INTERFERENCE OF TUMBLE PIGWEED (AMARANTHUS ALBUS) AND BUFFALOBUR (SOLANUM ROSTRATUM) WITH COTTON (GOSSYPIUM HIRSUTUM)

By

DOUGLAS WARREN RUSHING

Bachelor of Science
North Carolina State University
Raleigh, North Carolina
1978

Master of Science
Oklahoma State University
Stillwater, Oklahoma
1981

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
DOCTOR OF PHILOSOPHY
May, 1984

INTERFERENCE OF TUMBLE PIGWEED (*AMARANTHUS ALBUS*) AND BUFFALOBUR (*SOLANUM ROSTRATUM*) WITH COTTON (*GOSSYPIUM HIRSUTUM*)

Thesis Approved:

Don S. Murray
Thesis Adviser

Laval M. Verhalen

Robert L. Westerman

Jimmy F. Stritzke

Eddie Basler

Norman N. Durham
Dean of the Graduate College

ACKNOWLEDGMENTS

I would like to thank my major advisor, Don Murray for his guidance, understanding, and perserverance during my term at Oklahoma State University. I would also like to thank the members of my committee, Jim Stritzke, Bob Westerman, Eddie Basler, and Laval Verhalen for their helpful comments. A special thanks go to my fellow graduate students, both on and off the field, and especially to my wife, Angie for her emotional as well as financial support throughout all of these years.

Thank you to Jane and Neil Hackett for their typing and proofing of this manuscript.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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 Society of America.

PART I

INTERFERENCE OF TUMBLE PIGWEED (*AMARANTHUS ALBUS*) WITH COTTON (*GOSSYPIUM HIRSUTUM*)

INTERFERENCE OF TUMBLE PIGWEED (*AMARANTHUS ALBUS*)

WITH COTTON (*GOSSYPIUM HIRUSUTUM*)

Abstract. The relationship between cotton (*Gossypium hirsutum* L. 'Westburn M') production and full season interference from tumble pigweed (*Amaranthus albus* L. # *AMAAL*) densities ranging from 0 to 64 plants/10 m of row was measured in three field experiments. The damage threshold density where initial yield reductions occur ranged from 4 to 16 tumble pigweed plants/10 m of row in the three experiments. Regression analyses between lint yield of cotton and weed density revealed a curvilinear decrease in yield with increasing densities. Analyses of data from the three experiments showed lint yields were reduced from 8 to 11 kg/ha for each additional tumble pigweed present per 10 m of row. Dry weights of the weed increased from 82 to 198 kg/ha for each additional tumble pigweed/10 m of row. Cotton plant height was reduced in one of the three experiments, but harvesting difficulty was not encountered in that study. Interference from tumble pigweed did not signficantly affect cotton fiber length, uniformity, strength, or micronaire from hand harvested bolls.

Additional index words. Fiber quality, lint yield, plant height, weed density, weed height, AMAAL.

Introduction

A 1977 survey (9) reported that pigweeds (Amaranthus spp.) are among the most common weeds present in Oklahoma cotton fields as well as being one of the most common weeds present in other agronomic crops across the southern states. A later report (16), conducted in 1980, stated that approximately 3.5 million hectares or 12% of U.S. cotton were infected with pigweeds. Although numerous herbicides are registered for use in cotton which will effectively control pigweeds in Oklahoma, yield reductions of up to 53% have been attributed to uncontrolled pigweeds (16). Other states such as Texas, Alabama, and California have reported yield reductions of up to 38, 10, and 25%, respectively.

The competitiveness of several annual weeds with cotton has been reported (1,3,5,7). Some of the earlier research indicated that weeds exert the greatest influence on crops by competing for moisture, nutrients, and light (6,11,14). The effects of weed density (2,3,4,5,10) and duration of competition (1,10) by several weed species have been investigated in several environments with cotton.

Buchanan and Burns (3) demonstrated that full season competition from a density of eight common cocklebur (Xanthium pensylvanicum Wallr.) plants/7.3 m of row reduced seed cotton yield approximately 60%. The influence of full season interference by specified weed densities of Amaranthus spp. on yield has been examined as well. Densities of 48 redroot pigweed (Amaranthus retroflexus L.) plants/7.3 m of row reduced cotton yield 90% in Oklahoma (3). Pigweed (Amaranthus spp.) competition studies with integrated cotton in Texas showed that weed free cotton produced 666 kg/ha of lint; whereas, one weed per 0.3, 0.6, 1.2, and 2.4 m of row reduced lint production to 362, 321, and 130 kg/ha, respectively (12). Pigweed growth was reduced 50 to 66% when grown with cotton, indicating that cotton exerted a competitive influence on the weed. Mechanical harvesting efficiency with picker harvesters was not affected by the presence of pigweeds.

The weed free requirements of cotton and the tolerance of cotton to weed competition have been reported by Buchanan and Burns (1). At two locations in Alabama over a two year period, maximum yield was obtained when cotton was maintained weed free for approximately eight weeks after emergence. Cotton tolerated 4 to 7 weeks of weed competition after emergence without suffering loss in yield if the weeds were removed at this time, and the crop were kept free of weeds past this time. Data obtained in these studies were from mixed broadleaf and grassy species.

Several earlier studies (3,5,7) investigated the fiber qualities of cotton in relation to weed competition. Fiber length, strength, micronaire, and uniformity were not affected by interference from sicklepod (*Cassia obtusifolia* L.), common cocklebur, redroot pigweed, or four morningglory species; i.e., tall morningglory [*Ipomoea purpurea* (L.) Roth.], pitted morningglory (*I. lacunosa* L.), ivyleaf morningglory [*I. hederaceae* (L.) Jacq.], and entireleaf morningglory (*I. hederaceae* var. *integruiscula* Gray). However, the higher densities of tall morningglory substantially reduced harvesting efficiency.

Ten *Amaranthus* species are present in Oklahoma (15) though pigweed is one of those which is both prevalent and considered potentially serious weed in the southwestern U.S. including Oklahoma. Tumble pigweed appears to be spreading in area, and densities are increasing on infested sites. The impact on cotton production from this gradual, but relatively constant spread is unknown. Therefore, this research was conducted to determine the damage threshold density of tumble pigweed when allowed to interfere with cotton over the entire growing season.

Materials and Methods

Experiments were conducted during 1982 and 1983 on a Tipton silt loam (Pachis Arguistolls) in southwest Oklahoma at Tipton, and in 1983 on a Teller fine sandy loam (Udic Arguistolls) in North Central Oklahoma at Perkins. Soil pH was 7.6 and 7.1 at Tipton and Perkins, respectively. Soil fertility levels were adjusted each year according to state extension soil test recommendations. Westburn M cotton, a stripper-harvested cultivar, was planted with a conventional plants on a 101 cm row spacings at Tipton and on 91 cm row spacings at Perkins. Planting dates were June 3, May 19, and May 27 for Tipton in 1982 and 1983, and for Perkins in 1983, respectively. Growing seasons were 155, 176, and 167 days in those respective tests. The final crop stand was approximately 10 plants/m of row. Specified weed densities designed as treatments were arranged in a randomized complete block design with four replications. Each plot of cotton was four rows wide and 10 meters long. Immediately after planting, locally collected tumble pigweed seed were hand planted approximately 3 cm from the two center cotton rows on the south side of the row. The weed seed were planted about 1 cm deep in uniformly spaced hills. Three weeks after planting, pigweed seedlings were hand thinned to uniformly spaced densities of 0,2,4,8,16, 32 and 64 plants/10 m of row. Other weeds were removed throughout the growing season by hand hoeing. The outside row of each plot contributed to a two-row border between weed plots. A preemergence application of 1.4 kg/ha of metolachlor [2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl)acetamide] and 1.12 kg/ha of prometryn [2,4-bis (isopropylamino)-6-(methylthio)-s-triazine] was applied to the border rows to minimize hand labor. The experiment was conducted under non-irrigated conditions at Tipton in 1982. Irrigation was applied at both locations in 1983 on an as needed basis.

Insecticide applications were not required at Perkins; however, at Tipton, chlorpyrifos [O-O-diethyl O-(3,5,6-trichloro-2-pyridyl) phosphorothioate] was applied for cotton fleahopper [Pseudotomoscelis seriatus (Reuter)] control, and permethrin [(3-phenoxyphenyl) methyl 3-(2,2-dichloro-ethenyl)-2,2-dimethylcyclopropanecarboxylate] was applied for the bollworm [Heliothis zea (Boddie)] and tobacco budworm [H. Virescens (F.)] complex control in 1982 and 1983, respectively. Methyl parathion [O-O-dimethyl-O-(P-nitrophenyl)phosphorothiroate] plus chlordimeform [N'-(4-chloro-O-toly)-N-N-dimethylformamidine] was also applied for boll weevil (Anthonomus grandis Boheman) control at Tipton in 1983. These applications were made based on recommendations by extension entomologists after scouting the fields.

Tumble pigweed and cotton plant height was recorded in cm from the soil surface to the main stem apex using six measurements/plot. These measurements were taken approximately 24 days prior to harvest, but after a killing freeze. Tumble pigweed plants were removed from the plots for weight determinations. Weeds were cut at ground level, and green weights were recorded. A composite sample of the above ground portion of the tumble pigweed plants was then taken from each plot and dried in forage driers at 49C for 72 hours. Percentage weed dry weight was determined from the samples and used to calculate dry weight yield on a plot basis.

Immediately prior to cotton harvest in both years, one mature boll/plant was removed from the center portion of 15 randomly selected plants in the two center rows. In 1983, an additional boll sample was collected as a composite sample from the container holding the entire mechanically harvested plot. The two sampling procedures were compared because initial analysis of the 1982 data did not detect significant differences in fiber properties among the various weed densities. All samples were used to determine percent lint of the sample, and to determine fiber quality consisting of length, uniformity, strength, and micronaire measurements. Fiber length was measured on the digital fibrograph as 2.5 and 50% span lengths in inches which was then converted to millimeters. Uniformity index was calculated by dividing 50% span length by 2.5% span length and expressing the result as a percentage. Fiber strength was measured on the stelometer in gf/tex, converted into NM/tex. Micronaire was measured on the micronaire instrument, and the readings were expressed in standard units. Quality analyses were conducted in the Oklahoma State University Cotton Quality Lab.

When the cotton bolls were fully open and dry in early December, cotton was harvested from the two center rows of each plot with a brush roller type mechanical stripper. Plot yields were converted into lint yield in kg/ha.

All data were subjected to analyses of variance and regression analyses to determine the relationship between tumble pigweed density and cotton lint yield, cotton plant height, weed dry weight, and fiber quality analysis, and to estimate the relationship between tumble pigweed dry weight and cotton lint yield. Data were also pooled over the three year experiments; and regression analyses were conducted on all plot values rather than on mean values.

Results and Discussion

Tumble pigweed dry weights were generally higher both years at Tipton than at Perkins in 1983 (Table 1). For example, the density of 16 tumble pigweed plants/10 m of row (15,800 and 17,600 plants/ha at Tipton and Perkins respectively) produced 2.7 kg/plot at Perkins to 4.5 kg/plot at Tipton in 1983. Higher weed weights were observed at Tipton in 1982 than in 1983. Dry weights generally increased as weed densities increased. Significant differences were not observed between densities of 2 and 4 in any environment, nor between 4 and 8. Significant differences in dry weights were observed between densities of 2 versus 8 at Tipton in both years. Densities of 8 versus 16 versus 32 densities were not significant in any case; whereas, they were not significant in any of the three experiments. The relationship of weed density with weed dry weights was best described with a curvilinear fit of the data which resulted in a multiple correlation coefficient (r^2)=0.72 for the pooled data from the three environments. A linear fit of the data produced as r^2=0.68. The predicted model at at a specified density indicated that 149g (Perkins) to 402g (Tipton 1982) of weed weight would be produced for each additional tumble pigweed plant/10 m of row. Multiple regression analysis of the pooled weed dry weights indicated that the regression line was linear up to the

32 density. The curved portion of the line appeared between 32 and 64 densities. Regression analyses was again conducted omitting the 64 density, however, the complete model resulted in a higher r^2 value.

Individual tumble pigweed plant weights significantly decreased as densities increased (Table 1). Weed weights pooled over the three experiments showed a reduction from 268 g/plant at the 2 plant density to 57 g/plant at the 64 density. This decrease in plant size at the higher weed densities tends to reinforce the Snipes et al. (13) conclusion that intraspecific competition may be occurring at the higher densities. Studies by Buchanan et al. (5) with sicklepod and redroot pigweed responded linearly to increasing weed densities up to 32 plants/15 m of row. As a 3 year average, sicklepod produced approximately 240 kg/ha and redroot pigweed averaged 290 kg/ha of green weight for each plant/15 m of row. Our regression equations (not given) indicate that tumble pigweed dry weight increased from 82 kg/ha at Perkins to 198 kg/ha at Tipton in 1982 for each additional tumble pigweed/10 m of row. In the conversions to dry weights in this study, more than 50% of the fresh weight values in the field were attributed to water. Therefore, tumble pigweed fresh weights would be comparable to sicklepod and redroot pigweed.

The maximum change in cotton plant height occurred between the 0 and 64 densities of plant/10 m of row (Table 2); however, these differences only represented a change of 15, 10, and 10 cm for Perkins, Tipton in 1982, and Tipton in 1983, respectively. These changes at the extremes of the weed densities were statistically significant, but harvesting difficulty was not a factor. The height of the cotton crop was approximately 30 cm shorter at Perkins than at Tipton in 1983. The height of cotton grown under weed free conditions was only 42 cm at Perkins. Cotton grown under similar conditions at Tipton reached 73 cm height in both years. Cotton plant height was reduced at the 64 plant density compared to cotton grown under weed free conditions at Perkins. No significant differences were noted in cotton height at Tipton in either year. The predicted model at a specificed density indicated that a reduction in cotton plant height would occur of 0.4 to 1.2 cm for each additional tumble pigweed plant/10 m of row at Perkins and Tipton in 1983, respectively.

Cotton lint yield tended to decrease in each experiment with increases in weed density (Table 2). Lint yield under weed free conditions ranged from 400 kg/ha at Perkins to 590 kg/ha at Tipton in 1982. The damage threshold density in which yield reductions initially appear was at 8,16, and 4 tumble pigweed plants/10 m of row at Tipton in 1982, Tipton in 1983, and Perkins, respectively. On the average, sixteen tumble pigweed plants/10 m of row reduced cotton lint yield from 30 to 35% compared to that produced under weed free conditions. Tumble pigweed densities above 16 plants/10 m of row at Tipton in either year, and above 32 plants/10 m of row at Perkins did not cause significantly higher yield reductions. Regression analyses showed a curvilinear loss of 10, 11, and 8 kg/ha of cotton lint for each additional tumble pigweed plant/10 m of row at Tipton in 1982, Tipton in 1983, and Perkins, respectively. Calculated regressions for lint yield appeared to be linear up to 32 plants/10 m of row; however the best fit of this data (as indicated by r^2 values) over all densities were obtained with the curvilinear equations. The multiple correlation coefficient for the pooled data for lint yield was 0.47.

Regression analysis was conducted on the pooled lint yield data using pooled tumble pigweed dry weight as the predictor variable rather than the weed density (Figure 1). The predicted model at a specified weed weight/plot indicated a reduction in cotton lint yield of 56 kg/ha for each additional kg of tumble pigweed dry weight present/10 m of row (r^2=0.27). Because the r^2 value for the relationship between cotton lint yield and tumble pigweed density was 0.47, dry weights are probably not as accurate a predictor of lint yield as is plant density. Another variable examined (but not shown) versus lint yield was tumble pigweed main stem height. The predicted model at a specified height, indicated a reduction in lint yield of 2.1 kg/ha for each cm increase in tumble pigweed height (r^2=0.10). Tumble pigweed main stem height was not an accurate predictor of lint yield apparently due to yearly variations in environmental conditions.

Fiber quality analyses from samples collected prior to harvest indicated no significant differences among treatments at the 0.05 probability level. Fiber length, uniformity, strength, and micronaire were not influenced by tumble pigweed interference at any location. This was also true for the composite sample taken after harvest. Trends were noted in the samples collected prior to harvest for fiber length and uniformity; however, these were not significant at the 0.05 probability level. These results further document earlier reports (3,5,8) that these traits are not as sensitive as crop yield for measurement of weed competition effects. Cotton grade could not be considered because the weeds had to be removed prior to harvest; therefore, the opportunity was not available for foreign matter to influence the final cleanliness of the harvested product.

LITERATURE CITED

1. Buchanan, G. A. and E. R. Burns. 1970. Influence of weed competition on cotton. Weed Sci. 18:149-154.
2. Buchanan, G. A. and E. R. Burns. 1971. Weed competition in cotton. I. Sicklepod and tall morningglory. Weed Sci. 19:576-579.
3. Buchanan, G. A. and E. R. Burns. 1971. Weed competition in cotton. II. Cocklebur and redroot pigweed. Weed Sci. 19:580-582.
4. Buchanan, G. A., R. H. Crowley, and R. D. McLaughlin. 1977. Competition of prickly sida with cotton. Weed Sci. 25:106-110.
5. Buchanan, G. A., R. H. Crowley, J. E. Street, and J. A. McGuire. 1980. Competition of sicklepod (*Cassia obtusifolia*) and redroot pigweed (*Amaranthus retroflexus*) with cotton (*Gossypium hirsutum*). Weed Sci. 28:258-262.
6. Clements, F. F., J. E. Weaver, and H. C. Hansen. 1929. Plant competition - Analysis of community function. Pub. No. 398. Carnegie Inst. Washington, D. C.
7. Crowley, R. H. and G. A. Buchanan. 1978. Competition of four morninglory (*Ipomoea spp.*) species with cotton (*Gossypium hirsutum*). Weed Sci. 26:484-488.
8. Ivy, H. W. and R. S. Baker. 1972. Prickly sida control and competition in cotton. Weed Sci. 20:137-139.

9. McCormick, L. L. 1977. Category I. Weed Survey-Southern states. South. Weed Sci. Soc. Res. Rep. 30:184-215.

10. Patterson, M. G., G. A. Buchanan, J. E. Street, and R. H. Crowley. 1980. Yellow nutsedge (Cyperus esculentus) competition with cotton (Gossypium hirsutum) Weed Sci. 28:327-329.

11. Pavlychincko, T. K. 1949. Plant competition and weed control. Agric. Inst. Rev. 4:142-145.

12. Smith, D. T. and U. H. Tseng. 1970. Cotton development and yield as related to pigweed (Amaranthus spp.) density. Pages 37-38 in Proc. Beltwide Cotton Prod. Res. Conf. Natl. Cotton Coun. Amer., Memphis, TN. (Abstr.)

13. Snipes, C. E., G. A. Buchanan, J. E. Street, and J. A. McGuire. 1982. Competition of common cocklebur (Xanthium pensylvanicum) with cotton (Gossypium hirsutum). Weed Sci. 30:553-556.

14. Vengris, J., W. G. Colby, and M. Drake. 1955. Plant nutrient competition between weeds and corn. Agron. J. 47:213-217.

15. Waterfall, V. T. 1979. Keys to the flora of Oklahoma. Dep. Bot. Oklahoma State Univ., Stillwater, OK. 246 pp.

16. Whitwell, T., L. W. Wells, and J. M. Chandler. 1981. Report of 1980 cotton weed loss committee. Pages 175-178 in J. M. Brown, ed. Proc. Beltwide Cotton Prod. Res. Conf. Natl. Cotton Coun. Amer. Memphis, TN.

Table 1. Relationship of tumble pigweed density to dry weed weight and individual weed weight.

Tumble Pigweed density	Perkins	Tipton	Dry Weight of Weed: Tipton 1982	Tipton 1983	Perkins 1982	Perkins 1983	Individual Weed Weight
(plants/10 m row)	(plants/ha)		(kg/plot)				(g)
0	0	0	0a	0a	0a	0a	0a
2	2,200	2,000	1.5b	0.7a	0.9b	1.3b	268b
4	4,400	4,000	3.1b	1.8b	1.2b	2.5c	256c
8	8,800	7,900	4.3b	2.5b	1.6b	3.5d	177d
16	17,600	15,800	6.8c	4.5c	2.7c	5.5e	146e
32	35,200	31,700	8.6c	5.6c	3.6c	7.0f	93f
64	70,400	63,400	8.7c	8.3d	5.0d	7.5f	57g

Regr. equations: Dry wt. of weed (Tipton 1982) $y = 911^{b}+407^{b}x-4.5^{b}x^{2}$ (r^2=0.84)

(Tipton 1983) $y = 502^{b}+238^{b}x-1.8^{b}x^{2}$ (r^2=0.87)

(Perkins 1983) $y = 446^{b}+150^{b}x-1.2^{b}x^{2}$ (r^2=0.90)

(Pooled) $y = 620^{b}+265^{b}x-2.5^{b}x2$ (r^2=0.71)

Individual wt. of weed (Pooled) $y = 255^{b}+ 60^{b}x$ (r^2=0.60)

[a]Means within a column followed by the same letter were not significantly different at the 0.05 probability level using the L.S.D.

[b]Regression values significantly different from zero at the 0.05 probability level.

Table 2. Relationship of tumble pigweed density to cotton height and cotton lint yield.

Tumble pigweed density	Cotton Height			Cotton Lint Yield			
	Tipton		Perkins	Tipton		Perkins	
	1982	1983	1983	1982	1983	1983	Pooled
(plants/10 m row)	(cm)			(kg/ha)			
0	73a	73a	42a	590a	460a	400a	480a
2	69ab	68ab	42a	540ab	455ab	360a	450ab
4	66ab	68ab	42a	450a-c	450a-c	280b	390bc
8	69ab	72a	38ab	440bc	340a-d	290b	390bc
16	67ab	68ab	390cd	320c-e	280b	280b	330c
32	68ab	64b	33bc	320cd	250de	190c	260d
64	62b	63b	27c	220d	270e	130c	210d

Regr. equations: Cotton height (Tipton 1982) $y = 72.6^{b}-1.2^{b}x$ ($r^2=0.25$)

(Tipton 1983) $y = 72.7^{b}-1.2^{b}x$ ($r^2=0.11$)

(Perkins 1982) $y = 42.4^{b}-0.4^{b}x$ ($r^2=0.31$)

Cotton lint yield (Tipton 1982) $y = 544^{b}-10.5^{b}x+0.9^{b}x^2$ ($r^2=0.58$)

(Tipton 1983) $y = 464^{b}-10.9^{b}x+0.1^{b}x^2$ ($r^2=0.45$)

(Perkins 1983) $y = 388^{b}-8.2^{b}x+0.7^{b}x^2$ ($r^2=0.72$)

(Pooled) $y = 466^{b}-9.9^{b}x+0.09^{b}x^2$ ($r^2=0.47$)

[a]Means within a column followed by the same letter were not significantly different at the 0.05 probability level using the L.S.D.

[b]Regression values significantly different from zero at the 0.05 probability level.

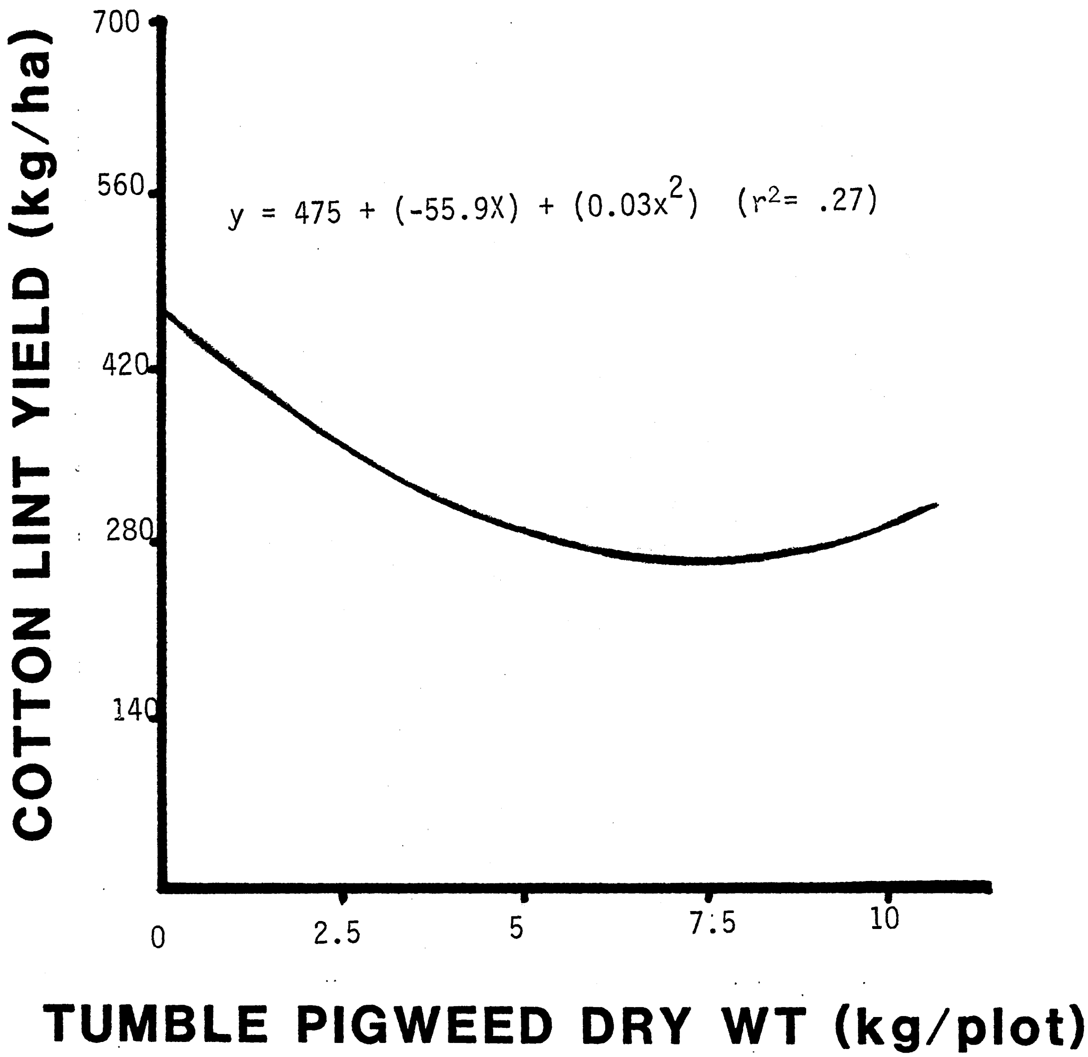

Figure 1. The relationship of cotton lint yield to dry weight of tumble pigweed (pooled).

PART II

INTERFERENCE OF BUFFALOBUR (*SOLANUM ROSTRATUM*) WITH COTTON (*GOSSYPIUM HIRSUTUM*)

INTERFERENCE OF BUFFALOBUR (*SOLANUM ROSTRATUM*)
WITH COTTON (*GOSSYPIUM HIRSUTUM*)

Abstract. Cotton (*Gossypium hirsutum* L. 'Westburn M') was grown with densities of buffalobur (*Solanum rostratum* Dunal. # *SOLCU*) ranging from 0 to 64 plants/10 m of row for full season competition. Experiments were conducted for two years at two locations. The damage threshold density where initial yield reductions occur were at 8 plants/10 m of row both years at the Tipton location and at densities of 2 and 32 plants/10 m of row at Perkins. Regression analyses of lint yield on weed density revealed a curvilinear decrease in yield with increasing densities. In the four experiments in which this study was conducted, lint yields were reduced from 5 to 18 kg/ha for each addition buffalobur present/10 m of row. Dry weights of buffalobur increased from 34 to 149 kg/ha for each additional buffalbur/10 m of row. Cotton plant height was reduced at the 16 plant density at Tipton and the 32 density at Perkins, compared to cotton grown under weed free conditions. Fiber quality characteristics were not signficantly influenced when averaged over all studies, however, measurements of fiber length, uniformity, and micronaire were significantly affected by buffalobur interference within some environments.

Additional index words. Fiber quality, lint yield, plant height, weed density, weed weight, SOLCU.

Introduction

Numerous investigators have studied the nightshade family, Solanaceae. However, most have dealt with the perennial members of the family, such as silverleaf nightshade (*Solanum elaeagnifolium* Cav.) (1,2,9) and horsenettle (*S. carolinense* L.) (10). According to a survey conducted in 1980, approximately 1.2 million hectares of U.S. cotton acreage were infested with *Solanum* spp., resulting in a 4% yield loss nationwide (17). *Solanum* spp. are relatively common in the western half of the U.S. Cotton Belt. *Solanum* spp. infest an estimated 45% of the cotton production acreage in Oklahoma resulting in an 11% yield loss. Over 30 species of Solanum are present in Oklahoma (16); however, only six are considered economically significant as weeds. Another report (11) lists silverleaf nightshade and horsenettle as the most troublesome weeds to cotton producers in Oklahoma. The most troublesome annual weed listed was buffalobur. The distribution of buffalobur ranges from Texas north the the Dakotas and east to the Great Lakes area.

Buffalobur is well adapted to the Plains region of the U.S. Wiese and Vandiver (18) reported that buffalobur produced much less growth under wet conditions than common cocklebur (*Xanthium pensylvanicum* Wallr.) and large crabgrass [*Digitaria sanguinalis* (L.) Scop.], but growth was not reduced under dry conditions. Under nonirrigated farming conditions in semi-arid and arid regions, common cocklebur and large crabgrass are not problems; however, buffalobur becomes troublesome.

The competitiveness of a number of annual weeds with cotton has been described (3,4,6,8). Some of the earlier work showed that weeds exert influence on crops by their competition for moisture, nutrients, and light (7,13,15). The effects of competition on cotton yield have been studied for several weed species (3,12), but no reports have described the interference of buffalobur with cotton. As a consequence, the objective of this research was to determine the damage threshold density of buffalobur when allowed to interfere with cotton for an entire growing season.

Materials and Methods

Experiments were employed on a Tipton silt loam (Pachic Argiustolls) at Tipton in southwest Oklahoma and on a Teller fine sandy loam (Udic Agiustolls) at Perkins in north central Oklahoma during 1982 and 1983. Soil pH was 7.6 at Tipton and 7.1 at Perkins. Soil fertility levels were amended each year according to state extension soil test recommendations for cotton. Westburn M cotton, a stripper type cultivar, was planted on 101 cm row spacings at Tipton and on 91 cm row spacings at Perkins with a conventional planter. Planting dates were June 3, May 19, June 8, and May 27 for Tipton 1982 and 1983 and for Perkins 1982 and 1983, respectively. The growing seasons were 155, 176, 149, and 167 days at Tipton in 1982 and 1983 and at Perkins in 1982 and 1983, respectively. The stand of cotton was approximately 10 plants/ meter of row. Immediately after planting, locally collected buffalobur seed were planted by hand about 3 cm from the cotton row on the south side. The weed seed were planted by hand about 3 cm from the cotton row on the south side. The weed seed were planted approximately 1 cm deep in uniformly spaced hills. Three weeks after planting buffalobur seedlings were hand thinned to one/hill with hills uniformly spaced at densities of 0, 2, 4, 8, 16, 32, and 64 plants/10 m of row. Other weeds were removed from the experiments throughout the growing season by hand hoeing.

Treatments (ie., buffalobur densities) were arranged in a randomized complete block design with four replications. Each cotton plot was four rows wide and 10 meters long. Weeds were maintained adjacent to the two center rows. The outside row of each plot was part of a two row border between plots. A preemergence application of 1.4 kg/ha of metolachlor [2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methlethyl) acetamide] and 1.12 kg/ha of prometryn [2,4-bis(isopropylamino)-6-(methylthio)-s-triazine] was applied to the border rows to minimize hand labor. The experiment was conducted under nonirrigated conditions at Tipton in 1982. Irrigation was practiced at Perkins in 1982 and at both locations in 1983.

Insecticides were not applied at Perkins; however, at Tipton, chlorpyrifos [O-O-diethyl O-(3,5,6-trichloro-2-pyridyl)phosphorothioate] was applied for cotton fleafhopper [*Pseudotomoscelis seriatus* (Reuter)] control, and permethrin [(3-phenoxyphenyl)methyl 3-(2,2-dichlorethenyl)-2,2-dimethylcyclopropanecarboxylate] was applied for the bollworm *Heliothis zea* (Boddie) and tobacco budworm [*H. virescens* (F.)] complex control in 1982 and 1983, respectively. Methyl parathion [O,O-dimethyl O-(p-nitrophenyl)phosphorothioate] plus chlordimeform [N'-(4-chloro-O-tolyl)-N,N-dimethylformamidine] was also applied for boll weevil (*Anthonomus grandis* Boheman) control at Tipton in 1983. Applications were made according to recommendations by extension entomologist field scouts.

Cotton plant height was measured in cm from the soil surface to the apex of the main stem on six plants/plot soon before cotton harvest. Buffalobur plant diameters were taken in late August. Approximately 3 to 4 weeks before cotton harvest, but after a killing freeze, buffalobur plants were harvested for weight determinations. The weeds were cut at ground level, and green weights were obtained. A composite sample of the above ground portion of the buffalobur was also taken from each plot and dried in forage driers at 49C for 72 hours. Weed dry weight was calculated from the samples and used to estimate dry weight for the plot.

Before cotton harvest each year, one mature boll/plant was removed from the center part of 15 randomly selected plants in the two center rows. In 1983, an additional boll sample was taken as a composite sample from the entire mechanically harvested plot. The additional sample was taken to find if differences between the sampling techniques could be detected. The samples were used to calculate percent lint for the sample, and to measure fiber length, uniformity, strength, and micronaire. Fiber length was measured on a digital fibrograph as 2.5 and 50% span lengths in inches (converted to mm). Uniformity index was calculated by dividing 50% span length by 2.5% span length and by then multiplying by 100. Fiber strength was measured on a stelometer in fg/tex (converted into mN/tex). Micronaire was measured in standard units on the micronaire machine. Fiber analyses were conducted in the Oklahoma State University Cotton Quality Lab.

In early December when the cotton bolls were fully open and dry, cotton was harvested from the two center rows of each plot with a roller brush-type mechanical stripper. Seed cotton yield from each plot was converted to lint yield in kg/ha.

All data were subjected to analyses of variance and regression analysis to determine the effects of buffalobur densities on cotton lint yield, cotton plant height, weed dry weight, weed diameters, and fiber quality analyses. Data were pooled over the four experiments, and results from regression analyses were based on individual plot values rather than on treatment means.

Results and Discussion

In all of the experiments, dry weights of buffalobur increased with increasing weed densities (Table 1). Buffalobur dry weights were more than 100% greater at both locations in 1983 than in 1982. Densities of 16 buffalobur plants/10 m of row (15,800 and 17,600 plants/ha at Tipton and Perkins, respectively) produced 4.6 and 5.6 kg/plot at Tipton and Perkins in 1983 compared to 3.5 and 1.1 kg/plot at the same locations in 1982. Location by density by year interaction was present. No differences were present among the 2, 4, and 8 plant densities at Perkins in 1982 and Tipton in 1983. Significant increases in dry weight were noted at the 8 plant density at Tipton in 1982 and Perkins in 1983 when compared to densities of 2/10 m of row. Densities of 8 versus 16 produced significant reductions in dry weights both years at Tipton, but not at Perkins. Dry weights of the 16 versus 32 densities were significantly different only at Tipton in 1983; however, this was not the only experiment in which no differences were observed between 32 and 64 densities.

Regression analysis indicated that the relationship between weed density and weed weight was curvilinear with multiple correlation coefficient values (r^2) ranging from 0.79 to 0.93 for the four experiments. The predicted model at a specified density indicated that for each additional buffalobur/10 m of row, there would be an increase in dry weight from 63g to 303g at Perkins in 1982 and Tipton in 1983, respectively. Multiple regression analysis of the weed dry weights indicated that the regression line was linear up to the 32 density. The curved portion of the line appeared between the 32 and 64 densities. Regression analysis was again conducted omitting the 64 density, however, the complete models consistently resulted in higher r^2 values.

Buffalobur dry weights were greater at both locations in 1983 than in 1982. The growth and development of buffalobur was not reduced under the drought conditions of 1983 which agrees with Wiese et al. (18) that buffalobur growth was not reduced by dry soil conditions. Earlier studies (6) indicated that sicklepod (Cassia obtusifolia L.) and redroot pigweed (Amaranthus retroflexus L.) produced approximately 240 and 290 kg/ha of green weight for each plant/15 m of row. In conversion to dry weights in this study, more than 50% of the fresh weight values in the field were attributed to water. Dry weights (not given) for each additional buffalobur plant/10 m of row ranged from 34 kg/ha to 149 kg/ha at Perkins in 1982 and Tipton in 1983, respectively. Averaging these values over the four experiments, buffalobur dry weights were 104 kg/ha for each buffalobur/10 m of row. This is less than reported by Snipes et al. (14) for common cocklebur which produced 342 kg/ha for each common cocklebur/15 m of row.

Individual buffalobur plant weights generally decreased as densities increased (Table 1). Weed weights pooled over the four experiments showed a reduction from 325g at the 2 plant density to 44g at the

64 density. Buffalobur plant weight decreases at the higher weed densities suggest that intraspecific competition may be occurring between the buffalobur plants. This coincides with Snipes et al. (14) that intraspecific competition often occurs when high populations of a single species exists in a limited environment.

Cotton plants grown under weed free conditions ranged from being 52 cm tall at Perkins to 75 cm at Tipton (Table 2). Density by location interaction was present for cotton plant height, therefore, results are presented by location. The height of cotton was shorter at Perkins than at Tipton. Cotton plant height generally decreased as weed densities increased, however, no signficant height reductions were noted until the 16 density at Tipton and the 32 density at Perkins when compared to cotton grown under weed free conditions. Further reductions occurred at the 64 plant densities with cotton plant height being reduced from 18 cm at Tipton to 6 cm at Perkins. Regression analysis indicated that the best fit of the data was with a linear response. The predicted model at a specified weed density showed a reduction in cotton height of 50 mm at Tipton and 23 mm at Perkins for each additional buffalobur/10 m of row. Although cotton plant height was reduced under higher buffalobur densities, harvesting was not hampered by the shorter cotton plants. These results demonstrate that cotton height may not be a good indicator of weed competition due to yearly variations in environmental conditions.

Cotton lint yield tended to decrease in each experiment with increases in weed density (Table 2). Analysis of the yield data indicated a density by year by location interaction. Lint yield under weed free conditions ranged from 500 kg/ha at Perkins in 1983 to 760 kg/ha at Tipton in 1983. The damage threshold density in which yield reductions initially appear was at 8 plants/10 m of row at Tipton both years compared to cotton grown under weed free conditions. Cotton lint yield reductions occurred at the 2 and 32 plant densities at Perkins in 1983 and 1982, respectively. No differences in yield were noted between 32 and 64 plants/10 m of row in any experiment. Pooled means of the four experiments showed that cotton lint yield was reduced 42, 52, and 58% at the 16, 32 and 64 plant densities when compared to cotton grown under weed free conditions. At Perkins in 1983, lint yield was reduced 52% with 4 plants/10 m of row, or one plant/2.5 m of row. At this density of one plant/2.5 m of row, an individual buffalobur plant diameter was approximately 90 cm (Table 2). Individual buffalobur plant diameter generally decreased as densities increased to the 16 plant density. No differences in buffalobur diameters were noted between the 16, 32, or 64 plant densities.

Simple and multiple regression analyses were conducted on the yield data (Table 2). A curvilinear fit of the data consistently resulted in higher r^2 values than simple linear regression models. Using the curvilinear model resulted in an r^2 value of 0.41 for the pooled yield data versus weed density. The linear model produced an r^2 of 0.32. This trend was consistent throughout the analyses of individual experiments. The predicted model for a specified density indicated a reduction in cotton lint of 5, 17, 15, and 18 kg/ha for each additional buffalbur/ 10 m of row at Perkins in 1982, 1983, and at Tipton in 1982 and 1983, respectively. The r^2 values ranged from 0.33 to 0.77.

Regression analysis was conducted on the pooled cotton lint yield using buffalobur dry weight as the predictor variable rather than weed density (Figure 1). Comparisons of regression analyses showed that the r^2 value for linear regression was 0.52 and the r^2 for curvilinear regression was 0.53. The predicted model at a specified weed weight/plot indicated a reduction in cotton lint yield of 51 kg/ha for each additional kg increase in buffalobur dry weight/10 m of row using the linear model. A 75 kg/ha reduction would be expected with the curvilinear model. The r^2 values of 0.52 and 0.53 from using weed dry weights as the predictors were better than r^2=0.41 from the pooled yield data when buffalobur densities were used. This indicates that weed dry weights may be a more accurate predictor of cotton lint yield than buffalobur densities.

Fiber quality analysis data, sampled prior to harvest, indicated no significant differences when pooled over the four experiments (Table 3); however, some parameters were significant when analyzed within experiments. Fifty percent span length (p=0.05) was reduced at 32 and 64 plants/10 m of row at Perkins in 1983. Micronaire, a measurement of fiber fineness versus coarseness, was reduced at the 32 and 64 plant densities (p=0.05) at Perkins in 1983; however, these values (4.2 and 4.0 micronaire units) were still within acceptable grading limits. Differences in uniformity index were observed at Tipton (p=0.10) and Perkins (p=0.05) in 1983. Values were reduced at 16 buffalobur plants/10 m of row when compared to cotton grown under weed free conditions. No further reductions were noted between the 16, 32, and 64 densities. No significant differences were observed for fiber quality when samples were collected as a composite sample after mechanical harvest. These results further document earlier reports (4,5) that fiber traits are not as sensitive as crop yield for measurement of weed competition effects. Cotton grades could not be considered as a variable because the weeds were removed prior to cotton harvest, therefore, different amounts of foreign material present between cotton plots would not have been expected.

LITERATURE CITED

1. Boyd, J. W. and D. S. Murray. 1982. Growth and development of silverleaf nightshade (Solanum elaeagnifolium). Weed Sci. 30:238-243.
2. Boyd, J. W. and D. S. Murray. 1982. Effects of shade on silverleaf nightshade (Solanum elaeagnifolium). Weed Sci. 30:264-269.
3. Buchanan, G. A. and E. R. Burns. 1970. Influence of weed competition on cotton. Weed Sci. 18:149-154.
4. Buchanan, G. A. and E. R. Burns. 1971. Weed competition in cotton. II. Cocklebur and redroot pigweed. Weed Sci. 19:580-582.
5. Buchanan, G. A., R. H. Crowley, and R. D. McLaughlin. 1977. Competition of prickly sida with cotton. Weed Sci. 25:106-110.
6. Buchanan, G. A., R. H. Crowley, J. E. Street, and J. A. McGuire. 1980. Competition of sicklepod (Cassia obtusifolia) and redroot pigweed (Amaranthus retroflexus) with cotton (Gossypium hirsutum). Weed Sci. 28:258-262.
7. Clements, F. F., J. E. Weaver, and H. C. Hansen. 1929. Plant competition - Analysis of community function. Pub. No. 398. Carnegie Inst. Washington, D.C.
8. Crowley, R. H. and G. A. Buchanan. 1978. Competition of four morningglory (Ipomoea spp.) species with cotton (Gossypium hirsutum). Weed Sci. 26:484-488.

9. Hackett, N. M. and D. S. Murray. 1982. Interference of silver-leaf nightshade (Solanum elaeagnifolium) with Spanish peanuts (Arachis hypogaea). Proc. South. Weed Sci. Soc. 35:66 (Abstr.)

10. Hackett, N.M. and D. S. Murray. 1983. Interference of horse-nettle (Solanum carolinense) with Spanish peanuts (Arachis hypogaea). Proc. South. Weed Sci. Soc. 36:53-54. (Abstr.)

11. McCormick, L. L. 1977. Category I - Weed survey - Southern states. South. Weed Sci. Soc. Res. Rep. 30:184-215.

12. Patterson, M. G., G. A. Buchanan, J. E. Street, and R. H. Crowley. 1980. Yellow nutsedge (Cyperus esculentus) competition with cotton (Gossypium hirsutum). Weed Sci. 28:327-329.

13. Pavlychincko, T. K. 1949. Plant competition and weed control. Agric. Inst. Rev. 4:142-145.

14. Snipes, C. E., G. A. Buchanan, J. E. Street, and J. A. McGuire. 1982. Competition of common cocklebur (Xanthium pensylvanicum) with cotton (Gossypium hirsutum). Weed Sci. 30:553-556.

15. Vengris, J., W. G. Colby, and M. Drake. 1955. Plant nutrient competition between weeds and corn. Agron. J. 47:213-216.

16. Waterfall, U. T. 1979. Keys to the flora of Oklahoma. Dep. Bot. Oklahoma State Univ., Stillwater, OK. 246 pp.

17. Whitwell, T., L.W. Wells, and J. M. Chandler. 1981. Report of 1980 cotton weed loss comittee. Pages 175-178 in J. M. Brown, ed. Proc. Beltwide Cotton Prod. Res. Conf. Natl. Cotton Coun. Amer., Memphis, TN.

18. Wiese, A. F. and C. W. Vandiver. 1970. Soil moisture effects on competition ability of weeds. Weed Sci. 18:518-519.

Table 1. Relationship of buffalobur density to dry weight and individual weed weight.

Buffalobur Density	Tipton	Perkins	Dry Weight of Weed: Tipton 1982	Dry Weight of Weed: Tipton 1983	Dry Weight of Weed: Perkins 1982	Dry Weight of Weed: Perkins 1983	Individual Weed Wt.
(plants/10 m row)	(plants/ha)		(kg/plot)				(g)
0	0	0	0a	0a	0a	0a	0a
2	2,000	2,200	0.4b	1.5b	0.5b	2.8b	325b
4	4,000	4,400	0.9b	2.4b	0.4b	3.5bc	222b
8	7,900	8,800	2.0c	2.8b	0.7bc	4.6cd	157c
16	15,800	17,600	3.5d	4.6c	1.1cd	5.6de	116d
32	31,700	35,200	3.3d	7.5d	1.6d	7.0ef	76e
64	63,400	70,400	4.2e	8.6d	2.2e	7.5f	44f

Regr. equations: Dry wt. of weed (Tipton 1982) $y = 286^{b}+177^{b}x-1.9^{b}x^{2}$ ($r^2=0.84$)

(Tipton 1983) $y = 626^{b}+306^{b}x-2.8^{b}x^{2}$ ($r^2=0.93$)

(Perkins 1982) $y = 159^{b}+63^{b}x-0.5^{b}x^{2}$ ($r^2=0.80$)

(Perkins 1983) $y = 1690^{b}+286^{b}x-3.1^{b}x2$ ($r^2=0.79$)

Individual weed wt. (Pooled) $y = 475^{b}+210^{b}x-2.2^{b}x^{2}$ ($r^2=0.67$)

[a]Means within a column followed by the same letter were not significantly different at the 0.05 probability level using the L.S.D.

[b]Regression values significantly different from zero at the 0.05 probability level.

Table 2. Relationship of buffalobur density to cotton height, cotton lint yield, and buffalobur plant diameter.

Buffalobur Density	Cotton Height Tipton	Cotton Height Perkins	Cotton Lint Yield Tipton 1982	Cotton Lint Yield Tipton 1983	Cotton Lint Yield Perkins 1982	Cotton Lint Yield Perkins 1983	Cotton Lint Yield Pooled	Buffalobur Plant Diameter
(plants/10 m row)	(cm)		(kg/ha)					(cm)
0	75a	52a	570a	700ab	600a	500a	600a	-
2	69ab	49ab	540ab	760a	520ab	390b	550b	101a
4	72ab	47a-c	500ab	600bc	490a-c	240c	450c	89a-c
8	72ab	51a-c	440b	500c	510ab	270c	430c	96ab
16	67bc	50a-c	260c	450c	490a-c	170d	350d	84bc
32	61c	44bc	310c	340d	410bc	100e	290de	81c
64	57cd	46c	290c	220d	380c	85e	250e	78c

Regr. equations: Cotton height (Tipton) $y = 77.7^{b} - 0.50^{b}x$ ($r^2=0.29$)

(Perkins) $y = 50.5^{b} - 0.23^{b}x$ ($r^2=0.05$)

Cotton lint yield (Tipton 1982) $y = 59.3^{b} - 15.4^{b}x + 0.18^{b}x^2$ ($r^2=0.65$)

(Tipton 1983) $y = 70.4^{b} - 17.7^{b}x + 0.16^{b}x^2$ ($r^2=0.72$)

(Perkins 1982) $y = 54.6^{b} - 5.5^{b}x + 0.05^{b}x^2$ ($r^2=0.33$)

(Perkins 1983) $y = 41.3^{b} - 17.0^{b}x + 0.19^{b}x^2$ ($r^2=0.77$)

(Pooled) $y = 65.5^{b} - 13.9^{b}x + 0.14^{b}x^2$ ($r^2=0.41$)

[a] Means within a column followed by the same letter were not significantly different at the 0.05 probability level using the L.S.D.

[b] Regression values significantly different from zero at the 0.05 probability level.

Table 3. Cotton fiber quality analyses as influenced by increasing buffalobur densities in 1983.

Buffalobur Density	Span Length[a] Uniformity Perkins	Uniformity Tipton	50% Perkins	Micronaire[a] Perkins
(plants/10 m row)	------------------		(mm)	(ug/in)
0	44.6	45.0	11.1	4.9
2	45.3	45.5	11.2	4.8
4	44.9	43.2	10.5	4.6
8	45.3	44.9	11.0	4.6
16	43.5	43.4	10.8	4.6
32	42.9	42.9	10.3	4.2
64	42.6	43.0	9.8	4.0
LSD 0.05	1.3 (p=.05)	1.7 (p=.10)	0.6 (p=.05)	0.3 (p=.05)

[a]Quality analysis samples were collected prior to harvest.

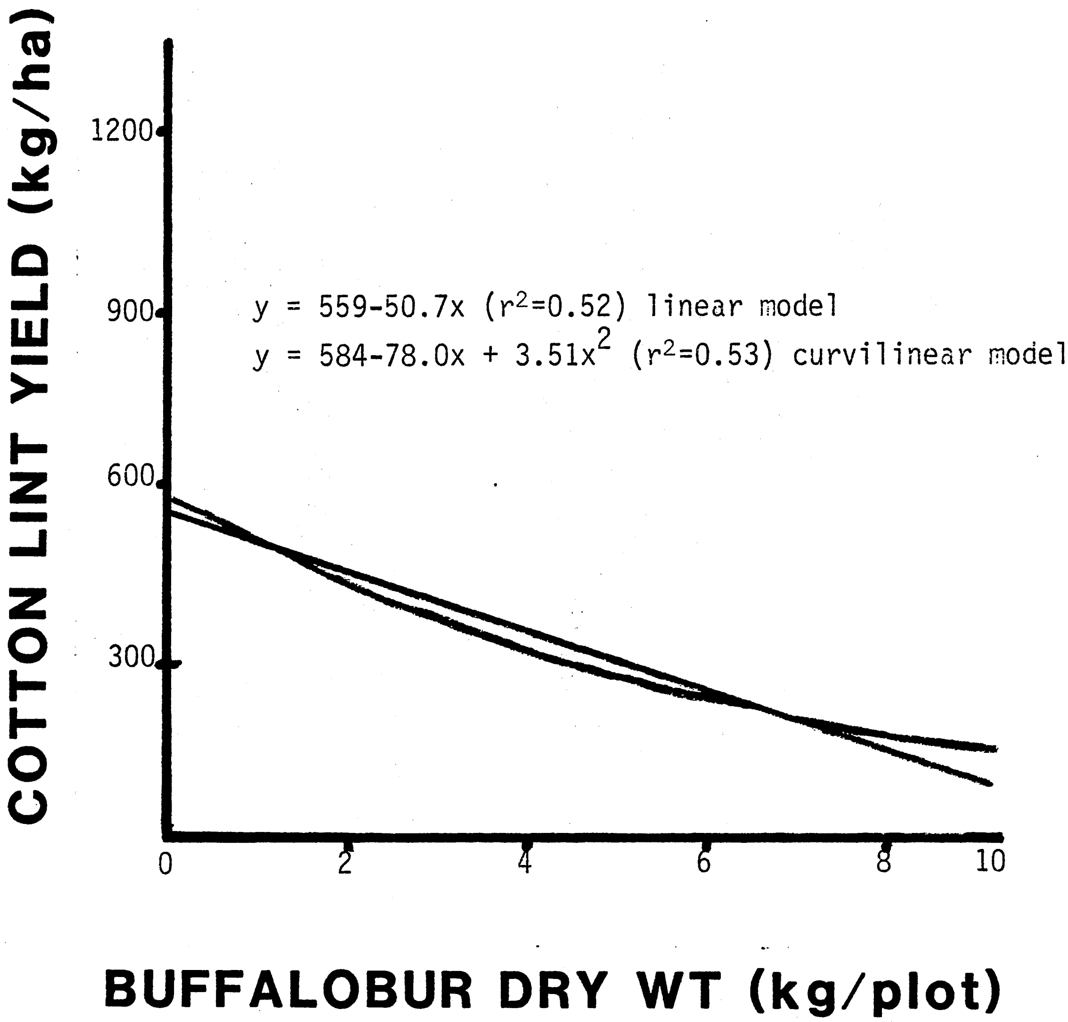

Figure 1. The relationship of cotton lint yield versus buffalobur dry weight (pooled).

VITA[2]

DOUGLAS WARREN RUSHING

Candidate for the degree of

Doctor of Philosophy

Thesis: INTERFERENCE OF TUMBLE PIGWEED (AMARANTHUS ALBUS) AND BUFFALOBUR (SOLANUM ROSTRATUM) WITH COTTON (GOSSYPIUM HIRSUTUM)

Major Field: Crop Science

Biographical:

Personal Data: Born February 1, 1956, in Wingate, North Carolina, son of Mr. and Mrs. Robert R. Rushing; Married Angela E. Rudroff, April 14, 1979.

Education: Graduated from Forest Hill H.S., Marshville, N.C., in 1974; received the Associate of Science degree in horticulture from Wingate Junior College, Wingate, N.C., in 1976; received the Bachelor of Science degree in horticulture from North Carolina State Univ., Raleigh, N.C. in 1978; received the Master of Science degree in Agronomy from Oklahoma State Univ., Stillwater, OK in 1981; and completed the requirements for the Doctor of Philosophy degree in Crop Science at Oklahoma State Univ., Stillwater, OK, in May, 1984.

Professional Experience: Assistant agricultural extension agent, North Carolina Agricultural Extension Service, Salisbury, N.C.; Research assistant in Weed Science, Oklahoma State Univ., Stillwater, OK, 1979 to present.

Member: American Society of Agronomy, Southern Weed Science Society, Weed Science Society of America.