Greenhouse Production of ‘Charentais’-type Cantaloupes
(Cucumis melo L. var. cantalupensis)

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Popular in France, ‘Charentais’ cantaloupes boast an extremely fragrant and sweet, orange flesh. In the U.S., ‘Charentais’ melons are not widely grown due to their short shelf-life and susceptibility to powdery mildew (Podosphaera xanthii). The objective of this study was to evaluate ‘Charentais’-type cantaloupes (bred for a longer shelf-life and improved disease resistance) for fruit yield, quality, and powdery mildew coverage (% PM) at harvest. During Spring and Fall 2008, seven lines of ‘Charentais’-type cantaloupes were produced in a passively-ventilated greenhouse at the University of Florida, Citra, FL. Mean fruit number per plant was greater in spring (4 fruits) as compared with the fall (2 fruits) season. Fruit yield and weight per square meter and fruit size (kg/fruit) were also greater in the spring; however, mean soluble solids content (SSC) was higher in fall (14 °Brix) than in spring (12 °Brix). Percent PM ranged from 8% to 63% in the spring and 7% to 100% in the fall. Flesh firmness [Newtons (N)] was higher in the spring for five lines, while two lines (WS5019 and WS5022) had similar firmness in both seasons. Mean fruit number per plant ranged from 2.2 fruits (WS5016) to 3.8 fruits (WS5031) over both seasons. Line WS5031 had the smallest fruits (0.6 kg/fruit), while all other lines weighed greater than 0.8 kg/fruit, with the largest fruits from WS5016 and WS5019 (1.2 kg/fruit). Fruit yield was greatest for WS5031 (mean 9.5 kg·m⁻²) and lowest for WS5016 and WS5033 (mean 5.5 kg·m⁻²). Mean SSC was 11.5 °Brix or greater for all lines. Therefore, ‘Charentais’ melons would be an excellent high-value crop for greenhouse producers in the U.S. because of their excellent flavor, sweetness, and ability to produce economic yields even in the presence of PM.

Fig. 1. The ‘Charentais’ (Cucumis melo L. var. cantalupensis Naud.) melon.

The ‘Charentais’ (Cucumis melo var. cantalupensis Naud.) is a smooth-skinned cantaloupe with exterior green sutures and a bright orange flesh (Fig. 1) (Goldman, 2002). The ‘Charentais’ is part of the cantalupensis melon group, or true cantaloupes (Whitaker and Davis, 1962), which originated from Cantaluppe, Italy (Robinson and Decker-Walters, 1997). They are usually non-netted, have rough/warty skin with prominent sutures (Whitaker and Davis, 1962), and flesh is orange or green. What is called a “cantaloupe” in the U.S. is actually a muskmelon (Cucumis melo L. var. reticulatus) (Bailey and Bailey, 1976).

‘Charentais’ fruit have a high soluble solids content ranging from 10 to 16 °Brix (Guerineau et al., 2000). It originated in the Poitou-Charentes region of western France about 1920. ‘Charentais’ is currently the favorite melon of France (Goldman, 2002) and is also popular throughout Europe (Schultheis et al., 2002).

Although ‘Charentais’ cantaloupes are popular due to their high soluble solids content, the climacteric, soft-textured fruit exhibits reduced shelf-life as compared to other melon types due to extremely rapid ripening (Hadfield et al., 2000). It is also highly susceptible to powdery mildew [Podosphaera xanthii (Px) (syn. Sphaerotheca fuliginea)] (Mitchell et al., 2006). Powdery mildew, the most common and aggressive cucurbit fungus (McGrath, 2005), can prohibit or slow plant growth and development, and ultimately reduce yield and fruit quality (Agrios, 2005). To meet these challenges, ‘Charentais’-type cantaloupes were bred for improved disease resistance and shelf-life to facilitate shipping to international markets (www.poloni-semences.fr/en/platinum).

‘Charentais’ types are considered a specialty melon in the U.S. Potentially, they could contribute to an expanding U.S. melon production, which in 2008 totaled $931 million (a 17% increase
from 2007) (Lucier and Dettman, 2009). As melon consumption increases, distributors have increased their interest in specialty melons. Melissa’s/World Variety Produce, Inc., for example, has had a 10% increase in specialty melon sales every year for the last 5 years (O’Keefe Swank, 2008). The increased interest of distributors for expanding markets has contributed to more research to find specialty melons such as ‘Charentais,’ for sales on the U.S. market. Recent research on ‘Charentais’ cantaloupes has occurred at the University of Florida (Mitchell et al., 2006), North Carolina State University (Schultheis and Jester, 2005), and the University of Missouri (Jett, 2005, 2006).

Since 2002, there has been a 19% increase in farms in the U.S. that produce protected vegetables and herbs (U.S. Census of Agriculture, 2007). Research on protected specialty melons, especially ‘Galia’ muskmelon, is extensive and includes tunnel production (Jett, 2006), production practices (Rodriguez et al., 2005, 2006, 2007; Shaw et al., 2001), fruit quality and disease susceptibility (Mitchell et al., 2006, 2007a, 2007b), and the potential profitability of greenhouse-grown melons (Shaw et al., 2004, 2007).

The study presented here lies at the nexus of research into specialty melons, protected agriculture, and was partly driven by consumer demand. As interest in melon production and consumption rises, consumer standards rise as well. Consumers demand high soluble solids content (°Brix), firmer fruits, and a long shelf-life (O’Keefe Swank, 2008). Ultimately, providing consumers with high-quality melons that meet their acceptance is paramount. Therefore, the objective of this study was to grow ‘Charentais’-type cantaloupes (bred for a longer shelf-life and improved disease resistance) in a passively-ventilated greenhouse and evaluate them for fruit yield, quality, and powdery mildew tolerance to determine their potential as a high-value, high-quality greenhouse crop.

**Materials and Methods**

**Plant Materials and Production.** During Spring and Fall 2008, seeds of seven ‘Charentais’-type cantaloupe lines were obtained from Western Seed® Americas, Inc. (International Seed Group, a division of Monsanto) and sown on 8 Feb. and 5 Aug. 2008. Seedlings were established according to the methods of Mitchell et al. (2007a). Seedlings were transplanted when they had the third true leaf on 10 Mar. and 4 Sept. 2008. Both spring and fall trials were conducted in a passively ventilated greenhouse (TOP Greenhouses, Ltd., Barkan, Israel) located at the University of Florida Protected Agriculture Greenhouse Complex at the Plant Science Research Education Unit located in Citra, FL. Using the guidelines of Shaw et al. (2001), the plants were produced using commercial greenhouse muskmelon production techniques and nutrient requirements. Plant density was 2.5 plants/m² with 60 cm between plants and 90 cm between rows. Three classes of bumble bee hives (Bombus impatiens; Natupol, Koppert Biological Systems, Inc., Romulus, MI) were used each season for pollination.

An integrated pest management (IPM) approach was used to control pests. Insect pests were monitored weekly using weekly scouting of one plant per plot. Beneficial insects and arthropods were released both preventatively and augmented to reduce pest populations. In Spring 2008, Neoseiulus californicus (Biotactics Inc., Perris, CA) predatory mites were released to control two-spotted spider mites (Tetranychus urticae). Predatory mites were released on 5 and 23 Apr., and 2 May at an average rate of 18 mites/m². Late in the season, an outbreak of two-spotted spider mites occurred in the melon crop. Abamectin miticide (Agri-Mek, Syngenta Crop Protection, Inc., Greensboro, NC) was sprayed (rate: 30 oz/ha) on the crop to control the outbreak. Eriococcus mundus (BEMIPAR, Koppert Biological Systems) were released to control whitefly. Neoseiulus californicus (BEMIPAR, Koppert Biological Systems), a predatory bug for control of flower thrips, were released on 19 Apr. 2008 at a rate of 4 wasps/m². Amblyseius swirskii (SWIRSKI-MITE PLUS, Koppert Biological Systems), predatory mites of thrips and whitefly, were released on 5 and 23 Apr., and 2 May at an average rate of 18 mites/m². In Fall 2008, there was one release of Neoseiulus californicus at planting at the rate of 20 mites/m² and a release of Amblyseius swirskii on 18 Sept. 2008.

During the spring crop, there was an epidemic of downy mildew (Pseudoperonospora cubensis) in an adjacent cucurbit crop within the same greenhouse. As a precautionary measure, preventative fungicides were sprayed in the spring to control downy mildew. Two applications of Azoxystrobin (Quadris, Syngenta Crop Protection; rate: 27 oz/ha) were sprayed on 17 Mar. and 3 May 2008; Propamocarb hydrochloride (Previcur Flex, Bayer Crop Science, RTP, NC; rate: 47 oz/ha) was applied on 28 Mar. 2008. Although Quadris can also help control powdery mildew, no other preventative powdery mildew fungicides were applied. In the fall crop, downy mildew was not expected and no preventative fungicides were sprayed. During both seasons, once powdery mildew disease symptoms were observed in the crop, potassium bicarbonate (Milstop, BioWorks Inc., Fairport, NY; rate: 2.8 kg ha⁻¹), a foliar fungicide that suppresses powdery mildew, was applied weekly to help maintain plant growth and fruit production.

Powdery mildew ratings were recorded at harvest. Plants were given a rating based on the percentage of the plant per plot covered in powdery mildew (or %PM) at time of each fruit harvest. The final average presented is the overall average from all fruits per plot harvested.

Greenhouse temperatures were recorded daily at 15-min intervals by WatchDog data loggers (Spectrum Tech., Plainfield, IL). Monthly temperature averages as well as the monthly minimum and maximum temperatures were recorded (Fig. 2).

**Fruit Harvest and Postharvest Quality.** ‘Charentais’ cantaloupes were harvested when a crack at the abscission layer was observed (stage AL or stage 2) (Mitchell-Harty et al., 2008). This was the recommended stage to harvest the fruit as per Western Seed® (H. Beukelman, pers. comm., 2008). Harvest began in the spring from 11 May and lasted until 16 June 2008 and in the fall from 27 Oct. to 2 Dec. 2008. Fruits were harvested daily during the harvest period. Immediately after harvest, all postharvest variables were measured according to the methods of Mitchell et al., 2006. Postharvest data included fruit weight, fruit length and width, flesh thickness, soluble solids content (°Brix) and internal firmness. The %PM rating was also recorded at harvest.

**Statistical Analysis.** The spring and fall trials were each conducted in a randomized complete-block design (RCBD) with treatments (lines) replicated three times with five plants per plot. In Spring 2008, number (n) of fruits per plot ranged from eight to 18 and in the fall number (n) of fruit per plot ranged from three to eight. Data were analyzed using the GLM procedure (SAS Institute, Version 9, Cary, NC). Means from significant treatment main effects were subjected to Fisher’s Least Significant Difference.
Results and Discussion

Among the seven lines, differences occurred for each measured variable (Table 1). Mean fruit number per plant was greater in spring, with four fruits per plant as compared with a mean of two fruits per plant in the fall crop. This trend was also observed in fruit number per square meter. Fruit yield was greatest for WS5033 (mean 9.5 kg·m⁻²) and lowest for lines WS5016 and WS5033 (mean 5.4 kg·m⁻²). The significant drop in fruit numbers in the fall crop may have been attributed to higher temperatures (> 27 °C) during fruit development stage, which was in late Sept. (Fig. 2). Low fruit number per plant in the fall as compared with increased spring yields have also been observed in greenhouse ‘Galia’ muskmelons (Mitchell et al., 2007a, 2007b). There were no cull fruits in either trial (data not shown).

Fruit weight was greater than 0.5 kg for all fruit. Line WS5031 had the smallest fruits (0.6 kg/fruit), while all other lines had fruits that weighed greater than 0.8 kg, with the largest fruits from lines WS5016 and WS5019 (1.2 kg/fruit). Over both seasons, fruit yield, weight, and width were also greater in the spring; however, the overall mean soluble solids content (SSC) was higher in fruits grown in fall (14 °Brix) as compared with those produced in spring (12 °Brix). The increased SSC in the fall crop could be attributed to cooler night temperatures (<10 °C at harvest) (Fig. 2). Higher SSC in fall melon crops has been previously associated with lower night temperatures as compared with warmer spring temperatures (Lester et al., 2006 and 2007). Soluble solids content for all melons in both seasons was excellent (>11.5 °Brix). The high SSC would place these ‘Charentais’-types at USDA grade ‘Fancy’ (the highest fruit quality grade for melons) (Lester and Shellie, 2004).

Line × season interactions occurred for fruit length, flesh firmness and %PM (Table 2). Overall, fruit width and weight were greater in the spring season (Table 1), which was also true for fruit length in the spring for five lines, while two lines (WS5017 and WS5031) had similar lengths in both seasons. Two lines (WS5019 and WS5022) had similar internal fruit firmness in both seasons. However, during the spring season, these lines

Table 1. Means of fruit yield and quality data of ‘Charentais’ cantaloupes grown in a passively-ventilated greenhouse, Spring and Fall 2008.

<table>
<thead>
<tr>
<th>Line</th>
<th>Fruit no/plant</th>
<th>Fruit no/m²</th>
<th>Wt (kg)</th>
<th>Kg fruit per plant</th>
<th>Kg fruit per m²</th>
<th>Width (mm)</th>
<th>Flesh thickness (mm)</th>
<th>SSC (°Brix)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WS5016</td>
<td>2.2</td>
<td>5.4</td>
<td>1.2</td>
<td>2.6</td>
<td>6.5</td>
<td>131</td>
<td>23.7</td>
<td>13.2</td>
</tr>
<tr>
<td>WS5017</td>
<td>2.8</td>
<td>6.9</td>
<td>1.1</td>
<td>2.9</td>
<td>7.4</td>
<td>125</td>
<td>22.1</td>
<td>12.0</td>
</tr>
<tr>
<td>WS5019</td>
<td>2.6</td>
<td>6.4</td>
<td>1.2</td>
<td>3.1</td>
<td>7.6</td>
<td>130</td>
<td>31.7</td>
<td>11.5</td>
</tr>
<tr>
<td>WS5020</td>
<td>3.1</td>
<td>7.7</td>
<td>0.8</td>
<td>2.5</td>
<td>6.3</td>
<td>116</td>
<td>26.9</td>
<td>13.4</td>
</tr>
<tr>
<td>WS5022</td>
<td>3.0</td>
<td>7.4</td>
<td>0.8</td>
<td>2.4</td>
<td>5.9</td>
<td>116</td>
<td>21.1</td>
<td>13.5</td>
</tr>
<tr>
<td>WS5031</td>
<td>3.8</td>
<td>9.5</td>
<td>0.6</td>
<td>2.1</td>
<td>5.3</td>
<td>106</td>
<td>16.6</td>
<td>13.1</td>
</tr>
<tr>
<td>WS5033</td>
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<td>5.7</td>
<td>1.0</td>
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<td>5.4</td>
<td>120</td>
<td>21.3</td>
<td>13.0</td>
</tr>
<tr>
<td>LSD</td>
<td>0.9</td>
<td>2.2</td>
<td>0.1</td>
<td>0.6</td>
<td>1.6</td>
<td>6.0</td>
<td>6.1</td>
<td>0.9</td>
</tr>
<tr>
<td>Season</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring 2008</td>
<td>3.6</td>
<td>8.9</td>
<td>1.0</td>
<td>3.3</td>
<td>8.4</td>
<td>123</td>
<td>23.9</td>
<td>11.9</td>
</tr>
<tr>
<td>Fall 2008</td>
<td>2.0</td>
<td>5.1</td>
<td>0.9</td>
<td>1.7</td>
<td>4.3</td>
<td>118</td>
<td>22.7</td>
<td>13.6</td>
</tr>
</tbody>
</table>

*Mean separation by Fisher’s least significant difference test, P ≤ 0.05.
**Nonsignificant and significant F test at P ≤ 0.01, respectively.

Fig. 2. Monthly average, minimum, and maximum temperatures for ‘Charentais’-type cantaloupes grown in a passively-ventilated greenhouse, spring and fall, 2008.
were among the least firm fruits. In the fall crop, line WS5019 was again among the least firm fruit, while WS5022 was among the firmest. Fruits were generally firmer in the spring crop. Increased fruit firmness in a spring versus fall melon crop has also been observed in greenhouse-grown ‘Galia’ and ‘Galia’-type muskmelons (Mitchell et al., 2007b).

During the spring crop, powdery mildew (PM) was first observed on 23 Apr. 2008. In spring, PM ranged from 8% to 63%. In the fall crop, PM was first observed on 22 Oct. 2008 and ranged from 7 to 100%. Generally, PM was more variable in the fall crop, with three lines at less than 15% PM and the remaining lines as high as 100%. In the spring crop, all lines except line WS5033 (8% PM) had a PM rating greater than 31% and some lines up to 63%. Of the seven lines, only three (WS5017, WS5020, and WS5022) had no significant differences in PM at harvest during both seasons, which ranged from 14% (WS5017, WS5020, and WS5022) to 63%. In the fall crop, PM was first observed on 22 Oct. 2008, while lines WS5016 and WS5033 had high %PM ratings greater than 100%. In the spring crop, all lines were among the least firm fruits. In the fall crop, line WS5019 was again among the least firm fruit, while WS5022 was among the firmest. Fruits were generally firmer in the spring crop. Increased fruit firmness in a spring versus fall melon crop has also been observed in greenhouse-grown ‘Galia’ and ‘Galia’-type muskmelons (Mitchell et al., 2007b).

Throughout a spring and fall season and varying rates of PM, these ‘Charentais’-type cantaloupes are both highly susceptible to PM, have variable SSC (8 and 11 °Brix, respectively) and much lower fruit firmness (2 and 12 N, respectively) when grown in a passively-ventilated greenhouse (Mitchell et al., 2007b).

Table 2. Line × season (L × S) means of fruit length, firmness and powdery mildew (%PM) coverage of ‘Charentais’ cantaloupes grown in a passively-ventilated greenhouse, Spring and Fall 2008.

<table>
<thead>
<tr>
<th>Line</th>
<th>Spring 2008 Length (mm)</th>
<th>Fall 2008 Length (mm)</th>
<th>Spring 2008 Firmness (N)</th>
<th>Fall 2008 Firmness (N)</th>
<th>Spring 2008 %PM</th>
<th>Fall 2008 %PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>WS5016</td>
<td>143</td>
<td>136</td>
<td>45.3</td>
<td>21.7</td>
<td>44.0</td>
<td>83.7</td>
</tr>
<tr>
<td>WS5017</td>
<td>129</td>
<td>130</td>
<td>40.9</td>
<td>29.5</td>
<td>63.3</td>
<td>37.0</td>
</tr>
<tr>
<td>WS5019</td>
<td>143</td>
<td>127</td>
<td>14.0</td>
<td>10.9</td>
<td>62.0</td>
<td>7.00</td>
</tr>
<tr>
<td>WS5020</td>
<td>119</td>
<td>108</td>
<td>33.4</td>
<td>16.2</td>
<td>34.3</td>
<td>13.7</td>
</tr>
<tr>
<td>WS5022</td>
<td>116</td>
<td>115</td>
<td>24.0</td>
<td>24.9</td>
<td>31.3</td>
<td>40.0</td>
</tr>
<tr>
<td>WS5031</td>
<td>97</td>
<td>97</td>
<td>32.9</td>
<td>17.9</td>
<td>54.7</td>
<td>8.67</td>
</tr>
<tr>
<td>WS5033</td>
<td>129</td>
<td>121</td>
<td>36.4</td>
<td>22.6</td>
<td>8.00</td>
<td>100</td>
</tr>
</tbody>
</table>

L × S, LSD (0.05) 6.56 6.60 30.3

*Mean separation for line × season interaction by Fisher’s least significant difference test (P ≤ 0.05).

**Literature Cited**


