CONTROL OF WILD CANE, *Sorghum bicolor*, IN SOYBEANS WITH HERBICIDES

by

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INTRODUCTION

Wild cane (Sorghum bicolor (L.) Moench) is a serious weed in summer crops in Kansas. This annual weedly sorghum has spread throughout a large portion of the sorghum-producing areas of the Midwest. Serious infestations of wild cane are generally associated with areas where grain sorghum or forage sorghum is grown continually. Mono-cropping favors the growth of those weedy species that are most capable of competing with the crop being grown. Wild cane is a vigorous competitor. Control of wild cane in closely-related grain and forage sorghums is difficult. It cross-pollinates with cultivated sorghums and competes as a weed. A diverse gene pool builds up rapidly. Wild cane seed is shed by shattering at early maturity and remains viable in the soil for several years making eradication difficult.

Recent weed control research has been aimed at determining the most effective placement of herbicides in the soil. Effective placement is generally meant to imply the location of the herbicide to facilitate the greatest uptake by the plant species one is attempting to control. The method of soil incorporation of herbicides applied to the soil has thus become important in the overall evaluation of an herbicide.

The purpose of this study was two-fold: (1) to determine the potential control of wild cane in soybeans using herbicides without mechanical cultivation; and (2) to evaluate two methods of incorporation of soil-applied herbicides in terms of differences in weed control and crop injury.

All common names of herbicides used in this manuscript are those approved by the Terminology Committee of the Weed Society of America.

REVIEW OF LITERATURE

Origin and Characteristics of Wild Cane

The native home of most sorghums is considered to be Africa. Many wild varieties were introduced into the United States. Selection and cross-pollination have resulted in many new varieties some of which have become weedy.

Vinall, Stevens, and Martin (1936) stated, "Sorghum, being indigenous to Egypt, was probably among the earliest of the wild plants to be domesticated and utilized as human food and as feed for livestock." They point out that records indicate the presence of sorghum in India in the first century A.D., and in China in the third century A.D.

According to Vinall et al. (1936), the Black Amber sorgos grown in the United States were obtained from introductions from China. Seed first reached the United States by way of France. The first importation of seed appears to have been in 1853 by William R. Prince, a nurseryman of Flushing, Long Island, New York. In 1854 a few pounds were sold to the public, and a much larger quantity was distributed the following year.

Piper (1915) described a species of chicken corn that was collected at New Orleans in 1832. He stated, "In Louisiana and Mississippi this plant has long been known as chicken corn, it appearing spontaneously each year in cultivated ground."

Snowden (1936) indicated the spikelet of chicken corn turns a dull-purple to black and is very glossy at maturity. The grains are tightly enclosed by the glumes and it lives over in the soil and becomes a weed in cultivated fields. Seed shattering is also common. Possibly chicken corn is one of the more important sources of the present day wild cane.

The weedy sorghums known as wild cane have a tremendous variation in plant and seed characteristics. Plant height may be from 3 to 12 feet; seed color may be light brown to black; and glumes may enclose the seed completely or only partially. Some of the wild cane plants have a strong resemblance to the Black Amber sorgos.

Burnside (1965) reported that wild cane is a forage sorghum that has escaped and become a serious weed. Like some other sorghums, wild cane shatters its seed and the seed remains viable in the soil for some time. These two characteristics make wild cane a troublesome weed. Since most of our present day sorghums are selected from wild types it should not be surprising that some of them become weedy.

Seed shattering is one of the characteristics of the weedy sorghums. Karper and Quinby (1947) reported that seed shattering occurs with the formation of a callus layer just below the seed where abcission takes place. Since formation of this callus is conditioned by two dominant genes, the breeding of non-shattering varieties is relatively easy.

Seed dormancy is the other important characteristic of wild cane. Fryer and Evans (1968) discuss dormancy in weed seeds. Seeds of most weed species possess some kind of dormancy. Plants which lack seed dormancy can become weeds only if they are repeatedly introduced, or can survive by their perennial habit and vegetative growth. Some seeds are dormant when they leave the parent plant. This primary dormancy is a property of the seed and is genetically controlled. Primary dormancy can usually be broken by a period of after-ripening at low temperatures, or by rupture of partial decay of the seed coat. Seeds may also show secondary dormancy resulting from their interaction with the environment. Seeds of some species require a brief exposure to specific wavelengths of electromagnetic radiation before they will germinate.

A number of workers, (Gritton and Atkins 1963) (Martin et al. 1935), have reported on dormancy mechanisms in sorghum. Goodsell (1957) reported that when slightly immature, seed harvested and dried rapidly exhibited more dormancy than seed harvested in a more mature stage and dried slowly. This is in agreement with Clark et al. (1967). Messersmith and Burnside (1964) studied factors affecting germination of wild cane. Rate of germination and initial germination were directly correlated with higher germination temperatures. Plants from seed germinating late in the season produced seed that had a lower percentage of germination and germinated more slowly. Exposure to a germination temperature of 35 degrees C. was the most effective treatment for overcoming dormancy.

Research by Condray (1968) demonstrated that wild cane seed germinated from depths of from 1 to 8 inches. No significant difference was evident in the number of seedlings emerging from the various depths.

Soil Incorporation and Site of Uptake of Herbicides

The incorporation of soil-applied herbicides has received considerable attention during the past several years. The main consideration is an attempt to eliminate or at least reduce the loss of the herbicide by photodegradation or volatilization. Not all herbicides are affected but with those that are the overall reduction in effective weed control may be great. Upchurch (1966) reported that the unfavorable effects of excessive volatility and photodecomposition necessitate that certain herbicides be mixed with the soil.

The superiority of soil incorporation of many herbicides over surface application is well substantiated. Hauser (1965) studied the subsurface placement of EPTC (ethyl N,N-dipropylthiolcarbamate) and several analogues. There was greater herbicidal activity with the subsurface placement than with the surface spraying. Burt (1959) found with 5 thiolcarbamates that incorporation into the upper 2 inches of soil increased their weed control effectiveness 100 per cent or more. The effect of soil incorporation in reducing herbicide loss depends on the colloidal surfaces available for adsorption sites. The addition of organic matter to the soil has been shown to increase the retention of trifluralin (a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine) (Bardsley et al. 1967). It appears that the increase in adsorptive capacity was important in increasing the retention.

Bailey and White (1964) list two general types of adsorption, physical and chemical. Physical adsorption or van der Waals adsorption results in low binding strength. Chemical adsorption results from the formation of bonds and is high in binding strength. Cation exchange capacity and organic matter content are highly correlated with adsorption.

In general, herbicides subject to volatilization have been found to be more effective in dry soil than in moist soil (Bailey and White, 1964) (Upchurch, 1966). Under low moisture conditions the herbicide is adsorbed but the binding energy is low enough so the chemical is available biologically. In a high moisture situation most of the herbicide may be in the soil solution and susceptible to vapor loss. This loss results in reduced effectiveness of the herbicide. Ashton and Sheets (1959) found that EPTC was adsorbed to a much greater extent by air-dry soil than by soil near field capacity. At low moisture conditions the chemical apparently can compete more effectively for adsorption sites in the soil. Gray and Weierich (1965) found that of the factors affecting EPTC loss from soils, soil moisture was the most important.

Loss of trifluralin due to volatilization increases with exposure to air and with exposure to sunlight or ultraviolet light (Bardsley et al. 1968)

(Wright and Warren, 1965). Placing the trifluralin in the soil one-half inch was sufficient to prevent volatilization and photodegradation. Phytotoxic concentrations of trifluralin moved little in the soil even when the rate of application was 2.5 times that recommended and under as much as 18 inches of simulated rainfall (Shahied et al. 1966).

Methods of incorporation were studied by Guse and Schwer (1964). Using trifluralin, surface spray applications gave erratic results and poor late season weed control. The power-driven rotary hoe and the tandem disk were the most consistently dependable tools for incorporating trifluralin under a wide range of conditions.

Site of uptake of herbicides has been the topic of much research in recent years. Upchurch (1966) stated, "The limits of what may be accomplished by herbicide application are set in part by the mode of action of the herbicide and by the degree of inherent selectivity between the crop and weed species. Compounds such as EPTC and diallate (S-2,3-dichloroallyl N,N-diisopropylthiolcarbamate), which act through the shoot of the germinating weed, must be placed in a position to contact the shoot." Hartley (1964) reported that, in general, less volatile, less soluble herbicides have the root as the most important path of entry. Entrance through the shoot is important for volatile herbicides such as EPTC. Parker (1966), working with sorghum, reported that EPTC, diallate, CDEC (2-chloroallyl diethyldithiocarbamate), and possibly CDAA (2-chloro-N,N-diallylacetamide) are dependent for their toxic effects on uptake via the shoot prior to emergence. In greenhouse studies, Standifer and Thomas (1965) found that Johnsongrass seedlings were killed when the first internode passed through trifluralin-treated soil.

Appleby, Furtick, and Fang (1965) studied the effect of soil placement of EPTC on oats using radioactive EPTC. Both the roots and coleoptiles readily absorbed EPTC from the soil although less toxicity was noted from root exposure. It was concluded that differential selectivity does not appear to be due to differences in uptake, translocation, or metabolic breakdown, but rather the shoot is the major site of lethal action of EPTC in oats. Parker (1963) found that little or no transport of diallate from the roots to the shoot occurs in oats. Knake et al. (1967) found that as depth of incorporation was increased control of Setaria viridis decreased indicating a dilution of the herbicide. Dawson (1963) found that most of the elongation responsible for Echinochloa crusgalli seedling emergence occurred in the first internode. The developing foliar leaves within the coleoptile were the consistent site of uptake which resulted in EPTC injury. Roots showed no sign of injury.

The site of uptake of vernolate (S-propyl dipropylthiocarbamate) and trifluralin by wild cane was investigated by Condray (1968). Vernolate was absorbed not only through the shoot but also through the root. Trifluralin controlled wild cane when placed with or above the seed. Trifluralin was taken up in toxic quantities through the shoot only. Nishimoto, Appleby, and Furtick (1967) found EPTC and trifluralin more effective through the shoot of oats.

Burnside (1968) studied the influence of herbicides, incorporation methods, and wild cane planting depths on wild cane and soybean yields. Wild cane yields were higher where herbicides were incorporated with a rotary hoe as compared to incorporation with a roto-tiller. Trifluralin at 1 pound active ingredient per acre (hereafter referred to as lb./A.) and vernolate at 3 lbs./A. were effective in controlling wild cane. Planting depth of wild cane had little influence on wild cane or soybean yields. Burnside (1968) also compared the influence of herbicides and cultivation on wild cane yields. Wild cane control was increased with the addition of two cultivations. Complete control of wild cane was obtained with combinations of trifluralin and cultivation.

METHODS AND MATERIALS

The field research reported in this paper was conducted during 1968. A site was chosen near the Kansas State University Agronomy Farm, Manhattan, Kansas, for the wild cane study. This site was known to have been heavily infested with wild cane in previous years. Grain sorghum had been planted the preceding year, but wild cane had practically taken over the field. The soil was a loam with a pH of 6.0 and an organic matter content of 2.8 per cent.

Ten treatments were evaluated. Trifluralin, diallate, and triallate at 1 and 2 lbs./A., vernolate at 3 lbs./A., and a combination of trifluralin at 1 lb./A. and vernolate at 2 lbs./A. were evaluated for each method of soil incorporation. A no-treatment plot and a hand-weeded plot were included in each replication. Treatments were replicated three times in a randomized split-plot design with treatments as whole plots and method of soil incorporation as the subplot. The plots were each 20 feet wide (subplot 10 feet) and 30 feet long with a 15-foot alley between replications.

The herbicides were applied May 21, 1968, using a tractor-mounted sprayer calibrated to deliver approximately 20 gallons per acre from tips spaced 20 inches apart. Two methods of soil incorporation were compared. A 5-foot tandem disk similar to the type used by farmers in the area was used, and the subplots receiving the disk incorporation were disked twice in the same direction. The other implement for soil incorporation was a 5-foot powered roto-tiller. The subplots receiving the roto-tiller incorporation were roto-tilled once. This was felt to be sufficient since the tractor speed when using the roto-tiller was considerably less than when using the disk, as well as the fact that the roto-tiller action resulted in a more finely pulverized soil. After incorporation the entire plot area was harrowed with a peg-tooth harrow to level the ridges and furrows left by the disk and roto-tiller. All herbicides were applied in the late afternoon. Soil conditions were ideal for incorporating soil-applied herbicides. During the night following application the area received approximately 1 inch of rain.

Two weeks later (June 3, 1968), the plots were planted to soybeans with a row spacing of 30 inches. Each plot consisted of 8 rows, each subplot, of 4 rows. The seeding rate was approximately 60 pounds per acre. Clark-63 soybeans were inoculated with Rhizobium bacteria. Planting depth was determined to be 1 to 1 1/2 inches. Since the objective was to determine the effectiveness of the herbicidal control without mechanical cultivation, none of the plots received cultivation after planting.

Observations were made immediately after soybean emergence to determine soybean injury. Later in the season weed control ratings were recorded from all plots.

Wild cane was harvested when the seed was just starting to shatter. A 5-foot-wide band of wild cane was removed by hand from each subplot. After green weights were taken, a sample of wild cane was dried to determine the per cent dry matter.

Soybeans were harvested at maturity using a specially built cutterbar mounted on a small Gravely tractor. This machine cut the soybean plants at ground level. Soybeans were threshed in a small combine and weights recorded. Harvesting was done in the morning to avoid shattering losses.

Data on soybean yield, wild cane yield, and soybean weight were analyzed statistically.

EXPERIMENTAL RESULTS

Visual observations made after soybean emergence indicated that vernolate was the only herbicide that caused soybean injury. Injury appeared as a reduction in seedling growth. The soybean stand was not affected. Initial retardation of growth was obvious for a few weeks but dissipated as the season progressed. No apparent reduction in yield could be attributed to the initial vernolate injury symptoms.

A heavy infestation of wild cane showed up immediately in plots receiving no herbicide treatment. All herbicides gave initial wild cane control though some treatments were better than others. The 1 lb./A. rate of diallate and triallate gave partial but unsatisfactory control of wild cane. Initially trifluralin and vernolate treatments appeared to be equally effective. At the soybean seedling stage no differences could be seen in any of the treatments between incorporation by tandem disk and incorporation by roto-tiller.

Treatment evaluations were made in July when the soybean plants were about 18 inches tall. Trifluralin and vernolate treatments were effectively controlling wild cane as well as other weedy species (*Amaranthus* spp., *Setaria* spp.). Diallate and triallate at the 2 lb./A. rate gave considerable wild cane control but failed to control most of the other weeds. Diallate and triallate at the 1 lb./A. rate were not providing acceptable control of wild cane or other weed species.

Wild cane from a 5-foot wide strip in each subplot was harvested by hand prior to harvesting soybeans. Yields on a per-acre basis are given in Table 2. Yields of wild cane were not significantly different when comparing the two methods of incorporation. None of the treatments gave 100 per cent wild cane control. Trifluralin at both the 1 and 2 lb./A. rate

Table 1. Average wild cane yield for herbicide treatments and methods of soil incorporation.

Treatment	lb./A.	Pounds per Acre Dry Matter Roto-tiller	Tandem Disk	Av.
trifluralin	1	455	624	539
trifluralin	2	64	42	53
vernolate	3	1397	730	1063
diallate	1	1703	1185	1444
diallate	2	1344	1079	1212
triallate	1	2740	3058	2899
triallate	2	138	339	238
trifluralin + vernolate	1 + 2	233	793	513
No Treatment	-	5819	6062	5940
Hand Weed	-	0	0	0
L.S.D. (.05 level)		2076		1454

provided good control (Fig. 1). The combination of trifluralin and vernolate also gave good wild cane control. Vernolate alone was not as effective as in combination with trifluralin. Triallate at the 2 lb./A. rate also gave good wild cane control, but overall weed control was unsatisfactory.

The two center rows of soybeans were cut from each subplot. The plants were cut at ground level and little shattering occurred. The soybeans were threshed in the field. Soybean yields are given in Table 2. There was no significant difference in soybean yield between methods of soil incorporation. The untreated plots averaged 12.6 bushels per acre. However, these plots were hand-harvested and thus few soybeans were lost. In a field situation

Table 2. Average soybean yield for herbicide treatments and methods of soil incorporation.

Treatment	lb./A.	Bushels per Acre Soybeans Roto-tiller	Tandem Disk	Av.
trifluralin	1	38.7	33.9	36.3
trifluralin	2	36.3	38.2	37.3
vernolate	3	31.9	33.9	32.9
diallate	1	28.1	26.1	27.1
diallate	2	31.0	33.4	32.2
triallate	1	27.6	27.6	27.6
triallate	2	35.3	33.9	34.6
trifluralin + vernolate	1 + 2	35.8	35.8	35.8
No Treatment		13.1	12.1	12.6
Hand Weed		38.7	37.8	38.3
L.S.D. (.05 level)		12.8		10.2

it is doubtful that mechanical harvesting would have been feasible due to the severe wild cane infestation.

To determine if any of the treatments affected soybean weight, a random sample of 100 soybeans from each subplot was weighed. Table 3 gives the weight per 100 beans. There was no significant difference in soybean weight between the untreated plots and the hand-weeded plots. It was therefore concluded that wild cane infestation did not affect soybean weight (Fig. 3). Trifluralin at 2 lbs./A. and triallate at 2 lbs./A. significantly reduced soybean weight. However, soybean seed weight is only one component of soybean yield.

Table 3. Average weight per 100 soybeans for herbicide treatments and methods of soil incorporation.

Treatment	lb./A.	Grams per 100 Soybeans Roto-tiller	Tandem Disk	Av.
trifluralin	1	14.2	14.0	14.10
trifluralin	2	13.3	13.4	13.35
vernolate	3	14.1	14.2	14.15
diallate	1	13.8	13.7	13.75
diallate	2	14.4	14.3	14.35
triallate	1	14.0	14.7	14.35
triallate	2	13.6	13.4	13.50
trifluralin + vernolate	1 + 2	13.7	13.8	13.75
No Treatment		13.9	14.0	13.95
Hand Weed		14.0	14.3	14.15
L.S.D. (.05 level)		1.09		.56

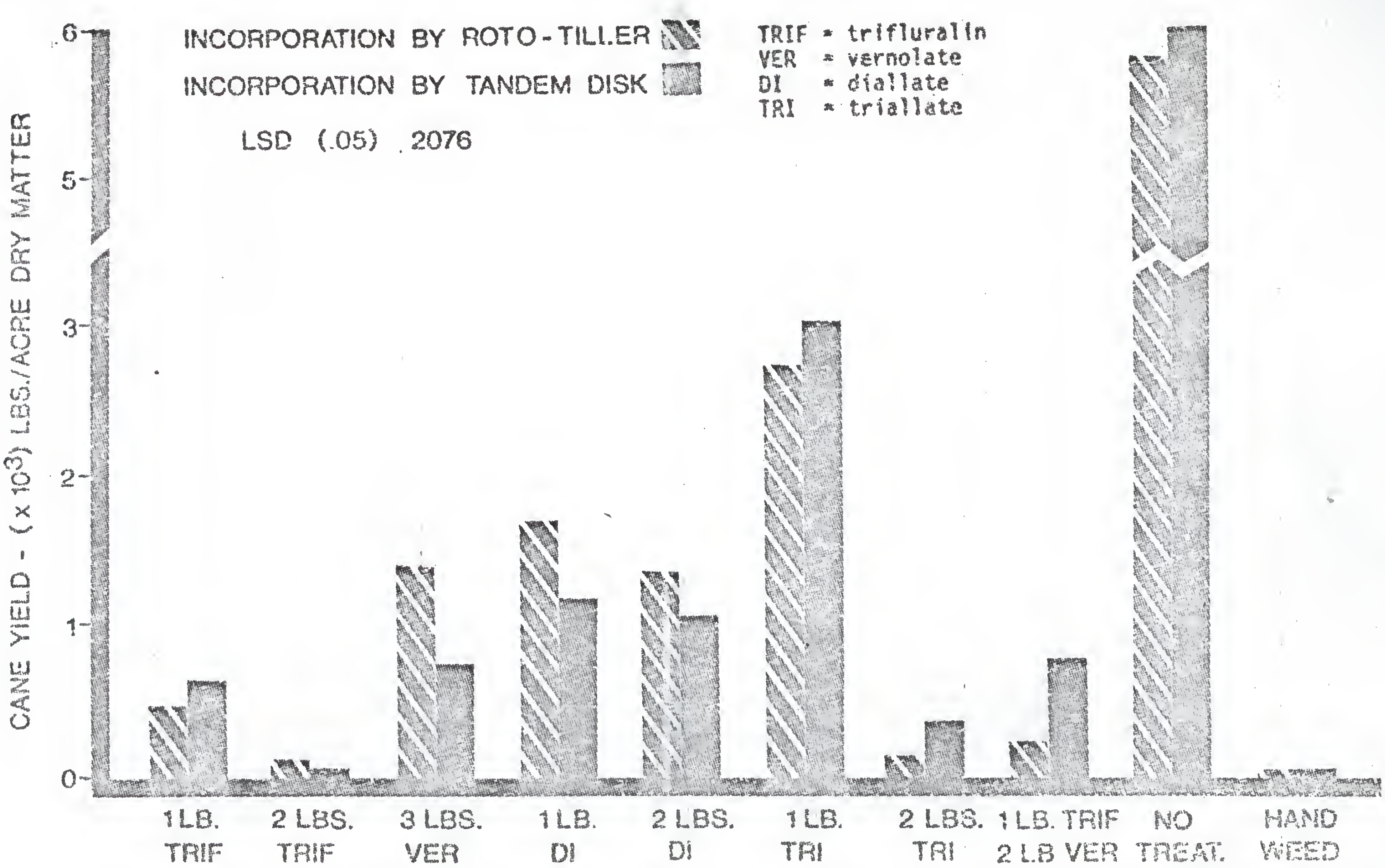

Fig. 1 Average wild cane yields for herbicide treatments and methods of soil incorporation.

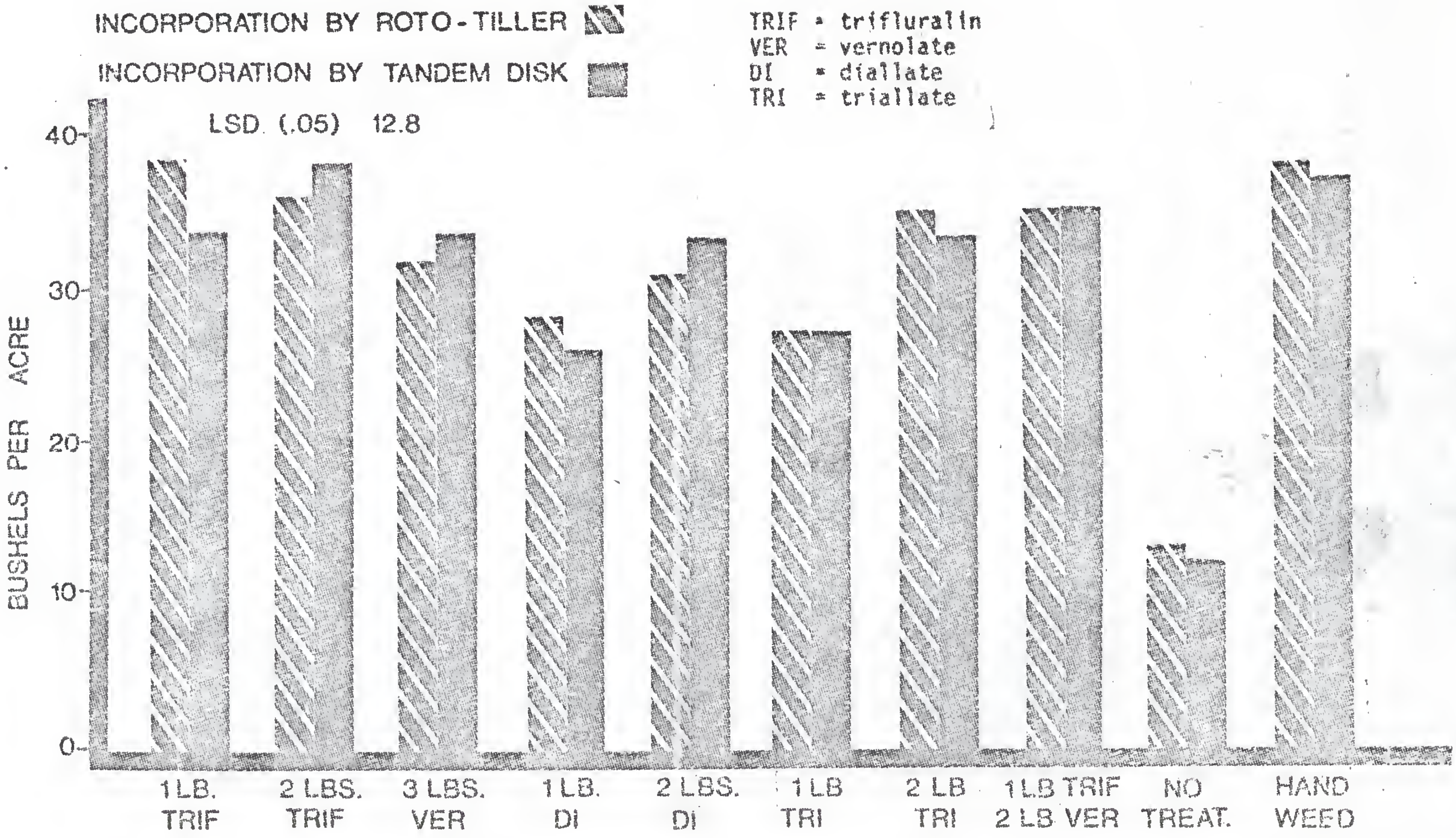

Fig. 2 Average yield of soybeans for herbicide treatments and methods of soil incorporation.

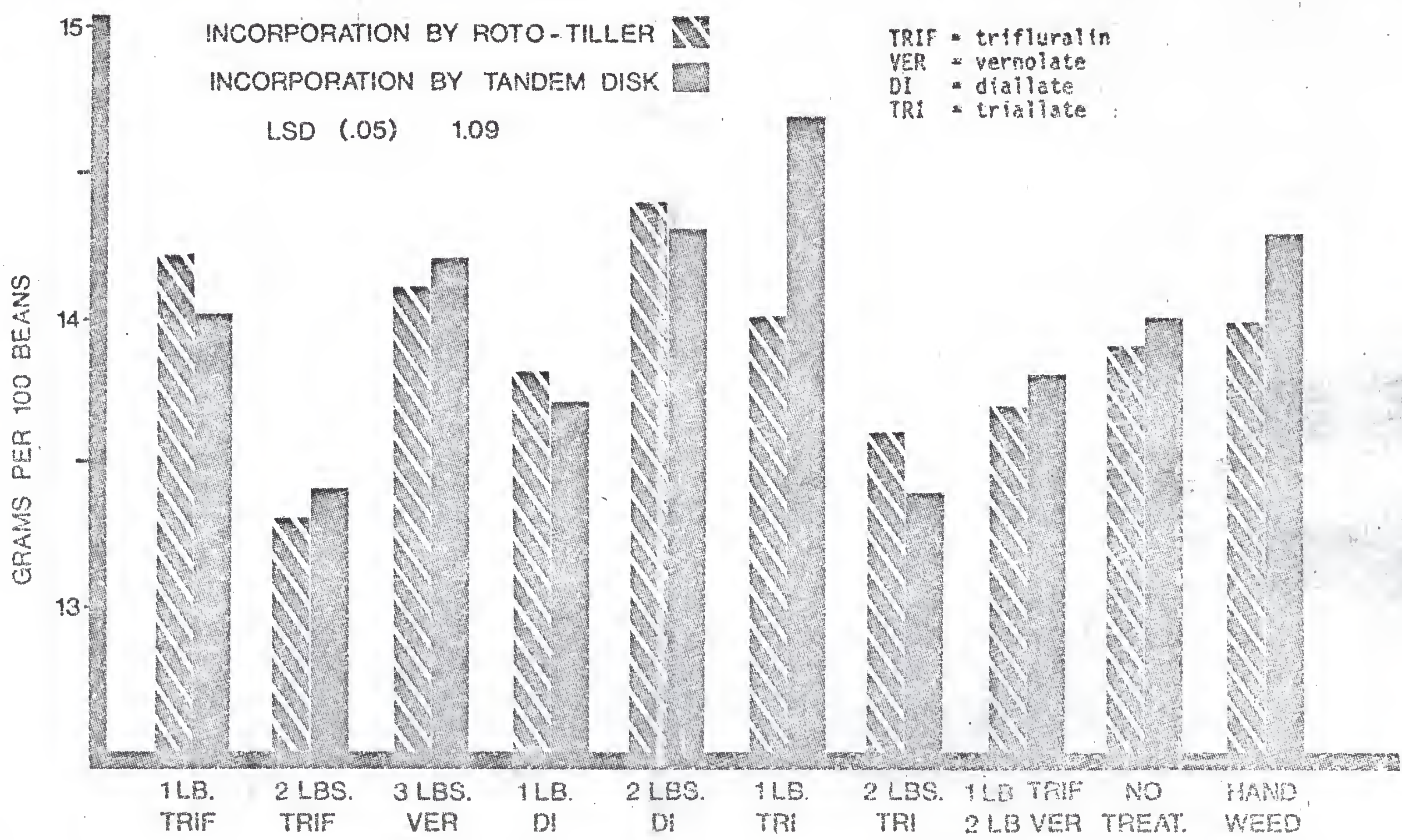

Fig. 3 Grams per 100 soybeans for herbicide treatments and methods of soil incorporation.

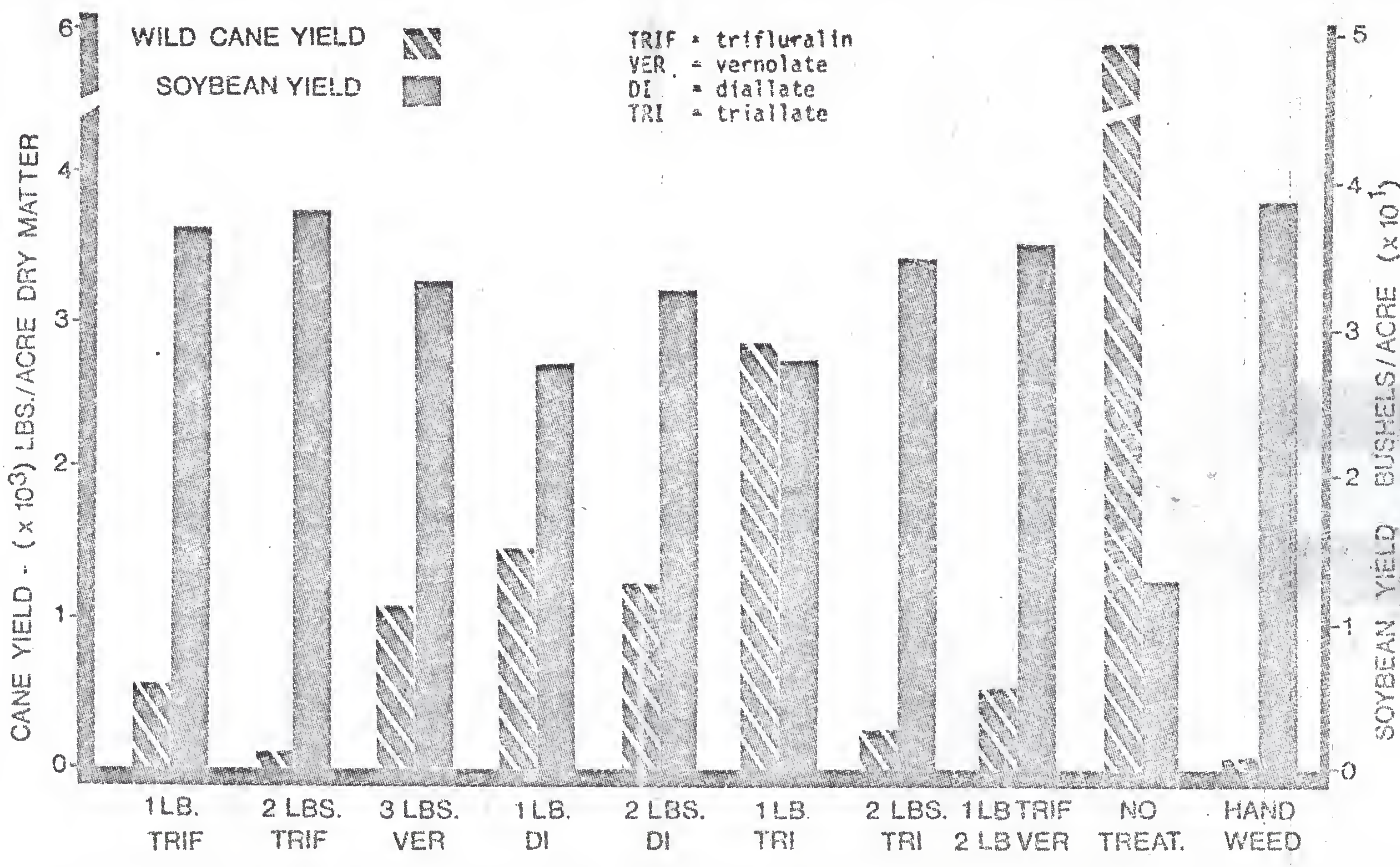

Fig. 4 Average wild cane yield and average soybean yield for herbicide treatments.

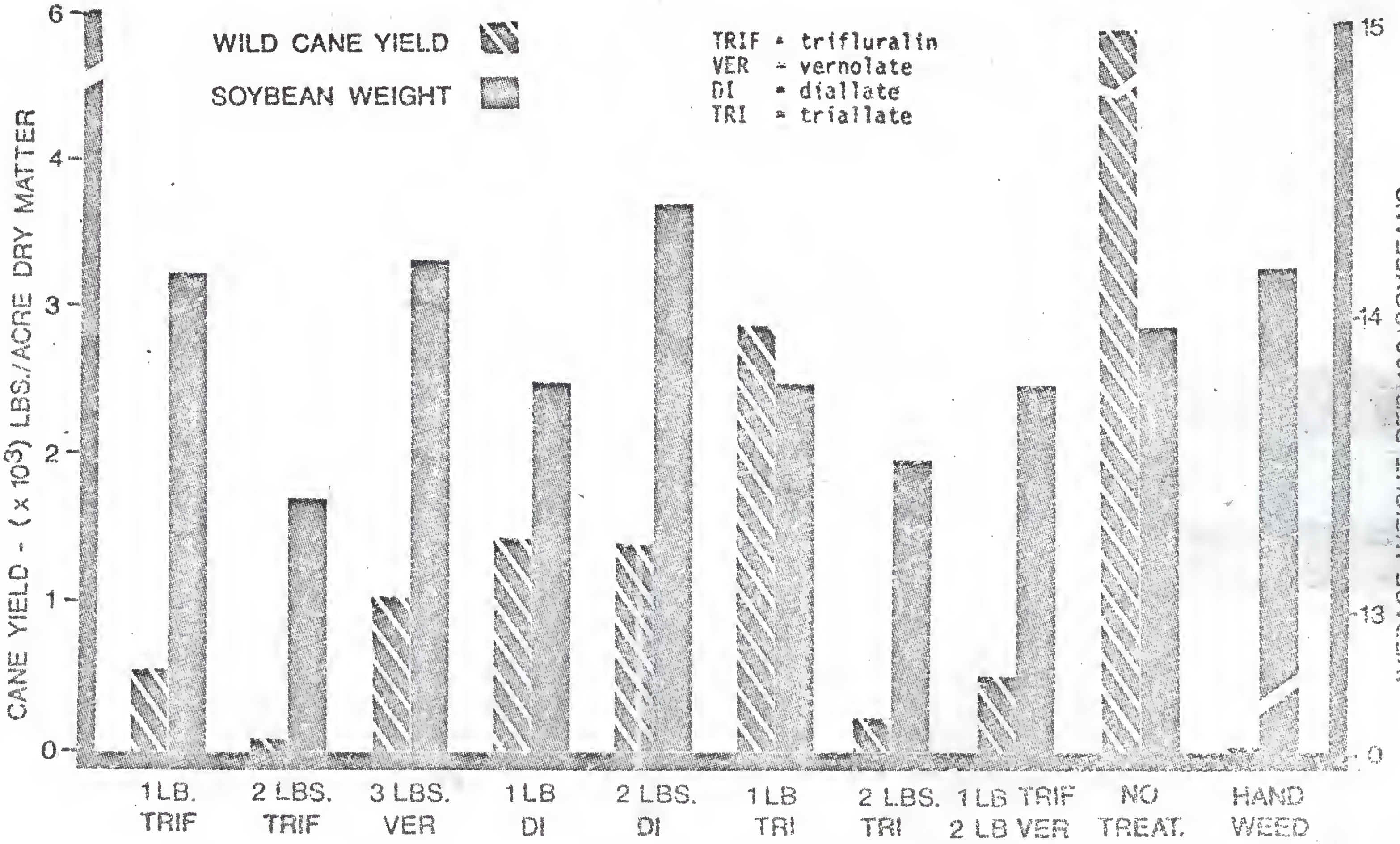

Fig. 5 Average wild cane yield and average weight per 100 soybeans for herbicide treatments.

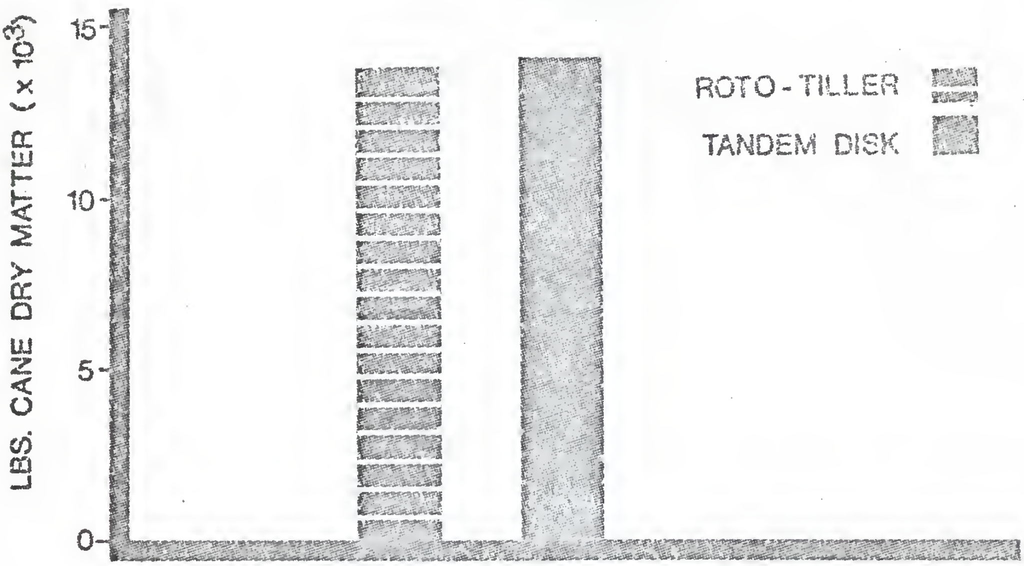

Fig. 6 Total wild cane yield of all plots with incorporation by roto-tiller and with incorporation by tandem disk.

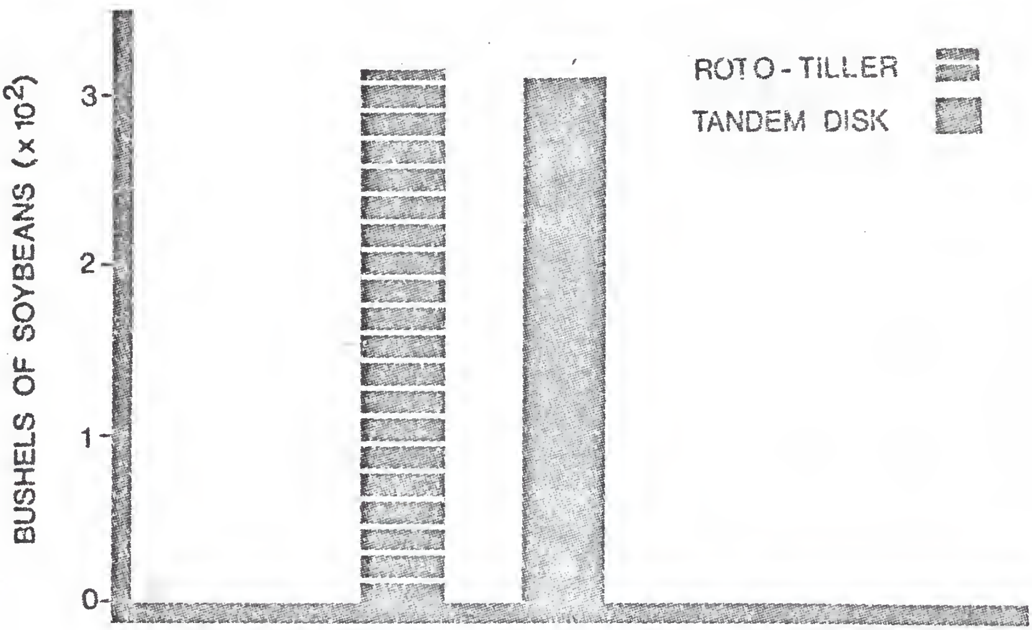

Fig. 7 Total soybean yield of all plots with incorporation by roto-tiller and with incorporation by tandem disk.

EXPLANATION OF PLATE I

Soil incorporation of herbicides applied prior to planting using a power-driven roto-tiller. Plots with incorporation by roto-tiller were roto-tilled once immediately after application of the herbicide.

EXPLANATION OF PLATE II

Soil incorporation of herbicides applied prior to planting using a tandem disk. Plots with incorporation by disk were disked twice immediately after application of the herbicide.

PLATE I

PLATE II

EXPLANATION OF PLATE III

Effective control of wild cane with 1 lb./A. trifluralin applied prior to planting and incorporated into the soil with a roto-tiller. Plot received no cultivation after planting.

EXPLANATION OF PLATE IV

Severe infestation of wild cane where no herbicide was applied and no cultivation employed after planting.

PLATE III

PLATE IV

DISCUSSION

Published literature on wild cane control in field crops is limited. As was pointed out in the review of literature, Burnside (1968) reported excellent control of wild cane with herbicides in soybeans. The present study was made under conditions considered optimum for growing soybeans. If the present experiment were repeated and all conditions could be duplicated the results would be expected to agree with the results obtained herein. However, several of the herbicides used in this wild cane study were applied at higher than the label registered rate. Under less than optimum conditions some soybean injury might be expected. Under extreme soybean stress conditions severe injury to the soybeans has been observed in the use of trifluralin even at normal rate. In a field study of this kind growing conditions can not be reproduced from year to year. The author wishes to emphasize the influence of climatic, cultural, and edaphic factors on the overall effectiveness of any soil-applied herbicide.

Results of comparing two methods of incorporation indicated no significant difference between incorporation of the herbicides used in this study with a tandem disk or with a roto-tiller, if all other conditions were comparable. This would indicate that the herbicides were effectively incorporated into the soil and that the differences in wild cane control were due to differences in the herbicidal properties of the different chemicals.

Methods and tools for herbicide incorporation other than the two used in this experiment may be equally effective. However, the tandem disk is probably the most widely used tool for soil incorporation of herbicides. The power-driven roto-tiller, which thoroughly pulverizes and mixes the soil, is becoming more widely used. Large soil aggregates that may contain many weed seeds are broken up.

The primary objective of this study was to determine how effectively wild cane could be controlled in soybeans with herbicides alone. Effective weed control implies the limitation of weed growth so that the crop may be economically produced. Wild cane can be completely controlled in any given year. But due to the dormant, viable seed remaining in the soil, re-infestation is likely to occur in succeeding years. According to the research reviewed in the literature, the phytotoxic pathway of the herbicides used in this experiment appears to be through the shoot. Condray (1968) reported that vernolate was absorbed through both the root and shoot of wild cane. "Shoot" here is used to define the tissue of the first internode and also that part of the coleoptile tissue remaining below the soil level. Everything above this level is also shoot tissue but is not involved in herbicide uptake once exposed above the soil surface. It is thus necessary to have an herbicide barrier somewhere between the seed and the surface of the soil. A shallow but thorough soil incorporation would appear to be optimum. Deep incorporation results in a dilution of the herbicide accompanied by a decrease in its effectiveness. If the herbicide is incorporated deeply, a somewhat increased rate may need to be used but this may present problems in terms of soil residue. A thin layer of concentrated chemical in the soil can be diluted by tillage after the crop is harvested thus theoretically reducing residue problems. The reduction in residue has significance with only those herbicides which are degraded slowly. The carbamate herbicides tend to present no residue problems.

SUMMARY

The results of this study indicate that in soybeans wild cane can be effectively controlled with herbicides. Wild cane competes vigorously, and, unless controlled, heavy infestations make the production of soybeans uneconomical.

Wild cane yield, soybean yield, and soybean weight were not significantly influenced by the method of soil incorporation. Rather, the degree of wild cane control was primarily determined by the effectiveness of the herbicides. Only the vernolate treatment caused soybean injury. Vernolate caused an initial reduction in rate of growth. This retardation diminished gradually. Soybean yields from all herbicide-treated plots were significantly better than those from untreated plots, but wild cane yields were significantly reduced by all herbicide treatments.

Trifluralin gave excellent control of wild cane; vernolate and a combination of trifluralin and vernolate gave acceptable control. Triallate controlled wild cane but did not satisfactorily control other weed species.

Reductions in weight of soybean seed could not be attributed to wild cane infestation. Trifluralin at the 2 lb./A. rate and triallate at the 2 lb./A. rate significantly reduced the weight of soybean seed harvested from these plots.

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APPENDIX

Table 4. Analysis of variance for data in Table 1.

Source of variation	df	SS	MS	F
Whole unit	29	18,893	651	
Herbicides	9	15,912	1768	13.75**
Replication	2	665		
Error (a)	18	2,315	128	
Method incorporation	1	0.004	0.004	0.00002
Herbicide x incorp	9	177.3	19.7	0.098
Error (b)	20	3,996.0	199.8	
Total	59	19,928.0		

Herbicide LSD at .05 level = 13.75 lbs./plot.
Herbicide x incorp. LSD at .05 level = 19.62 lbs./plot.

** significant at the 99% level.

Table 5. Analysis of variance for data in Table 1.

Source of variation	df	SS	MS	F
Whole unit	29	193.48	6.67	
Herbicides	9	135.23	15.02	4.97**
Replication	2	3.87		
Error (a)	18	54.48	3.02	
Method incorporation	1	.07	.07	.023
Herbicide x incorp.	9	2.54	.28	.085
Error (b)	20	66.18	3.31	
Total	59	204.02		

Herbicide LSD at .05 level = 2.11 lbs./plot
Herbicide x incorporation LSD at .05 level = 2.64 lbs./plot

** significant at 99% level.

Table 6. Analysis of variance for data in Table 3.

Source of variation	df	SS	MS	F
Whole unit	29	13.95	.481	
Herbicides	9	6.42	.713	3.32*
Replication	2	3.66		
Error (a)	18	3.87	.215	
Method incorporation	1	0.05	.05	.076
Herbicide x incorp.	9	0.96	.11	.015
Error (b)	20	14.17	.71	
Total	59	21.6		

Herbicide LSD at .05 level = .56 grams.
Herbicide x incorp. LSD at .05 level = 1.09 grams.

* significant at the 95% level.

RAINFALL LOG-AGRONOMY FARM 1968
KANSAS STATE UNIVERSITY

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.
1									
2				.38				1.80	
3	.02			1.03				.82	
4									.25
5									.02
6					.73		.21		
7					.26				
8									
9						.09	.93	.14	
10						.52		.08	
11						.09		.62	
12	.16								
13									
14				.30	1.16	.64			
15		.04				.32			
16						.53	.28		
17				.75			.33		
18						.07		.45	
19				.01		.56			
20				.45					
21		.09							
22				.10	.81				
23				.08	.14				
24					.02		3.85	.27	.01
25		.17				.10	.25		
26					.15		.13		
27							.44		
28				.09				.02	
29								.31	
30							.07	.48	
31					.53		.35		
TOTAL	.18	.30	T	3.19	3.80	2.92	6.84	4.99	1.51

CONTROL OF WILD CANE, *Sorghum bicolor*, IN SOYBEANS WITH HERBICIDES

by

THOMAS W. SCHILLING

B. S., Southern Illinois University, 1967

AN ABSTRACT OF A MASTER'S THESIS

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Manhattan, Kansas

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The literature was reviewed on the possible origin of wild cane; the general characteristics of wild cane; the influence of soil incorporation on herbicide activity in grasses; the site of uptake of herbicides by grass species; and the control of wild cane in field crops.

The potential control of wild cane in soybeans was investigated using a number of herbicides in a field study conducted near Manhattan, Kansas, 1968. A site was chosen that was severely infested with wild cane. Herbicides were applied to the soil and incorporated prior to planting soybeans. Two methods of soil incorporation were evaluated to determine if the method of incorpoation had any influence on the overall effectiveness of the herbicides. A tandem disk and a roto-tiller were used.

Experimental results indicated there was no significant difference between the two methods of incorporation in terms of wild cane yield, soybean yield, and weight of soybeans. Trifluralin (a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine), vernolate (S-propyl dipropylthiocarbamate), and triallate (S-2,3,3-trichloroallyl N,N-diisopropylthiolcarbamate) gave effective control of wild cane. Only vernolate showed indications of causing injury to the soybeans in the seedling stage. Soybean yields were directly influenced by the degree of wild cane control. Soybean weight was not affected by wild cane infestation. High rates of trifluralin and triallate reduced soybean weight.

A brief discussion of factors affecting the performance of soil-applied herbicides was given in light of results of experimental research reviewed in the literature.