

Strawberry Transplant Production and Performance in Annual Plasticulture System in the Eastern United States

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Abstract

Tissue-cultured ‘Chandler’ strawberry plants were grown in a greenhouse to produce stolons. Plantlet size and position on the stolon affected rooting and quality of transplants. Cold stored plantlets developed fewer roots than plantlets plugged fresh in July or August. In the field, fewer of transplants that were cold stored survived, but those that did survive developed more stolons than transplants harvested in July and August and plugged immediately. Plants that were plugged in July and grown in the greenhouse until field planting bloomed in November. Plants that were plugged in July produced 703 g/plant while those plants plugged in August produced 521 g/plant. Greenhouse soilless systems can be used to grow ‘Chandler’ mother plants for generating plantlets for annual plasticulture, but storing rooted transplants or runner tips one month or more at low temperature with lights or at 3° C under low CO₂ concentrations, reduced field survival and propagation efficiency.

INTRODUCTION

Annual-hill strawberry plasticulture is increasing in the mid-Atlantic coast region of the USA (Poling, 1993). The benefits of the system include production in 7 to 8 months; large, clean, easy-to-pick, premium-priced early fruit and fewer weeds. Two of the many parameters of the system that will require optimization for colder production regions are the cultivar and the plant type used. The cultivar Chandler is most widely used. There are two drawbacks when using fresh-dug plants. Fresh-dug plants require daily overhead irrigation for one to two weeks after planting for successful establishment. Also, fresh-dug plants from Canada are not available until the third week of September (Hicklenton and Reekie, 2002), past the best planting dates (mid-August to mid-September) in the colder production areas of the eastern seaboard and the Midwest (Poling, 1993). Also, field transplant production exposes transplants to soil-borne pathogens. Although, nursery soils are fumigated to reduce disease outbreaks, fumigation may not completely eliminate *Colletotrichum* and *Phytophthora*. Reducing transplant exposure to potential pathogens is a prudent strategy.

We harvested runner tips in a greenhouse over two months from tissue cultured mother plants growing in suspended gutters (Takeda et al., 2004). The objectives were to evaluate the effects of harvest period (July vs. August), cold storage duration and conditions, and daughter plant size and position on stolon “strings”, on runner tip viability, transplant production and subsequent field performance.

MATERIALS AND METHODS

“Strings” with several daughter plants were collected from ‘Chandler’ plants growing in soilless substrate during July and August in 2002 and 2003 (Takeda et al., 2004). In 2002, July-harvested “strings” or tips were plugged or cold stored at 3° C under ambient, 3%, or 6% CO₂ atmospheric conditions for 6 weeks. In August, transplants were grown out in the greenhouse until Sept. 10, cold stored in dark room until Sept. 10, cold stored with fluorescent lamp (16 h/day), cold stored in dark for 4 weeks, followed by 2 weeks in the greenhouse; or cold stored in dark for 2 weeks, followed by 2 weeks in the greenhouse and then 2 weeks in cold room. Among August-harvested “strings”, tips were sorted by position (1st to 5th positions on stolon) and size (very small to large). Tips were plugged into 72 cell packs (~110 cc) with Sunshine No.5 Plug Mix and placed on a mist propagation bench. After 7 days, four sets of six tips were gently pulled out of rooting substrate and root number and length of the longest root recorded. At 21 days, four sets of six plug plants were assessed for survival and pulled out of the cell packs to determine whether root growth was enough to hold the rooting media intact.

In 2003, runner tips were harvested in July and cold stored for 3 weeks at 2° or 5° C in sealed and unsealed bags. Bags were 20 cm x 20 cm zipper type locking seal, 0.05 mm thickness (SkilCraft, Wichita, KS). Carbon dioxide (CO₂) and ethylene (C₂H₄) were measured by gas chromatography. Carbon dioxide and ethylene were measured by injecting one ml headspace samples onto a gas chromatograph (HP 5890). Ethylene was determined using a FID detector, packed activated alumina column (0.30 cm diam, 183 cm length, Alltech, Deerfield, IL), gas flow of 30 ml/min helium and temperatures of 100:125:175°C oven:detector:injector. Carbon dioxide was determined using a packed CTRI column (Alltech), 0.64 cm diameter, 183 cm length. Gas flow was 50 ml/min and 50:75:125°C oven:detector:injector temperatures were used. After 3 weeks, runner tips were plugged into 72-cell pack trays and then evaluated for root formation and field performance.

All transplants were established at the University of Maryland Wye Research and Education Center in Carmichael, MD on 12 Sept 2002 and 10 Sept. 2003 on plastic covered raised beds as described by Poling (1993). Plants were established in two rows at 30 cm apart on top of raised beds that were spaced 1.8-m apart center to center, resulting in ~40,800 plants per hectare. Ten-plant plots were randomized in a complete block design with four replications for each treatment. In late November, the percentage of live plants and plants with flowers were determined for each plot, and branch crowns and runners per plant counted. Runners were then detached. In the following springs, crown number, yield, and average fruit size were determined. Data were analyzed for treatment differences using SAS PROC MIXED model analysis (SAS Institute, Cary, N.C., USA), at $P \leq 0.05$.

RESULTS

Runner tips harvested in July and plugged immediately had the most prolific adventitious roots. Nearly all had developed enough roots in 3 weeks for field transplanting (Table 1). July-plugged transplants flowered in the fall and had more branch crowns in the fall than those plugged in August (2 per plant vs. 1 per plant). None of August-plugged transplants flowered in the fall. Cold storing rooted transplants under low light reduced field survival to about half. Cold storing runner tips at 3°C with ambient or 3% CO₂ level decreased rooting compared with fresh plugged tips. However, if tips were cold stored under 6% CO₂ concentration, loss in rooting was not observed. July-plugged transplants produced 703 g/plant while August-plugged transplants produced 559 g/plant. Excellent fruit size was maintained throughout the harvest.

Plant handling techniques affected concentration of CO₂ and C₂H₄. Higher concentrations of CO₂ and C₂H₄ were detected in the 5°C than in the 2°C chamber and higher concentrations were detected in the sealed bags than in the open bags. C₂H₄ concentration in sealed bags stored at 2°C ranged 0 ~ 0.2 µL/L and 0 ~ 0.4 µL/L in the bag stored at 5°C. CO₂ concentration was 0.1-1.8% and 0.8 to 2.8 % at 2° and 5°C, respectively. In unsealed bags, CO₂ concentration was near ambient (0.030%) and C₂H₄ was not detected.

‘Chandler’ plants averaged 2 branch crowns in late fall and about 5 by June 2004. About 80% of July-plugged plants produced flowers in the fall while none of August-plugged plants did (Table 1). Harvest began on 10 May (12 days earlier than in 2003), but lasted only 2 weeks. Yield per plant was similar to the 2003 season, but the fruit were smaller. The plugging date (July vs. August) or cold storage temperature (2° or 5°C) had no effect on fruit production or on any of the growth parameters measured in fall and spring.

DISCUSSION

A substantial root system is desired for successful transplanting of runner tips. The best root system was achieved with fresh plugged daughter plants. If it becomes necessary to store runner tips for time before plugging then only those weighing (1 to 6 g fresh weight) should be cold stored near zero degrees. Large and small tips that are cold stored produce fewer roots than medium-sized tips. At higher storage temperatures (5-6°C), CO₂ concentration should be raised to 6% because storage at 5°C without supplemental CO₂ reduced because only half of tips developed good root system compared to nearly all in fresh-plugged tips. Less than half of rooted transplants that were cold stored under low light illumination survived in the field. Such a low survival rate will significantly reduce yield/ha. The most notable finding of this study was that July-plugged transplants that were retained in the greenhouse until field establishment produced the highest yields (~28 MT/ha) in spring and showed potential for fall fruit production under protected cover. These results suggest that early plugging dates could be used to develop a fall-and-spring double-cropping of short-day cultivars. In summary, these studies showed that daughter plant and runner tip handling influence nursery propagation efficiency. To ensure success in nursery production, tips that are harvested early should be plugged or cold stored under elevated CO₂ concentrations. If tips are

plugged early then the rooted transplants should be retained in the greenhouse rather than storing them at low temperatures.

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Table 1. Summary of 2002-2003 study showing effects of runner tip harvest time and tip handling techniques on percent of tips rooted after 3 weeks under mist sprinklers, percent of plants with flowers in the fall, and spring yield. All transplants were established in the field on 10 September.

| Harvest | Handling technique | Rooted ^y | Field survival (%) | Plants with flowers (%) | Yield (kg/plant) |
|---------------------|--|---------------------|--------------------|-------------------------|------------------|
| July | Fresh plugged and retained in GH ^z | 83 | 100 | 100 a | 0.70 a |
| August | Fresh plugged and retained in GH | 74 | 100 | 0 b | 0.56 b |
| July | Tips cold stored, ambient CO ₂ ^x | 62 | 100 | 0 b | 0.58 b |
| July | Tips cold stored, 3% CO ₂ | 66 | 100 | 0 b | 0.58 b |
| July | Tips cold stored, 6% CO ₂ | 78 | 98 | 3 b | 0.52 b |
| <i>P</i> > <i>F</i> | | 0.154 | 0.445 | < 0.001 | 0.003 |

^zGreenhouse

^y Percentage of plugs that had cohesive rootballs which did not fall apart when lifted from the cell pack.

^x Tips were cold stored for 4 weeks and then plugged.