	15	17,438,096.60	1,162,539.80	14.50**
Error	45	3,608,336.90	80,185.30	

ns-not significant
*Significant at the 5% level.
**Significant at the 1% level.

Table 5. Analysis of variance for the 1979 8-week rating for control of rhizomic johnsongrass.

Source of variation	df	SS	MS	F
Total	73	83,074.65		
Replications	3	595.59	198.50	3.97ns
Treatments	17	79,930.90	4,701.82	94.00**
Error	51	2,548.26	49.97	

Table 6. Analysis of variance for the 1979 11-week rating for control of rhizomic johnsongrass.

Source of variation	df	SS	MS	F
Total	73	94,906.99		
Replications	3	601.38	299.46	1.39ns
Treatments	17	86,965.74	5,115.63	35.54**
Error	51	7,339.88	143.92	

ns-not significant
**Significant at the 1% level.

Table 7. Analysis of variance for 1979 soybean yields in the rhizomic johnsongrass area.

Source of variation	df	SS	MS	F
Total	71	27,739,451.60		
Replications	3	938,727.90	312,909.30	2.67ns
Treatments	17	20,805,829.20	1,223,872.80	10.43**
Error	51	5,985,894.50	117,370.50	

ns-not significant
**Significant at the 1% level.

Table 8. Rainfall at the Western Kentucky University farm from June 7 to August 31, 1979.

Date		Amount (cm)
June	7	4.22
	21	0.94
	24	3.30
July	4	0.25
	8	8.97
	12	1.14
	21	2.54
	23	0.38
	25	2.29
	26	1.63
	27	0.25
	29	1.04
August	8	1.65
	14	1.27
	23	2.54
	25	1.91
	27	2.54
	29	1.78
	31	3.15
Total		42.15

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