Sandal and Its Products

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Alternanthera nana R.Br. Nursery Sowing-time Influences Santalum album L. Growth Following Field Planting

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Abstract

In past pot-host selection experiments the benefit of pot-hosts for Santalum has usually been assessed during and at the end of the period of growth under nursery conditions. Our results with S. album and the pot-host Alternanthera nana show that, compared with the carry-over effects after field establishment, effects on growth during this period are insignificant. The benefit of the presence of the pot-host was increased survival and growth of S. album in the field. Further, the timing of the introduction of A. nana to the S. album pot during the nursery phase was critical. Under the climatic conditions at Kununurra, Western Australia, S. album grown together with A. nana for 109 days before field planting showed maximum survival (98%), and those in combination for 134 days showed maximum growth six months after being planted into the field.

There is interest in cultivating Santalum album L. as a plantation species in the Ord River Irrigation Area (ORIA), northern Western Australia (McKinnell 1993). S. album silviculture is more complex than traditional monocultural plantations due to the need to provide a range of host plants for S. album. The establishment of Santalum species in plantations involves initial culture under nursery conditions, during which time a pot-host is essential (Srinivasan et al. 1992; Surata 1992; Nasi 1995; Barrett and Fox 1995; Fox et al. 1996; Radomiljac 1998). The pot-host functions both in the nutrition and water relations of S. album, and it reduces outplanting stress when transferred to the field. Alternanthera nana R. Br. has been shown to be a superior pot-host for S. album (Radomiljac 1998).

In this study we report that the time at which A. nana is introduced into the nursery container with S. album directly affects survival and growth of S. album in the field.

Methods

S. album seedlings were grown in 1.4-litre pots following Radomiljac (1998). Uniform seven-week-old seedlings were selected and A. nana cuttings introduced, so that at the time of field planting S. album seedlings had variously 134, 109, 84, 60 and 35 days' growth in association with A. nana. There were 60 seedlings for each time period and 60 control pots without A. nana.

At the time of field establishment S. album height and diameter at 20 mm above ground were recorded. Seedlings were harvested from each treatment and S. album leaf, stem, root and A. nana shoot dry weight was measured. Seedlings were then planted in the field in a fully randomised complete block design using standard establishment procedures and irrigation regimes (Radomiljac 1998). Each treatment plot consisted of a single row of ten seedlings planted at three-metre spacings along the row, replicated five times with a 1.8 m buffer between rows.

Plants were assessed up to 23 weeks after planting for S. album survival, height and diameter at 100 mm above ground and also for A. nana survival. At each assessment a sample of three representative S. album

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seedlings was taken from each treatment and *S. album* stem, leaf, root and *A. nana* shoot dry weight was measured after the plant material had been oven-dried at 80°C for 48 hours.

**Results and Discussion**

*A. nana* did not enhance growth of *S. album* seedlings in the nursery prior to field establishment. The growth of *A. nana* was dependent on the time at which it was introduced into the pot during the nursery phase (Table 1).

Virtually all *S. album* plants survived for the first 16 weeks in the field. After that, survival of *S. album* seedlings without *A. nana* as a pot-host decreased. *S. album* survival rate was proportional to the length of time that seedlings had been grown with *A. nana* before field establishment, except that survival for seedlings in the 134-day treatment was slightly less than for the 109-day treatment (Fig. 1(i)). The growth in height and diameter of the seedlings that were grown with *A. nana* for 134 and 109 days before field establishment was almost double that of seedlings grown without *A. nana* (Fig. 1(ii)). Data is not shown for diameter growth.

The beneficial effect of 134 and 109 days of *A. nana* is also seen in the dry-weight of the plants (only data for plants after 11 weeks in the field are shown) (Fig. 1(iii)). Unattached *S. album* showed an increase in root:shoot ratio, while the root:shoot ratio for those seedlings grown with *A. nana* was lower and remained relatively stable after field establishment (Fig. 1(iv)).

Several studies have evaluated pot-host species for *S. album*, but have dealt only with parasite and host performance during the nursery phase (Surata 1992; Fox and Doronila 1993). In this study, the growth of seedlings grown without *A. nana* was similar to that of seedlings grown with *A. nana* during the nursery phase. This indicates that seedlings may grow satisfactorily in the absence of a pot-host when conditions are favourable. This experiment showed that the influence of the pot-host was most apparent following transplanting to the field and shows the importance in evaluating pot-host species performance after field establishment.

We found that the length of time that there was a parasitic relationship between *S. album* and *A. nana* significantly affected growth and survival after transfer to the field. Highest survival and growth of *S. album* in the field was after 109–134 days of association with *A. nana* in the nursery. *S. album* growth was highest given 134 days’ nursery association with *A. nana*, but survival was slightly less than for the 109 days’ treatment, suggesting that growth of the pot-host may have been too vigorous for the small *S. album* seedling.

Other pot-host species, such as *Cajanus cajun* Huth., *Desmanthus virgatus* (L.) Willd., *Alternanthera* spp. Forsskal cv., and *Acacia villosa* Willd., are reported to be utilised for periods much longer than 134 days in India and Indonesia (Srinivasan et al. 1992; Surata et al. 1995; Fox et al. 1996).

The differences in root:shoot ratio in this study suggest that partitioning of resources changes from root to shoot once effective haustorial connections have been made. This means that the parasite would be very vulnerable to water and nutrient deficits if the host plant were to die.

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**Table 1.** The effect of the number of days in which *Santalum album* and *Alternanthera nana* are grown together, on *S. album* height, stem diameter at 20 mm, plant dry-weight (DW), and *A. nana* shoot DW immediately prior to field establishment. (Control is no *A. nana* pot-host.)

<table>
<thead>
<tr>
<th>Age of <em>S. album</em> at the time of <em>A. nana</em> introduction (days)</th>
<th>Length of <em>S. album</em>/ <em>A. nana</em> association in a pot before field establishment (days)</th>
<th><em>S. album</em> height (mm)</th>
<th><em>S. album</em> diameter (mm)</th>
<th><em>S. album</em> plant DW (g)</th>
<th><em>A. nana</em> shoot DW (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>54</td>
<td>134</td>
<td>374.1</td>
<td>3.9</td>
<td>59.1</td>
<td>221.5</td>
</tr>
<tr>
<td>79</td>
<td>109</td>
<td>398.2</td>
<td>4.4</td>
<td>56.0</td>
<td>52.6</td>
</tr>
<tr>
<td>104</td>
<td>84</td>
<td>390.0</td>
<td>4.2</td>
<td>65.3</td>
<td>11.6</td>
</tr>
<tr>
<td>128</td>
<td>60</td>
<td>329.5</td>
<td>4.0</td>
<td>53.1</td>
<td>10.2</td>
</tr>
<tr>
<td>153</td>
<td>35</td>
<td>379.5</td>
<td>4.1</td>
<td>64.3</td>
<td>4.4</td>
</tr>
<tr>
<td>Control</td>
<td>0</td>
<td>394.5</td>
<td>4.2</td>
<td>67.4</td>
<td>–</td>
</tr>
</tbody>
</table>

51
Figure 1. Growth of Santalum album following field establishment when attached to Alternanthera nana as a pot-host for (■) 134, (▲) 109, (●) 84, (△) 60, (◆) 35 days, or had no pot-host (▼) whilst in a nursery container before field establishment. (Means followed by the same letter are not significantly different (P>0.05) using Tukey’s pairwise t-test.)
(i) Survival of S. album (data from 5 replicates)
(ii) Height growth of S. album (5 replicates)
(iii) S. album plant dry-weight (3 replicates) ■ = Plant DW; ▲ = Leaf DW; ● = Stem DW; ◇ = Root DW
(iv) S. album root:shoot ratio (3 replicates)

Conclusion
This nursery and field experiment showed that early survival and growth of S. album plantations can be markedly improved by precise timing of utilisation of A. nana as a pot-host.

References
Fox, J.E.D. and Doronila, A.I. 1993. Selection of primary host (pot stage) for Santalum album. Mulga Research Centre, School of Environmental Biology, Curtin University of Technology. Report to the Sandalwood Research Institute, 23 p.
17th Pacific Science Congress, Honolulu, Hawaii. ACIAR Proceedings No. 49, 43 p.


