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A Comparison of Herbicides for Postemergence Grass Control in Soybeans

Brian C. Laube

A COMPARISON OF HERBICIDES FOR POSTEMERGENCE GRASS CONTROL IN SOYBEANS

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BRIAN C. LAUBE

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This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable for meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

W. E. Arnold
Major Adviser

Date

Maurice L. Horton
Head, Plant Science Department

Date

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INTRODUCTION

No-till and minimum tillage agriculture limits preplant incorporated herbicides and cultivation for weed control in soybeans. Furthermore, reduced tillage leaves crop residue on the soil surface, thereby also limiting the effectiveness of many preemergence herbicides. A reduced tillage system with the utilization of postemergence weed control practices may reduce soil erosion and production costs while increasing weed control, water infiltration, moisture conservation, and crop yields.

Postemergence herbicides are less affected by soil type and moisture than soil applied herbicides. However, the effectiveness of postemergence herbicides may be reduced when rain occurs too soon after treatment.

Quackgrass [Agropyron repens (L.) Beauv.], foxtail spp. [Setaria spp.], and corn (Zea mays L.) are problem weeds in the corn-soybean rotation of the northern corn belt. The presence of these grassy weeds in soybean fields is unsightly and often results in severe yield reductions.

Fluazifop butyl {2-[4-[5-(trifluoromethyl-2-pyridinyloxy)] phenoxy]propanoate}, CGA 82725 {2-propynyl 2-[4-[3,5-dichloro-2-pyridinyl)oxy]phenoxy]propionate}, Dowco 453 {methyl 2-4-[3-chloro-5-(trifluoromethyl)-2-pyridinyl]oxy]phenoxy]propanoate}, and RO 13-8895 {acetone-O-[D-2-[p-(α,α,α-trifluoro-p-tolyl)-oxy]phenoxy]propionyl] oxime}, are being developed as postemergence herbicides to control several grass species in soybeans. The purpose of these studies was to

evaluate and compare fluazifop butyl, CGA 82725, Dowco 453, and RO 13-8895 as late-season rescue treatments for annual grass and quackgrass control in soybeans and to determine the effect of rainfall on the control of weeds by these herbicides.

LITERATURE REVIEW

Fluazifop butyl, CGA 82725, RO 13-8895, and Dowco 453 are being developed as postemergence herbicides to control several annual and perennial grass species in soybeans (14, 22, 24, 30, 31, 32, 37). The level of activity and the range of susceptible grass species has not yet been fully determined for these herbicides.

Quackgrass is a troublesome weed in soybeans in the north temperate regions of the United States and has been listed as one of the ten worst weeds of field crops (26). Young et al. (43) reported an 11% soybean yield reduction when quackgrass was present for six weeks and a 33% yield reduction when quackgrass was present for the full season. Wyse (41) reported over 60% yield reduction when quackgrass was not controlled.

Few herbicides are available for selective quackgrass control and cultivation alone is seldom effective (26). Wyse (41) studied the effectiveness of vernolate (S-propyl dipropylthiocarbamate) for selective quackgrass control in soybeans when applied as a preplant treatment alone or as a sequential treatment to glyphosate [N-(phosphonomethyl) glycine]. Vernolate alone gave only 30 to 58% quackgrass control whereas pretillage treatments of glyphosate followed by vernolate preplanting incorporated gave over 95% control. However, quackgrass should reach the three- to four-leaf stage before glyphosate treatment in the spring and this may delay soybean planting beyond the optimum time (40). Soybeans are not tolerant to postemergence glyphosate applications.

A selective postemergence herbicide for the control of quackgrass without injury to soybeans would be beneficial. Young and Wyse (42) found that HOE 29152 {2-[4-trifluoromethyl phenoxy)phenoxy] propanoate} applied postemergence at rates of 1.68 to 3.36 kg/ha effectively controlled quackgrass, however, 33% soybean injury occurred with 3.36 kg/ha applied at the fifth-trifoliate stage of growth. Simkins and Doll (32) reported good to excellent quackgrass control with fluazifop butyl at 0.75 kg/ha, RO 13-8895 at 0.3 kg/ha and Dowco 453 at 0.25 kg/ha.

Selective postemergence control of annual grasses is desirable to overcome the limitations of the present weed control practices. No-till and minimum tillage methods limit preplant incorporated herbicides and cultivation. Kapusta (23) reported lower soybean yields under a no-till situation than with minimum or conventional tillage because of poor herbicidal weed control and no mechanical cultivation. Weed control with preemergence treatments or cultivation depends largely on weather conditions. Precipitation of 1.3 to 1.9 cm is often necessary to leach the herbicide into the weed seed germination zone whereas excessive rainfall may delay cultivation and prevent effective weed control (34). However, even with the best normal cultivation practices, soybean yield may be reduced 10% by weed competition. Burnside and Moomaw (9) cited the need for a weed control program utilizing postemergence herbicides to control such weed escapes in soybeans. Small residual infestations of annual grasses have resulted in sizeable corn yield reductions; however, soybean yields may not be as severely affected if late season

rains occur (35).

Soybean yields are affected by the available moisture and the shading ability of the weeds (27, 33, 35). Staniforth (33) found that foxtail competition reduced soybean yields when drought conditions were present in August and September. Murphy and Gossett (27) reported a 27% soybean yield reduction from a weed population in which annual grasses predominated. This reduction was less than expected because the weeds present did not have the shading ability of broadleaf weeds that had been reported in other studies (4, 17).

Volunteer corn makes soybean fields unsightly and difficult to harvest, while lowering grain quality and reducing yields (1, 2, 3, 8). Available soil-applied herbicides do not satisfactorily control volunteer corn. Mechanical control or rogueing is difficult and time consuming. Andersen et al. (3) reported that an early postemergence treatment may reduce corn interference resulting in higher soybean yields. Glyphosate applied with a rope-wick applicator to contact only the corn above the soybeans and diclofop 2-[4-(2,4-dichlorophenoxy) phenoxy]propanoic acid applied as an early over-the-top spray both effectively controlled volunteer corn, however, with higher densities of corn diclofop treatments often resulted in higher yields than did glyphosate treatments. Uncontrolled volunteer corn in clumps 2.4 m apart in the soybean row reduced yields an average of 31%.

Phytotoxicity of foliar applied herbicides is influenced by rainfall (5, 6, 7, 15, 16, 18, 19, 21, 38). The phytotoxicity is influenced by the amount of rainfall and the interval between herbicide

application and rainfall; however, the herbicide, herbicide rate, surfactant, and plant species sensitivity may modify the effects of rainfall. Doran and Andersen (15) observed reduced bentazon (3-isopropyl-1H-2,1,3-benzothiadiazin-4(3H)-one 2,2-dioxide) activity with simulated rainfall less than 8 h after treatment in greenhouse studies and after less than 24 h in field studies. Also, bentazon plus petroleum oil or vegetable oil gave better weed control than bentazon alone with rainfall simulation 4 or 8 h after application. Intense, simulated rainshowers did not reduce 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) effectiveness on woody plants even when applied 5 minutes after herbicide application (38). Phytotoxicity decreased in greenhouse studies with increased amounts of simulated rainfall following application of 2,4-D (2,4-dichlorophenoxyacetic acid) to common lambsquarters (Chenopodium album L.) (5). Upchurch et al. (38) reported that the herbicidal action of picloram (4-amino-3,5,6-trichloropicolinic acid) plus 2,4-D on woody plants was reduced when 2.54 cm of rainfall was applied as compared to 0.75 cm. Increasing paraquat (1,1-dimethyl-4,4-bipyridinium ion) and 2,4-D:2,4,5-T rates on mango (Mangifera indica L.) and guava (Psidium guajava L.) partially offset the negative effects of rainfall simulation after herbicide application (7).

MATERIALS AND METHODS

Quackgrass Control Experiment

Field studies were conducted near Brookings, South Dakota in 1981 and 1982. The experiments were arranged in a randomized complete block design with four replications. Plot size was 3 by 3.6 m with three soybean rows per plot. 'Hodgson 78' soybeans were planted in rows spaced 91 cm apart in 1981 and 'Hardin' soybeans were planted in 76-cm rows in 1982. Treatments were applied when soybeans were in the three- to four-trifoliate leaf stage and the quackgrass shoots were 15 to 20 cm tall. In 1981, CGA 82725 at 0.56, 1.12, and 1.68 kg ai/ha, fluazifop butyl at 0.28, 0.56, and 0.84 kg ai/ha, and RO 13-8895 at 0.28, 0.56, and 0.84 kg ai/ha were applied in combination with a non-ionic surfactant[1] at 0.1% (v/v). In 1982, the CGA 82725 and fluazifop butyl treatments were repeated; however, RO 13-8895 was discontinued in 1982 and Dowco 453 at 0.07, 0.14, and 0.28 kg ae/ha plus crop oil concentrate[2] at 1.0% (v/v) was added to the experiment. Herbicides were applied in a spray volume of 187 L/ha at a pressure of 245 kPa with a bicycle-mounted sprayer. Plots were not cultivated. Visual evaluations of quackgrass control were taken 4 and 15 weeks after treatment in 1981, and 4 and 12 weeks after treatment in 1982. Ratings were based on a 0 to 99 scale with 0 indicating no control and 99 representing complete

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[1]Union Carbide Agricultural Products Co., Inc. Trade name: Herbimax.

[2]ICI Americas, Inc. Trade name: Atplus.

control. Quackgrass samples for dry weight determinations were taken 4 and 12 weeks after treatment in 1981, and 4 and 16 weeks after treatment in 1982. Samples were collected from three 625-cm^2 squares per plot. Soybeans were harvested from the entire plot with a plot combine. Data were subjected to analysis of variance and treatment means were compared with the Waller-Duncan k-ratio T test (P = 0.05 and k-ratio = 100). Several comparisons were made using orthogonal contrasts.

Annual Grass Control Experiment

Field studies were conducted near Centerville, South Dakota in 1981 and 1982. A randomized complete block design with four replications was used for both experiments. 'Hodgson 78' soybeans were planted in rows 76 cm apart. Plots were three rows, 12.2 m long in 1981 and 9.1 m long in 1982. Shelled corn was broadcast at 17,000 kernels/ha and harrowed to cover the seed in 1982, simulating a volunteer corn infestation.

In the first year, CGA 82725 at 0.28, 0.56, and 0.84 kg ai/ha, fluazifop butyl at 0.14, 0.28, and 0.56 kg ai/ha, and RO 13-8895 at 0.14, 0.28, and 0.56 kg ai/ha were applied alone and in combination with a non-ionic surfactant at 0.1% (v/v). In 1982 the CGA 82725 and fluazifop butyl treatments were repeated; however, since RO 13-8895 was discontinued in 1982, Dowco 453 at 0.03, 0.07, and 0.14 kg ae/ha alone and with crop oil concentrate at 1.0% (v/v) was added. Herbicides were applied in a spray volume of 187 L/ha at 245 kPa with a bicycle-mounted sprayer. Soybeans were in the four-trifoliate leaf stage when the treatments were applied. Yellow foxtail [*Setaria lutescens* (Weigel)

Hubb.] was at the early heading stage both years. Barnyardgrass [Echinochloa crus-galli (L.) Beauv.] was at the six-leaf stage and volunteer corn at the eight-leaf stage in 1982.

Weed control was visually evaluated 4 weeks after treatment and again at soybean senescence. Evaluations were based on a 0 to 99 scale with 0 indicating no control and 99 representing complete control. Yellow foxtail samples were collected 4 weeks after treatment from three 625-cm^2 squares per plot for dry weight determinations. Soybeans were harvested from the entire plot with a plot combine. Data were subjected to analysis of variance and treatment means were compared using the Waller-Duncan k-ratio T test (P = 0.05 and k-ratio = 100). Several factors were compared with orthogonal contrasts.

Rainfall Experiments

General

Field studies were conducted at Redfield, South Dakota in 1981 and at Centerville, South Dakota in 1982. Herbicides tested in 1981 were fluazifop butyl, CGA 82725, and RO 13-8895. RO 13-8895 was discontinued after 1981 and Dowco 453 was added in 1982. A bicycle-mounted sprayer was used to apply all herbicides in 187 L/ha at 245 kPa. Rainfall was applied with an oscillating 80° flat-fan nozzle mounted on a rectangular steel frame. The nozzle was positioned 2.7 m above ground level and delivered 10.1 L/min at a pressure of 66 kPa over a 2.4- by 3-m area. This simulates 6.6 cm of rainfall in a 1 hour period.

Experimental design was a randomized complete block with four replications. Plot size was 3 m by 3.6 m with three soybean rows per

plot. 'Hodgson 78' soybeans were planted in rows spaced 91 cm apart in 1981 and 76 cm in 1982. Shelled corn was broadcast and harrowed in to represent a volunteer corn infestation in 1982. Metribuzin [4-amino-6-tert-butyl-3-(methylthio)-as-triazin-5(4H)-one] at 0.43 kg ai/ha was applied preemergence in 1981 and a postemergence application of acifluorfen 5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-nitrobenzoic acid at 0.43 kg ai/ha was used in 1982 for broadleaf weed control. Herbicide and rainfall treatments were applied when soybeans were in the three- to four-trifoliate leaf stage. Yellow foxtail was 10 to 15 cm tall with 10 to 15 plants/m^2 in 1981 and 50 to 60 plants/m^2 in 1982. Volunteer corn was 25 to 40 cm tall with six to eight plants/m^2. Four weeks after treatment, yellow foxtail samples were collected from two 625-cm^2 areas per plot for dry weight determinations. Weed control was visually evaluated 6 weeks after treatment, based on a 0 to 99 scale with 0 indicating no control and 99 representing complete control. Soybeans were harvested manually from 2.4 m of the middle row in each plot in 1981. A plot combine was used to harvest the entire plot in 1982. Results were analyzed statistically and the means were compared with the Waller-Duncan k-ratio T test (P = 0.05 and k-ratio = 100).

Rainfall Interval

In 1981, fluazifop butyl was applied at 0.28 kg ai/ha, CGA 82725 at 0.56 kg ai/ha, and RO 13-8895 at 0.28 kg ai/ha. All treatments included a non-ionic surfactant at 0.1% (v/v). RO 13-8895 was discontinued in 1982 and Dowco 453 at 0.07 kg ae/ha plus crop oil concentrate at 1.0% (v/v) was added to the experiment. Rainfall was

applied within 5 min. prior to, and 0, 0.5, 1, 2, 4, and 8 h after herbicide application in 1981. A 24 h interval was included in 1982. Also, rainfall was applied with no herbicide treatment, as a comparison check in 1981. In 1982, three comparison checks, one for each herbicide, were used to reduce the variability due to uneven weed pressure. The amount of rainfall was 1.65 cm in a 15-min period, similar to an intense, summer shower.

Rainfall Quantity

Herbicide treatments were applied at the same rates as described in the preceding section. Rainfall was applied in quantities of 0, 0.25, 2.5, 6.4, 12.7, and 25.4 mm immediately after herbicide treatment. Rainfall was not applied to comparison checks.

Herbicide Rate

In 1981, CGA 82725 at 0.28, 0.56, and 0.84 kg/ha with and without surfactant at 0.1% (v/v) and fluazifop butyl and RO 13-8895 at 0.14, 0.28, and 0.56 kg/ha with and without surfactant at 0.1% (v/v) were applied. RO 13-8895 was discontinued in 1982 and Dowco 453 was included in the study at rates of 0.03, 0.07, and 0.14 kg/ha with and without crop oil concentrate at 1.0% (v/v). Rainfall of 12.7 mm was applied immediately after herbicide treatment and to the comparison checks.

RESULTS AND DISCUSSION

Quackgrass Control Experiment

Quackgrass control varied with the herbicide and dosage applied. Dowco 453 at a dosage of 0.28 kg/ha controlled quackgrass better than fluazifop butyl or CGA 82725 in the 1982 experiment (Table 1). Quackgrass control with fluazifop butyl and RO 13-8895 was similar in the 1981 experiment (Table 2). CGA 82725 did not effectively control quackgrass (Table 1).

Dowco 453 at 0.28 kg/ha effectively controlled quackgrass as indicated by the visual control ratings and plant dry weights (Table 1). Dowco 453 reduced the number of quackgrass plants and stunted the remaining plants. Toxicity symptoms appeared first as a cessation of meristematic growth followed by leaf yellowing until plant death occurred 3 to 4 weeks after herbicide treatment. Quackgrass dry weights decreased as the dosage of Dowco 453 was increased from 0.07 to 0.28 kg/ha. Quackgrass control obtained with Dowco 453 at 0.28 kg/ha resulted in significantly higher soybean yields than with fluazifop butyl at 0.28 kg/ha, CGA 82725 at all rates tested, and the untreated check.

Quackgrass control with Dowco 453 was maintained through the season (Table 2). Control of quackgrass with Dowco 453 was evident the spring following application as visual control estimates with 0.14 and 0.28 kg/ha were 25 and 70%, respectively (data not shown). Season-long control of quackgrass is important to reduce the need for retreatment and to reduce the number of cultivations necessary for control. Dowco

Table 1. Effect of dosage on phytotoxicity of CGA 82725, fluazifop butyl, RO 13-8895, and Dowco 453 to quackgrass. Brookings, South Dakota, 1981 and 1982.

Treatment[b]	Rate	1981[a] Quackgrass control (Weeks after treatment)		1981[a] Quackgrass dry weight (Weeks after treatment)		1981[a] soybean seed yield	1982[a] Quackgrass control (Weeks after treatment)		1982[a] Quackgrass dry weight (Weeks after treatment)		1982[a] soybean seed yield
		4	15	4	12		4	12	4	16	
	(kg/ha)	----(%)-----		------(g)-------		(kg/ha)	----(%)----		-----(g)------		(kg/ha)
CGA 82725	0.56	3 c	9 ef	5.5 bc	18.0 d	810 abc	10 de	8 d	5.7 c	10.0 de	1210 bc
CGA 82725	1.12	24 b	16 def	6.6 cd	16.7 cd	730 abc	11 de	6 d	4.2 bc	8.4 cd	1170 bc
CGA 82725	1.68	31 b	29 b-e	3.8 abc	14.7 bcd	640 bc	18 d	12 cd	5.5 c	9.2 de	1090 c
Fluazifop butyl	0.28	60 a	31 bcd	1.3 a	6.8 a	1130 ab	9 de	3 d	4.8 bc	8.6 cd	1170 bc
Fluazifop butyl	0.56	69 a	39 abc	1.5 a	9.7 abc	1080 ab	35 c	25 c	2.7 ab	4.8 bc	1340 ab
Fluazifop butyl	0.84	75 a	55 a	0.8 a	7.4 a	1210 a	66 b	52 b	2.7 ab	3.9 ab	1310 ab
RO 13-8895	0.28	57 a	40 abc	1.9 a	7.4 a	940 abc	--	--	---	---	----
RO 13-8895	0.56	33 b	20 c-f	2.3 ab	10.5 abc	1070 ab	--	--	---	---	----
RO 13-8895	0.84	66 a	45 ab	1.0 a	9.3 ab	850 abc	--	--	---	---	----
Dowco 453	0.07	--	--	---	---	---	19 d	25 c	4.1 bc	8.8 de	1240 bc
Dowco 453	0.14	--	--	---	---	---	78 b	59 b	2.4 ab	3.2 ab	1290 b
Dowco 453	0.28	--	--	---	---	---	91 a	94 a	1.5 a	0.5 a	1480 a
Untreated check	----	0 c	0 f	9.2 d	20.9 d	480 c	0 e	0 d	10.9 d	12.5 e	920 d

[a]Values in a column followed by a common letter are not significantly different at the 5% level using the Waller-Duncan k-ratio T test (P = 0.05 and k-ratio = 100).

[b]CGA 82725, fluazifop butyl, and RO 13-8895 were applied with a non-ionic surfactant at 0.1% (v/v). Dowco 453 was applied with crop oil concentrate at 1.0% (v/v).

Table 2. Orthogonal contrasts of herbicide treatments for quackgrass control in soybeans. Brookings, South Dakota, 1981 and 1982.

Orthogonal contrast of quackgrass control	Quackgrass control
1981	
CGA 82725 averaged across rates at 4 wk vs CGA 82725 averaged across rates at 15 wk	20 vs 18
RO 13-8895 averaged across rates at 4 wk vs RO 13-8895 averaged across rates at 15 wk	52 vs 35**
Fluazifop butyl averaged across rates at 4 wk vs Fluazifop butyl averaged across rates at 15 wk	68 vs 42**
RO 13-8895 at 0.84 kg/ha averaged across time vs Fluazifop butyl at 0.84 kg/ha averaged across time.	55 vs 65
RO 13-8895 at 0.84 kg/ha averaged across time vs CGA 82725 at 1.68 kg/ha averaged across time.	55 vs 23**
1982	
CGA 82725 averaged across rates at 4 wk vs CGA 82725 averaged across rates at 12 wk	13 vs 9
Dowco 453 averaged across rates at 4 wk vs Dowco 453 averaged across rates at 12 wk	63 vs 59
Fluazifop butyl averaged across rates at 4 wk vs Fluazifop butyl averaged aross rates at 12 wk	37 vs 27*
Dowco 453 at 0.28 kg/ha averaged across time vs Fluazifop butyl at 0.84 kg/ha averaged across time	93 vs 59**
Dowco 453 at 0.28 kg/ha averaged across time vs CGA 82725 at 1.68 kg/ha averaged across time	93 vs 15**

*, **Significant F-test at 0.05 and 0.01 levels, respectively.

453 was unique among the herbicides tested for its season-long control of quackgrass.

Quackgrass control with fluazifop butyl was not satisfactory under the conditions of these tests. A clear effect of dosage was not evident with this compound in 1981, however, control was significantly higher with rate increases in 1982 (Table 1). Regrowth of quackgrass is indicated by late-season evaluations which were lower than evaluations made 4 weeks after treatment (Table 2). None of the plots were cultivated so the results may differ from control expected in commercial fields. Cultivation or retreatment of the quackgrass should reduce regrowth and improve control above that obtained in the trials described.

Similar quackgrass control was attained with RO 13-8895 and fluazifop butyl (Table 2). All RO 13-8895 applications reduced quackgrass dry weights as compared to the check, however, soybean yields were variable with no trends evident (Table 1).

CGA 82725 did not effectively control quackgrass (Table 1). Visual estimates of late-season control were similar to early-season evaluations (Table 2). Quackgrass dry weights did not significantly vary between CGA 82725 treatments in 1981 or 1982 (Table 1). Soybean yields did not significantly differ between rates, however yields did tend to decline with each increase in herbicide dosage in 1981 and 1982. No soybean injury was apparent in visual evaluations. The CGA 82725 may have been absorbed into the soybean foliage without causing apparent external injury and still have affected seed production. However, CGA

has soil activity; Dale (13) has reported that soybean seed treated with CGA 82725 at 1.1 g a.i. kg^{-1} seeds has produced plants with reduced dry weights while seeds treated with fluazifop butyl were not affected. Root exudates from herbicide treated quackgrass and other plants have been shown to affect plants in other studies (10, 11, 12). Therefore, either the herbicide sprayed on the soil or the root exudate from the quackgrass plants treated with high rates of CGA 82725 may have also affected the soybean growth and yield.

Annual Grass Control Experiment

CGA 82725 applied at a dosage of 0.28 kg/ha plus a non-ionic surfactant at 0.1% (v/v) gave yellow foxtail control equal or superior to any application of fluazifop butyl or RO 13-8895 in 1981 (Table 3). CGA 82725 gave better yellow foxtail, barnyardgrass, and volunteer corn control and higher soybean yields than fluazifop butyl or Dowco 453 in 1982 (Table 4). Similar weed control was attained with fluazifop butyl and Dowco 453 in 1982.

CGA 82725 gave satisfactory yellow foxtail control with all treatments except 0.28 kg/ha alone in 1981 (Table 3). The addition of surfactant to CGA 82725 at 0.28 kg/ha improved yellow foxtail control from 49 to 89%. No further increases in control were gained by increasing the CGA 82725 dosage or applying surfactant with the higher rates. Yellow foxtail dry weights tended to decrease as the rate of CGA 82725 was increased, however reductions were not significant. In 1982, yellow foxtail, barnyardgrass, and volunteer corn were satisfactorily controlled with CGA 82725 at all rates with and without surfactant

Table 3. Effect of herbicide treatments on yellow foxtail control and dry weights, and soybean seed yield. Centerville, South Dakota, 1981.

Herbicide Treatment	Rate (kg/ha)	Yellow foxtail control[a] (%)	Yellow foxtail dry weight[a] (g)	Soybean seed yield[a] (kg/ha)
CGA 82725	0.28	49 gh	35 a-e	2480 bcd
CGA 82725 + surfactant[b]	0.28 + 0.1% (v/v)	89 a-d	15 abc	2530 bc
CGA 82725	0.56	92 abc	5 ab	2420 bcd
CGA 82725 + surfactant	0.56 + 0.1% (v/v)	94 ab	8 abc	2470 bcd
CGA 82725	0.84	95 a	8 a-c	2380 cd
CGA 82725 + surfactant	0.84 + 0.1% (v/v)	97 a	1 a	2420 bcd
fluazifop butyl	0.14	63 e-h	122 hi	2810 a
fluazifop butyl + surf.	0.14 + 0.1% (v/v)	69 d-g	64 d-g	2410 bcd
fluazifop butyl	0.28	47 h	77 e-h	2500 bc
fluazifop butyl + surf.	0.28 + 0.1% (v/v)	73 b-f	81 fgh	2360 cd
fluazifop butyl	0.56	82 a-e	52 c-f	2490 bc
fluazifop butyl + surf.	0.56 + 0.1% (v/v)	79 a-e	23 a-d	2510 bc
RO 13-8895	0.14	51 fgh	47 b-f	2390 cd
RO 13-8895 + surfactant	0.14 + 0.1% (v/v)	73 b-f	20 a-c	2550 abc
RO 13-8895	0.28	82 a-e	30 a-d	2670 ab
RO 13-8895 + surfactant	0.28 + 0.1% (v/v)	84 a-e	10 a-c	2470 bcd
RO 13-8895	0.56	50 gh	100 ghi	2210 d
RO 13-8895 + surfactant	0.56 + 0.1% (v/v)	94 ab	3 ab	2470 bcd
Untreated Check	----	0 i	142 i	2380 cd

[a]Means with a column followed by a common letter are not significantly different at the 5% level using the Waller-Duncan k-ratio T test (P = 0.05 and k-ratio = 100).

[b]The surfactant used was Herbimax.

Table 4. Orthogonal contrasts of herbicide treatments for yellow foxtail, barnyard grass, and volunteer corn control in soybeans. Centerville, South Dakota, 1982.

Contrast	Weed Control			Soybean seed yield
	Yellow foxtail	Barnyardgrass	Volunteer corn	
	(%)			(kg/ha)
Fluazifop butyl with adjuvant vs Dowco 453 with adjuvant	88 vs 89	81 vs 78	95 vs 96	1410 vs 1370
Fluazifop butyl without adjuvant vs Dowco 453 without adjuvant	83 vs 81	75 vs 67	95 vs 96	1370 vs 1240
CGA 82725 with adjuvant vs Average of (fluazifop butyl with adjuvant and Dowco 453 with adjuvant)	94 vs 89**	95 vs 80**	98 vs 95**	1600 vs 1390**
CGA 82725 without adjuvant vs Average of (fluazifop butyl without adjuvant and Dowco 453 without adjuvant)	93 vs 82	96 vs 71	99 vs 96	1580 vs 1310*
Average of all herbicide treatments with adjuvant vs Average of all herbicide treatments without adjuvant	90 vs 86**	85 vs 80**	96 vs 97**	1460 vs 1400
CGA 82725 at 0.56 kg/ha w/wo adjuvant vs CGA 82725 at 0.84 kg/ha w/wo adjuvant	93 vs 95	95 vs 97	99 vs 99	1440 vs 1700
Fluazifop butyl at 0.28 kgha w/wo adjuvant vs Fluazifop butyl at 0.56 kg/ha w/wo adjuvant	84 vs 90	84 vs 94*	95 vs 98	1470 vs 1460
Dowco 453 at 0.07 kg/ha w/wo adjuvant vs Dowco 453 at 0.14 kg/ha w/wo adjuvant	86 vs 91	78 vs 91**	97 vs 99**	1360 vs 1330

*, ** Significant F-test at 0.05 and 0.01 levels, respectively.

(Table 5). Neither an increase in dosage nor the addition of surfactant improved weed control. Soybean yields did not differ between CGA 82725 treatments in either 1981 (Table 3) or 1982 (Table 5).

The addition of surfactant to fluazifop butyl at 0.28 kg/ha improved yellow foxtail control in 1981 (Table 3). Increasing the dosage from 0.28 to 0.56 kg/ha increased yellow foxtail control when the ratings were averaged across adjuvants (Table 6). Maximum yellow foxtail control with fluazifop butyl was obtained with 0.14 kg/ha plus surfactant in 1982 (Table 5). Yellow foxtail dry weights did not significantly differ, however they did tend to decrease as the fluazifop butyl dosage was increased or when a surfactant was used. Likewise, control of volunteer corn increased as the dosage of fluazifop butyl was increased, yet 93% control was achieved at the lowest dosage. Barnyardgrass control was higher with fluazifop butyl at 0.56 kg/ha than at 0.28 kg/ha (Table 4). Soybean yields from fluazifop butyl treatments were variable with no trends evident. The variablity in yields may be due to the late application time, since this experiment was designed to evaluate the herbicides as late-season rescue treatments. Numerous studies have indicated that weed control during the first 3 to 5 weeks is necessary for optimum yields (20, 25, 27, 29, 39). These treatments were applied 6 to 7 weeks after planting; thus, large yield differences would not be expected. However, weed removal studies indicate that better quality grain and greater ease of harvest are benefits of late season weed control (28, 39).

The addition of surfactant to RO 13-8895 at 0.56 kg/ha

Table 5. Effect of herbicide treatments on yellow foxtail control and dry weights, barnyardgrass control, volunteer corn control, and soybean seed yield. Centerville, South Dakota, 1982.

Herbicide Treatment	Rate (kg/ha)	Yellow foxtail control[a] (%)	Yellow foxtail dry weight[a] (g)	Barnyard-grass control[a] (%)	Volunteer corn control[a] (%)	Soybean seed yield[a] (kg/ha)
CGA 82725	0.28	93 ab	38 abc	95 a	99 a	1620 abc
CGA 82725 + surfactant[b]	0.28 + 0.1% (v/v)	93 ab	28 ab	93 a	98 a	1650 ab
CGA 82725	0.56	93 ab	30 abc	97 a	99 a	1400 a-e
CGA 82725 + surfactant	0.56 + 0.1% (v/v)	93 ab	26 ab	93 a	99 a	1480 a-d
CGA 82725	0.84	93 ab	42 abc	98 a	99 a	1720 a
CGA 82725 + surfactant	0.84 + 0.1% (v/v)	96 a	10 a	98 a	98 a	1680 a
fluazifop butyl	0.14	70 e	59 abc	47 e	93 d	1310 cde
fluazifop butyl + surf.	0.14 + 0.1% (v/v)	81 cde	56 abc	66 cd	93 d	1190 de
fluazifop butyl	0.28	87 abc	43 ab	84 abc	96 bc	1490 a-d
fluazifop butyl + surf.	0.28 + 0.1% (v/v)	82 cd	26 ab	84 abc	95 c	1440 a-d
fluazifop butyl	0.56	91 abc	31 abc	95 a	98 a	1330 cde
fluazifop butyl + surf.	0.56 + 0.1% (v/v)	88 abc	25 ab	94 a	97 ab	1590 abc
Dowco 453	0.03	72 de	84 cd	41 e	92 d	1120 e
Dowco 453 + COC[c]	0.03 + 1.0% (v/v)	83 bc	71 bcd	58 de	92 d	1320 cde
Dowco 453	0.07	81 cde	58 abc	71 bcd	97 ab	1250 de
Dowco 453 + COC	0.07 + 1.0% (v/v)	91 abc	47 abc	86 ab	98 a	1480 a-d
Dowco 453	0.14	90 abc	33 abc	90 a	99 a	1350 b-e
Dowco 453 + COC	0.14 + 1.0% (v/v)	93 ab	57 abc	92 a	98 a	1320 cde
Untreated check	----	0 f	146 e	0 f	0 e	340 f

[a]Means within a column followed by a common letter are not significantly different at the 5% level using the Waller-Duncan k-ratio T test (P = 0.05 and k-ratio = 100).

[b]The surfactant used was Herbimax.

[c]The crop oil concentrate used was Atplus.

Table 6. Orthogonal contrasts of herbicide treatments for yellow foxtail control in soybeans. Centerville, South Dakota, 1981.

Contrast	Yellow foxtail control (%)	Soybean seed yield (kg/ha)
Fluazifop butyl with adjuvant vs RO 13-8895 with adjuvant	74 vs 84	2420 vs 2500**
Fluazifop butyl without adjuvant vs RO 13-8895 without adjuvant	64 vs 61	2600 vs 2420
CGA 82725 with adjuvant vs Average of (fluazifop butyl with adjuvant and RO 13-8895 with adjuvant)	93 vs 79**	2480 vs 2460
CGA 82725 without adjuvant vs Average of (fluazifop butyl without adjuvant and RO 13-8895 without adjuvant)	79 vs 63*	2430 vs 2510
Average of all herbicide treatments with adjuvant vs Average of all herbicide treatments without adjuvant	84 vs 68**	2470 vs 2480
CGA 82725 at 0.56 kg/ha w/wo adjuvant vs CGA 82725 at 0.84 kg/ha w/wo adjuvant	93 vs 96	2450 vs 2400
Fluazifop butyl at 0.28 kg/ha w/wo adjuvant vs Fluazifop butyl at 0.56 kg/ha w/wo adjuvant	60 vs 81*	2430 vs 2500
RO 13-8895 at 0.28 kg/ha w/wo adjuvant vs RO 13-8895 at 0.56 kg/ha w/wo adjuvant	83 vs 72	2570 vs 2340**

*,**Significant F-test at 0.05 and 0.01 levels, respectively.

significantly improved yellow foxtail control, however control with RO 13-8895 at 0.28 kg/ha alone or with surfactant did not differ from 0.56 kg/ha with surfactant (Table 3). Similar results were obtained with the dry weights of yellow foxtail plants. Soybean yields with RO 13-8895 plus an adjuvant averaged across rates were higher than with fluazifop butyl plus an adjuvant (Table 6). However, RO 13-8895 at 0.56 kg/ha averaged across adjuvants yielded less than the 0.28 kg/ha treatments. This yield reduction may indicate crop injury which was not apparent.

Dowco 453 gave acceptable yellow foxtail control (> 80%) with all treatments except 0.03 kg/ha alone (Table 5). Yellow foxtail control with Dowco 453 at 0.03 kg/ha increased when crop oil concentrate was applied with the herbicide. Barnyardgrass appeared more difficult to control than did yellow foxtail. Dowco 453 at 0.03 kg/ha plus crop oil gave 58% barnyardgrass control, while yellow foxtail control was 83% with the same treatment. Dowco 453 at 0.07 kg/ha plus crop oil controlled barnyardgrass as well as 0.14 kg/ha alone. Volunteer corn was very susceptible to Dowco 453. Dowco 453 at 0.03 kg/ha gave 92% volunteer corn control and control increased to 97% with 0.07 kg/ha. The addition of crop oil did not affect control, however, soybean yields tended to be higher when crop oil was applied with the lower rates of Dowco 453. The herbicide dosage did not affect yield (Tables 4 and 5).

CGA 82725 treatments tended to resulted in higher soybean yields in 1982 than the average of the fluazifop butyl and Dowco 453 treatments (Table 4). When the lower dosages of each herbicide are compared, yellow foxtail, barnyardgrass, and volunteer corn were better controlled

with CGA 82725 than with Dowco 453 or fluazifop butyl (Table 5). Barnyardgrass was less susceptible than yellow foxtail or volunteer corn to fluazifop butyl and Dowco 453. CGA 82725 controlled all species tested equally well in this experiment. The addition of surfactant or crop oil to fluazifop butyl and Dowco 453 tended to give an increase in weed control similar to that of increasing the herbicide dosage. Orthogonal contrasts indicated the addition of adjuvant gave significantly higher control than the herbicides applied alone (Tables 4 and 6). Surfactant and crop oil are generally less costly than chemical, thus the addition of a surfactant or crop oil may be more economical than increasing the herbicide dosage.

Rainfall Experiments

Rainfall Interval

All herbicide treatments controlled yellow foxtail in 1981, however there were no significant differences in control due to the herbicide or the length of the rain-free period (Table 7). Yellow foxtail control was varied with the herbicide and the delay interval in 1982. Fluazifop butyl required a longer rain-free period to significantly reduce yellow foxtail dry weights than did Dowco 453, which, in turn, required a longer rainfall delay than CGA 82725 (Figure 1). Dry weights from CGA 82725 applications were lower than the comparison checks, regardless of rainfall treatment. Fluazifop butyl required a 2-h rain-free period and Dowco 453 a 1-h period to attain yellow foxtail dry weights significantly lower than those in the checks and equivalent to the lowest obtained with CGA 82725. Yellow foxtail control, as

Table 7. Effect on yellow foxtail control and soybean seed yield by CGA 82725, RO 13-8895, and fluazifop butyl performance with 1.7 cm simulated rainfall applied prior to and 0, 0.5, 1, 2, 4, and 8 h after treatment. Redfield, South Dakota, 1981.

Herbicide	Interval between treatment and rainfall (hrs)	Yellow foxtail control[a] (%)	Soybean seed yield[b] (kg/ha)
CGA 82725	prior	91 a	1260
	0	88 a	1150
	0.5	81 a	1210
	1	84 a	1290
	2	83 a	1370
	4	73 a	1060
	8	83 a	1520
RO 13-8895	prior	76 a	1390
	0	51 a	870
	0.5	48 a	1040
	1	67 a	1040
	2	48 a	1370
	4	53 a	930
	8	67 a	1200
Fluazifop butyl	prior	52 a	1100
	0	69 a	1390
	0.5	61 a	1570
	1	47 a	1310
	2	77 a	1250
	4	85 a	1180
	8	73 a	1020
No herbicide	--	0 b	960

[a]Values in a column followed by a common letter are not significantly different at the 5% level.

[b]Values are not significantly different at the 5% level.

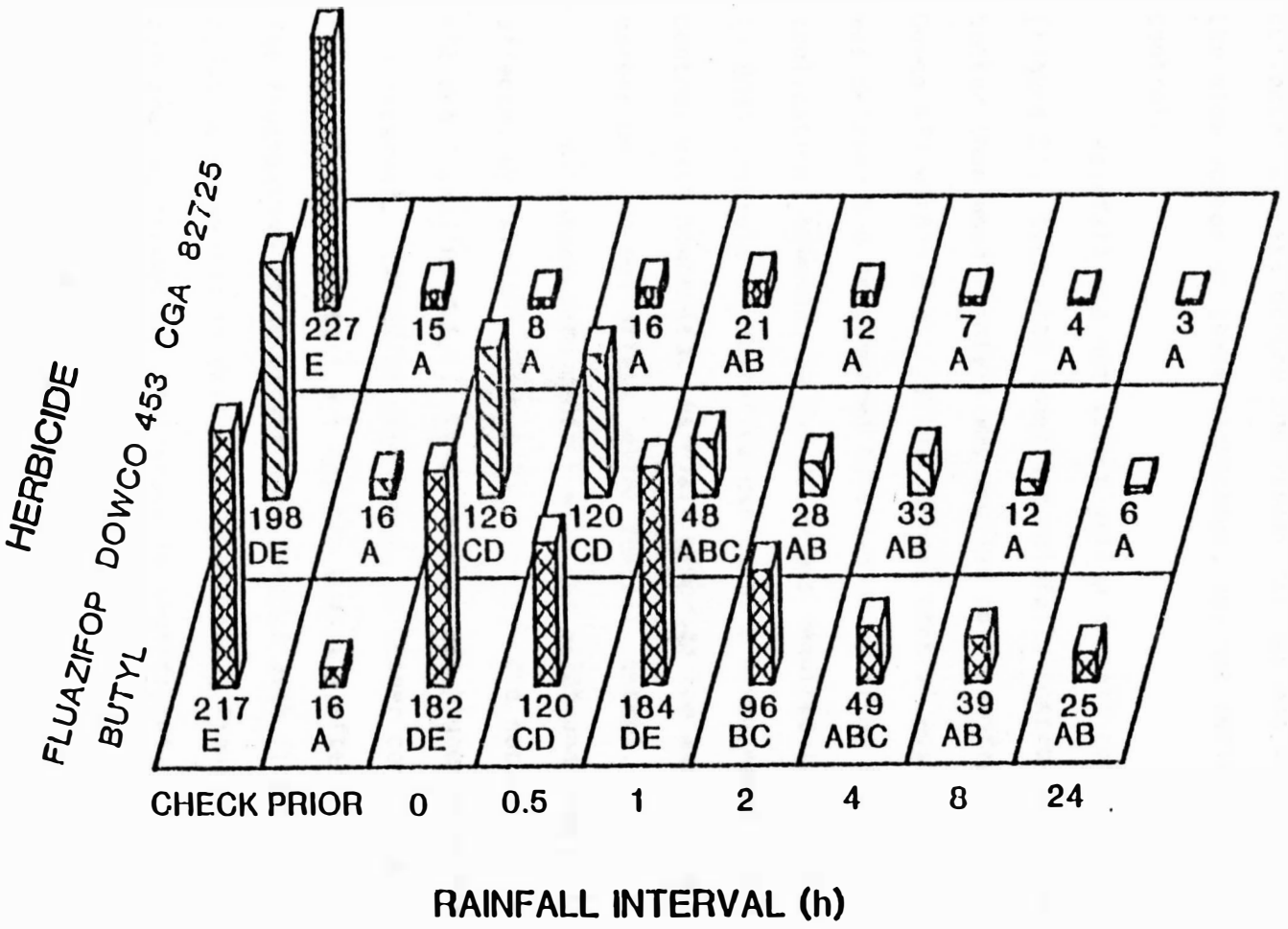

Figure 1. The effect of the time interval between CGA 82725, Dowco 453, fluazifop butyl application and rainfall treatment on yellow foxtail dry weights. Values at the base of each column represent the mean dry weight (g). Values with a common letter beneath are not significantly different at the 5% level.

determined by dry weights, was not affected by rainfall prior to herbicide application. The yellow foxtail dry weight samples were collected 2 weeks before the visual ratings and therefore, because of the slow action of these herbicides, may not reflect the same degree of control.

Rainfall did not affect yellow foxtail control with CGA 82725 (Figure 2). Even with immediate rainfall, control with CGA 82725 was better than when rainfall was applied to fluazifop butyl within 8 h, or Dowco 453 within 2 h. Yellow foxtail control was higher when rainfall was delayed 4 h as compared to a 1-h delay after fluazifop butyl application, however, an 8-h delay was required to obtain acceptable (> 80%) control. A rain-free period of 2 h was necessary for maximum control with Dowco 453. Rainfall prior to the application of the herbicides did not affect yellow foxtail control.

Volunteer corn control with CGA 82725 and Dowco 453 was not affected by rainfall (Figure 3). Control did not differ between Dowco 453 and fluazifop butyl, except control was higher with Dowco 453 at the 1-h interval. CGA 82725 gave better volunteer corn control than fluazifop butyl when rainfall was applied 0 or 1 h after herbicide treatment. The fluctuation of volunteer corn control with fluazifop butyl at the 0.5-h delay period is difficult to explain. Figure 1 indicates a comparable, though not statistically significant, fluctuation in yellow foxtail control. Doran and Andersen (15) reported a similar increase in bentazon activity with rainfall. Rainfall may remoisten the herbicidal deposits thereby increasing penetration and effectiveness, similar to

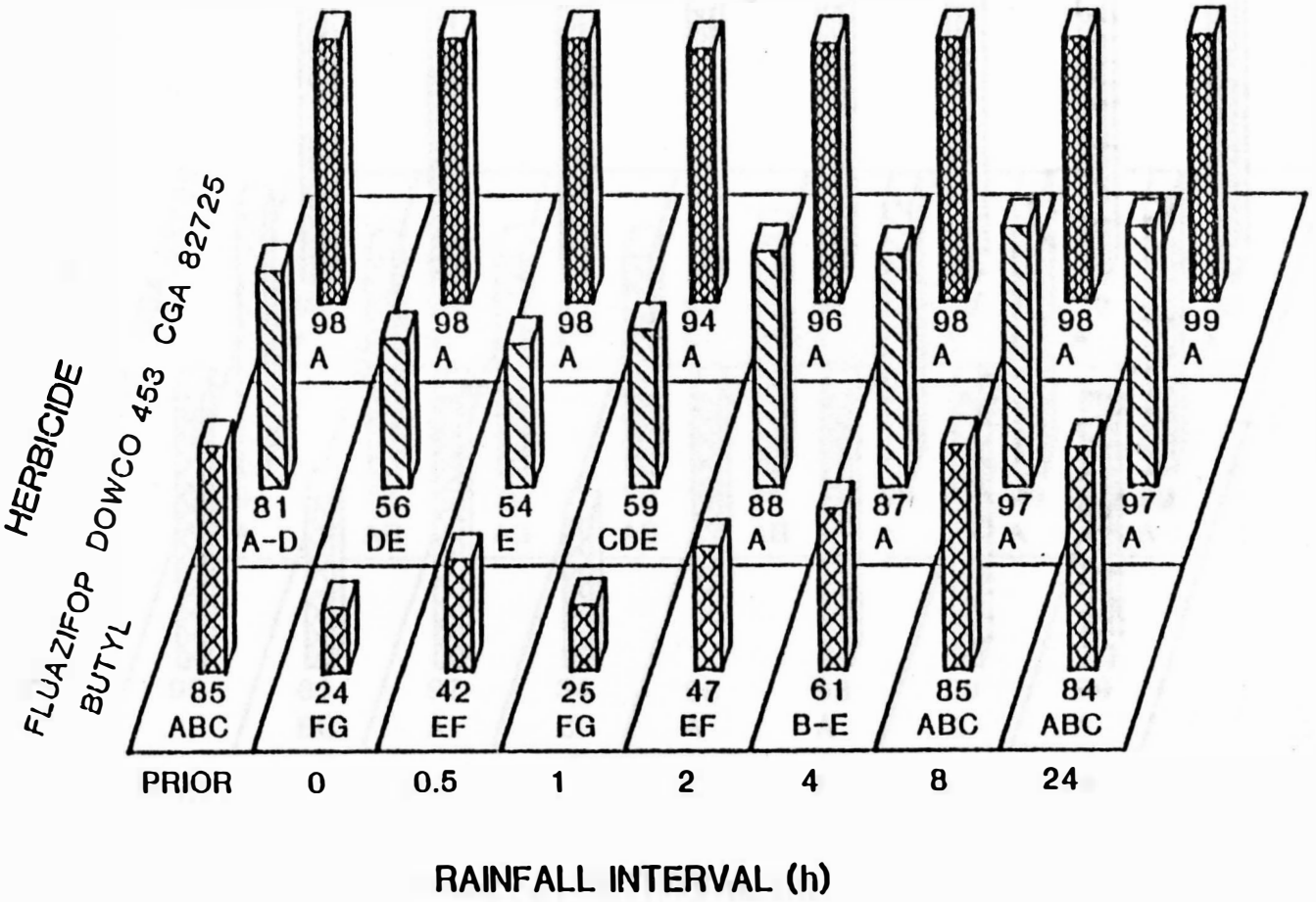

Figure 2. The effect of the time interval between herbicide application and rainfall treatment on yellow foxtail control with fluazifop butyl, Dowco 453, and CGA 82725. Centerville, South Dakota, 1982. Values at the base of each column are percent yellow foxtail control. Values with a common letter beneath are not significantly different at the 5% level.

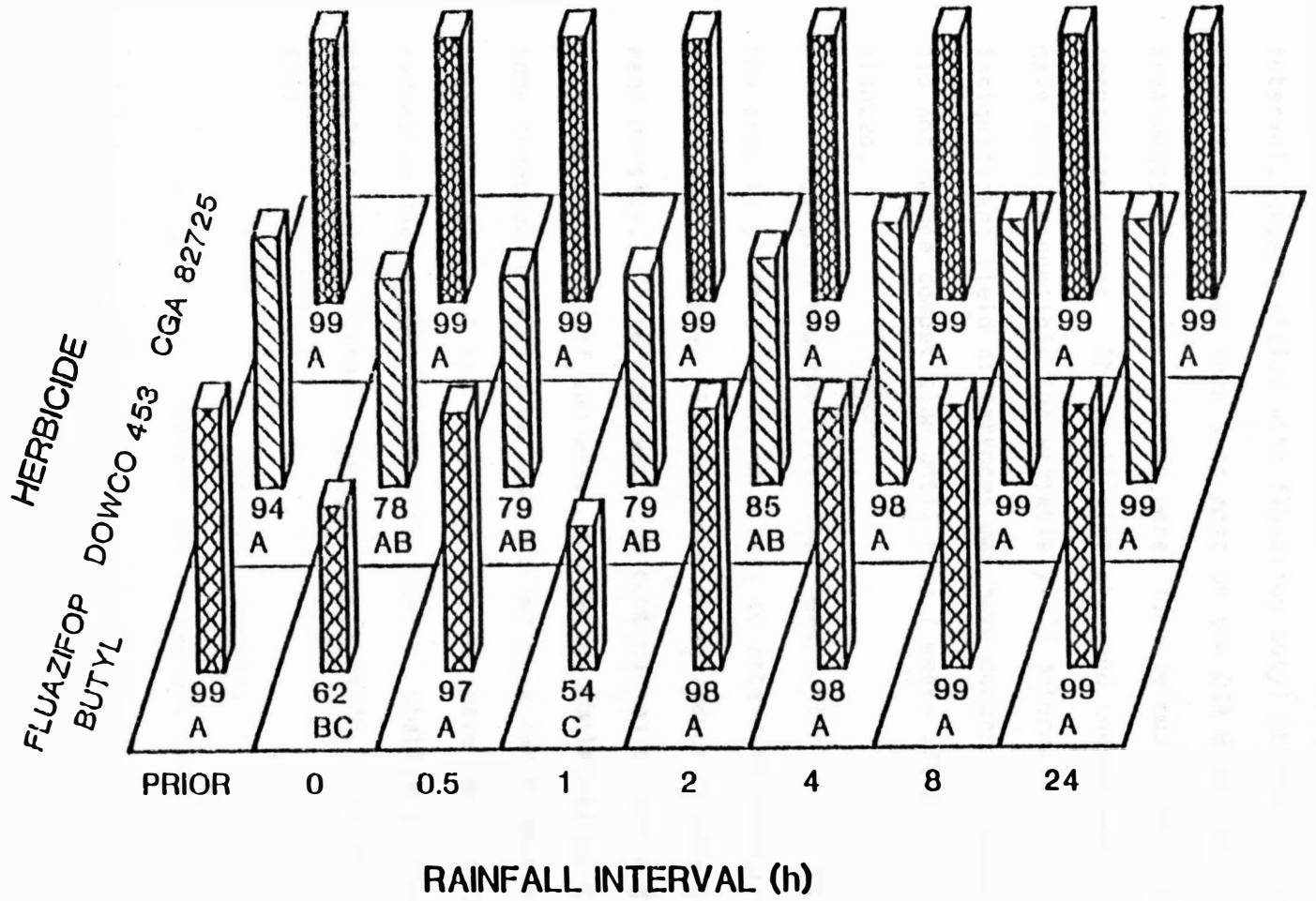

Figure 3. The effect of the time interval between herbicide application and rainfall treatment on volunteer corn control with fluazifop butyl, Dowco 453, and CGA 82725. Centerville, South Dakota, 1982. Values at the base of each column are percent volunteer corn control. Values with a common letter beneath are not significantly different at the 5% level.

2,4-D work cited by Hammerton (21).

Soybean yields were not significantly affected by the rainfall interval, except yields with fluazifop butyl at the 0-h delay were significantly lower than with most of the CGA 82725 and Dowco 453 treatments (Table 8). Yields were, for the most part, lowest in the comparison checks. The small plot size and uneven weed pressure may have been responsible for variable yield determinations, however, insignificant yield differences may have occurred because the herbicides did not reduce competition until 6 to 7 weeks after the soybeans were planted.

Research has indicated that weed control for 3 to 5 weeks after the crop is planted may be necessary to attain maximum yields (20, 25, 27, 29, 39). Feltner (20) reported yield reduction was proportional to weed density. Therefore, with the combination of early grass competition in all plots and weeds not being completely controlled with some treatments, yields varied, but not by a large degree. The competitive effects of the volunteer corn may have been the main yield reduction factor in the comparison checks, similar to the competitive effects of giant foxtail (Setaria faberi Herrm.) reported by Staniforth (36).

Rainfall Quantity

Yellow foxtail control was equivalent with fluazifop butyl and CGA 82725 and was not affected by the amount of rainfall applied in 1981 (Table 9). However, when 2.5 mm rainfall or more was applied after RO 13-8895, there was no yellow foxtail control as compared to the check.

Table 8. Effect on soybean seed yield by CGA 82725, Dowco 453, and fluazifop butyl performance with 1.7 cm simulated rainfall applied prior to, and 0, 0.5, 1, 2, 4, 8, and 24 h after treatment. Centerville, South Dakota, 1982.

Interval between treatment and rainfall	Soybean seed yield[a]		
	Dowco 453	CGA 82725	Fluazifop butyl
---- hrs -----	---------- (kg/ha) ----------		
prior	3030 a	2840 a	2670 a
0	2840 a	2660 a	1790 bcd
0.5	2670 a	2970 a	2370 ab
1	2380 ab	2870 a	2330 abc
2	2960 a	2420 ab	2300 abc
4	2730 a	2730 a	2500 ab
8	2990 a	2810 a	2880 a
24	2340 ab	2760 a	2380 ab
No herbicide	1700 bcd	1510 cd	1400 d

[a]Values followed by the same letter are not significantly different at the 5% level.

Table 9. Effect of amount simulated rainfall applied immediately after fluazifop butyl, CGA 82725, and RO 13-8895 on yellow foxtail control. Redfield, South Dakota, 1981.

Amount simulated rainfall	Fluazifop butyl	CGA 82725	RO 13-8895
	Yellow foxtail control[a]		
(mm)	(%)		
0	44 bcd	53 abc	58 ab
0.25	53 abc	68 a	38 cd
2.5	50 abc	53 abc	14 efg
6.4	26 def	40 bcd	0 g
12.7	33 cde	42 bcd	10 fg
25.4	38 bcd	40 bcd	5 fg
Comparison Check	0 g	0 g	0 g

[a]Values followed by the same letter are not significantly different at the 5% level.

The poor yellow foxtail control with all the herbicides in 1981 may have been due to the low soil moisture conditions at application time. Dortenzio and Norris (16) reported the foliar activity of diclofop 2-[4-(2,4-dichlorophenoxy)phenoxy]propanoic acid was decreased up to 50% by dry soil conditions.

Yellow foxtail control, volunteer corn control, and soybean yields were higher with all herbicide treatments than in the comparison checks in 1982, indicating that up to 25.4 mm rainfall will not eliminate all herbicide activity (Table 10).

Volunteer corn was controlled by all herbicides, regardless of rainfall, except Dowco 453 with 12.7 mm rainfall (Table 10). Volunteer corn control with fluazifop butyl significantly decreased with 25.4 mm rainfall, yet 92% control was attained. CGA 82725 gave excellent yellow foxtail control ($\geq$ 97%) regardless of the amount of rainfall applied. Yellow foxtail control, as measured by visual estimates and plant dry weights, was higher with CGA 82725 at all rainfall amounts than fluazifop butyl with 2.5 mm or more rainfall and Dowco 453 with 12.7 mm or more.

Yellow foxtail control with fluazifop butyl was not affected by the amount of rainfall applied in 1981, however the 1982 visual ratings decrease at 2.5 mm or more rainfall (Table 10). Control as measured by plant dry weights was reduced with 6.4 mm rainfall or more.

Dowco 453 gave better yellow foxtail control than fluazifop butyl when 2.5 mm and higher rainfall treatments are compared, except control at the 12.7 mm rainfall treatment does not differ (Table 10).

Table 10. Percent control of volunteer corn and yellow foxtail, yellow foxtail dry weight samples, and soybean seed yield at Centerville, South Dakota in 1982 as affected by differing amounts of simulated rainfall applied immediately after fluazifop butyl, CGA 82725, and Dowco 453.

Herbicide	Amount rainfall (mm)	Volunteer corn control[a] (%)	Yellow foxtail control[a] (%)	Yellow foxtail dry weight[a] (g)	Soybean seed yield[a] (kg/ha)
Fluazifop butyl	0	99 a	87 abc	33 ab	1950 e
	0.25	99 a	86 abc	23 ab	2660 abc
	2.5	99 a	63 de	55 abc	2220 de
	6.4	99 a	50 ef	150 e	2430 a-d
	12.7	95 ab	34 f	151 e	2370 cde
	25.4	92 b	40 f	136 e	2280 cde
Comparison Check	----	0 d	0 g	216 f	1290 f
CGA 82725	0	99 a	99 a	2 a	2660 abc
	0.25	99 a	98 a	2 a	2830 a
	2.5	99 a	99 a	2 a	2780 a
	6.4	99 a	98 a	8 a	2570 a-d
	12.7	98 ab	97 ab	13 ab	2740 ab
	25.4	99 a	97 ab	16 ab	2760 ab
Comparison Check	----	0 d	0 g	149 e	830 g
Dowco 453	0	99 a	99 a	0 a	2660 abc
	0.25	99 a	99 a	5 a	2790 a
	2.5	99 a	95 ab	22 ab	2770 a
	6.4	96 ab	81 bc	73 bcd	2670 abc
	12.7	76 c	39 f	124 de	2340 b-e
	25.4	96 ab	73 cd	98 cde	2730 ab
Comparison Check	----	0 d	0 g	221 f	1460 f

[a]Values within a column followed by a common letter are not significantly different at the 5% level.

Rainfall greater than 2.5 mm decreased yellow foxtail control with Dowco 453 as measured by visual estimates and plant dry weights. However, control of yellow foxtail and volunteer corn increased with 25.4 mm rainfall as compared with 12.7 mm. Dowco 453 is water soluble and has soil activity. The washoff from the plants and the herbicide sprayed on the soil may have been activated by the 25.4 mm rainfall and resulted in additional weed control. The root uptake of Dowco 453 by volunteer corn was sufficient to give 96% control whereas control was 73% for yellow foxtail.

Soybean yields did not significantly differ between herbicides regardless of the amount of rainfall applied (Table 10). However, all herbicide treatments produced significantly higher yields than in the comparison checks.

Herbicide Rate

Neither the CGA 82725 dosage nor the addition of surfactant directly affected yellow foxtail control under rainfall conditions in 1981, however control was significantly higher with CGA 82725 at 0.84 kg/ha plus surfactant than at 0.28 kg/ha alone (Table 11). CGA 82725 at 0.56 and 0.84 kg/ha gave significantly better yellow foxtail control than 0.28 kg/ha in 1982. The addition of surfactant did not affect control. Soybean yields were not affected by herbicide treatments and did not differ from the untreated check in 1981. In 1982, soybean yields did not differ between herbicide treatments, however soybean yields with CGA 82725 at 0.28, 0.56, and 0.84 kg/ha with surfactant and 0.84 kg/ha alone were significantly higher than the check. Slower

Table 11. Influence of herbicide rate when 12.7 mm simulated rainfall was applied immediately after CGA 82725 treatment. Redfield, South Dakota, 1981. Centerville, South Dakota, 1982.

Herbicide treatment	Rate	Volunteer corn control[a]	Yellow foxtail control[a]		Yellow foxtail dry weight[a]	Soybean seed yield[a]	
		1982	1981	1982	1982	1981	1982
	(kg/ha)	(%)			(g)	-- (kg/ha) --	
CGA 82725 + surfactant[b]	0.84 + 0.1% (v/v)	99 a	86 a	99 a	8 a	1620 a	2680 a
CGA 82725	0.84	99 a	73 ab	99 a	8 a	1220 a	2730 a
CGA 82725 + surfactant	0.56 + 0.1% (v/v)	99 a	61 ab	98 a	16 a	1530 a	2810 a
CGA 82725	0.56	99 a	63 ab	98 a	82 a	1680 a	2570 ab
CGA 82725 + surfactant	0.28 + 0.1% (v/v)	97 a	65 ab	81 b	70 a	1280 a	2660 a
CGA 82725	0.28	98 a	50 b	82 b	70 a	1270 a	2510 ab
Comparison Check	--------	0 b	0 c	0 c	267 b	1210 a	1880 b

[a]Values in a column followed by a common letter are not significantly different at the 5% level.

[b]The surfactant used was Herbimax.

herbicidal action in CGA 82725 treatments without surfactant was noted during field observations. The slowed phytotoxic activity may have lengthened the period of weed competition, thus the yields in these plots did not differ from the check.

Yellow foxtail control with fluazifop butyl was poor under the rainfall conditions of this experiment (Table 12). Fluazifop butyl did not respond directly to dosage increases or the addition of surfactant. In 1981, fluazifop butyl at 0.56 kg/ha plus surfactant controlled yellow foxtail better than 0.14 kg/ha alone or with surfactant. However, control with 0.14 kg/ha did not significantly differ from 0.28 kg/ha with and without surfactant or 0.56 kg/ha alone. Yellow foxtail control and soybean yields did not differ between herbicide treatments in 1982. However, volunteer corn control was nearly complete with all fluazifop butyl treatments.

Yellow foxtail control under rainfall conditions was not satisfactory with any rate of RO 13-8895 (Table 13). However, control with RO 13-8895 at 0.28 kg/ha plus surfactant and at 0.56 kg/ha with and without surfactant was better than the comparison check. Yellow foxtail control was increased by the addition of surfactant to RO 13-8895 at 0.28 kg/ha. Soybean yields were not affected by RO 13-8895 and did not differ from the untreated check.

Yellow foxtail control with Dowco 453 was best at 0.07 kg/ha plus crop oil and at 0.14 kg/ha with and without crop oil (Table 14). The addition of crop oil at the 0.07 kg/ha Dowco 453 rate significantly improved yellow foxtail control and tended to increase the control with

Table 12. Influence of herbicide rate when 12.7 mm simulated rainfall was applied immediately after fluazifop butyl treatment. Redfield, South Dakota, 1981. Centerville, South Dakota, 1982.

Herbicide Treatment	Rate	Volunteer corn control[a]	Yellow foxtail control[a]		Yellow foxtail dry weight[a]	Soybean seed yield[a]	
		1982	1981	1982	1982	1981	1982
	(kg/ha)	(%)			(g)	(kg/ha)	
Fluazifop butyl + surfactant[b]	0.56 + 0.1% (v/v)	98 a	81 a	54 a	119 a	1260 a	2540 ab
Fluazifop butyl	0.56	99 a	64 ab	73 a	95 a	1390 a	2690 a
Fluazifop butyl + surfactant	0.28 + 0.1% (v/v)	97 a	48 ab	59 a	132 a	1290 a	2480 ab
Fluazifop butyl	0.28	99 a	44 ab	54 a	136 a	1000 a	2580 ab
Fluazifop butyl + surfactant	0.14 + 0.1% (v/v)	94 a	39 bc	42 a	153 a	910 a	2680 a
Fluazifop butyl	0.14	94 a	25 bc	40 a	189 a	960 a	2540 ab
Comparison Check	------	0 b	0 c	0 b	170 a	1210 a	1870 b

[a]Values in a column followed by a common letter are not significantly different at the 5% level.

[b]The surfactant used was Herbimax.

Table 13. Influence of herbicide rate when 12.7 mm simulated rainfall was applied immediately after RO 13-8895 treatment. Redfield, South Dakota, 1981.

Herbicide treatment	Rate (kg/ha)	Yellow foxtail control[a] (%)	Soybean seed yield[a] (kg/ha)
RO 13-8895 + surfactant[b]	0.56 + 0.1% (v/v)	43 ab	1370 a
RO 13-8895	0.56	40 ab	1500 a
RO 13-8895 + surfactant	0.28 + 0.1% (v/v)	56 a	1320 a
RO 13-8895	0.28	18 bc	1380 a
RO 13-8895 + surfactant	0.14 + 0.1% (v/v)	15 bc	1270 a
RO 13-8895	0.14	23 abc	1640 a
Comparison Check	------	0 c	1210 a

[a]Values in a column followed by a common letter are not significantly different at the 5% level.

[b]The surfactant used was Herbimax.

Table 14. Influence of herbicide rate when 12.7 mm simulated rainfall was applied immediately after Dowco 453 treatment. Centerville, South Dakota, 1982.

Herbicide treatment	Rate	Volunteer corn control[a]	Yellow foxtail control[a]	Yellow foxtail dry weight[a]	Soybean seed yield[a]
	(kg/ha)	(%)		(g)	(kg/ha)
Dowco 453 + crop oil concentrate[b]	0.14 + 1.0% (v/v)	98 a	92 a	18 a	2760 a
Dowco 453	0.14	99 a	86 a	105 b	2900 a
Dowco 453 + crop oil concentrate	0.07 + 1.0% (v/v)	91 ab	74 a	118 bc	2700 a
Dowco 453	0.07	57 c	34 b	180 c	2620 ab
Dowco 453 + crop oil concentrate	0.03 + 1.0% (v/v)	64 bc	33 b	168 bc	2200 bc
Dowco 453	0.03	14 d	16 bc	119 bc	2120 c
Comparison Check	--------	0 d	0 c	264 d	1460 d

[a]Values in a column followed by a common letter are not significantly different at the 5% level.

[b]Crop oil concentrate used was Atplus.

the other rates. All Dowco 453 applications reduced yellow foxtail dry weights as compared to the check. The addition of crop oil to Dowco 453 at 0.14 kg/ha resulted in the lowest yellow foxtail dry weight recorded. Volunteer corn control was affected by herbicide rate and the addition of crop oil. The addition of crop oil to Dowco 453 at 0.03 and 0.07 kg/ha significantly increased volunteer corn control. All treatments except Dowco 453 at 0.03 kg/ha resulted in higher volunteer corn control than in the comparison check. Soybean yields were significantly increased when Dowco 453 controlled the yellow foxtail and volunteer corn. Dowco 453 applications greater than 0.07 kg/ha did not further increase soybean yield.

The results of this washoff experiment indicate that the phototoxicity of RO 13-8895 and Dowco 453 may increase with the addition of a surfactant. Fluazifop butyl and CGA 82725 did not respond to an increase in dosage or the addition of a surfactant.

SUMMARY

Dowco 453 gave the best quackgrass control and was the only herbicide tested that maintained season-long control. Fluazifop butyl and RO 13-8895 gave poor quackgrass control in this study, therefore retreatment or cultivation may be necessary to achieve acceptable quackgrass control. CGA 82725 was not effective on quackgrass.

CGA 82725 gave the best annual grass control. Barnyardgrass was less susceptible than yellow foxtail to fluazifop butyl and Dowco 453. Volunteer corn was very susceptible to the herbicides tested, therefore the lower herbicide dosages gave acceptable control. The combination of these herbicides with a surfactant generally enhanced weed control.

Rainfall did not affect the efficacy of CGA 82725. Rainfall did not affect the control of volunteer corn with Dowco 453, however a 1-h rain-free period was required to achieve maximum yellow foxtail control. Fluazifop butyl required a 2-h rain-free period to reach maximum volunteer corn and yellow foxtail control.

The amount of rainfall applied did not affect the phytotoxicity of CGA 82725; however, 2.5 mm or more rainfall reduced yellow foxtail control with fluazifop butyl, RO 13-8895, and Dowco 453. The amount of rainfall did not affect the control of volunteer corn.

The application of a surfactant with RO 13-8895 and Dowco 453 increased the phytotoxicity under rainfall conditions. CGA 82725 and fluazifop butyl did not respond to an increase in dosage or the addition of surfactant.

Soybean yields generally were improved by the herbicides but

seldom varied with the herbicide, the herbicide dosage, the addition of surfactant, or the rainfall treatment.

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