TIME OF REMOVAL OF CROWNBEARD (*Verbesina encelioides*) FROM PEANUTS (*Arachis hypogaea*) AND INFLUENCE OF CROWNBEARD (*Verbesina encelioides*) DENSITIES ON PEANUT (*Arachis hypogaea*) YIELD

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By

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I would also like to thank Dr. R. Brent Westerman, Dr. Shea W. Murdock, N. Craig Talley, Cody J. Gray, Michael S. Moore, John B. Willis, Deana S. Titus, Research Station personnel, and any others for their unyielding assistance in conducting this research and for the great friendships created.

I would especially like to thank my family for their love, guidance, support, and encouragement throughout my entire education and life. This thanks goes to my father, Harold Farris, my mother, Irene Farris, my sister, Robyn Moore, my nieces, Kelsey, Sidney and Kylie, my brother-in-law, Jerry Moore, my grandparents, Ez and Roma Farris and R.B. and Ruth Blackshire, and to all other members of my family.

PREFACE

Chapter I of this thesis contains information and data that were collected by Cody Jack Gray and included in Chapter II of Cody Jack Gray's thesis. The title of Cody Jack Gray's thesis is "MANAGEMENT OF THREE WEED SPECIES COMMONLY FOUND IN OKLAHOMA PEANUTS *Arachis hypogaea* AND INTERFERENCE OF CROWNBEARD *Verbesina encelioides* WITH PEANUTS" and was submitted to the faculty of the Graduate College of Oklahoma State University as a requirement for the degree of Master of Science on May, 2001. Due to white-tailed deer (*Odocoileus virginianus*) consuming the peanut yield from one of Cody Jack Gray's experimental locations, I repeated the experiment so that multi-year data could be obtained. Cody Jack Gray's information and data were combined and included in Chapter I of my thesis in order to provide more scientific evidence of the interference nature of crownbeard with peanuts.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Figure Page

INTRODUCTION

Chapters I and II of this thesis were written to facilitate submission for publication in Weed Technology, a journal of the Weed Science Society of America.

Chapter I

TIME OF REMOVAL OF CROWNBEARD (*Verbesina encelioides*) FROM PEANUTS (*Arachis hypogaea*)

TIME OF REMOVAL OF CROWNBEARD (*Verbesina encelioides*) FROM PEANUTS (*Arachis hypogaea*)

Abstract: Field experiments were conducted in southwestern Oklahoma in 2000 near Colony and in 2001 near Ft. Cobb to measure the effects of competitive duration of a natural population of crownbeard with peanuts. Data collected were weed counts and weed weights at eight weed removal times and in-shell peanut yields. Crownbeard were removed at 4, 6, 8, 10, 12, 14, and 16 wk (full-season) after crop emergence (WAE) and there was a treatment maintained weed-free for the entire season. Weed density was a poor predictor of dry weed weight and peanut yield; however, dry weed weight and competitive duration were good predictors of peanut yield. There was a linear relationship between crownbeard dry weight and peanut yield. Weed growth was minimal up to 4 WAE and increased after the 6 wk removal time. For each week of crownbeard growth, a 522 kg/ha/week increase in dry weed weight was measured. Peanut yield decreased linearly due to crownbeard competition. For each 1 kg/plot increase in dry weed weight there is a 129 kg/ha or 5.1% peanut yield reduction. For each week of crownbeard interference, a 75 kg/ha or 2.8% peanut yield reduction occurred; resulting in approximately a 42% reduction in peanut yield if crownbeard is allowed to interfere full-season. Crownbeard control 4 to 6 WAE is essential to minimize a loss in Oklahoma peanut yields.

Nomenclature: Crownbeard, *Verbesina encelioides* (Cav.) Benth. & Hook F. ex Gray #[1] VEEEN; peanut, *Arachis hypogaea* L.

Additional index words: Competitive duration, crownbeard competition, dry weed weight, interference, peanut yield, time of removal, weed density.

Abbreviations: WAE, weeks after emergence

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[1]Letters following this symbol are a WSSA-approved computer code from *Composite List of Weeds*, Revised 1989. Available only on computer disk from WSSA, 810 East 10th Street, Lawrence, KS 66044-8897.

INTRODUCTION

Crownbeard (*Verbesina encelioides*), a summer annual of the sunflower (Asteraceae/Compositae) family (Grichar and Sestak 1998), is ranked as the third most common and the sixth most troublesome weed in Oklahoma peanuts (Webster 2001). Crownbeard is also known by some as golden crownbeard, yellowtop, or cowpen daisy (Mitchell and Smith Jr. 1996). This summer taprooted annual weed (NPWRC 2001) is native to the southwestern U.S. and the Mexican Plateau, but can also be found in several other regions of the world (Coleman 1966). Crownbeard has also been reported as a perennial weed growing in the semiarid regions of India (Inderjit et al. 1999). Crownbeard generally grows from May through Oct (Radford et al. 1968) and grows on disturbed sites with deep sandy soils (McCoy 1987). Crownbeard is resilient to drought stress conditions (Kaul and Mangal 1987) and can survive when only watered once a month during the growing season (OALS 2001).

Crownbeard grows to approximately 1.3 m tall. When mature, the top leaves are alternately arranged while the leaves near the base of the plant are oppositely arranged. The leaves are grayish-green in appearance due to the dense pubescence of the leaf surface (NPWRC 2001). The leaves are coarsely serrate, ovate, acute, with truncate to slightly cordate bases, approximately 4 to12 cm long, and approximately 3 to 9 cm wide. The disc and ray flowers are yellow with the ray flowers being 1.5 to 2.5 cm long, 1 to 1.5 cm wide, 3 to 5 toothed or lobed apex (Radford et al. 1968), and borne in an open inflorescence (NPWRC 2001). Crownbeard is propagated by seed contained in winged achenes, which are black or dark brown, pubescent, 4 to 6 mm long, 1 to 1.7 mm wide, and white to pale brown wing with 1 to 2 mm long awns (Radford et al. 1968). Seeds are abundantly produced throughout the growing season (Mahmoud et al. 1984).

Crownbeard has been shown to posses allelopathic properties. Inderjit et al. (1999) used crownbeard root leachate to amend soil and test the leachate's effects on the growth of radish (*Raphanus sativus* L.) seedlings and total soil phenolic content. They reported that crownbeard root leachate interfered with radish seedling growth and increased the amount of water-soluble phenols in the soil.

The weed is also toxic to livestock (Lopez et al. 1996; Keeler et al. 1986; Keeler et al. 1992). The toxin galegine (3-methyl-2-butenylguanine) is present in the foliage of crownbeard. The concentration of galegine found in crownbeard is high enough to be toxic to livestock, causing pulmonary congestion and edema, hemorrhaging in the heart, ultimately death of livestock (Keeler et al. 1992). The use of baled peanut vines as a livestock feed source could increase the potential of livestock poisoning, if crownbeard plant parts are present in the peanut hay.

Crownbeard is susceptible to the tomato spotted wilt virus and is therefore a host or alternate host for this disease. Thrips (*Frankliniella* spp.) are vectors for the spread of tomato spotted wilt virus (Mitchell and Smith, Jr. 1996; Yudin et al. 1988) to other plants, both crop and weed.

Interference experiments have been conducted with peanuts in Oklahoma (Hill and Santelmann 1969; Hackett et al. 1987a; Hackett et al. 1987b); however, there are no research results published regarding the effects of crownbeard interference with peanuts. Weed interference is defined as the total adverse effect that a plant can exert upon another plant when growing in a mutual ecosystem and can include competition, biotic, allelopathic, or other modification effects, which would hinder plant processes or growth

(Strahan et al. 1999). The ultimate goal of competition/interference experiments is to determine the critical period or magnitude of the effects of weeds on yield or other important parameters (Oliver and Buchanan 1986).

The degree of weed competition is influenced by the species of weed, density of the weeds, the crop, and the duration of weed growth (Hill and Santelmann 1969). Hackett et al. (1987b) found that, due to weed interference, early season weed control is necessary to reduce the risk of decreasing peanut yields. Hacket et al. (1987a) reported that peanut yields were greater when there was no horsenettle (*Solanum carolinense* L.) interference for at least 6 wks. Their work predicted a 40 kg/ha yield decrease for Spanish peanuts and a 96 kg/ha decrease in yield for runner-type peanuts for each week of horsenettle interference with the peanuts. Peanut yields are increased by 3.7% (compared to percent of yield for unweeded controls) for each week the peanuts grow without silverleaf nightshade (*Solanum elaeagnifolium* Cav.) interference and for each week that silverleaf nightshade is allowed to interfere with the peanuts, there is a predicted 4.5% decrease in peanut yield (Hacket et al. 1987b).

Crownbeard is a poisonous weed which also serves as a disease host; however, the interference effects of this weed on peanuts is not known or has not been reported. The objective of this field research was to determine the critical times of crownbeard interference on peanut yields. This research should provide information about the potential peanut loss associated with increasing duration of crownbeard interference. With this information, a producer can make a more knowledgeable decision about the management of this weed.

MATERIALS AND METHODS

Field experiments were conducted in southwestern Oklahoma during the summer of 2000 on a producers field near Colony and in 2001 at the Caddo Research Station near Ft. Cobb. The Colony experiment was conducted on a Shellabarger fine sandy loam (fine-loamy, mixed, thermic Udic Argiustoll). This site had a pH of 6.9 and an organic matter content of 0.7%. The Ft. Cobb experiment was conducted on a Cobb fine sandy loam (fine-loamy, mixed, thermic Udic Haplustalfs). Soil pH at Ft. Cobb was 6.8 and the organic matter content was 0.7%.

The experimental design, for both locations, was a randomized complete block design with four replications. 'Tamspan 90', a Spanish peanut cultivar, was planted in both experiments at a seeding rate of 90 kg/ha on sites with natural infestations of crownbeard. Peanuts were planted on beds on May 25 and May 16 for the Colony and Ft. Cobb experiments, respectively. Plots were 4 rows wide by 12 m long with 0.9 m row spacing. Overhead side-row sprinkler irrigation was applied as needed throughout the peanut growing season, to both experimental areas. The decision to apply supplemental irrigation was based on visual observations of soil moisture and any signs of plant stress. Fungicide and insecticide applications were applied by the producer, as needed, to the Colony experimental area.

Crownbeard removal periods of 0 (weed-free check), 4, 6, 8, 10, 12, 14, and 16 wk (full-season) after crop emergence (WAE) were established to measure the effects of crownbeard interference duration on peanuts. The crownbeard plants were removed from all four rows by hoeing, hand pulling, or clipping; however, between rows 2 and 3 the crownbeard were counted, clipped off at soil level, dried in a forage dryer for 1 wk, and dry weights recorded. All crownbeard, regardless of size, were counted, dried, and weighed. After each crownbeard removal period, the plots were maintained weed-free for the remainder of the growing season through herbicide use, hoeing, and hand pulling. For the Colony experiment, metolachlor [2-chloro-*N*-(2-ethyl-6-methylphenyl)-*N*-(2-methoxy-1-methylethyl)acetamide] at 2.24 kg ai/ha plus imazapic [2-[4,5-dihydro-4-methyl-4-(1-mehtylethyl)-5-oxo-1*H*-imidazol-2-yl]-5-methyl-3-pyridinecarboxylic acid] at 0.07 kg ai/ha was soil surface applied up to 8 WAE to the plots in which crownbeard had been removed. These applications were made for the residual control of crownbeard and was not used beyond 8 WAE due to canopy closure and the potential for herbicide injury to the peanuts. For the Ft. Cobb experiment, diclosulam [N-(2,6-dichlorophenyl)-5-ethoxy-7-fluoro[1,2,4]triazolo[1,5-c]pyrimidine-2-sulfonamide] at 0.02 kg ai/ha was applied immediately following weed removal. The application of diclosulam was not made for the 16 wk removal period due to the proximity to peanut harvest and adequate control of unwanted weeds for the remainder of the peanut growing season through hand hoeing and pulling.

Peanuts from the center two rows were mechanically dug and inverted for the Colony and Ft. Cobb experiments on Oct 13 and Sept 28, respectively. The peanuts were field cured, machine combined on Oct 20 and Oct 1, placed in a peanut drying facility, and dry in-shell weights were obtained Oct 27 and Oct 5 for the Colony and Ft. Cobb experiments, respectively.

Data collected in both of these experiments were weed numbers, dry weed weights, and in-shell peanut yields. Peanut yield data were converted to percent of check values for additional data analysis. Data from all locations were subjected to analysis of variance using the PROC MIXED procedure (SAS 2001) to test for linear, quadratic, lack of fit, and overall treatment effects. The following data correlations were tested: weed density vs. dry weed weight, weed density vs. peanut yield (kg/ha and % of check), time of removal vs. dry weed weight, dry weed weight vs. yield (kg/ha and % of check), time of removal vs. weed density, and time of removal vs. yield (kg/ha and % of check). All correlations were tested for goodness-of-fit to linear regression models. The linear regression models were analyzed using PROC REG (SAS 2001).

RESULTS AND DISCUSSIONS

Location was treated as a random effect and data were tested, controlling for location. Mean data were pooled over location for all variables measured. ANOVA and regression analysis both showed highly significant linear relationships between the reported compared variables. Regression analysis revealed a linear response for all reported comparative variables with no significant difference between regression equations; therefore the mean data from both locations were pooled and a common intercept and slope were obtained. Mean data points for the two locations are graphically presented; however, due to the common intercept and slope from pooled data being obtained, the mean data points are only presented for the purpose of additional reader information.

The compared variables of weed density vs. dry weed weight, time of removal vs. weed density, and weed density vs. peanut yield resulted in no significant correlation; therefore, they will not be reported. The poor relationships between the weed density variable and the before mentioned variables is possibly due to the variance in weed density and the manner that individual crownbeard plants were counted in the field. Crownbeard of all sizes were counted at each removal period and these numbers varied widely, both within and across removal times; therefore, the variance in density could, in part, account for the poor relationship of weed numbers to other variables. The mean weed densities for the Colony experiment were 173, 147, 174, 172, 217, 95, and 202 for time of removal periods of 4, 6, 8, 10, 12, 14, and 16 WAE, respectively. The mean weed densities for the Ft. Cobb experiment were 183, 230, 160, 253, 124, 164, and 99 for time of removal periods of 4, 6, 8, 10, 12, 14, and 16 WAE, respectively.

Dry weed weight increased linearly as time of removal or weeks of competition increased (Figure 1). There was a correlation of $R^2 = 0.89$ between dry weed weight and time of removal. These data show a 0.52 kg/plot increase in dry weed weight for each week that crownbeard was allowed to grow in the presence of peanuts. The data further shows that crownbeard growth was minimal up to 4 WAE and increased after the 6 week removal time.

Peanut yield decreased linearly as dry weed weight increased (Figure 2 and 3). When peanut yield kg/ha is reported, there was a correlation of $R^2 = 0.64$ between dry weed weight and peanut yield. There was a 129 kg/ha reduction in peanut yield for each 1 kg/plot increase in dry weed weight. When using the converted peanut yield (% of check), there was a correlation of $R^2 = 0.73$ between peanut yield and dry weed weight. Peanut yield was reduced 501% for each 1 kg/plot increase in dry weed weight. These data suggest that there is a correlation between weed weight and peanut yield and crownbeard dry weed weight can be used to predict peanut yield reduction.

Peanut yield decreased linearly for each weed removal time or each week of weed interference (Figure 4 and 5). Crownbeard emergence occurred approximately 2 wks after peanut planting (author's personal observation). For each week of weed interference beginning at 4 WAE, there is a 75 kg/ha or 2.8% decrease in peanut yield. Full-season interference of crownbeard caused approximately a 42% reduction in peanut yield. This is comparable to the results seen in (Figure 3) where there is approximately a 38% reduction in peanut yield due to the highest dry weed weight. When the 2001 Oklahoma average irrigated peanut yield of 3300 kg/ha (Oklahoma Agricultural Statistics Service 2001) and the estimated 2.8% decrease in peanut yield per week of interference by crownbeard, these data and model would predict a yield reduction of approximately 94 kg/ha for each week of crownbeard interference.

To minimize crownbeard interference with peanuts, some type of weed control measure should be implemented within the early period of the peanut growing season; otherwise peanut yields will be reduced due to weed interference within the early growth period. Hill and Santelmann (1969) showed that annual weeds such as smooth pigweed (*Amaranthus hybridus* L.) and large crabgrass (*Digitaria sanguinalis* (L.) Scop.) decreased peanut yield if allowed to continue to compete after 3 wks but did not cause a yield reduction if allowed to interfere for less than 3 wks.

From these data, it can be concluded that dry crownbeard weight increased with time. Time of removal and crownbeard dry weight are the most accurate variables for predicting peanut yield reduction. There was minimal weed growth and interference up to 4 WAE with increased growth and interference after this time period; therefore, the removal of crownbeard 4 to 6 WAE, when weeds are small and can be effectively controlled with chemical or mechanical means, can minimize a reduction in peanut yield. If crownbeard is not removed at or before 6 WAE, it is predicted that a producer will suffer approximately a 3% per week yield.

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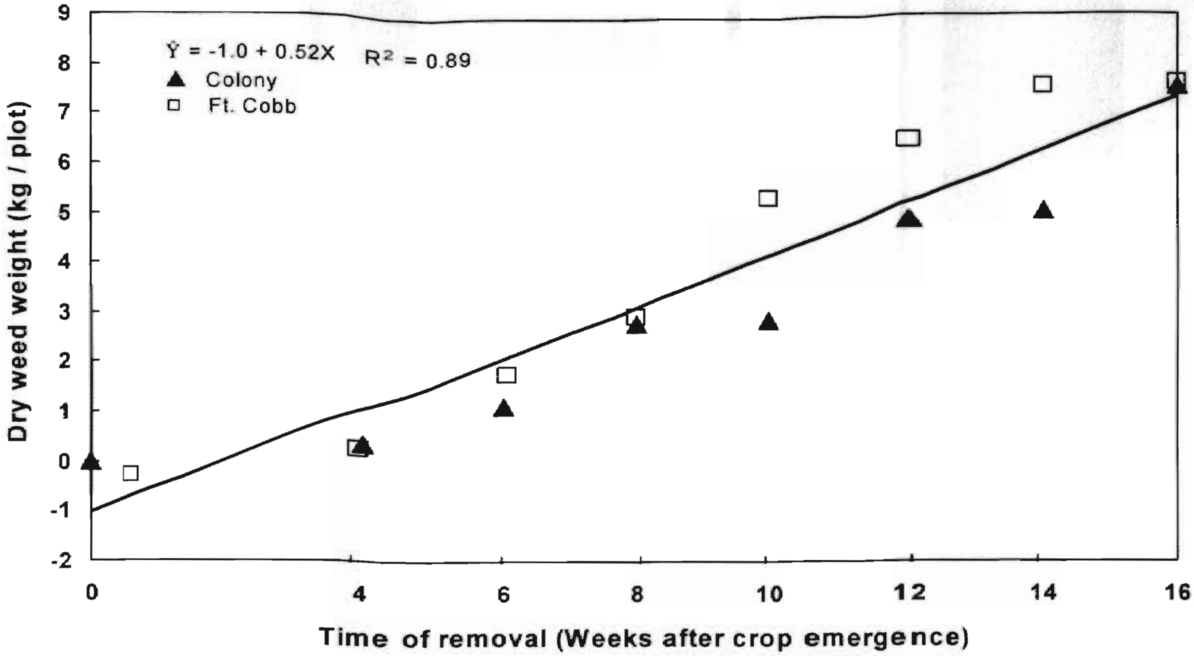

Figure 1. Pooled data from Colony and Ft. Cobb on the relationship of crownbeard duration with dry weed weight, ($P \leq 0.05$).

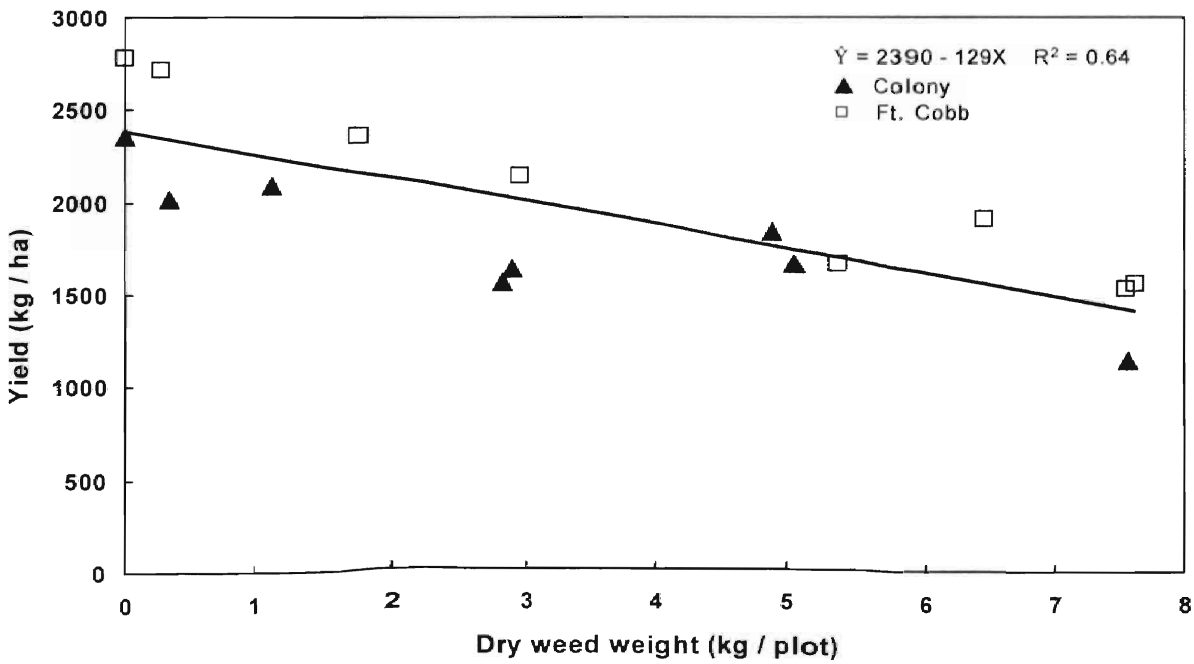

Figure 2. Pooled data from Colony and Ft. Cobb on the relationship of crownbeard dry weight with peanut yield (kg / ha), ($P \leq 0.05$).

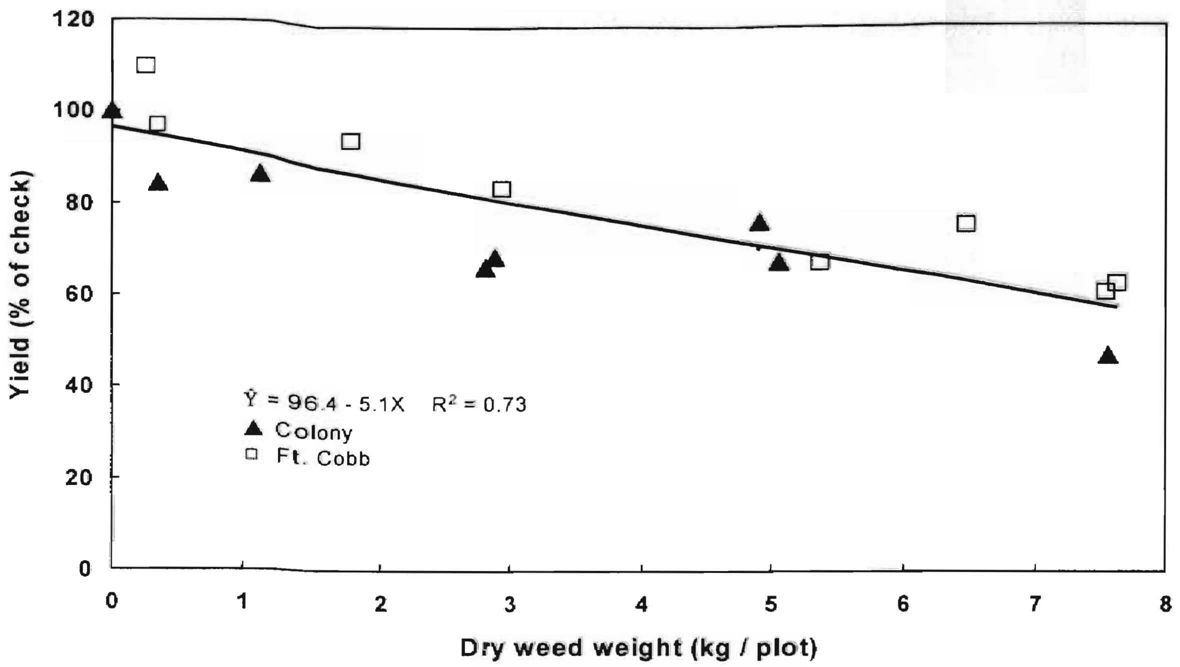

Figure 3. Pooled data from Colony and Ft. Cobb on the relationship of crownbeard dry weight with peanut yield (% of check), ($P \leq 0.05$).

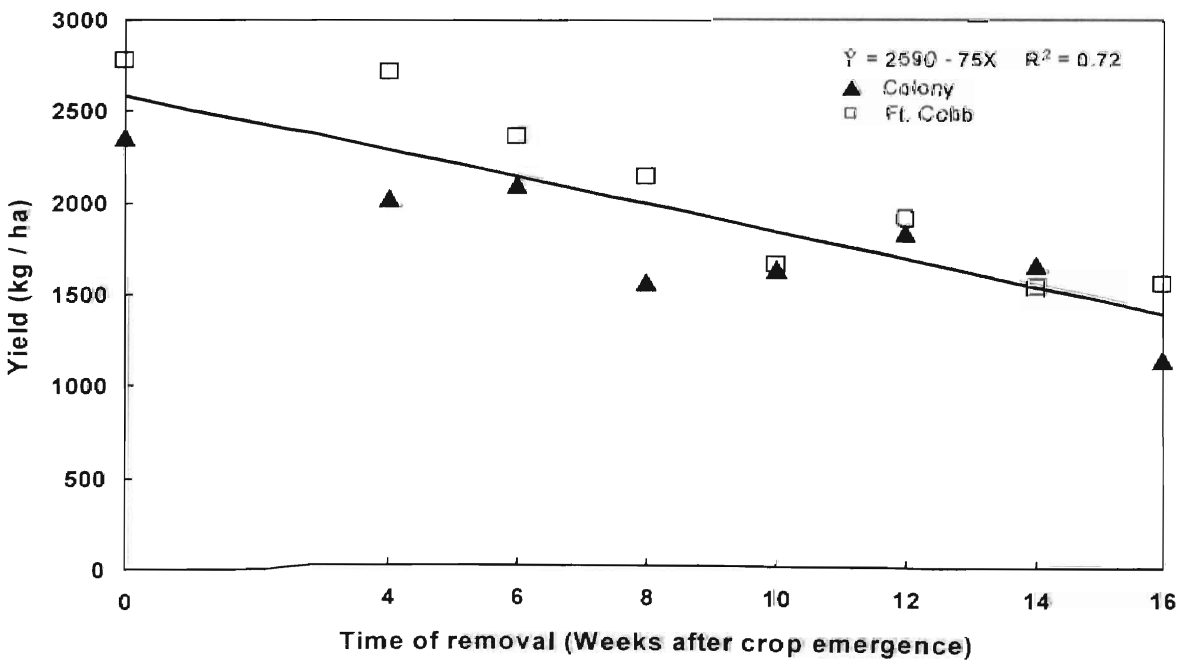

Figure 4. Pooled data from Colony and Ft. Cobb on the relationship of crownbeard duration with peanut yield (kg / ha), ($P \leq 0.05$).

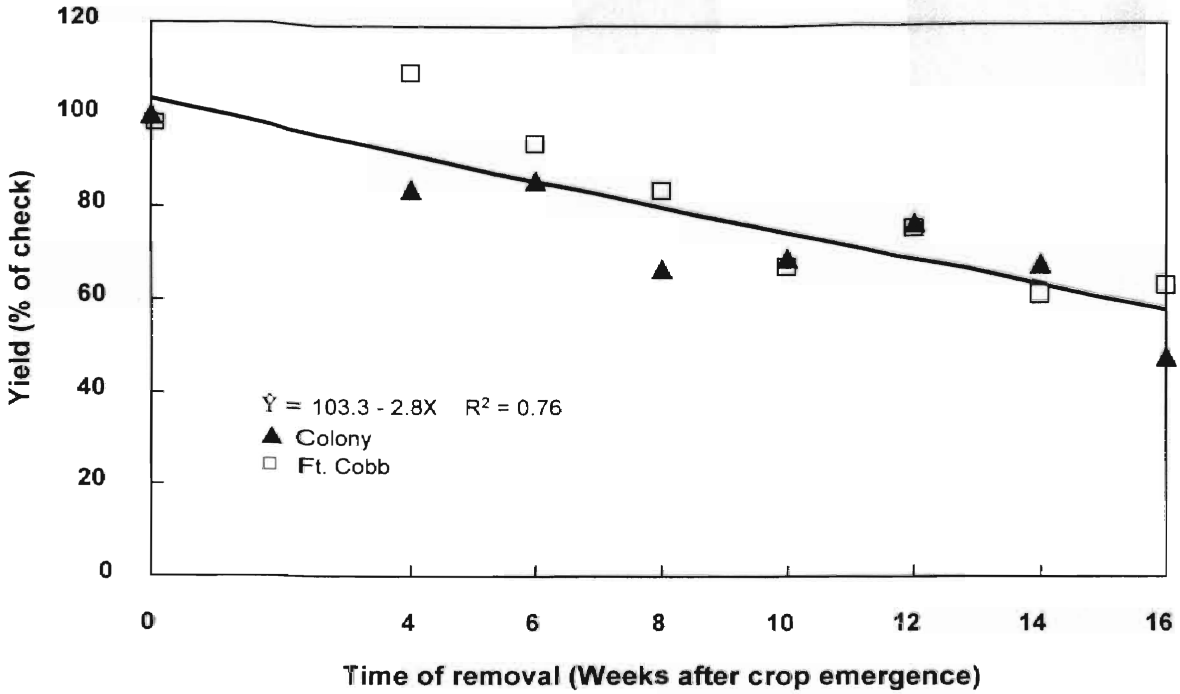

Figure 5. Pooled data from Colony and Ft. Cobb on the relationship of crownbeard duration with peanut yield (% of check), ($P \leq 0.05$).

Chapter II

INFLUENCE OF CROWNBEARD (*Verbesina encelioides*) DENSITIES ON PEANUT (*Arachis hypogaea*) YIELD

INFLUENCE OF CROWNBEARD (*Verbesina encelioides*) DENSITIES ON PEANUT (*Arachis hypogaea*) YIELD

Abstract: Field experiments were conducted at the Caddo Research Station near Ft. Cobb and at the Agronomy Research Station near Perkins to measure the effects of seven crownbeard *(Verbesina encelioides*) densities on peanut *(Arachis hypogaea)* yield. The seven densities evaluated were 0 (weed-free check), 2, 4, 8, 16, 24, and 32 weeds/10 m of row. Data collected consisted of weed weights and peanut yields. Correlation between weed density vs. dry weed weight, dry weed weight vs. peanut yield (kg/ha and % of check), and weed density vs. peanut yield (kg/ha and % of check) were determined. For each weed/10 m of row, dry weed weight increased by 0.34 kg/plot. According to correlation coefficients, dry weed weight was a good predictor of peanut yield. For each kg/plot of dry weed weight, a 190 kg/ha or 4.6% reduction in peanut yield occurred. Weed density was a good predictor of peanut yield. For each weed/10 m of row, a 56 kg/ha or 1.6% peanut yield reduction occurred. At the highest crownbeard density of 32 weeds/10 m of row, peanut yield was reduced approximately 50%.

Nomenclature: Crownbeard, *Verbesina encelioides* (Cav.) Benth. & Hook F. ex Gray #[1] VEEEN; peanut, *Arachis hypogaea* L.

Additional index words: crownbeard competition, dry weed weight, peanut yield, weed density.

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Crownbeard has been shown to posses allelopathic properties. Inderjit et al. (1999) used crownbeard root leachate to amend soil and test the leachate's effects on the growth of radish (*Raphanus sativus* L.) seedlings and total soil phenolic content. They reported that crownbeard root leachate did interfere with radish seedling growth and increased the amount of water-soluble phenols in the soil.

The weed has been shown to exhibit toxic effects to livestock (Lopez et al. 1996; Keeler et al. 1986; Keeler et al. 1992). The toxin galegine (3-methyl-2-butenylguanine) is present in the foliage of crownbeard. The concentration of galegine found in crownbeard is high enough to cause pulmonary congestion and edema, hemorrhaging in the heart, ultimately death of the livestock (Keeler et al. 1992). The use of baled peanut vines as a livestock feed source could increase the potential of livestock poisoning, if crownbeard plant parts are present in the peanut hay.

Crownbeard is susceptible to the tomato spotted wilt virus of the genus (*Tospovirus*) and is therefore a host or alternative host for this disease. Thrips (*Frankliniella* spp.) are vectors for the spread of tomato spotted wilt virus (Mitchell and Smith, Jr. 1996; Yudin et al. 1988) to other plants, both crop and weed. A study conducted by Mitchell and Smith Jr. (1996), in farmer peanut fields infected with tomato spotted wilt virus, concluded that peanut plants adjacent to crownbeard were not as prevalent to infection with tomato spotted wilt virus, as compared to more distant peanut plants. They concluded that crownbeard was not the primary host of tomato spotted wilt virus and was not the primary plant attracting or infecting new thrips in peanut fields. However, since crownbeard can act as a source for tomato spotted wilt virus and is an attractant for thrips, which spread the virus, managing the weed is the best option for reducing the thrip vector and tomato spotted wilt virus (Yudin et al. 1988).

Oklahoma is ranked as the number one producer of Spanish peanuts. Peanuts are ranked as the 11th Oklahoma agricultural commodity (ODAFF 2002) and is nationally ranked as the 6th of 9 peanut producing states with approximately 70,000 of 1,469,000 U.S. acres planted to peanuts (USDA-ESS 2002). Due to the state and national rankings for peanuts, weed interference information for peanuts is especially important due to the potential for yield and thus economic losses. The degree of weed interference is influenced by the species of weed(s), density of the weed(s), the crop, and the duration of weed growth (Hill and Santelmann 1969). Hackett et al. (1987b) reported that, due to weed interference, early season weed control was necessary to maintain peanut yields without loss.

With the exception of the above mentioned articles reporting duration of interference, no peer reviewed articles have been published on research reporting interference of annual weeds on peanuts grown in Oklahoma. However, reported research on perennial or annual weeds from other states has shown that weed density has a negative effect on peanut yield. Hackett et al. (1987a) showed that one horsenettle (*Solanum carolinense* L.)/m of row reduced peanut yield 11%. In Alabama, one bristly starbur (*Acanthospermum hispidum* DC.)/m of row reduced peanut yield 16% (Walker et al. 1989). Cardina and Brecke (1989) found that Florida beggarweed (*Desmodium tortuosum* (Sw.) DC.) reduced peanut yield by 24% if there was only 1 weed/m of row. Wild poinsettia (*Euphorbia heterophylla* L.) (Bridges et al. 1992), common ragweed (*Ambrosia artemisiifolia* L.) (Clewis et al. 2001), and common cocklebur (*Xanthium* *strumarium* L.) (Royal et al. 1997) density also had an effect on peanut yield; reducing yield 31, 40, and 70%, respectively.

Since weed infestations can potentially increase production cost and decrease harvest efficiency, yield and producer profits, weed interference research is needed to determine critical weed densities. This information can then be used to support or aid producer decisions of weed control, cost of treatment, and application timings in order to minimize weed interference and increase producer yields and profits. Since crownbeard is a problem in Oklahoma peanut production and early season weed control is particularly important in peanuts in order to maintain high yields, the objectives of this research were to determine the degree peanut yield is reduced from season-long weed interference from seven weed densities and to determine if weed density and/or late-season dry weed weight measurements can be used to predict peanut yield.

MATERIALS AND METHODS

Field experiments were conducted in southwestern Oklahoma at the Caddo Research Station near Ft. Cobb and in northcentral Oklahoma at the Agronomy Research Station near Perkins during the summer of 2002. The Ft. Cobb experiment was conducted on a Cobb fine sandy loam (fine-loamy, mixed, thermic Udic Haplustalfs); this soil had a pH of 6.4 and an organic matter content of 0.3%. The Perkins experiment was conducted on a Teller fine sandy loam (fine-loamy, mixed, thermic Udic Argiustoll); this soil had a pH of 5.6 and an organic matter content of 0.3%.

The experimental design, for both locations, was a randomized complete block design with four replications. 'Tamspan 90', a Spanish peanut cultivar was planted in both experiments at a seeding rate of 90 kg/ha. Peanuts were planted on beds on May 16 at Ft.

Cobb and without beds on May 15 at Perkins. Plots were 4 rows wide by 13 m long with 0.9 m row spacing. Before peanut digging, 1.5 m was removed from each end of each peanut row to remove any end-row effect; therefore, a peanut row length of 10 m remained for harvest. Overhead side-row sprinkler irrigation was applied as needed to both experimental areas throughout the peanut growing season. The decision to apply supplemental irrigation was based on visual observations and attempts were made to avoid water stress.

The seven weed densities used to measure crownbeard interference were: 0 (weed-free control), 2, 4, 8, 16, 24 and 32 weeds per 10 m of crop row. A staggered arrangement of weeds along the 10 m of peanut row was used for rows 2 and 3 of the 4 row plot. Rows 1 and 4 served as border rows between plots. Immediately after the peanuts were planted, plastic pot stakes (serving as a place marker for weed transplants) were uniformly spaced and placed, according to there assigned density, into the soil approximately 8 cm to the left or right of center of the peanut row. Paper plates, 23 cm in diameter, were then placed over the plastic pot stake markers in order to provide a herbicide-free spot of soil where weeds were later transplanted. A preemergence application of metolachlor [2-chloro-*N*-(2-ethyl-6-methylphenyl)-*N*-(2-methoxy-1-methylethyl)acetamide] at 1.7 kg ai/ha was applied to the entire experimental area for control of annual grasses and small-seeded broadleaf weeds . The paper plates were removed immediately after the herbicide application. The paper plate cover procedure has been used successfully in other reported research (Smith et al. 1990; Pawlak et al. 1990; Rogers et al. 1996; Wood et al. 1999). These procedures were utilized for both experimental areas.

The crownbeard weed seedlings were started in Jiffy-7® peat pellets[1] in a laboratory on the day that the peanuts were planted in the field. When approximately 2 wks old, the crownbeard seedlings growing in the peat pellet were transplanted into the field at the site designated by the small plastic pot stakes. Research conducted by Albers-Nelson et al. (2000) on establishment methods for common cocklebur, showed no differences with the comparison of early season transplanted peat pellets and direct seeding propagation methods; therefore, the assumption was made that crownbeard established in peat pellets would have similar phenological and biological characteristics to those directly seeded. The peat pellet procedure was also successfully used by Rowland et al. (1999) for the establishment of Palmer amaranth (*Amaranthus palmeri S. Wats.*). Unwanted weeds not controlled by the preemergence metolachlor application were controlled throughout the growing season by herbicides, hoeing and hand pulling. Clethodim [(*E*,*E*)-2-[1-[[(3-chloro-2-propenyl)oxy]imino]propyl]-5-[2-(ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one] at 0.14 kg ai/ha and a second application of metolachlor at 1.7 kg ai/ha was applied approximately 4 wk after peanut planting in order to control unwanted weeds. These procedures were utilized for both experimental areas.

Crownbeard was allowed to grow for the full peanut growing season. Crownbeard above-ground biomass was removed from the Ft. Cobb experiment on Oct 4 and from the Perkins experiment on Oct 6. At crownbeard removal, weeds in rows 2 and 3 were clipped-off at soil surface with hand shears, placed into a forage dryer for 1 wk, and dry weed weights recorded.

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[1]Forestry Suppliers, Inc., P.O. Box 8397, Jackson, MS 39284

Peanuts from the center two rows were mechanically dug and inverted at Ft. Cobb and Perkins on Oct 4 and 7, respectively. Peanuts were allowed to field cure and were combined on Oct 16 and 14, respectively. The peanuts from both locations were placed in a drying facility, and dry in-shell weights were recorded on Oct 21. Peanuts were dug and combined with the use of conventional peanut harvesting equipment.

Data collected in both of these experiments were dry weed weight and in-shell peanut yields. Peanut yield data were converted to percent of check values for additional data analysis. Data from all locations were subjected to analysis of variance using the PROC MIXED procedure (SAS 2001) to test for linear, quadratic, lack of fit, and overall treatment effects. The following data correlations were tested: weed density vs. dry weed weight, dry weed weight vs. peanut yield (kg/ha and % of check), and weed density vs. peanut yield (kg/ha and % of check). All correlations were tested for goodness of fit to linear regression models. The linear regression models were analyzed using PROC REG (SAS 2001).

RESULTS AND DISCUSSIONS

Location was treated as a random effect and data were tested, controlling for location. Mean data were pooled over location for all variables measured. ANOVA and regression analysis resulted in highly significant linear relationships between the variables compared. Regression analysis revealed a linear response for all comparative variables with no significant difference between regression equations; therefore the average data from the two locations were pooled and a common intercept and slope were obtained. Mean data points for the two locations are graphically presented; however, due to the common intercept and slope from pooled data being obtained, the mean data points are presented for the purpose of additional reader information.

The data analysis resulted in a correlation of $R^2 = 0.85$ between crownbeard density and crownbeard dry weight (Figure 1). Crownbeard dry weight increased linearly as crownbeard density increased. The increase of dry weed weight as weed density increases can be expected since an increase in weed population generally gives rise to more weed biomass. For each weed/10 m of row there was a corresponding 0.34 kg/plot increase in dry weed weight. With the maximum density of 32 weeds/10 m of row used for the experiment, there was approximately 12 kg/plot of dry weed biomass that was produced. Furthermore, it did not appear that the weed densities were high enough to cause intraspecific interference. However, based on the graphical data points of 16, 24, and 32 weeds/10 m of row for the Ft. Cobb location, interspecific interference may be a factor influencing the pooled data results. Crownbeard density can be used to predict dry weed weight. Crownbeard weed weight or biomass information is important not only for it's interference with peanuts, but also due to the increased potential of poisoning livestock. The more weed biomass there is in a peanut field, the more likely the chance of harvesting peanut hay infested with crownbeard.

Peanut yield, presented in kg/ha and as percent of check, showed a linear decrease as dry weed weight increased (Figure 2 and 3). Results predict a 190 kg/ha decrease in peanut yield for each 1 kg/plot increase in dry weed weight ($R^2 = 0.52$) (Figure 2). Linear regression accounted for 94% of the variation in peanut yield (% of check) and predicted a 4.6% reduction in peanut yield for each 1 kg/plot increase in dry weed weight (Figure 3). Dry weed weight is an excellent predictor of peanut yield reduction. Due to the reduction in peanut yield as dry weed weight increases, controlling crownbeard weed biomass and thus, crownbeard density, will help reduce peanut yield losses. Statistical analysis did allow for pooling of mean data between loctions. However, observations of the Ft. Cobb data, in particular Figures 2 and 3, appears to exhibit intraspecific interference at three weed densities (16, 24, and 32 weeds/10 m of row). This intraspecific interference was not apparent at the Perkins location. These statements are made and supported, in part, by the Ft. Cobb data shown in Figure 1 where the total weed weights between the three highest weed densities did not increase. This lack of weed weight increase could be due to the peanuts interfering with the growth of the crownbeard.

Peanut yield loss was also correlated to increasing weed density ($R^2 = 0.86$) (Figure 4 and 5). Peanut yield decreases linearly for each weed/10 m of row. Regression analysis predicted that for each weed/10 m of row there is an approximate 1.6% peanut yield reduction (Figure 5). Full-season weed interference from the maximum weed density of 32 weeds/10 m, used for the experiment, resulted in approximately a 50% reduction in peanut yield. Average in-shell peanut yield was approximately 3650 kg/ha in the weed-free plots. If a peanut producer had a crownbeard density of 32 weeds/10 m of row and the 50% peanut yield loss prediction is utilized against the 3650 kg/ha average control plot yield, one would expect a peanut loss of approximately 1825 kg/ha. Peanut yield presented in kg/ha resulted in a weak correlation with weed density ($R^2 = 0.34$) (Figure 4), compared to the correlation using peanut yield (% of check). This difference is possibly due to the location effects, which is removed with the yield conversion to percent of check. The linear responses, with peanut yield as kg/ha and % of check, both indicated that interspecific interference was an important factor at crownbeard densities of 32 weeds/10 m of row or less; therefore, crownbeard density at or below 32 weeds/10 m of row can be used to accurately predict peanut yield loss.

From the data, it can be concluded that crownbeard and the crownbeard densities evaluated did interfere with peanut yields. Crownbeard density can be used to predict crownbeard dry weight. The data also revealed that both dry weed weight and weed density can be used to accurately predict peanut yield loss; however, the use of weed density predicted percent yield loss much better than yield loss in kg/ha. Because crownbeard density has an effect on weed biomass and results in a competitive effect on peanut yield, weed control is needed to prevent peanut yield loss.

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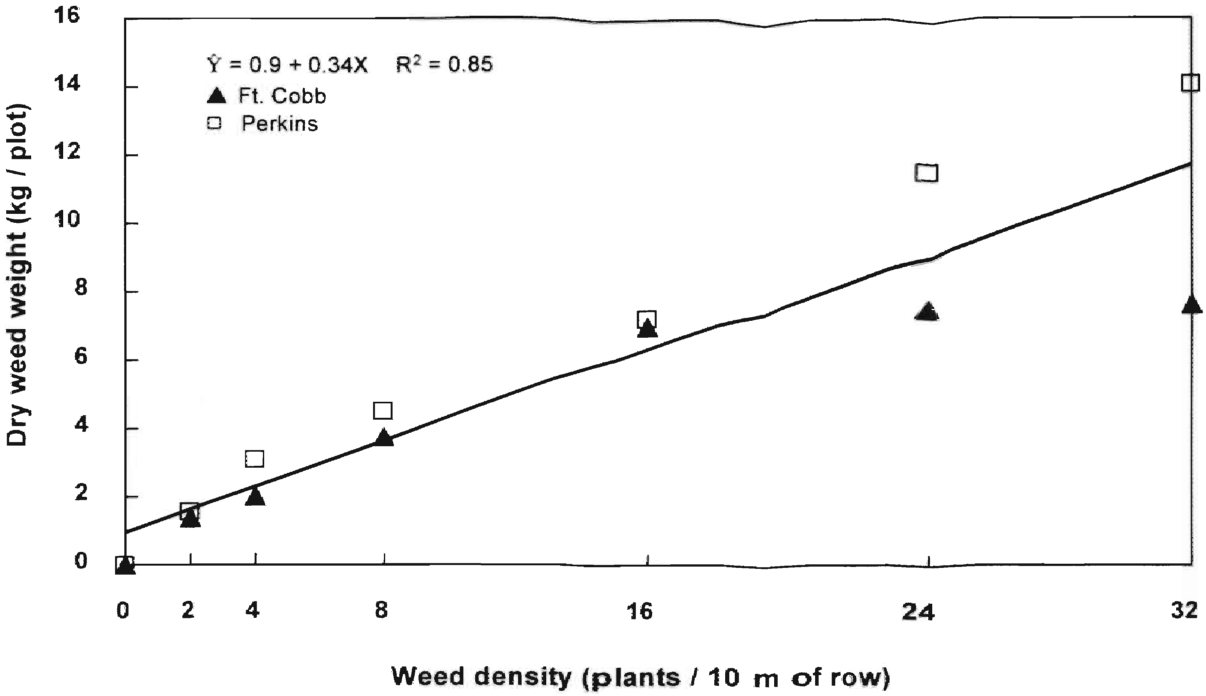

Figure 1. Pooled data from Ft. Cobb and Perkins on the relationship of crownbeard density with dry weed weight, ($P \leq 0.05$).

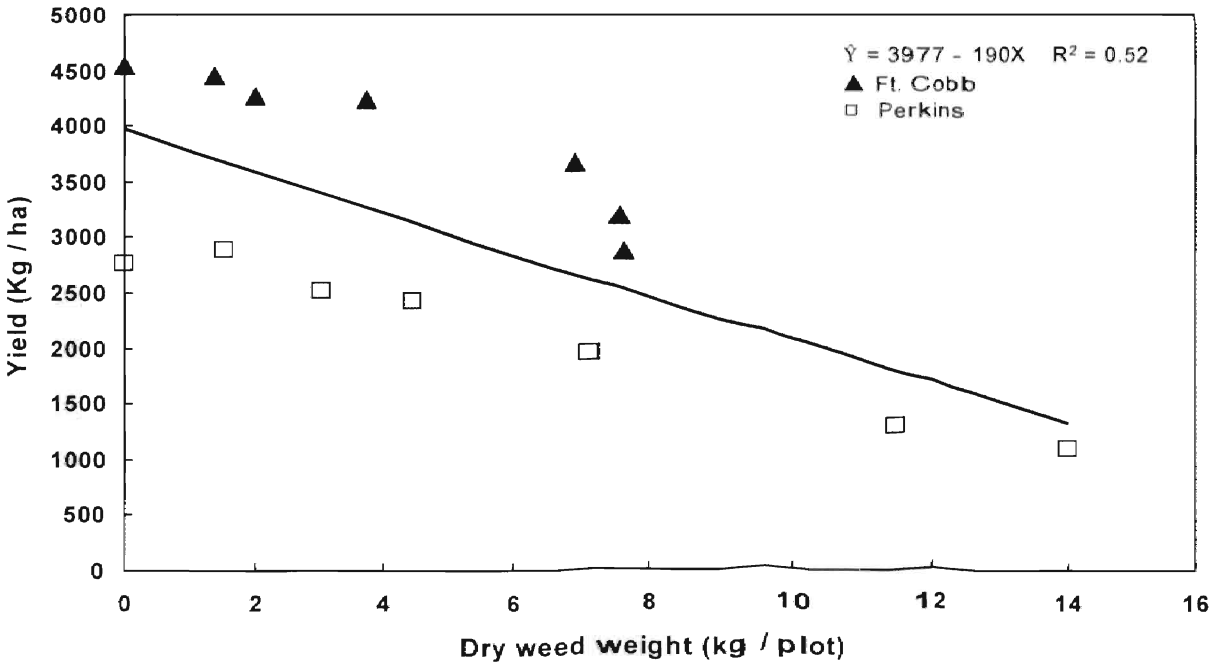

Figure 2. Pooled data from Ft. Cobb and Perkins on the relationship of crownbeard dry weight with peanut yield (kg / ha), ($P \leq 0.05$).

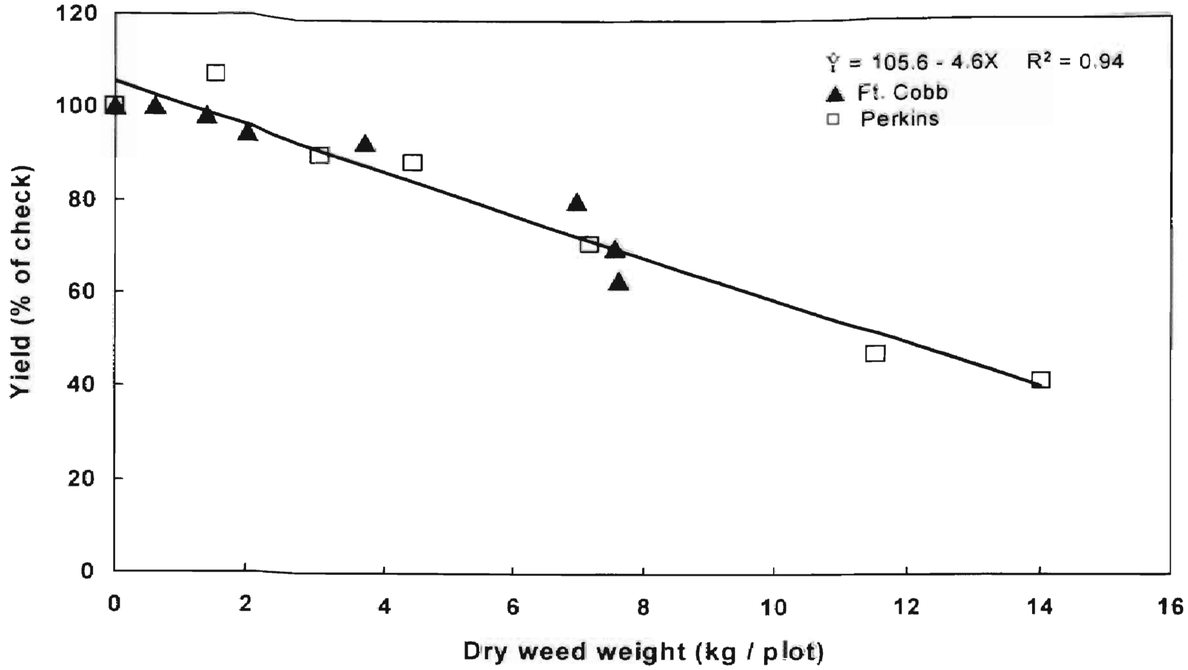

Figure 3. Pooled data from Ft. Cobb and Perkins on the relationship of crownbeard dry weight with peanut yield (% of check), ($P \leq 0.05$).

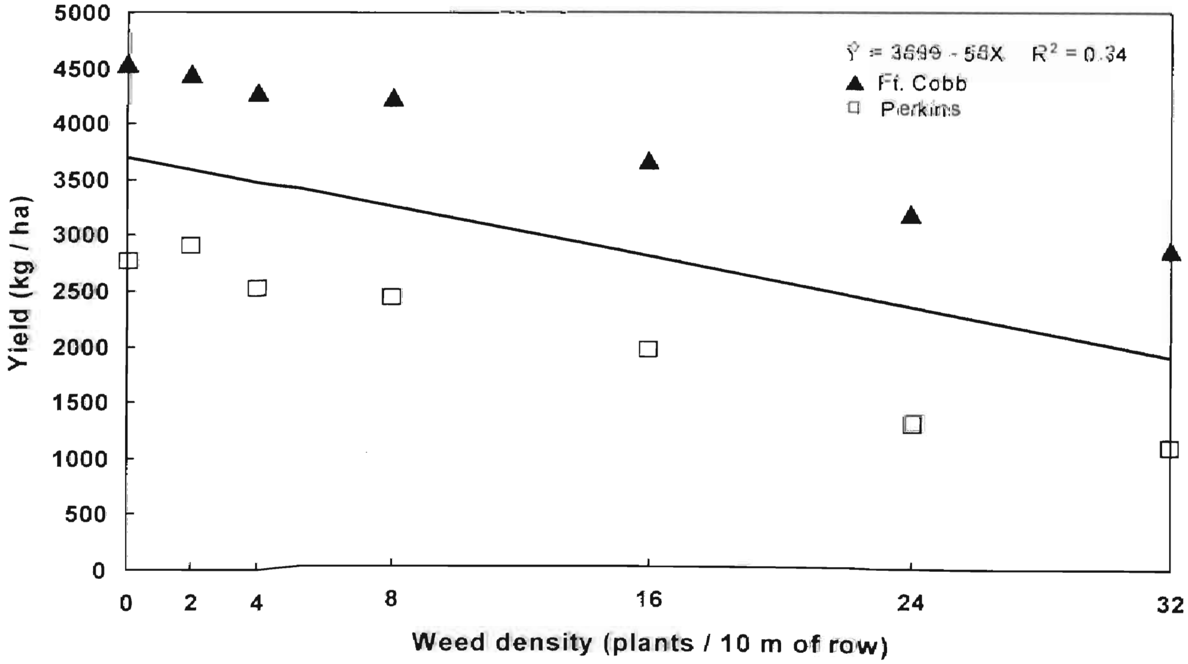

Figure 4. Pooled data from Ft. Cobb and Perkins on the relationship of crownbeard density with peanut yield (kg / ha), ($P \leq 0.05$).

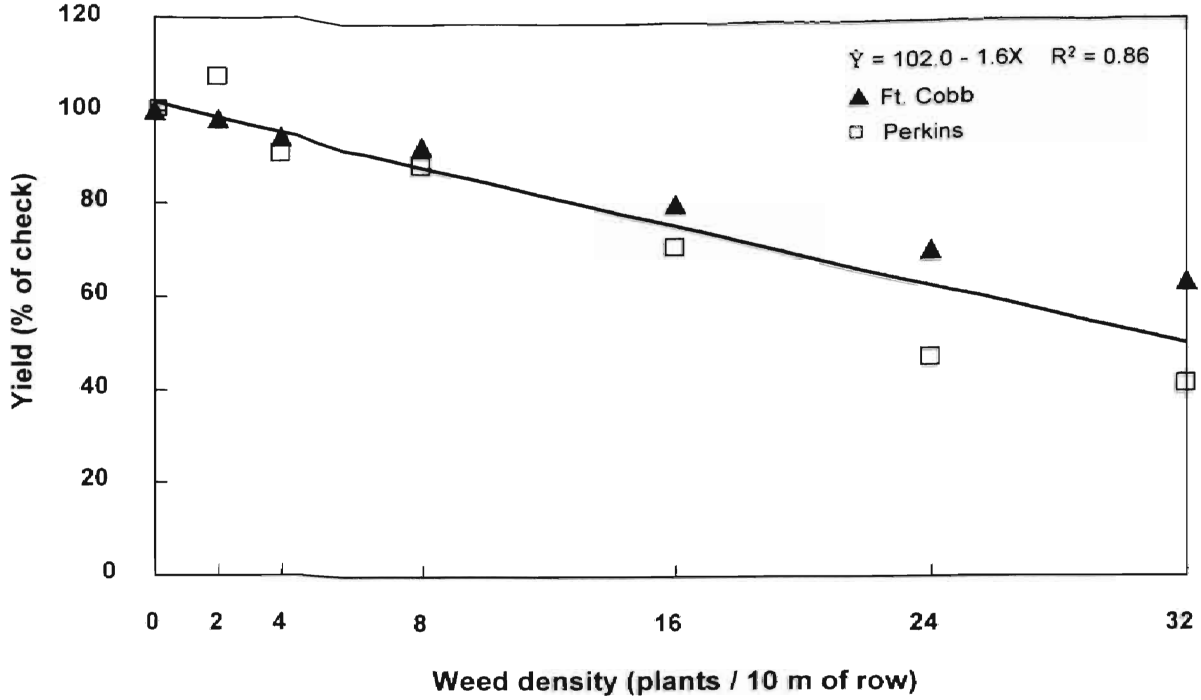

Figure 5. Pooled data from Ft. Cobb and Perkins on the relationship of crownbeard density with peanut yield (% of check), ($P \leq 0.05$).

APPENDIX

Appendix Table 1. Crownbeard density, dry weed weight, and peanut yield response to crownbeard interference for the Colony experiment.[1]

Weed duration	Weed density					Dry weed weight					Peanut yield					
	Replication				Mean	Replication				Mean	Replication				Mean	Mean
	I	II	III	IV		I	II	III	IV		I	II	III	IV		% check
WAE[2]	plants / plot					kg / plot					kg / plot					%
0	0	0	0	0	0	0	0	0	0	0	4.09	4.83	5.68	6.47	5.26	100.00
4	338	27	219	109	173	0.46	0.09	0.51	0.33	0.35	2.95	3.18	4.06	7.78	4.49	82.42
6	317	107	83	82	147	1.77	0.91	0.94	0.94	1.14	3.01	3.75	5.05	6.81	4.65	86.35
8	176	116	38	364	174	4.05	1.81	1.61	3.81	2.82	2.27	3.75	6.47	1.36	3.46	67.02
10	44	42	213	389	172	2.69	2.16	3.41	3.29	2.89	3.01	3.29	3.92	4.31	3.63	69.33
12	242	208	63	354	217	5.73	4.19	3.75	5.93	4.90	1.88	4.37	7.26	2.84	4.09	77.04
14	105	51	191	34	95	6.67	5.02	4.58	3.95	5.05	1.48	4.19	3.97	5.14	3.69	68.07
16	368	158	170	110	202	10.33	7.44	5.87	6.61	7.56	1.70	2.75	1.42	4.34	2.56	47.65

[1] Dimensions used for harvested area were 1.85 m by 12 m.

[2] WAE weeks aft

Appendix Table 2. Crownbeard density, dry weed weight, and peanut yield response to crownbeard interference for the Ft. Cobb experiment.[1]

Weed duration	Weed density					Dry weed weight					Peanut yield					
	Replication				Mean	Replication				Mean	Replication				Mean	Mean
	I	II	III	IV		I	II	III	IV		I	II	III	IV		% check
WAE[2]	plants / plot					kg / plot					kg / plot					%
0	0	0	0	0	0	0	0	0	0	0	5.65	4.80	5.95	5.90	5.56	100.00
4	200	144	131	257	183	0.23	0.11	0.34	0.39	0.27	4.75	6.35	7.20	5.95	6.06	109.56
6	136	279	71	432	230	1.48	2.49	0.68	2.49	1.79	4.75	4.85	7.35	4.10	5.26	94.53
8	68	301	116	156	160	1.93	4.31	2.95	2.61	2.95	3.00	3.20	7.40	5.45	4.76	84.13
10	234	85	509	183	253	5.68	3.63	7.04	5.11	5.36	2.35	4.95	4.30	3.15	3.69	67.59
12	64	160	100	170	124	6.81	8.06	4.43	6.58	6.47	4.80	3.20	5.50	3.50	4.25	75.85
14	54	98	300	203	164	6.58	7.83	9.53	6.24	7.55	4.20	2.90	4.00	2.50	3.40	61.09
16	78	74	111	134	99	7.26	4.77	8.85	9.65	7.63	2.70	3.95	3.70	3.55	3.48	63.11

[1] Dimensions used for harvested area were 1.85 m by 12 m.
[2] WAE, weeks after emergence

Appendix Table 3. Crownbeard dry weed weight and peanut yield response to crownbeard density for the Ft. Cobb experiment.[1]

Weed Density	Dry weed weight					Peanut yield					
	Replication				Mean	Replication				Mean	Mean
	I	II	III	IV		I	II	III	IV		% of
#/10 m of row	kg/plot					kg/plot					check
0	0	0	0	0	0	8.75	8.41	8.64	7.73	8.38	100.00[2]
2	0.79	0.79	1.14	2.84	1.39	9.09	7.84	8.07	7.61	8.15	98.29
4	1.59	2.16	2.95	1.36	2.02	7.50	7.61	7.73	8.52	7.84	94.52
8	3.86	3.97	3.07	3.97	3.72	7.73	7.50	7.95	7.84	7.76	93.38
16	9.32	5.91	7.16	5.57	6.99	6.36	7.61	5.80	7.05	6.70	81.02
24	6.81	6.81	9.43	7.27	7.58	6.93	4.55	6.02	5.91	5.85	70.61
32	8.52	7.39	8.29	6.36	7.64	4.55	6.36	4.20	5.91	5.26	63.58
0	0	0	0	0	0	7.16	8.18	9.55	8.18	8.27	——

[1] Dimensions used for harvested area were 1.85 m by 10 m.

[2] Peanut yield % of check - The two check plots per replication are averaged together in order to obtain the mean check percentage.

Appendix Table 4. Crownbeard dry weed weight and peanut yield response to crownbeard density for the Perkins experiment.[1]

	Dry weed weight					Peanut yield					
	Replication				Mean	Replication				Mean	Mean
Weed Density	I	II	III	IV		I	II	III	IV		% of
#/10 m of row	kg/plot					kg/plot					check
0	0	0	0	0	0	4.55	4.66	5.00	5.91	5.03	100.00[2]
2	2.05	0.91	0.91	2.27	1.54	5.11	5.34	6.48	4.43	5.34	107.23
4	2.73	2.95	3.52	2.95	3.04	4.20	3.64	5.23	5.34	4.60	90.71
8	4.09	5.80	2.95	5.00	4.46	4.77	4.32	5.57	3.07	4.43	89.20
16	6.36	5.80	11.14	5.45	7.19	3.07	4.55	2.50	4.20	3.58	71.34
24	10.45	9.20	13.64	12.95	11.56	2.61	2.39	2.27	2.16	2.36	47.43
32	11.70	11.36	13.30	19.77	14.03	3.52	2.16	1.36	0.91	1.99	41.50
0	0	0	0	0	0	4.55	4.55	5.23	6.02	5.09	——

[1] Dimensions used for harvested area were 1.85 m by 10 m.

[2] Peanut yield % of check - The two check plots per replication are averaged together in order to obtain the mean check percentage.

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VITA

RODNEY LEWIS FARRIS

Candidate for the Degree of

Master of Science

Thesis: TIME OF REMOVAL OF CROWNBEARD (Verbesina encelioides) FROM PEANUTS (Arachis hypogaea) AND INFLUENCE OF CROWNBEARD (Verbesina encelioides) DENSITIES ON PEANUT (Arachis hypogaea) YIELD

Major Field: Plant and Soil Science

Biographical:

Personal Data: Born in Paris, Texas, on November 12, 1974, the son of Harold G. and Irene M. Farris.

Education: Graduated from Valliant High School, Valliant, Oklahoma, in May, 1993. Received the Bachelor of Science degree in Animal Science, in December, 1997, a Bachelor of Science degree in Wildlife and Fisheries Ecology and a Minor in Soil Science, in May, 2001, and completed the requirements for the Master of Science degree in Plant and Soil Science, in May, 2003, all from Oklahoma State University, Stillwater, Oklahoma.

Experience: Worked on family ranch in Valliant, Oklahoma, while in high school. Worked as a Ranch Hand for the Fight'n 7 Ranch in Ft. Townson, Oklahoma, May 1993 to December 1994. Worked as a Field Manager for watermelon production and sales for Woolsey's Watermelons in Valliant, Oklahoma, April 1990 to August 2000. Employed as a student employee with Oklahoma State University at the Agronomy Research Station, Stillwater, Oklahoma, September 2000 to May 2001. Employed as a Graduate Research Assistant in the Department of Plant and Soil Science, Oklahoma State University, Stillwater, Oklahoma, May 2001 to present.

Professional Memberships: Southern Weed Science Society