Summer Cover Crop and In-season Management System Affect Growth and Yield of Lettuce and Cantaloupe

Guangyao Wang
Department of Botany and Plant Science, University of California, Riverside, CA 92521

Mathieu Ngouajio
Department of Horticulture, Michigan State University, East Lansing, MI 48824

Milton E. McGiffen, Jr.
Department of Botany and Plant Sciences, University of California, Riverside, Riverside, CA 92521-0124

Chad M. Hutchinson
Horticultural Sciences Department, University of Florida/IFAS, Hastings, FL 32145

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Abstract. The effect of summer cover crop and management system on subsequent fall romaine lettuce (Lactuca sativa L.) and spring muskmelon (Cucumis melo L.) growth and yield was evaluated in the Coachella Valley of California from 1999 to 2003. Cover crop treatments included: 1) cowpea (Vigna unguiculata (L.) Walp.,) incorporated into the soil in the fall (CPI), 2) cowpea used as mulch in the fall (CPM), 3) sudangrass [Sorghum bicolor (L) Moench] incorporated into the soil in the fall (SGI), and 4) a bare ground control (BG). Management system treatments included: 1) conventional system (CON), 2) integrated crop management (ICM), and 3) organic system (ORG). Cowpea cover crop, either incorporated or used as surface mulch, increased lettuce growth and yield by increasing biomass allocation to lettuce leaf and leaf area growth. Cowpea mulch decreased muskmelon leaf and biomass growth and reduced muskmelon yield. Sudan grass produced more biomass than cowpea and reduced lettuce growth and yield. However, in the following spring, the SGI treatment had the highest muskmelon yield. Lettuce growth was significantly affected by management system, while muskmelon growth at the early stage was unaffected. The organic system reduced both lettuce and muskmelon yield compared with CON and ICM management systems.

The objective of this work was to evaluate cowpea and sudangrass as potential cover crops for improvement of growth and yield in a lettuce–muskmelon rotation system in the low desert of southeastern California under three management systems, which included conventional, integrated crop management (ICM), and organic.

Materials and Methods

Site description. Field experiments were conducted from 1999 to 2003 at the University of California Coachella Valley Agricultural Research Station in Thermal, CA. The Coachella Valley is located in the lower Colorado River desert in Southern California. Field experiments were conducted on a Coachella sandy loam (coarse-silty, mixed, calcareous, hyperthermic typic torrifluvents) with 64% sand, 33% silt, less than 1% organic matter, and a pH of 8.3. Mean daily temperature varies from 29 to 37 °C during the cover crop growing season, 11 to 23 °C during the lettuce growing season, and 13 to 34 °C during the muskmelon growing season.

Experimental design and field practices. The experimental plot area was fallow before seeding cowpea (var. Iron Clay) and sudangrass (var. Piper) cover crops in the summer of 1999. Cover crops were grown in the soil (from July to September) followed by lettuce in the fall (from October to December) and muskmelon in the spring (from February to June) from 1999 to 2003. The experiment was a split-plot design with four replications. The main plot factor was summer cover crop type and the subplot growers to adopt more sustainable production techniques such as crop rotation and the use of cover crops (Hartwig and Ammon, 2002). Cover cropping may provide nitrogen for cash crops, add organic matter to soil, and improve the physical properties of soil (Aguia et al., 2001; Creamer and Baldwin, 2000; Hartwig and Ammon, 2002). At the same time, planting cover crops could help suppress pest populations and reduce soil erosion, nutrient leaching, and contamination of surface and groundwater (Hartwig and Ammon, 2002; Hutchinson and McGiffen, 2000). However, cover crops could also reduce the subsequent crop yield (Al-Khatib et al., 1997; Scott and Knudsen, 1999). Although the practice of cover cropping is highly recommended in sustainable production, cover crops and crop management practices have to be carefully selected and investigated to maximize these benefits.

The common vegetable crop rotation in the low desert provides a niche in the cropping cycle that is ideal for a warm season cover crop. Lettuce is planted in the fall (September to October) followed by spring muskmelon in February to March. After muskmelon harvest in June and July, there is not enough time to grow a third cash crop before the next lettuce season in the fall. In addition, excessive summer temperatures preclude the production of many vegetables in the area (Hutchinson and McGiffen, 2000). Production fields are traditionally fallowed during the hot summer months, creating a gap in the production season of 2 to 3 months to integrate cover crops into the vegetable production system.

Summer cover crops that fit into current desert production practices have to be heat-tolerant and capable of producing adequate biomass in a relatively short cycle (Aguiera et al., 2001). Cowpea and sudangrass are adapted to tropical conditions and tolerate high temperatures (Creamer and Baldwin, 2000). Cowpea is a leguminous cover crop used in many parts of the southern and western United States (Ehlers et al., 2002; Ehlers and Hall, 1997; Hall and Frate, 1996). Sudangrass is also a common warm season forage crop that forms a dense canopy that effectively shades out weeds. Both cowpea and sudangrass have been shown to suppress weeds and other pests when rotating with cash crops and to recycle excess nitrogen in the soil (Danso et al., 1991; Hutchinson and McGiffen, 2000; Robertis et al., 2005; Wang et al., 2006, 2008).

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1Current address: Department of Plant Sciences, University of Arizona, Maricopa Agricultural Center, 37860 W. Smith-Enke Road, Maricopa, AZ 85239.

2To whom reprint requests should be addressed; e-mail milt@ucr.edu.
factor was management system. Cover crop treatments included: 1) cowpea incorporated into the soil in the fall (CPI), 2) summer cowpea used as surface mulch in the fall (CPM), 3) summer sudangrass incorporated into the soil in the fall (SGI), and 4) a summer bare ground dry fallow (BG). Summer bare ground dry fallow is the standard practice used by vegetable growers in the Coachella Valley (Hutchinson and McGiffen, 2000). Management systems included: 1) conventional (CON), 2) ICM, and 3) organic (ORG).

Each main plot was 18 m long and 9 m wide with six 1.5-m beds. Main plots were further subdivided into three subplots of equal size each with six beds. The three subplots were then managed as the CON, ICM, and ORG treatments. During the 5 years, all treatments (cover crop and management system) were kept in the same location using permanent marks.

Bare ground, sudangrass, or cowpea cover crop treatments were established in July of each year. Both sudangrass and cowpea cover crops were seeded as two double rows on each bed using a push planter at a rate of 50 and 60 kg·ha⁻¹, respectively. Cover crops were drip-irrigated and hand weeding was conducted 2 to 3 weeks after germination. Two months after planting, cover crops were incorporated and the beds reshaped (except in the cowpea mulch plots) before lettuce planting.

Synthetic fertilizer (15N–15P–15K) was used in the CON and ICM systems at a rate of 1130 kg·ha⁻¹ and an organic fertilizer consisting of 50:50 composted yard waste and chicken manure (Ν = 1.7%, Ρ = 2.2%, Κ = 1.43%) was used in the ORG system at a rate of 5 t·ha⁻¹ 2 weeks before the lettuce crop and 4 weeks before the muskmelon crop. After application, beds were reshaped for transplanting, except CPM plots. For insect control, a formulation of Bacillus thuringiensis subsp. azawai (XenTari, Valient BioSciences Corp., Liberryville, IL) was used in the ORG plots. In the CON and ICM plots, bifenthrin (Capture, FMC Agricultural Products, Philadelphia, PA) was used on lettuce and imiadacloprid (Admire, Bayer CropSciences, RTP, NC) and bifenthrin on muskmelon for insect control. In the ORG and ICM plots, insecticide applications were initiated only when a threshold of two insects per 10 plants was reached. In the CON system, however, there was a preestablished schedule of four applications. In all treatments, weeds were controlled manually.

The main difference between the CON and the ICM system was the reduced number of insecticide applications in the ICM system.

‘Shining Star’ romaine lettuce seedlings (Head Start Nursery, Gilroy, CA) were transplanted in double rows in 1.5-m wide beds to a final density of 45,000 plant·ha⁻¹ on 19 Oct. 1999, 17 Oct. 2000, 11 Oct. 2001, 14 Oct. 2002, and 12 Oct. 2003. The field was irrigated by sprinklers during the first 3 days after transplanting and then drip-irrigated thereafter. Lettuce was harvested on 13 Dec. 1999, 20 Dec. 2000, 28 Nov. 2001, 6 Dec. 2002, and 10 Dec. 2003. Lettuce heads harvested from the four middle beds (36 m²) were separated into marketable and nonmarketable yield according to U.S. Department of Agriculture (USDA) standards (USDA, 2007). Marketable lettuce consists of plants that were well-developed, well-trimmed, and free from damages. Head number and total weight of marketable yield were recorded.

After lettuce harvest, crop residue was incorporated into the soil and the beds reshaped, except for the cowpea mulch plots that were maintained as no-till for the lettuce and muskmelon seasons. ‘Magellan’ muskmelon (Head Start Nursery, Gilroy, CA) was grown after lettuce in the rotation until the spring of 2004. Muskmelon was transplanted on 22 Mar. 2000, 16 Mar. 2001, 28 Mar. 2002, and 18 Feb. 2003 and harvested on 8 June 2000, 4 June 2001, 24 June 2002, and 20 June 2003. A second harvest was conducted 1 to 2 weeks after the first harvest. Muskmelon fruit were separated into marketable and nonmarketable yields according to USDA standards (USDA, 2007). Marketable fruits consist of muskmelons that are mature but not overripe, well-formed and well-netted, and free from damages. Crop residue was incorporated in all plots in 1 week after muskmelon harvest and beds reshaped with the same spacing as with the lettuce and muskmelon crops in preparation for the summer cover crop.

Before cover crop diskimg, an area of 1.5 m² (1-m bed) was randomly chosen in each plot for biomass evaluation on 28 Sept. 1999, 5 Sept. 2000, 26 Sept. 2001, 26 Sept. 2002, and 15 Sept. 2003. Plants within the area were cut at the soil surface and dried at 70 °C with ventilation until a constant weight was reached. Lettuce and muskmelon plants were sampled for growth analysis every 2 weeks for a total of five times and four times each year, respectively, from 1999 to 2001 growing seasons. At transplanting, 100 representative lettuce or muskmelon seedlings were sampled. During the next two samplings, 10 plants were cut at the soil surface. As a result of increased plant size, five plants were cut at the remaining sampling dates. Both aboveground plant weight and leaf weight of lettuce or muskmelon were measured. Leaf area of each sample was also measured using a LI-3100 (Li-COR Biosciences, Lincoln, NE) optical leaf area meter.

Statistical analysis. Crop yield data were analyzed by analysis of variance and the means separated using Fisher’s protected least protected difference at a probability level of 0.05. Data were combined when there were significant treatment interactions. Year-by-treatment interactions of crop growth data were tested by analysis of covariance (McGiffen et al., 1997). Because interaction of cover crop and management system was not significant, results were presented as means for main plot and subplot treatments.

Exponential growth curves were fitted for shoot biomass, leaf area, or leaf weight samples as the dependent variable and with growing degree days (GDD) as the independent variable:

\[ W(GDD) = a_w \exp(b_w GDD) \]  
\[ LA(GDD) = a_d \exp(b_d GDD) \]  
\[ LW(GDD) = a_d \exp(b_d GDD) \]

where \( W(GDD) \), \( LA(GDD) \), and \( LW(GDD) \) are lettuce or muskmelon shoot biomass, leaf area, and leaf weight, respectively, over GDD. GDD was calculated using the single sine method (Zalom et al., 1983) with a base temperature of 3.5 °C for lettuce (Scaife et al., 1987) and 10 °C for muskmelon (Baker and Reddy, 2001). Parameters \( a_w, a_d, \) and \( b_w, b_d, b_\text{lw} \) are initial value of shoot biomass, leaf area, and leaf biomass, respectively, when lettuce or muskmelon was transplanted. Parameters \( b_\text{lw} \), \( b_w, b_d, \) and \( b_\text{lw} \) of different cover crops and management systems were compared using the generalized linear model method in Wang et al. (2004).

Unit leaf ratio (ULR), leaf area ratio (LAR), specific leaf area (SLA), and leaf weight ratio (LWR) over GDD are obtained by functional growth analysis using parameters from Eqs. [1] to [3] (Chiariello et al., 1991):

\[ \text{ULR}(GDD) = \frac{1}{\text{LA}(GDD)} \frac{d(W(GDD))}{d(GDD)} = \frac{a_d}{a_w} \exp((b_w - b_d)GDD) \]  
\[ \text{LAR}(GDD) = \frac{\text{LA}(GDD)}{W(GDD)} = \frac{a_d}{a_w} \exp((b_w - b_d)GDD) \]  
\[ \text{SLA}(GDD) = \frac{\text{LA}(GDD)}{LW(GDD)} = \frac{a_d}{a_w} \exp((b_w - b_d)GDD) \]  
\[ \text{LWR}(GDD) = \frac{\text{LW}(GDD)}{W(GDD)} = \frac{a_d}{a_w} \exp((b_w - b_d)GDD) \]

Results

Cover crop biomass. Because there were no year-by-treatment interactions, the averages of cover crop biomass from 1999 to 2003 are presented. The average cowpea biomass in the CPI and CPM treatments was 2.6 and 2.1 t·ha⁻¹, respectively (Fig. 1). Average biomass of sudangrass was 5.4 t·ha⁻¹. Management system did not affect biomass production of cover crops.
treatment had the highest lettuce LWR, whereas the SGI treatment the lowest, indicating that lettuce plants in the SGI treatment invested more biomass into stem instead of leaves.

Management system did not affect lettuce ULR and SLA, but LAR and LWR were lower in the ORG system (Fig. 3). This indicates that lettuce plants in the ORG system had lower leaf biomass and leaf area per unit shoot biomass as well as lower leaf area per unit leaf biomass.

**Lettuce yield.** Lettuce yield data are presented separately for each year because there was significant year–by-treatment interaction 

(\(P < 0.05\)). The CPI had the highest marketable weight and largest head number in the 1999 and 2000 growing seasons but equivalent yield to the BG treatment in 2001 to 2003 (Table 2). Lettuce in the CPM treatment produced higher marketable weight, head number, and head size compared with the BG treatment in the 2000 growing season but equivalent weight in the other four growing seasons. The SGI treatment had the lowest weight, head number, and head size in the 1999 growing season and lowest marketable weight in the 2002 growing season. There was no significant difference among cover crop treatments in 2003.

Compared with the ORG system, the CON and ICM systems had higher lettuce marketable weight in 1999 and 2001 and an equivalent marketable weight in 2000 (Table 2). However, the ORG system had higher or equivalent weight than the CON and ICM systems in 2002 and 2003. Lettuce head number in the ORG system was lower or equivalent in the first three growing seasons but higher in the last two growing seasons compared with the CON and ICM systems. The ORG system generally produced smaller head size compared with the CON system 4 of 5 years.

**Muskmelon growth and development.** Muskmelon plants in the CPM treatment had lower RGR, relative leaf area growth rate, and relative leaf weight growth rate than the CPI, SGI, and BG treatments (Table 3). Compared with the BG treatment, the CPM treatment reduced muskmelon RGR, relative leaf area growth rate, and relative leaf weight growth rate than (\(P < 0.05\)). The CPI had the highest marketable weight and largest head number in the 1999 and 2000 growing seasons but equivalent yield to the BG treatment in 2001 to 2003 (Table 2). Lettuce in the CPM treatment produced higher marketable weight, head number, and head size compared with the BG treatment in the 2000 growing season but equivalent weight in the other four growing seasons. The SGI treatment had the lowest weight, head number, and head size in the 1999 growing season and lowest marketable weight in the 2002 growing season. There was no significant difference among cover crop treatments in 2003.

Compared with the ORG system, the CON and ICM systems had higher lettuce marketable weight in 1999 and 2001 and an equivalent marketable weight in 2000 (Table 2). However, the ORG system had higher or equivalent weight than the CON and ICM systems in 2002 and 2003. Lettuce head number in the ORG system was lower or equivalent in the first three growing seasons but higher in the last two growing seasons compared with the CON and ICM systems. The ORG system generally produced smaller head size compared with the CON system 4 of 5 years.

**Table 1. Growth parameters of lettuce affected by cover crops and management systems.**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Level</th>
<th>Relative growth rate</th>
<th>Relative leaf area growth rate</th>
<th>Relative leaf wt growth rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover crop</td>
<td>Initial value</td>
<td>0.413</td>
<td>0.0158</td>
<td>0.348</td>
</tr>
<tr>
<td>CPI</td>
<td>0.00671 a</td>
<td>0.00569 a</td>
<td>0.00673 a</td>
<td>0.00672 a</td>
</tr>
<tr>
<td>CPM</td>
<td>0.00670 a</td>
<td>0.00575 a</td>
<td>0.00672 a</td>
<td>0.00672 a</td>
</tr>
<tr>
<td>SGI</td>
<td>0.00614 b</td>
<td>0.00503 b</td>
<td>0.00615 b</td>
<td>0.00615 b</td>
</tr>
<tr>
<td>BG</td>
<td>0.00634 b</td>
<td>0.00526 b</td>
<td>0.00636 b</td>
<td>0.00636 b</td>
</tr>
<tr>
<td>Management system</td>
<td>Initial value</td>
<td>0.413</td>
<td>0.0158</td>
<td>0.348</td>
</tr>
<tr>
<td>CON</td>
<td>0.00655 a</td>
<td>0.00555 a</td>
<td>0.00658 a</td>
<td>0.00658 a</td>
</tr>
<tr>
<td>ICM</td>
<td>0.00657 a</td>
<td>0.00557 a</td>
<td>0.00660 a</td>
<td>0.00660 a</td>
</tr>
<tr>
<td>ORG</td>
<td>0.00628 b</td>
<td>0.00518 b</td>
<td>0.00630 b</td>
<td>0.00630 b</td>
</tr>
</tbody>
</table>

*All cover crops were planted in the summer followed by lettuce in the fall from 1999 to 2003. Cover crop treatments include cowpea incorporated into the soil (CPI), cowpea used as surface mulch (CPM), sudangrass incorporated into the soil (SGI), and a bare ground control (BG). Management system treatments include conventional (CON), integrated crop management (ICM), and organic (ORG). The growth data were measured every 2 weeks after lettuce transplanting until harvest from 1999 to 2001 and combined for analysis.

*Exponential growth curves were fitted into data from different treatments within cover crop or management system using a common initial value because lettuce plants were the same at transplanting.

*Within each cover crop or management system, treatments followed by the same letter are not significantly different at \(P = 0.05\).
Because there was no significant year-by-treatment interaction for muskmelon yield, the yield data were pooled for analysis. After cover crop in the previous summer and lettuce in the previous fall, the SGI and CPI treatments had higher muskmelon marketable fruit weight compared with the BG treatment, the SGI and CPI treatments had higher muskmelon yield, and the SGI and CPI treatments increased muskmelon fruit weight by 18.2% and 13.1%, respectively. Cover crop treatments did not affect muskmelon fruit size.

In a North Carolina study using the same cultivars, the C:N ratio of cowpea (21) was lower than that of sudangrass (53; Creamer and Baldwin, 2000). The nitrogen-fixing property of cowpea makes it a promising cover crop for intensive vegetable production in the low desert. Our results showed that cowpea cover crop incorporated into the soil in the fall increased the yield of both fall lettuce (2 of 5 years) and spring muskmelon. Using cowpea as a surface mulch has been shown to increase soil fertility and reduce pest problems in the field in the low desert area (Hutchinson and McGiffen, 2000; Roberts et al., 2005). Cover crop mulch has also been shown to reduce emergence of annual weed. However, perennial weed species often increase as a result of reduced tillage when cover crop mulch is used (Buhler, 1995; Hartwig and Ammon, 2002).

Muskmelon plants in all cover crop treatments had similar ULR, LAR, and SLA early in the growing season, indicating that the cover crop treatment did not affect the efficiency of new growth produced by leaves and leaf area per unit biomass or per unit leaf biomass (data not shown). Plants in the CPM treatment had lowest LWR among the treatments, indicating that muskmelon plants in the CPM treatment invested more biomass into stem instead of leaves and resulted in lower RGR, relative leaf area growth, and relative leaf weight growth. The ORG management system did not affect ULR, LAR, SLA, and LWR compared with the CON and ICM systems (data not shown).

Although similar early growth was observed in all management system treatments, the CON and ICM treatments produced higher marketable fruit weight and fruit number compared with the ORG system. ORG treatment reduced muskmelon fruit weight by 14.7% compared with the CON system. Management system did not affect muskmelon fruit size.

**Discussion**

Research has shown that high C:N ratio and biomass production of sudangrass may immobilize nitrogen and reduce nitrogen availability to the next cash crop (Creamer and Baldwin, 2000). The lower nitrogen in the soil and allelopathic effects of sudangrass could have reduced lettuce leaf area and biomass growth rates, which reduced lettuce marketable weight and head size in three of the five growing seasons compared with the CPI treatment (Weston et al., 1989). Another disadvantage for sudangrass was that the large amount of biomass interfered with hand weeding. Research has also shown that high C:N ratio and biomass production of sudangrass may immobilize nitrogen and reduce nitrogen availability to the next cash crop (Creamer and Baldwin, 2000). The lower nitrogen in the soil and allelopathic effects of sudangrass could have reduced lettuce leaf area and biomass growth rates, which reduced lettuce marketable weight and head size in three of the five growing seasons compared with the CPI treatment (Weston et al., 1989). Another disadvantage for sudangrass was that the large amount of biomass interfered with hand weeding.

**Table 2.** The effect of cover crop and management system on lettuce marketable yield in the five growing seasons. a

<table>
<thead>
<tr>
<th>Factor</th>
<th>Lettuce wt (g·ha⁻¹)</th>
<th>Lettuce head number</th>
<th>Lettuce head size (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover crop</td>
<td>CPI</td>
<td>9.8 a</td>
<td>10.2 a</td>
</tr>
<tr>
<td></td>
<td>CPM</td>
<td>7.8 b</td>
<td>8.8 b</td>
</tr>
<tr>
<td></td>
<td>SGI</td>
<td>3.8 c</td>
<td>7.7 b</td>
</tr>
<tr>
<td></td>
<td>BG</td>
<td>8.1 b</td>
<td>5.7 c</td>
</tr>
<tr>
<td>Management</td>
<td>CON</td>
<td>9.0 a</td>
<td>8.2 a</td>
</tr>
<tr>
<td>system</td>
<td>ICM</td>
<td>8.0 a</td>
<td>8.5 a</td>
</tr>
<tr>
<td></td>
<td>ORG</td>
<td>5.1 b</td>
<td>7.6 a</td>
</tr>
</tbody>
</table>

aAll cover crops were planted in the summer followed by lettuce in the fall from 1999 to 2003. Cover crop treatments include cowpea incorporated into the soil (CPI), cowpea used as surface mulch (CPM), sudangrass incorporated into the soil (SGI), and a bare ground control (BG). The yield data were analyzed separately because significant year-by-treatment interactions.
lettuce transplanting, partially contributing to the lower lettuce marketable head number in two of the five growing seasons in the SGI treatment. However, sudangrass increased after muskmelon yield by 18.2%, probably as a result of the long and steady availability of nitrogen in the soil from the decomposition of sudangrass residue (Myers et al., 1997).

Summer cover crops helped improve Coachella Valley fall lettuce and spring muskmelon growth and yield in this research. The integration of appropriate cover crops into the production system could improve the current vegetable rotations. Cowpea cover crops, either soil-incorporated or as a surface mulch, would fit in conventional, integrated, and organic production systems. A sudangrass cover crop should be carefully managed to avoid potential yield loss.

In this study, management system had a significant effect on the growth and yield of lettuce and muskmelon. Compared with the CON system, lettuce marketable weight and head number in the ORG system were lower or equivalent in the first 3 years but higher or equivalent in the fourth and fifth years. Results of this study are similar to results obtained by other researchers (Blackshaw, 2005; Liebhardt et al., 1989; MacRae et al., 1993). For example, Blackshaw (2005) showed that wheat yield with organic fertilizer (manure or compost) was lower during the first year of the experiment and then equivalent in the third and fourth year to broadcast and banded granular ammonium nitrate under weed-free conditions. These results indicate that soils under long-term conventional management may require more than 2 years reaching a new equilibrium under organic management (Delate, 2002; Drinkwater, 2002). Lettuce plants in the ORG system had slower leaf and biomass growth than in the CON system, resulting in smaller head size in 4 of 5 years.

Although muskmelon plants in the ORG system had growth rates comparable to the CON system at the early growth stage, muskmelon fruit weight and fruit number in the ORG system were smaller, indicating that muskmelon yield was reduced at the later stage in the ORG system. The lower muskmelon yield was probably the result of late-season weed competition because there were considerable weeds left after the third weeding in the muskmelon crop as a result of spreading character of muskmelon canopy, and organic fertilizer may increase weed competitive ability with crops (Blackshaw, 2005; Menalled et al., 2004).

### Table 3. Growth parameters of muskmelon affected by cover crops and management systems.a

<table>
<thead>
<tr>
<th>Factor</th>
<th>Level</th>
<th>Relative growth rate</th>
<th>Relative leaf area growth rate</th>
<th>Relative leaf wt growth rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover crop</td>
<td>Initial value</td>
<td>0.335</td>
<td>0.0055</td>
<td>0.238</td>
</tr>
<tr>
<td>CPI</td>
<td>0.0117 a</td>
<td>0.0098 a</td>
<td>0.0113 a</td>
<td></td>
</tr>
<tr>
<td>CPM</td>
<td>0.0108 b</td>
<td>0.0089 b</td>
<td>0.0104 b</td>
<td></td>
</tr>
<tr>
<td>SGI</td>
<td>0.0116 a</td>
<td>0.0098 a</td>
<td>0.0112 a</td>
<td></td>
</tr>
<tr>
<td>BG</td>
<td>0.0116 a</td>
<td>0.0096 a</td>
<td>0.0112 a</td>
<td></td>
</tr>
<tr>
<td>Management</td>
<td>Initial value</td>
<td>0.335</td>
<td>0.0055</td>
<td>0.238</td>
</tr>
<tr>
<td>system</td>
<td>CON</td>
<td>0.0114 a</td>
<td>0.0094 a</td>
<td>0.0110 a</td>
</tr>
<tr>
<td>ICM</td>
<td>0.0115 a</td>
<td>0.0096 a</td>
<td>0.0112 a</td>
<td></td>
</tr>
<tr>
<td>ORG</td>
<td>0.0114 a</td>
<td>0.0095 a</td>
<td>0.0110 a</td>
<td></td>
</tr>
</tbody>
</table>

aAll cover crops were planted in the previous summer followed by lettuce in the previous fall and muskmelon in the spring of 2000, 2001, 2002, and 2003. Cover crop treatments include cowpea incorporated into the soil (CPI), cowpea used as surface mulch (CPM), sudangrass incorporated into the soil (SGI), and a bare ground control (BG). Management system treatments include conventional (CON), integrated crop management (ICM), and organic (ORG). The growth data were measured every 2 weeks after muskmelon transplanting for four times each year from 2000 to 2002 and combined for analysis.

Exponential growth curves were fitted into data from different treatments within cover crop or management system using a common initial value because muskmelon plants were same at transplanting.

Within each cover crop or management system, treatments following the same letter are not significantly different at P = 0.05.

### Table 4. The effect of cover crops and management systems on muskmelon marketable yield in the four growing seasons.a

<table>
<thead>
<tr>
<th>Factors</th>
<th>Levels</th>
<th>Fruit wt (t/ha)</th>
<th>Fruit number (&lt;1000 ha)</th>
<th>Fruit size (G)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover crop</td>
<td>CPI</td>
<td>24.0 a</td>
<td>24.3 a</td>
<td>997.9 a</td>
</tr>
<tr>
<td></td>
<td>CPM</td>
<td>21.0 b</td>
<td>21.1 b</td>
<td>1,008.8 a</td>
</tr>
<tr>
<td></td>
<td>SGI</td>
<td>25.1 a</td>
<td>24.5 a</td>
<td>1,000.4 a</td>
</tr>
<tr>
<td></td>
<td>BG</td>
<td>21.3 b</td>
<td>21.5 b</td>
<td>1,033.0 a</td>
</tr>
<tr>
<td>Management system</td>
<td>CON</td>
<td>23.7 a</td>
<td>23.3 a</td>
<td>1,021.0 a</td>
</tr>
<tr>
<td></td>
<td>ICM</td>
<td>24.7 a</td>
<td>24.7 a</td>
<td>1,011.8 a</td>
</tr>
<tr>
<td></td>
<td>ORG</td>
<td>20.2 b</td>
<td>20.5 b</td>
<td>997.1 a</td>
</tr>
</tbody>
</table>

aAll cover crops were planted in the previous summer followed by lettuce in the previous fall and muskmelon in the spring of 2000, 2001, 2002, and 2003. Cover crop treatments include cowpea incorporated into the soil (CPI), cowpea used as surface mulch (CPM), sudangrass incorporated into the soil (SGI), and a bare ground control (BG). Management system treatments include conventional (CON), integrated crop management (ICM), and organic (ORG). The yield data were combined because there were no significant year-by-treatment interactions.

Treatments within a column followed by the same letter are not significantly different at P = 0.05.

### Literature Cited


Macane, R.I., S.B. Hill, G.R. Methys, and J. Henning. 1993. Farm-scale agronomic and economic conversion from conventional to...