CNSSL-sprayed plants respectively. When plants maintained in troughs were sprayed with WP, 32–46.67% plants were damaged. When CNSSL alone was sprayed, the intensity of scorching ranged from 20 to 27.33%. However, when the formulation was applied @ 10 g/100 ml and 5 g/100 ml on 4% CNSSL-sprayed plants, a marked increase in the disease intensity by 98.67 and 97.33% respectively, was observed (Figure 1).

The most effective concentration of WP @ 5 g/100 ml was tested on water hyacinth plants in Akkulam lake. The plants were sprayed with 5% CNSSL @ 50 ml/m² and was allowed to dry for a period of 30 min and then sprayed with WP @ 5 g/100 ml and @ 50 ml/m². Higher concentration of CNSSL (5%) was used in the lake as the water hyacinth plants were much more robust than under trough condition. The plants exhibited typical blighting symptom on the fourth day of spraying. The disease gradually spread from the leaves to the swollen petiole and by the seventh day, the plants started sinking to the bottom of the lake and the disease intensity ranged from 83.4 to 94.5% (Figure 2a). Cent per cent control of the weed was achieved when the plants were sprayed with the formulation for a second time, two weeks after the first spraying (Figure 2b). It was also observed that spraying of F. pallidoroseum (5% WP) and CNSSL (5%) did not show any toxicity to the aquatic fauna and flora. The results of the present study clearly indicate that F. pallidoroseum is an effective biocidal agent of water hyacinth. The efficiency of F. pallidoroseum could be further enhanced by pre-treating the plants with CNSSL at lower concentration, which is a product of plant origin easily available in Kerala. Also, F. pallidoroseum is not harmful to commonly cultivated plants or to the fauna found in the waterways. Work is in progress to evolve a technique to mass multiply the inoculum using cheaper substrate for large-scale field applications.


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Axillary shoot production in micropropagated date palm (Phoenix dactylifera)

Date palm (Phoenix dactylifera L.) is propagated traditionally by offshoots or suckers, which are produced in the leaf axils and usually appear at or below the ground level surrounding the stem base. Small offshoots that appear above the ground level on the trunk are usually destroyed due to difficulty in rooting. Offshoots are produced in a limited number for a certain period in the lifetime of a young palm tree. Offshoot formation is dependent on the genetic makeup of the cultivar and environmental factors. The number of offshoots produced by an individual date palm tree is highly variable and varies from one cultivar to another. The traditional method of vegetative propagation through offshoot is slow, laborious, time-consuming and expensive24. Transmission of disease-causing pathogens and insects is another disadvantage of conventional offshoot propagation. This has focussed on micropropagation technique during the past 20 years as
tivar Barhi clonally produced through the somatic embryogenesis method were studied. Earlier studies on axillary shoot formation in field-grown date palms of different cultivars showed similarity in the growth habits. These studies did not observe the formation or the frequency of hapaxanthic axillary shoot (HAS). Recently, in February 2000, a demonstration orchard containing 5 plants each from 12 different micropropagated date palm cultivars were established at KISR campus, Kuwait, for field evaluation. Early growth of the palms showed normal and uniform vegetative growth similar to the seedling palms.

Date palm plantlets of different cultivars were produced on a large-scale (3000 plantlets/month) through the somatic embryogenesis and adventive embryony method (Figure 1) at KISR, Kuwait. Plantlets of 12 cultivars (Table 1) acclimatized and maintained in the greenhouse for one year were used for the field experiments. In total, 60 plantlets, five from each cultivar were transplanted to the research site field in February 2000. All the 60 plantlets were planted in 70 x 70 x 70 cm pits without damaging the root systems. The young palms were maintained in the field by irrigating daily in summer months and once a week during the winter months through a drip irrigation system. Fertilizer (NPK 20:20:20 + trace elements) was applied once a month at a rate of 200 g per plant.

After three months of field planting, 100% of the palms survived and started to grow. Growth and the juvenile leaf morphology of the micropropagated date palm plants for a few months in the greenhouse were similar to the seedlings. The first few leaves are phylloides, followed by the gradual appearance of partially split leaves. Growth of young in vitro raised palms in the orchard (Figure 2 a) was uniform and similar to the seedling palms. The growth was slow initially during the first six months, but was vigorous afterwards, producing mature leaves. Axillary shoots started to develop from the basal leaf axis during the second year of growth. A majority of the tissue culture derived palms started to produce axillary shoots during the second year irrespective of cultivars, whereas a few produced them in the third year of planting (Table 1). Axillary shoots were of two types; normal and hapaxanthic. All the hapaxanthic shoots produced terminal inflorescences and died afterwards. Normal axillary shoots developed into offshoots

**Figure 1.** Date palm (*Phoenix dactylifera* L.) tissue culture. a. Embryogenic callus; b. Somatic embryos; c. Somatic embryo multiplication; d. Somatic embryo germination; e. Acclimatized plantlets in the greenhouse.

<table>
<thead>
<tr>
<th>Cultivar and origin</th>
<th>Axillary shoots (average)</th>
<th>HAS (average)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2nd Year</td>
<td>3rd Year</td>
</tr>
<tr>
<td>Kyara-Iraq</td>
<td>7.0 ± 1.2</td>
<td>9.0 ± 0.7</td>
</tr>
<tr>
<td>Oudhi-Iraq</td>
<td>5.6 ± 1.8</td>
<td>6.0 ± 1.0</td>
</tr>
<tr>
<td>Sheshi-Saudi Arabia</td>
<td>5.0 ± 0.0</td>
<td>9.0 ± 0.8</td>
</tr>
<tr>
<td>Anbara-Saudi Arabia</td>
<td>3.4 ± 0.9</td>
<td>4.0 ± 0.0</td>
</tr>
<tr>
<td>Saccari-Saudi Arabia</td>
<td>1.2 ± 0.4</td>
<td>8.4 ± 0.5</td>
</tr>
<tr>
<td>Sowi-Egypt</td>
<td>1.2 ± 0.8</td>
<td>8.0 ± 0.0</td>
</tr>
<tr>
<td>Nebit sedi-Saudi Arabia</td>
<td>0.6 ± 1.3</td>
<td>4.0 ± 0.7</td>
</tr>
<tr>
<td>Majdool-Morocco</td>
<td>11.4 ± 1.3</td>
<td>15.0 ± 1.9</td>
</tr>
<tr>
<td>Barhi-Iraq</td>
<td>1.4 ± 0.5</td>
<td>5.4 ± 1.1</td>
</tr>
<tr>
<td>Khlas-Saudi Arabia</td>
<td>0</td>
<td>3.0 ± 0.0</td>
</tr>
<tr>
<td>Sultana-Saudi Arabia</td>
<td>0.6 ± 0.9</td>
<td>2.6 ± 0.5</td>
</tr>
<tr>
<td>Hilali-Saudi Arabia</td>
<td>1.8 ± 0.8</td>
<td>4.2 ± 0.5</td>
</tr>
</tbody>
</table>

HAS, Hapaxanthic Axillary Shoot; (±), Standard error; Data from 5 plants each in 12 cultivars.
Among the 12 cultivars, Majdool produced more number of axillary shoots (Figure 2b) than all other cultivars included in the experiment. The size of the mother palms was much smaller than the other plants that produced fewer offshoots. Cultivars Anbara, Nebut scifl, Barhi, Khlas, Sultana and Hilaly showed lower number of axillary shoots than other cultivars (Table 1). Most cultivars produced HAS except Kyara, Siwi and Sultana. Majdool and Barhi produced more HAS than other cultivars (Table 1). The palms with few or no axillary shoots were larger in size than the palms with more axillary shoots, and 85% of the palms started to give a yield during the third year (Figure 3).

Micropropagated palms were similar to the seedling palms in their growth, axillary shoot production and flowering. They produce hapaxanthic axillary shoots during the second and third years of growth. HAS were common in seedlings and micropropagated palms while rare in the palms propagated via suckers. Among the 12 cultivars, HAS were observed in nine cultivars. Most of the palms produced HAS during the second year of growth and less during the third year (Table 1). These results confirm the findings of Sudhersan et al. This preliminary observation suggested that the formation of HAS is associated with juvenility and, as the palms grew, HAS formation declined.

All the 12 cultivars produced axillary shoots, however, the number of shoot production varied from one cultivar to another. Generally, these offshoots take 3–5 years to attain the normal size necessary for clonal propagation. Removal of axillary shoots during the early stages of growth and flowering enhances the growth of the mother tree. In conclusion, it is recommended to remove the axillary shoots as they form on micropropagated date palms in order to enhance the growth of trees, since true-to-type micropropagated plants are now available at low cost. Earlier studies on axillary shoot production in different cultivars showed a similarity in the growth habits of micropropagated and seedling palms. The present work justifies the need for tissue culture technology for the mass propagation of elite date palm cultivars.

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