Effects of Plugging Methods on the Performance of Containerized Strawberry Transplants

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Most of the strawberry (Fragaria ×ananassa) production area in Florida is planted with bare-root transplants, which are relatively inexpensive and provide high yields. High water volumes are needed for bare-root transplant establishment: Approximately 600,000 gal/acre per season with only 3% efficiency. Plug (containerized) transplants can be established with no overhead watering, being an alternative to traditional bare-root transplants. However, plug transplants used in Florida are mostly imported from Canada and California and cost twice as much as bare-root transplants. Research was conducted to evaluate the feasibility of producing strawberry plug transplants under Florida conditions. Treatments consisted of: a) 4-week-old plug transplants, b) 4-week-old plug transplants dipped into indole-3-butyric acid (IBA) at 0.10% v/v, c) 6-week-old plug transplants, d) 6-week-old plug transplants dipped into IBA, and e) bare-root transplants. Results showed no total fruit weight difference between bare-root transplants and Florida-produced 6-week-old plug transplants. These results demonstrated that there is potential for Florida growers to use locally-produced plug transplants, leading to reduced production costs and water use during transplant establishment.

Florida is the largest strawberry (Fragaria ×ananassa) producer in the U.S. during winter with over 10,000 acres planted in 2012 (Florida Department of Agriculture and Consumer Services, 2012). In order for growers to take advantage of high fruit prices in late November, bare-root transplants are bought from Canadian nurseries and established in fields during late September under high temperatures (Bish et al., 1996). Bare-root transplants are relatively inexpensive and provide high yields. However, they are often not uniform in size, infected with pathogens, and are difficult to establish under high temperatures (Bish et al., 1996, 1997). Growers apply overhead (sprinkler) irrigation to cool down the air around crowns in order to get optimum establishment of transplants (Bish et al., 2001). Currently, sprinkler irrigation is used for up to 10 days for 8 h/day to establish bare-root transplants (Bish et al., 2001; Bish and Chandler, 2002; Hochmuth et al., 2006a). This practice has only 3% efficiency, consuming approximately 600,000 gal of water per acre through the first 10 days. During strawberry establishment, it is estimated that about 582,000 gal/acre of water are lost to the row middles and drainage canals. This excessive water usage increases nutrient leaching, depletes agricultural and urban wells, and increases the risk for sinkholes occurrence in urban areas, while adding an extra $320/acre in diesel fuel. Several alternatives are available to reduce water usage for strawberry establishment. Anti-transpirants, intermittent irrigation, low volume sprinklers, and plug transplants are potential alternatives to increase water savings while reducing production costs of strawberry.

Plug (containerized) transplants could be established with reduced or no sprinkler watering and could replace traditional bare-root transplants (Bish et al., 1996; Durner et al., 2002; Hochmuth et al., 2006a). The advantages of plug transplants range from improved plant health and rate of establishment to high early yield (Durner et al., 2002). However, plug transplants used in Florida are mostly imported from Canada and California and cost twice as much as bare-root transplants (Bish and Chandler, 2002; Durner et al., 2002; Rowley et al., 2010). Few growers can afford to spend an extra $2,600 to avoid water losses. Part of the extra cost of plug transplants is due to labor and handling expenses and shipping (Durner et al., 2002). Bare-root and plug transplants were compared in previous research, and several authors agree that plug transplants increase strawberry early yield (Bish et al., 1997; Bish and Chandler, 2002; Hochmuth et al., 2000; Hochmuth et al., 2006b). Nevertheless, it is still unclear if plug transplants have higher or equal total yield compared to bare-root transplants (Gilreath et al., 2006; Hennion et al., 1997; Hochmuth et al., 2000; Hochmuth et al., 2006a; Menzel and Toldi, 2010). Also, there is limited research on strawberry plugs production in Florida conditions. The hypothesis of this study was that commercial-grade plug transplants can be produced under Florida conditions. Based on this assumption, the objective of this study was to assess the performance of strawberry plugs produced locally without pre-chilling and in long day conditions.

Materials and Methods

PLUG PRODUCTION. ‘Strawberry Festival’ mother plants from the 2011–12 strawberry seasons were established in a 1,800 ft² greenhouse (United Greenhouse Systems, Inc., Edgerton, WI). Plants from the field were planted in 1-gal pots using potting mix (Farfard-2 mix; Farfard, Agawam, MA) as growing media. Irrigation was adjusted according to the crop requirements. Irrigation emitters had a flow of approximately 125 mL/min (John Deere, San Diego, CA). Irrigation cycles per plant were of 125 mL delivered in 1 min, three to four times per day. Strawberry runners were harvested in late August and plugged into 50-cell trays, using the same potting mix as described above as growing media. Runners
were grown for either 4 or 6 weeks according to the treatments. Indole-3-butyric acid (IBA) at 0.10% w/w was applied as rooting hormone depending on the treatments. Runners were submerged into IBA before plugging into the trays. Runners were irrigated three times per day using micro-jets (Netafim, Israel) with a flow of approximately 930 mL/min with irrigation cycles of 10 min. Fertilization started 10 d after plugging. Plants received 0.5 lb/acre of N in a daily application until ready for field transplanting.

The field study was conducted in the 2012–13 season at the Gulf Coast Research and Education Center in Balm, FL. The soil at the experimental site was a Myakka fine sand siliceous hyperthermic Oxyaquic Alorthod with 1.5% organic matter and pH of 6.6. Prior to the experiment the soil was tilled twice at an approximate depth of 8 inches to ensure proper soil structure. In late Aug. 2012, a standard bedder was used to form planting beds that were 27 inches wide at the base, 24 inches wide at the top, 8 inches high, and 4 ft apart in the centers. Simultaneously with bedding, the soil was fumigated with Pic-Clor 60 at a rate of 300 lb/acre. Two drip lines (0.12 gal/100 ft per min, 12 inches between emitters; T-Tape Systems International, San Diego, CA) were buried 2 inches below the surface at 8 inches from the bed edges. Beds were covered with high density black polyethylene mulch (0.025-mm thick; Intergro Co., Clearwater, FL).

‘Strawberry Festival’ bare-root and plug transplants with three to five leaves were planted in early Oct. 2012. The plants were set in double rows 15 inches apart and plots were 17.5 ft long with 20 plants. Treatments were: a) bare-root transplants (control), b) 4-week-old plugs, c) 6-week-old plugs, d) 4-week-old plugs submerged in 0.10% IBA, and e) 6-week-old plugs submerged in 0.10% IBA. Irrigation was turned on for 8 h/day for the first 10 days during establishment. The fertilization program followed current recommendations for the crop in the state (Peres et al., 2010). Treatments were arranged in a randomized complete-block design with four replications. Plant and crown diameter and crown number were measured at 6, 12, and 18 weeks after transplanting. Plots were harvested twice a week starting on 10 Dec. A marketable fruit was defined as one over 10 g in weight and physiologically mature with more than 80% fruit dark red and free of defects or disease injury. For early yield, marketable fruit weight was collected for the first 10 harvests. Data were analyzed using a general linear model (P < 0.05) and treatment values were separated using Fisher’s protected least significant difference test (Statistix Analytical Software, version 9, Tallahassee, FL).

Results and Discussion

Treatments showed no differences in any of the plant growth variables at either 6, 12, or 18 weeks after transplanting, which means that all plants in the experimental units had similar size (data not shown). Six-week-old plug transplants with and without IBA treatment resulted in the highest early yield (Table 1). Furthermore, bare root control resulted in the same early yield as 4-week-old plugs regardless of IBA application. For total yield, 6-week-old plugs with or without IBA showed no difference from bare-root transplants, while 4-week-old plugs resulted in the lowest total yield (Table 1).

These results indicated that it is possible to obtain equal total yield to bare-root transplant with locally-produced plugs. Similar results were found by Menzel and Toldi (2010), who reported no differences in total yield for three strawberry cultivars when using bare-root and plug transplants. On the other hand, early yield of plots planted with 6-week-old plugs was 29% higher than bare-root transplants, while 4-week-old plugs resulted in the same early yield as bare-root transplants. In other studies, Hochmuth et al. (2000) found that plug transplants had 51% higher early yield compared to bare-root transplants. Hochmuth et al. (2006a) concluded that plug transplants had earlier flowering compared to bare-root transplants, which directly increased early yield.

In this study, plug transplants were successfully produced in Florida conditions, resulting in higher early yield and the same total yield as bare-root transplants. Using plug transplants could potentially result in large water savings for the state (6 billion gal per season in Florida; Hochmuth et al., 2006a). Using plug transplants not only could save water, but also could increase grower profits by producing 29% higher yield between early December and early January, representing a potential extra income during the first 10 harvests. Additionally, plug transplants produced in Florida could allow growers to access more affordable plugs and reduce cost of water pumping ($320/acre for 10 days of establishment) and plug transplant shipping ($0.05/plant) (Durner et al., 2002) Plug transplants require very little or no overhead irrigation for establishment, and just by changing 10% of the planted area with inexpensive plugs, growers can save up to 600 million gal of water per season. Furthermore, strawberry plug production could represent the beginning of a new industry in the state. In conclusion, the major findings of this study were: a) 6-week-old Florida-produced plug transplants increased early yield of strawberry by 29%, compared to bare-root transplants, and b) it is possible to produced plug transplants in Florida conditions with equal yield per season as bare-root transplants.

Table 1. Effects of plugging treatments on early and total fruit yield of ‘Strawberry Festival’, 2012–13, Balm, FL.

<table>
<thead>
<tr>
<th>Treatments (ton/acre)</th>
<th>Early yield (ton/acre)</th>
<th>Total yield (ton/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare-root transplants</td>
<td>3.11 b</td>
<td>10.76 ab</td>
</tr>
<tr>
<td>6-week-old plugs</td>
<td>3.36 ab</td>
<td>10.05 abc</td>
</tr>
<tr>
<td>4-week-old plugs</td>
<td>2.70 b</td>
<td>9.59 c</td>
</tr>
<tr>
<td>6-week-old plugs + IBA</td>
<td>4.37 a</td>
<td>11.07 a</td>
</tr>
<tr>
<td>4-week-old plugs + IBA</td>
<td>3.04 b</td>
<td>9.75 bc</td>
</tr>
</tbody>
</table>

*Values followed by the same letters do not differ at the 5% significance level, according to Fisher’s least significant difference test. IBA = 0.10% (w/w) indole-3-butyric acid.*

Literature Cited


