To the Graduate Council:

I am submitting herewith a thesis written by Jerry Eugene Freeny entitled "Sicklepod Control and Competition in Soybeans." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Plant and Soil Science.

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SICKLEPOD CONTROL AND COMPETITION
IN SOYBEANS

A Thesis
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Master of Science
Degree
The University of Tennessee, Knoxville

Jerry Eugene Freeny

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ABSTRACT

Field studies were conducted to determine: (1) a systematic approach to selectively control sicklepod (Cassia obtusifolia L.) in soybeans (Glycine max (L.) Merr.) utilizing preplant incorporated, preemergence, and postemergence applications of appropriate herbicides, (2) the competition effects involving removal of sicklepod plants at different times during the soybean growing season, and (3) production costs and net dollar return for each herbicide system.

The herbicide systems and competition studies were conducted in 1980 at the Plant Science Field Laboratory at Knoxville and on a farm near Benton, Tennessee. Parameters measured were percent sicklepod control and soybean yield in the herbicide study, and sicklepod stand count and soybean yield in the competition study. Net dollar return was also determined for the study. At both locations the soybean cultivar 'Essex' was used.

Metribuzin (4-amino-6-tert-butyl-3-(methylthio)-as-triazin-5(4H)-one) plus vernolate (S-propyl dipropylthiocarbamate) applied preplant incorporated followed by linuron (3(3,4-dichlorophenyl)-1-methoxy-1-methylurea) plus 2,4-DB (4-(2,4-dichlorophenoxy) butyric acid) applied postemergence directed gave excellent control of sicklepod. Metribuzin mixed with either metolachlor (2-chloro-N-(2-ethyl-6-methylphenyl) acetamide) or alachlor (2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide) applied preemergence followed by linuron plus 2,4-DB applied postemergence directed, also gave effective sicklepod control.

Generally, postemergence herbicide treatments such as acifluorfen

(5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-nitrobenzoic acid), or toxaphene (chlorinated camphene containing 67-69% chlorine) used alone were not as effective in controlling sicklepod as they were when used following a preemergence herbicide. Better sicklepod control was achieved with toxaphene and acifluorfen when they were applied to sicklepod in the cotyledon or unifoliolate stage of growth.

Generally, soybean yields were higher as more sicklepod control was achieved. Dollar net returns were generally higher where sicklepod was effectively controlled.

Soybean yields were generally higher if soybeans were kept free of sicklepod for 4 or more weeks after planting.

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CHAPTER I

INTRODUCTION

Sicklepod (Cassia obtusifolia L.) is a problem weed in soybeans (Glycine max (L.) Merr.) particularly in the southeastern region of the United States. Sicklepod is a member of the Leguminosae family and is atypical of species in the family in that it does not form nodules or fix nitrogen. Sicklepod is found throughout tropical America, Asia, and Africa and was probably introduced into this country sometime before 1800 as a contaminant in cottonseed (23).

Chemically controlling sicklepod is a problem in soybeans because they are both legumes, therefore few herbicides will selectively control sicklepod without injuring soybeans. Many sicklepod seeds remain dormant and do not germinate uniformly in the spring but may germinate sporadically after every rainfall. The seed can germinate under a wide range of soil pH and from various depths within the soil. Since most preemergence herbicides have short residual lives, sicklepod can become established as soon as the herbicide is sufficiently detoxified. Because of these characteristics, researchers (15, 22, 36) suggest a systems approach to sicklepod control consisting of a residual preplant incorporated or preemergence herbicide followed by a postemergence herbicide to provide season long control.

The objectives of this experiment were to determine: (1) a systematic approach to selectively control sicklepod in soybeans utilizing preplant incorporated, preemergence, and postemergence applications of appropriate herbicides, (2) the competition effects of sicklepod on soybeans by removing the sicklepod at different times during the soybean growing season, and (3) production costs and net dollar returns for each herbicide system.

CHAPTER II

LITERATURE REVIEW

Sicklepod is a member of the Leguminosae family and is found throughout the southeastern United States (23). Sicklepod is not new to this area, having been found as early as 1880 to be a problem weed in cotton (38). A recent survey has indicated that sicklepod is a problem weed in 11 southern states and is on the increase in 12 others (40). Researchers (34,35,36,39) suggest that yearly use of dinitroaniline herbicides, particularly trifluralin (α,α,α-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine), has caused a shift in weed populations. Teem et al. (37) found that sicklepod was tolerant to trifluralin, noting that root elongation was not inhibited except when high rates of it were used. Since sicklepod is tolerant to trifluralin, with trifluralin use competitive species have been reduced allowing the tolerant sicklepod population to increase (37). Sicklepod is tolerant to many herbicides commonly used in soybeans. Sicklepod will also germinate after each rainfall (11,34,35,36,39). This lack of a major flush often nullifies a single weed control approach of applying a herbicide either preplant incorporated, preemergence, or postemergence (31). If a single herbicide approach is used, the herbicide breaks down allowing sicklepod to germinate and to become established before soybeans can form a canopy and shade the space between the rows. Since both sicklepod and soybeans are leguminous species, the number of herbicides which control sicklepod without injuring soybeans are very limited (31).

Several properties contribute to sicklepod's extremely competitive growth habits. Murray et al. (34) reported plants reached heights of 2 meters. Teem et al. (40) reported that sicklepod produces many seeds with hard seed coats capable of germinating from depths of up to 12.5 cm. Sicklepod can germinate over a wide temperature range of 15 to 36 C with an optimum range of 24 to 36 C and exhibits very rapid seedling emergence. Teem et al. (40) reported that 63% of sicklepod seed planted at a depth of 2.5 cm. germinated within 3 days. Because of its rapid emergence, sicklepod has a competitive advantage over most crop species. Buchanan et al. (14) reported that sicklepod was tolerant to low pH, while Creel et al. (23) found that under laboratory conditions sicklepod would grow over a wide pH range of 3.2 to 7.9. Hoveland et al. (27) demonstrated that sicklepod could tolerate lower levels of phosphorus and potassium than soybeans and most other crop and weed species. Creel et al. (17) reported that sicklepod showed greater response to fertilization than did soybeans. They also showed that when sicklepod residues were incorporated into the soil prior to planting, seedling cotton vigor was reduced suggesting a possible allelopathic effect. Sicklepod has an added competitive advantage over soybeans since it is more tolerant to drought stress. Buchanan and Hoveland (13) observed sicklepod's ability to fold its leaflets together thus reducing evapotranspiration. This ability to fold its leaflets also makes it difficult to adequately cover the plant with postemergence herbicides (28). Kraatz and Anderson (29) observed that sicklepod leaflets folded together and drooped at night and expanded during the day. They found that diurnal change in projected leaf area is a factor in the efficacy of postemergence herbicide treatments. They reported that control of sicklepod with linuron (3(3,4-dichlorophenyl)-1-methoxy-1 methylurea) applied postemergence at intervals throughout 24 hour periods was greater from daytime applications than from late evening, night, and early morning applications.

Thurlow and Buchanan (41) reported less soybean yield reduction from sicklepod when moisture was plentiful. They suggested that competition for moisture was a more important factor in soybean yield reduction than was competition for light, nutrients, or space. Buchanan and Burns (10) reported that sicklepod densities as low as 8 plants per 7.3 meters of row could reduce soybean yields as much as 80%. Thurlow and Buchanan (41) reported soybean yield reductions of 13, 25, and 51% with sicklepod populations of 1, 2, and 3 plants per 30 cm. of row, respectively. The following year they reported (42) densities of 7.7 sicklepod plants per square meter reduced soybean yields from 19 to 35% at two locations. Other crops have shown similar results. Buchanan et al. (12) reported a linear decrease in cotton yields with increasing sicklepod densities. Sicklepod was grown with cotton at densities ranging from 0 to 32 plants per 15 meters of row. Losses in hand harvested yields of seed cotton ranged from 34 to 43 kg/ha for each sicklepod plant per 15 meters of row. Hauser and Buchanan (25) reported that peanut yields were not reduced if kept free of sicklepod for the first 4 to 5 weeks after planting. With 10 to 14 weeks of sicklepod competition, peanut pod weight was reduced. They also showed that sicklepod fresh weight was inversely proportional to peanut yield if the sicklepod plants were not removed in the first 5 weeks of peanut growth.

In addition to competition with crops, sicklepod has been reported

(11,26,36) to interfere with mechanical harvesting and to reduce harvesting efficiency because of additional plant material.

The use of herbicides has been one important method of sicklepod control, although control has been less satisfactory than mechanical control in many cases. Vernolate (S-propyl dipropylthiocarbamate) marketed as "Vernam" by Stauffer Chemical Company is a preplant incorporated herbicide used to control annual grasses and certain broadleaf weeds (9). Oliver et al. (36) reported that 2.2 kg/ha of vernolate provided enough early suppression of sicklepod growth to enable soybeans to become competitive.

Metribuzin (4-amino-6-tert-butyl-3-(methylthio)-as-triazin-5 (4H)-one) is marketed by MoBay Chemical Company as "Sencor" and by E. I. DuPont de Nemours and Company as "Lexone." According to their product labels (5,8) metribuzin controls many broadleaf weeds including sicklepod. Metribuzin can be applied preplant incorporated, preemergence, or as a postemergence directed spray (5,8). Chapman and Aitken (16) reported that metribuzin tank mixed with trifluralin at 0.4 kg/ha + 0.6 kg/ha applied preplant incorporated was the best treatment of several compared for sicklepod control. They determined that better control was obtained when metribuzin was applied at 0.4 kg/ha as opposed to 0.3 kg/ha. Crowley et al. (18) reported that metribuzin applied at 0.3, 0.6, and 1.1 kg/ha gave sicklepod control of 72%, 100%, and 100% respectively. In other studies (8,34,36) soybean injury has occurred when metribuzin rates were high enough to control sicklepod. Because of crop injury, metribuzin is not recommended for use on light textured soils which are low in organic matter (5,8). Wilcox and Currey

(43) reported tank mixes of alachlor (2-chloro-2',6'-diethyl-N-(methoxymethyl)acetanilide) plus metribuzin at 2.2 + 0.42 kg/ha gave excellent results.

Alachlor is marketed as "Lasso" by Monsanto Chemical Company. It is a preemergence herbicide commonly used to control annual grasses and certain broadleaf weeds in soybeans (4). Lunsford (31) reported sicklepod control of 30% when alachlor was used at either 2.2 kg/ha or 3.4 kg/ha. He found that when alachlor was combined with naptalam (N-1-napthylpthalamic acid) and dinoseb (2-sec-butyl-4,6-dinitrophenol) better results were obtained. A mixture of naptalam and dinoseb is marketed as "Dyanap" by Uniroyal. Andrews et al. (2) in 1970 conducted 25 herbicide trials in 7 states and found that alachlor at 4.5 kg/ha controlled sicklepod in soybeans. Several authors (1,19,20,21,36) have reported improved sicklepod control with alachlor combined with other herbicides.

Often the use of preplant incorporated or preemergence herbicides is not adequate for season-long control; therefore a postemergence herbicide is required. There are two basic types of postemergence herbicides: (1) those which can be sprayed over-the-top of the crop, and (2) those which due to soybean injury potential must be applied as a spray directed to the base of the plant.

Toxaphene (chlorinated camphene containing 67-69% chlorine) which is marketed as "Attac 6" or "Attac 8" by Boots Hercules Chemical Company is an insecticide. It has been reported to exhibit herbicidal properties on young sicklepod (3,36,44). Lunsford (32,33) summarized several experiments using toxaphene on sicklepod and concluded that the best stage to apply toxaphene was when sicklepod plants were in the cotyledon or unifoliolate leaf stage. Control decreased after sicklepod plants reached the first trifoliolate stage. If applied at the unifoliolate stage, control ranged from 65% when toxaphene was applied one time and up to 95% when it was applied as split applications 7 to 10 days apart. French et al. (22) reported that the addition of an adjuvant greatly increased the activity of toxaphene. Toxaphene at 2.2 kg/ha + oil concentrate provided the same control as the 4.5 kg/ha rate alone.

Acifluorfen (5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-nitrobenzoic acid) marketed as "Blazer" by Rohm and Haas is sprayed over-the-top of soybeans for postemergence control of many broadleaf weeds (33). French et al. (22) and Lunsford et al. (33) reported that acifluorfen at the 1.12 kg/ha rate applied only once gave 50% control of sicklepod. When acifluorfen was sprayed as a split application, 7 to 10 days apart, it gave 90% control. They also noted, however, that injury to soybeans was excessive with the split application acifluorfen treatments.

Paraquat (1,1'-dimethyl-4,4'-bipyridinium ion) is marketed by Chevron Chemical Company as a nonselective herbicide. It is labeled for use in soybeans as a post-directed spray when the soybeans are at least 20 cm. tall. Oliver et al. (36) reported that paraquat applied to sicklepod in soybeans at the V4 and V6 stages of growth controlled 89% of the sicklepod with no soybean yield reduction. Buchanan et al. (15) noted that paraquat effectively controlled sicklepod, but they also noted that there was some soybean injury.

According to the label for linuron (6), effective control of sicklepod can be achieved if it is tank mixed with 2,4-DB (4-(2,4-dichlorophenoxy) butyric acid). The label states that this tank mix should be applied when the soybeans are at least 20 cm. tall and when weeds do not exceed 10 cm. in height. Linuron is marketed by E. I. Dupont de Nemours and Company as "Lorox", and 2,4-DB is marketed by Union Carbide Agricultural Products Company as "Butyrac 200" and by Rhone-Poulenc Chemical Company as "Butoxone."

Cultivation can be a very effective means to control sicklepod with reports of control as high as 85 to 93% (34). Hauser et al. (24) found that in Georgia, cultivation alone gave control as high as 90%.

The use of either a preemergence herbicide or a postemergence herbicide alone will not give adequate control of sicklepod. Many authors (15,22,36) have shown a systems approach using an effective preemergence herbicide treatment followed by a later postemergence treatment to be the most promising method for the control of sicklepod in soybeans.

CHAPTER III

MATERIALS AND METHODS

This study was conducted to determine: (1) a systematic approach to selectively control sicklepod utilizing preplant incorporated, preemergence, and postemergence applications of appropriate herbicides, (2) the competition effects involving removal of sicklepod plants at different times during the soybean growing season, and (3) production costs and net dollar return for each herbicide system.

The study was conducted at two locations in the state of Tennessee, i.e., the Plant Science Field Laboratory at Knoxville, and a farm located near Benton in Polk County.

The study was initiated in 1980 at Knoxville on May 28, and at Benton on June 30.

The field experiment at Knoxville was established on an Emory silt loam. Fertilizer was applied at the rate of 160 kg/ha of 6-12-12. The field experiment at Benton was established on Decatur silty clay loam. Fertilizer was applied at the rate of 65 kg/ha muriate of potash.

At both locations the seedbed was prepared by plowing in the spring, followed by disk incorporation of fertilizer. The seedbed was then smoothed with a drag-harrow and planted.

Sicklepod was overseeded at Knoxville in January of 1980. The sicklepod population at Benton consisted of the existing natural population.

Herbicide Systems Study

The experimental design at both locations was a randomized complete block design with three replications. At Knoxville 21 herbicide treatments were included (Table 1), and at Benton 15 treatments were included (Table 2). Planting date, herbicide application dates, cultivar used, plot size, and row width for both locations are given in Table 3.

Visual ratings of percent sicklepod control were made on July 2 and August 1 at Knoxville, and on July 22, July 30, and August 13 at Benton. A rating of 0% denotes no sicklepod control while a rating of 100% denotes complete sicklepod control. In Chapter IV sicklepod control will be discussed using the following scale:

excellent control	= 90% - 100%
good control	= 75% - 89%
fair control	= 60% - 74%
poor control	= 0% - 59%

Sicklepod and other weeds were removed by hand hoeing in the weed free treatment. Yield data was obtained by hand-harvesting a 4.7 m and a 4.0 m section from the center row in each plot at Benton and Knoxville, respectively. Harvest dates were November 4 at Benton and November 7 at Knoxville. Soybeans were threshed with an "Almaco Plot Thresher," weighed to determine yield.

Economic Analysis of Sicklepod Control Systems

After the field data were obtained and soybeans were harvested, the yields, costs, and returns were projected. The estimated production

TABLE 1. Treatments Used in the Sicklepod Control Experiment at Knoxville, Tennessee, 1980.

Treatment	Rate (kg/ha)	Crop* Stage
Metribuzin	0.6	PRE
Linuron + 2,4-DB**	0.6 + 0.2	POD
Metribuzin	0.6	PRE
Paraquat**	0.1	POD
Metribuzin	0.6	PRE
Acifluorfen	0.6	POD
Metribuzin	0.6	PPI
Toxaphene***	2.2	COTY
Metribuzin	0.4	PPI
Metribuzin	0.3	PRE
Linuron + 2,4-DB**	0.6 + 0.2	POD
Metribuzin	0.4	PPI
Metribuzin	0.3	PRE
Paraquat**	0.1	POD
Vernolate	3.4	PPI
Linuron + 2,4-DB**	0.6 + 0.2	POD
Vernolate	3.4	PPI
Paraquat**	0.1	POD
Vernolate + Metribuzin	3.4 + 0.3	PPI
Linuron + 2,4-DB**	0.6 + 0.2	POD
Vernolate + Metribuzin	3.4 + 0.3	PPI
Paraquat**	0.1	POD
Metribuzin	0.6	PRE
Alachlor + Metribuzin	2.2 + 0.6	PRE
Linuron + 2,4-DB**	0.6 + 0.2	POD
Alachlor + Metribuzin	2.2 + 0.6	PRE
Paraquat **	0.1	POD
Metolachlor + Metribuzin	2.2 + 0.6	PRE
Linuron + 2,4-DB**	0.6 + 0.2	POD

TABLE 1 (Continued)

Treatment	Rate (kg/ha)	Crop* Stage
Alachlor + Naptalam + Dinoseb	2.2 + 1.7 + 3.4	PRE
Linuron + 2,4-DB**	0.6 + 0.2	POD
Alachlor + Naptalam + Dinoseb	2.2 + 1.7 + 3.4	PRE
Paraquat**	0.1	POD
Alachlor + Metribuzin	2.2 + 0.6	PRE
Toxaphene ***	2.2	COTY
Acifluorfen	0.6	COTY
Toxaphene***	2.2	COTY
Cultivation	----	----
Untreated Check	----	----

*Crop stage abbreviations are as follows:
PRE = preemergence
POD = postemergence directed
COTY = Cotyledon stage.

**Ortho X-77 surfactant added (.5% V/V)

***AtPlus oil concentrate added (.5% V/V)

TABLE 2. Treatments Used in the Sicklepod Control Experiment at Benton, Tennessee, 1980.

Treatment	Rate (kg/ha)	Crop* Stage
Metribuzin	0.6	PRE
Linuron + 2,4-DB**	0.6 + 0.2	POD
Metribuzin	0.6	PRE
Paraquat**	0.1	POD
Metribuzin	0.6	PRE
Acifluorfen	0.6	COTY
Metribuzin	0.6	PRE
Toxaphene***	2.2	COTY
Metribuzin	0.6	PRE
Alachlor + Metribuzin	2.2 + 0.6	PRE
Linuron + 2,4-DB**	0.6 + 0.2	POD
Alachlor + Metribuzin	2.2 + 0.6	PRE
Paraquat**	0.1	POD
Metolachlor + Metribuzin	2.2 + 0.6	PRE
Linuron + 2,4-DB**	0.6 + 0.2	POD
Alachlor + Naptalam + Dinoseb	2.2 + 1.7 + 3.4	PRE
Linuron + 2,4-DB**	0.6 + 0.2	POD
Alachlor + Naptalam + Dinoseb	2.2 + 1.7 + 3.4	PRE
Paraquat**	0.1	POD
Alachlor + Metribuzin	2.2 + 0.6	PRE
Toxaphene***	2.2	COTY
Acifluorfen	0.6	COTY
Toxaphene***	2.2	COTY
Cultivation	----	----
Untreated Check	----	----

*Crop stage abbreviations are as follows: as follows:

PRE = preemergence
POD = postemergence directed
COTY = Cotyledon stage

**Ortho X-77 surfactant added (.5% V/V)

***AtPlus oil concentrate added (.5% V/V)

TABLE 3. Conditions existing for experiments conducted in 1980.

	Knoxville		Benton	
	Herbicide Systems Study	Competition Study	Herbicide Systems Study	Competition Study
Planting Date	May 28	May 28	June 30	June 30
Herbicide Application Dates:				
Preplant Incorporated	May 28	----	----	----
Preemergence	May 28	----	July 1	----
Cotyledon	June 19	----	July 15,22	----
Postemergence Directed	July 18	----	August 6	----
Cultivar	Essex	Essex	Essex	Essex
Plot Size	2.7m(3 rows) x 4.5m	2.7m(3 rows) x 4.5m	2.7m (3 rows) x 9.1m	2.7m(3 rows) x 9.1m
Spray Volume--l/ha (gpa)	187 (20)	----	187 (20)	----
Spray Pressure--kg/cm^2 (PSi)	2.1 (30)	----	2.1 (30)	----
Row Width (cm.)	91	91	91	91

*Toxaphene applied as a split application.

costs for the economic study were determined using the "Farm Planning Manual" published by the Agricultural Extension Service of the University of Tennessee (37). Herbicide prices were obtained from commercial sources. The fixed, variable, and total costs, and interest cost per hour for selected machinery items used for herbicide applications in soybeans are presented in Table 4. These costs are based on new cost, estimated annual use rate, and a charge for repairs. Depreciation, storage, and insurance make up the fixed costs. Variable costs for machinery without engines consists only of repairs. Variable costs for machinery with engines include fuel and lubrication costs in addition to repair costs.

Estimated costs for seed and fertilizer inputs are presented in Table 5. The cost of one herbicide application and for one herbicide incorporation are presented in Tables 6 and 7. Herbicide prices per hectare and application costs per hectare for each treatment are given in Table 8. Total production cost less weed control is given in Table 9. Gross returns were obtained by multiplying soybean yield by $7.00 per 27 kg (1 bu).

Competition Study

The experimental design at both locations was a randomized complete block with three replications. At both locations the experiment consisted of 11 treatments (Table 10). Planting date, cultivar used, plot size, and row width for both locations are given in Table 3.

At both locations alachlor was applied preemergence for grass control at the rate of 2.2 kg/ha at planting. The herbicide was applied

TABLE 4. Estimated Machinery Fixed and Variable Costs for an Estimated Annual Use on a Per Hour Basis, Plus Machine and Labor Time Requirements per Hectare for Conventional-Tillage Soybeans.*

Machine	Annual fixed cost, $	Estimated hrs/yr.	Fixed costs per hr.	Variable costs $ per hr.	Total costs $ per hr.	Interest cost $ per hr.	Hours/Hectare	
							Machine	Labor
Fertilizer spreader, (3m)	226	60	3.77	.71	4.48	1.11	1.0	1.2
Planter, (4 row)	741	70	10.58	3.90	14.48	5.12	.7	.9
Herbicide Sprayer (with boom)	73	40	1.83	.97	2.80	.68	.5	.6
Tractor, 100 PTO	2854	600	4.76	8.94	13.70	2.36	----	----
Tractor, 60 PTO	1463	600	2.44	5.26	7.70	1.20	----	----
Plow, (7-36 cm)	173	100	1.73	.94	2.67	.83	1.8	2.3
Mounted Tandem Disk 4m	325	70	4.65	1.64	6.29	2.15	.5	.6
Wheeled Harrow, (3m)	78	70	1.12	.31	1.43	.54	.6	.7
Cultipacker, (3m)	329	40	8.23	2.26	10.49	3.96	.7	.9
Truck, 2 MT w/hoist	1741	300	5.80	12.14	17.94	2.83	.8	1.0
Combine (4m S.P.)	4401	175	25.15	16.20	41.34	10.10	.8	1.0

*Adapted from "Farm Planning Manual" (37).

TABLE 5. Estimated Expenses of Seed and Fertilizer Inputs for Soybean Production per Hectare in a Conventional Tillage System.*

Item	Description	Unit	Quantity	$ Price/Unit	$ Total
Soybean	Seed	kg.	44.8	0.33	14.78
Inoculation	Rhizobium japonicum	pkg.	0.8	0.50	0.40
Fertilizer	P_2O_5	kg.	44.8	0.48	21.50
Fertilizer	K_2O	kg.	44.8	0.33	14.78
Lime	2.7 M.T./4 yrs.	M.T.	0.7	11.57	8.10
Total					59.56

*Adapted from "Farm Planning Manual" (37).

TABLE 6. Total Cost of One Herbicide Spraying per Hectare.*

Item	Description	Unit	Quantity	Price (Dollars)	Amount (Dollars)
Variable Expenses					
Sprayer	with Boom	hr.	0.5	0.97	0.49
Tractor	60 PTO-HP	hr.	0.5	5.26	2.63
				Total	3.12
Fixed Expenses					
Sprayer	with Boom	hr.	0.5	1.83	0.92
Tractor	60 PTO-HP	hr.	0.5	2.44	1.22
				Total	2.14
Interest					
Operational Capital	6mo.@12%	ha.	1.0	0.18	0.18
Fixed Capital	12mo.@7½%	ha.	1.0	0.65	0.92
				Total	1.10
Labor					
------------------------------		hr.	0.6	3.50	2.10
				Total	2.10
		Total Cost of One Spraying			8.46

*Adapted from "Farm Planning Manual" (37).

TABLE 7. Total Cost of One Herbicide Incorporation per Hectare.*

Item	Description	Unit	Quantity	Price (Dollars)	Amount (Dollars)
Variable Expenses					
Tandem Disk	4m wheeled	hr.	0.5	1.64	0.82
Tractor	100 PTO-HP	hr.	0.5	8.94	4.47
				Total	5.29
Fixed Expenses					
Tandem Disk	4m wheeled	hr.	0.5	4.65	2.33
Tractor	100 PTO-HP	hr.	0.5	4.76	2.38
				Total	4.71
Interest					
Operational Capital	6mo.@12%	ha.	1.0	0.32	0.32
Fixed Capital	12mo.@7½%	ha.	1.0	2.21	2.21
				Total	2.53
Labor					
------------------------------		hr.	0.6	3.50	2.10
				Total	2.10
Total Cost of One Herbicide Incorporation					14.63

*Adapted from "Farm Planning Manual" (37).

TABLE 8. Total Herbicide Costs in Dollars per Hectare at Knoxville and Benton, Tennessee, 1980.

Treatment	Herbicide Cost $/ha	Application Cost $/ha	Total
Acifluorfen	46.33	8.46	54.79
Metribuzin	23.69	8.46	32.15
Metribuzin, Acifluorfen	70.02	16.92	86.94
Metribuzin + Alachlor, Linuron + 2,4-DB + Surfactant	65.88	16.92	82.80
Metribuzin + Alachlor, Paraquat + Surfactant	56.63	16.92	73.55
Metribuzin + Alachlor, Toxaphene + Oil Concentrate	53.62	16.92	70.54
Metribuzin + Alachlor, Toxaphene + Oil Concentrate*	59.75	25.38	85.13
Metribuzin, Linuron + 2,4-DB + Surfactant	42.08	16.92	59.00
Metribuzin + Metolachlor, Linuron + 2,4-DB + Surfactant	70.74	16.92	87.66
Metribuzin, Metribuzin, Linuron + 2,4-DB + Surfactant	48.24	31.55	79.79
Metribuzin, Metribuzin, Paraquat + Surfactant	38.99	31.55	70.54
Metribuzin, Toxaphene + Paraquat + Surfactant	32.83	16.92	49.75
Metribuzin, Toxaphene + Oil Concentrate	29.82	16.92	46.74
Metribuzin, Toxaphene + Oil Concentrate*	35.95	25.38	61.33
Metribuzin + Vernolate, Linuron + 2,4-DB + Surfactant	55.24	23.09	78.33

TABLE 8 (Continued)

Treatment	Herbicide Cost $/ha	Application Cost $/ha	Total
Metribuzin + Vernolate, Paraquat + Surfactant	45.99	23.09	69.08
Naptalam + Dinoseb + Alachlor, Linuron + 2,4-DB + Surfactant	88.05	16.92	104.97
Naptalam + Dinoseb + Alachlor, Paraquat + Surfactant	78.80	16.92	95.72
Toxaphene + Oil Concentrate	6.13	8.46	14.59
Toxaphene + Oil Concentrate*	12.26	16.92	29.18
Vernolate, Linuron + 2,4-DB + Surfactant	43.39	23.09	66.48
Vernolate, Paraquat	34.14	23.09	57.23

*Two applications of Toxaphene, 7 days apart, at Benton.

TABLE 9. Components of Soybean Production Costs per Hectare Under Conventional Tillage Excluding Weed Control Operations.*

Item	Description	Unit	Quantity	Price ($)	Amount ($)
Variable Expenses					
Soybean Seed	----	kg.	44.8	0.33	14.78
Inoculation	Rhizobium japonicum	pkg.	0.8	0.50	0.40
Fertilizer	P_2O_5	kg.	44.8	0.48	21.50
Fertilizer	K_2O	kg.	44.8	0.33	14.78
Lime	2.7 M.T./4 yrs.	M.T.	0.7	11.57	8.10
Tractor	60 PTO-HP	hr.	1.5	5.26	7.89
	100 PTO-HP	hr.	3.6	8.94	32.18
Truck	2 M.T.	hr.	0.8	12.14	9.71
Combine	4m S.P.**	hr.	0.8	16.20	12.96
				Total	122.30
Fixed Expenses					
Tractor	60 PTO-HP	hr.	1.5	2.44	3.66
	100 PTO-HP	hr.	3.6	4.76	17.14
Truck	2 M.T.	hr.	0.8	5.80	4.64
Combine	4m S.P.**	hr.	0.8	25.15	20.12
				Total	45.56
Interest					
Operational Capital	6mo.@12%	ha.	1	8.25	8.24
Fixed Capital	12mo.@7.5%	ha.	1	23.04	23.04
				Total	31.28
Labor					
----------------------------		hr.	8.7	3.50	30.45
				Total	30.45
		Total Production Cost			219.59

*Adapted from "Farm Planning Manual" (37).

**S.P. means "self-propelled."

TABLE 10. Treatments Used in Competition Experiments at Benton and Knoxville, Tennessee, 1980.

Treatment	Weeding Weeks after Planting 2	4	6	8	12	16
Weed Free for full season	X	X	X	X	X	X
Hand-hoeing	X	X		X		
Hand-hoeing (weed free 4-6 weeks)		X	X			
Hand-hoeing (weed free 8 weeks)	X	X	X	X		
Hand-hoeing (weed free 6 weeks)	X	X	X			
Hand-hoeing (weed free 4 weeks)	X	X				
Hand-hoeing (weed free 2 weeks)	X					
Hand-hoeing (competition 2 weeks)		X	X	X		
Hand-hoeing (competition 4 weeks)			X	X		
Hand-hoeing (competition 6 weeks)				X		
No Weeding-Full Season Competition						

at 187 l/ha at 2.1 kg/cm^2 (20 gpa at 30 psi) using a hand held sprayer with CO_2 as a pressure source.

Hand-hoeing was the method used to remove sicklepod plants from specified treatments in the competition study.

Sicklepod populations at the end of the season were determined by counting the plants per 4.9 m of row in Knoxville on both sides of the center row. Counts were made November 4 at Benton and on November 7 at Knoxville. Yield data was obtained by the same procedure as used in the herbicide systems study.

CHAPTER IV

RESULTS AND DISCUSSION

The results will be divided into sections dealing with weed control systems, economic analyses, and competition. Each of these sections will be subdivided by location.

I. Weed Control Systems

A. Knoxville

Preplant incorporated and preemergence herbicides

Metribuzin + vernolate (Tmts. 13, 14) applied preplant incorporated was the only treatment showing excellent control of sicklepod (Table 11). Tank mixes of metribuzin + alachlor (Tmts. 4, 5, 6) and metribuzin + metolachlor (Tmt. 8) showed good sicklepod control. Since metribuzin (Tmts. 2, 7, 11) used alone gave fair to good control of sicklepod and vernolate (Tmts. 18, 19) showed good control, the above treatments suggest a synergistic action in the control of sicklepod. Metribuzin applied preplant incorporated followed by metribuzin applied preemergence (Tmts. 9, 10) gave fair control of sicklepod (Table 11). Naptalam + dinoseb + alachlor applied as a preemergence tank mix (Tmts. 15, 16) exhibited good control (Table 11).

Generally, the preplant incorporated herbicides were more effective in controlling sicklepod than were the preemergence herbicides. Both herbicides were applied on May 28. No precipitation was recorded for 20 days (Table A-1, Appendix) until June 17; therefore, the preemergence herbicides probably were not activated, whereas, the preplant

TABL

Trea No	Sipo % Control* **, PRE** and tyledon** 7/2	Total System 8/1	Soybean Yield* (kg/ha)
1	38f	0h	549b
2	85ab	32g	954efgh
3	88ab	63def	1416bcde
4	82abcd	92ab	1971ab
5	87ab	90ab	1485bcde
6	85ab	53f	1104defgh
7	78abcde	88ab	1638abcd
8	78abcd	94ab	1806abc
9	60de	88ab	1386cde
10	85ab	67de	1848abc
11	61cde	68bc	798fgh
12	83abc	62ef	1506bcde
1[illegible]	97a	99a	1761abc
14	92ab	82bc	1596bcd
1[illegible]	80abcde	88ab	1998ab
1[illegible]	58c	75cd	1302cdef
1[illegible]	78abcde	0h	672h
1[illegible]	83abc	93ab	1584bcd
1[illegible]	72bcde	73cde	1332cdef
2[illegible]	100a	100a	2202a
2	0g	0h	756gh

e Test.

ected.

incorporated herbicides were. This could account for the observed differences in the effectiveness of control.

Topical Postemergence Herbicides

Toxaphene and acifluorfen were applied when sicklepod plants were in the cotyledon stage of growth. Toxaphene (Tmt. 17) exhibited good sicklepod control while acifluorfen (Tmt. 1) showed poor control (Table 11).

Toxaphene and acifluorfen were also applied following a preemergence application of metribuzin. Metribuzin alone (Tmt. 2) gave good control of sicklepod. Where toxaphene followed metribuzin (Tmt. 12), sicklepod control was increased 5% over toxaphene (Tmt. 17) applied alone (Table 11). Where acifluorfen followed metribuzin (Tmt. 3), sicklepod control was 50% greater than when acifluorfen (Tmt. 1) was applied alone (Table 11).

Six weeks after application of acifluorfen (Tmt. 1) and toxaphene (Tmt. 17) treatments, sicklepod control had decreased from 38% to 0% and 78% to 0%, respectively. Where toxaphene followed metribuzin (Tmt. 12), sicklepod control fell from 83% to 62% and where it followed alachlor + metribuzin (Tmt. 6) control fell from 85% to 53%. Where acifluorfen followed metribuzin (Tmt. 3), control fell from 88% to 63% (Table 11) during the six week period.

Directed Postemergence Herbicides

Herbicide systems containing a tank mix of linuron + 2,4-DB applied post-directed gave 88 to 99% control of sicklepod (Table 11). Systems giving excellent control were: (1) preplant incorporated or preemergence treatments of vernolate + metribuzin (Tmt. 13), (2) metolachlor + metribuzin (Tmt. 8), (3) vernolate (Tmt. 18), and (4) alachlor + metribuzin (Tmt. 4), all followed by linuron + 2,4-DB. Systems giving good control, also followed by linuron + 2,4-DB were: (1) metribuzin (Tmt. 7), (2) alachlor + naptalam + dinoseb (Tmt. 15), and (3) metribuzin + metribuzin (Tmt. 9).

Herbicide systems containing paraquat applied post-directed gave sicklepod control ranging from 67 to 90% (Table 11). Only alachlor + metribuzin applied preemergence followed by paraquat (Tmt. 5) gave excellent sicklepod control, while vernolate + metribuzin and alachlor + naptalam + dinoseb followed by paraquat (Tmts. 14, 16) gave good control. Fair sicklepod control was obtained by using vernolate (Tmt. 19), metribuzin (Tmt. 11), and metribuzin + metribuzin (Tmt. 10) all followed by paraquat. Paraquat caused slight burn on lower leaves of soybeans in some plots, but no vigor reduction was noted.

In order for a post-directed herbicide to be most effective in soybeans a height difference must exist between the crop and the particular weed you are trying to control. In the previously mentioned systems, the better preemergence treatments suppressed the sicklepod allowing the soybeans to grow taller resulting in more effective control from the post-directed herbicide treatments.

Soybean Yield

Yield ranged from 549 kg/ha to 2202 kg/ha (Table 11). The weed free check had the highest yield at 2202 kg/ha, while the weedy check had a yield of only 756 kg/ha. Lowest yields were from plots receiving toxaphene and acifluorfen treatments. Where toxaphene and acifluorfen followed preemergence treatments, yields were higher (Table 11). Soybean yield was lower where metribuzin was used alone, and higher where metribuzin was tank mixed with vernolate or followed by a post-directed spray. Generally, where better sicklepod control was obtained, soybean yields were higher.

Soybean yields were generally low possibly due to low rainfall (Table A-1, Appendix) throughout the season and shatter at harvest.

B. Benton

Preemergence Herbicides

Metolachlor + metribuzin (Tmt. 8) gave excellent control of sicklepod, while alachlor + metribuzin (Tmts. 4, 5) gave good sicklepod control (Table 12). Metribuzin (Tmts. 2, 7, 9) used alone gave only fair-to-poor sicklepod control. Alachlor + naptalam + dinoseb gave good control in one treatment (Tmt. 11) and poor control (Tmt. 12) in another. As at Knoxville, drought occurred after application of the preemergence herbicides and only .25 cm. of rain fell in the first 22 days (Table A-2, Appendix) which was inadequate to activate these herbicides, thereby reducing their effectiveness.

Topical Postemergence Herbicides

Unlike the Knoxville study, at the Benton study toxaphene was used in split applications 7 days apart. After the first application, toxaphene (Tmt. 13) gave 58% control of sicklepod. The second application only increased control to 65% (Table 12). A late season rating showed control of sicklepod by toxaphene had fallen to 37%, which resulted from delayed sicklepod germination.

TABLE

Treat No	Sipo % Control* PRE** and Cotyledon 7/22	Sipo % Control* Total System 8/13	Soybean Yield* (kg/ha)
1	65bc	30c	726bcde
2	63bc	47c	629de
3	89ab	47c	104abcd
4	77abc	100a	1131abcd
[illegible]	73abc	100a	1099abcd
[illegible]	98a	92ab	818bcde
[illegible]	63bc	100a	1226ab
[illegible]	95a	100a	1447a
[illegible]	52c	100a	1164abc
1	90ab	75b	1037abcd
1	78abc	100a	1258ab
1	58c	100a	1037abcd
1	58c	37c	662cde
1	100a	100a	1258ab
1	0d	0d	454e

le Range Test.

Like toxaphene, acifluorfen (Tmt. 1) gave fair sicklepod control, and poor late season control dropped to 30% by late rating (Table 12).

As in the Knoxville study, when toxaphene and acifluorfen followed a preemergence treatment of metribuzin, control of sicklepod was increased (Table 12). Toxaphene applied following alachlor + metribuzin (Tmt. 6) or metribuzin (Tmt. 10) alone gave excellent sicklepod control. Acifluorfen following metribuzin (Tmt. 3) gave good sicklepod control. In both cases use of toxaphene and acifluorfen was more effective if sicklepod plants were in the cotyledonary stage of growth.

Directed Postemergence Herbicides

Excellent sicklepod control was achieved with all herbicide systems containing paraquat (Table 12). Some burning of lower leaves on the soybeans was noted, but no vigor reduction was observed.

All herbicide systems containing a tank mix of linuron + 2,4-DB gave excellent control of sicklepod. These treatments were very effective because an adequate height differential of soybeans over sicklepod existed.

Soybean Yield

Yields ranged from 454 kg/ha to 1447 kg/ha (Table 12). The system producing the highest yield was metolachlor + metribuzin applied preemergence followed by linuron + 2,4-DB postemergence directed (Tmt. 8). The lowest yielding treatment was the weedy check (Tmt. 15). Other low yielding treatments were those where only one herbicide was applied such as acifluorfen (Tmt. 1), toxaphene (Tmt. 13), and metribuzin (Tmt. 2). Where good sicklepod control was obtained, higher soybean yields generally resulted.

Yields were low due to low rainfall (Table A-2, Appendix) throughout the growing season and soybean pod shattering at harvest.

II. Economic Analyses

A. Knoxville

Highest net returns at Knoxville (Table 13) came from plot treated with metribuzin + alachlor followed by linuron + 2,4-DB at $208.61 per hectare. Other treatments giving high net returns were naptalam + dinoseb + alachlor followed by linuron + 2,4-DB, metribuzin + vernolate followed by linuron + 2,4-DB, and metribuzin + metolachlor followed by linuron + 2,4-DB.

The largest net loss (Table 13) came from the system of acifluorfen used alone at -$132.38. Other systems giving losses were metribuzin and toxaphene, each used alone.

Generally, where better sicklepod control was obtained resulting in higher soybean yield, higher net return resulted.

B. Benton

Highest net return at Benton (Table 14) came from plots treated with metribuzin + metolachlor followed by linuron + 2,4-DB at $67.65 per hectare. Other treatments giving high net returns were naptalam + dinoseb + alachlor followed by linuron + 2,4-DB and metribuzin followed by linuron + 2,4-DB.

The largest net loss (Table 14) came from the system of metribuzin + alachlor followed by toxaphene at -$92.72. Other systems resulting in losses were metribuzin, acifluorfen, and toxaphene, each used alone.

TABLE 13. Soybean Yields, Cost and Returns for Various Sicklepod Control Systems in Soybeans Grown at Knoxville, Tennessee 1980.

Herbicide Treatment and Stage of Application			Soybean* Yield	Costs $/ha		Returns $/ha	
PPI or Pre**	Cotyledon	POD**	(kg/ha)	Weed Control	Production	Gross	Net
-------	Acifluorfen	-------	549 h	46.33	228.05	142	-132.38
Metribuzin	-------	-------	954 dfgh	23.69	228.05	247	- 4.74
Metribuzin	Acifluorfen	-------	1416 bcde	70.02	236.51	367	60.47
Metribuzin + Alachlor	-------	Linuron + 2,4-DB	1971 ab	65.88	236.51	511	208.61
Metribuzin + Alachlor	-------	Paraquat	1485 bcde	56.63	236.51	385	91.86
Metribuzin + Alachlor	Toxaphene	-------	1104 defgh	53.62	236.51	286	- 4.13
Metribuzin	-------	Linuron + 2,4-DB	1638 abcd	42.08	236.51	425	146.41
Metribuzin + Metolachlor	-------	Linuron + 2,4-DB	1806 abc	70.74	236.51	468	160.75
Metribuzin + Metribuzin	-------	Linuron + 2,4-DB	1386 cde	48.24	251.14	359	59.62
Metribuzin + Metribuzin	-------	Paraquat	1848 abc	38.99	251.14	479	188.87
Metribuzin	-------	Paraquat	798 fgh	32.83	236.51	207	- 62.34
Metribuzin	Toxaphene	-------	1506 bcde	29.82	236.51	390	123.67
Metribuzin + Vernolate	-------	Linuron + 2,4-DB	1761 abc	55.24	242.68	457	159.08
Metribuzin + Vernolate	-------	Paraquat	1596 bcd	45.99	242.68	414	125.33
Naptalam + Dinoseb + Alachlor	-------	Linuron + 2,4-DB	1998 a	88.05	236.51	518	193.44
Naptalam + Dinoseb + Alachlor	-------	Paraquat	1302 cdef	78.80	236.51	338	22.69
-------	Toxaphene	-------	672 h	6.13	228.05	174	- 60.18
Vernolate	-------	Linuron + 2,4-DB	1584 bcd	43.39	242.68	411	124.93
Vernolate	-------	Paraquat	1332 cdef	34.14	242.68	345	68.18
Weedy Check	-------	-------	756 gh	-----	219.59	196	- 23.59

*Values within a column followed by the same letter are not significantly different at the 5% level, according to Duncan's Multiple Range Test.

**Herbicide stage of application abbreviations are as follows:

PPI = preplant incorporated
PRE = preemergence
POD = postemergence directed

TABLE 14. Soybean Yields, Costs and Returns for Various Sicklepod Control Systems in Soybeans Grown at Benton, Tennessee, 1980.

Herbicide Treatment & Stage Application			Soybean* Yield	Cost $/ha		Returns $/ha	
PRE**	Cotyledon	POD**	(kg/ha)	Weed Control	Produc-tion	Gross	Net
-------	Acifluorfen	-------	726 bcde	46.33	228.05	188	- 86.38
Metribuzin	-------	-------	629 de	23.69	228.05	163	- 88.74
Metribuzin	Acifluorfen	-------	1004 abcd	70.02	236.51	260	- 46.53
Metribuzin + Alachlor	-------	Linuron + 2,4-DB	1131 abcd	65.88	236.51	293	- 9.39
Metribuzin + Alachlor	-------	Paraquat	1099 abcd	56.63	236.51	285	- 8.14
Metribuzin + Alachlor	Toxaphene	-------	818 bcde	59.75***	244.97	212	- 92.72
Metribuzin	-------	Linuron + 2,4-DB	1226 ab	42.08	236.51	318	39.41
Metribuzin + Metolachlor	-------	Linuron + 2,4-DB	1447 a	70.74	236.51	375	67.75
Metribuzin	-------	Paraquat	1164 abc	32.83	236.51	302	32.66
Metribuzin	Toxaphene	-------	1037 abcd	35.95***	244.97	269	- 11.92
Naptalam + Dinoseb + Alachlor	-------	Linuron + 2,4-DB	1258 ab	88.05	236.51	326	1.44
Naptalam + Dinoseb + Alachlor	-------	Paraquat	1037 abcd	78.80	236.51	269	- 46.31
-------	Toxaphene	-------	662 cde	12.26***	236.51	172	- 76.77
Weedy Check	-------	-------	454 e	-------	219.59	118	-101.59

*Values within a column followed by the same letter are not significantly different at the 5% level, according to Duncan's Multiple Range Test.

**Herbicide stage of application abbreviations are as follows:
PRE = preemergence
POD = postemergence directed

***Two applications of Toxaphene, 7 days apart, were made.

As at Knoxville, generally where better sicklepod control was obtained, higher net returns resulted.

III. Competition Study

A. Benton

Treatments where sicklepod was allowed to compete with soybeans for 2, 4, and 6 weeks after planting and were then removed by hand hoeing showed no significant differences among soybean yields at any of the three intervals. A trend was noted, however, which indicated soybean yields decreased as the time before sicklepod removal increased (Table 15). Treatments maintained sicklepod-free for up to 8 weeks after planting showed a trend in that the longer soybeans were kept sicklepod free, the higher was soybean yield, although none of the removal intervals were significantly different from each other as to yield.

Full season sicklepod competition gave the lowest soybean yield of all treatments even though it was not significantly different from some other treatments (Table 15).

Sicklepod stand counts are given in Table 15. Even though sicklepod stand varied throughout the season, stand counts made at harvest followed a trend that higher counts of sicklepod were noted in those treatments showing lowest soybean yields.

B. Knoxville

No data are included from this location. Low rainfall (Table A-1, Appendix) throughout the growing season resulted in an erratic stand of sicklepod giving widely varying results.

TABLE 15. Soybean Yield and Sicklepod Stand Count in the Soybean Vs. Sicklepod Competition Study at Benton, Tennessee, 1980.

Treatment	Dates of Weeding Weeks after Planting						SiPo Stand Count* (plts./plot)	Soybean* Yield (kg/ha)
	2	4	6	8	12	16		
Weed Free for full season	X	X	X	X	X	X	0 e	1571 ab
Hand-hoeing	X	X		X			3 e	1131 ab
Hand-hoeing (weed free 4-6 weeks)		X	X				44 cd	1447 ab
Hand-hoeing (weed free 8 weeks)	X	X	X	X			0 e	1604 ab
Hand-hoeing (weed free 6 weeks	X	X	X				58 c	1636 a
Hand-hoeing (weed free 4 weeks)	X	X					55 c	1698 a
Hand-hoeing (weed free 2 weeks)	X						124 b	1007 ab
Hand-hoeing (competition 2 weeks)		X	X	X			0 e	1571 ab
Hand-hoeing (competition 4 weeks)			X	X			4 e	1477 ab
Hand-hoeing (competition 6 weeks)				X			36 d	1037 ab
No weeding--Full Season Competition							185 a	913 b

*Values in columns followed by the same letter are not significantly different at the 5% level, according to Duncan's Multiple Range Test.

CHAPTER V

SUMMARY AND CONCLUSIONS

Field studies were conducted at Knoxville and Benton to evaluate various herbicide systems involving preplant incorporated, preemergence, and postemergence herbicides, for the control of sicklepod in soybeans, and to determine the magnitude of sicklepod competition on soybean growth and yield by removing sicklepod plants at different times throughout the soybean growing season. An economic analysis was conducted to determine production costs and net dollar returns for each herbicide system.

Ratings taken for percent control of sicklepod showed that at both locations metribuzin plus vernolate applied preplant incorporated followed by linuron + 2,4-DB applied post-directed gave excellent control of sicklepod. Metribuzin plus either metolachlor or alachlor applied preemergence followed by linuron plus 2,4-DB applied post-directed also provided effective sicklepod control.

Acifluorfen, toxaphene, or metribuzin used alone, were not as effective in controlling sicklepod as when a preemergence treatment was added in the case of acifluorfen or toxaphene, or when a postemergence treatment was added in the case of metribuzin. Better sicklepod control was achieved with toxaphene and acifluorfen when they were applied to sicklepod in the cotyledon stage than at the unifoliolate stage.

A general trend was observed in which better soybean yields were recorded for treatments showing better sicklepod control. The same general trend followed for dollar net returns showing better sicklepod control.

Soybean yields were generally higher when kept sicklepod free for at least 4 weeks after planting. Where higher number of sicklepod plants were counted in plots at harvest soybean yields were generally lower.

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LITERATURE CITED

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APPENDIX

TABLE A-1. Rainfall data 1980, Plant Science Field Laboratory of The University of Tennessee, Knoxville.

Day	May	June	July	Aug.	Sept.	Oct.
1	.25*					
2				.18		
3			1.14			.05
4			1.22			
5				.25		
6	.08		1.47			
7						
8	.18					
9						
10					1.47	
11			.10			
12				7.62		
13			1.40			
14						
15	.03					
16				T		
17	.20	.08		.38		
18	5.28	1.27		2.46	1.14	
19						2.11
20	.97			.25		
21	1.80				.64	
22			.20			
23	.58		.66			
24	.64	.05				
25	.08	1.70			.36	2.24
26			.08		.20	
27			.41			
28			3.05			.97
29					1.42	
30		T		.79	.13	
31						
TOTAL	10.09	3.10	9.73	11.93	5.36	5.37

*Rainfall recorded in centimeters.

TABLE A-2. Rainfall Data 1980, Cleveland, Tennessee

Day	June	July	Aug.	Sept.	Oct.
1			.03		
2				.08	
3		.25			
4			.10	1.14	
5			T		.46
6					
7					
8					
9					
10		T			
11			4.01		
12			.38		
13					
14					
15			.25		
16					
17	.61*	T		.86	T
18	.18		T		1.65
19			4.27		
20			.51	1.63	
21					
22					.03
23	.18	2.77			
24	.56	T		.66	.61
25	1.12			1.02	.38
26	.71			.03	
27		.13			1.68
28		.05		1.42	.05
29			1.50	1.57	
30	.20		.43	1.65	
31					
TOTAL	3.56	3.20	11.48	10.06	4.86

*Rainfall recorded in centimeters.

VITA

Jerry Eugene Freeny was born in Enid, Oklahoma on August 14, 1956. He is the son of Mr. and Mrs. Ross C. Freeny of Maryville, Tennessee. He received his public school education from Alma Elementary School at Mesa, Arizona; Union and Fort Craig Elementary Schools at Maryville, Tennessee, Alcoa Junior High School, and Alcoa High School, at Alcoa, Tennessee, and graduated in May 1974.

In September 1974, he entered The University of Tennessee, Knoxville, and in December 1978 he received a Bachelor of Science degree with a major in Plant and Soil Science. He entered the Graduate School at The University of Tennessee, Knoxville, in January 1979, and received the Master of Science degree in Plant and Soil Science with emphasis in Weed Science in June 1981. He is a member of Alpha Zeta honorary fraternity.

He is married to the former Christine Marie Foster of Oak Ridge, Tennessee.

He has a brother, Ross Lynn Freeny, of Maryville, Tennessee.