RESPONSE OF VOLUNTEER CORN (ZEA MAYS L.) AND SOYBEANS [GLYCINE MAX (L.) MERRILL] TO DICLOFOP OR SETHOXYDIUM AS INFLUENCED BY CORN HEIGHT, CARRIER VOLUME, HERBICIDE RATE, AND CORN CULTIVAR

by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Volunteer corn (Zea mays L.) refers to the F_2 generation of the hybrid used in previous years. Infestations in volunteer corn occur due to crop rotation between soybeans and corn in the corn producing area. Also, changes in management practice point to more volunteer corn in the future (17). The shift to reduced tillage in recent years has allowed volunteer corn to become a serious problem.

Volunteer corn results when corn ears and kernels drop to the ground, survive the winter and germinate the next year.

Volunteer corn may reduce soybean yield by competition. Uncontrolled volunteer corn at density 0.4 clump/m of row reduced yield 83% (7). Also volunteer corn interferes with soybean harvest and increases dockage in soybean sales.

Some herbicides were tested. Preplanting soil incorporated herbicides caused stunt and suppressed corn, but gave incomplete control.

In recent years, two herbicides have been used as postemergence, for controlling volunteer corn; diclofop a selective herbicide is sprayed over the top of volunteer corn and soybeans, and glyphosphate, a non-selective herbicide which is applied with certain equipment that permits the glyphosate to contact only volunteer corn that is taller than soybeans.

Corn hybrids respond differentially to some herbicides such as atrazine, simazine, diclofop, and glyphosate.

Objectives of this study were to evaluate the effectiveness of a new herbicide, Sethoxydim[1] "ISO proposed" besides diclofop as postemergence

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[1] Poast is the trade name and BAS 9052 OH is a development code number for sethoxydim.

application in different rates and different volumes of the carrier for controlling volunteer corn in soybeans, and to show if control of volunteer corn is affected by corn size. Also, another objective of this study was to test different responses of 88 corn hybrids to diclofop and sethoxydim at two different stages of corn growth.

REVIEW OF LITERATURE

1. Control volunteer corn in soybeans:

A. PPI and premergence: Andersen (2) reported that preplanting soil incorporated with dinitroaniline herbicide mostly stunted volunteer corn, but gave partial control. Basalin, Cobex, Prowl, Tolban and Treflan may stunt and suppress corn; but they do not provide complete control, Fawcett (17) reported.

Andersen (4) tested numerous herbicides as preplanting incorporation, but none of these herbicides showed promising activity for controlling volunteer corn.

B. Postemergence: Two postemergence herbicides glyphosate and diclofop have been tested and show promising results for controlling volunteer corn in soybeans. Fawcett (17) reported that diclofop as a postemergence selective herbicide for grassy species and glyphosate a nonselective herbicide in recirculating sprayers gave good control for volunteer corn.

Andersen (2) and Andersen and Geadelmann (6) found under field conditions that HOE 23408 methyl {2-[4-(2,4-dichlorophenoxy) phenoxy] propanoate} at 0.84 to 3.36 kg/ha controlled volunteer corn when sprayed over the top of soybeans and corn. Andersen (2) also suggested that the first trifoliolate of soybeans was the ideal stage for applying diclofop. At this stage of soybeans, enough time has elapsed to allow weeds to emerge; however, weeds have not reached resistant stages, and soybeans have not developed a dense canopy that protects weeds.

Andersen (3) applied diclofop postemergence treatment to different varieties or species of annual grasses. Results showed the highest potential of diclofop for controlling corn compared to the other grassy species. Gorecka and others (23) found that corn is susceptible but wheat is tolerant to diclofop.

Grand and others (24) of American Hoechst Corporation showed that volunteer corn was effectively controlled with diclofop at the rate of 1.4 kg/ha. Best control was observed when applications were made to corn with heights of 20 cm or slightly greater. Marrese (26) reported that later applications of diclofop at the 25 cm corn height are preferred because of the long period of continuing corn germination.

Clark (13) noted that diclofop gave excellent control of volunteer corn at the rates 1.12, 1.27 and 1.4 kg/ha. However, there was no significant difference between the treatments of the three rates, though the yields of all diclofop treatments were significantly greater than an untreated control.

Reports (2, 3, 14, 24, 26) indicate that soybeans have excellent tolerance to diclofop; even when it was applied at rate 3.36 kg/ha, soybean yields were not reduced.

Glyphosate [N-(phosphanomethyl) glycine], a non selective herbicide showed good activity for controlling tall weeds including volunteer corn (16). Fawcett (17, 19) noticed excellent control of volunteer corn with glyphosate using a box-type, broadcast recirculating sprayer, and rope wick applicator. Fawcett and Becker (18) reported that rope wick applicators provided volunteer corn control comparable to recirculating sprayers. Dale (15) attributed the difference in soybean yields sprayed by both methods to splattering of sprayed glyphosate in recirculating sprayer and resulted in reduction of soybean yields.

Andersen and others (7) noted that glyphosate (one part commercial formulation and two parts water) was highly effective in controlling volunteer corn and increasing soybean yields in comparison to soybeans having uncontrolled corn.

Carlson and Burnside (10) observed volunteer corn was controlled at 75 to 100% in soybeans with glyphosate or paraquat (1,1-dimethyl-4, 4-bipyridinium ion) when applied through a recirculating sprayer. Furrer and others (20) observed that volunteer corn control in grain sorghum ranged between 75 to 82% for the rope wick-type applicator, with no injury to sorghum was noticed.

Reports (7, 17) agree that application of glyphosate must not be delayed too long since the longer the corn is left the more it competes with soybeans. Andersen (7) noticed that when corn densities were high, diclofop treatments often resulted in greater soybean yield than did glyphosate treatment. It was suggested the lower yields resulted because corn competed for a longer time before glyphosate treatments were applied.

Besides diclofop and glyphosate some other herbicides have been tested on volunteer corn. Arnold (9) evaluated KK80 at different dosages and concluded that KK80 did not control volunteer corn when applied premergence. However, postemergence application at 1.12 kg/ha appeared to control volunteer corn better than did diclofop.

Gates and Prochaska (21) of 3M Company recommended applying MBR 12325 2S postemergence soybean herbicide at 0.28 kg/ha as broadcast treatments to control volunteer corn when soybeans were in the 2 to 6th trifoliate.

Bas 9052 OH {2-[1-(ethoxyimino) butyl]-5-[2-(ethylthio) propyl]-3-hydroxy-2-cyclohexen-1-one} a new postemergence herbicide was recommended for grassy weeds (8). Veenstra and others (29) tested Bas 9052 OH.

Their preliminary results showed that the herbicide achieved 95 to 100% control of wild proso millet, large crabgrass, shattercane and volunteer corn. At rates 0.28 to 0.84 kg/ha, no injury was noticed on soybeans and there was no activity on broadleaf weeds.

Campbell and Penner (11) reported that a tank-mix combination of bentazon and diclofop at used rates decreased annual grass control. This interaction was not observed with combination of bentazon with Bas 9052 OH except at very low rates in greenhouse trials.

McAvoy (27) found addition of an oil concentrate increased Bas 9052 activity significantly on grassy weeds. He also reported that translocation of Bas 9052 in both basipetally and acropetally resulted in death of meristematic tissues in the shoots, roots, rhizomes, and stolons.

Pearson (28) reported that Bas 9052 is a postemergence herbicide with excellent selectivity in soybeans and other broadleaf crops. Activity has been observed on annual and perennial grasses over a wide range of conditions and at low rates.

2. Response of Corn hybrids to the herbicides

Andersen (1) and Grogan and others (25) noticed that corn hybrids respond differentially to simazine and atrazine.

Andersen and Geadelmann (5, 6) reported that volunteer corn is susceptible to diclofop and that the parentage of corn may play an important role for variation in percent control of volunteer corn by diclofop. However, satisfactory control of corn in soybeans by foliar application of diclofop depends in part on the pedigree of corn hybrids grown the previous year (22).

Andersen (2) applied diclofop at 0.56 kg/ha to corn inbreds. Percent control ranged from 100% for the most susceptible inbreds to

22% for the most resistant inbreds. When the rate of diclofop was doubled, control of corn ranged from 100 to 42%.

In another study, Andersen and Geadelmann (5) tested the response of 240 hybrids to diclofop at rate 1.12 kg/ha. Control ranged between 60 to 100% for different hybrids.

Also, Andersen and Geadelmann (6) found a wide range in response to glyphosate among F_2 hybrids. They concluded that because of the differential response among F_2 corn hybrids have been shown for both diclofop and glyphosate, parentage could be important in determining the degree of control obtained with either herbicide, but more likely with diclofop.

Geadelmann and Andersen (22) suggested that genes at several loci (at least three) controlled tolerance to diclofop.

MATERIALS AND METHODS

1. Control volunteer corn in soybeans

The experiment was conducted in field studies at Manhattan, Kansas, at the Ashland unit of the Agronomy Research Farm in 1979, 1980, and 1981. The study was conducted in 1979 and 1980 on a Muir silt loam soil with 2.4 percent organic matter and a pH of 6.1, while in 1981 the experiment was carried on a Reading silt loam soil with 2.2 percent organic matter and a pH of 6.3.

The soybean cultivar "Williams" which is well adapted for eastern Kansas growing condition was used in the three year studies with corn.

All soybean seeds were treated with captan (N-trichloromethylmercapto-4-cyclohexene-1,2-dicarboximide) to prevent fungal infection prior to emergence.

Soybean seeds were mixed with seeds of volunteer corn at a ratio of 3:1 to simulate volunteer corn and seed mix was planted at the rate of 33 seeds/meter.

A combination of 2.24 kg/ha of alachlor [2-chloro-2,6-diethyl-N-(methoxymethyl) acentailide] and 1.12 kg/ha of linuron [3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea] was applied preemergence treatment to prevent grassy and broadleaf weeds.

A randomized complete block design for 19 treatments with three replications was used for three years. Individual plots were two rows 9.1 m long and 0.76 m wide.

Herbicide applications consisted of sethoxydim and diclofop applied as postemergence treatments above soybeans and volunteer corn in different rates and on three heights of volunteer corn and soybeans (As shown in Table 1).

Herbicides were applied using a tractor mounted sprayer equipped with tapered flat-fan stainless steel nozzles. Tractor speed of application was 5.5 km/hr. Air was bubbling through spray mixture used for herbicide agitation. Water was used as a carrier for these herbicides at 187 L/ha or 374 L/ha and a pressure of 1.21 kg/cm^2. Oil concentrate, a surface active agent was used with sethoxydim for activation purpose.

Corn ears were picked, and corn plants were removed by hoeing to avoid interference with soybean harvesting.

Soybean yields, weight of corn kernels and percent control of volunteer corn were measured. Also injury of soybeans was visually evaluated. Soybean yields and weight of corn kernels were reported as kg/ha; control of volunteer corn was expressed as percent control based on number of controlled plants (with 0 percent = no control and 100 percent = complete control).

2. Varietal response of corn hybrids:

Response of 88 corn hybrids to diclofop and sethoxydim was examined in field studies at Manhattan, Ashland Farm in 1981. The study was conducted at two locations on a Muir silt loam with organic matter contents of 2.4 percent and pH 6.1.

A split plot design used for this experiment with herbicides as main plots and hybrids as subplots. Two postemergence herbicides were applied, diclofop at 0.8 kg/ha and sethoxydim at 0.3 kg/ha with 2.3 L/ha. Oil concentrate was used at 187 L/ha of water as a carrier.

First date of planting was May 1. Herbicides were applied on June 1 when corn was at 30 cm tall.

The second date of planting was July 8. Herbicides were applied on July 24 when corn was at 20 cm tall.

Percent control of each hybrid was determined two weeks after herbicide application.

Table 1. Diclofop and sethoxydim treatment rates, carrier volume, and volunteer corn height when herbicides were applied in 1979, 1980, and 1981.[1]

Herbicide Treatment	Rate	Carrier Volume	Volunteer Height
	(kg/ha)	(L/ha)	(Cm)
Diclofop	0.84	187	10-20
Diclofop	0.84	187	20-30
Diclofop	0.84	187	30-40
Diclofop	0.84	374	10-20
Diclofop	0.84	374	20-30
Diclofop	0.84	374	30-40
Diclofop	1.12	187	10-20
Diclofop	1.12	187	20-30
Diclofop	1.12	187	30-40
Sethoxydim[1]	0.28	187	10-20
Sethoxydim	0.28	187	20-30
Sethoxydim	0.28	187	30-40
Sethoxydim	0.56	187	10-20
Sethoxydim	0.56	187	20-30
Sethoxydim	0.56	187	30-40
Sethoxydim	1.12	374	10-20
Sethoxydim	1.12	374	20-30
Sethoxydim	1.12	374	30-40
No treatment	---	---	---

[1]Oil concentrate was used at rate 2.3 L/ha with all sethoxydim treatments.

RESULTS AND DISCUSSION

1. Control volunteer corn in soybeans

Volunteer corn control was expressed as percentage. Kernel weight of volunteer corn and yields of soybeans were also evaluated as responses to percent control of corn.

Drought stress had a great influence on our trials which involved herbicide evaluations. High variability in soybean yields and weight of corn kernels was noted during the three years of this study due to fluctuation in rainfall amount between growing seasons.

Growing Season 1979

Results obtained from 1979 (Table 2) showed that sethoxydim provided complete control for volunteer corn in all plots at all rates used in this experiment regardless of corn height.

Diclofop showed less activity than sethoxydim for controlling taller volunteer corn. Percent control decreased from 96 when diclofop at 0.84 kg/ha was applied on corn 10-20 cm tall to 38 when application made on corn 30-40 cm tall (Table 2).

Volunteer corn did not produce ears or kernels in any of sethoxydim treated plots, but in diclofop treated plots corn produced ears and greater seed weight was obtained with rate 0.84 kg/ha when used with carrier volume 187 L/ha than with carrier volume twice that amount.

Control plots (no treatment was applied) produced amounts of corn kernels significantly greater than treated plots with either herbicide.

In most instances in 1979, yields of soybeans (Table 3) were increased by either herbicide treatment. However, yields of untreated plots were not statistically greater than some of treated plots with diclofop or sethoxydim.

Growing season 1980

Due to severe drought in this year, all corn plants were killed just after the treatments were made when corn was 30-40 cm tall. Neither percent control of volunteer corn nor kernel weight was evaluated (Table 4). Under that drought condition, some soybean plants were killed and therefore yields were low. Although most plots treated with diclofop or sethoxydim showed increase in soybean yields, however they were not significantly greater than untreated plots.

Growing season 1981

Rain was adequate and distributed throuthout the growing season. Results of percent control of volunteer corn (Table 5) showed that sethoxydim treatments at rate 0.56 and 1.12 kg/ha achieved complete control (100%) at all corn stages. Low rates of sethoxydim (0.28 kg/ha) showed less activity in controlling taller volunteer corn.

Diclofop showed less activity in controlling volunteer corn than sethoxydim treatments. Percentage of diclofop control decreased as height of corn at time of application increased.

Untreated plots produced significantly greater corn kernel weight than plots treated with sethoxydim or diclofop.

Reduction in corn kernel weight was observed (Table 5) when rate of diclofop increased from 0.84 to 1.12 kg/ha. Also, doubling the carrier volume from 187 to 374 L/ha enhanced the effectiveness of the diclofop applied at 0.8 kg/ha in terms of reduction of corn kernel weight.

Sethoxydim applied at 0.28 kg/ha and diclofop at 0.84 kg/ha with carrier volume 374 L/ha gave incomplete control of volunteer corn plants treated at 10-20 or 20-30 cm height but prevented kernel production. It appeared that some corn plants had recovered and survived after treatments were made, but they were weakened and failed to form ears and kernels.

Adequate rainfall in 1981 also resulted in excellent soybean yield (Table 6).

At low rates, sethoxydim showed incomplete control for volunteer corn but surviving plants were reduced in vigor and showed less competition to soybeans. No statistical difference appeared in soybean yields occurred when corn was treated at low or high rates.

Unsatisfactory control of corn treated with diclofop at 30 to 40 cm reflected in soybean yield reduction. Yield reduction was observed when diclofop was applied at the higher rate with 187 L/ha carrier volume when corn was 30-40 cm tall. No significant reduction in soybean yield was observed when diclofop was used with carrier volume of 374 L/ha.

Comparison of 3 years data

Data showed that volunteer corn competition is highly affected by climatic conditions. Soybean yields of some treatments were not significantly increased by herbicide treatments in 1979; also there was no significant difference in soybean yields between treated and untreated plots in 1980. This can be attributed to heat and moisture stress which reduced the competitions of volunteer corn with soybeans. While under favorable conditions in 1981, volunteer corn showed a severe competition with soybeans which was reflected in a severe reduction of soybean yields in untreated plots. Also presence of adequate moisture in 1981 resulted in

Table 2. Kernel weight and percent control of volunteer corn as influenced by herbicide treatments, rate, carrier volume and corn heights in 1979.[1]

Herbicide Treatment	Rate	Carrier Volume	Volunteer Corn height	Volunteer corn control	Corn Kernel weight
	(kg/ha)	(L/ha)	(Cm)	(%)	(kg/ha)
Diclofop	0.84	187	10-20	96ab	5d
Diclofop	0.84	187	20-30	56d	122cd
Diclofop	0.84	187	30-40	39d	258b
Diclofop	0.84	374	10-20	88b	26d
Diclofop	0.84	374	20-30	59d	179bc
Diclofop	0.84	374	30-40	70cd	69cd
Diclofop	1.12	187	10-20	86b	0d
Diclofop	1.12	187	20-30	84bc	50cd
Diclofop	1.12	187	30-40	58d	69cd
Sethoxydim	0.28	187	10-20	100a	0d
Sethoxydim	0.28	187	20-30	100a	0d
Sethoxydim	0.28	187	30-40	100a	0d
Sethoxydim	0.56	187	10-20	100a	0d
Sethoxydim	0.56	187	20-30	100a	0d
Sethoxydim	0.56	187	30-40	100a	0d
Sethoxydim	1.12	374	10-20	100a	0d
Sethoxydim	1.12	374	20-30	100a	0d
Sethoxydim	1.12	374	30-40	100a	0d
No treatment	---	---	---	0e	1184a

[1] Values in the same column followed by the same letter are not significantly different at 5% level according to Duncan's Multiple Range Test.

Table 3. Soybean yields as influenced by herbicide treatments for controlling volunteer corn in different rates, carrier volume, and corn height in 1979[1].

Herbicide Treatment	Rate	Carrier volume	Volunteer Corn height	Soybean yield[a]
	(kg/ha)	(L/ha)	(Cm)	(kg/ha)
Diclofop	0.84	187	10-20	2224a
Diclofop	0.84	187	20-30	1237bc
Diclofop	0.84	187	30-40	1909ab
Diclofop	0.84	374	10-20	1106c
Diclofop	0.84	374	20-30	1855abc
Diclofop	0.84	374	30-40	1508abc
Diclofop	1.12	187	10-20	1573abc
Diclofop	1.12	187	20-30	1660abc
Diclofop	1.12	187	30-40	1670abc
Sethoxydim	0.28	187	10-20	1855abc
Sethoxydim	0.28	187	20-30	2137a
Sethoxydim	0.28	187	30-40	1866abc
Sethoxydim	0.56	187	10-20	1703abc
Sethoxydim	0.56	187	20-30	1866abc
Sethoxydim	0.56	187	30-40	1453abc
Sethoxydim	1.12	374	10-20	1584abc
Sethoxydim	1.12	374	20-30	1974ab
Sethoxydim	1.12	374	30-40	2137a
No treatment	---	---	---	1117c

[1] Values in the same column followed by the same letter are not significantly different at 5% level according to Duncan's Multiple Range Test.

Table 4. Soybean yields as influenced by herbicide treatments for controlling volunteer corn in different rates, carrier volume, and corn heights in 1980.[1]

Herbicide Treatment	Rate	Carrier Volume	Volunteer Corn height	Soybean yield[2]
	(kg/ha)	(L/ha)	(Cm)	(kg/ha)
Diclofop	0.84	187	10-20	705ab
Diclofop	0.84	187	20-30	314c
Diclofop	0.84	187	30-40	477abc
Diclofop	0.84	374	10-20	390bc
Diclofop	0.84	374	20-30	586abc
Diclofop	0.84	374	30-40	423bc
Diclofop	1.12	187	10-20	586abc
Diclofop	1.12	187	20-30	553abc
Diclofop	1.12	187	30-40	510abc
Sethoxydim	0.28	187	10-20	401bc
Sethoxydim	0.28	187	20-30	781a
Sethoxydim	0.28	187	30-40	380c
Sethoxydim	0.56	187	10-20	564abc
Sethoxydim	0.56	187	20-30	521abc
Sethoxydim	0.56	187	30-40	434bc
Sethoxydim	1.12	374	10-20	575abc
Sethoxydim	1.12	374	20-30	553abc
Sethoxydim	1.12	374	30-40	531abc
No treatment	---	---	---	456abc

[1]Drought stress affected soybean yields severely, also, corn plants were killed just after the third application of herbicide. Neither percent control nor kernel weight of volunteer corn was obtained.

[2]Values in the same column followed by the same letters are not significantly different at the 5% level by Duncan's Multiple Range Test.

Table 5. Kernel weight and percent control of volunteer corn as influenced by herbicide treatments, rates, carrier volume and corn height in 1981.[1]

Herbicide Treatment	Rate	Carrier Volume	Volunteer Height	Volunteer Control	Corn Kernel Weight
	(kg/ha)	(L/ha)	(Cm)	(%)	(kg/ha)
Diclofop	0.84	187	10-20	82de	293c
Diclofop	0.84	187	20-30	75e	65c
Diclofop	0.84	187	30-40	44f	1475b
Diclofop	0.84	374	10-20	93bcd	0c
Diclofop	0.84	374	20-30	89cde	0c
Diclofop	0.84	374	30-40	48f	347c
Diclofop	1.12	187	10-20	91bcd	0c
Diclofop	1.12	187	20-30	99ab	0c
Diclofop	1.12	187	30-40	47f	423c
Sethoxydim	0.28	187	10-20	96abc	0c
Sethoxydim	0.28	187	20-30	89cde	0c
Sethoxydim	0.28	187	30-40	86cde	0c
Sethoxydim	0.56	187	10-20	98ab	0c
Sethoxydim	0.56	187	20-30	100a	0c
Sethoxydim	0.56	187	30-40	100a	0c
Sethoxydim	1.12	374	10-20	100a	0c
Sethoxydim	1.12	374	20-30	100a	0c
Sethoxydim	1.12	374	30-40	100a	0c
No treatment	---	---	---	0g	5434a

[1]Values in the same column followed by the same letters are not significantly different at the 5% level according to Duncan's Multiple Range Test.

Table 6. Soybean yields as influenced by herbicide treatments for controlling volunteer corn in different rates, carrier volume, and corn height in 1981.[1]

Herbicide Treatment	Rate	Carrier Volume	Volunteer Height	Soybean Yield
	(kg/ha)	(L/ha)	(Cm)	(kg/ha)
Diclofop	0.84	187	10-20	3330ab
Diclofop	0.84	187	20-30	3080abc
Diclofop	0.84	187	30-40	2733c
Diclofop	0.84	374	10-20	3493a
Diclofop	0.84	374	20-30	3341ab
Diclofop	0.84	374	30-40	3287ab
Diclofop	1.12	187	10-20	3405a
Diclofop	1.12	187	20-30	3569a
Diclofop	1.12	187	30-40	2874bc
Sethoxydim	0.28	187	10-20	3417a
Sethoxydim	0.28	187	20-30	3482a
Sethoxydim	0.28	187	30-40	3189abc
Sethoxydim	0.56	187	10-20	3319ab
Sethoxydim	0.56	187	20-30	3471a
Sethoxydim	0.56	187	30-40	3287ab
Sethoxydim	1.12	374	10-20	3498a
Sethoxydim	1.12	374	20-30	3471a
Sethoxydim	1.12	374	30-40	3384a
No treatment	---	---	---	1887d

[1]Values in the same column followed by the same letters are not significantly different at the 5% level according to Duncan's Multiple Range Test.

higher yields of soybeans (Table 6), twice as great as 1979 and six times more than in 1980.

An excellent degree of control was obtained in 1981 when application of sethoxydim and diclofop was made when corn was 10-20 cm tall just one hour before heavy rain. Translocation studies by Campbell and Penner (12) showed rapid transport of sethoxydim and accumulation in metabolic sinks.

It was easy to differentiate each herbicide treatment after observing symptoms on corn plants in the field. Diclofop causes chlorosis within 4 to 7 days after application while sethoxydim symptoms appear on the upper leaves as necrosis within 5 to 7 days after application.

None of sethoxydim or diclofop treatments in all 3 year trials reduced the stand of soybeans.

Soybean injury was visually evaluated. Drought stress could account for enhancement of a slight injury for soybeans. Under a severe dry period in 1980 slight injury appeared as necrosis on some soybean leaves when diclofop had been applied at rate 0.84 kg/ha with carrier volume 374 L/ha. No injury was shown with rate 0.84 and 1.12 kg/ha with carrier volume 187 L/ha.

More obvious necrosis symptoms on soybean leaves were observed with sethoxydim at 1.12 kg/ha. Soybean leaves were recovered within a week after appearance of the necrosis.

Such slight necrosis was not shown in 1979 and 1981 under more favorable rainfall.

From this interpretation we can draw some conclusions about this study regarding application of sethoxydim and diclofop on volunteer corn and soybeans.

1. Volunteer corn proved to be a severe competitor with soybeans and resulted in great reduction in soybean yield.

2. Most diclofop and sethoxydim treatments on soybeans infested with volunteer corn resulted in significant increase in soybean yields.

3. Sethoxydim appeared to be superior to diclofop where differences could be noted especially on taller corn. We would recommend that diclofop should be used on small corn with higher rate. Sethoxydim at 0.56 kg/ha is the optimum rate to be used for controlling volunteer corn. If application is made earlier, sethoxydim at 0.28 kg/ha would be adequate for controlling volunteer corn.

4. Increasing the carrier volume gave greater reduction in corn vigor and reduced or eliminated kernel production. This might be attributed to better coverage of volunteer corn by increasing the carrier volume.

5. Results indicated that dockage of soybean seeds infested with corn seed is more likely to occur from plots treated with diclofop than from plots treated with sethoxydim.

6. More interference of volunteer corn with soybean harvesting may be expected with diclofop treatments, usually when those treatments are made later in the season.

2. Response of Corn Hybrids

In this study we tested corn hybrids (F_1-generation) as volunteer corn because corn seed of F_2 generations was not available. Also, genetic tolerance of the hybrids can be inherited in F_2 generations, Geadelmann and Andersen (22) reported that HOE 23408 (Diclofop) failed to achieve satisfactory control of volunteer corn due to genetic tolerance of the hybrids' inbred parents.

Results obtained from testing 88 corn hybrids showed that the statistical analysis for corn hybrids (as subplots) indicated significant F values for hybrids and for the interaction between hybrids and herbicides when application was made on corn height 20 and 30 cm in both locations 1 and 2. This significant result indicated variable response among hybrids to diclofop and sethoxydim. Andersen (1) observed that corn inbreds responded differentially to different herbicides.

All 88 corn hybrids showed complete susceptibility (100% control) to sethoxydim when treated at 20 cm height in both locations. Also, most hybrids showed susceptibility to diclofop in this stage; however, a few hybrids showed slight tolerance. The lowest percent of control was 87 for FONTANELLE 580 (location 1) and 88 for PIONEER 3720 (Location 2).

Significant hybrid tolerance to sethoxydim was observed when application of this herbicide was made on corn height 30 cm. Percent control ranged between 73 for FONTANELLE 580 (location 1) and 57 for WAC 918 (location 2) to 100 for several hybrids.

In previous studies, Andersen (1) suggested that spraying diclofop on earlier stage of volunteer corn might be more desirable. Our data also indicated that as corn height increased, tolerance of some hybrids to diclofop increased. Although diclofop was used at higher rate (0.84 kg/ha) than sethoxydim (0.28 kg/ha), some hybrids showed more resistance to diclofop. Percent control ranged between 27 and 29 for PIONEER 3194 in location 1 and 2 respectively.

From this study, we can conclude as corn size increased, tolerance to herbicides also increased. This tolerance was more for diclofop than sethoxydim.

Table 7. Response of 88 corn hybrids to diclofop at 0.84 kg/ha and sethoxydim at 0.28 kg/ha. Treatments made on two corn stages.[1]

Hybrids	Corn Stage 1 (corn was 20 cm tall)				Corn Stage 2 (corn was 30 cm tall)			
	Location 1		Location 2		Location 1		Location 2	
	Sethoxydim 0.28 kg/ha	Diclofop 0.84 kg/ha	Sethoxydim 0.28 kg/ha	Diclofop 0.84 kg/ha	Sethoxydim 0.28 kg/ha	Diclofop 0.84 kg/ha	Sethoxydim 0.28 kg/ha	Diclofop 0.84 kg/ha
ACCO PAYMASTER UC7251	100a	100a	100a	99ab	95 a-f	83a-j	96abc	90a-d
ASGROW RX 61A	100a	100a	100a	100a	100a	96a-e	100a	100a
ASGROW RX 90	100a	99ab	100a	99ab	79a-k	84a-j	100a	100a
ASGROW RX 98	100a	100a	100a	100a	99ab	71b-k	100a	92a-d
ASGROW RX 858	100a	99ab	100a	100a	99ab	97a-d	100a	97abc
ASGROW RX 909	100a	100a	100a	100a	99ab	71b-k	100a	92a-d
BO-JAC 562	100a	100a	100a	99ab	91a-h	100a	100a	100a
BO-JAC 923	100a	100a	100a	100a	96a-e	69c-k	100a	99ab
CARGILL 934	100a	100a	100a	100a	99ab	89a-h	100a	93a-d
CARGILL 921	100a	100a	100a	100a	98abc	80a-k	99ab	89a-d
CARGILL 967	100a	100a	100a	100a	73b-k	77a-k	69d-h	82a-f
DEKALB XL-63	100a	100a	100a	100a	100a	92a-g	100a	99ab
DEKALB XL-67	100a	100a	100a	100a	91a-h	72b-k	74c-h	100a
DEKALB XL-71	100a	100a	100a	100a	98abc	92a-g	91a-d	82a-f
DEKALB XL-73	100a	100a	100a	100a	98abc	71b-k	98abc	92a-d
DEKALB XL-72AA	100a	100a	100a	98ab	98abc	88a-i	87a-e	83a-e
DEKALB XL-74B	100a	100a	100a	99ab	99ab	67d-k	100a	96abc
EK PREMIUM EK 8865	100a	100a	100a	96abc	81a-k	100a	100a	99ab
EK PREMIUM EK 9910	100a	94cd	100a	100a	100a	99ab	100a	100a

Table 7 Continued...

Hybrids	Corn Stage 1 (corn was 20 cm tall)				Corn Stage 2 (corn was 30 cm tall)			
	Location 1		Location 2		Location 1		Location 2	
	Sethoxydim 0.28 kg/ha	Diclofop 0.84 kg/ha	Sethoxydim 0.28 kg/ha	Diclofop 0.84 kg/ha	Sethoxydim 0.28 kg/ha	Diclofop 0.84 kg/ha	Sethoxydim 0.28 kg/ha	Diclofop 0.84 kg/ha
FARM BUREAU FB 215	100a	100a	100a	100a	96a-e	86a-j	85a-e	91a-d
FARM BUREAU FB 223	100a	100a	100a	100a	99ab	67d-k	89a-d	96abc
FONTANELLE 580	100a	87d	100a	100a	73b-k	85a-j	89a-d	96abc
FONTANELLE 590	100a	94cd	100a	100a	73b-k	93a-g	100a	99ab
FONTANELLE 611	100a	93cd	100a	100a	100a	89a-h	93a-d	100a
FUNK'S G-4522	100a	100a	100a	100a	80a-k	87a-i	100a	100a
FUNK'S G-4583	100a	90cd	100a	100a	100a	79a-k	100a	96abc
FUNK'S G-4733	100a	97bc	100a	100a	76b-k	84a-j	86a-e	98abc
FUNK'S G-4740	100a	100a	100a	100a	99ab	86a-j	100a	94a-d
GROWERS 80119 EXP	100a	100a	100a	100a	100a	76b-k	100a	100a
GROWERS GSA 2120	100a	98ab	100a	100a	100a	89a-h	89a-d	96abc
GROWERS NS 212	100a	99ab	100a	100a	99ab	76b-k	100a	82a-f
GROWERS SEED 2340	100a	100a	100a	100a	90a-h	92a-g	100a	98abc
HOEGEMEYER SX 2700	100a	100a	100a	100a	93a-g	58h-k	95a-d	98abc
HOEGEMEYER SX 2840	100a	100a	100a	100a	100a	100a	89a-d	97abc
LYNKS LX 4315	100a	100a	100a	100a	100a	95a-f	88a-d	100a
LYNKS LX 4355	100a	100a	100a	100a	90a-h	95a-f	100a	99ab
LYNKS LX 4364	100a	100a	100a	100a	96a-e	90a-h	100a	95a-d

Table 7 Continued...

Hybrids	Corn Stage 1 (corn was 20 cm tall)				Corn Stage 2 (corn was 30 cm tall)			
	Location 1		Location 2		Location 1		Location 2	
	Sethoxydim 0.28 kg/ha	Diclofop 0.84 kg/ha	Sethoxydim 0.28 kg/ha	Diclofop 0.84 kg/ha	Sethoxydim 0.28 kg/ha	Diclofop 0.84 kg/ha	Sethoxydim 0.28 kg/ha	Diclofop 0.84 kg/ha
LYNKS LX 4545	100a	100a	100a	100a	95a-f	60h	100a	100a
MCCURDY 84AA	100a	100a	100a	100a	96a-e	60h	100a	87a-e
MCCURDY 7440	100a	99ab	100a	100a	92a-g	92a-g	100a	98abc
MCCURDY 7676	100a	100a	100a	100a	100a	79a-k	98abc	95a-d
MCCURDY 7787	100a	100a	100a	100a	83a-j	94a-f	100a	100a
MCCURDY 8150	100a	100a	100a	100a	99ab	100a	100a	100a
MFA 5802	100a	98ab	100a	100a	92a-g	93a-g	91a-d	99ab
MFA 6707	100a	100a	100a	100a	100a	92a-g	100a	85a-e
MIGRO HP-44	100a	99ab	100a	98ab	99ab	91a-h	99ab	97abc
MIGRO HP-87	100a	100a	100a	100a	95a-f	39ijk	89a-d	83a-e
MIGRO HP-470	100a	100a	100a	100a	79a-k	100a	100a	100a
MIGRO M-0707	100a	100a	100a	100a	83a-j	76b-k	99ab	97abc
MIGRO SPX-77	100a	100a	100a	100a	93a-g	80a-k	100a	94a-d
NC + 59	100a	95bcd	100a	100a	91a-h	83a-j	100a	95a-d
NC + 3990	100a	100a	100a	97bc	100a	58h-k	100a	82a-f
NC + 4710	100a	100a	100a	100a	94a-f	98abc	100a	100a
NC + 8331	100a	100a	100a	99ab	94a-f	89a-h	100a	94a-d
NEBRASKA 715	100a	100a	100a	100a	99ab	92a-g	100a	100a

Table 7 Continued...

Hybrids	Corn Stage 1 (corn was 20 cm tall)				Corn Stage 2 (corn was 30 cm tall)			
	Location 1		Location 2		Location 1		Location 2	
	Sethoxydim 0.28 kg/ha	Diclofop 0.84 kg/ha	Sethoxydim 0.28 kg/ha	Diclofop 0.84 kg/ha	Sethoxydim 0.28 kg/ha	Diclofop 0.84 kg/ha	Sethoxydim 0.28 kg/ha	Diclofop 0.84 kg/ha
NORTHRUP-KING PX 74	100a	100a	100a	99ab	90a-h	58h-k	100a	91a-d
NORTHRUP-KING PX 87	100a	100a	100a	100a	90a-h	82a-j	90a-d	99ab
NORTHRUP-KING PX 95	100a	99ab	100a	100a	100a	84a-j	100a	32gh
NORTHRUP-KING X 6169	100a	100a	100a	100a	80a-k	95a-f	99ab	98abc
O'S GOLD 3344	100a	100a	100a	96bc	98abc	91a-h	100a	99ab
O'S GOLD 5291	100a	100a	100a	100a	94a-f	95a-f	100a	95a-d
P-A-G SX 83	100a	100a	100a	99ab	96a-d	91a-h	100a	99ab
P-A-G-SX 277	100a	100a	100a	100a	96a-e	81a-k	100a	76b-k
P-A-G SX 333	100a	100a	100a	100a	87a-i	63f-k	100a	82a-f
P-A-G SX 373	100a	100a	100a	100a	100a	98abc	100a	99ab
P-A-G SX 397	100a	100a	100a	100a	100a	88a-i	100a	89a-d
P-A-G SX 70W	100a	99ab	100a	99ab	100a	49ijk	100a	41fgh
PIONEER 3183	100a	100a	100a	100a	82 a-j	44ijk	98abc	80a-g
PIONEER 3194	100a	98ab	100a	100a	99ab	27k	100a	28h
PIONEER 3541	100a	100a	100a	100a	100a	99ab	100a	97abc
PIONEER 3720	100a	99ab	100a	88d	100a	34jk	100a	35fgh
STAUFFER SEEDS 767	100a	100a	100a	100a	98abc	81a-k	100a	98abc
STAUFFER SEEDS S 114+	100a	100a	100a	100a	89a-h	94a-f	100a	98abc

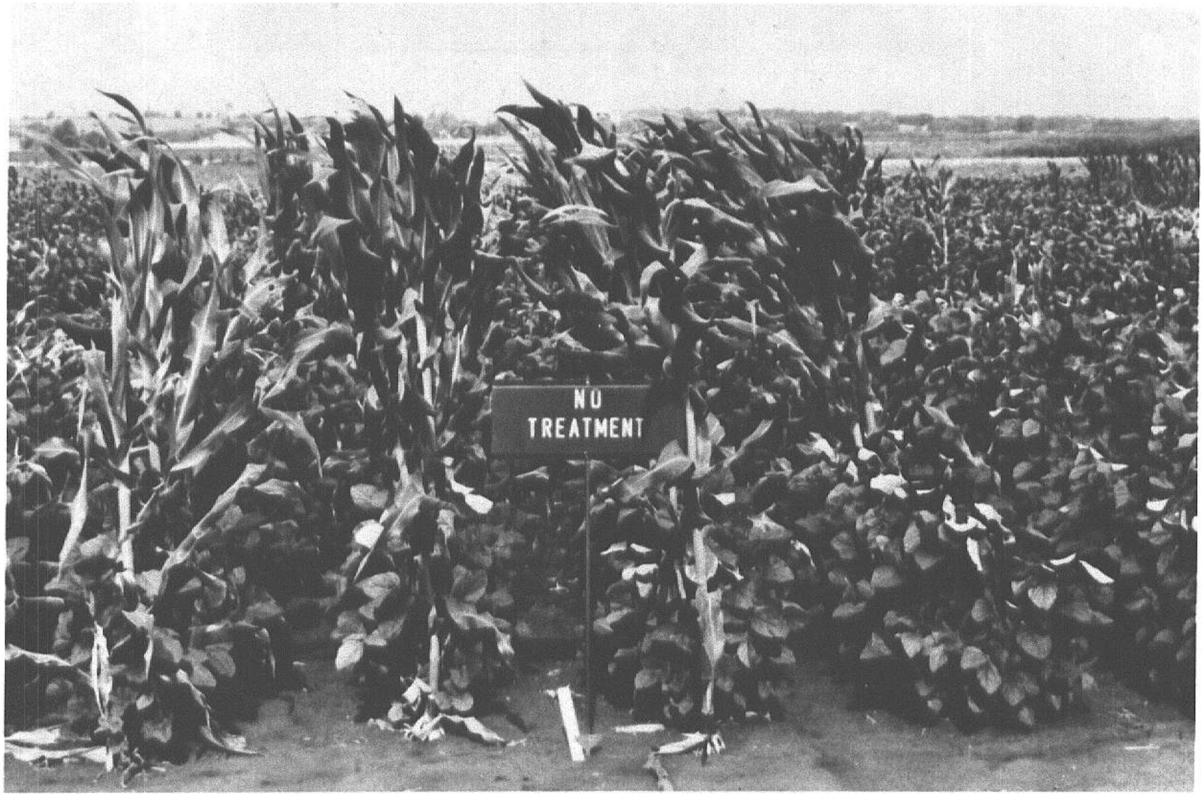
Table 7 Continued...

Hybrids	Corn Stage 1 (corn was 20 cm tall)				Corn Stage 2 (corn was 30 cm tall)			
	Location 1		Location 2		Location 1		Location 2	
	Sethoxydim 0.28 kg/ha	Diclofop 0.84 kg/ha	Sethoxydim 0.28 kg/ha	Diclofop 0.84 kg/ha	Sethoxydim 0.28 kg/ha	Diclofop 0.84 kg/ha	Sethoxydim 0.28 kg/ha	Diclofop 0.84 kg/ha
STAUFFER SEEDS S 818	100a	99ab	100a	100a	98abc	67d-k	100a	97abc
STAUFFER SEEDS S 7795	100a	100a	100a	100a	87a-i	72b-k	99ab	94a-d
STAUFFER SEEDS S 37S	100a	100a	100a	100a	99ab	80a-k	92a-d	96abc
SUPER CROST 5440	100a	100a	100a	100a	100a	60h-k	99ab	78b-h
SUPER CROST 7600	100a	100a	100a	99ab	83a-j	90a-h	99ab	99ab
SUPER CROST 80052 EXP	100a	100a	100a	100a	82a-j	95a-f	100a	96abc
TAYLOR EVANS T-E 6945	100a	100a	100a	100a	94a-f	63f-k	100a	88a-d
TROJAN T 1230	100a	100a	100a	100a	98abc	54ijk	100a	98ab
TROJAN TXS 115A	100a	99ab	100a	99ab	83a-j	86a-j	99ab	100a
WAC 917	100a	100a	100a	99ab	96a-e	88a-i	100a	96abc
WAC 918	100a	100a	100a	100a	90a-h	75b-k	57fgh	99ab
WAC 920 C	100a	99ab	100a	99ab	96a-e	79a-i	100a	94a-d
WILSON 1800	100a	100a	100a	100a	74b-k	59h-k	98abc	87a-c
WILSON 1600A	100a	100a	100a	100a	99ab	96a-e	100a	98abc
WILSON 1800A	100a	100a	100a	100a	86a-j	58h-k	90a-d	92a-d

[1] Values in the same column followed by the same letters are not significantly different at 5% level by Duncan's Multiple Range Test.

Figure 1. Soybean infested with volunteer corn (plots with no treatment).

Figure 2. Soybean plots after volunteer corn was controlled with diclofop when application was made on small size corn.


NO
TREATMENT


DICLOFOP
1.12 KG/HA
HEIGHT:10-20CM
24 DAT

Figure 3. Large size volunteer corn in soybean plots were not satisfactorily controlled with diclofop.

Figure 4. Large size volunteer corn in soybean plots was effectively controlled by sethoxydim treatment.


DICLOFOP
.84 KG/HA
HEIGHT:30-40CM
15 D A T


POAST
.56 KG/HA
HEIGHT:30-40CM
15 D A T

SUMMARY

Our study indicated that both diclofop and sethoxydim treatments on soybeans infested with volunteer corn resulted in higher soybean yields. Sethoxydim appeared to be superior to diclofop for controlling volunteer corn. Both diclofop rates (0.84 and 1.12 kg/ha) failed to achieve good control when applications were made on corn 30-40 cm tall, and resulted in significant decrease in soybean yields compared to the other treatments when applied on smaller corn. Diclofop activity at the same rate was enhanced by doubling the carrier volume from 187 to 374 L/ha. Although sethoxydim at 0.28 kg/ha showed less activity on taller corn, rates of 0.56 and 1.12 kg/ha did satisfactorily control volunteer corn. None of the sethoxydim or diclofop treatments reduced the stand of soybeans, and no significant injury was observed. Also, results indicated that most corn hybrids were highly susceptible to both herbicides when treatment was made on small corn size while some hybrids showed more tolerance to diclofop than sethoxydim when applied on taller corn.

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APPENDIX

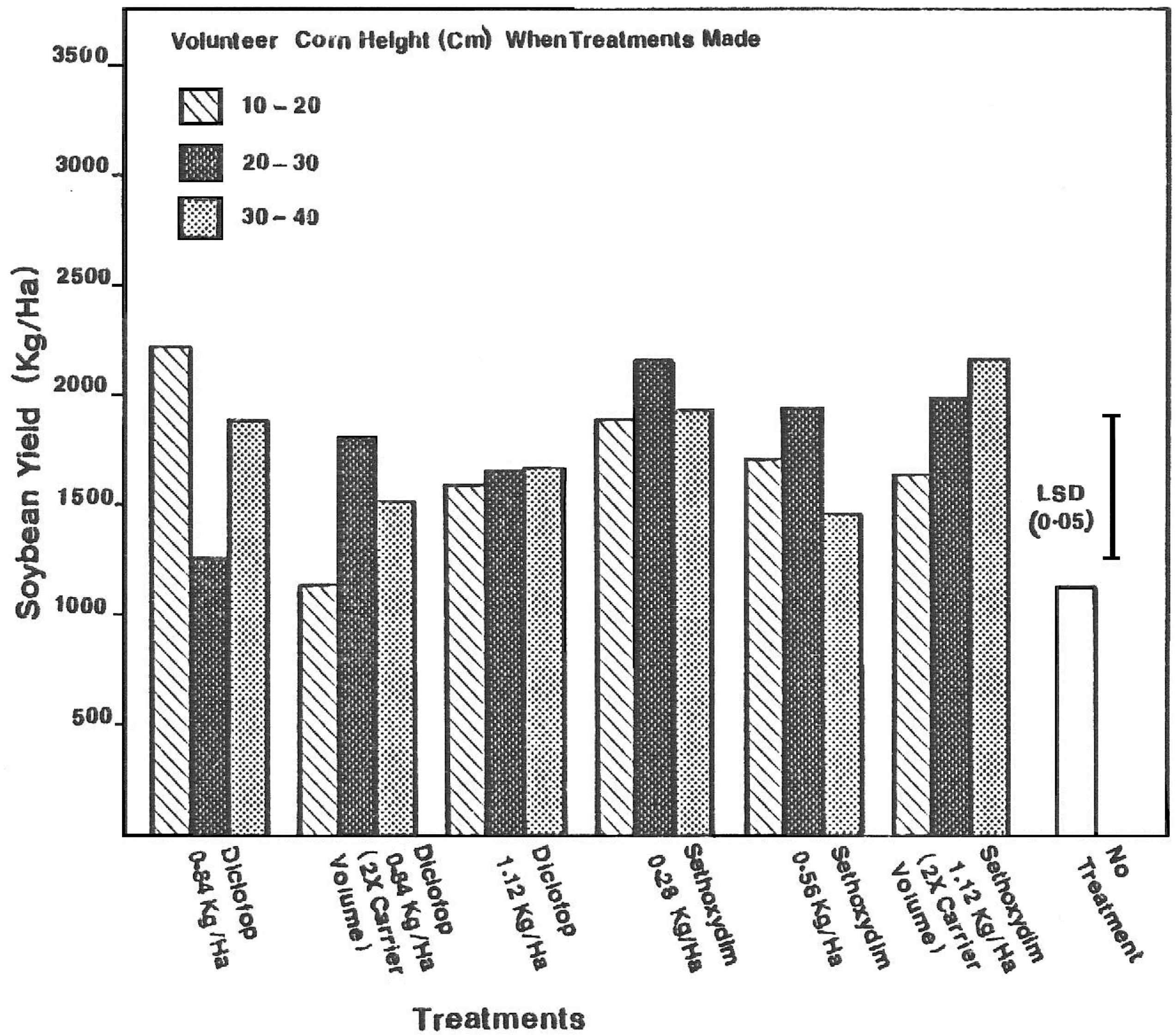

Figure 5. Soybean yields in 1979 as influenced by sethoxydim and diclofop treatments when applications were made on different volunteer corn stages.

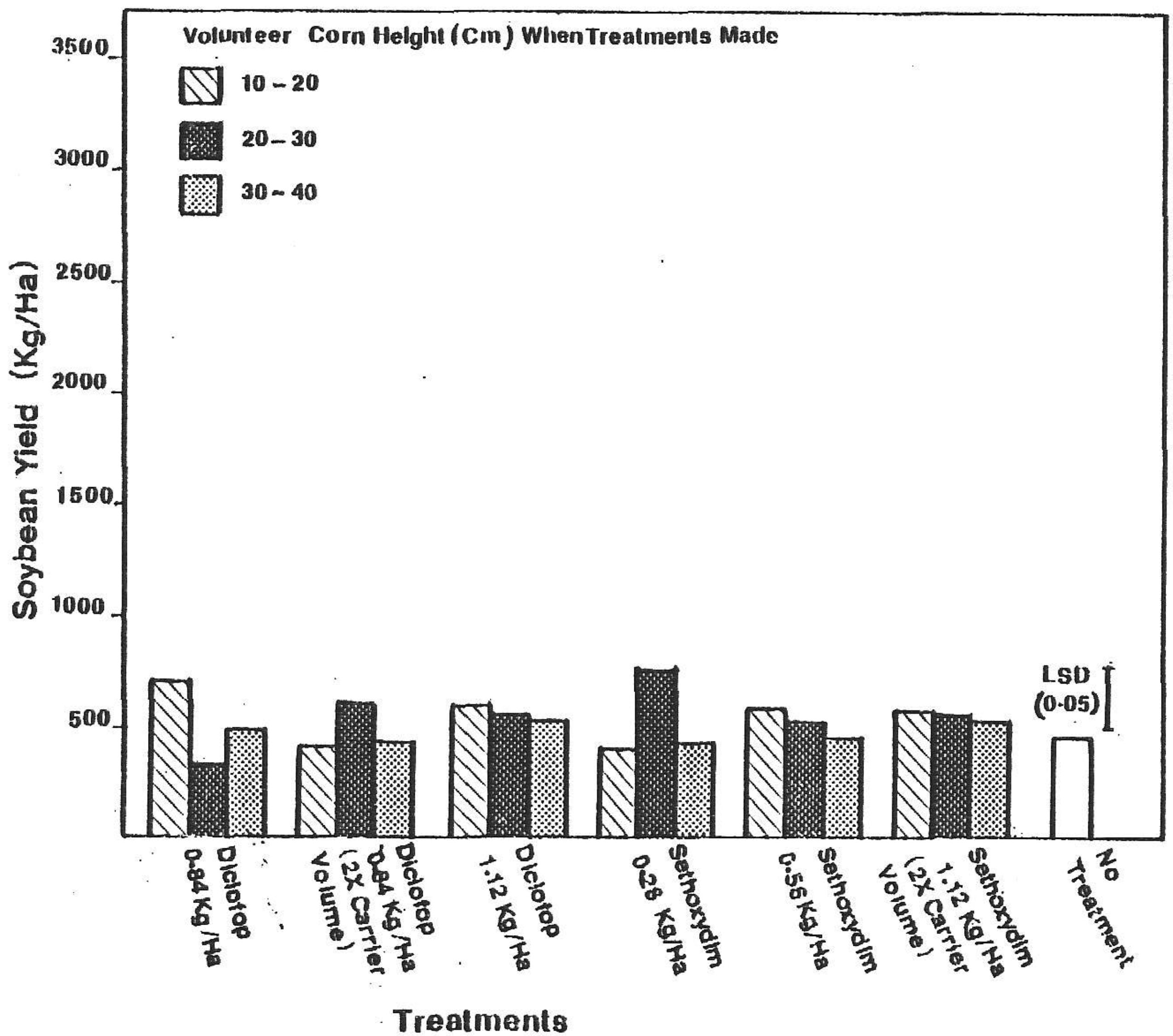

Figure 6. Soybean yields in 1980 as severely affected by moisture stress and there was no significant difference between untreated and treated plots with diclofop or sethoxydim.

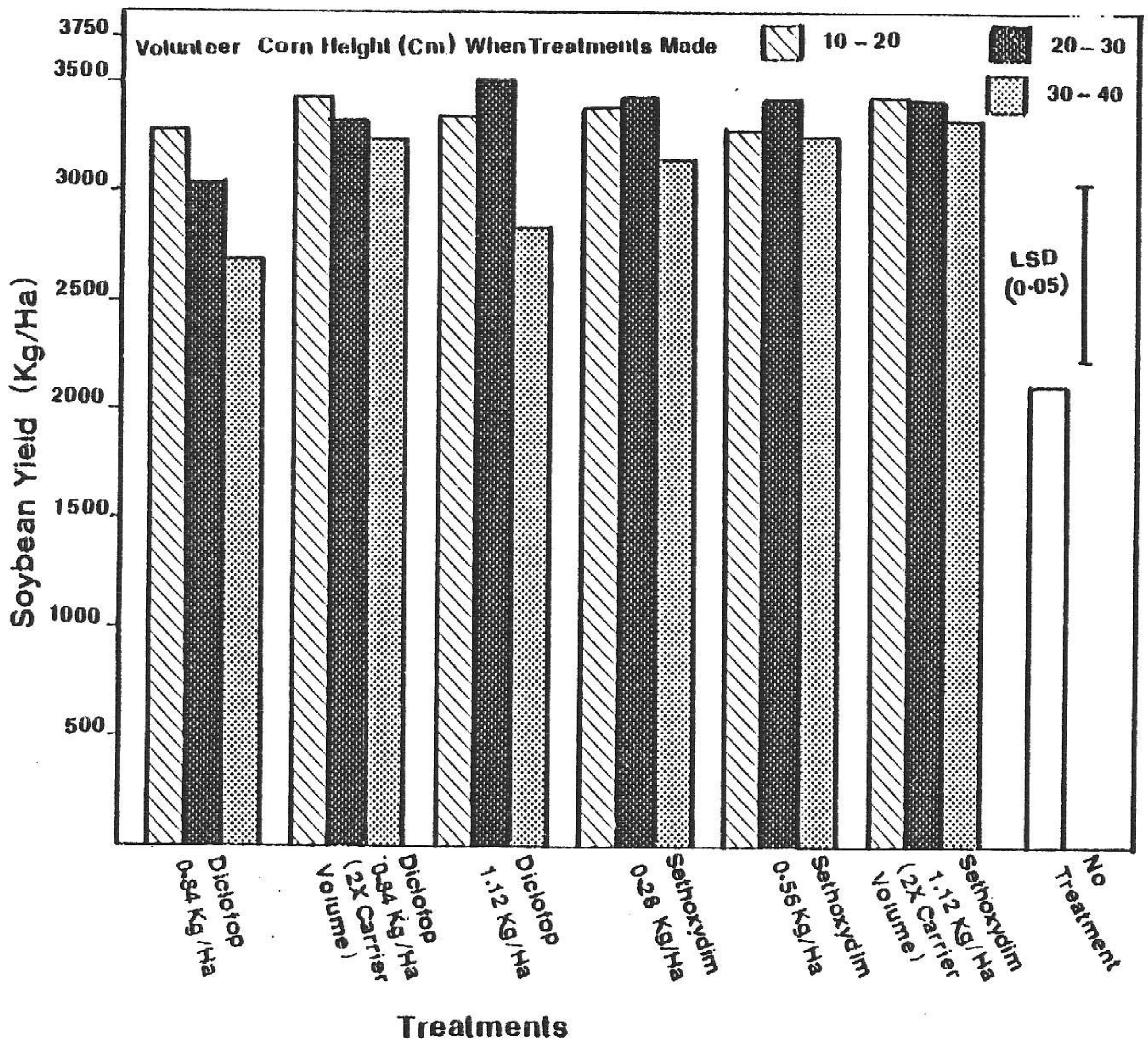

Figure 7. Soybean yields in 1981 as influenced by sethoxydim and diclofop treatments when applications were made on different volunteer corn stages.

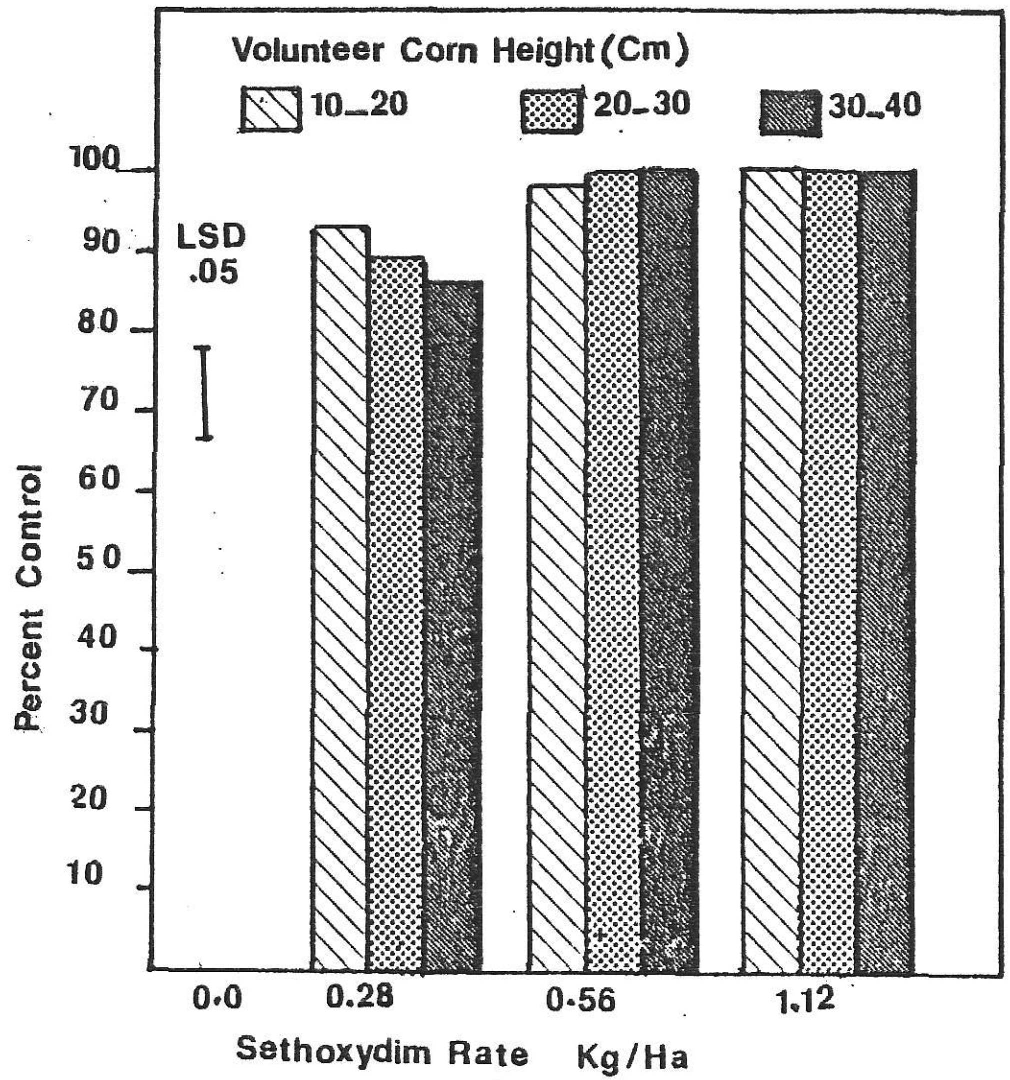

Figure 8. Percent control of volunteer corn as influenced by sethoxydim rate and corn stage.

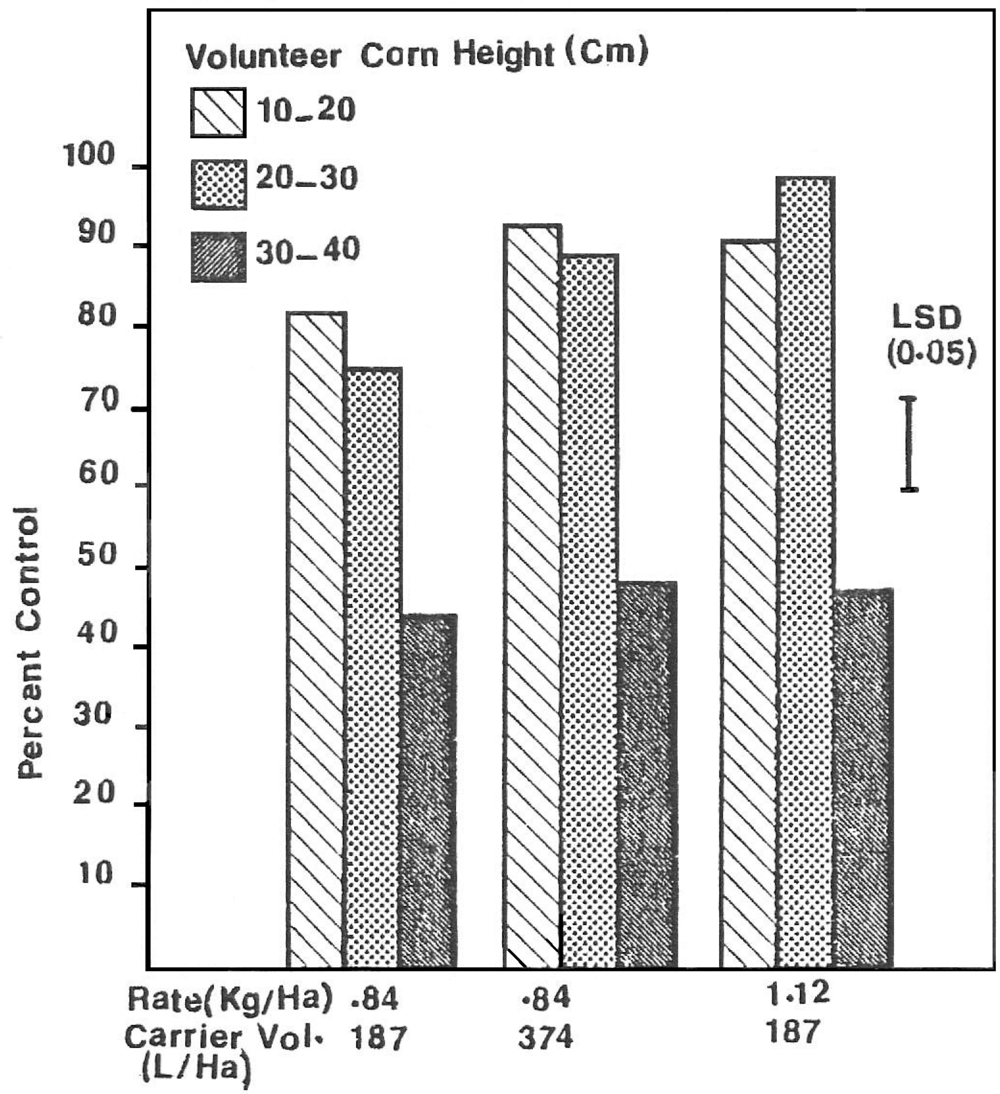

Figure 9. Percent control of volunteer corn as influenced by diclofop rate, carrier volume and corn stage.

Table 8. Effect of sethoxydim at 0.28 and diclofop at 0.84 kg/ha on 88 corn hybrids when applied to corn 20 cm tall.

Percent Control Classes	Number of hybrids			
	Location 1		Location 2	
	Diclofop	Sethoxydim	Diclofop	Sethoxydim
	%			
96-100	96	100	99	100
91-95	3	0	0	0
86-90	1	0	1	0
LSD Loc 1 = 5				
LSD Loc 2 = 3				

Table 9. Effect of sethoxydim at 0.28 and diclofop at 0.84 kg/ha on 88 corn hybrids when applications were made on corn 30 cm tall).

Percent Control Classes	Number of hybrids			
	Location 1		Location 2	
	Diclofop	Sethoxydim	Diclofop	Sethoxydim
	--------------------------%	--------------------		
96-100	15	56	57	80
91-95	22	16	18	5
81-90	25	19	16	12
71-80	17	9	6	1
61-70	7	0	0	1
41-60	11	0	0	1
<40	3	0	3	0

LSD Loc 1 = 18

LSD Loc 2 = 18

RESPONSE OF VOLUNTEER CORN (*ZEA MAYS* L.) AND SOYBEANS [*GLYCINE MAX* (L.) MERRIL] TO DICLOFOP OR SETHOXYDIM AS INFLUENCED BY CORN HEIGHT, CARRIER VOLUME, HERBICIDE RATE, AND CORN CULTIVAR.

by

SALEH HASSAN SAMIR

B.S., Baghdad University, Iraq, 1975

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Agronomy

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1982

Volunteer corn (Zea mays L.) can be a serious problem in soybeans [Glycine max (L.) Merr.] due to their crop rotation. Field studies were conducted during 1979, 1980, and 1981 to evaluate the effectiveness of two postemergent herbicides, diclofop {2-[4-(2,4-dichlorophenoxy) phenoxy] propanoic acid} and sethoxydim "ISO Proposed" {2-[1-(ethoxyimino) butyl]-5-[2-(ethylthio) propyl]-3-hydroxy-2-cylohexen-1-one}, in controlling volunteer corn in soybeans. Results indicated that both diclofop and sethoxydim treatments on soybeans infested with volunteer corn resulted in higher soybean yields. Sethoxydim appeared to be superior to diclofop for controlling volunteer corn. Both diclofop rates (0.84 and 1.12 kg/ha) failed to achieve good control when applications were made on corn 30-40 cm tall, and resulted in significant decrease in soybean yields compared to the other treatments when applied on smaller corn. Diclofop activity at the same rate was enhanced by doubling the carrier volume from 187 to 374 L/ha. Although sethoxydim at 0.28 kg/ha showed less activity on taller corn, rates of 0.56 and 1.12 kg/ha did satisfactorily control volunteer corn. However, there was no significant difference in soybean yields among sethoxydim treatments when they were applied on different corn stages. None of the sethoxydim or diclofop treatments in all 3 year trials reduced the stand of soybeans, and no significant injury was observed. Response of 88 corn hybrids to diclofop at 0.84 kg/ha and sethoxydim at 0.28 kg/ha was tested in 1981. Results indicated that most corn hybrids were highly susceptible to both herbicides when treatment was made on small corn while some hybrids showed more tolerance

to diclofop than sethoxydim when applied on taller corn.