# INTERFERENCE OF IVYLEAF MORNINGGLORY (*Ipomoea hederacea*) WITH COTTON (*Gossypium hirsutum*)

By

JOY BETH ROGERS

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Thesis Approved:

Don S. Murray
Thesis Adviser

P. Larry Claypool

Laval M. Verhalen

Thomas C. Collins
Dean of the Graduate College

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# INTERFERENCE OF IVYLEAF MORNINGGLORY (Ipomoea hederacea) WITH COTTON (Gossypium hirsutum)

**Abstract.** The effects of full-season interference and critical duration of early-season ivyleaf morningglory [Ipomoea hederacea (L.) Jacq.] with cotton [Gossypium hirsutum L. 'Paymaster 145 & HS-26'] were measured in two Oklahoma environments. The effects of densities ranging from 0 to 64 weeds/10 m row were evaluated on cotton yield, fiber properties, and harvest efficiency. Regression analysis using piecewise linear regression within PROC NLIN in SAS proved superior to linear, curvilinear, and linear plateau models. Lint yield reductions of 36.9 kg/ha at Perkins were recorded for each increase of 1 weed/10 m from densities up to 8.7 weeds/10 m. At densities greater than 8.7 weeds/10 m, yield is reduced by an additional 3.0 kg/ha for each increase of 1 weed/10 m. At Chickasha, lint yield was reduced 29.7 kg/ha for each increase of 1 weed/10 m from densities up to 9.0 weeds/10 m, and an additional loss of 3.6 kg/ha for each increase of 1 weed/10 m at densities greater than 9.0 weeds/10 m.

Critical duration of early season ivyleaf morningglory interference was conducted from 0 to 12 wk, at 3 wk intervals and full-season interference. At Perkins, lint yield was reduced 53.0 kg/ha, for each week weed removal was delayed, up to 9.5 wk. An estimated additional 1.0 kg/ha was lost for each increase of 1 wk of interference greater than 9.6 wk. At Chickasha, lint yield was reduced 49.0 kg/ha with each wk of interference up to 11.4 wk, and an additional loss of 1.2 kg/ha for each increase of one wk of interference greater than 11.4 wk. Nomenclature: Ivyleaf morningglory, *Ipomoea hederacea* (L.) Jacq. #[1] IPOHE; cotton, *Gossypium hirsutum* L., 'Paymaster 145' and 'Paymaster HS-26'. Additional index words: competition, harvest efficiency, fiber quality, cotton yield, IPOHE.

## INTRODUCTION

Morningglories are the third "most troublesome" and the fourth "most common" weed in Oklahoma cotton (6). Approximately 12,000 hectares of Oklahoma cotton were infested by Ipomoea spp. in 1992 (3). Ivyleaf morningglory is one of the five morningglory species present in the state and is considered the most difficult to control.

Numerous publications report the results of weed interference research with cotton, and several reviews have summarized them (13, 22). The effect of full-season interference from various weed densities on cotton (1, 2, 5, 7, 14, 16, 17, 19, 20) and the critical duration of that interference (2, 9, 10, 14, 19, 20) have been measured. Zimdahl (22) discusses the importance of such results and how they can be used to formulate weed management strategies.

Interference of annual weeds with cotton has reduced lint yield (1, 2, 5, 7, 9, 10, 11, 14, 16, 17, 19, 20, 21), fiber quality (2, 7, 11, 16, 17), and harvest efficiency (5, 7, 20). However, few reports have included Ipomoea spp, and none were found in stripper-harvested cotton. Interference from several weeds, other than morningglory, has been evaluated in Oklahoma field research (7, 11, 14, 16, 17, 19).

The effects of four Ipomoea spp. on picker-harvested cotton yield have been reported (5). Tall morningglory [I. purpurea (L.) Roth], entireleaf morningglory [I. hederacea var. _integriuscula_ Gray], ivyleaf morningglory, and pitted morningglory (_I._ _lacunosa_ L.) densities of 8 weeds/15 m row reduced cotton yield 19, 9, 6, and 3%, respectively. At densities of 32 weeds/15 m, those species reduced yield 88, 50, 44, and 44%, respectively. In the same investigation, harvest efficiency was reduced from 3 to 31% with increasing densities of tall morningglory; however, efficiencies were not affected by the other species. Wide variation in harvest efficiency and interference was attributed to weather conditions and disease incidence.

In other research, a density of 8 tall morningglory/7.3 m row reduced picker cotton yield 10 to 75%; some of that variation was attributed to soil type (1). Interference by 4, 8, and 12 devil's-claw (_Proboscidea_ _louisianica_ (Mill.) Thellung) plants/10 m row reduced cotton yield by 22, 49, and 56 kg/ha, respectively, for each week of interference (14).

Oliver (13) describes the two methods used for critical duration determinations. One involves the weed-free maintenance of a crop beginning with crop emergence and then ceasing weed control at prescribed intervals and allowing the weed to grow with the crop. The second involves allowing the weeds and crop to emerge and grow together for a period of time before the weed is removed. If feasible, he advocates using both methods simultaneously in the same experiment.

Utilizing the weed-free maintenance method of critical duration investigations, coffee senna (Cassia occidentalis L.) reduced picker cotton yield 8% with as few as 2 wk of interference (9). Yield was not affected when maintained free from prickly sida (Sida spinosa L.) for at least 5 wk after cotton planting (2). Weed-free periods of 8 wk or longer are necessary to prevent yield loss from interference by common cocklebur (Xanthium strumarium L.) (21).

In California, picker cotton yield was zero when ivyleaf morningglory was allowed to interfere during the first 12 wk of cotton establishment (10). Morningglories planted 16 wk after cotton reduced yield 8% while no reductions in yield were measured from those planted 18 wk or more after cotton.

Measuring the impact of ivyleaf morningglory interference on stripper-harvested cotton would provide useful information for implementing weed control programs in the Oklahoma-Texas-eastern New Mexico region. Producers may not be forced to control all morningglory each year to avoid yield losses.

The objectives of this research were to determine the interference of seven ivyleaf morningglory densities on cotton lint yield, fiber properties, and stripper-harvest efficiency and to determine the critical duration period of early-season interference from that weed.

## MATERIALS AND METHODS

**General field procedures.** Experiments were conducted during 1992 and 1993 on a Teller fine sandy loam (fine-loamy, mixed, thermic Udic Argiustoll) in North Central Oklahoma near Perkins and on a Reinach silt loam (coarse-silty, mixed thermic Pachic Haplustoll) in South Central Oklahoma near Chickasha. The Perkins soil pH was 6.9 with 0.9% organic matter, and the Chickasha soil pH was 7.6 with 0.3% organic matter. At Perkins, irrigation was applied using a side-roll system on an "as needed" basis. The Chickasha location was dryland. Soil fertility levels were adjusted in accordance with state extension soil test recommendations for desired yield goals of 400 kg lint/ha at Perkins and 430 kg lint/ha at Chickasha. At Perkins, nitrogen as ammonium nitrate was applied at the rate of 56 kg/ha on July 9, 1992, and July 26, 1993. No applications were made at Chickasha either year. Phosphorus and potassium were adequate at both locations; therefore, none was applied during either year.

At Perkins, a stripper-harvested cotton cultivar, 'Paymaster HS-26', was planted using a conventional four-row planter on a 91-cm row spacing. At Chickasha, another such cultivar, 'Paymaster 145', was planted on a 102-cm row spacing. Planting dates were July 2 and June 18 for Perkins and June 22 and June 2 for Chickasha in 1992 and 1993, respectively. The optimum growing season expected for cotton in Oklahoma is 130 to 150 d. In 1992 the effective growing season was 125 d at Perkins and 104 d at Chickasha.

Planting delays, caused by prolonged early-season rainfall combined with an unusually early killing freeze contributed to a greatly shortened growing season in that year. In 1993 the effective growing season was more adequate being 134 d at Perkins and 150 d at Chickasha.

All treatments were arranged in randomized complete block designs and replicated four times. Each plot was four rows wide by 13 m long. Two weeks before harvest, 1.5 m was removed from each end of each harvest row to eliminate the "end-row" effect; therefore, each harvest row was effectively 10 m in length.

Hand-harvested, pulled cotton yields were collected separately from rows 2 and 3 in each plot. At Perkins harvest was Nov. 22 and Nov. 9 and at Chickasha Dec. 2 and Nov. 16 in 1992 and 1993, respectively. Harvest efficiency using a one-row mechanical stripper at Perkins was determined Nov. 9 and at Chickasha on Nov. 23, 1993.

Plot samples were mechanically deburred and weights recorded. Seedcotton samples from each harvested row were then ginned in a small laboratory-type gin. Weights, recorded before and after ginning, were used to estimate the gin turn-out percentages on all yields taken. All yields are reported as lint in kg/ha and as a percent of the check. Samples of fiber from each plot were retained for fiber quality analyses.

**Ivyleaf morningglory densities.** Seven ivyleaf morningglory densities 0 (weed-free or check), 4, 8, 16, 32, 48, and 64 plants/10 m of crop row were used. Immediately after planting the cotton, four to eight weed seed (previously scarified in sulfuric acid for 10 minutes) were hand planted approximately 1.25 cm deep and 8 cm from the left side of cotton rows 2, 3 and 4 within each four row plot.

A PRE application of prometryn [N,N'-bis(1-methylethyl)-6-(methylthio)-1,3,5-triazine-2,4-diamine] at 1.24 kg ai/ha and metolachlor [2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl)acetamide] at 2.5 kg ai/ha was applied immediately after planting each year. Ivyleaf morningglory were protected from the herbicides by shielding them with 23-cm diameter paper plate covers which were removed after application. Smith et al. (19) pioneered this technique of providing protection for weed seed from herbicide applications in previous investigations. At the 2- to 4-true leaf stage, the ivyleaf morningglory seedlings were hand thinned to one/spatial location resulting in the desired weed densities. Other weed species were removed by hoeing and hand pulling each week throughout the growing season.

At Chickasha, an application of ethephon [(2-chloroethyl) phosphonic acid] at 3.7 kg ai/ha was made on Nov. 2, 1992. At Perkins, a tank mix of ethephon at 3.7 kg ai/ha and butifos (S,S,S-tributyl phosphorotrithioate) at 3.7 kg ai/ha was applied Oct. 28, 1993, to assist in boll opening and defoliation. No other applications of the same or similar materials were made during 1992 or 1993 at either location.

**Fiber quality analyses.** The USDA, Agricultural Marketing Service, Cotton Division Classing Office in Altus, OK, determined fiber length, length uniformity, strength, micronaire, color, plus leaf and extraneous matter on the samples from each plot (4). All analyses are done using high volume instrument (HVI) testing.

Fiber length is the average length of the longer one-half of the fibers (upper half mean length). Measurements are reported in both 100ths (0.79 & shorter to 1.36 & longer) and 32nds of an inch (24 to 44 & longer). Length uniformity is a ratio of mean length and the upper half mean length. Values are given as percents and are always less than 100% due to natural variations in length. Strength measurements are reported in grams per tex. A tex unit equal to the weight in grams of 1,000 meters of fiber, and strength is the force necessary to break one tex unit of fiber.

Micronaire measures fiber fineness confounded with fiber maturity. Micronaire readings considered premium fall between 3.7 to 4.2 while base and discount ranges are above and below these readings. Color is measured in terms of degree of reflectance or grayness (Rd) and yellowness (Hunter's +b). Desirable numbers for Rd are between 48%, the darker and less desirable, and 82%, less dark, more reflective, and more desirable. The +b values range from 5.0, less yellow and more desirable, up to 17.0, more yellow and less desirable.

Trash content is considered all non-lint materials in a sample and is calculated after video scanning. The scanner can detect parts of leaves, stems, bark, broken bracts, hulls, pieces of burs, and other foreign material up to 5.0%. Even though instruments are used for measuring color and trash, if the classer considers trash content significant, it is reflected in the final grade assigned.

Grade assignments are made to each sample from a series of values, the best being good middling, white '11-1', and the worst below grade, yellow stained '85-5'. The first number indicates reflectance and yellowness, while the second indicates a sub-division within the grade based on small differences as detected by the instruments used.

**Harvest efficiency investigations.** A one-row, brush-roll stripper was used for the harvest efficiency investigations. Using row 4 within each plot of the density investigations, mechanical harvest was conducted starting with the treatment of 0 ivyleaf morningglory plants/10 m row. All replicates with the same density treatment were harvested before proceeding to the next higher density. This step-wise progression was continued until the harvester would no longer perform.

In those plots where mechanical harvest could be accomplished, cotton remaining on the plants in the row, the small portion which fell to the ground, and any cotton remaining in the tangled mass of morningglory vines in the stripper brush were collected by hand. This portion was weighed and used to determine harvest efficiency.

**Critical durations of early-season ivyleaf morningglory interference.** Sites for these investigations in 1993 were conducted on areas used for ivyleaf morningglory density investigations in 1992 (15). Following cotton harvest in 1992, plants on the experimental sites were shredded and the organic material disked into the soil four times changing angles of incorporation each time in an attempt to uniformly distribute the morningglory seed. Treatments consisted of allowing the cotton and morningglory emerge and grow together for 0 (weed-free or check), 3, 6, 9, and 12 wk after cotton planting plus full-season interference (20 wk at Perkins and 23 wk at Chickasha).

The weed-free or check plots were treated immediately after planting with a tank mix of prometryn at 1.24 kg ai/ha and metolachlor at 2.5 kg ai/ha. All other plots received only an application of metolachlor at 2.5 kg ai/ha to control annual grasses and pigweed. All plots were hoed and hand pulled each week to remove undesired weed species, including undesired Ipomoea spp. In addition, trailing morningglory vines encroaching on adjacent plots were cut.

At the designated removal time, the morningglory vines among all four rows and from one half of the middle between adjacent plots were removed by hand. After the vines were removed, the plots were maintained weed-free for the remainder of the growing season.

Data collection at each removal date included representative cotton plants and morningglory biomass samples. One cotton plant was collected from row 4 in the check plots, full-season weed interference plots, from any plot where weeds were being removed, and from plots where weeds had previously been removed.

Ivyleaf morningglory biomass from 0.25 $m^2$ was collected from the center of the four-row plots just before weed removal. The biomass only represented the sampling area and could not be related to an individual weed. All cotton plant and morningglory biomass samples were placed in forage driers for 72 h at 49 C. Biomass dry weights were used to estimate kg morningglory/ha and the dry weight of a single cotton plant.

**Data analyses.** All data except lint grades were subject to analysis of variance. All data analyses were initially kept separate by row, but because there were no differences between them, the rows were pooled. Differences were expected between locations; therefore, traits were analyzed by separate locations.

Yields are presented as lint in kg/ha and were converted to a percent of the check. Regression equations tested for "best fit" included linear, curvilinear, linear plateau, and piecewise regressions. The two latter models required the use of PROC NLIN in SAS (18). Harvest efficiency analyses were conducted only as analysis of variance. The relationship between cotton yields (Y) and weed density (X) is estimated by two linear line segments. More specifically, $Y = B_o + B_1X$ for $X < X_w$ and $Y = B_o + B_1X_w + B_2(X - X_w)$ for $X > X_w$.

## RESULTS AND DISCUSSION

**Ivyleaf morningglory densities.** In 1992, early season rainfall, cool wet growing season and an early killing freeze contributed to poor yields. At Perkins, seedcotton yield of 170 kg/ha, the equivalent of 0.4 bale of lint/ha, and at Chickasha, 373 kg seedcotton/ha or the equivalent of 0.9 bale of lint/ha were recorded. These yields were not considered representative of Oklahoma cotton production; therefore, the results of 1992 investigations will not be included in this discussion.

Neither simple linear nor curvilinear regression models were efficient for estimating the relationship between cotton yield and morningglory density. Curvilinear models estimate an increase in yield as weed density increases; however, this is an artifact of this type model and is not biologically realistic.

Models using two straight line segments joined at a break point more realistically fit the data, and are referred to as a piecewise regression (12). The break point, to be referred to as the weed density joint or

WDjoint, estimates the weed density at which the slope of the estimated relationship changes. These models resulted in higher $r^2$ values and more realistic estimate of yields. Since WDjoint is an estimate of the average weed density (number of weeds/10 m row) at which the greatest change in slope appears, WDjoint need not be an integer.

The two straight line, TSL, model in its simplest form reduces to the linear plateau model. However, from a biological viewpoint, it is more realistic for the yield to continue to decrease as weed densities increase. Models which allow for this phenomenon were used in place of the linear plateau models. Estimation of the WDjoint, given by the $X_w$ parameter, indicates that the TSL models are no longer linear regression models; hence, PROC NLIN in SAS was used to obtain parameter estimates (18).

These segments indicate a more rapid decrease in yield before WDjoint than after; that is $B_1 < B_2$. The inequality appears reversed since the $B_1$ and $B_2$ slopes are both negative.

In 1993 at Perkins, the mean yield was 551 kg lint/ha from plots with 0 weeds/10 m. Lint yields from densities of 4, 8, 16, 32, 48, and 64 weeds/10 m were 384, 252, 231, 118, 104, and 86 kg/ha, respectively. At Perkins, the WDjoint was estimated at a density of 8.7 weeds/10 m for lint yields (Figure 1). The initial lint yield loss, given by the first line segment, is estimated to be 36.9 kg/ha for each increase of 1 weed/10 m up to 8.7. After this initial loss, yield is decrease by an additional 3.0 kg/ha for each increase of 1 weed/10 m, for densities greater than 8.7 weeds/10 m. For example, the mean lint yield is estimated to be 366.7, 230.2, 220.4 kg/ha for 5, 8.7 (WDjoint), and 12 weeds/10 m, respectively.

At Chickasha, the lint yield from plots with 0 weeds/10 m plots was 598 kg/ha. Lint yields in plots with densities of 4, 8, 16, 32, 48, and 64 weeds/10 m were 403, 343, 273, 261, 118 and 97 kg/ha, respectively. The WDjoint was estimated at 9.0 weeds/10 m. Estimates indicate lint yield decreases by 29.7 kg/ha for each increase of 1 weed/10 m, up to 9.0 weeds/10 m (Figure 1). At densities greater than 9.0, an additional loss of 3.6 kg/ha for each increase of 1 weed/10 m would be expected. An example, mean lint yield is estimated to be 425.2, 306.8, and 295.6 kg/ha for densities of 5, 9.0 (WDjoint), and 12 weeds/10 m.

Transposing the data to a percent of check, yield was reduced 30% and 33%, at Perkins and Chickasha, respectively, from as few as 4 weeds/10 m row. Weed densities of 8, 16, 32, and 48 reduced yields 54, 58, 79, and 81% at Perkins, respectively. The same densities, at Chickasha, reduced yields 43, 55, 56, and 80%, respectively. The density of 64 weeds/10 m row reduced yields by 84% at both locations.

Using PROC NLIN to analyze data as percent of check, the weed density joint, WDjoint, was 10.0 weeds/10 m at Perkins. Yield reductions of 5.9% could be expected for each increase of 1 weed/10 m, up to a density of 10.0

(Figure 2). At densities greater than 10.0 (WDjoint), an additional loss of 0.5% is expected for each increase of 1 weed/10 m. An example, reductions to 70.5, 41.2, and 40.2 of the possible yield would be estimated for 5, 10.0 (WDjoint), and 12 weeds/10 m, respectively.

At Chickasha, the weed density joint, as percent of check, was 11.4 weeds/10 m, and yield is reduced by 3.9% for each increase of 1 weed/10 m up to 11.4 weeds/10 m. At densities greater than 11.4 (WDjoint) the yield would be reduced an additional 0.7% for each increase of 1 weed/10 m (Figure 2). For example, of the expected possible yield, reductions to 77.3, 52.2, and 51.8 would be expected from 5, 11.4 (WDjoint), and 12 weeds/10 m, respectively.

**Fiber quality analyses.** Genetics and environmental factors, and the interaction between the two, can greatly affect fiber properties. Early season rainfall, a cool wet growing season combined with early killing freeze contributed to low yield quantity and quality in 1992; therefore, no fiber analysis was conducted on those yields.

The relationship of ivyleaf morningglory density on cotton fiber properties for Perkins are shown in Table 1 and for Chickasha in Table 2. At Perkins, the only treatment where length was significantly different from the check, was the 64 weeds/10 m treatment. At Chickasha, length was significantly different from the check in only the 48 and 64 weeds/10 m treatments.

At Perkins, there were no significant differences in uniformity among the 7 treatment densities; however, at Chickasha, uniformity for the check was significantly different from the 48 and 64 weeds/10 m treatments. Strength was not affected by any of the 7 treatment densities at Perkins. At Chickasha the only significant differences in strength were measured for the densities of 16 and 48 weeds/10 m.

At Perkins, micronaire measurements in the 64 weeds/10 m treatment, were significantly different from the check, 4, 8, and 16 weeds/10 m treatments. At Chickasha, only the check and 8 weeds/10 m treatments were significantly different from the 64 weeds/10 m treatment.

At Perkins, color trait Rd for the check was not significantly different from any other treatment. At Chickasha, Rd values for the check were significantly different from only the 4, 32, 48, and 64 weeds/10 m treatments. Color trait +b values, for the checks at both locations, were not significantly different from any other treatments.

Trash content in the check, at Perkins, was significantly different from only the 64 weeds/10 m treatment. At Chickasha, trash in the check was significantly different from all other treatments, except 8 weeds/10 m treatment.

**Harvest efficiency investigations.** Mechanical harvest at Perkins was conducted in plots with densities of 0 to 16 weeds/10 m and lint yield was 242, 253, 242 and 242 kg/ha, respectively. At Chickasha, lint yield from densities of 0 to 8 weeds/10 m were 191, 196 and 186 kg/ha, respectively. At each location, mechanical harvest was discontinued when a large tangled mass of morningglory vines rolling inside the stripper brush and caused the machine to lodge.

No differences were measured in the mechanically harvested portions of lint at either location. However, machine missed portions were significantly different among plots which were mechanically harvested. The differences in machine missed portions were attributed to increased trash content. Actual weight of the machine missed portions were inadequate for HVI analysis; therefore, this determination was made in a subjective manner.

Buchanan et al. (2) reported cotton harvest may be slightly reduced, one percent, by 12 prickly sida plants/15 m row. This investigation suggested a relationship existed between weed density and machine harvest efficiency; however, no statistical proof was evident from 3 yrs comparison of machine harvested and machine missed yields.

Lint samples from the machine harvested portions were analyzed for differences in fiber properties (Table 3). As a general trend, at Perkins, the 0 weeds/10 m samples are strict low middling, tinged, while samples from densities 4 to 16 weeds/10 m were below grade, spotted and tinged range.

Fiber analysis from Chickasha indicated samples were of a lower grade; however, more desirable in terms of reflectance (Table 3). Lint samples with 0 weeds/10 m were good ordinary, white, while samples with 4 and 8 weeds/10 m were good ordinary, white to below grade, white and spotted. At both locations in the mechanically harvested samples grade decreases as weed density increases.

**Critical durations of early-season ivyleaf morningglory interference.** Similar regression analysis was used for the data collected in these investigations and once again, the best fit resulted from the TSL model or use of piecewise linear regression (12). The relationship between cotton yield (Y) and critical duration (X) is estimated using the same two segments as those used in the density investigations. Again, yield decreases at a faster rate before the break point than after.

The break point, now to be referred to as critical duration joint or CDjoint, is the average number of wk at which the greatest change in slope actually appears. Both line segments have negative slopes and the estimate $X_w$ of the parameter CDjoint, again need not be an integer since it is only an estimate.

Morningglory species in the test area were ivyleaf and entireleaf morningglory (I. hederacea var. integriuscula Gray). This area was used for the 1992 density investigations (15) and in that year all undesired weed species were removed weekly and only ivyleaf morningglory were allowed to mature. Even though removal was precise, seeds of undesired Ipomoea spp. remaining in the soil germinated during the 1993 investigations. The mixture of ivyleaf and entireleaf morningglories is commonly found in Oklahoma cotton and because morningglory seed can remain viable in the soil up to ten years, random germination during many growing seasons can be expected (8).

Crowley and Buchanan (5) investigated the interference of four Ipomoea spp. with cotton and found ivyleaf and entireleaf were almost identical in their competitive potentials for yield reduction. Every attempt was made to eliminate the undesired Ipomoea spp.; nevertheless, the high densities and complete ground cover resulted in a few escape species.

At Perkins, lint yield in the weed-free or check plots was 477 kg/ha. Lint yield in the removal plots were 439, 190, 31, and 13 kg/ha for durations of 3, 6, 9, and 12 wk of interference, respectively. Lint yield in the full season interference plots (20 wk) was 4.0 kg lint/ha.

Using PROC NLIN the CDjoint, at Perkins, was estimated to be 9.6 wk of interference (Figure 3). Estimated initial lint yield loss, given by the first line segment, was 52.9 kg/ha with each increase of 1 wk of interference up to 9.6 wk. The second line segment represents lint yield after the initial loss, where an additional 1.0 kg/ha is lost for each increase of 1 wk of interference greater than 9.6 wk. An example, if weeds were removed after 5, 9.6 (CDjoint), and

12 wk of interference the lint yield would be 257.7, 19.4, and 11.9 kg/ha, respectively.

At Chickasha, lint yield in the weed-free or check plots was 616 kg/ha, and from the removal plots lint yield was 594, 469, 167, and 125 kg/ha for durations of 3, 6, 9, and 12 wk of interference, respectively. Yield in the full season interference plots (23 wk) was 112 kg/ha. The CDjoint was estimated to be 11.3 wk of interference (Figure 3).

Estimated initial lint yield loss, given by the first line segment, was 49.0 kg/ha for each increase of 1 wk of interference up to 11.3 wk. The second line represents an additional loss of 1.2 kg/ha for each increase of 1 wk of interference greater than 11.3 wk. An example, lint yield is be estimated to be 437.2, 128.5, and 127.9 kg/ha for 5, 11.3, and 12 wk of interference, respectively.

Transposing the data to a percent of check, at Perkins, the critical duration joint was 9.6 wk (Figure 4). Lint yield would be reduced by 11.1% of the possible yield for each increase of 1 wk of interference up to 9.6 wk. After the CDjoint, yield is reduced by an additional 0.2% for each increase of 1 wk of interference greater than 9.6 wk. An example, mean lint yield would be reduced to 54.0, 3.0, and 2.0% of the expected possible yield, from 5, 9.6 (CDjoint), and 12 wk of interference, respectively.

At Chickasha, the critical duration joint, as percent of check, was 11.4 wk (Figure 4). Estimated initial lint yield loss, given by the first line segment, would be 7.8% for each increase of 1 wk up to 11.4 wk of interference. For each increase of 1 wk of interference greater than 11.4, lint yield is reduced by an additional 0.2%, given by the second line segment. An example, mean lint yield would be reduced to 71.5, 21.6, and 21.5% of the yield possible, for 5, 11.5 (CDjoint), and 12 wk of interference, respectively.

At Perkins, morningglory biomass samples were significantly different for all samples taken across all removal dates (Table 4). Cotton plant samples, taken from row 4 in each plot, the same date as morningglory removal showed on differences in development from 3 to 12 wk of interference. Cotton plants from plots maintained weed-free for the entire growing season were not significantly different for 3 to 6 wk of development; however, they were significantly different compared to all other treatments. Cotton samples taken from plots used as full season weed interference had no significant differences for 3 to 6 wk; however, they were different than samples taken after 12 wk of interference.

At Chickasha, morningglory biomass samples were not significantly different for 3 to 6 wk of development, nor between 6 to 12 wk (Table 4). Development of cotton plant samples, taken at the time of weed removal, showed no significant differences from 3 and 9 wk of development and none from 6 to 12 wk. Cotton samples taken from the weed-free plots were not significantly different from 3 to 6 wks;

however, differences did exist between those and the 9 and 12 wk of interference samples. Cotton samples taken from the full season weed interference plots were significantly different after 3 wk of interference; however, no differences existed for the 6 and 12 wk of interference treatments.

## CONCLUSIONS

Ivyleaf morningglory cause yield losses, harvest problems and seed remaining in the soil can infest future crops for many years. Field observations indicate cotton producers, with areas highly infested by morningglories, approach this weed problem in different manners. Some producers sacrifice cotton early by mowing or burning areas infested with morningglory, while other producers leave morningglory and cotton the entire season and harvest around infested areas. In both cases, yield losses are incurred by the producer and warrant research into this problem weed.

Understanding the phenomenon of weed interference, scientists can assist producers in controlling weed infestations. Leaving some weeds in the field is possible, without causing excessive yield loss; however, if left completely uncontrolled the potential for problems in the future is greatly increased.

## LITERATURE CITED

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Table 1. Relationship of ivyleaf morningglory density on cotton fiber quality at Perkins[a].

| Weed density | Fiber Properties | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | Color[b] | | |
| | Length | Uniformity | Strength | Micronaire | Rd | +b | Trash |
| No./10 m row | cm | % | gms/tex | unit | % | % | % |
| 0 | 2.81 a | 83 | 32 | 3.8 bc | 64 ab | 11 ab | 1.9 b |
| 4 | 2.72 ab | 83 | 33 | 3.9 bc | 63 b | 12 a | 1.8 b |
| 8 | 2.76 ab | 83 | 33 | 3.6 c | 63 b | 12 a | 1.9 b |
| 16 | 2.72 ab | 83 | 35 | 3.8 bc | 63 b | 11 ab | 1.9 b |
| 32 | 2.65 ab | 83 | 31 | 4.2 ab | 63 b | 11 ab | 2.6 ab |
| 48 | 2.78 a | 84 | 32 | 4.3 ab | 66 a | 10 b | 1.7 b |
| 64 | 2.61 b | 82 | 32 | 4.5 a | 62 b | 11 ab | 3.1 a |
| LSD 0.05% | 0.16 | NSD | NSD | 0.5 | 2 | 1 | 1.0 |

[a]Means within a column followed by the same letter are not significantly different at the 0.05 probability level (using the protected LSD).

[b]Color components are grayness (Rd), with 70% or greater being desirable and yellowness (Hunter's +b) with 9.0 or lower being desirable.

Table 2. Relationship of ivyleaf morningglory density on cotton fiber quality at Chickasha[a].

| Weed density | Fiber Properties | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | Color[b] | | |
| | Length | Uniformity | Strength | Micronaire | Rd | +b | Trash |
| No./10 m row | cm | % | gms/tex | unit | % | % | % |
| 0 | 2.60 a | 83 a | 27 ab | 5.2 a | 70 a | 8.5 | 0.9 d |
| 4 | 2.48 ab | 81 ab | 25 ab | 4.9 ab | 66 b | 8.3 | 1.4 cd |
| 8 | 2.56 ab | 81 ab | 26 ab | 5.1 a | 67 ab | 8.0 | 1.7 c |
| 16 | 2.57 ab | 82 ab | 29 a | 4.6 ab | 67 ab | 8.5 | 2.0 bc |
| 32 | 2.60 a | 81 ab | 27 ab | 4.9 ab | 65 b | 8.1 | 2.4 b |
| 48 | 2.46 b | 80 bc | 23 b | 4.8 ab | 66 b | 8.2 | 2.4 b |
| 64 | 2.45 b | 79 c | 25 ab | 4.3 b | 66 b | 8.5 | 3.5 a |
| LSD 0.05% | 0.12 | 2 | 4 | 0.6 | 3 | NSD | 0.6 |

[a]Means within a column followed by the same letter are not significantly different at the 0.05 probability level (using the protected LSD).

[b]Color components are grayness (Rd), with 70% or greater being desirable and yellowness (Hunter's +b) with 9.0 or lower being desirable.

Table 3. Grade designations for lint from mechanical harvest efficiency investigations in cotton[a].

| Location | Weed density | Grade: Color[b] mode | Grade: Name[c] |
|---|---|---|---|
| | no./10 m row | | |
| Perkins | 0 | 44 | strict low middling, tinged |
| | 4 | 63 | strict good ordinary, spotted |
| | 8 | 84 | below grade, tinged |
| | 16 | 84 | below grade, tinged |
| Chickasha | 0 | 71 | good ordinary, white |
| | 4 | 71/ 83 | good ordinary, white/ below grade, spotted |
| | 8 | 81 | below grade, white |

[a]Harvest efficiency was conducted on row 4 of each plot within the density investigations, starting at 0 weeds/10 m treatment progressing to higher densities until the stripper would no longer perform.

[b]Twenty-five official color grades are used for American Upland Cotton. These include 7 for white, 6 for spotted and light spotted, 4 for tinged, and 2 for yellow stained lint plus 5 "below grade" designations. The higher the number within a color designation, the poorer the fiber.

[c]Names of the grades progress from "good middling" (the most desirable) through "strict middling", "middling", "strict low middling", "low middling", "strict good ordinary", "good ordinary", and "below grade" (the least desirable).

Table 4. Cotton and ivyleaf morningglory biomass sample weights for Perkins and Chickasha[a].

| Time of removal[e] | Weed biomass | | Cotton plant biomass: By week of removal[b] | | Cotton plant biomass: No weed interference[c] | | Cotton plant biomass: Full-season weed interference[d] | |
|---|---|---|---|---|---|---|---|---|
| | Perkins | Chickasha | Perkins | Chickasha | Perkins | Chickasha | Perkins | Chickasha |
| wks | gms/0.25 $m^2$ | | gms/ 1 plant | | | | | |
| 3 | 8.7 a | 7.7 a | 2.4 a | 2.2 a | 8.2 a | 5.3 a | 2.2 a | 2.0 a |
| 6 | 33.6 b | 54.1 ab | 3.9 a | 18.6 b | 13.0 a | 20.6 a | 4.0 ab | 16.5 c |
| 9 | 82.4 c | 80.0 b | 2.1 a | 16.9 ab | 34.7 b | 39.4 b | 7.3 b | 11.2 b |
| 12 | 152.1 d | 91.0 b | 3.6 a | 17.8 b | 94.2 c | 108.4 c | 22.6 c | 14.7 c |
| LSD 0.05% | 18.7 | 49.0 | NSD | 15.6 | 23.7 | 16.7 | 4.1 | 3.1 |

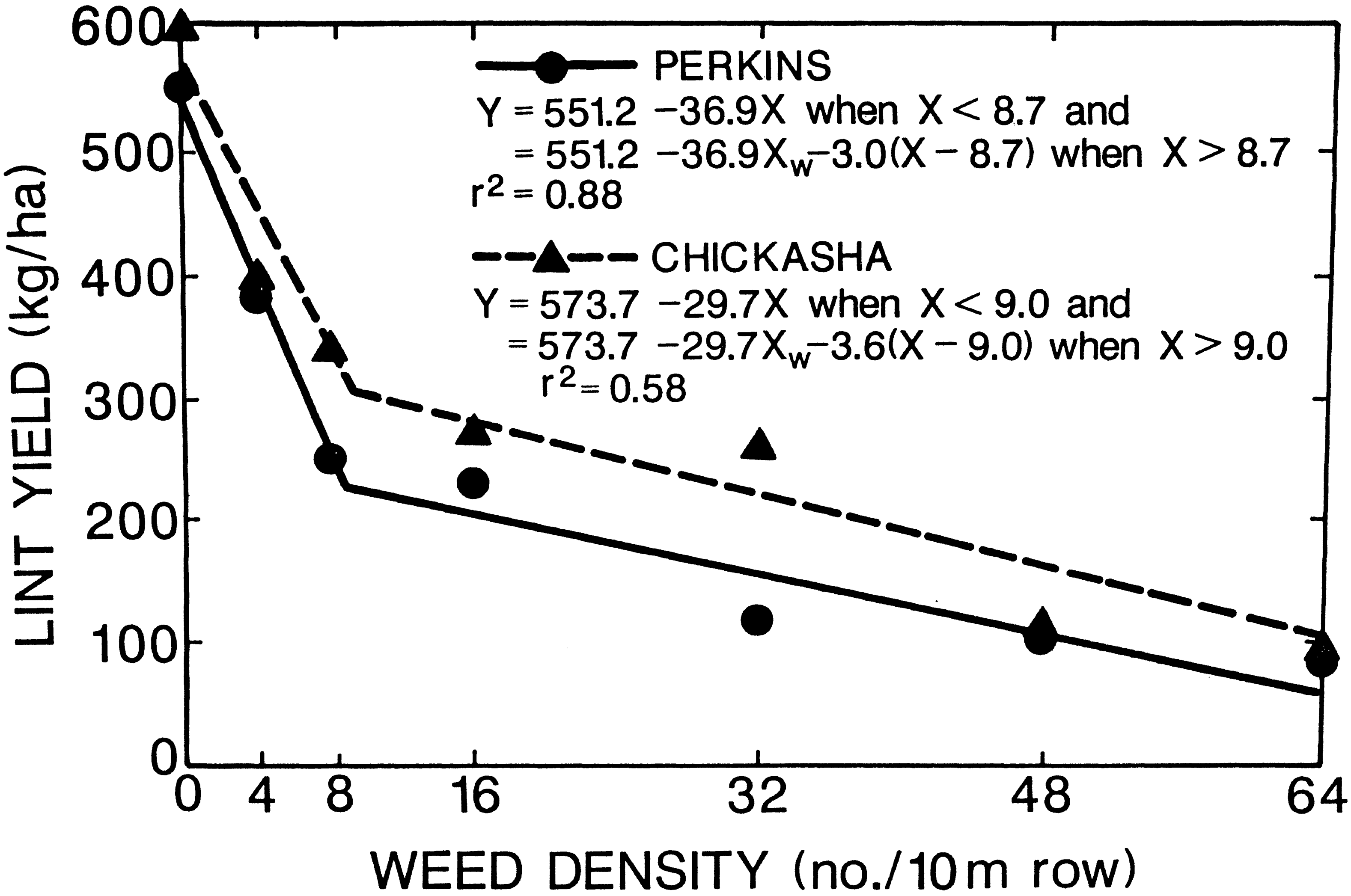
[a]Means within a column followed by the same letter are not significantly different at the 0.05 probability level (using the protected LSD).

[b]Cotton samples taken within same plot as morningglory biomass on removal date.

[c]Plots maintained as weed-free checks all season.

[d]No weed removal, plots used as full-season weed interference checks.

[e]Weed interference for 3-wk intervals, weeds removed, plots then maintained weed-free remainder of the growing season.




<u>Figure 1.</u> Ivyleaf morningglory density relative to mean cotton lint yield (kg/ha) for Perkins and Chickasha.

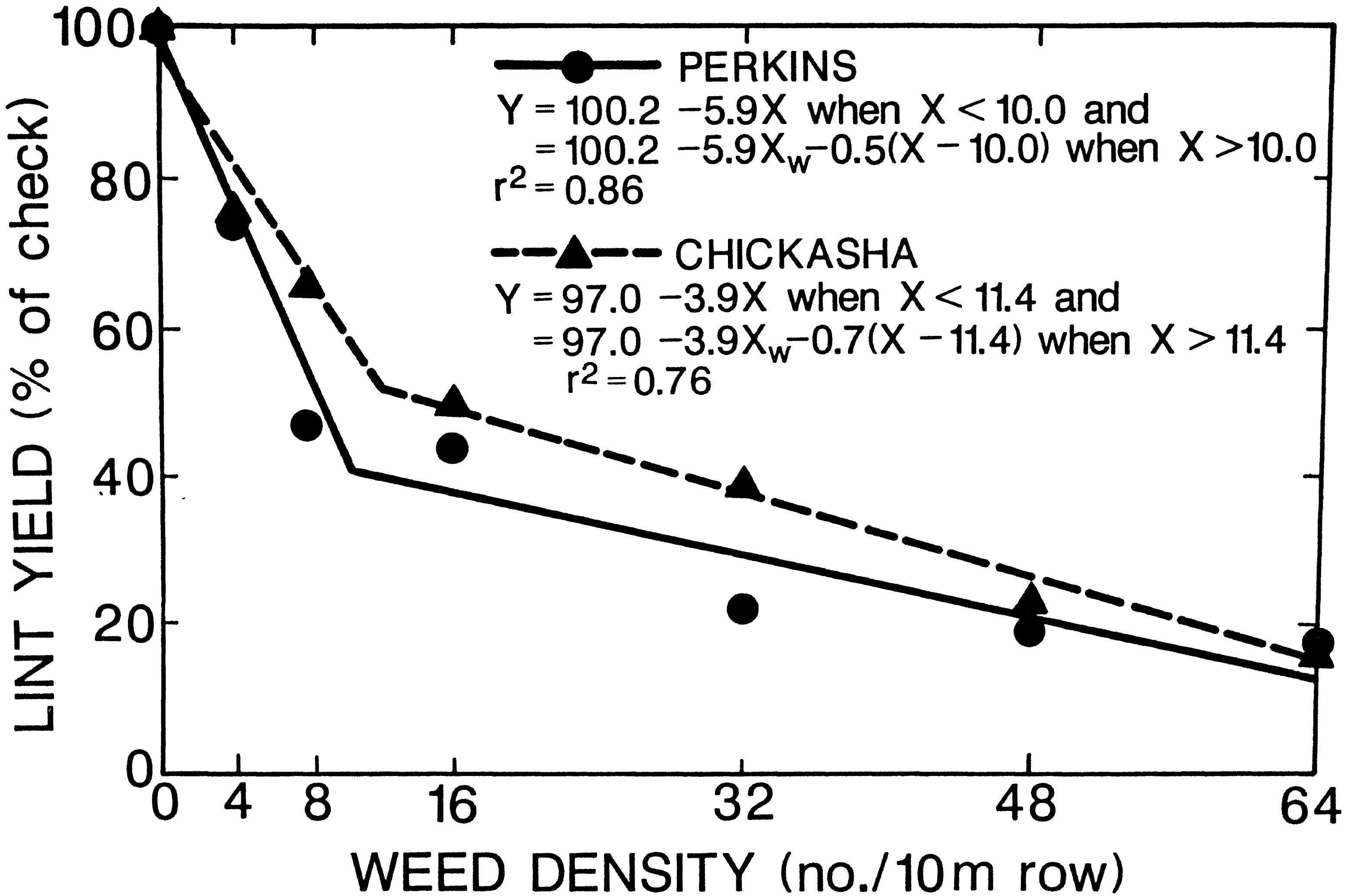



Figure 2. Ivyleaf morningglory density relative to mean cotton lint yield (percent of check) for Perkins and Chickasha.

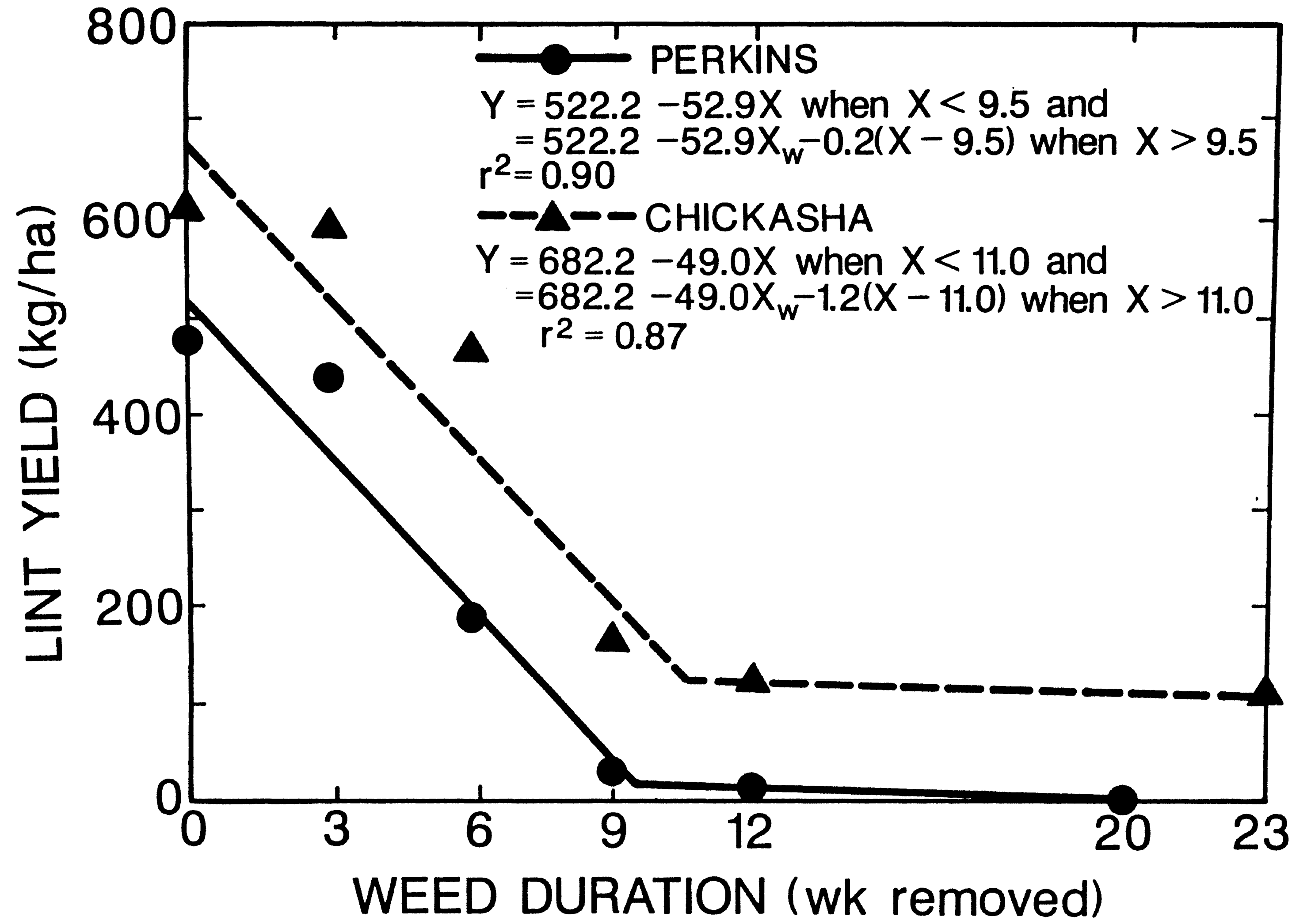



**Figure 3.** Duration of ivyleaf morningglory relative to mean cotton lint yield (kg/ha) for Perkins and Chickasha.

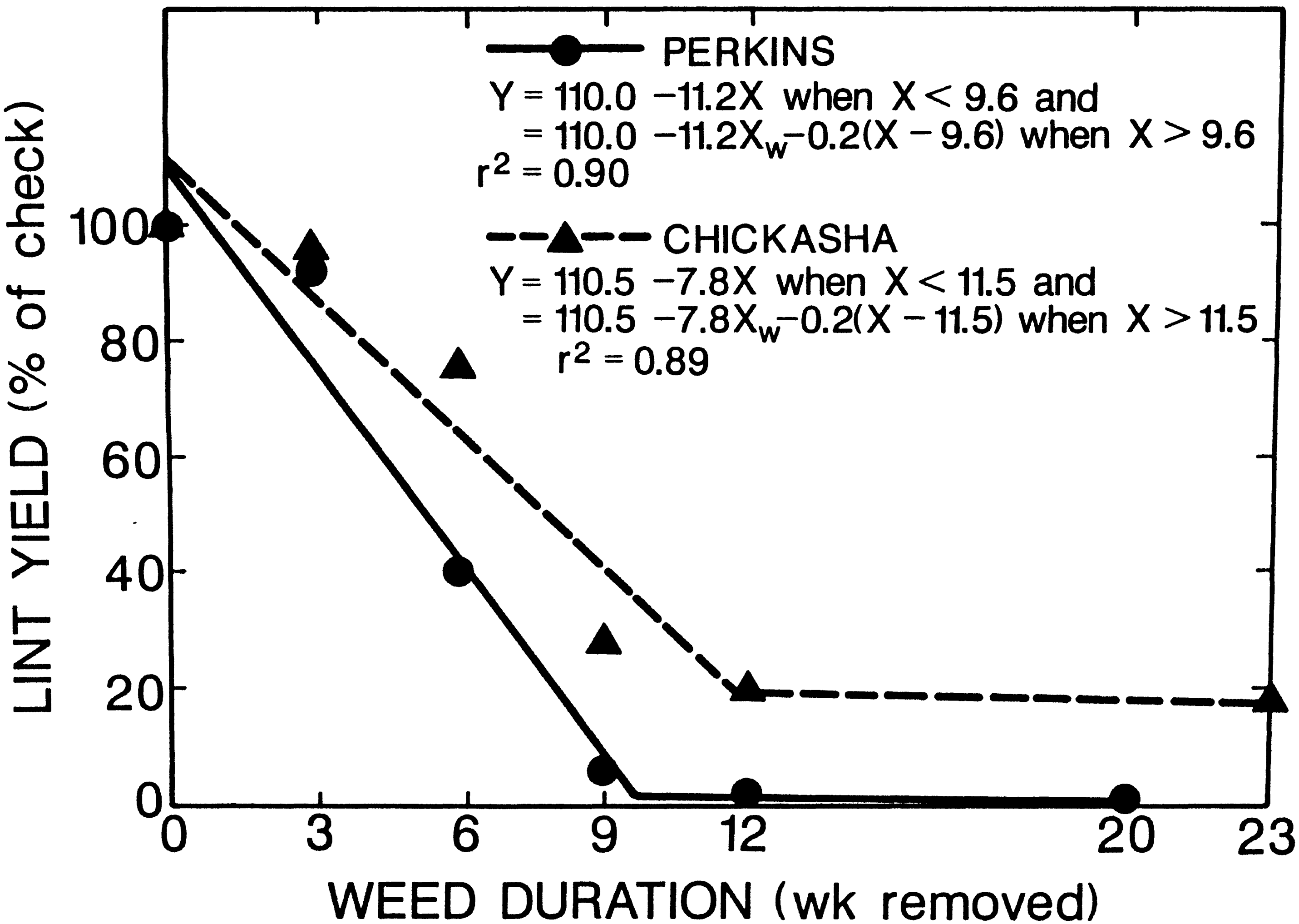



Figure 4. Duration of ivyleaf morningglory relative to mean cotton lint yield (percent of check) for Perkins and Chickasha.

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# VITA

Joy Beth Rogers

Candidate for the Degree of

Master of Science

Thesis: INTERFERENCE OF IVYLEAF MORNINGGLORY (Ipomoea hederacea) WITH COTTON (Gossypium hirsutum)

Major Field: Crop Science

Biographical:

Personal Data: Born in San Francisco, California, February 6, 1961 the daughter of Roy and Wanda Rogers. Married August 11, 1993 to Steve A. Owens.

Education: Graduated from Seneca Valley High School, Gaithersburg, Maryland, in May 1979; received Bachelor of Science degree in Agronomy from Oklahoma State University, December 1991; completed requirements for the Master of Science degree in Agronomy at Oklahoma State University in May 1994.

Experience: Garden Center Assistant, Potomac Gardens, Inc., Gaithersburg, MD, Sept. 1977 to Aug. 1979; Delivery Person, Maritime Industries, Inc., Rockville,MD, Aug. 1979 to Sept. 1980; Sub-Miniature Electronic Assembly Specialist, Weinschel Engineering, Gaithersburg, MD, Sept. 1980 to June 1985; Farm Manager, Shiloh Ranch and Equine Center, Aug. 1985 to Dec. 1989; Radio Announcer, KKID Radio-DeMaree Media, Inc., Sallisaw, OK, Jan. 1987 to Mar. 1988; employed by Oklahoma State University, Department of Agronomy as an undergraduate; employed by E. I. DuPont de Nemours & Co., Inc., Agric. Prod. Dept., as a summer intern, May 1989 to Aug. 1989; Graduate research assistant Jan. 1991 to May 1994;

Professional Organizations: Southern Weed Science Society