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Field Performance of Tissue Cultured Date Palm (Phoenix dactylifera) Clonally Produced by Somatic Embryogenesis

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ABSTRACT

Phoenix dactylifera (date palm) plants from tissue culture, derived from somatic embryos, fruited within four years from field planting of small plants with leaf length of 100 cm and 1.5 cm diameter at base. Fruit of commercial quality was available in year six and by year eight commercial quantities of fruit production were being approached. Fruit from the tissue culture derived plants, cultivar Barhi, was indistinguishable from fruit of plants which had originated from suckers ("offshoots"). The technical feasibility of clonal propagation of date palm by tissue culture was confirmed and the agronomic acceptability of the tissue culture product was demonstrated. These results justify commercial scale-up of the micropropagation procedure using somatic embryogenesis to provide a rapid cost-effective means of obtaining elite date palm planting material, particularly of cultivars in short supply.

The date palm is clonally propagated by suckers ("offshoots") that develop at the base of established trees. For some highly desirable cultivars, the number of suckers produced during the lifetime of the tree cannot meet market demand. Clonal propagation by tissue culture has the potential to produce plants at a competitive cost and in the large numbers needed to meet the demand. Date palm can be propagated both by somatic embryogenesis and via axillary buds (Reynolds and Murashige 1979, Tisserat and DeMason 1981, Poulain et al. 1979, Drira and Buvat 1983). Gabr and Tisserat (1985) concluded, on the basis of some preliminary results, that mass cloning of palms is only possible through somatic embryogenesis. There is little doubt that micropropagation by somatic embryogenesis is more efficient in terms of rates of multiplication and production costs than micropropagation by axillary branches and is, therefore, a commercially more attractive means of micropropagation of the date palm. However, because of problems that have been experienced with oil palm plants derived from somatic embryos, the large-scale introduction of date palm plants produced by this process requires that producers have quality assurances of phenotypic uniformity and agronomic performance (Corley et al. 1986). This paper describes some preliminary results on the development and fruiting of plants derived from somatic embryos of the cultivar Barhi, an elite cultivar currently in great demand but in short supply.

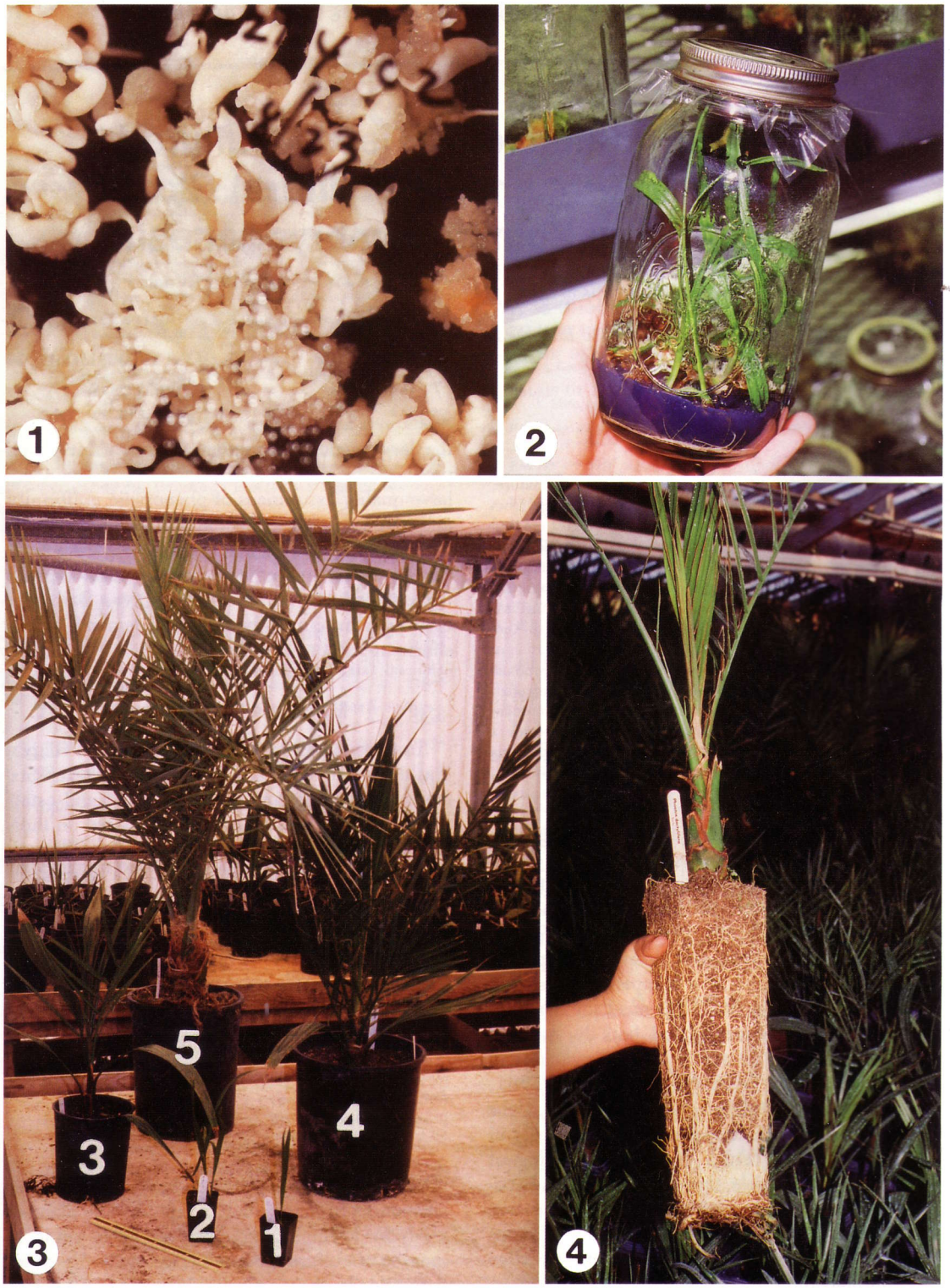
Materials and Methods

In the summer of 1982, suckers of the cultivar Barhi, from USDA Date and Citrus Research Station, Indio, California, were dissected and established in culture using procedures based on those of Tisserat (1981). Plants derived from somatic embryos that developed from callus were acclimatized in a high humidity environment in a growth room and grown to field planting stage in a greenhouse. Small plants grown in one gallon containers, having about 1.5 cm base diameter with only undivided juvenile leaves about 100 cm long, were planted out eight meters apart in the field in Indio, California in the fall of 1984 (Fig. 5). Maintenance followed standard field practices for date palm suckers.

Results and Discussion

Somatic embryos developed between three and six months from initiation of cultures and plantlets ready for acclimatization were available within 12 months of culture initiation (Figs. 1,2). Up to ten thousand plantlets can be produced from one sucker in two years making this an attractive clonal production system for the date palm.

Acclimatization in a controlled high humidity environment permitted high establishment rate



1. Date palm somatic embryos derived from callus of young leaf explants. 2. Plantlets derived from somatic embryos ready for acclimatization. 3. Growth of date palm plants from tissue culture. 1—about one month from culture; 2—about four months from culture; 3—about 12 months from culture; 4—about 18 months from culture; 5—about 30 months from culture. 4. Tissue culture plant at a size ready for field planting.

5. Tissue culture plant (date palm cultivar Barhi) established in the field in April 1985. 6. Plant shown in Figure 5 three years later showing first fruit in the khalal stage. 7. Barhi fruit in the khalal stage from tissue culture compared with fruit from a tree derived from a sucker ("offshoot").

with the small number of losses attributed to root damage or plants too small to survive (Tisserat 1981). After progressive reduction of humidity to ambient levels, plants could be transferred to a greenhouse, with negligible losses, after 4 to 8 weeks in acclimatization. Plants were ready for field planting after 9 to 14 months in the greenhouse and plants approaching the typical size used in conventional sucker ("offshoot") propagation were produced in two to three years (Figs. 3,4). Improved handling practices and a good growing environment will reduce the time period for growing plants up to size for field planting.

About 10% of the young plants potted from tissue culture exhibited slow growth or no growth at all. In many cases this was associated with shoot tip abortion and with the development of a terminal inflorescence. Ammar et al. (1987) have observed this development in seedlings grown in vitro which, they concluded, may be associated with endoge-

8. Barhi trees produced by tissue culture in the sixth year showing formation of several good-sized bunches. 9. Barhi tree produced by tissue culture in the eighth year. 10. Barhi fruit from tree shown in Figure 9 with commercial quality fruit in the khalal stage.

nous hormonal effects possibly cytokinins. The visual symptoms enable simple culling at the nursery stage and in only one case out of many thousand have we failed to pick up this development at the nursery stage. This rare development has not proved to be of any practical significance in the micropropagation of date palm by somatic embryogenesis.

No losses were sustained in the transfer of plants to the field despite the small size of the plants, leaf length 100 cm and base 1.5 cm, relative to suckers (Figs. 4,5). The high rate of success is attributed to the strong root system of the container-grown plants (Fig. 4). First fruiting shown in Figure 6 occurred in four years (four growing seasons) from the small plant depicted in Figure 5. Climatic conditions are important because comparable plants grown in Bahrain fruited one year earlier. The four-year time period was much less than the 8–10 years reported by Ammar et al. (1987) for seed-derived date palms to flower and bear fruit.

The overall form and appearance of the tissue culture trees were comparable to those of suckers except for a higher propensity for sucker development at the base of the tree. All the trees from tissue culture had five or more suckers in comparison to Barhi plants from suckers which were observed to form four or more suckers in only about 30% of the trees at the same location. Although some of the suckers grew to a size suitable for propagation, some of the suckers of the micropropagated trees aborted at an early stage. Some aborted suckers were associated with inflorescence formation from the terminal bud. Some of the inflorescences even formed pathenocarpic fruit. Similar developments have been observed in plants derived from suckers (Swingle 1927, Hilgeman 1954). Swingle (1927) noted that up to 10% of suckers of Deglet Noor exhibit these abortive suckers so the development is not unusual and is not specific to plants derived from tissue culture. This development has not visibly affected tree performance.

The fruit that formed on the trees derived from somatic embryos was indistinguishable from fruit of trees derived from suckers (Fig. 7). The important low astringency character and yellow color of Barhi fruit in the immature khalal stage was retained. The fruit abnormalities observed in oil palm by Corley et al. (1986) have not been observed in any date palm tree from tissue culture.

The first bunches which developed in year four had few fruits per inflorescence and suffered damage because of their proximity to the ground (Fig. 6). By year six, however, trees with up to seven bunches of high quality commercial fruit were observed (Fig. 8) and, by year eight, trees were close to full commercial production (Figs. 9,10).

Conclusions

The results demonstrate the technical and commercial feasibility of clonal propagation of date palm by tissue culture and the agronomic acceptability of the tissue culture product. These results justify scale-up of the micropropagation procedure using somatic embryogenesis to provide a rapid cost-effective means of obtaining elite date palm planting material of cultivars in short supply. The relatively low cost of elite varieties of date palms from tissue culture and provision of strong plants with well-established root systems will provide growers with a much more attractive means to propagate date palm than propagation by suckers. Replacement of old date palm plantations, particularly seedling plantations, with high quality planting material is now possible using micropropagated plants.

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PALM BRIEF

Pritchardiopsis Lives!

Perhaps because it sounds like a personal patronym (which it is not!), I have long had an interest in the endemic New Caledonian palm *Pritchardiopsis jeanenneyi*, the only fan palm native to that palm-rich island of the south-west Pacific. Yet it seemed that my interest came too late. According to Langlois in the Supplement to Palms of the World (1976), this palm had literally vanished, a victim of multifarious stresses including mining, forest clearing, and consumption of its "cabbage" by convicts at the Bay of Prony penal colony. In the course of three trips to New Caledonia, I was too busy with other faunal and floral preoccupations, and made no effort to "rediscover" *Pritchardiopsis*.

But all was not lost. Having recently obtained copies of Dowe's Palms of the South-west Pacific (1989) and Moore and Uhl's The Indigenous Palms of New Caledonia, I learned that a single mature specimen of *Pritchardiopsis*, surrounded by about thirty of its offspring, and all confined to a single hectare, had been located in a remote area near Baie de Prony, at about 200 m altitude, in the later 1970's. The identification had been confirmed by botanists at ORSTOM in Noumea.

Before my most recent expedition to New Caledonia in December 1991, I wrote ahead to my colleague Jean-Louis d'Auzon of the Association pour la Sauvegarde de la Nature Neo-Caledonienne, of which I am a member, and asked if it would be possible for our chartered ship to visit Baie de Prony to see what we could find. But time did not allow; our expedition was taking us north from Noumea, to Belep and the d'Entrecasteaux Islands, and Baie de Prony was to the south. But d'Auzon did draw my attention to the existence

The author with *Pritchardiopsis* in the garden at ORSTOM in New Caledonia. Photo by S. Pritchard.

of four specimens in cultivation in the ORSTOM gardens in Noumea.

I was able to visit the gardens in my last days in New Caledonia. The plantings were unlabelled, and, while gardeners and scientific staff were extremely courteous, there was nobody able to direct me to the *Pritchardiopsis* specimens. So I had to find and identify them myself. The description in the Langlois book had indicated that the leaf of *Pritchardiopsis* was distinctive in being wedge-shaped (only about one-sixth orbicular), and only about 18 inches long, with a 12–15 inch petiole. But Beccari's material, on which this description was based, was clearly immature; the illustration of the mature tree in Dowe's book showed leaves about a meter wide, with 1.5 m petioles, and more than 75% orbicular.

Finally I found the little grove of about four young trees—healthy and beautiful, and with leaves identical to those in the photograph of the single mature wild specimen (Fig. 1). So *Pritchardiopsis* not only lives, it may even have a future!

Another seemingly extinct monotypic genus of