FULL-SEASON INTERFERENCE AND SOIL WATER RELATIONS OF SILVERLEAF NIGHTSHADE (*SOLANUM ELAEAGNIFOLIUM*) WITH UPLAND COTTON (*GOSSYPIUM HIRSUTUM*)

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SILVERLEAF NIGHTSHADE (SOLANUM ELAEAGNIFOLIUM)

WITH UPLAND COTTON (GOSSYPIUM HIRSUTUM)

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This thesis is dedicated in loving memory of my mother, Doris Green, who's love will always be felt.

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INTRODUCTION

Each of the two parts of this thesis is a separate manuscript to be submitted for publication in *Weed Science*, the journal of the Weed Science Society of America.

PART I

FULL-SEASON INTERFERENCE OF SILVERLEAF NIGHTSHADE (*SOLANUM ELAEAGNIFOLIUM*) WITH UPLAND COTTON (*GOSSYPIUM HIRSUTUM*)

Full-Season Interference of Silverleaf Nightshade (*Solanum elaeagnifolium*) with Upland Cotton (*Gossypium hirsutum*)

Abstract. Full-season interference of silverleaf nightshade (*Solanum elaeagnifolium* Cav. #[1] SOLEL) with upland cotton (*Gossypium hirsutum* L. 'Paymaster 145') was evaluated in five field experiments during 1984 and 1985. The experiments were established in dryland and irrigated environments at weed densities ranging from 0 to 32 plants/10 m of crop row. Dry weight of silverleaf nightshade increased from 0.08 to 0.39 kg/plot for each additional weed/10 m of row. Intraspecific competition among weed plants was not evident. However, cotton plant height was reduced at weed densities of 4 plants/10 m of row and above. When compared to cotton grown under weed-free conditions, the threshold densities at which initial lint yield reductions occurred ranged from 4 to 32 weed plants/10 m of row under the five environments. Irrigated cotton more effectively competed with the weed than did dryland cotton suggesting that moisture is one of the primary competition factors between this crop and weed. The lint yield component, boll size, was reduced at densities of 2 weeds/10 m of row and above. Silverleaf nightshade reduced mechanical harvest efficiency only at the 16- and 32-weed densities. Fiber properties were not affected by the weed. A regression model predicted that lint yield reduction would be approximately

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[1]Letters following this symbol are a WSSA-approved computer code from Composite List of Weeds, Weed Sci. 32, Suppl. 2. Available from WSSA, 309 West Clark St., Champaign, IL 61820.

1.54% for each silverleaf nightshade plant/10 m of cotton row. Within the 0 to 30 cm range, the distance silverleaf nightshade was established from the crop row did not affect the weed's interference with cotton. Additional index words. Competition, weed biomass, crop height, lint yield, boll size, harvest efficiency, fiber quality, predictor model, distance from row, SOLEL.

INTRODUCTION

Silverleaf nightshade is a deep-rooted perennial herb which can be propagated by either seed or root fragments (2, 10). The leaves are covered with numerous short, porrect stellate hairs, which give the plant its dusky or silver gray appearance (3). It is currently a serious weed problem in the southwestern United States (11) and in other semiarid regions of the world (3). Silverleaf nightshade has been declared a noxious weed in 21 of the United States (11), including Oklahoma and Texas, where it is considered one of the most troublesome perennial weeds to cotton producers (9).

Both crop yield losses and lower quality of harvestable products from fields infested with silverleaf nightshade have been reported in cotton (1, 21), grain sorghum [*Sorghum bicolor* (L.) Moench] (18), peanut (*Arachis hypogaea* L.) (12), and cereal grains (8). Abernathy and Keeling (1) estimated that cotton yield was reduced by 75% with moderate infestations of silverleaf nightshade when cotton was grown in skip-row patterns under semiarid conditions. Smith et al. (18) reported that cotton and grain sorghum yield losses were inversely related to the density of silverleaf nightshade. Hackett and Murray (12) reported a

67% reduction in dryland Spanish peanut yield with full-season interference from silverleaf nightshade.

The competitive relationships among various annual weed species and cotton have been studied extensively (5, 7, 16, 17, 19, 20). However, few competition studies with cotton have been conducted using perennial species. Keeley and Thullen (13) reported furrow-irrigated cotton yield was reduced by 34% from season-long competition of yellow nutsedge (Cyperus esculentus L. # CYPES). Also, with yellow nutsedge, Patterson et al. (14) reported a yield loss of 18 kg/ha of seed cotton for each weed plant/m^2 (when monitoring naturally occurring populations). The competitiveness from initial and second-season establishment of bermudagrass [Cynodon dactylon (L.) Pers. # CYNDA] was evaluated with cotton by Brown et al. (4). During the initial year of bermudagrass establishment, they reported minimal effects on yield from weed densities of 1 to 16 plugs/7.5 m of cotton row; whereas yield was reduced by 25% or more during the second season following establishment.

The influence of weed position in relation to the cotton row has not been extensively investigated. Buchanan et al. (6) reported that pitted morningglory (Ipomoea lacunosa L. # IPOLA), prickly sida (Sida spinosa L. # SIDSP), and redroot pigweed (Amaranthus retroflexus L. # AMARE) placed 15 to 45 cm from the cotton row competed equally. However, Robinson (15) showed that cotton yields were reduced more when large crabgrass [Digitaria sanguinalis (L.) Scop. # DIGSA], spurred anoda [Anoda cristata (L.) Schlecht. # ANVCR], prickly sida, and velvetleaf (Abutilon theophrasti Medik. # ABUTH) were grown in a 33-cm band directly over the drilled-row compared to a band of weeds between the rows. The influence of differing weed populations were not evaluated by these scientists.

The effects of selected densities of newly established silverleaf nightshade on cotton growth and development have not been investigated previously. These experiments were initiated to determine the threshold densities of silverleaf nightshade which would affect weed dry matter production, cotton plant height, lint yield, boll size, harvest efficiency, and fiber properties; to develop a model to predict lint yield reduction as caused by full-season weed interference; and to measure the influence of weed distance from the crop row on the competitiveness of silverleaf nightshade with cotton.

MATERIALS AND METHODS

Silverleaf nightshade threshold densities. Field experiments were conducted in 1984 near Perkins in north central Oklahoma on a Teller fine sandy loam (Udic Argiustoll) and near Tipton in southwest Oklahoma on a Tipton silt loam (Pachic Argiustoll). In 1985, experiments were repeated at Perkins. Each year at Perkins, two studies were conducted under differing moisture regimes (i.e., dryland and irrigated). The experiment at Tipton in 1984 was irrigated on an "as needed" basis. The term "environments" (five) will be used throughout this paper to depict a location, year, and moisture combination of variables; and "Perkins (dryl.)" and "Perkins (irri.)" will be used to represent the dryland and irrigated conditions at Perkins, respectively.

Treatments (i.e., silverleaf nightshade densities) in each of the five environments were arranged in randomized complete block designs with four replications. Individual plots were four rows by 10 m in length, with rows planted on a 91-cm spacing at Perkins and a 101-cm spacing at Tipton. Soil pH's at Perkins and Tipton were 6.9 and 7.2, respectively. Less than 1% organic matter was reported at both locations. Soil fertility levels were maintained each year according to state extension soil test recommendations for cotton.

Supplemental irrigations in the Perkins (irri.) environments were made using a side-roll sprinkler irrigation system (3 cm/irrigation) on July 14, July 24, August 5, and August 22 in 1984 and on July 15 and August 13 in 1985. No irrigation was applied to the dryland environments. At Tipton, supplemental furrow irrigation (5 cm/irrigation) was applied on May 4, May 24, July 2, July 16, July 26, August 16, and August 30, 1984.

A preemergence herbicide application of 1.1 kg/ha of metolachlor [2-chloro-*N*-(2-ethyl-6-methylphenyl)-*N*-(2-methoxy-1-methylethyl)-acetamide] plus 1.1 kg/ha of dipropetryn [6-(ethylthio)-*N*,*N'*-bis(1-methylethyl)-1,3,5-triazine-2,4-diamine] was made at Perkins in 1984. In 1985 at that location, 1.1 kg/ha of metolachlor plus 1.1 kg/ha of prometryn [*N*,*N'*-bis(1-methylethyl)-6-(methylthio)-1,3,5-triazine-2,4-diamine] were applied preemergence over the experimental area. No herbicides were applied at the Tipton location. Throughout the growing season, undesirable weeds which emerged were removed by hand hoeing. Insecticide applications of permethrin [(3-phenoxyphenyl)methyl 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate] and carbaryl [1-naphthyl methylcarbamate] were applied with a hand sprayer throughout the growing season to control Colorado potato beetle [*Leptinotarsa decemlineata* (Say)] which were feeding on the silverleaf nightshade plants.

Silverleaf nightshade seed used in these experiments were collected by hand harvesting fruit in the fall of 1983 from the Agronomy Research Station at Stillwater, OK. In early March of 1984 and 1985, silverleaf nightshade seedlings were initiated in a greenhouse by planting seed in peat tablets[2] and subsequently were thinned to obtain one plant/tablet. When seedlings reached the 4- to 6-true leaf stage, they were transplanted into the field at uniformly spaced densities of 0, 1, 2, 4, 8, 16, and 32 plants/10 m of cotton row. Weed seedlings were transplanted approximately 10 cm to the side of three premarked cotton rows in each four-row plot (Figure 1). At Perkins on April 19, 1984, and April 26, 1985, the silverleaf nightshade seedlings were transplanted on the south side of the cotton row; and at Tipton on April 12, 1984, the weed was transplanted on the north side of the crop row. The outside row on the right-hand side of each plot (Figure 1, Row D) was part of a border between plots containing different densities of silverleaf nightshade.

After the transplanted weeds had grown for approximately 6 weeks and were at a 10- to 12-true leaf stage (30 cm height), cotton seed (cultivar 'Paymaster 145') were planted with a conventional planter to achieve a stand density of approximately 15 plants/m of row. Planting dates for cotton at Perkins were on June 6, 1984, and May 30, 1985, and at Tipton on May 31, 1984. Immediately following cotton planting, silverleaf nightshade plants were clipped near the soil surface. All silverleaf nightshade plants resprouted at their designated sites after clipping and regrowth from the established root stock occurred at the same time as cotton emergence.

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[2]Forestry Suppliers, Inc., Jackson, MS. 39204.

When cotton had reached physiological maturity (defined as "greater than 80% boll opening") and the silverleaf nightshade and cotton began to senesce, the weed plants growing with cotton rows B and C (Figure 1) were harvested. The weeds were clipped near ground level, and all aboveground foliage was weighed. Composite samples of four plants/plot were dried at 49 C in forage driers. The dried composite samples were used to estimate dry weed weight in kilograms/plot and to calculate individual weed weight within each plot in grams/plant. Weed weights at Perkins were taken on September 19, 1984, and October 4, 1985, and at Tipton on September 29, 1984. Cotton plant heights were also measured on the same day of weed harvest for all five environments. Six cotton plants from rows B and C (3/row) were randomly selected and measured from the soil surface to the apex of the main stem.

Prior to cotton harvest in each environment, one fully mature boll/plant was removed from 15 randomly selected plants from rows B and C of each plot. These boll samples were used to calculate pulled lint percentage [(wt. of lint/wt. of seed cotton plus bur) x 100] and boll size (seed cotton wt./boll in g) and to measure cotton fiber length, length uniformity, strength, and micronaire (i.e., fineness). Fiber property analyses were conducted in the Oklahoma State University Cotton Quality Research Laboratory. Fiber length was measured in inches (converted to mm) on a digital fibrograph at the 2.5 and 50% span lengths. Uniformity index is a ratio of 50% span length divided by 2.5% span length, expressed as a percentage. Fiber strength was measured in grams-force/tex on a stelometer and reported in kilonewton meter/kg (kN m/kg). The fineness of the fiber was measured on a micronaire instrument in standard units.

Cotton was machine harvested each year in late November to early December with a brush-type mechanical stripper when the bolls became fully open and dry (after a killing freeze). Each row within a plot was harvested separately to determine if lint yield differed between rows B and C within the plot. Because lint yield between those rows did not differ significantly ($P>0.05$), yield determinations were based on the two center rows combined for each plot. Stripped cotton yield was converted to lint yield using pulled lint percentage estimates obtained from each plot.

Silverleaf nightshade plants transplanted adjacent to the outside row (Row A) of each plot were retained through cotton harvest to determine the effect of the weed on harvest efficiency and cotton grade. Harvest efficiency was estimated by machine harvesting the row followed by hand picking all cotton which remained on the plant and ground. In the three 1984 experiments, a composite lint sample, obtained from the mechanically harvested row, was submitted for cotton grade analyses by the USDA Agricultural Marketing Service at Altus, OK.

Data were compared using analyses of variance and regression procedures based on individual plot values. Initial analyses were conducted on all data sets pooled over the five environments. If statistically significant interaction terms of treatments by environments (0.05 probability level) were obtained from the pooled data sets, separate means were presented in the tables; however, if no interaction occurred, the data means were calculated over environments. The LSD was used for separation of treatment means at the 0.05 probability level. Silverleaf nightshade dry weight/plot, dry weight/plant and cotton plant height, lint yield, boll size, harvest efficiency, and fiber properties were evaluated relative to weed density.

Model to predict lint yield loss. A pooled analysis of cotton lint yields over environments indicated a significant environment by weed density interaction. When cotton lint yields were converted to a percentage yield, regression analysis showed no significant interaction. Percent yield was obtained by dividing the lint yield on each plot by the weed-free check plot within that replication and yield losses were determined by subtracting that value from 100%. Thus, an analysis of percent yield data, pooled over environments, was used to describe a model to predict cotton yield losses caused by silverleaf nightshade interference. The upper and lower 95% confidence bands were also calculated for the model.

Distance of weed from cotton row. An additional field experiment was conducted at Perkins, OK in 1985 to evaluate the influence of distance of the silverleaf nightshade from the cotton row and weed density. Treatments consisted of silverleaf nightshade transplanted on one-side of the cotton row at distances of 0, 10, 20, and 30 cm from the crop row at weed densities of 0, 1, 2, 4, and 8 plants/2.5 m of row. The experimental design was a factorial arrangement of a randomized complete block design with four replications. Individual plot size was 1 row by 2.5 m in length with a three-row border between plots on a 91-cm row spacing.

Silverleaf nightshade seedlings were initiated in a greenhouse and then transplanted into the field in an irrigated area adjacent to the previously described experiments at Perkins. Weed seedlings were transplanted on April 26; and cotton 'Paymaster 145' was planted approximately 5 weeks later on May 30, 1985. At cotton planting, when silverleaf nightshade plants had reached the 8- to 10-true leaf stage, the weed was clipped near the soil surface in the same manner as previously described. Silverleaf nightshade was harvested on October 2 for dry weed weight/plot determinations. Cotton plant height was measured on three randomly selected plants/plot on October 9. Cotton yield was determined by hand harvesting bolls on November 22 and converting to lint yield using the pulled lint percentage derived from a 15-boll sample.

Data were compared using analyses of variance for a factorial arrangement of treatments. Mean separation of treatments was again conducted using the LSD at the 0.05 probability level.

RESULTS AND DISCUSSION

Silverleaf nightshade threshold densities. A general increase in dry weed weight/plot occurred with increasing silverleaf nightshade plant densities in each of the five environments; however, the average weed weight/plot at a given density varied among environments (Table 1). Significant differences in dry weed weight/plot within an environment were not detected at densities of 4 or below at Perkins (dryl.) in either year or at Tipton. However, differences were observed at Perkins (dryl.) in 1984 at silverleaf nightshade plant densities of 4<8, 16<32 where < indicates significant differences at the 0.05 probability level. At Perkins (dryl.) 1985, dry weed weight/plot differences were detected at 4, 8<16<32; and at Tipton, the significant relationships were 4<8<16<32. Both years in the Perkins (irri.) environments, differences in dry weed weight/plot were not observed at densities of 8 or below. In both years, the relationship was 8, 16<32. Comparison of the irrigated vs. dryland results at Perkins in 1984 and 1985 suggest that irrigated cotton can effectively compete with approximately twice the number of silverleaf nightshade plants than can dryland cotton before significant increases in dry matter production of the weed occur. It also suggests that moisture is one of the prime competition factors between this crop and weed.

Regression analyses revealed a linear relationship between silverleaf nightshade plant densities and dry weed weight/plot in each of the five environments (Table 1). The models predicted, for each silverleaf nightshade plant/10 m of row, an increase in weed yield from 0.08 kg/plot at Perkins (irri.) 1985 to 0.39 kg/plot at Tipton. Coefficient of determination (r^2) values indicated that 75 to 93% of the variability in weed yield could be attributed to weed number/unit area. The two lowest values obtained were from the Perkins (irri.) tests.

Silverleaf nightshade dry weights/plant were analyzed over all five environments. Results of the combined analysis showed that the interaction of weed density by environments was not significant and that the dry weight/plant did not differ as weed density increased.

Cotton plant height displayed no significant environment by weed density interactions. Under weed-free conditions, mean cotton height was approximately 68 cm (Table 2). It was significantly reduced at the 4-plant density to approximately 65 cm and further reduced to 62 cm at the 8-plant density, to 56 cm at 16-plants, and to 51 cm at 32-plants. At the highest weed density, crop height was reduced 25% compared to that without weed competition. Regression analysis showed that the relationship between silverleaf nightshade plant density and cotton plant height was linear, but only 13% of the variation in cotton plant height could be accounted for by weed density.

Cotton lint yield displayed a significant environment by weed density interaction, necessitating separate analyses in each environment. Lint yields under weed-free conditions ranged from 519 kg/ha at Perkins (dryl.) 1984 to 1284 kg/ha at Tipton (Table 2). With increases in weed density, lint yield generally decreased in all environments. The threshold densities at which crop yield reductions occurred were between 4 and 16 silverleaf nightshade plants/10 m of row. At Perkins (dryl.) 1984, a significant reduction in lint yield, compared to the weed-free condition, was detected at a density of 4 weed plants/10 m of row. At an 8-plant density, a significant reduction was observed at Perkins (dryl.) 1985 and at Tipton; whereas at Perkins (irri.), densities of 16 (in 1984) or 32 (in 1985) plants/10 m of row were required to significantly reduce cotton lint yield. At the highest weed density of 32 plants/10 m of row, approximately a 50% decrease in lint yield was observed in four of the five environments. A reduction of only about 30% was recorded at Perkins (irri.) 1985 where the amount of rainfall received during the early summer months was 50 cm above normal. Comparisons of the irrigated vs. dryland results at Perkins in 1984 and 1985 again suggest that irrigated cotton more effectively competes with silverleaf nightshade than does dryland cotton and that moisture is one of the prime competition factors between this crop and weed.

Regression analyses predicted a linear decrease in lint yield with increasing silverleaf nightshade plant densities for each environment (Table 2). The predictor equations showed a reduction in lint yield from approximately 8.4 kg/ha at Perkins (dryl.) 1984 to 19.8 kg/ha at

Tipton for each silverleaf nightshade plant/10 m of row. Coefficient of determination values ranged from 0.55 to 0.88 with the two lower values again associated with the two Perkins (irri.) environments.

Cotton boll size showed no significant environment by weed density interaction. Boll size was gradually reduced with increasing silverleaf nightshade density (Table 2). Average boll size was approximately 5.3 g under weed-free conditions and was significantly reduced to approximately 5.0 g at the 2-, 4-, and 8-plant densities. At the 16-weed density, it was reduced to 4.8 g; and at the 32-plant density, average boll size was further reduced to 4.4 g or by about 17% compared to the weed-free condition. Regression analysis showed that the relationship between silverleaf nightshade plant density and boll size was linear. Because boll size is a component of lint yield, at least part of the yield reductions caused by greater weed densities can be attributed to the smaller bolls produced.

Harvest efficiency displayed no significant environment by weed density interactions. Harvest efficiency under weed-free conditions was approximately 98% with the brush-type mechanical stripper (Table 2). It was reduced to approximately 96% at the two highest weed densities of 16- and 32-plants/10 m of row. Analyses of cotton grades in the three 1984 experiments showed no significant environment by weed density interactions nor significant main effects related to silverleaf nightshade density (data not shown).

Fiber property analyses revealed no significant environment by weed density interactions nor main effect differences in cotton fiber length, length uniformity, strength, or fineness at the 0.05 probability level (Table 3). However, a significant decrease in 2.5% span length at the two highest silverleaf nightshade densities was observed relative to the weed-free treatments at the 0.10 probability level.

Model to predict lint yield loss. Data from cotton lint yield (calculated as a yield percentage compared to weed-free plots) were used to develop a mathematical model to describe the yield losses caused by silverleaf nightshade interference. Analyses of the percentage data detected no significant environment by weed density interactions, but did show significant main effects for weed densities (not shown). The resulting equation plus the upper and lower 95% confidence limits for the equation are illustrated (Figure 2). The model predicts a linear decrease of 1.54% in cotton lint yield for each silverleaf nightshade plant/10 m of row. For example, at a density of 8 weed plants/10 m of row, the expected cotton yield loss would be approximately 12%. By regressing all percentage plot values over all five environments 62% of the variation in percent lint yield losses were accounted for by variation in silverleaf nightshade plant densities. Results suggest that this mathematical model can predict the percent of cotton yield loss under differing environmental conditions.

Distance of weed from cotton row. An analysis of variance showed no significant interaction between the distance siverleaf nightshade was established from the cotton row and weed density for dry weed weight/plot, cotton plant height, or cotton lint yield. In addition, analyses revealed that a distance of 30 cm from the row or less was not a significant factor in silverleaf nightshade interference for the variables evaluated (Table 4). However, means for dry weed weight/plot and cotton lint yield averaged over distance from the crop row were significant among silverleaf nightshade plant densities and followed the same general trends as described previously (Table 5). Although cotton plant height (when averaged over distance from the row) tended to decrease, it was not significantly reduced from 0- to 8-silverleaf nightshade plants/2.5 m of row at the 0.05 probability level.

Results from these experiments showed that cotton growth and development can be affected by full-season silverleaf nightshade interference. Previous reports on the competitiveness of other weed species in cotton have shown that intraspecific competition often occurs at high weed densities (16, 19). However, in these experiments, intraspecific competition among silverleaf nightshade plants was not evident at densities between 1 and 32 plants/10 m of cotton row.

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Table 1. Relationship of silverleaf nightshade plant density to dry weed weight per plot and per plant[a].

Silverleaf nightshade plant density			Dry weed weight/plot					
			Perkins				Tipton	
Row basis	Area basis		Dryl.		Irri.		Irri.	
	Perkins	Tipton	1984	1985	1984	1985	1984	Dry weed weight/plant[b]
(no./10 m)	(no./ha)		(kg/plot)					(g/plant)
0	0	0	—	—	—	—	—	—
1	1 100	1 000	0.18 a	0.24 a	0.26 a	0.10 a	0.50 a	127 a
2	2 200	2 000	0.38 a	0.40 a	0.33 a	0.21 a	0.84 a	107 a
4	4 400	3 900	0.62 a	0.84 ab	1.07 a	0.44 a	1.53 a	113 a
8	8 700	7 900	1.60 b	1.90 b	1.83 ab	0.60 ab	3.82 b	122 a
16	17 500	15 700	2.43 b	3.07 c	3.13 b	1.32 b	7.59 c	110 a
32	35 000	31 500	4.10 c	4.59 d	6.26 c	2.45 c	12.15 d	92 a

Dry weed weight/plot[c]:

[Perkins (dryl.) 1984]	$y = 0.17 + 0.13\,x$[d]	($r^2 = 0.86$)
[Perkins (dryl.) 1985]	$y = 0.27 + 0.15\,x$	($r^2 = 0.82$)
[Perkins (irri.) 1984]	$y = 0.10 + 0.19\,x$	($r^2 = 0.76$)
[Perkins (irri.) 1985]	$y = 0.05 + 0.08\,x$	($r^2 = 0.75$)
[Tipton (irri.) 1984]	$y = 0.26 + 0.39\,x$	($r^2 = 0.93$)

[a]Means within a column followed by the same letter are not significantly different using the LSD mean separation test at the 0.05 probability level.

[b]Data pooled over all five environments.

[c]All regression values were significantly different from zero at the 0.05 probability level.

[d]The number of silverleaf nightshade plants/10 m of row equals x.

Table 2. Relationship of silverleaf nightshade plant density to cotton plant height, lint yield, boll size, and harvest efficiency[a].

Silverleaf nightshade plant density	Cotton plant height[b]	Cotton lint yield: Perkins, Dryl., 1984	Perkins, Dryl., 1985	Perkins, Irri., 1984	Perkins, Irri., 1985	Tipton, Irri., 1984	Boll size[b]	Harvest efficiency[b]
(no./10 m row)	(cm)	(kg/ha)					(g)	(%)
0	68 a	519 a	972 ab	958 ab	1072 ab	1284 ab	5.31 a	98.1 a
1	67 ab	489 ab	1025 a	1011 a	1119 a	1223 ab	5.10 ab	97.8 a
2	66 ab	498 ab	983 ab	1010 a	1053 ab	1304 a	5.03 b	97.8 a
4	65 b	465 b	901 bc	878 ab	1126 a	1177 bc	5.03 b	97.2 ab
8	62 c	389 c	819 c	776 bc	1068 ab	1103 c	4.99 bc	97.1 ab
16	56 d	339 d	696 d	649 cd	915 b	981 d	4.76 c	96.3 bc
32	51 e	247 e	499 e	484 d	739 c	641 e	4.40 d	95.8 c

Cotton plant height[c]:	[All environments pooled]	$y = 67 - 0.6x^{d}$	$(r^2 = 0.13)$
Cotton lint yield:	[Perkins (dryl.) 1984]	$y = 497 - 8.4x$	$(r^2 = 0.81)$
	[Perkins (dryl.) 1985]	$y = 986 - 16.0x$	$(r^2 = 0.86)$
	[Perkins (irri.) 1984]	$y = 973 - 16.6x$	$(r^2 = 0.59)$
	[Perkins (irri.) 1985]	$y = 1118 - 11.6x$	$(r^2 = 0.55)$
	[Tipton (irri.) 1984]	$y = 1280 - 19.8x$	$(r^2 = 0.88)$
Boll size:	[All environments pooled]	$y = 5.16 - 0.02x$	$(r^2 = 0.15)$
Harvest efficiency:	[All environments pooled]	$y = 97.8 - 0.07x$	$(r^2 = 0.07)$

[a]Means within a column followed by the same letter are not significantly different using the LSD mean separation test at the 0.05 probability level.

[b]Data pooled over all five environments.

[c]All regression values were significantly different from zero at the 0.05 probability level.

[d]The number of silverleaf nightshade plants/10 m of row equals x.

Table 3. Relationship of silverleaf nightshade plant density to cotton fiber properties pooled over all five environments[a].

Silverleaf nightshade plant density	Fiber length 2.5% Span	Fiber length Unif. index	Stelometer strength	Micro- naire
(no./10 m row)	-(mm)-	(ratio)	(kN m/kg)	(units)
0	25.3 a	48.8 a	193 a	5.0 a
1	25.1 a	49.1 a	190 a	4.9 a
2	25.1 a	48.9 a	197 a	4.9 a
4	25.2 a	49.1 a	194 a	4.9 a
8	25.3 a	49.2 a	194 a	4.9 a
16	24.9 a	49.2 a	192 a	4.9 a
32	24.6 a	48.8 a	190 a	4.9 a

[a]Means within a column followed by the same letter are not significantly different using the LSD mean separation test at the 0.05 probability level.

Table 4. Relationship of silverleaf nightshade distance from the cotton row averaged over weed densities relative to dry weed weight per plot, cotton plant height, and cotton lint yield at Perkins, OK[a].

Distance of weed from cotton row	Dry weed weight	Cotton plant height	Cotton lint yield
(cm)	(kg/plot)	(cm)	(kg/ha)
0	0.09 a	71.8 a	671 a
10	0.09 a	71.9 a	660 a
20	0.10 a	71.3 a	681 a
30	0.11 a	74.1 a	685 a

[a]Means within a column followed by the same letter are not significantly different using the LSD mean separation test at the 0.05 probability level.

Table 5. Relationship of silverleaf nightshade plant density averaged over distance from the cotton row relative to dry weed weight per plot, cotton plant height, and cotton lint yield at Perkins, OK[a].

Silverleaf nightshade plant density				
Row basis	Area basis	Dry weed weight	Cotton plant height	Cotton lint yield
(no./2.5 m)	(no./ha)	(kg/plot)	(cm)	(kg/ha)
0	0	—	74.6 a	762 a
1	4 400	0.03 a	72.5 a	748 a
2	8 700	0.08 a	73.2 a	674 b
4	17 500	0.13 b	71.6 a	598 c
8	35 000	0.24 c	69.5 a	590 c

[a]Means within a column followed by the same letter are not significantly different using the LSD mean separation test at the 0.05 probability level.

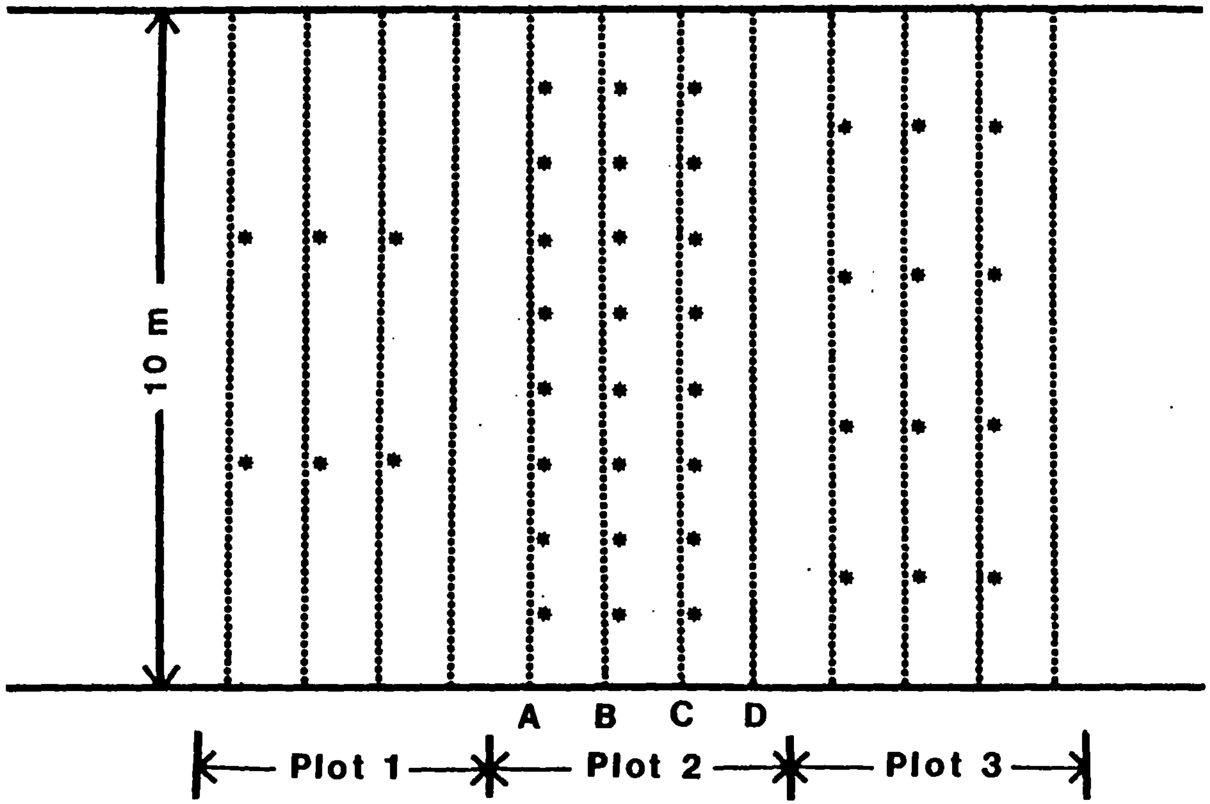

Figure 1. Digram illustrating the design of individual plots. The center plot (Plot 2, cotton rows designated A, B, C, and D) represents a silverleaf nightshade plant (*) density of 8 plants/10 m of cotton row. Plot 1 and Plot 3 represent weed densities of 2 and 4 plants/10 m of row, respectively.

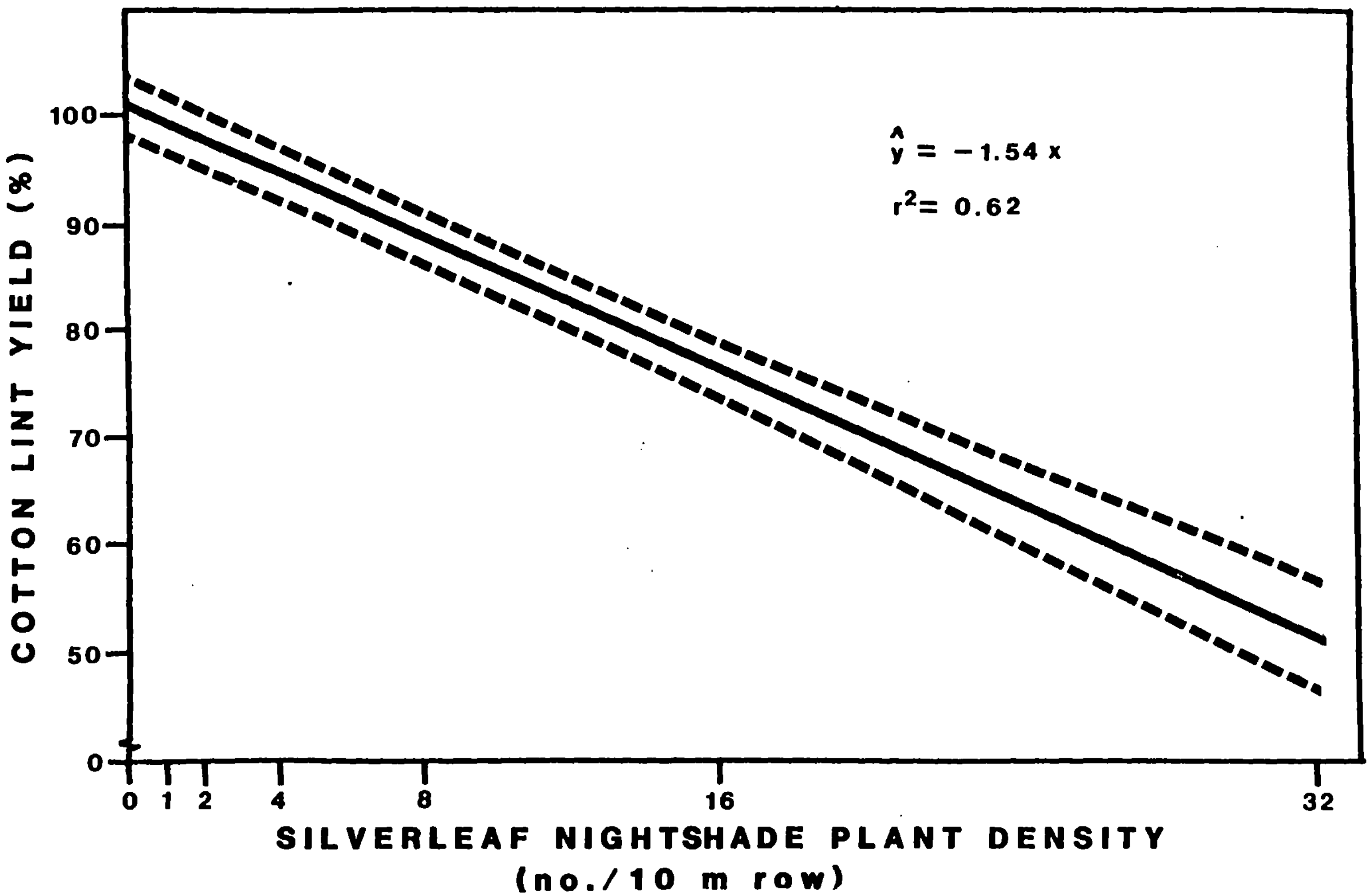

Figure 2. Cotton lint yield (expressed as a percentage of the weed-free treatments plus the upper and lower 95% confidence bands) relative to silverleaf nightshade plant density pooled over all five environments.

PART II

SOIL WATER RELATIONS OF SILVERLEAF NIGHTSHADE (*SOLANUM ELAEAGNIFOLIUM*) WITH UPLAND COTTON (*GOSSYPIUM HIRSUTUM*)

Soil Water Relations of Silverleaf Nightshade (*Solanum elaeagnifolium* with Upland Cotton (*Gossypium hirsutum*)

Abstract. Field experiments were established near Perkins, OK, to measure differences in soil water relations throughout the growing season between plots in which upland cotton (*Gossypium hirsutum* L. 'Paymaster 145') was grown with or without silverleaf nightshade (*Solanum elaeagnifolium* Cav. #[1] SOLEL) interference. Measurements were taken weekly at 15 cm increments to a maximum depth of 120 and 150 cm during 1984 and 1985, respectively, in a dryland and an irrigated environment. Volumetric soil water loss was much greater at lower depths within the soil profile earlier in the growing season when cotton was grown with silverleaf nightshade than when cotton was alone. An exception was noted in the irrigated environment in 1985 when soil moisture during the growing season was higher than normal. Cotton yield also reflected the amount of soil moisture available for cotton growth and development. Based on these findings, soil water is an important factor involved in silverleaf nightshade interference with cotton.
Additional index words. Soil water depletion, soil water utilization, volumetric soil water, soil moisture, competition, interference, SOLEL.

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[1]Letters following this symbol are a WSSA-approved computer code from Composite List of Weeds. Weed Sci. 32, Suppl. 2. Available from WSSA, 309 West Clark St., Champaign, IL 61820.

INTRODUCTION

Water is one of the primary factors for which plants compete (2, 8). Pavlychenko and Harrington (9) stated that competition begins below the soil surface when the root system of one plant overlaps with another in their exploration for water and nutrients and that under dryland and semiarid conditions the competition for soil moisture was intensified. The competitive ability of weeds can also be influenced by soil moisture conditions. Wiese and Vandiver (14) reported that kochia [Kochia scoparia (L.) Schrad. # KCHSC], Russian thistle (Salsola iberica Sennen & Pau # SASKR), and buffalobur (Solanum rostratum Dun. # SOLCU) were more competitive under dry soil conditions, whereas, some other weed species such as common cocklebur (Xanthium strumarium L. # XANST) and large crabgrass [Digitaria sanguinalis (L.) Scop. # DIGSA] were more competitive under wet soil conditions. Green et al. (6) found that silverleaf nightshade competed more effectively with dryland than with irrigated cotton.

The ability of plants to extract water from the soil profile is partially dependent on their root distribution (4, 13). Silverleaf nightshade roots have been reported below 3.0 m in fine sandy loam and silt loam soils (3), and a depth greater than 2.7 m was necessary to excavate 99% of the roots in the fine sandy loam soil. The rooting depth of cotton seldom exceeds 1.5 m with the principle soil moisture extraction region in the upper 1.0 m of the soil profile (11). Therefore, silverleaf nightshade has the potential to extract water at much greater depths in the soil profile than cotton.

Investigations by Stuart et al. (12) showed that the competition of smooth pigweed (Amaranthus hybridus L. # AMACH) with cotton resulted in less water being available for cotton at lower depths in the soil profile. The effects of annual weeds on soil water status have also been reported for soybean [Glycine max (L.) Merr.] (1), grain sorghum [Sorghum bicolor (L.) Moench] (5), Spanish peanuts (Arachis hypogaea L.) (7), and wheat (Triticum aestivum L.) (10). Banks et al. (1) showed that in conventionally tilled and no-tilled soybeans, early season soil water loss was greatest from the highest sicklepod (Cassia obtusifolia L. # CASOB) densities. Feltner et al. (5) reported that soil moisture depletion was more pronounced below the 50 cm depth early in the growing season when tall waterhemp [Amaranthus tuberculatus (Moq.) J.D.Sauer # AMATU) competed with grain sorghum.

Silverleaf nightshade competition studies demonstrated that cotton lint yield could commonly be reduced by 50% at densities of 32 weeds/10 m of cotton row. In addition, soil water is normally a limiting factor in upland cotton production in Oklahoma; thus, a better understanding of water utilization and availability for the crop when grown with weed interference is important. The objective of this study was to determine the effects of silverleaf nightshade on soil water relations when grown full-season with dryland and irrigated cotton.

MATERIALS AND METHODS

Experiments were conducted in 1984 and 1985 on the same dryland and irrigated experiments at Perkins, OK as described in the previous article on silverleaf nightshade interference (Part I). Treatments evaluated in this research consisted of cotton grown with and without silverleaf nightshade interference at the 32 plants/10 m of cotton row density. The experimental design was a randomized complete block with four replications. Supplemental water (3 cm/irrigation) was applied to the irrigated environments by an side-roll sprinkler irrigation system on July 14, July 24, August 5, and August 22, 1984, and on July 15 and August 13, 1985. Rainfall and irrigation amounts and frequencies are illustrated in (Figure 1).

Soil water content was measured weekly in 1984 beginning June 18 (2 weeks after weed and crop emergence) and continued until September 17 when cotton began to senesce. Depths of measurement were 0 to 120 cm at 15 cm increments. Measurements were increased in 1985 to a maximum depth of 150 cm which were taken weekly from June 17 until September 16. The method of measurement was by a Troxler Model 3323 neutron probe[2] with an Am:Be source. One access tube/plot (Nominal 3.8 cm EMT thin-wall steel tubing[3]) was driven into the soil midway between the two center rows of the four row plots having a silverleaf nightshade density of 0 and 32 plants/10 m of cotton row. Neutron scattering readings were converted to volumetric water content (θ) in cm^3 of water/cm^3 of soil and plotted against depth and time of measurement.

For a quantitative analysis of the soil water status over time, volumetric water content was converted to cm of soil water within a profile depth of 127 cm in 1984 and 157 cm in 1985 for each individual plot. In addition, the depletion of soil water was determined from the initial soil water content at three different time intervals. Time intervals in 1984 were from June 18 to July 1, July 1 to August 6, and

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[2]Troxler Electronics Laboratories, Inc., Research Triangle Park, NC 27709.

[3]Emsco Electric Supply Co., Inc., Oklahoma City, OK 73113.

August 6 to September 17 and in 1985 from June 17 to July 1, July 1 to August 5, and August 5 to September 16. The net change in soil water for each sampling depth represents the average depletion (or increase) of soil water in a 15-cm zone of the soil profile (measured depth plus 7.5 cm above and minus 7.5 cm below), except at the 15-cm depth which was calculated from 0 to 23 cm.

Statistical analysis procedures were used to quantify the depletion of water in the soil profile for each year and environment. To analyze the decrease in soil water with time, an analysis of variance procedure and LSD mean separation test (0.05 probability level) were used with individual plot values. A comparison of soil water content between cotton grown with vs. without silverleaf nightshade interference for each time interval and for soil water depletion at each depth over time were subjected to a paired two-tailed *t*-test procedure.

Additional materials and methods concerning cotton planting and establishment of silverleaf nightshade are described in greater detail in the previous paper (Part I).

RESULTS AND DISCUSSION

In general, volumetric soil water content did not change during the first 2 weeks of measurement in 1984, from June 18 to July 1, in either treatment (cotton with and without silverleaf nightshade) within the dryland or irrigated environments (Figure 2). Between July 1 and July 16, a reduction in volumetric soil water content was observed in the upper half of the soil profile (0 to 75 cm depth) with little or no change occurring in the soil water content in the lower half (75 to 120 cm). In the dryland area, a decline in volumetric soil water content was observed on August 6 at all depths above 120 cm (Figure 2a and 2b). This decrease was more evident in the lower portion of the profile (75 to 120 cm) in plots containing silverleaf nightshade. The same trend was noted in the irrigated plots, but the decrease in volumetric soil water content was less pronounced (Figure 2c and 2d).

Because of results obtained in 1984, soil water measurements were increased 30 cm to a maximum depth of 150 cm in 1985 (Figure 3). As observed in 1984, volumetric soil water content did not change from June 17 to July 1 while cotton was in the early stages of growth (5 to 6 true leaf stage). A noticable reduction in volumetric soil water content occurred from July 1 to July 15 in the upper 75 cm of the soil profile. By August 5 in the dryland environment, volumetric soil water content was reduced at all depths above 150 cm in plots containing silverleaf nightshade (Figure 3b). In comparison, volumetric soil water content was only reduced in the upper 90 cm with no weed present (Figure 3a). Later measurements also revealed that volumetric soil water content had decreased at the lower depths of the profile earlier in the growing season when cotton was grown with silverleaf nightshade compared to cotton grown alone. In the irrigated environment, the reduction in volumetric soil water content on August 5 was evident only in the upper 90 cm for both treatments (Figure 3c and 3d).

With respect to time, the greatest changes in the status of total soil water content within the measured profile occurred during the period between July 1 to August 6, 1984 and July 1 to August 5, 1985 (Table 1). This change was also evident between the comparison of means in the amount of soil water in the profile when cotton was grown with and without silverleaf nightshade interference. The significance levels

(P>t) were less than 0.10 on July 1 to July 30, 1984 and July 22, 1985 in the dryland environments and July 8,1984 in the irrigated environment. As observed with volumetric soil water content for the irrigated environment in 1985, there was no evidence of differences in the water status within the soil profile between treatments for any of the time intervals.

Differences in the amount of soil water in the profile between sampling dates allowed for the depletion (or gain) of soil water to be evaluated at three separate time intervals. In 1984, the depletion of total soil water from June 18 until September 17 did not differ between cotton grown alone and with silverleaf nightshade interference in the dryland or irrigated environments (Tables 2 and 3). However, an analysis of the change in soil water for each of the three separate time intervals did show differences in soil water between the two treatments within the upper (0 to 82 cm) and lower (82 to 127 cm) portion of the soil profiles between the two treatments. In the dryland environment from June 18 to July 1, 1984 (the first time interval), the depletion of total soil water within the measured profile (0 to 127 cm) was negligible (Table 2). Evaluation of the upper 82 cm of the soil profile showed that a higher depletion in soil water occurred in plots with silverleaf nightshade than without (P>t = .103), but did not differ in the lower profile.

Between July 1 and August 6, 1984 (second time interval), greater depletion in soil water was observed in the lower portion of the soil profile (P>t = .021) when silverleaf nightshade was present compared to cotton alone. The most significant difference occurred between treatments at the 105 cm depth (P>t = .018) and between treatments at 120 cm

(P>t = .015). On the same dates no difference in soil water content was observed in the upper soil profile. Total soil water depletion from August 6 to September 17 (third time interval) was greater in plots containing cotton alone than from plots containing both cotton and silverleaf nightshade. The greatest differences were observed in the soil profile at the 75, 90, and 105 cm depths where P>t was less than 0.10.

The depletion of soil water in the irrigated environment from June 18 to July 1, 1984 did not differ in the upper or lower profile (Table 3). However, between July 1 and August 6 the depletion of soil water in the lower profile was slightly higher in plots containing silverleaf nightshade than in plots with cotton alone (P>t = .096), but soil water depletion was not as pronounced as that shown for the dryland environment. In contrast, there appeared to be greater water depletion in the upper profile when cotton was growing alone (P>t = .041) than cotton grown with silverleaf nightshade. This could possibly be attributed to a more vigorous exploration of the upper rooting zone by cotton as a result of irrigation. The recharge zone from addition of 3 cm of supplemental water on July 15 and August 13, 1984 appeared to be limited to the upper 30 cm of the soil profile (Figure 2). Soil water depletion between treatment was not observed from August 6 to September 17. Examination of the total depletion of soil water throughout the season (June 18 to September 17) revealed that within the lower soil profile (82 to 127 cm) soil water reduction was greater when cotton was grown in the presence of silverleaf nightshade (P>t = .097).

Total soil water depletion from June 17 to September 16, 1985 tended to be higher in the dryland environment for cotton with silverleaf nightshade (P>t = .116) compared to cotton growing alone (Table 4). As observed in 1984, no difference in soil water depletion was seen from June 17 to July 1 in either the upper (0 to 82 cm) or lower soil profile (82 to 157 cm). A greater decline in soil water was observed in the lower profile (P>t = .025) of the dryland environment during the period of July 1 to August 5 when cotton was grown with silverleaf nightshade. In addition, soil water depletion in the upper profile (0 to 82 cm) tended to be higher (P>t = .116) in plots with the weed. A greater decline in soil water in the upper soil profile occurred at depths of 30, 45, 60, and 75 cm (P>t less than 0.10) during the period of August 5 to September 16 when cotton was growing without weed interference. In contrast, a greater depletion in soil water occurred with silverleaf nightshade in the lower profile at depths of 120, 135, and 150 cm. Examination of soil water depletion in the lower profile from June 17 to September 16 was also higher when cotton was grown with weed interference (P>t = .055).

In the irrigated environment from June 17 to September 16, 1985 depletion of total soil water did not differ between treatments (Table 5). In contrast to the other experimental areas, soil water depletion also did not differ within the measured profile or from examination of the upper and lower profiles for each of the three time intervals evaluated. Lack of differences in the soil water relationship between cotton grown with and without silverleaf nightshade can be attributed to higher than normal moisture conditions in 1985 during early cotton development and from two supplemental irrigations applied in mid-July and mid-August.

Results from these experiments revealed that in three of the environments, soil water content was reduced earlier in the growing season when cotton was grown with silverleaf nightshade interference compared to cotton growing alone. Differences in soil water content were greatest within the lower depths of the soil profile. The largest differences in soil water depletion occurred in mid-August when cotton was in the mid-bloom stages of growth, a critical time for cotton growth and development. The exception occurred under the irrigated conditions in 1985 where soil water depletion was equivalent for any time during the growing season whether cotton was grown in the presence or absence of silverleaf nightshade.

These findings can also be related to observed cotton yield losses caused by silverleaf nightshade interference. In the dryland environment both years and the irrigated environment in 1984, cotton lint yields were reduced by approximately 50% when silverleaf nightshade was present at 32 plants/10 m of cotton row (Part I). In the 1985 irrigated environment (when more soil moisture was available), cotton lint yields were reduced only by 30% at the highest weed density of 32 plants. Although supplemental water was applied to the irrigated environment in 1984, a sufficient supply of soil water was not available to overcome the effects of increasing silverleaf nightshade density on cotton yield losses.

In these studies, silverleaf nightshade was competitive with cotton. Threshold densities at which full-season silverleaf nightshade interference reduced cotton lint yields were between 4 to 16 plants/10 m of cotton row. Cotton plant height and harvesting efficiency was also reduced. Cotton fiber properties were not affected by silverleaf nightshade interference. Examination of soil water relations revealed that soil water depletion occurred earlier in the growing season at the lower depths within the soil profile when cotton was grown with silverleaf nightshade interference compared to cotton growing alone. Thus, soil water appears to be an important factor involved in interference of silverleaf nightshade with cotton.

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Table 1. Total soil water content throughout the measured profile between cotton grown with and without silverleaf nightshade interference during 1984 and 1985.[a]

Total soil water content							
1984				1985			
Date	Cotton alone	Cotton plus SOLEL	Paired[b] t-test	Date	Cotton alone	Cotton plus SOLEL	Paired[b] t-test
	—(cm/127 cm)—		(P>t)		—(cm/157 cm)—		(P>t)
Dryland							
6/18	32.98 a	32.38 a	.030	6/17	38.13 a	38.13 a	.996
6/24	32.14 ab	31.66 a	.285	6/24	37.49 ab	37.43 a	.930
7/1	32.64 a	31.66 a	.037	7/1	37.61 a	37.42 a	.760
7/8	31.69 b	29.66 b	.008	7/8	36.87 b	35.63 b	.190
7/16	29.22 c	26.32 c	.025	7/15	34.91 c	32.93 c	.142
7/23	—	—	—	7/22	33.30 d	30.85 d	.084
7/30	23.88 d	21.69 d	.059	7/29	32.77 d	30.61 d	.147
8/6	21.88 e	19.96 e	.130	8/6	30.11 e	27.99 e	.151
8/13	20.65 f	19.54 ef	.299	8/12	27.37 g	25.76 f	.194
8/20	19.81 fg	18.85 fg	.367	8/20	28.19 f	26.28 f	.180
8/27	19.50 g	18.74 fg	.400	8/27	26.05 h	24.38 g	.236
9/3	19.23 gh	18.52 fg	.419	9/2	24.42 i	23.08 h	.339
9/10	18.91 gh	18.40 g	.581	9/9	23.36 j	21.75 i	.277
9/17	18.42 h	17.93 g	.561	9/16	24.00 ij	21.97 hi	.185
Irrigated							
6/18	31.83 a	30.98 a	.111	6/17	39.32 a	39.44 a	.850
6/24	31.18 ab	30.00 a	.120	6/24	38.88 a	38.96 a	.810
7/1	30.98 b	29.96 a	.181	7/1	39.03 a	39.00 a	.940
7/8	29.76 c	27.95 b	.096	7/8	37.99 b	37.82 b	.758
7/16	27.89 d	26.71 c	.466	7/15	36.32 c	36.36 c	.894
7/23	—	—	—	7/22	33.78 d	34.25 d	.323
7/30	24.44 e	23.86 d	.758	7/29	33.20 d	33.57 d	.423
8/6	22.79 f	22.26 e	.668	8/5	30.39 e	30.51 e	.630
8/13	21.64 g	21.13 f	.674	8/12	27.84 g	27.95 g	.774
8/20	19.92 h	19.70 gh	.819	8/20	29.29 f	29.72 f	.424
8/27	20.34 h	20.60 fg	.832	8/27	26.90 h	27.11 h	.373
9/3	19.61 hi	20.00 g	.654	9/2	25.46 i	25.46 i	.986
9/10	18.96 i	18.86 h	.887	9/9	24.14 j	24.26 j	.731
9/17	17.88 j	17.25 i	.427	9/16	24.26 j	24.47 j	.231

[a]Means within a column at each environment followed by the same letter are not significantly different using the LSD mean separation test at the 0.05 probability level.

[b]Comparison of means at each time interval between cotton alone and plus SOLEL (silverleaf nightshade) are statistically represented by the probability of a greater t-value (P>t) using a paired two-tailed t-test procedure.

Table 2. Soil water depletion from cotton grown with and without silverleaf nightshade interference in the dryland environment during 1984.[a]

	Soil water depletion[b]											
	(6/18 to 7/1)			(7/1 to 8/6)			(8/6 to 9/17)			Season totals (6/18 to 9/17)		
Soil Depth	Cotton alone	Cotton plus SOLEL	Paired t-test	Cotton alone	Cotton plus SOLEL	Paired t-test	Cotton alone	Cotton plus SOLEL	Paired t-test	Cotton alone	Cotton plus SOLEL	Paired t-test
(cm)	———(cm)———		(P>t)	———(cm)———		(P>t)	———(cm)———		(P>t)	———(cm)———		(P>t)
15	0.52	0.44	.442	3.05	2.87	.269	0.06	0.14	.130	3.62	3.45	.317
30	-0.09	0.00	.118	2.18	2.02	.198	0.04	0.01	.228	2.13	2.02	.230
45	-0.06	0.04	.013	1.96	1.83	.445	0.08	0.01	.171	1.98	1.88	.448
60	-0.09	0.09	.033	1.57	1.53	.827	0.17	0.08	.398	1.65	1.70	.761
75	-0.06	0.02	.143	1.03	1.24	.449	0.48	0.15	.077	1.45	1.42	.860
90	0.04	0.01	.674	0.58	0.96	.150	0.80	0.34	.037	1.42	1.31	.051
105	0.06	0.03	.661	0.26	0.78	.018	0.98	0.51	.016	1.30	1.32	.780
120	0.01	0.08	.136	0.14	0.47	.015	0.85	0.79	.583	1.01	1.34	.025
Above 82	0.22	0.59	.103	9.79	9.50	.734	0.83	0.39	.214	10.84	10.47	.558
Below 82	0.11	0.12	.821	0.98	2.20	.021	2.63	1.64	.014	3.72	3.97	.298
Total	0.33	0.71	.158	10.77	11.70	.416	3.46	2.03	.026	14.56	14.44	.885

[a]Comparison of means at each depth between cotton alone and plus SOLEL (silverleaf nightshade) are statistically represented by the probability of a greater t-value (P>t) using a paired two-tailed t-test procedure.

[b]A minus sign (-) before a value indicates that soil water increased.

Table 3. Soil water depletion from cotton grown with and without silverleaf nightshade interference in the irrigated environment during 1984.[a]

	Soil water depletion[b]											
	(6/18 to 7/1)			(7/1 to 8/6)			(8/6 to 9/17)			Season totals (6/18 to 9/17)		
Soil Depth	Cotton alone	Cotton plus SOLEL	Paired t-test	Cotton alone	Cotton plus SOLEL	Paired t-test	Cotton alone	Cotton plus SOLEL	Paired t-test	Cotton alone	Cotton plus SOLEL	Paired t-test
(cm)	----(cm)----		(P>t)	----(cm)----		(P>t)	----(cm)----		(P>t)	----(cm)----		(P>t)
15	0.55	0.63	.721	2.01	1.47	.184	1.02	1.06	.910	3.60	3.15	.160
30	0.06	0.08	.552	1.85	1.49	.014	0.21	0.22	.965	2.12	1.79	.003
45	0.03	0.10	.174	1.68	1.38	.001	0.14	0.28	.248	1.85	1.75	.161
60	0.02	0.04	.601	1.27	0.98	.146	0.28	0.46	.316	1.57	1.47	.031
75	-0.04	-0.01	.672	0.80	0.93	.627	0.67	0.60	.868	1.43	1.52	.639
90	0.10	0.05	.095	0.35	0.69	.146	0.98	0.78	.510	1.42	1.52	.453
105	0.11	0.05	.184	0.13	0.51	.063	0.95	0.78	.448	1.20	1.34	.244
120	0.04	0.08	.344	0.10	0.26	.112	0.66	0.85	.197	0.79	1.19	.034
Above 82	0.62	0.84	.446	7.61	6.24	.041	2.32	2.61	.714	10.55	9.69	.148
Below 82	0.24	0.18	.414	0.58	1.46	.096	2.59	2.41	.749	3.41	4.05	.097
Total	0.86	1.02	.591	8.19	7.70	.481	4.91	5.02	.934	13.96	13.74	.767

[a]Comparison of means at each depth between cotton alone and plus SOLEL (silverleaf nightshade) are statistically represented by the probability of a greater t-value (P>t) using a paired two-tailed t-test procedure.

[b]A minus sign (-) before a value indicates that soil water increased.

Table 4. Soil water depletion from cotton grown with and without silverleaf nightshade interference in the dryland environment during 1985.[a]

	Soil water depletion[b]											
	(6/17 to 7/1)			(7/1 to 8/5)			(8/5 to 9/16)			Season totals (6/17 to 9/16)		
Soil Depth	Cotton alone	Cotton plus SOLEL	Paired t-test	Cotton alone	Cotton plus SOLEL	Paired t-test	Cotton alone	Cotton plus SOLEL	Paired t-test	Cotton alone	Cotton plus SOLEL	Paired t-test
(cm)	----(cm)----		(P>t)	----(cm)----		(P>t)	----(cm)----		(P>t)	----(cm)----		(P>t)
15	0.10	0.24	.401	2.46	2.60	.385	0.01	0.13	.682	2.58	2.97	.095
30	0.04	0.12	.354	1.78	1.79	.870	0.28	0.13	.073	2.10	2.04	.550
45	0.03	0.13	.050	1.45	1.56	.295	0.48	0.32	.067	1.95	2.01	.532
60	0.08	0.04	.355	0.85	1.21	.163	0.78	0.58	.015	1.71	1.83	.549
75	0.10	-0.01	.077	0.34	0.76	.111	1.08	0.84	.090	1.52	1.59	.801
90	0.00	-0.02	.002	0.20	0.56	.029	1.20	0.94	.123	1.40	1.48	.606
105	0.06	0.09	.434	0.15	0.30	.127	0.93	0.98	.686	1.14	1.36	.275
120	0.01	0.03	.604	0.11	0.28	.035	0.57	0.79	.034	0.69	1.09	.008
135	0.03	0.07	.451	0.10	0.20	.091	0.47	0.71	.095	0.60	0.98	.046
150	0.07	0.04	.201	0.07	0.18	.003	0.31	0.61	.042	0.44	0.82	.044
Above 82	0.35	0.52	.517	6.88	7.92	.116	2.63	1.99	.152	9.86	10.43	.361
Below 82	0.17	0.20	.655	0.62	1.51	.025	3.48	4.02	.112	4.27	5.73	.055
Total	0.52	0.72	.535	7.50	9.43	.062	6.11	6.01	.827	14.13	16.16	.116

[a]Comparison of means at each depth between cotton alone and plus SOLEL (silverleaf nightshade) are statistically represented by the probability of a greater t-value (P>t) using a paired two-tailed t-test procedure.

[b]A minus sign (-) before a value indicates that soil water increased.

Table 5. Soil water depletion from cotton grown with and without silverleaf nightshade interference in the irrigated environment during 1985.[a]

	Soil water depletion[b]											
	(6/17 to 7/1)			(7/1 to 8/5)			(8/5 to 9/16)			Season totals (6/17 to 9/16)		
Soil Depth	Cotton alone	Cotton plus SOLEL	Paired t-test	Cotton alone	Cotton plus SOLEL	Paired t-test	Cotton alone	Cotton plus SOLEL	Paired t-test	Cotton alone	Cotton plus SOLEL	Paired t-test
(cm)	----(cm)----		(P>t)	----(cm)----		(P>t)	----(cm)----		(P>t)	----(cm)----		(P>t)
15	0.08	0.05	.690	2.91	2.91	.947	0.00	−0.04	.907	2.99	2.92	.844
30	0.04	0.06	.409	1.98	1.96	.576	0.27	0.22	.220	2.29	2.24	.433
45	0.01	0.04	.644	1.63	1.56	.507	0.46	0.45	.962	2.10	2.05	.443
60	0.01	0.02	.146	0.95	0.98	.855	0.86	0.79	.593	1.82	1.79	.629
75	0.05	0.03	.745	0.43	0.41	.860	1.12	1.07	.436	1.60	1.51	.219
90	−0.01	0.04	.574	0.26	0.21	.170	1.22	1.16	.249	1.47	1.40	.499
105	0.05	0.05	.991	0.15	0.16	.682	0.84	0.88	.368	1.04	1.09	.364
120	0.05	0.09	.278	0.10	0.11	.903	0.50	0.57	.081	0.66	0.77	.265
135	0.00	0.00	.750	0.11	0.11	.984	0.49	0.51	.610	0.60	0.62	.785
150	0.00	0.07	.074	0.10	0.07	.088	0.38	0.43	.405	0.48	0.57	.239
Above 82	0.19	0.19	.923	7.90	7.82	.819	2.71	2.49	.508	10.80	10.50	.551
Below 82	0.10	0.25	.216	0.74	0.66	.606	3.42	3.55	.294	4.26	4.46	.440
Total	0.29	0.44	.449	8.64	8.48	.675	6.13	6.04	.747	15.06	14.96	.885

[a]Comparison of means at each depth between cotton alone and plus SOLEL (silverleaf nightshade) are statistically represented by the probability of a greater t-value (P>t) using a paired two-tailed t-test procedure.

[b]A minus sign (-) before a value indicates that soil water increased.

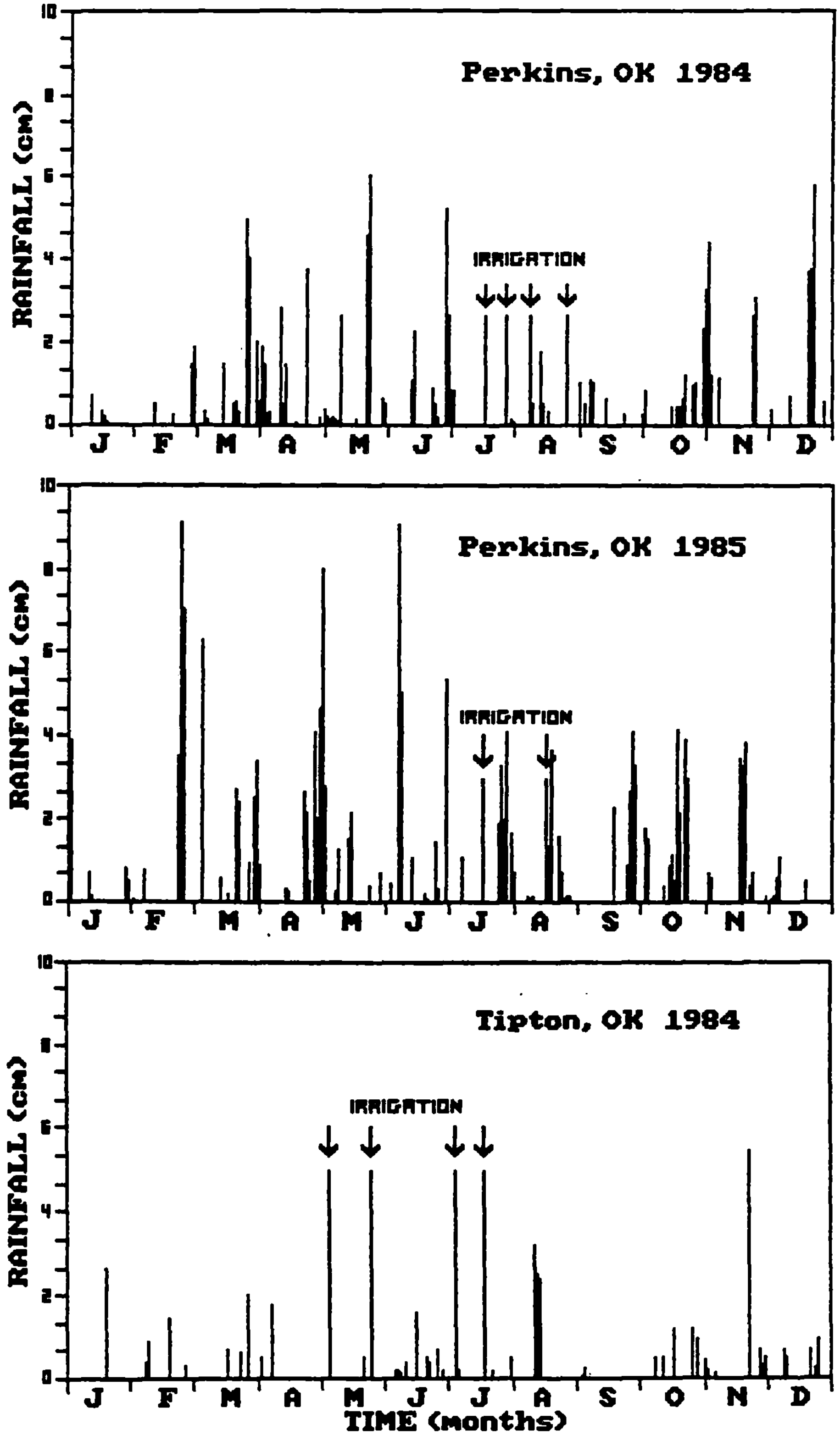

Figure 1. Rainfall and irrigation amounts and frequencies at Perkins, OK during 1984 and 1985, and at Tipton, OK during 1984.

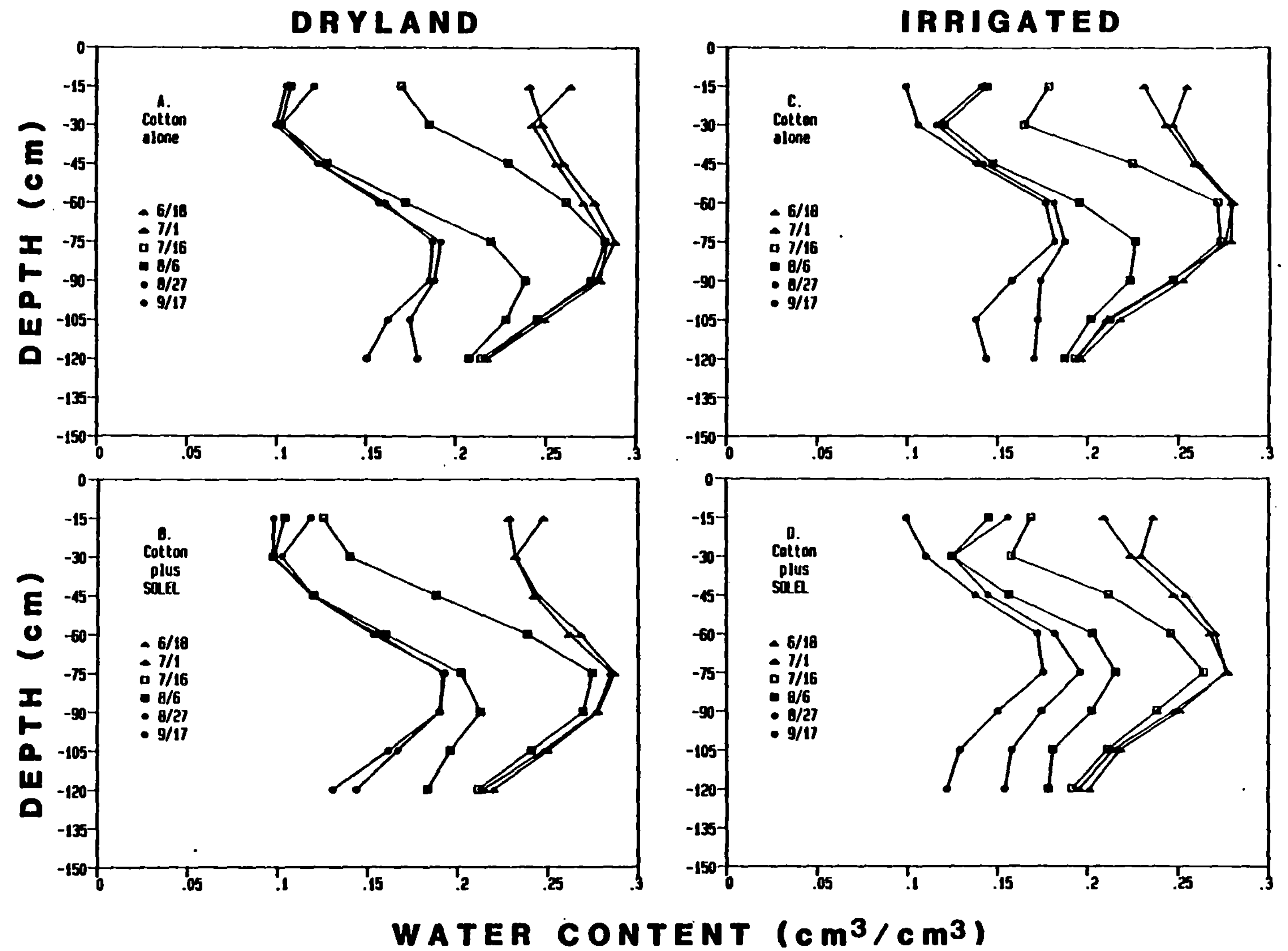

Figure 2. Volumetric soil water content by depth and time in 1984 under a dryland environment with (A) cotton alone and (B) cotton plus SOLEL (silverleaf nightshade) and under an irrigated environment with (C) cotton alone and (D) cotton plus SOLEL.

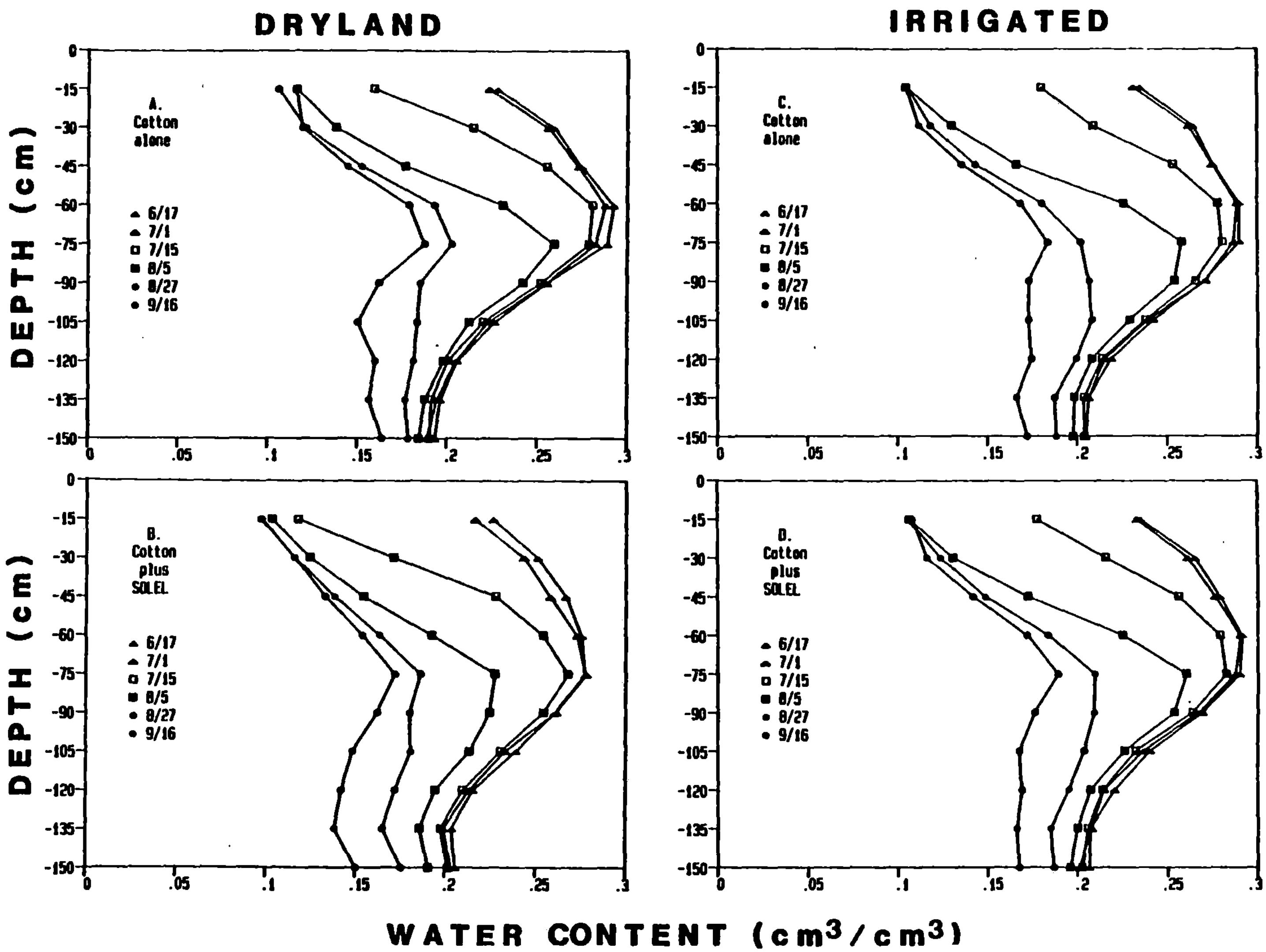

Figure 3. Volumetric soil water content by depth and time in 1985 under a dryland environment with (A) cotton alone and (B) cotton plus SOLEL (silverleaf nightshade) and under an irrigated environment with (C) cotton alone and (D) cotton plus SOLEL.

VITA 2

Jonathan David Green

Candidate for the Degree of

Doctor of Philosophy

Thesis: FULL-SEASON INTERFERENCE AND SOIL WATER RELATIONS OF SILVERLEAF NIGHTSHADE (*SOLANUM ELAEAGNIFOLIUM*) WITH UPLAND COTTON (*GOSSYPIUM HIRSUTUM*)

Major Field: Crop Science

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