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Season-Long Interference of American Black Nightshade with Watermelon

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Field trials were conducted over two spring seasons (2005 and 2006) to investigate the interference between American black nightshade and watermelon in polyethylene-mulched and nonmulched (bare ground) trials. Competition studies were performed with watermelon at 1 plant/m in-row and American black nightshade grown at 0, 2, 4, 6, and 8 plants/m^2 in-row. Watermelon yield reductions started to plateau at only 2 American black nightshade plants/m^2. Yield reduction was 80, 89, 96, and 98% and 54, 67, 81, and 85% at 2, 4, 6, and 8 American black nightshade plants/m^2 in mulched watermelon production in 2005 and 2006, respectively. When watermelon was grown on bare ground, yield reduction was 100% at 2 American black nightshade plants/m^2 in 2005 and 68, 81, 89, and 93% at 2, 4, 6, and 8 American black nightshade plants/m^2 in 2006, respectively. Watermelon fruit numbers were reduced due to American black nightshade interference, but no significant differences in individual fruit weight were observed.

Nomenclature: American black nightshade, *Solanum americanum* Mill., SOLAM; watermelon, *Citrullus lanatus* (Thunb.) Matsum. & Nakai. cv. 'Mardi Gras'.

Key words: Additive design, competition, mulch, plasticulture, yield loss.

Florida traditionally supplies a major portion of the watermelons consumed in the United States. Florida ranks in the top three watermelon-producing states with an annual income of 127 million dollars in 2005 (NASS 2005). Florida watermelons are primarily transplanted on polyethylene-mulched beds (70%), but there is still a significant acreage grown on nonmulched beds (Larson et al. 2004). Regardless of production method, watermelons require high temperatures for initial growth and wide-row spacing to allow for optimum vine growth (Olson et al. 2005). Wide-row spacing and high temperatures are ideal for weed emergence and growth.

Watermelon is known to be a poor competitor with many weed species. Goosegrass (*Eleusine indica* L.) was found to reduce watermelon yield at a density of only 3 plants/m^2 (Wallinder and Talbert 1983). Large crabgrass (*Digitaria sanguinalis* L.) reduced watermelon yield by 90% at a density of 250 plants/m^2 (Monks and Schultheis 1998). Terry et al. (1997) found that smooth amaranth (*Amaranthus hybridus* L.) at 6 plants/m^2 reduced watermelon yield by 100% with season-long interference, and Buker et al. (2003) showed that 2 yellow nutsedge (*Cyperus esculentus* L.) plants/m^2 reduced watermelon yield 10%, and 25 yellow nutsedge plants/m^2 reduced yield 50% compared to the weed-free control.

A significant amount of the watermelon grown in Florida comes from South Florida, where American black nightshade is a problematic weed (Bewick et al. 1991). There are a limited number of herbicides registered for use in watermelon production and no herbicide is labeled for use in watermelon crops to control American black nightshade. No published information is available on competitive effects of nightshades with watermelons or on the effects of watermelon production methods on the competition between these species. The objectives of this research were to determine the effects of season-long competition of American black nightshade in watermelon production in both mulched and nonmulched production systems.

Materials and Methods

Additive studies were conducted in the spring of 2005 at the North Florida Research and Education Center, Live Oak, FL (NFREC) and in spring of 2006 at NFREC and the Plant Science Research and Education Center, Citra, FL (PSREC). These studies were conducted to determine the effects of season-long American black nightshade interference with 'Mardi Gras' watermelon with or without polyethylene mulch. The soil at the NFREC is a Lakeland series sand (Thermic, coated, Typic Quartzipsamments) with 1% organic matter, cation exchange capacity of 4.9, and pH 6.7. The soil at PSREU is a Hague series sand (Loamy, siliceous, semiactive, hyperthermic Arenic Hapludalfs), 1.4% organic matter, cation exchange capacity of 6.1, and pH of 5.8. Beds were 1 m wide and 2.4 m from row middle to row middle. Plots were 6 m long. Two weeks prior to planting, soil was fumigated with a mixture of methyl bromide:chloropicrin in a 98:2 ratio, at 392 kg/ha. At the time of fumigation, black polyethylene mulch along with drip tape to accommodate fertigation, were placed over the raised seedbeds. One week after fumigation, the mulch was removed from the beds in the nonmulch trials. Production and drip fertigation practices followed the recommendations of the University of Florida IFAS Extension Service (Olson et al. 2005). Weeds other than American black nightshade that emerged were removed by hand or by mechanical means. 'Mardi Gras' watermelon were transplanted 1 m apart in rows on March 31, 2005 at the NFREC, and on March 23 and 27, 2006, at the PSREU and NFREC, respectively. Pest management was implemented according to the University of Florida, IFAS Extension Service recommendations (Olson et al. 2005). Approximately 6 to

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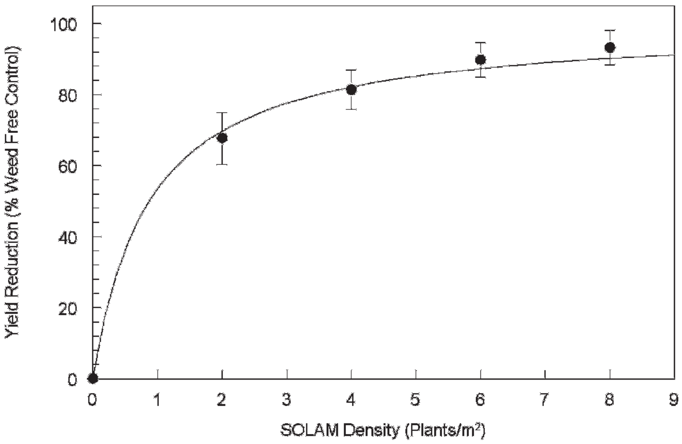

Figure 1. Watermelon yield reduction (%) in 2006 (means of two locations) as affected by season-long interference at different American black nightshade densities (open culture). The model is Y = IX/(1 + IX/100) where I = 115.

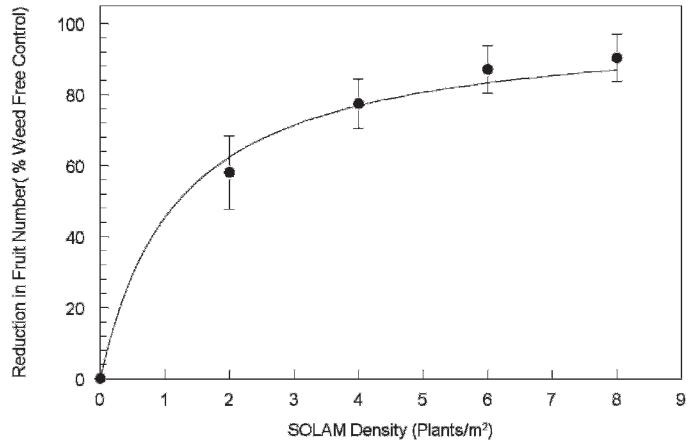

Figure 2. Watermelon fruit number reduction (%) in 2006 (two locations means) as affected by season long interference at different American black nightshade densities (open culture). The model is Y = IX/(1 + IX/100), where I = 83.02.

8 wk prior to planting, American black nightshade was seeded into 2.54-cm cells in trays[1] and grown in a greenhouse. On the same day of the watermelon planting, 5 to 7 wk old American black nightshade seedlings (5 cm high) were transplanted 10 cm from the watermelon transplants and each other in a linear arrangement. Treatments consisted of American black nightshade transplants planted at four rates per unit area (2, 4, 6, and 8 plants/m^2), with the control being a weed-free plot. In all trials, a randomized complete block design was used with four replications.

Fruits were harvested twice, weighed, counted, and graded for marketability. In this study, "marketable" fruit indicated uniform fruit shape and fruit weighing over 6 kg. Fruit number and fruit weight were recorded at each harvest. Data were expressed as percent of weed-free control in order to normalize trends between trials and locations. Analysis of variance was performed using PROC GLM to test for significant effects and interactions at the 5% level (SAS 2006). All normalized data were then regressed using SAS to show differences in treatments by mulch type. Plots of the means indicated that the data were not linear, so PROC NLIN (SAS 2006) was used to fit rectangular hyperbola models (Cousens 1985) to explain the relationships between the watermelon yields, number of melons, and American black nightshade density for the mulched and nonmulched trials. The model fitted was:

$$Y = IX/(1 + IX/100) \qquad [1]$$

where Y is the yield reduction as a percentage of the control, I is the percentage yield reduction per unit American black nightshade density as density approaches zero, and X represents any American black nightshade density.

Results and Discussion

Analysis of data from the 2005 and 2006 trials revealed watermelon yields were significantly affected by American black nightshade density and production method (mulched or nonmulched or bare ground). Due to interaction by year, data were analyzed separately for each year. In 2005, the results were presented only for the NFREC because the watermelons were lost to disease at the PSREC. In 2006, there was no significant treatment by location interaction, so data were averaged over location for mulched trials and for bare ground trials. Total yield and marketable yield responses were similar, so only total yields are presented.

Watermelons grown on bare ground (nonmulched) were greatly affected by American black nightshade density. In 2005, 2 American black nightshade /m^2 reduced yields by 100% (data not shown). In 2006, yield reduction was only 68% at 2 American black nightshade /m^2 with nonmulched watermelon (Figure 1). Yield reduction started to plateau after 2 American black nightshade/m^2 with losses of 81, 89, and 93% at 4, 6, and 8 American black nightshade/m^2, respectively. The number of melons produced followed the same trend with loss as a percent of the weed-free control of 58, 77, 87, and 90 at densities of 2, 4, 6, and 8 American black nightshade/m^2, respectively (Figure 2).

Watermelon yield reduction at the NFREC in 2005, grown in mulch culture, was 80% at 2 American black nightshade/m^2, respectively (Figure 3), respectively. Yield reduction increased to 89, 96, and 98% with 4, 6, and 8 American black nightshade/m^2, respectively. A similar response was obtained with fruit number. Reduction in fruit number was 72, 85, 90, and 98% with 2, 4, 6, and 8 American black nightshade/m^2, respectively (Figure 4). Watermelon yield reduction due to American black nightshade interference in mulched culture was less in 2006. The model again started to plateau at 2 American black nightshade/m^2. Yield reductions averaged over location were 54, 67, 81, and 85% at 2, 4, 6, and 8 American black nightshade/m^2, respectively (Figure 5) and reduction in number of melons was 48, 64, 77, and 79% at 2, 4, 6, and 8 American black nightshade/m^2, respectively (Figure 6).

Watermelon growth and yield have been shown to be greater in polyethylene mulched production than with open bare-ground culture (Brinen et al. 1979; Lu et al. 2003;

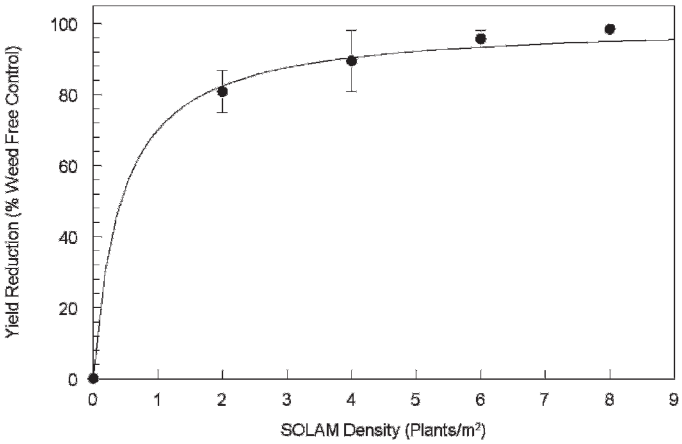

Figure 3. Watermelon yield reduction (%) in 2005 (one location) as affected by season-long interference at different American black nightshade densities (mulched). The model is Y = IX/(1+IX/100), where I = 235.

Sanders et al. 1999). This was also apparent in these studies where the mulched weed-free controls yielded at 36 t/ha and the nonmulched controls produced a yield of 24 t/ha in 2006 ($P = 0.05$, data not shown). In 2005, mulched, weed-free controls at NFREC yielded 24 t/ha vs. 16 t/ha produced in the nonmulched controls.

The use of mulch improved the competitiveness of watermelons with American black nightshade. Regardless of whether the watermelons were grown on mulch or bare ground, low American black nightshade densities severely reduced watermelon yield. Watermelon yield and fruit number loss exceeded 50% in all trials with 2 American black nightshade/m^2, ranging from 54% when grown on mulch in 2006 to 100% when grown in open culture in 2005. Yield reduction with an American black nightshade density of 8 plants/m^2, was 85 to 100% in the trials.

The sensitivity of watermelon to competition from relatively low weed densities is consistent with the results of previous studies (Buker et al. 2003; Monks and Schultheis 1998; Terry et al. 1997; Wallinder and Talbot 1983).

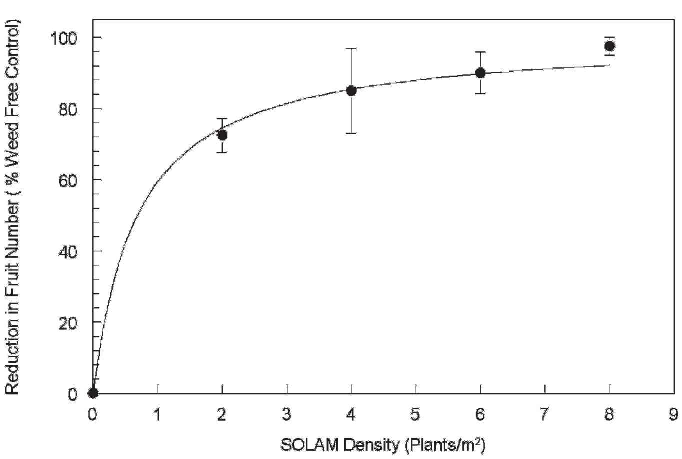

Figure 4. Watermelon fruit number reduction (%) in 2005 (one location) as affected by season-long interference at different American black nightshade densities (mulched). The model is Y = IX/(1 + IX/100), where I = 146.

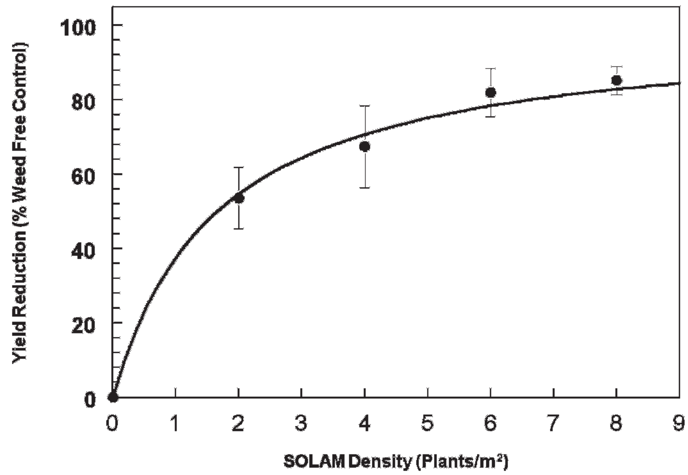

Figure 5. Watermelon yield reduction in 2006 (two locations means) as affected by season-long interference at different American black nightshade densities (mulched). The model is Y = IX/(1 + IX/100), where I = 60.29.

Collectively, these findings indicate that watermelon is a poor competitor with weeds.

Fruit weight was not affected by American black nightshade interference in either the mulched or bare-ground studies (data not shown). This indicates that the interference of American black nightshade in watermelon reduced fruit set and not fruit development (fruit weight). Therefore, given American black nightshade interference, fewer, but full-sized fruit were produced. Monks and Schultheis (1998), and Buker et al. (2003) reported that large crabgrass and yellow nutsedge reduced watermelon fruit number per plant but not the weight per fruit or the soluble solids content of the fruit. Terry et al. (1997) reported that both the fruit number per plant and the weight per fruit were reduced by smooth amaranth interference. However, they found that fruit number was more sensitive than weight per fruit. Collectively, these results suggest that weeds primarily interfere with watermelon yield by reducing fruit numbers.

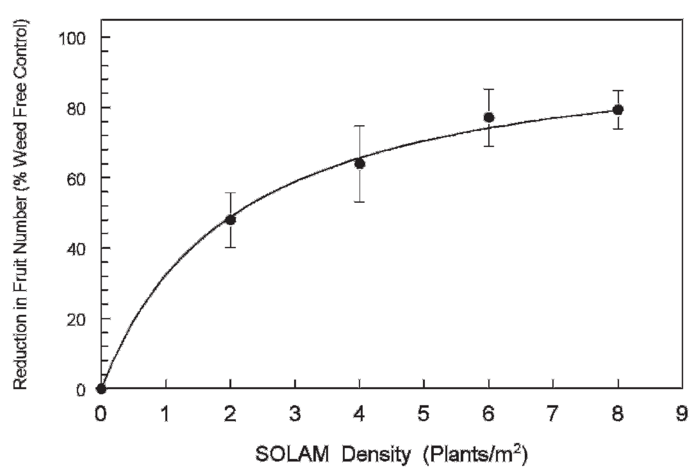

Figure 6. Watermelon fruit number reduction (%) in 2006 (two locations means) as affected by season-long interference at different American black nightshade densities (mulched). The model is Y=IX/(1+IX/100), where I=47.89.

Sources of Materials

[1] Planting trays, Speedling, Inc., P.O. Box 7220, Sun City, FL. 33586

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