

## Planting Date Affects Early Season Fruit Yield of Strawberry in a Subtropical Environment

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### Abstract

A study was conducted to determine the effect of planting date on the fruit yields of strawberry (*Fragraria x ananassa* Duch.) transplants grown in a winter annual hill production system. Bare-root and plug transplants of 'Sweet Charlie' and 'Camarosa' from a high latitude or high elevation nursery were planted each week during October 1999 and 2000 at Dover, Fla. Planting date had a significant effect on December yield. Transplants planted in early October generally had higher December yields than transplants planted in late October. Planting date also had significant effects on January, February, and March yields, but these effects were not consistent across years or cultivars. Economic analysis demonstrated that bare-root transplants returned significantly more revenue than did plug transplants.

### Introduction

The annual hill production system is used in west central Florida and other subtropical areas, such as southeastern Queensland, Australia and north central Argentina, to produce strawberry fruit during late fall and winter. Fruiting fields are reestablished each year by planting fresh dug or plug transplants in October (northern hemisphere) or April (southern hemisphere). These plants usually start producing a few flowers within three to six weeks of planting, and this flowering continues, intermittently, until spring. Flowers typically develop into ripe fruit within 30 days. In Florida, acceptable total season yields have been obtained when transplants are planted anytime during October, but in previous studies with locally propagated transplants, the highest early season yields were obtained when transplants were planted in early October (1, 2, 3). Growers should benefit financially by taking steps to increase their early season yield, particularly their November/December yield. Although November/December production during a 10-year period in Florida amounted to only 10% of the total crop, the average value per 5.4 kg flat was \$16.25, compared to \$12.86, \$10.13, and \$7.00 for January, February, and March respectively. (Florida Agricultural Statistics, [www.nass.usda.gov/fl](http://www.nass.usda.gov/fl)).

Currently, more than 95% of Florida's 2800 hectares of strawberries are planted using bare-root, non-defoliated transplants from high latitude ( $\geq 42^\circ$  N) or high elevation ( $> 900$  m) nurseries. The remaining acreage is planted with plug plants that are also from high latitude or high elevation nurseries. Growers prefer transplants from these areas because they tend to have fewer disease problems and begin to flower sooner than locally produced transplants. Bare-root transplants are produced in open fields where daughter plants remain attached to the mother plant and are allowed to root into the soil. Plug plants are produced by removing and placing young daughter plants in standard transplant trays, misting them until sufficient roots are formed, and allowing them to grow and develop in the trays for four to six weeks (6). This may be done in greenhouses or open fields. Relatively low cost and ample supply make bare-root plants an attractive option for growers. Water savings at establishment and potentially earlier yields make plug plants desirable (7); however, their cost can be twice as much as that for bare-root plants. The objective of this study was to determine the effect of planting date on fruit yields and economic returns of strawberry transplants from high latitude/high elevation nurseries.

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### Materials and Methods

Experimental design was a randomized complete block design with four replicates. Treatments were a factorial combination of two transplant types and 4 transplant dates. Bare-root and standard (75 cm<sup>3</sup>) plug transplants of 'Sweet Charlie' and 'Camarosa' were obtained from a commercial nursery in Nova Scotia, Canada and western North Carolina, respectively. Transplants were dug (in the case of the bare-roots), packed, and immediately shipped by refrigerated truck to arrive at the Gulf Coast Research Center-Dover three days before the intended planting date. Transplants were planted on 1, 8, 15, and 22 Oct. 1999, and 2, 9, 16 and 23 Oct. 2000. Each plot contained 16 plants on two-row raised beds, with plants spaced 30 cm apart within and between rows. Micro-overhead irrigation, applied intermittently, was used for 10 days to establish the plots of bare-root transplants. Irrigation approximated grower standard practice of 16 acre inches of water for establishment. No overhead irrigation was applied to plug transplants. After the establishment period for bare roots and immediately for plug transplants, drip irrigation was used to meet the plants' water requirement. University of Florida Cooperative Extension Service recommendations for water, fertilizer, and pest management (8) were followed throughout the season. Fruit were harvested, graded, and weighed twice weekly beginning on 3 Dec. 1999 and 15 Dec. 2000. Berries were graded for visible incidence of malformations, anthracnose fruit rot, and *Botrytis*; in addition any fruit less than 10g was culled. Data for bare-roots and plugs were analyzed separately using PROC GLM (SAS Institute, 2001) because the bare-roots were propagated in a different location than the plugs, and nursery location has been shown to have a significant effect on the fruit yield of strawberry transplants in west central Florida (9). Economic return estimates were calculated by multiplying yields by the average monthly price of a 5.44 kg medium-large flat (USDA Agricultural Marketing Service) for the 1999-2000 and 2000-2001 seasons. No attempt was made to include factors such as water and transplant cost into the analysis.

### Results and Discussion

For bare-root transplants, which are by far the more important type of strawberry transplant in Florida, planting date significantly affected December yield (Table 1). Transplants planted during the first week of October had higher December yield than transplants planted during the third and fourth week of October, and transplants planted during the second and third week of October had higher December yield than transplants planted during the fourth week of October. In fact, the transplants planted during the third and fourth week of October produced only 64% and 32%, respectively, of the December fruit yield produced by transplants planted in the first week of October. Production after December was also affected by planting date, but the influence of planting date was not consistent across years or cultivars (Table 1). Transplants of 'Camarosa' planted during the third week of October produced significantly more January fruit than 'Camarosa' transplants planted during the first week of October, but a significant planting date effect on 'Sweet Charlie' January yield was not detected. After January, the effect of planting date on the yield of bare-root transplants was minimal. Total yield was not significantly different among any treatment or their interaction.

The effects of planting date on the December and January yield of plug transplants were similar to those obtained with bare-root transplants (Table 2). Plug plants planted in early October tended to produce more fruit during December than those planted in late October. In terms of December yield, the second, third and fourth week of October were the best weeks to plant 'Sweet Charlie' (Table 2), while the first and second weeks were the best weeks to plant 'Camarosa'. However, 'Camarosa' transplants planted during the first week in October 1999 had lower January yield than those planted later in October (data not shown). This association of high yield one month with low yield the next has been noted in other strawberry field trials in west central Florida (3,5). The February yield of 'Sweet Charlie' plug plants planted during week one, two, and three were similar, while the plug plants planted during week four produced significantly less fruit than those planted during week two (Table 2). The February yield

**Table 1.** Effect of planting date on fruit production (5.44 kg flats) of bare-root strawberry transplants at Dover, Fla.

Planting Date	Marketable fruit (flats·ha <sup>-1</sup> )						
	December <sup>w</sup>	January		January		February	
		'00	'01	SC <sup>x</sup>	Cam	'00	'01
Week 1 <sup>z</sup>	636a <sup>y</sup>	636b	790a	559a	868b	1176a	1051ab
Week 2	521ab	1003a	656a	713a	1051ab	1311a	944b
Week 3	405b	1099a	742a	607a	1244a	1176a	1350a
Week 4	202c	887ab	732a	530a	1099a	1234a	1138ab

*Significance*

	<u>December</u>	<u>January</u>	<u>February</u>	<u>March</u>	<u>Total</u>
Year (Y)	NS	**	**	***	NS
Planting date (P)	***	**	NS	NS	NS
Y x P	NS	**	**	NS	NS
Y x Cultivar (C)	***	NS	***	*	***
C x P	NS	**	NS	NS	NS
P x Y x C	NS	NS	NS	*	NS

<sup>z</sup> Week 1-4 represents planting dates of 1, 8, 15 and 22 Oct. 1999 and 2, 9, 16, and 23 Oct. 2000.

<sup>y</sup> Mean separation within columns by Fisher's protected LSD at  $P \leq 0.05$ .

<sup>x</sup>SC = Sweet Charlie; Cam = Camarosa

<sup>w</sup> Mean of 1999-2000 and 2000-2001 seasons

NS, \*, \*\*, \*\*\* Nonsignificant or significant at  $P \leq 0.05$ , 0.01 or 0.001, respectively.

of 'Camarosa' plug plants was not affected by planting date. Total yield was not affected by planting date or the interaction of planting date with other factors.

Economic analysis showed significance for transplant type ( $P < 0.0001$ ), cultivar ( $P < 0.0001$ ), and transplant date ( $P < 0.0001$ ). Bare root transplants returned \$6,179 per hectare more than plug transplants (Table 3). In addition, 'Camarosa' had a \$15,453 per hectare greater return than 'Sweet Charlie'. This is mainly due to the high volume of berries produced by 'Camarosa' during March. Finally, transplants planted on October 22 and 23 returned \$2,325 less on average than those planted earlier in October. No significant differences were detected for year or interaction of main effects.

The 1999-2000 season had a higher monthly air temperature in October, November,

December, January, and March, but a lower monthly air temperature in February, than did the 2000-2001 season (Figure 1). These differences in air temperature could have contributed to the year x planting date interactions detected in this study.

The influence of planting date on the high latitude/high elevation transplants in this study was similar to the influence of planting date on the locally propagated transplants used by Albregts and Howard (1,2) and Chandler et al. (4). For both high latitude/high elevation and locally propagated transplants, planting date had a consistent effect on early season yield, but its effect on late season yields was variable.

The Florida strawberry industry uses over 100 million transplants each year, and it would be virtually impossible for the nurseries to dig, grade, pack, and ship all of these plants

**Table 2.** Effect of planting date on fruit production (5.4 kg flats) of plug strawberry transplants at Dover, Fla.

Planting Date	Marketable fruit (flats·ha <sup>-1</sup> )											
	December		December		January		January		February		March	
	'99	'00	SC <sup>x</sup>	Cam	'00	'01	SC	Cam	SC	Cam	SC	Cam
Week 1 <sup>z</sup>	559ab <sup>y</sup>	453a	328b	684a	270b	328a	347a	251c	1003ab	433a	395a	2940a
Week 2	675a	569a	530a	713a	549a	299a	415a	434b	1080a	453a	492a	3008a
Week 3	443b	559a	521a	501b	694a	376a	415a	656a	1012ab	463a	511a	2690
Week 4	405b	251b	598a	405b	598a	376a	387a	588ab	752b	684a	357a	2159a

*Significance*

	<u>December</u>	<u>January</u>	<u>February</u>	<u>March</u>	<u>Total</u>
Year (Y)	**	***	NS	NS	**
Planting date (P)	***	**	NS	***	NS
Y x P	**	**	NS	NS	NS
Y x Cultivar (C)	NS	*	***	***	***
C x P	***	*	**	**	NS
P x Y x C	NS	*	NS	NS	NS

<sup>z</sup>Week 1-4 represents planting dates of 1, 8, 15 and 22 Oct. 1999 and 2, 9, 16, and 23 Oct. 2000.

<sup>y</sup> Mean separation within columns by Fisher's protected LSD at  $P = 0.05$ .

<sup>x</sup>SC = Sweet Charlie; Cam = Camarosa

NS, \*, \*\*, \*\*\* Nonsignificant or significant at  $P = 0.05, 0.01$  or  $0.001$ , respectively

to growers so they would arrive (fresh) within the first two weeks in October. Equipment, labor, and weather are factors that limit how fast this operation can be accomplished. Also, even if all the transplants could be obtained in the first two weeks of October, growers in Florida probably would not be able to obtain enough labor to plant all of the transplants, which, currently, are totally set by hand. But, in view of the fact that

transplants delivered to growers in late October are likely to have relatively low December yields and total economic returns, there might be justification for adjusting the price of transplants according to delivery date. In other words, growers may be justified in paying more for transplants that are delivered to them during the first half of October and less for transplants that are delivered to them later in the month.

**Table 3.** Effect of transplant type and transplanting date on seasonal monetary returns per acre (in U.S. dollars) to growers for ‘Sweet Charlie’ and ‘Camarosa’ strawberries plant the first through fourth week of October 1999 and 2000.

<i>Transplant Type</i>	
Bare root (BR) <sup>z</sup>	\$38,909a <sup>y</sup>
Plug plant (PP)	\$32,730b
<i>Cultivar</i>	
‘Camarosa’	\$43,621a
‘Sweet Charlie’	\$28,168b
<i>Transplant Date</i>	
Week 1	\$36,842a
Week 2	\$37,635a
Week 3	\$38,177a
Week 4	\$31,417b

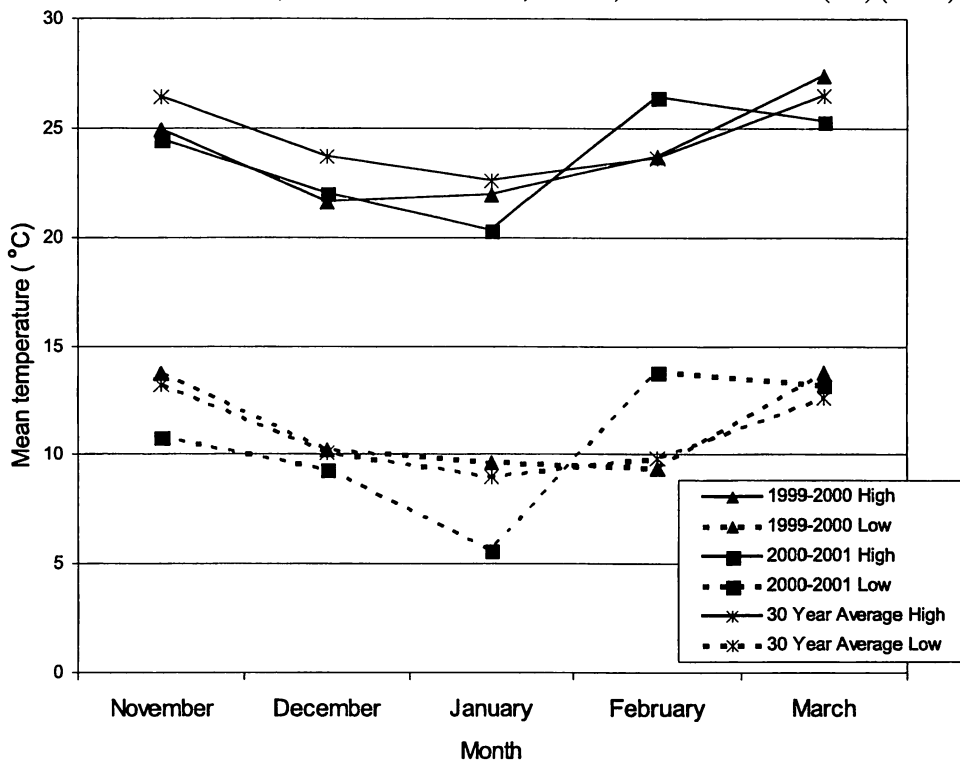
<sup>y</sup> Monetary returns do not take transplant price into account. Bare root and plug transplants cost \$75-\$125 and \$175-\$250 per 1000 plants respectively.

<sup>z</sup> Mean separation by Fischer’s LSD ( $P < 0.05$ )

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**Figure 1.** Monthly average high and low temperature (°F) average for Plant City, FL for the 1999-2000 and 2000-2001 seasons, and the 30-year historical average. Data from the National Weather Service, 2525 14th Avenue SE, Ruskin, FL 33570.  $1^{\circ}\text{C} = (5/9) \cdot (^{\circ}\text{F} - 32)$ .



## CALL FOR WILDER SILVER MEDAL NOMINATIONS

The Wilder Committee of the American Pomological Society (APS) invites nominations for the 2005 Wilder Silver Medal Award. All active members of APS are eligible to submit nominations. The award was established in 1873 in honor of Marshall P. Wilder, the founder and first president of APS. The award consists of a beautifully engraved medal which is presented to the recipient at the annual meeting of APS, held during the ASHS Annual Meeting.

The Wilder medal is presented to individuals or organizations that have rendered outstanding service to horticulture in the area of pomology. Special consideration is given to work relating to the origination and introduction of meritorious fruit cultivars. Individuals associated with either commercial concerns or professional organizations will be considered if their introductions are truly superior and have been widely planted. Significant contributions to the science and practice of pomology other than through fruit breeding will also be considered. Such contributions may relate to any important area of fruit production such as rootstock development and evaluation, anatomical and morphological studies, or noteworthy publications in any of the above subjects. Information about the award, past recipients, etc. can be found on the APS website at <http://americanpomological.org>

To obtain nomination guidelines, please contact committee chairperson, Dr. Desmond R. Layne, Dept. of Horticulture, Clemson University, Clemson, SC 29634-0375; phone: 864-656-4961; fax: 864-656-4960; e-mail: [dlayne@clemson.edu](mailto:dlayne@clemson.edu).

Nominations must be submitted by 1 May 2005.