Strawberry Fruit and Plug Plant Production in the Greenhouse

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Abstract

Soilless greenhouse culture systems were used for winter fruit production and to produce stolon tips for plug plant propagation in the summer. In the first study, 'frigo' transplants were potted in July and August. Rooted plants were transferred to a hydroponic system in early October. Harvest commenced in late October in dayneutral 'Aromas', 'DIAMANTE', 'Seascape', 'Selva' and everbearing 'Everest' strawberries and in November in short-day 'Camarosa' and 'Chandler'. Seasonal yield ranged from ~1.2 kg for Camarosa to 0.6 kg for Selva. Fruit size averaged > 40g at the beginning and gradually declined to < 15 g in June. When flower removal was extended to mid October, the yield increased 0.4 kg per plant and berry weight increased 0.5 g. Earliness, compact growth habit, and fruit production on short, stiff peduncles (e.g. 'DIAMANTE') are desirable traits for high density, protected cultivation of strawberries for winter fruit production. In the second study, in vitro grown 'Chandler' plants were established in Nutrient Film Technique gutters to produce stolons. The one-time harvest of 'strings' resulted in more than 90 daughter plants per mother plant with a wide range in size. With exception of very small daughter plants (< 1 g), the performance of plug plants that were derived from stolon tips greater than 1 g was satisfactory in a plasticulture fruit production system.

INTRODUCTION

The strawberry has long been an important fruit crop in the Middle Atlantic Coast region of the United States. However, the makeup of the strawberry industry in the region has changed considerably in the last 10 years as acreage devoted to strawberry production has decreased and all of the field nurserymen have ceased operation (Hokanson and Finn, 2000). They have been replaced by start-up greenhouse (soilless) nursery facilities to produce container plants for the expanding high-density annual plasticulture system. The new system, in contrast to the traditional matted row culture, allows cultivars developed elsewhere (e.g. 'Chandler', 'Marmalada', and 'Sweet Charlie') to be grown in the region. Also, these cultivars provide opportunities to extend the harvest season as well as make fruit harvesting more efficient. However, the annual plasticulture system requires changes in planting dates and materials to achieve high fruit yields and quality. The use of 'frigo' plants for mid summer or early fall establishment date is problematic. Fresh-dug plants from Canadian nurseries are not available until mid September and their establishment in the field requires large amounts of irrigation water.

The objectives of this study were to evaluate soilless strawberry culture systems in a greenhouse to generate runner tips for the production of plug plants and to use the controlled environment of a greenhouse to produce out-of-season fruit.

MATERIALS AND METHODS

On April 27, 1999, plants were established in nutrient film technique (NFT) culture using 10.2-cm polyvinyl chloride (PVC) gutters (Genova Products, Inc., Davison, Mich.), suspended 2 m above the greenhouse floor in a N-S orientation. A slope was created over the length of the gutter by hanging the south end of the 4.6-m long gutter approximately 15 cm higher to allow for nutrient flow over the length of the gutter. The

gutters were filled with coarse horticultural perlite (Geiger Co., Harleysville, Pa.). The 'Chandler' "mother" plants were allowed to develop primary stolons or "strings" until 20 July. However, all secondary stolons that developed laterally from daughter plants on the primary stolons were pinched.

The nutrient solution consisting of Chem-Gro (5-15-25) Strawberry Formula (Hydro-Gardens, Inc., Colorado Springs, Co.) with supplemental calcium nitrate and magnesium sulfate was mixed into a 760 L tank. The nutrient solution was pumped to a drip emitter (7.6 L/h) located at the high end of each gutter for 15 min at 2 h intervals. Percolate collected at the lower end of the gutter was returned to the tank. A controller was used to maintain the solution pH at 6.2 with injection of concentrated phosphoric acid. The volume of nutrient solution was maintained constant by daily addition of tap water. At 10 to 14 day intervals when the volume of added tap water reached 760 L, the nutrient solution was discarded and a new batch was added to the tank. The greenhouse was maintained at 23.3 \pm 5 °C day and 18.3 \pm 5 °C night temperatures and photoperiod was extended to 16-h by activating 1,000 W high pressure sodium lamps (115~135 μ M photosynthetic photon flux density at plant canopy height) during pre-dawn hours.

All stolons were detached from 'Chandler' "mother" plants on 20 July and the number of daughter plants on each stolon was determined. Daughter plants were then removed from stolons with five daughter plants and grouped by their node positions or chronological age (2nd, 4th, 6th, etc.) on stolons. Weights of 20 randomly selected daughter plants from each node position were determined. Remaining daughter plants were sorted into the following categories: Very Small (< 1 g), Small (between 1 g and 2.5 g), Medium (between 2.5 g and 5 g), Large (between 5 g and 7.5 g), and Very Large (> 7.5 g). Daughter plants were then plugged into 48-cell packs and placed under intermittent mist sprinklers for rooting. On 13 August, plug plants were transplanted into plasticulture beds.

In July and August, 'frigo' plants of 'Aromas', 'Camarosa', 'Chandler', 'DIAMANTE', 'Seascape', and 'Selva' were acquired from Lassen Canyon Nursery in Red Bluff, CA. They were transplanted into 0.9 L pots containing perlite-peat substrate. Runner tips of 'Everest' were obtained from Nourse Plant Farm in South Deerfield, MA in July and rooted under mist in 50-cell packs. In early October, all plants were transferred to 15×15 (WxD) PVC gutters filled with perlite. Greenhouse was maintained at 20 ± 3 °C and 14 ± 3 °C during day and night, respectively. The high-pressure sodium lamps provided about $5.4 \text{ M} \cdot \text{m}^{-2} \cdot \text{d}^{-1}$ photosynthetically active radiation over ambient solar energy on overcast days. The plants were fertigated intermittently through a drip line laid over the substrate using a closed, recirculating nutrient delivery system (Takeda, 1999).

RESULTS AND DISCUSSION

Harvesting of day-neutral ('Aromas', 'DIAMANTE', 'Seascape', and 'Selva'), everbearing ('Everest') commenced in late October and short-day ('Camarosa' and 'Chandler') strawberries in November. Seasonal yield per plant (average of 6 plants per plot) ranged from ~1.2 kg for 'Camarosa' to 0.6 kg for 'Selva'. Fruit size averaged from >40g in the beginning to nearly 10 g in June. For the season, the mean berry weight ranged from 21 g for 'DIAMANTE' to ~12 g for 'Selva', 'Seascape', and 'Everest'. Mite infestation was most severe on 'Selva' and 'Everest'. When de-blossoming was extended for additional 4 weeks until mid October, yield was increased 0.4 kg per plant and averaged berry weight increased from 14.8 g to 15.2 g.

Yield per plant was highly variable in 'DIAMANTE' strawberry and it may be associated with its crown being "loose." Root development from crown tissues was much lower in 'DIAMANTE' than in either 'Camarosa' or 'Chandler'. 'DIAMANTE' plants averaged about five roots while 'Camarosa' and 'Chandler' had between 20 and 80 new roots from crown tissue. The lack of new roots from the crown in 'DIAMANTE' strawberry caused plants to topple over to the side with a cluster of fruit. This was most noticeable when 'DIAMANTE' was grown in perlite substrate. More recent root growth study conducted on this cultivar revealed that there were more roots developed from

crown tissue when the plant was grown in sifted field soil or peat-based media than in perlite substrate.

'Chandler' plants produced about 12 stolons per plant from May to July. Daughter plant counts averaged 30 per mother plant. The number of daughters per stolon ranged from two to six. A wide range in daughter plant size (90 g per 100 daughters to 980 g per 100 daughters) was obtained. Along the length of a stolon, the daughter plant most proximal (oldest) was the largest (672 g per 100), followed by daughters in the 2nd, 3rd, 4th, and 5th (151 g per 100) position. Many of the daughter plants produced by this production technique developed "spider" roots at the node. It was difficult to insert these daughter plants into the rooting medium. However, they developed more roots under mist. More than 96% of the daughter plants harvested from the 1st to the 4th position on the stolon developed into plug plants in two weeks. Only 87% of daughter plants from the 5th position or weighing less than 100 g per 100 developed into plug plants.

Transplants grew vigorously in the field. However, no effect of either the position or size of 'Chandler' daughter plants on stolon production or branch crown formation was observed during the fall growing season. Stolon numbers averaged about 10 and the number of branch crowns was between 1.5 and 2.0 per plant.

This study has demonstrated that mother plants growing in soilless culture system can produce sufficient numbers of stolon tips by mid-summer and can be considered an economically viable option. Greenhouse production schemes permit nurserymen to produce stolon tips in an environment in which insect pests can be excluded and the production of disease free "clean plants" is possible. Using this system the nurseries can generate transplantable plug plants for grower fields within six months after the plantlets are taken out of a sterile, in vitro environment and grown out in the greenhouse to produce stolons. In a typical field nursery production system, a two-year multiplication phase is needed to produce dormant, bare-root plants. When the production of stolons and plug plants in a protected environment is combined with a shorter propagation phase the potential of exposing plants to virus-transmitting insects is reduced significantly. Another advantage of this system is that phytosanitary concerns for soil fungal pathogens, nematodes, and insects encountered in field nurseries is minimized. The propagation scheme described in this report did not require methyl bromide soil fumigation.

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