USING AN *Ascophyllum* KELP EXTRACT AND AN AMINO ACID MIXTURE TO HASTEN THE GROWTH IN NURSERY OF RECENTLY BUDDED TAHITI LIME (*Citrus latifolia* TANAKA)

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INTRODUCTION

In Puerto Rico, budded transplants are commonly used to establish commercial citrus orchards (González Vélez et al., 2002). Citrus transplants take approximately 100 days from budding to being ready to be transplanted to commercial orchards (Morales-Payan and Santiago, 2008; Santana et al., 2006). Budded Tahiti limes are usually at the adequate stage for transplanting to definite orchards (ATS) when (1) the scion (Tahiti lime) stem has a diameter of at least 0.7 cm at its union with the rootstock, and (2) the scion shoot is >50 cm in length.

It would be to the advantage of transplant growers to implement practices that shorten the time between budding and the ATS. Such decrease in time requirement may result in freeing space in the nursery sooner, as well as reducing labor, watering, fertilization, and plant protection, all of which may save the grower money and time.

Application of biostimulants has been shown to accelerated transplant growth in coffee (*Coffea arabica*) (Villacres Vallejo, 1992) and fruit crops transplants such as papaya (*Carica papaya*) (Morales-Payan and Stall, 2005) and various citrus. In Puerto Rico, Morales-Payan and Santiago (2008) showed that kelp (*Ascophyllum nodosum*) extracts and amino acid blends significantly reduced the time in nursery of tangelo (*Citrus reticulata* x *C. paradisi*), and similar results were found by Morales-Payan (2008) working with two cultivars of grapefruit (*Citrus paradisi*). In the Dominican Republic, Santana et al. (2006) reported that several biostimulants were useful in shortening the time in nursery in orange (*Citrus sinensis*) budded onto two rootstocks.

Little is known about the effects of amino acids, kelp extracts, and their interactions on the growth of Tahiti lime. The objective of this research was to determine the effect of a kelp extract (Stimplex™) and an amino acid mixture (Macro-Sorb Radicular™) on the in-nursery growth of Tahiti lime budded onto ‘Cleopatra’ mandarin (*Citrus reticulata*).
MATERIALS AND METHODS

The research was conducted in 2007 and 2008 at the fruit crops nursery of the Alzamora Teaching and Research Farm of the University of Puerto Rico in Mayagüez, Puerto Rico. Tahiti lime recently budded on ‘Cleopatra’ tangerine was used for the experiments. Transplants were grown following local recommendations, except for the application of biostimulants.

The biostimulants Stimplex® [a commercial extract of kelp (*Ascophyllum nodosum*) (Stimplex®) produced by Acadian Seaplants] and Macro-Sorb Radicular® (a commercial blend of amino acids and peptides produced by BioIberica) were drench-applied separately at the rates of 0, 0.25, 0.5, 0.75, and 1.0 ml per L of water per application. Additionally, the biostimulants were tested tank-mixed in the following combinations: (a) 0.25 ml *A. nodosum* extract + 0.25 ml amino acid blend/L/per application, (b) 0.25 ml *A. nodosum* extract + 0.50 ml amino acid blend per L per application, (c) 0.50 ml *A. nodosum* extract + 0.50 ml amino acid blend per L per application, and (d) 0.75 ml *A. nodosum* extract + 0.75 ml amino acid blend per L per application. Each budded plant received 150 ml of biostimulant aqueous solution. Biostimulant applications started 30 days after budding and were repeated every 15 days until 90 days after budding or when plants reached the adequate transplanting stage (ATS), whichever occurred first.

Treatments were set in a randomized complete block design with 10 replications. Every 15 days after the first biostimulant application, shoot height and stem diameter were registered. Transplants were considered at ATS when the stem of the Tahiti lime shoot was 50-cm long and its diameter was at least 0.7 cm at the union with the rootstock. The data was submitted to regression analysis (5% level).

RESULTS AND DISCUSSION

The growth of Tahiti lime transplants was significantly affected by both biostimulants. When treated with the same rate of either the kelp extract or the amino acid blend, Tahiti lime scions attained adequate transplanting stage at the same time. As the rate of the kelp extract and the amino acid blend increased, the time necessary to grow the transplants to ATS decreased linearly (Table 1).
Table 1. Effect of a commercially available amino acid blend and an *Ascophyllum nodosum* extract on the time to grow Tahiti lime budded on Cleopatra tangerine to adequate transplanting stage*.

<table>
<thead>
<tr>
<th>Treatment (ml/L/application)</th>
<th><em>Ascophyllum nodosum</em> extract (Stimplex®)</th>
<th>Amino acid blend (Macro-Sorb Radicular®)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (water only)</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>0.25</td>
<td>143</td>
<td>142</td>
</tr>
<tr>
<td>0.50</td>
<td>137</td>
<td>134</td>
</tr>
<tr>
<td>0.75</td>
<td>129</td>
<td>126</td>
</tr>
<tr>
<td>1.00</td>
<td>120</td>
<td>118</td>
</tr>
</tbody>
</table>

Regression equation  
\[ y = 113.7 - 110.6x; r^2 = 0.90 \]  
\[ y = 112.4 - 108.1x; r^2 = 0.91 \]

* = Tahiti lime shoot reaching 50-cm long, its diameter at least 0.7 cm at the union with the rootstock.

When the kelp extract and the amino acid blend were applied after tank-mixed, their effect was additive (Table 2). In Tahiti lime treated with kelp extract+amino acid blend, time to adequate transplanting stage was reduced by as much as 26% (Table 2).
Table 2. Effect of drench application of an amino acid blend tank-mixed with an *Ascophyllum nodosum* extract on the time to grow Tahiti lime budded on Cleopatra tangerine to adequate transplanting stage*.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Days to adequate transplanting stage**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (water only)</td>
<td>150 a</td>
</tr>
<tr>
<td>0.25 ml <em>A. nodosum</em> extract + 0.25 ml amino acid blend/L/per application</td>
<td>139 b</td>
</tr>
<tr>
<td>0.25 ml <em>A. nodosum</em> extract + 0.50 ml amino acid blend/L/per application</td>
<td>130 b</td>
</tr>
<tr>
<td>0.50 ml <em>A. nodosum</em> extract + 0.50 ml amino acid blend/L/per application</td>
<td>117 bc</td>
</tr>
<tr>
<td>0.75 ml <em>A. nodosum</em> extract + 0.75 ml amino acid blend/L/per application</td>
<td>111 c</td>
</tr>
</tbody>
</table>

* = Tahiti lime shoot reaching 50-cm long, its diameter at least 0.7 cm at the union with the rootstock.

**Values followed by the same letters are not significantly different.

The acceleration of growth found in Tahiti lime in this research is similar to the effects reported when biostimulants such as *Ascophyllum* kelp extract, amino acid blends, and folcysteine were applied to crops such as tangelo (*Citrus reticulata* x *C. paradisi*), grapefruit (*Citrus paradisi* Macf.), orange (*Citrus sinensis*), papaya (*Carica papaya*), and coffee (*Coffea arabica*) (Morales-Payan 2007; Morales-Payan and Stall, 2005; Morales-Payan and Santiago, 2008; Santana et al., 2006; Villacres Vallejo, 1992).

Our results show that the kelp extract and the amino acid mixture may be useful tools to accelerate Tahiti lime growth in nursery. In our experiments, such time reduction was as high as 39 days or 26% of the time required for ATS in control plants (Table 2). These results are relevant because limes budded on Cleopatra tangerine have notoriously slow growth rates (Stenzel and Neves, 2004; Stuchi et al., 2009), which delays their growth in nursery and in their first years in commercial orchards. In future experiments, other biostimulants will be tested, looking for treatments that reduce the time necessary for ATS in Tahiti lime transplants.
ACKNOWLEDGEMENTS

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REFERENCES


