Improving Irrigation Management for Strawberry Establishment in West-central Florida

BIELINSKI M. SANTOS*1, TERESA P. SALAME-DONOSO1, ALICIA J. WHIDDEN2, and MARICRUZ RAMÍREZ-SÁNCHEZ1

1University of Florida, IFAS, Gulf Coast Research and Education Center, 14625 CR 672, Wimauma, FL 33598
2University of Florida, IFAS, Hillsborough County Extension, 5339 South CR 579, Seffner, FL 33584

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A study was conducted to assess the use of kaolin clay-based crop protectants in combination with sprinkler irrigation for strawberry (Fragaria ×ananassa) transplant establishment. Bare-root strawberry transplants were set in fumigated, raised beds covered with polyethylene mulch. Seven treatments resulted from the combination of duration of sprinkler irrigation (8 h/day) and foliar application of kaolin clay: 4 d of sprinkler irrigation; 4 d of sprinkler irrigation plus kaolin clay on day 5; 6 d of sprinkler irrigation; 6 d of sprinkler irrigation plus kaolin clay on day 7; 8 d of sprinkler irrigation; 8 d of sprinkler irrigation plus kaolin clay on day 9; and 10 d of sprinkler irrigation (control). The results indicated that there were no significant differences in plant establishment and early fruit weight of strawberry between plants that were established with the application of 10 d of sprinkler irrigation and either 6 or 8 d of sprinkler irrigation plus foliar-applied kaolin clay. With the use of foliar-applied kaolin clay, water savings were between 3.7 and 5.6 acre-inch/acre of water, which might have a major impact on water management for strawberry production in west-central Florida.

Strawberry producers in west-central Florida use bare-root transplants produced in high altitude nurseries in Canada and California. To establish these transplants in late September and early October, strawberry growers apply sprinkler irrigation for the first 10 d. The daily duration of this irrigation fluctuated between 8 to 10 h, depending on local evaporative conditions. This practice seeks lowering temperatures and replenishing soil moisture around strawberry transplant crowns. However, the water volumes used for this purpose were extremely high (between 14 and 22 acre-inch/acre) and its efficiency was very low because most applied water moves down from mulched beds, into row middles and finally into drainage canals. Because most growing fields in the Plant City–Dover production area in Hillsborough County, FL, were in close proximity to urban developments, which obtain water from wells tapping into the same aquifers as their agricultural neighbors, it was important to identify irrigation practices that could save water for strawberry establishment. Furthermore, any modification to current practices has to consider the risk associated to the cost/benefit relationship for a crop that requires approximately $12,500/acre to be produced in Florida.

Kaolin clay is a naturally occurring mineral that can be used to reduce heat stress in crops. In previous studies, it was determined that application of kaolin clay solutions to apple (Malus ×domestica) trees significantly reduced heat stress and fruit sunburn (Glenn et al., 2001; Schupp et al., 2002). Jifon and Syvertsen (2003) indicated that kaolin clay application on grapefruit (Citrus paradisi) trees decreased leaf temperature by 3 °C, as well as leaf to air vapor pressure, and improved net CO₂ assimilation and yield. Rosati et al. (2007) suggested that foliar kaolin clay application improved the distribution of photosynthetically active radiation in almond (Prunus dulcis) and walnut (Juglans regia). In contrast, other research results showed that foliar applications of the product failed to enhance tomato (Solanum lycopersicum) fruit yield (Kahn and Damicone, 2008).

Preliminary observations in Hillsborough County, FL, indicated that kaolin clay-based crop protectants could potentially reduce heat stress during plant establishment. However, formal studies needed to be conducted to confirm this hypothesis. One alternative practice would be reducing the number of days needed of sprinkler irrigation, followed by application of kaolin clay on the foliage to reduce heat stress. The objectives of this study were to determine the effect of foliar kaolin clay applications on the plant establishment of bare-root strawberry transplants, and to assess the potential water volume savings by application of this technology.

Materials and Methods

A field study was conducted between Oct. 2008 and Jan. 2009 at the Gulf Coast Research and Education Center of the University of Florida in Balm. The soil was a sandy, siliceous, hyperthermic Oxyaquic Alorthod with 1.5% organic matter and pH 7.3. Planting beds were 27 inches wide at the base, 24 inches wide at the top, 8 inches high, and spaced 4 ft apart on centers. Finished beds were fumigated with methyl bromide plus chloropicrin (67:33 v/v) at a rate of 350 lb/acre to eliminate soilborne diseases, nematodes, and weeds in the soil. Beds were covered with black high-density polyethylene mulch (0.7 mil-thick) immediately after injection of the fumigant. A single-drip tape line (0.23 gal/100 ft/min, 12 inches between emitters, T-Tape Systems International, San

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*Corresponding author; phone: (813) 634-0000; email: bmsantos@ufl.edu
Diego, CA) was buried 2 inches below the surface on the bed center, and the experiment are in a was equipped with 4 gal/min sprinklers for frost protection and crop establishment. On 15 Oct. 2008, bare-root ‘Strawberry Festival’ transplants from certified nurseries in Nova Scotia, Canada, were set 15 inches apart in double rows and a distance of 15 inches between rows.

Seven transplant establishment treatments resulted from combinations of duration of sprinkler irrigation and foliar application of kaolin clay: 1) 4 d of sprinkler irrigation; 2) 4 d of sprinkler irrigation plus kaolin clay on the day 5; 3) 6 d of sprinkler irrigation; 4) 6 d of sprinkler irrigation plus kaolin clay on day 7; 5) 8 d of sprinkler irrigation; 6) 8 d of sprinkler irrigation plus kaolin clay on day 9; and 7) 10 d of sprinkler irrigation (control). Immediately after transplanting, overhead irrigation was used for 8 h for the first 10 d to ensure plant establishment using approximately 6000 gal/acre per h of water. Kaolin clay treatments were applied using a hand-held foliar sprayer using a rate of 25 lb/acre (Surround WP, Tessenderlo Kerley, Phoenix, AZ) mixed in a water volume of 60 gal/acre. Application occurred along planted beds between 7 and 8 AM of the following day after sprinkler irrigation was suspended. Treatments were arranged in a randomized complete-block design with four replications. Experimental units were 12.5-ft long (20 plants per plot).

After establishment, plants were irrigated twice per day with one irrigation in the morning between 8 and 9 AM and another in the early afternoon from 1 to 2 PM. Irrigation cycles were 15 min from October to mid-November, 30 min from mid-November to early December, and 45 min from early December to the end of the season. Fertigation was applied through drip irrigation lines beginning at 10 d after transplanting. Fertilization and pest control were achieved following current crop recommendations (Peres et al., 2006).

Strawberry establishment was determined by counting actively-growing plants in the experimental units 3 weeks after transplanting (WAT). Marketable strawberry fruit had the following characteristics: attached calyx, a minimum of 80% red surface, over 10 g in weight, and free of mechanical defects, insects or diseases. Early marketable fruit weight was collected from each plot, two times per week for a total of 10 harvests starting on the third week in Dec. 2008 and ending on the third week of Jan. 2009. Data were analyzed with analysis of variance (P < 0.05) and treatment means were separated with Fisher’s-protected least significant difference test. Percentages of transplant establishment were transformed with arc sin⁻¹ prior to analysis of variance to normalize treatment means.

Results and Discussion

There were significant treatment effects on transplant establishment and early marketable fruit weight. Plots treated with either 6 d of sprinkler irrigation plus kaolin clay on day 7, 8 d of sprinkler irrigation plus kaolin clay on day 9, or 10 d of sprinkler irrigation (control) had the highest transplant establishment with ≥97% (Table 1). Application of only 6 to 8 d of sprinkler irrigation failed to reach the strawberry establishment of the control plots with values ranging between 78% and 87%, respectively.

The highest strawberry early fruit weight was achieved in plots transplanted with either 6 d of sprinkler irrigation plus kaolin clay on day 7, 8 d of sprinkler irrigation plus kaolin clay on day 9, or 10 d of sprinkler irrigation (control) and their yields ranged between 3.5 and 3.6 ton/acre. The application of only 8 d of sprinkler irrigation for transplant establishment caused a result in a 14% reduction of early yields in comparison with the control treatment, while shorter durations of sprinkler irrigation during transplanting further increased early fruit weight losses.

Several hypotheses might explain these responses. First, foliar application of kaolin clay may have reduced leaf and crown temperatures by reflecting solar radiations. Second, the product might have decreased evaporation around strawberry crowns, thus allowing faster formation of new leaves and roots. Third, a combination of both effects might be occurring. These findings were supported by previous studies indicating that kaolin clay application reduced high temperature stress and air vapor pressure in other crops (Glenn et al., 2001; Jifon and Syvertsen, 2003; Schupp et al., 2002). Further studies will focus on determining the physiological mechanisms of this response. In summary, foliar application of kaolin clay starting on the seventh day after sprinkler irrigation could save between 3.7 and 5.6 acre-inch/acre of water, which might have a major impact on water management for strawberry production in west-central Florida.

Literature Cited


*Significant (P < 0.05). Values followed by the same letter do not differ according to Fisher’s-protected least significant difference at the 5% level.

Table 1. Effects of combinations of establishment programs of bare-root strawberry transplants using duration of sprinkler irrigation and foliar kaolin clay applications. Balm, FL, 2008–09.

<table>
<thead>
<tr>
<th>Transplant establishment program</th>
<th>Transplant establishment (%)</th>
<th>Early fruit wt (ton/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 d of sprinkler irrigation</td>
<td>97 a</td>
<td>3.5 a</td>
</tr>
<tr>
<td>8 d of sprinkler irrigation</td>
<td>87 b</td>
<td>3.0 b</td>
</tr>
<tr>
<td>6 d of sprinkler irrigation</td>
<td>98 a</td>
<td>3.6 a</td>
</tr>
<tr>
<td>+ kaolin clay on day 9</td>
<td>78 b</td>
<td>2.1 c</td>
</tr>
<tr>
<td>6 d of sprinkler irrigation</td>
<td>97 a</td>
<td>3.5 a</td>
</tr>
<tr>
<td>+ kaolin clay on day 7</td>
<td>56 c</td>
<td>1.6 d</td>
</tr>
<tr>
<td>4 d of sprinkler irrigation</td>
<td>82 b</td>
<td>2.3 c</td>
</tr>
<tr>
<td>+ kaolin clay on day 5</td>
<td></td>
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</tr>
</tbody>
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Significance (P < 0.05) * *