Effects of Planting Densities on the Performance of Strawberry Cultivars under High Tunnels

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A study was conducted to assess the effect of planting densities on commonly-grown strawberry cultivars inside high tunnels. The study was conducted inside 16-ft high × 26-ft wide high tunnels covered with clear, double-layered polyethylene mulch (30% light reduction). Bare-root strawberry transplants were planted in early October. The transplants were set in double rows separated from each other by 12 inches. Two planting densities (17,400 and 21,780 plants/acre) and three cultivars (‘Strawberry Festival’, ‘Florida Radiance’, and ‘Winterstar’) were tested. The interaction between the two factors did not influence early and total marketable fruit weights. However, cultivars had an effect on early and total marketable fruit weights. The highest early marketable fruit weight was observed in plots planted with ‘Winterstar’, whereas ‘Florida Radiance’ had the largest total marketable fruit weight among all cultivars. There was no effect of planting density on either fruit weight variable, demonstrating that increasing densities from 17,400 to 21,780 plants/acre failed to improve early and total yields, regardless of cultivars.

In Florida, strawberries (Fragaria xananassa) generate about US $362 million in annual gross sales and are produced in open fields, with heavy harvesting occurring mostly in the winter months of the year (U.S. Department of Agriculture, 2011). This allows Florida strawberry growers to take advantage of the high fruit prices when other states do not have production due to cold weather. In spite of this competitive advantage, increasing competition from international markets has prompted growers to seek alternative production systems that could enhance crop yield and quality, as well as fruit earliness. Protected culture may be an alternative to fulfill those goals.

A protective structure is defined as any structure designed to modify the environment in which plants are grown. Protective structures, such as greenhouses, screen houses, and high tunnels, are known worldwide as production systems for high-quality vegetable and fruit crops. Protective structures increase crop yield and quality by altering environmental factors, such as light, temperature, air humidity, wind, and/or pest pressure. Manipulation of these environmental factors depends on the specific properties of the materials used on the roofs and sides of structures, as well as on the height, shape, and position if the structures. High tunnels are the low-cost version of greenhouses. They are non-permanent structures with passive ventilation through the sides and ends, and have reduced construction and maintenance costs. These structures can be moved from one place to another, which allows for rotating to new soils and avoiding pests, disease buildup, and nutrient depletion. The structure height (between 10 and 16 ft) directly influences air and soil temperatures under plastic roof covers. High tunnels are passively ventilated structures built with metal (e.g., galvanized steel or iron), plastic (e.g., polyvinyl chloride pipes), or wood, which is usually covered with one or more layers of plastic film and anti-insect screen while allowing access to personnel and agricultural equipment.

It has been widely demonstrated that using protective structures offers major advantages from the standpoint of improving yield and quality of vegetable and fruit crops. Among those advantages, protected culture could reduce the effects of rain and wind injury and freezing weather, as well as ameliorating plant and fruit damage due to certain pests, such as diseases, insects, weeds, and nematodes (Chism, 2002; Jett, 2007; Kadir et al., 2006; Ozdemir and Kaska, 1997; Voca et al., 2007). Scarce references exist on the effects of protected culture on strawberry in Florida. Small-plot research that compared high tunnel and open field production in Florida (Salame-Donoso et al., 2010) resulted in high tunnels being found to improve strawberry early and marketable fruit weight by averages of 28% and 54%. The results indicated that protection against freezing weather may have been the principal reason for the observed marketable yield increase. However, because of the cost of protective structures, efficient the space utilization is a principal concern for growers to improve net returns. Therefore, this study was conducted to assess the effect of planting densities on common-grown strawberry cultivars inside high tunnels.

**Materials and Methods**

A field trial was conducted in 2010 at the Gulf Coast Research and Education Center of the University of Florida in Balm, FL. The soil at the experimental site was a sandy, siliceous, hyperthermic Oxyaquic Alorthod with <1.5% organic matter and pH of 6.6. In mid-August, planting beds were formed using a standard bedder, which pressed beds 27 inches wide at the base, 24 inches wide on the top, and 8 inches high. Beds were spaced 4 ft apart on the centers. The soil was fumigated with 350 lb/acre of methyl bromide + chloropicrin (67/33, v/v) in early September. Within 1 minute after fumigation, a single drip tape line (0.23 gal/100 ft per min, T-Tape Systems International, San Diego, CA) was

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buried 2 inches below the surface on bed centers and beds were covered with black, high-density polyethylene mulch (0.025 mm thick, Intergro Co., Clearwater, FL).

The study was conducted inside 16-ft high × 26-ft wide high tunnels (Haygrove, Redbank, Ledbury, UK) covered with clear, double-layered polyethylene mulch (30% light reduction). The experimental area was equipped with 4 gal/min sprinklers for transplant establishment. Bare-root strawberry transplants with three to five leaves from nurseries in Canada (Lareault Nursery, Lavaltrie, Quebec, Canada) were planted in early October. The transplants were set in double rows separated 12 inches from each other. Two planting densities (17,400 and 21,780 plants/acre) and three cultivars (‘Strawberry Festival’, ‘Florida Radiance’, and ‘Winterstar’) were tested. The treatments were set up in a split-plot design with four replications, with the cultivars in the main plots. Each plot consisted of 20 plants and was 12.5 ft long, with a 10-ft-long non-treated buffer zone at the end of each plot.

Immediately after transplanting, overhead irrigation was turned on at 8:00 AM each morning for 8 h/day during the first 10 d to ensure plant establishment. An approximate volume of 20 acre-inch/acre of water was used during those 10 d to establish transplants. After establishment, plants were irrigated twice per day with an irrigation cycle in the morning between 8:00 and 9:00 AM and another in the early afternoon from 1:00 to 2:00 PM. After transplant establishment, drip 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.

 Marketable strawberry fruit with the calyxes attached were harvested twice per week initiating on the third week of December. A marketable fruit was defined as one over 10 g in weight and physiologically mature with more than 80% of the fruit surface dark red, free of mechanical defects, and insect or disease injury. Total marketable fruit weight consisted of 20 harvests, whereas early marketable fruit weight was the cumulative marketable weight of the first 10 harvests. Treatment effects were examined for significance (P < 0.05) with the general linear model (Statistix Analytical Software, Tallahassee, FL). Means were compared with a Fisher’s protected least significance difference (LSD) test at the 5% significance level.

### Results and Discussion

The data indicated that the interaction between the two factors, plant density and cultivar, did not influence early and total marketable fruit weights. However, cultivar had an effect on early and total marketable fruit weights (Table 1). The highest early marketable fruit weight was observed in plots planted with ‘Winterstar’ (1.8 ton/acre), whereas ‘Florida Radiance’ had the largest total marketable fruit weight among all cultivars (25.8 ton/acre). There was no effect of planting density on either fruit weight variable, demonstrating that increasing density from 17,400 to 21,780 plants/acre failed to improve early and total yields, regardless of cultivars.

Although it is recommended to maximize use of the space inside a protective structure like high tunnels, these results indicated that the current practice of using the same planting density as in open fields (17,400 plants/acre) for most Florida cultivars seems to be accurate. Further research should focus on studying a wider range of planting densities, as well as planting configurations (e.g., number of rows per bed and bed width) and their effect on crop performance.

### Literature Cited


