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Full Length Research Paper

Influence of redroot pigweed (*Amaranthus retroflexus*) density and biomass on peanut (*Arachis hypogaea*) yield

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Studies were conducted in 2004 and 2005 to evaluate the effect of redroot pigweed on peanut. Redroot pigweed aboveground dry weight was 44, 42, 40, 38, 35 and 30 g plant^{-1} at density of 0.2, 0.5, 0.8, 1.2, 2.3, or 4.7 plants m^{-1} of crop row. Peanut yield decreased as weed density increased. Yield reduction under redroot pigweed interference was 4.1 and 63.9% at 0.2 and 4.7 plants m^{-1} crop row, respectively. The results suggest that redroot pigweed is a strong competitor with peanut and should be controlled to prevent high peanut yield loss.

Key words: Competition, *Amaranthus retroflexus*, density, interference, peanut, biomass.

INTRODUCTION

Peanut cultivars that commonly preferred by producers are relatively short. Taller weed species can cause significant yield losses by compete with peanut even at relatively low densities. Redroot pigweed (*Amaranthus retroflexus* L.) is one of the most common weed in peanut in Turkey and in the most peanut producing regions of the world (Dowler, 1995).

Pigweed species are difficult to control in peanuts (Wilcut and Swann, 1990; Bridges et al., 1994; Grichar, 1994; Jordan et al., 1994; Scott et al., 2002). Redroot pigweed can grow more than 1 m which makes it advantageous to capture more sunlight and other resources such as water and nutrients in a relatively short time (Jones et al., 1997) resulted in large amounts of dry matter accumulation. Plant dry weight is an indicator of the competitive ability of several species (Radosevich et al., 1997). A rapid growth and tall plant traits make redroot pigweed extremely competitive with crops.

The ability of redroot pigweed to cause serious yield losses is documented for some crops such as cotton, soybean and snap beans (Knezevic et al., 1999; Aguyoh and Masiunas, 2003; Bensch et al., 2003; Culpepper et al., 2006). However, information related to the density dependent effects of redroot pigweed on peanut yield losses are lack. Those losses would be even more important for short plants such as peanut It is well known that weed competitiveness varies by species, density and time of emergence relative to the crop, as well as environmental conditions (Klingman and Oliver, 1994; Knezevic et al., 1997; Bensch et al., 2003). The degree of weed competition is influenced by the several other factors such as weed dry biomass (Farris et al., 2005). Since density dependent data on redroot pigweed interference with peanut has not been reported, studies were to evaluate several redroot pigweed densities on peanut yield to provide information to producer and researchers make decision regarding the management of this weed species. Therefore, this study was conducted to (i) study the effect of redroot pigweed on peanut yield and (ii) determine yield loss at different weed densities.

MATERIALS AND METHODS

Experimental area

Field studies were conducted in Şanlıurfa, Turkey in 2004 and 2005. The experimental area soil contents of 1 to 1.2% organic matter with pH 7.5 to 7.6.

Weed interference experiment

Experimental plots were prepared according farmers management. Cultivar “NC-7” was planted in 26 May, 2004 and 2 June, 2005. Bed spacing was 75 cm and plant spacing on the same bed was 20 cm, corresponding to a final plant population of ~66,667 plants ha^{-1} (about 150 kg seed ha^{-1}). The design was a randomized complete block with 4 replications. Individual plots consisted of 4 rows of peanut 6 m long and 3 m wide. Fertilization and irrigation programs followed standard recommendations for peanut production in the region (İşler et al., 1996). All of the fertilizer was broadcast before planting at the rate of 60 kg ha^{-1} N and 60 kg ha^{-1} P and crop was irrigated immediately following planting to maintain uniform emergence. During each of the growing seasons, the crop was irrigated 10 times. Irrigation intervals and amounts varied depending on rainfall and air temperature.

Middle rows of each peanut plot were allowed to compete with different densities redroot pigweed while the outside rows were maintained weed free with regular hand weeding. Redroot pigweed densities were 0, 1, 3, 5, 7, 14 or 28 plants per 6 m crop row, corresponding to 0, 0.2, 0.5, 0.8, 1.2, 2.3, or 4.7 plants m^{-1} of row, respectively. Redroot pigweed was allowed to interfere with peanut until harvest (Clewis et al., 2001). All other weed species on rows were removed by hand and those between rows removed by hoeing. Natural densities of redroot pigweed in the experimental site exceeded the maximum density used. Therefore, weed seedlings were thinned to desired density after emergence. Redroot pigweed emerged three days after irrigation. At the end of each growing season, the weeds were cut at ground level and removed from plots to facilitate peanut harvest. Since it has formed fairly big habitus, four redroot pigweed plants were selected from each plot, dried, and weighed to determine average plant dry weight. Peanut was harvested in 4 October, 2004 and October 9, 2005 by digging pods in the two middle rows of each plot. Pods were air dried in the field for two weeks prior to weighing for final crop yield (Clewis et al., 2001).

Statistical analyses

Percent yield loss was calculated by using weed-free plots yield and data were tested for homogeneity of variance prior to statistical analysis by plotting residuals. ANOVA was performed on redroot dry weight and peanut yield loss a percentage of weed-free yields. Linear, quadratic and higher-order polynomial effects of weed densities were tested by portioning sums of squares (Draper and Smith, 1981). Year was considered a random variable. Weed density was the main effect and was tested using the error term associated with appropriate year by weed density interaction (McIntosh, 1993). If significant redroot pigweed density effects were observed on weed dry biomass or peanut yield, regression analysis was performed. Nonlinear models were used if ANOVA indicated that higher-order polynomial effects of redroot pigweed density were more significant than linear or quadratic effects. Iterations were performed to determine parameter estimates with least sums of squares for all nonlinear models, using the Gauss-Newton method by PROC NLIN in SAS (SAS 2004).

The relationship between plant densities and dry matter weight was best described with a reciprocal quadratic model over the two years:

$$Dw = \frac{1}{(a + bd + cd^2)} \quad (1)$$

Where, Dw is the dry weight of redroot pigweed in g per plant; a, b and c are the constant and d is the redroot pigweed density in plants per meter of crop row.

A rectangular hyperbola (Cousens, 1988; Thomas et al., 2004) was used to relate peanut yield loss as a function of weed density:

$$Y_L = \frac{Id}{1 + \left(\frac{Id}{A}\right)} \quad (2)$$

Where, Y_L is the peanut yield loss (% of weed-free yield); A is the asymptote (% yield loss as d approaches infinity); d is the weed density (plants per meter of crop row) and I is the yield loss per weed as weed density approaches zero. The parameter estimates were calculated using PROC NLIN (SAS 2004).

RESULTS AND DISCUSSION

Peanut yield losses

Increasing densities of redroot pigweed resulted in more peanut yield losses. Redroot pigweed interference resulted in 4.1 to 63.9% yield loss with 0.2 and 4.7 weed plants m^{-1} crop row (Figure 1). The estimated yield loss as density approached zero was (I) 49.1% while asymptotic or maximum yield loss (A) was 89.8% for redroot pigweed (Figure 1).

One plant of redroot pigweed m^{-1} of row caused 31.7% yield loss when allowed to interfere with peanut throughout the growing season. Previous studies using other weed species at the same density showed lower peanut yield reduction. Predicted yield losses due to wild poinsettia in peanut were 4, 8, 12, 15, 26, 40 or 54% for season-long interference of densities of 1, 2, 4, 8, 16 or 32 with poinsettia 9 m^{-1} of row in Georgia (Bridges et al., 1992). Florida beggarweed (*Desmodium tortuosum*) (Buchanan et al., 1982; Cardina and Brecke, 1989) and bristly starbur (*Acanthospermum hispidum*) (Walker et al., 1989) interference in peanut with one plant of per crop row caused 24 and 16% yield loss, respectively indicating that redroot pigweed is more competitive than those weeds if all experimental conditions were similar (Figure 1).

The relation between redroot pigweed dry biomass and peanut yield (pod weight) was best described with a linear equation (Figure 2). Peanut yield in the weed-free plots was 3080 and 3010 kg ha^{-1} in 2004 and 2004, respectively. As weed dry weight (g m^{-1} crop row) increased, peanut yield decreased. Previous studies reported similar inverse relationship between weed biomass accumulation and peanut yield with horsenettle (*Solanum carolinense*) and crownbeard (*Verbesina encelioides*) (Hackett et al., 1987; Farris et al., 2005).

At the highest weed density of 4.7 plants m^{-1} of row used in this study, redroot pigweed accumulated 30.0 g plant^{-1} (140 g m^{-1} of row) total dry biomass. Based on results weed dry biomass is a useful tool to predict peanut yield losses.

Weed dry biomass and densities

Year effects by treatment (weed density) interaction were

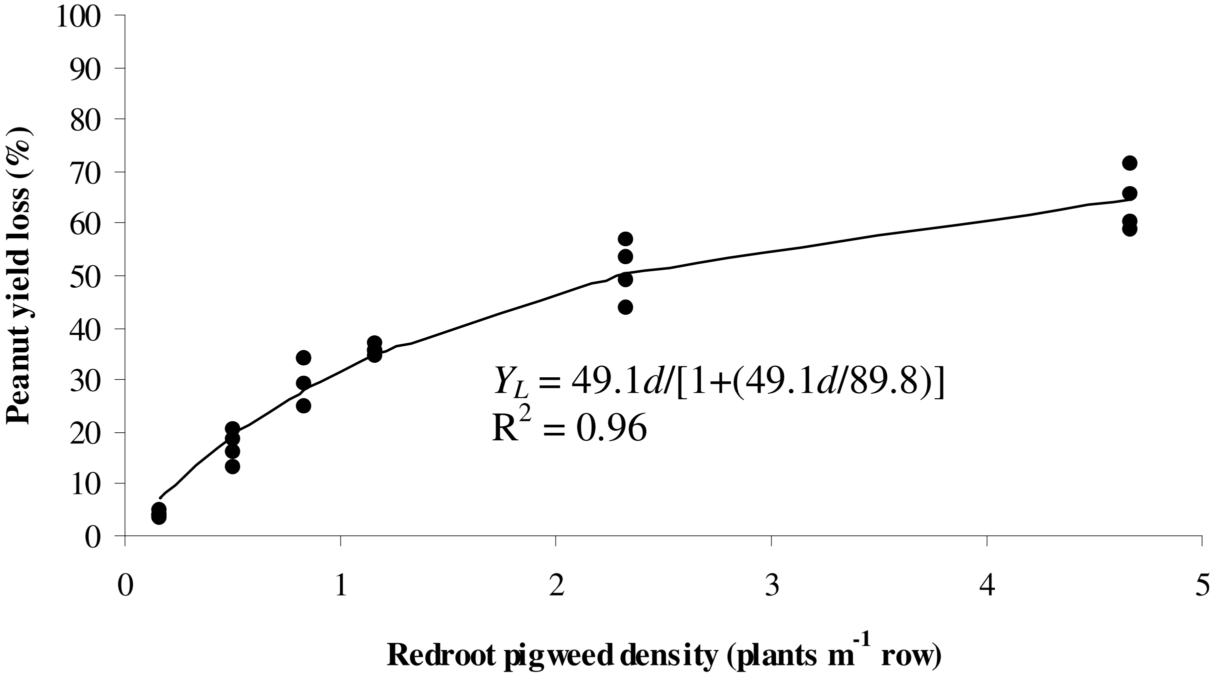

Figure 1. Peanut yield loss as influenced by redroot pigweed (*Amaranthus retroflexus*) interference at different densities. Data averaged over 2004 and 2005.

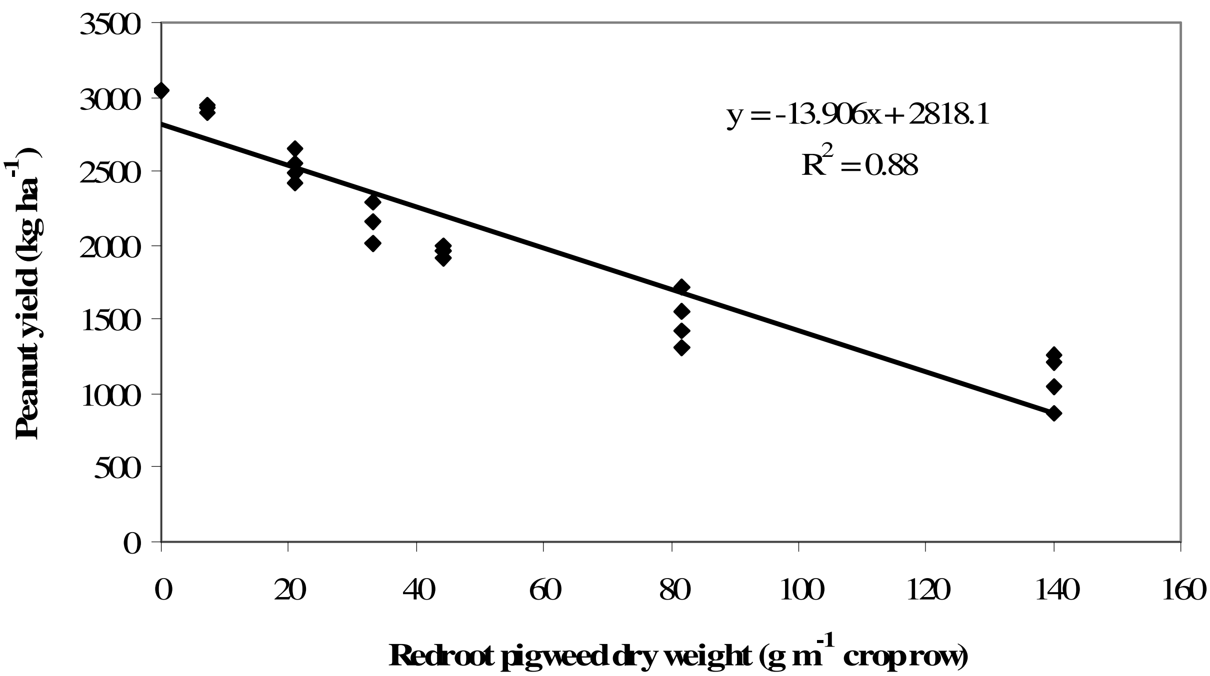

Figure 2. Relationship between redroot pigweed (*Amaranthus retroflexus*) dry biomass and peanut yield (dry pod weight). Data averaged over 2004 and 2005.

not significant for redroot pigweed dry biomass accumulation, thus data were pooled for both years. The relationship redroot pigweed dry biomass and his respective densities were best described by reciprocal quadratic model (Equation 1, Figure 3).

Dry weight per plant decreased as densities increased (Figure 3). Density dependent decline in weed dry biomass per plant is indicative of intraspecific competition

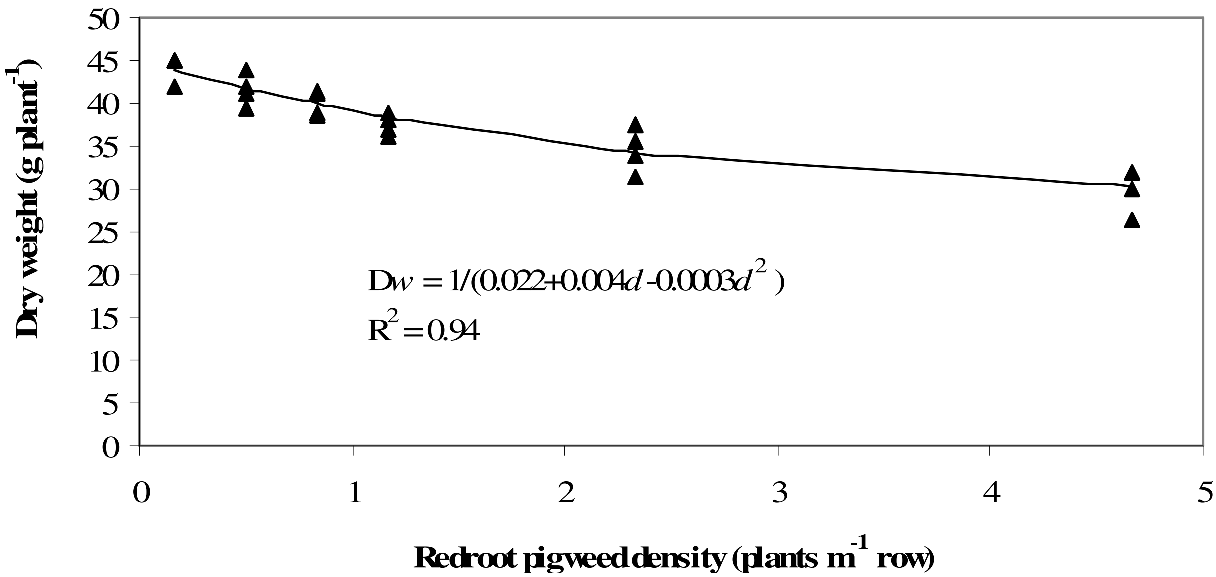

Figure 3. Relationship between redroot pigweed (*Amaranthus retroflexus*) density and dry biomass. Data averaged over 2004 and 2005.

(Snipes et al., 1982, 1987; Rushing et al., 1985; Bridges and Chandler, 1987; Thomas et al., 2004). The dry biomass of redroot pigweed was 44.0 g per plant at 0.2 plants m^{-1} of peanut row and only reduced to 30.2 g $plant^{-1}$ at 4.7 plants m^{-1} of crop row. The proportion of biomass allocation may reflect the ability of the species to obtain resources and compete with other plants (Horak and Loughin, 2000). The present study provides base data to the researchers and peanut producers to make decisions regarding the management of this weed species for their future competition studies.

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