Research Reports

The Impact of Weeding Regime, Planting Density, and Growth Habits on Watermelon Yield in an Organic System

Suzanne P. Stone¹, George E. Boyhan²,
and W. Carroll Johnson, III³

ADDITIONAL INDEX WORDS. *Citrullus lanatus*, mechanical weed control, organic weed control, weeding cost

SUMMARY. The southeastern United States produces 50% of U.S. conventional watermelon (*Citrullus lanatus*) but only 7% of U.S. organic watermelon. Weeds are a major threat to watermelon yield in the southeastern United States, and organic weed control is estimated to cost 20-times more than conventional herbicide programs. The objectives of this study were to determine the optimal weed control regime to reduce hand-weeding costs while maintaining yield and to compare the weed suppression of two watermelon types with differing growth habits in an organic system. In 2014 and 2015, watermelon plots were randomly assigned to the following treatments in a factorial arrangement: vine or compact growth habit; 1.0- or 0.5-m in-row spacing; and weekly weed control (kept weed-free by hoeing and hand-pulling weeds) for 0, 4, or 8 weeks after transplanting (WAT). At the time of the watermelon harvest, not weeding resulted in average total weed densities of 86.6 and 87.0 weeds/m², and weeding for 4 WAT resulted in average total weed densities of 26.4 and 7.0 weeds/m² in 2014 and 2015, respectively. Nonetheless, weeding for 4 WAT resulted in watermelon yields and fruit counts comparable to those of weeding for 8 WAT during both years. This partial-season weeding regime resulted in 67% and 63% weeding cost reductions for vine and compact plants, respectively, in 2014, and a 43% reduction for both growth habit types in 2015. In 2015, a separate experiment that evaluated weeding regimes that lasted 0, 1, 2, 3, 4, and 8 WAT found that yields resulting from weeding for 3 WAT were greater than those resulting from weeding for 2 WAT. However, the yields did not differ when weeding was performed for 4 WAT and 8 WAT.

Watermelon is a \$215 million industry in the southeastern United States. This region produces 50% of U.S. conventional watermelon but only 7% of U.S. organic watermelon (U.S. Department of Agriculture, 2014, 2016a). Because organic sales have increased more than 80% since 2007, wholesale prices of organic watermelon are twice that of conventional watermelon, and 80% of organic products are sold within 500 miles of the farm (USDA, 2014).

Therefore, there is unmet market potential for organic watermelon in the southeastern United States. However,

research to support and improve organic watermelon production in the region is lacking. Although there have not been many studies of organic watermelon production, one study evaluated the impact of reduced tillage on watermelon production and found no statistically significant differences between reduced tillage and tillage treatments (Butler et al., 2016).

Weeds are severe in the humid, subtropical southeastern United States, and they are a major threat to watermelon yield of both conventional and organic systems. Weeds compete with the crop for space, light, and nutrients, can promote disease and insect damage, and impede pollination and harvest (MacDonald, 2000). Typically, watermelons are transplanted 3 to 4 weeks after sowing and are harvested 8 to 10 weeks later. Approximately 1 to 2 weeks after transplanting, vines begin to enter row middles, making chemical or mechanical weed control nearly impossible. Although vigorously vining in nature, watermelon plants are poor weed competitors early during their growth cycle; plants must be sown or transplanted ≈ 2 m² apart and require 4 to 6 weeks to create a closed canopy with adjacent plants, thus allowing ample space and time for weeds to emerge. Various weeds, even at low densities, have been shown to impact watermelon yield throughout the growing season. Large crabgrass (*Digitaria sanguinalis*) was shown to impact watermelon yield for up to 6 WAT (Monks and Schultheis, 1998), smooth pigweed (*Amaranthus hybridus*) impacted the yield up to 3 WAT (Terry et al., 1997), and american black nightshade (*Solanum americanum*) impacted the yield up to 4 WAT (Adkins et al., 2010). Densities as low as 2 weeds/m² of yellow nutsedge [*Cyperus esculentus* (Baker et al., 2003)], goosegrass [*Echinochloa indica* (Wallinder and Talbert, 1983)], and american black nightshade (Gilbert et al., 2008) have been shown to reduce watermelon yield.

Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
0.4047	acre(s)	Ha	2.4711
0.3048	ft	m	3.2808
0.0929	ft ²	m ²	10.7639
2.54	inch(es)	cm	0.3937
0.4536	lb	kg	2.2046
1.1209	lb/acre	kg-ha ⁻¹	0.8922

Conventional watermelon production in the southeastern United States relies on synthetic preemergence and postemergence herbicides (Culpepper and Smith, 2016), which are not permitted in organic production (USDA, 2016b). Organic weed control must use an integrated approach that may include the following: cover cropping, crop rotation, stale seedbed preparation, competitive crop genotype selection, tillage, and mechanical weeding (Bàrberi, 2002). When watermelon plants begin to vine at ≈ 1 to 2 weeks after transplanting, cultivation is limited, with hand-pulling and mulches being an organic grower's few options for weed control.

Organic weed-control for other vining crops has been investigated. For example, in Washington, pumpkin (*Cucurbita pepo*) and butternut squash (*C. moschata*) yields comprised 80% of conventional production when a no-till roller crimper system was used (Luna et al., 2012). A variety of mulches, including shredded newspaper, shredded newspaper and grass clippings, hardwood bark chips, and black polyethylene plastic, were evaluated in another study and were shown to reduce the total weed biomass by 78% or more for pumpkin production (Splawski et al., 2016).

Weed control during organic production is a serious barrier to economic sustainability because mechanical weeding, including hand-weeding, is estimated to cost growers up to 20-times more than conventional herbicide programs (Gianessi and Reigner, 2007). Klonsky (2012) reported 192%, 168%, and 110% increases in weed-control costs for

organic vs. conventional production of tomato (*Solanum lycopersicum*), broccoli (*Brassica oleracea* var. *italica*), and lettuce (*Lactuca sativa*), respectively, in California. Identifying cost-effective organic weed-control strategies would greatly benefit organic growers. To our knowledge, this study is the first to determine the cost of weed-control for organic watermelon production.

A more long-term approach to sustainable weed management for organic production may be the breeding and selection of competitive crop varieties. To breed weed competitiveness, the qualities that allow high watermelon yields in weedy conditions or under a specific weeding regime must be determined (Pester et al., 1999). At this time, no studies relating the watermelon plant architecture to weed competitiveness are available. We hypothesized that short-internode plants, which have a compact growth habit, are well-suited for weed management in an organic system. Compact plants develop a denser leaf canopy that may shade competing weeds. Nonsprawling vines may be easier to hoe and hand-weed than a traditional vine-type variety. Although the vine length of commercial watermelon varieties can exceed 4 m, the compact variety selected for this study, called Companion, has vines that grow to only 1 m in length. Vine-type watermelon varieties are typically grown 1 m apart, and compact-type watermelon are grown 0.5 m apart (Fig. 1). Although 'Companion' was bred to be a non-harvested pollinizer for seedless

watermelon production and is not grown commercially, it was included in this study to determine if its unique compact growth habit trait conferred improved weed management in an organic system that could be exploited in plant breeding.

The objectives of this study were to determine the optimal weed control regime to reduce hand-weeding costs while maintaining the yield in an organic system and to evaluate the compact growth habit, a nontypical watermelon trait, for weed competitiveness and improved hand-weeding efficiency.

Materials and methods

The study was conducted on certified (Georgia Crop Improvement Association, Athens, GA) organic land at the University of Georgia Durham Horticulture Farm in Watkinsville (lat. 33°55'N, long. 83°25'W), which has been organically managed since 2007. The soil type is a Cecil sandy loam (fine, kaolinitic, thermic, typic, kanhapludults) with soil organic matter of 1.5%. The study, which was conducted in 2014 and 2015, observed similarly managed neighboring plots within an ongoing 4-year rotation scheme and followed USDA National Organic Program standards. Fertilizer with 10N-0.9P-6.6K (Nature Safe, Irving, TX) was broadcast and tilled into the soil 2 weeks before transplanting at a rate of 150% of the nitrogen recommended (180 lb/acre) for conventional watermelon production in northeast Georgia (Boyhan et al., 2000). This was performed to compensate for the slow release of

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¹2416 Radio City Street, Las Vegas, NV 89135-1114

²University of Georgia, Department of Horticulture, 1111 Miller Plant Science Building, Athens, GA 30602-5004

³USDA-ARS, Tifton Campus, P.O. Box 748, Tifton, GA 31793-0748

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G.E.B. is the corresponding author. E-mail: gboyhan@uga.edu.

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Fig. 1. A single plant of vine-type 'AU-Producer' watermelon (left photo) and two plants of compact-type 'Companion' watermelon (right photo). Polyvinyl chloride frame = 1 m² (10.8 ft²).

organic fertilizers due to the mineralization process. Untreated seeds were sown in organic potting media (Organic Fafard 3B; Sun Gro Horticulture, Agawam, MA) in greenhouse flats and transplanted 4 weeks later. Seedlings were transplanted in mid May, and fruit were harvested from mid to late July. Beds were prepared on 6-ft centers with no mulch. All plots were weed-free at the time of watermelon transplantation by using a stale seedbed technique during which surface weed seeds were allowed to germinate; then, they were removed by shallow cultivation 2 weeks before transplanting and by hand-pulling on the day of transplanting. Fields were irrigated with overhead sprinklers as needed to ≈ 1 inch/week. One harvest was conducted at 9 WAT in 2014, but the harvest in 2015 was conducted daily from 8 to 10 WAT due to animal predation pressure. No pesticides were applied during the study.

The experimental design was a randomized complete block with three replications both years. Treatments involved a three-way factorial arrangement of growth habits (vine or compact), in-row spacing (1.0 or 0.5 m), and weeding regime (hand-weeding once per week for 0, 4, or 8 WAT). Weeding for 0 WAT was performed for the nonweeded control, and weeding for 8 WAT was performed for the weeded control. Each experimental unit contained 10 watermelon plants, which means the experimental unit sizes differed based on in-row spacing. Fruit from all 10 plants were harvested regardless of the size of the experimental unit.

The varieties selected for the study to represent the vine and compact growth habit were AU-Producer and Companion, respectively. 'AU-Producer' produces 20- to 35-lb 'Crimson Sweet' fruit and demonstrates good disease resistance (Norton et al., 1985). 'Companion', bred by Seminis (St. Louis, MO) to be a non-harvested pollinizer for seedless watermelon production, produces 8- to 10-lb fruit that are gray and blocky. Its compact growth habit is a consequence of its short internode length. In addition to short internodes, 'Companion' has a rhomboid leaf shape instead of the lobed leaf shape more common in most watermelons.

Three levels of weeding regime were examined. Plots were weeded by the same three people each week using stirrup hoes and hand-pulling. The work hours required to weed each plot were recorded and converted to costs using a labor wage of \$10/h (Fake et al., 2009). Weed pressure was evaluated weekly, just before the weeding treatment. Weeds were counted according to species within two random 0.25-m² quadrants per plot. Weed density, watermelon yield, fruit count, and weeding cost per treatment were recorded and analyzed using an analysis of variance and Fisher's protected least significant difference test (Stata 14.1; StataCorp, College Station, TX). In 2015, a second study was performed that evaluated the effects of weeding for 0, 1, 2, 3, 4, and 8 WAT using 'AU-Producer' planted with 1-m in-row spacing. This study followed all of the protocols of the 2014–15 study, including the experimental design and cultural practices.

Results and discussion

Weeds were more prevalent and watermelon yield was lower in 2014 than in 2015. Because these differences in magnitude resulted in many treatment $\times$ year interactions, all response variables were analyzed separately by year. Nonetheless, trends in the effects of the weeding regime, growth habits, and in-row spacing on yield and weeding costs were consistent between years.

WEED OCCURRENCE. Large crabgrass, johnsongrass (*Sorghum halepense*), and goosegrass were the most common monocot weeds, and smooth pigweed and carpetweed (*Mollugo verticillata*) were the most common dicot weeds in the study areas both years. Before harvest, grasses were denser than dicot weeds. Weeding regime, but not growth habit or in-row spacing, had an effect on total weed density both years (Table 1). During both years, crabgrass density exceeded 30 weeds/m². In 2014, johnsongrass density of the nonweeded treatment group exceeded 11 weeds/m², but it was less than 2 weeds/m² with both weeding treatments. In 2015, johnsongrass density was less than 3 weeds/m² for all treatments. In 2014, goosegrass depended on the weeding regime, averaging the

highest for the 4 WAT weeding treatment. In 2015, goosegrass comprised more than 40 weeds/m² with the nonweeding treatment compared with less than 2 weeds/m² with the weeding treatments. In 2015, the goosegrass density was 1.5-times higher for compact than for vine-type nonweeding treatments, but it was less than 2 weeds/m² for both weeding treatments. The smooth pigweed density exceeded 30 weeds/m² with the nonweeding treatment in 2014, but it did not exceed 2.5 weeds/m² in 2015. Carpetweed density was low overall, with the weeding regime 4 WAT resulting in the greatest number of weeds compared with the nonweeding treatment. Its density was significantly greater in weeded plots, which was likely a consequence of taller weeds in these plots becoming predominant as time passed.

It should be noted that although total weed counts occurred with the 8 WAT weeding treatment, these weeds likely had no effect on yield because they were only present for 1 week before harvest and were only in the seedling stage. The percent weed coverage, although a visual estimate and therefore susceptible to observer bias, combined both weed density and biomass estimates, and it was impacted by the weeding regime in 2014 and by the weeding regime and growth habit main effects in 2015 (data not shown). In 2014, weeding only for 4 WAT resulted in $\approx 30\%$ more weed coverage than weeding for 8 WAT. In 2015, weeding for 8 WAT compared with weeding for 4 WAT resulted in 2% less weed coverage, and vine-type watermelon experienced 7% less weed coverage than compact watermelon.

These results suggest that the impact of weed density on yield depends on the weed species and the duration of weed interference. Variations in weed density and percent coverage between years and among treatments illustrated the necessity for growers to search for weed species and consider weed ecology when applying integrated weed management.

WATERMELON YIELD AND FRUIT COUNT. The yield and fruit count trends in response to the weeding regime were consistent for both varieties and both years (Table 2): weeding for 4 WAT resulted in yield and

Table 1. Significant main and interaction effects of growth habits, spacing, and weeding regime on weed density in organic watermelon plots at the time of fruit harvest in 2014 and 2015.

Main effect or interaction ^z	Total weed count		Crabgrass		Johnsongrass		Goosegrass		Smooth pigweed		Carpetweed	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
----- (weeds/m ²) ^y -----												
Weeding regime main effect ^x												
Not weeded	86.6 c	87.0 b	33.3 b	32.3 b	11.2 b	2.2	0.0 a	47.0 b	30.3 b	2.2 b	0.7 a	0.0 a
4 WAT	26.4 b	7.0 a	7.2 a	0.3 a	0.7 a	0.0	6.0 c	1.3 a	0.9 a	0 a	6.3 b	1.4 b
8 WAT	12.5 a	2.2 a	2.3 a	0.0 a	1.8 a	0.3	2.2 b	0.2 a	0.2 a	0 a	3.7 ab	0.3 ab
Interactions												
Habit × weeding regime												
Vine, not weeded								37.3 b	0.1 b			
Vine, 4 WAT								1.3 a	0.0 a			
Vine, 8 WAT								0.3 a	0.0 a			
Compact, not weeded								56.7 c	2.5 c			
Compact, 4 WAT								1.3 a	0.0 a			
Compact, 8 WAT								0.0 a	0.0 a			
Habit × spacing × weeding regime												
Vine, 1 m, not weeded												
Vine, 1 m, 4 WAT												
Vine, 1 m, 8 WAT												
Vine, 0.5 m, not weeded												
Vine, 0.5 m, 4 WAT												
Vine, 0.5 m, 8 WAT												
Compact, 1 m, not weeded												
Compact, 1 m, 4 WAT												
Compact, 1 m, 8 WAT												
Compact, 0.5 m, not weeded												
Compact, 0.5 m, 4 WAT												
Compact, 0.5 m, 8 WAT												

^xWithin each main or interaction effect, means followed by different letters are significantly different according to Fisher's protected least significant difference ($P \leq 0.05$).^y1 weed/m² = 0.0929 weed/ft².^zWeeding regimes were not weeded, 4 WAT (weeded each week for 4 weeks after transplanting), or 8 WAT (weeded for 8 weeks after transplanting). Habit refers to vine (normal vining habit of watermelon variety AU-Producer) and compact (short-internode growth habit of variety Companion).

Table 2. Main and interaction effects of growth habit, spacing, and weeding regime on organic watermelon yield and weeding labor cost.

Main effects or interaction ²	Yield		Fruit		Weeding cost	
	2014	2015	2014	2015	2014	2015
	----- (kg·ha ⁻¹) ^y -----	----- (kg·ha ⁻¹) ^y -----	----- (no./ha) ^y -----	----- (no./ha) ^y -----	----- (\$/ha) ^y -----	----- (\$/ha) ^y -----
Habit						
Vine	33,740 a	54,850 a	3,928	4,589	\$1,157	\$1,344
Compact	18,322 b	25,390 b	4,686	5,595	\$909	\$1,151
Spacing						
1 m	23,039	36,654	3,211 b	4,121 b	\$881	\$1,125
0.5 m	29,023	43,576	5,402 a	6,064 a	\$1,184	\$1,369
Weeding regime						
Not weeded	4,110 b	19,050 b	2,171 b	2,935 b	\$0 c	\$0 c
4 WAT	36,188 a	51,650 a	5,437 a	6,181 a	\$799 b	\$1,364 b
8 WAT	37,297 a	49,650 a	5,313 a	6,160 a	\$2,300 a	\$2,378 a
Interactions						
Habit × weeding regime						
Vine, not weeded	7,360 c		5,648 c	8,290 cd	\$0 a	
Vine, 4 WAT	46,450 a		10,476 b	11,569 bc	\$1,912 b	
Vine, 8 WAT	47,420 a		9,838 b	10,476 c	\$5,737 d	
Compact, not weeded	1,860 c		3,917 c	4,646 d	\$0 a	
Compact, 4 WAT	25,930 b		13,482 a	15,668 ab	\$1,609 b	
Compact, 8 WAT	27,180 b		13,573 a	16,671 a	\$4,402 c	
Spacing × weeding regime						
1 m, not weeded					\$0 a	
1 m, 4 WAT					\$1,488 b	
1 m, 8 WAT					\$4,343 c	
0.5 m, not weeded					\$0 a	
0.5 m, 4 WAT					\$2,034 b	
0.5 m, 8 WAT					\$5,796 d	

²Weeding regimes were not weeded, weeded for 4 weeks after transplanting (WAT), or 8 WAT. Habit refers to vine (normal vining habit of watermelon variety AU-Producer) and compact (short internode growth habit of variety Companion). Within each main or interaction effect, means followed by different letters are significantly different according to Fisher's protected least significant difference ($P \leq 0.05$); 1 m = 3,2808 ft.

^y1 kg·ha⁻¹ = 0.8922 lb/acre, 1 fruit/ha = 2.4711 fruit/acre, \$1/ha = \$2.4711/acre.

Table 3. Effects of weeding regime on weed density, watermelon yield, fruit count, and weeding cost in an organic system as an additional study in 2015.

Treatment	Weed density (no./m ²) ^z	Yield (kg·ha ⁻¹) ^z	Fruit (no./ha) ^z	Weeding cost (\$/ha) ^z
Weeding regime				
Not weeded	88.6 c ^y	13,930 d	3,281 d	\$0 a
1 WAT ^x	64.7 c	37,390 c	5,286 bc	\$748 a
2 WAT	20.7 b	51,260 b	6,015 ab	\$1,710 b
3 WAT	13.1 ab	63,110 a	7,655 a	\$3,111 c
4 WAT	7.1 ab	71,410 a	8,202 a	\$4,879 d
8 WAT	2.3 a	64,740 a	8,202 a	\$8,146 e

^z1 weed/m² = 0.0929 weed/ft², 1 kg·ha⁻¹ = 0.8922 lb/acre, 1 fruit/ha = 2.4711 fruit/acre, \$1/ha = \$2.4711/acre.

^yMeans within a column followed by different letters are significantly different by Fisher's protected least significant difference ($P \leq 0.05$).

^xWeeks after transplanting.

fruit count that were similar to those of weeding for 8 WAT. Previous studies demonstrated that, generally, weeds can interfere with watermelon yield at 3 to 6 WAT and at densities as low as 2 weeds/m². These previous evaluations were conducted using both bare ground (Monks and Schultheis, 1998; Terry et al., 1997) and plastic mulch (Adkins et al., 2010). In the present experiment, the significant finding was that weeds that were allowed to grow after 4 WAT, despite the total weed counts that averaged 26.4 and 7.0 weeds/m² in 2014 and 2015, respectively, did not reduce the yield compared with the weeded control. This suggested that controlling weeds through the fruit set stage, which approximately corresponds to 4 WAT, may be an effective weed-control strategy for organic watermelon growers to preserve the yield. The impact of a partial weeding regime on the weed seedbank was not investigated in the present study, but it should be considered in an integrated weed management program.

'AU-Producer' (vining habit) had greater yield than 'Companion' (compact habit) during both years, which was consistent with the differences in these varieties' performances, which were known before the present study. Denser in-row watermelon spacing increased the fruit count during both years and the yield in 2014, but not in 2015. The impacts of cultivar selection and plant spacing factors on watermelon yield and fruit count are well-established in the literature and were not research objectives of the present study because these factors are of interest only to those trying to determine their impact on weeding costs.

WEEDING COSTS. The cost of weeding increases with time invested. Based on the comparable yield response to both 4 WAT and 8 WAT weeding treatments discussed previously, the most cost-effective weeding treatment was clearly weeding for 4 WAT (Table 2).

A secondary objective of this study was to determine if the compact growth habit conferred lower weed-control costs. Plant spacing was included in the factorial design to account for differences in space requirements for compact and vine-type watermelon.

In 2014, the interactions of habit × weeding regime and in-row spacing × weeding regime significantly impacted weeding costs (Table 2). When weeding was performed during the whole season, compact plants cost less to hand-weed than vine-type plants. However, the cost reduction was no longer significant when weeding was performed only for 4 WAT. Similarly, watermelon spaced 1 m apart required less work hours for weeding than watermelon spaced 0.5 m apart when weeding was performed for 8 WAT. This spacing effect was not significant when weeding was performed only for 4 WAT. In 2015, the main effects of the weeding regime and in-row spacing were significant. Weeding for 4 WAT cost 43% less than weeding for 8 WAT. Weeding watermelon spaced 1 m apart cost 18% less than watermelon spaced 0.5 m apart. These results indicated that more plants per area will not reduce weeding costs; however, if a grower uses higher-density planting to reduce the total area planted with watermelon, then weeding costs would also be reduced. There was no detectable difference in weeding time ($P = 0.614$ and

$P = 0.649$ for 2014 and 2015, respectively) for the planned comparison of vine-type watermelon spaced 1 m apart and compact-type watermelon spaced 0.5 m apart.

It was hypothesized that compact plants are better suited for hand-weed-control than plants with sprawling vines. Compact plants were quicker to hand weed than vine types in weeded control groups, but no advantage was detected when weeding was applied only for 4 WAT. Unfortunately, because the experimental design included only single-row plots, the potential benefit of row middles free of sprawling vines was not clearly investigated. Further evaluations of these growth habit types under various row middle cultivation and mulching strategies are warranted.

ADDITIONAL STUDY OF WEEDING REGIMES. The effects of weeding for 0, 1, 2, 3, 4, or 8 WAT on weed density, watermelon yield, fruit count, and weeding costs were evaluated in an additional study performed in 2015 using 'AU-Producer' with 1-m in-row spacing (Table 3). Consistent with the primary study in 2015, weeding for 4 WAT resulted in no significant differences in weed density and watermelon yield compared with weeding for 8 WAT. In fact, weeding for 3 WAT resulted in the same total weed density and yield as weeding for 8 WAT (weeded control). Weeding for 2 WAT resulted in a fruit count identical to that of weeding for 8 WAT (weeded control). All partial weeding regimes produced an average fruit size that was the same as that of the weeded control (data not shown). Weeding for 3 WAT reduced weeding costs by 62% yet maintained a yield comparable to that of the weeded control. These findings suggested that weeding for less than 4 WAT may be effective for preserving the yield and fruit count of organic watermelon. However, further investigations are warranted.

RECOMMENDATIONS FOR GROWERS. This study provided a much needed estimation of hand-weeding costs for organic watermelon production. It should be noted that this study involved hand-weeding, which is common among small organic growers in Georgia; however, for larger growers using weed-control equipment, these results may not be applicable. In addition, unique local conditions such as weed species, the

weed seed bank, weather conditions, and previous management have an impact on weed-control strategies.

Weed-control during the growing season was found to be critical; not weeding resulted in 84% and 93% yield reductions for vine and compact watermelon, respectively, in 2014, and in 62% yield reductions for both growth habit types in 2015. Nonetheless, weeding during the whole season is not necessary to protect the yield; during both years, weeding for 4 WAT resulted in the same yield as weeding for 8 WAT. This weeding regime resulted in 67% and 63% weeding cost reductions for vine and compact plants, respectively, in 2014, and in 43% reductions for both growth habits in 2015. Using this weed management plan, the control cost ranged from \$1488 to \$3007 per ha, depending on the year, growth habit, and in-row spacing; therefore, our results are substantial but prudent. Growers who choose to use a partial-season weeding regime should take precautions to minimize the weed seed bank and rotate crops appropriately to sustainably manage weeds during the long-term.

The experimental yield of the commercial vine-type 'AU-Producer' in an organic system exceeded the national average of the conventional yield (31,815 lb/acre in 2014 and 30,298 lb/acre in 2015) and Georgia's average conventional yield (26,997 lb/acre in 2014 and 28,996 lb/acre in 2015) (USDA, 2016a). It is noteworthy that the study area had been organically managed for 7 years, and that no pesticides were applied to organic watermelon during these experiments, indicating the potential for this cropping system in the southeastern United States.

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