Strawberry waiting bed plants: a valid alternative to increase early and total yields in sub-tropical regions

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Abstract

Strawberry (\textit{Fragaria}\texttimes\textit{ananassa} Duch.) production in sub-tropical areas is characterized by a low late-fall and early-winter fruit yield, a time when the value of the crop is highest. The objective of the present study was to evaluate the feasibility of waiting-bed plants for late fall and early winter production in order to increase early and total fruit yields in the Argentine sub-tropic. Plants of the cultivar ‘Chandler’ produced in a waiting-bed (WB), at high-latitude (HL), high-altitude (HA), or low-altitude (LA) were compared at two locations in Tucuman, NW Argentina: Famailla (1995, experiment 1; 1996, experiment 2) and Lules (1995, experiment 3). Total production from WB plants was 41% higher than from HA plants in experiment 1. Total production from WB plants was 83% and 53% greater than from HL plants and LA plants, respectively, in experiment 2. Early season fruit production was greater in WB (241%) than HL plants in experiment 2. In experiment 3, early fruit production from WB plants was greater than HL, HA, and LA, by 573%, 177%, and 158%, respectively. The number of marketable fruit from WB plants was greater than in the other treatments. WB percentages of marketable fruit were above 90%. WB plants could be considered as an alternative to HL, HA, and LA plants to improve fruit production and yield distribution in South American sub-tropical regions. © 2000 Elsevier Science B.V. All rights reserved.

Keywords: \textit{Fragaria}\texttimes\textit{ananassa}; Transplant; Waiting-bed; Fruit; Production

1. Introduction

The winter strawberry (\textit{Fragaria}\texttimes\textit{ananassa} Duch.) industry in sub-tropical regions is characterized by low early season fruit production; a time when the
value of the crop is the highest. Examples from both hemispheres illustrate this pattern. Florida’s largest strawberry growing region (28°N latitude) has a harvest period of basically five months, which goes from late November to April (winter–spring). More than 70% of Florida’s strawberry production takes place in March and April, when the prices of the berries are equal or lower than the production cost (Florida Department of Agriculture and Consumer Services, 1997). A similar scenario is found in Tucuman (27°S latitude), Argentina’s largest winter fresh strawberry production area. Tucuman’s production occurs basically from June to November (winter–spring), with the season almost a mirror image of Florida’s. The current production system includes annual planting, black polyethylene mulch, drip fertigation, and polyethylene one-row tunnels (Gargantini, 1989).

Three kinds of transplants are used in Tucuman: high-latitude (HL) and high-altitude (HA) (both bare-root plants), and low-altitude (LA) transplants. HL transplants are produced in cold areas of southwestern Argentina (~35°S latitude). HA plants are grown in northwestern Argentina (27°S latitude, 1900 m altitude). Both classes of transplants are characterized by receiving natural chilling in the nursery, which pre-conditions the plants for early and total production (Voth, 1989). Foliage from HL and HA is removed before or after being mechanically dug, similar to the Californian system (Galletta and Himelrick, 1990). HL transplants are usually available by mid April, while HA are available late in March. On the other hand, LA transplants do not receive chilling in the nursery and are individually dug with ~200 cm³ volume of soil and transplanted with leaves intact. ‘Chandler’ LA transplants are desired by growers due to their precocious fruit production, which may be a result of their ability to better withstand transplant stress. The LA plants are adapted to sub-tropical environments since nurseries are located in sub-tropical areas. The disadvantage of LA plants is that they may harbor pests (Lemme et al., 1996) and diseases (Mena et al., 1974, 1975).

A strawberry WB plant can be defined as a heavy, large, multi-crowned plant, conditioned to start fruiting about 5–8 weeks after planting, depending on the cultivar, planting date, and environmental conditions after planting (Dijkstra, 1989; Jamieson, 1991). The production system for WB is described in Fig. 1. The strawberry waiting-bed system (WB) was developed for early production inside greenhouses in the The Netherlands in the early 1970s with the purpose of expanding fruit production during the months in which berry prices are high and there is less competition from other production areas (Dijkstra, 1989). This system has extended to other countries, such as Belgium, Canada, France, Italy, and Spain. Several cultivars have been tested for adaptability to WB systems, such as ‘Sivetta’ (Dijkstra, 1989), ‘Rainier’ (Baumann and Daubeney, 1987), ‘Honeoye’ (Jamieson, 1991), and ‘Kent’ (Chercuitte et al., 1991), in which yields ranged from 6000 to 25,000 kg ha⁻¹. Experiments with WB plants of short-day Californian strawberry cultivars were carried out in Southern Europe with the aim
of increasing summer and fall fruit production. In France (Roudeillac et al., 1989), ‘Chandler’ WB plants outyielded other cultivars, producing 305 g of berries per plant (24,000 kg ha⁻¹). In Spain (Lopez-Galarza et al., 1997), ‘Chandler’ and ‘Pajaro’ transplants grown in a WB system produced 723 g per plant, almost double that of fresh plants.

There could be a potential for using the WB plant system in warmer areas, such as the sub-tropics, in order to obtain more berries in the autumn. Furthermore, little information on the use of WB plants in South America is available. The objective of the present study was to evaluate the feasibility of using a waiting bed plant system for winter strawberry production (cv. ‘Chandler’) in the Argentine sub-tropic to increase early and total fruit yields.

2. Materials and methods

Three experiments were conducted at two different ecological regions of subtropical Tucuman, Argentina: INTA-Famailla Experiment Station (location 1), in 1995 and 1996, and at a farm in Lules (location 2), in 1995. The transplants used were WB and HL ‘Chandler’ produced by Plantas Argentinas S.A. (Mendoza, Argentina), HA transplants produced by local growers in the Calchaqui valleys (Tucuman, Argentina), and LA transplants produced by local growers in Lules or Famailla (Tucuman, Argentina). The range of crowns per plant for WB transplants was 1–3 at planting, while the other kinds of plants were all single crowned.

2.1. Establishing experiments in location 1

In 1995, WB and LA transplants were planted on 28 March, HA and HL plants on 4 and 11 April, respectively. In 1996, WB, HL, and HA plants were
transplanted 10 April, and LA plants on 15 April. Cropping beds consisted of mechanically built raised beds 0.30 m high, 0.50 m wide, and 1.20 m between centers. Drip irrigation tubes were laid on the beds, which were covered with black polyethylene mulch. The trials were conducted on a clay loamy soil (pH 6.5) at INTA-Famailla Experiment Station (Argentina). Pre-plant fertilization consisted of 48 kg ha\(^{-1}\) N and 123 kg ha\(^{-1}\) P\(_2\)O\(_5\). Additional N (144 kg ha\(^{-1}\)) and K (303 kg ha\(^{-1}\) K\(_2\)O), as well as P (57 kg ha\(^{-1}\) P\(_2\)O\(_5\)), Ca (125 kg ha\(^{-1}\) CaO), and Mg (25.5 kg ha\(^{-1}\) MgO), were applied two times per week during the season through the drip irrigation system. Irrigation was done three to four times per week.

Plant spacing within each two-row bed was 0.23 m in 1995, and 0.21 m in 1996. Row spacing within the bed was 0.20 m. In order to protect the flowers from frost damage, the plants were covered with clear polyethylene (200 \(\mu\)m thick) one-row tunnels from May to August. The experimental design was a randomized–complete block, with three replications of 20 plants each. First flowers of bare-root transplants (HA, HL, and WB) were removed until plants developed five fully expanded leaves. Fruits were harvested from the second week of June to 28 November, in 1995, and from the first week of July to 28 October, in 1996. Harvest frequency was one to three times a week, according to fruit maturity. Fruit was graded into marketable (> 5 g per fruit) and non-marketable (<5 g, diseased, deformed). The threshold value for marketable fruit was 5 g since fruits over this weight are sold for either fresh consumption (larger fruit sizes) or for processing (smaller fruit sizes). Early fruit production was recorded until 31 August. Treatment means were grouped by Duncan’s Multiple Range test at 95% confidence level.

2.2. Establishing the experiment in location 2

In 1995, LA plants were planted on 25 March, WB plants on 1 April, HA plants on 4 April, and HL on 11 May. The soil type was a sandy loam (pH 6.1). Fruit was picked once a week from 12 July to 18 October. All other cultural practices were similar to location 1.

3. Results

Total production from WB plants in Famailla was 41% higher than from HA plants in 1995, and 83% and 53% higher than from HL and LA plants, respectively, in 1996 (Table 1). In Lules, no statistical differences for total yield were found between the transplant systems studied. Early season fruit production
favored the WB plant over the HL plant in Famailla in 1996. WB plants outyielded all the other treatments in Lules in 1995. Harvesting started later in 1996 due to a later planting date. Consequently, yields for Famailla in 1996 were lower than in 1995. In Famailla, the periods from planting to first harvest for WB transplants ranged from 10.5 (1995) to 11.5 (1996) weeks, and yields were 514 (1995) and 374 (1996) g per plant. In Lules, WB plants yielded 166 g per plant.

The numbers of marketable fruit in 1995 and 1996 from Famailla were significantly greater from WB plants than from the other transplant types. In 1996, HA plants produced essentially as much marketable fruit as all other transplant types grown at Famailla (Table 2). Data on the number of marketable fruit from Lules were not significant. The average percentage of

Table 1

<table>
<thead>
<tr>
<th>Plant type</th>
<th>Total yield (kg ha(^{-1}))</th>
<th>Early yield (kg ha(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>WB</td>
<td>37,033 a</td>
<td>29,530 a</td>
</tr>
<tr>
<td>LA</td>
<td>28,701 ab</td>
<td>19,314 b</td>
</tr>
<tr>
<td>HL(^a)</td>
<td>28,122 ab</td>
<td>16,096 b</td>
</tr>
<tr>
<td>HA</td>
<td>26,238 b</td>
<td>22,419 ab</td>
</tr>
</tbody>
</table>

\(^a\) HL = high-latitude; WB = waiting-bed; HA = high-altitude; LA = low-altitude. Means within columns followed by the same letter are not significantly different (\(p = 0.05\)).

Table 2

<table>
<thead>
<tr>
<th>Plant type</th>
<th>No. of marketable fruit/plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>WB</td>
<td>36.9 a</td>
</tr>
<tr>
<td>HA</td>
<td>24.7 b</td>
</tr>
<tr>
<td>LA</td>
<td>24.7 b</td>
</tr>
<tr>
<td>HL(^a)</td>
<td>22.2 b</td>
</tr>
</tbody>
</table>

\(^a\) HL = high-latitude; WB = waiting-bed; HA = high-altitude; LA = low-altitude. Means within columns followed by the same letter are not significantly different (\(p = 0.05\)).
marketable fruit from all the treatments in all the experiments was between 84% and 94%.

4. Discussion

HA, HL, and WB plants received natural chilling in the nursery. Higher early yields were obtained from WB transplants possibly because of the multi-crowns that were induced. Transplanting date is critical in order to achieve higher early and total yields as evidenced by the marked early and total yield reduction in 1996 compared to 1995 in Famailla. These results agreed with Chercuitte et al. (1991), who reported yields were reduced by about 50% when ‘Kent’ WB plants were transplanted in the field on 18 July compared to 17 June. In addition, early and total marketable yield of ‘Oso Grande’ HL plants and of ‘Dover’ LA plants were severely reduced when planted in sub-tropical environments on 15 October or 1 November, compared to 1 October (Albregts and Howard, 1980; Chandler et al., 1991). Planting date was reported to be more important than altitude of the nursery for ‘Chandler’ cropped under tunnels in southern Spain (Anon., 1996). Possibly ‘Chandler’ does not need as much chilling for early and total fruit production as other short-day cultivars, such as ‘Dover’, which was more influenced by nursery location (Chandler et al., 1989). The nursery site did not have a major influence on yields of ‘Chandler’ in this study. A similar pattern has been observed in Spain, where ‘Chandler’ LA plants produced a greater proportion of cull fruit than HA plants (Anon., 1996).

Our results agree with Lopez-Galarza et al. (1997), who reported better performance of ‘Chandler’ WB plants versus fresh plants in terms of total and early production, although the authors did not mention whether the plants they used were HL or HA (both currently known as fresh plants). In Famailla, the productivity of ‘Chandler’ WB plants (374–514 g per plant) were within the reported ranges of others (Roudeillac et al., 1989; Lopez-Galarza et al., 1997). Most of the reviewed studies on WB plants were done in high latitudes rather than in the sub-tropics. In high latitudes, WB plants have shown a high fruit production in a very short period, and a winter fruiting pause. However, in the sub-tropics, WB plants produced fruit continuously during almost half a year. Yield in Lules was lower than in Famailla since the plots were harvested only once a week and for a shorter duration than in Famailla.

The WB plant system is a feasible alternative to HA, HL, and LA systems in order to improve early and total yield in South American sub-tropical areas. In the WB system, high productivity relies on a greater initial number of crowns per plant and on the chilling received prior to transplanting. WB plants showed more
regularity in terms of early and total yield than HA, HL, and LA plants. WB plant performance was less affected by time and location than were the other types of plant. A ‘Chandler’ WB plant system is suitable for winter strawberry production in Famailla and Lules. However, other cultivars should also be tested. Additionally, planting WB transplants by the end of March could improve early and total yields over later settings.

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References


