Hapaxanthic Axillary Shoots in Date Palm Plants Grown *in vivo* and *in vitro*

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Date palm (*Phoenix dactylifera* L.) produces axillary shoots from axillary shoot meristems and inflorescences from floral meristems. Axillary shoots are produced during the early vegetative growth period and cease when flowering starts after three years. A few axillary shoots produce terminal inflorescences and die. These flowering shoots are termed hapaxanthic axillary shoots and appear in seedling palms and tissue culture palms during the second or third year of vegetative growth. The production of hapaxanthic shoots does not affect the normal growth of the mother tree.

Date palms are propagated sexually by seeds and vegetatively by offshoots or tissue culture plantlets. Both the tissue culture plantlets and the seedling palms resemble each other in growth and development in the field except that seedlings start with juvenile leaves while the offshoot-derived palms start with adult leaves. Axillary shoots are produced during the early vegetative phase prior to the onset of flowering in the fourth year. However, axillary shoots may develop during the reproductive phase in certain cultivars. These axillary shoots are called *racoobs*, and they develop higher up on the tree.

During our 15 years of experience with *in vitro* and *in vivo* date palm growth and development, we observed a third type of axillary shoot in addition to the offshoots and *racoobs*. These peculiar axillary shoots are morpho-logically different from the normal offshoots and *racoobs*. These axillary shoots are hapaxanthic, i.e., they produce terminal inflorescences after one or two years of growth and die. This phenomenon is common in both tissue culture palms and seedling palms during their second or third year of growth in the field.

Vegetative proliferations from inflorescences or from floral sites has been reported in many palms: *Cocos* (Davis 1948, 1967; Balaga 1975; Sudasrip et al. 1978), *Elaeis* (Henry & Scheidecker 1953), *Areca catechu* (Davis 1968) and *Borassus* (Davis & Basu 1969). In rare instances, the apical meristem of the flower bud proliferates to form floral or vegetative organs (Eames 1961; Padmanabhan et al. 1987). Recently Mohamed (1997) reported on axillary shoots that terminated in inflorescences in the date palm cultivar 'Mishring wad-khatib.' We observed hapaxanthic shoots of several date palm cultivars *in vitro* and *in vivo*. The details of our observations are presented in this paper.

Observations

Hapaxanthic axillary shoots (HAS) were observed in tissue culture date palm (Figs. 1, 2) cultivars 'Maktoomi,' 'Nebut-seif,' 'Succari,' 'Barhi,' 'Munifi' and 'Sheshi' (Table 1). The same phenomenon was also observed in several seedling palms (both male and female) grown for landscaping. These hapaxanthic axillary shoots (Fig. 3) were periodically removed from the mother plant and dissected out in the laboratory for observation (Figs. 3–12).

Morphologically, these axillary shoots were distinct from offshoots and *racoobs*. They produced 2–8 basal leaves with a full complement of leaflets, followed by 2–3 leaves with few leaflets at the tip followed by 3–5 cataphylls (Fig. 5). These shoots grew for a year or two and produced terminal inflorescences (Figs. 7, 8). Some of them produced inflorescences at their basal leaf axils (Fig. 9). The inflorescence axis was cylindrical and tapering towards the end (Figs. 7, 8). There was no prophyll covering the inflorescence at the early developmental stage. Each inflorescence axis had several nodes with bracts or scale leaves (Figs. 10–12). The basal bracts were larger, and the upper ones were gradually reduced to a smaller size. Some of the inflorescence axes produced flowers at all the nodes (Figs. 11, 12), some flowered only at basal nodes and some did not produce any flowers (Figs. 7, 8). There was no rachilla development, but some inflorescences showed small branches with flower buds at the basal nodes (Fig. 10). The inflorescences emerged with 4–15 flowers. The flowers were normal and produced parthenocarpic fruits. Some of the pollinated ones produced normal fruits with seeds.

Terminal inflorescences were induced to form on date palm seedlings *in vitro*, when cultures were supplemented with indole acetic acid (IAA), benzyl aminopurine (BAP) and sucrose (Ammar et al. 1987). The same growth regulators (IAA and BAP) and sucrose did not induce floral bud formation in plantlets induced via embryogenesis in callus cultures (personal observations). Among the date palm plantlets produced in culture, 0.1% produced flowers (Fig. 13). Some of the *in vitro* flowered plantlets were hapaxanthic (Figs. 14, 15). A few plantlets produced terminal inflorescences and some with axillary shoots terminated in inflorescences. After producing flowers the plantlets lived for a month or two and then died.

Discussion

Hapaxanthic axillary shoots (HAS) were observed as a common phenomenon among seedlings and tissue culture derived palms growing under regularly irrigated soil conditions. None of the plants that we observed produced this type of shoot during the reproductive phase. Occurrence of HAS during the juvenile stage in both tissue cultured and seedling palms indicated that it is highly related to the juvenile stage. Each palm produced one or two such shoots during the second or third year of the vegetative growth. HAS were rare among the palms developed from the offshoots.

The developmental pattern of HAS was similar to the development of terminal inflorescences in banana. After one year of vegetative growth, the number of leaflets per leaf diminished, and the leaflets finally became cataphylls (without leaflets). Later the meristem terminated in an infloresence without bracts or rachillae. Since the earlier growth was similar to the normal offshoot growth, it is clear that the shoot meristem later converted into a floral meristem. This developmental pattern was also confirmed by the plantlets growing in culture showing the similar HAS phenomenon. Our present study confirmed that HAS production occurs not only in tissue culture plants but also in seedling palms. These shoots died after the development of terminal inflorescences without affecting the growth of the mother plant. Further detailed study is needed to find out the real cause of the development of hapaxanthic axillary shoots in date palm.

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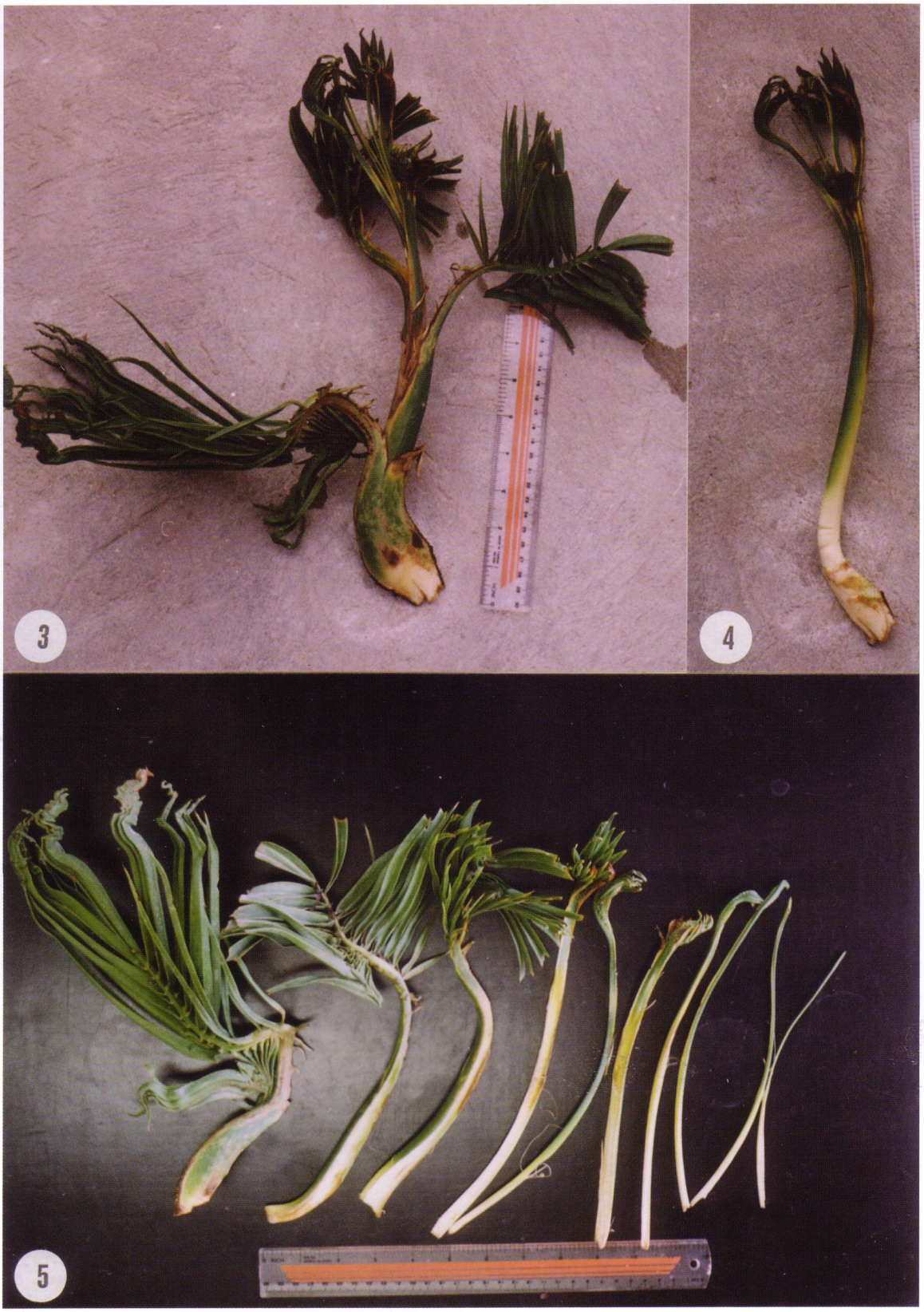
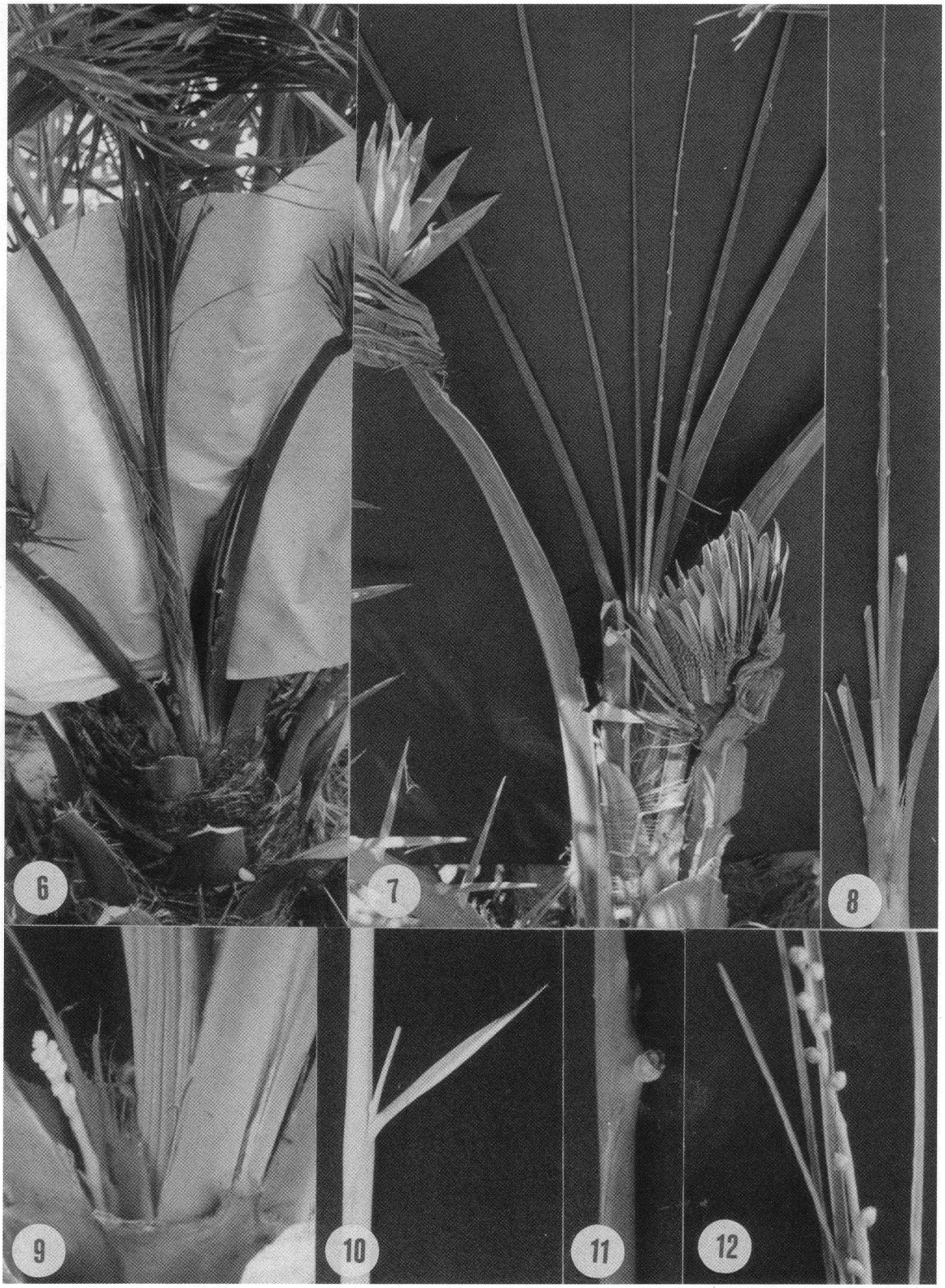
Table 1. Different date palm cultivars and percentage of hapaxanthic axillary shoots (HAS).

Cultivar	No. of plants observed	No. of plants with HAS	% of plants with HAS
'Maktoomi'	30	27	90
'Nebut-seif'	30	24	80
'Barhi'	20	12	60
'Shesi'	20	20	100
'Munifi'	12	8	66.7
Seedling palms	170	78	45.9

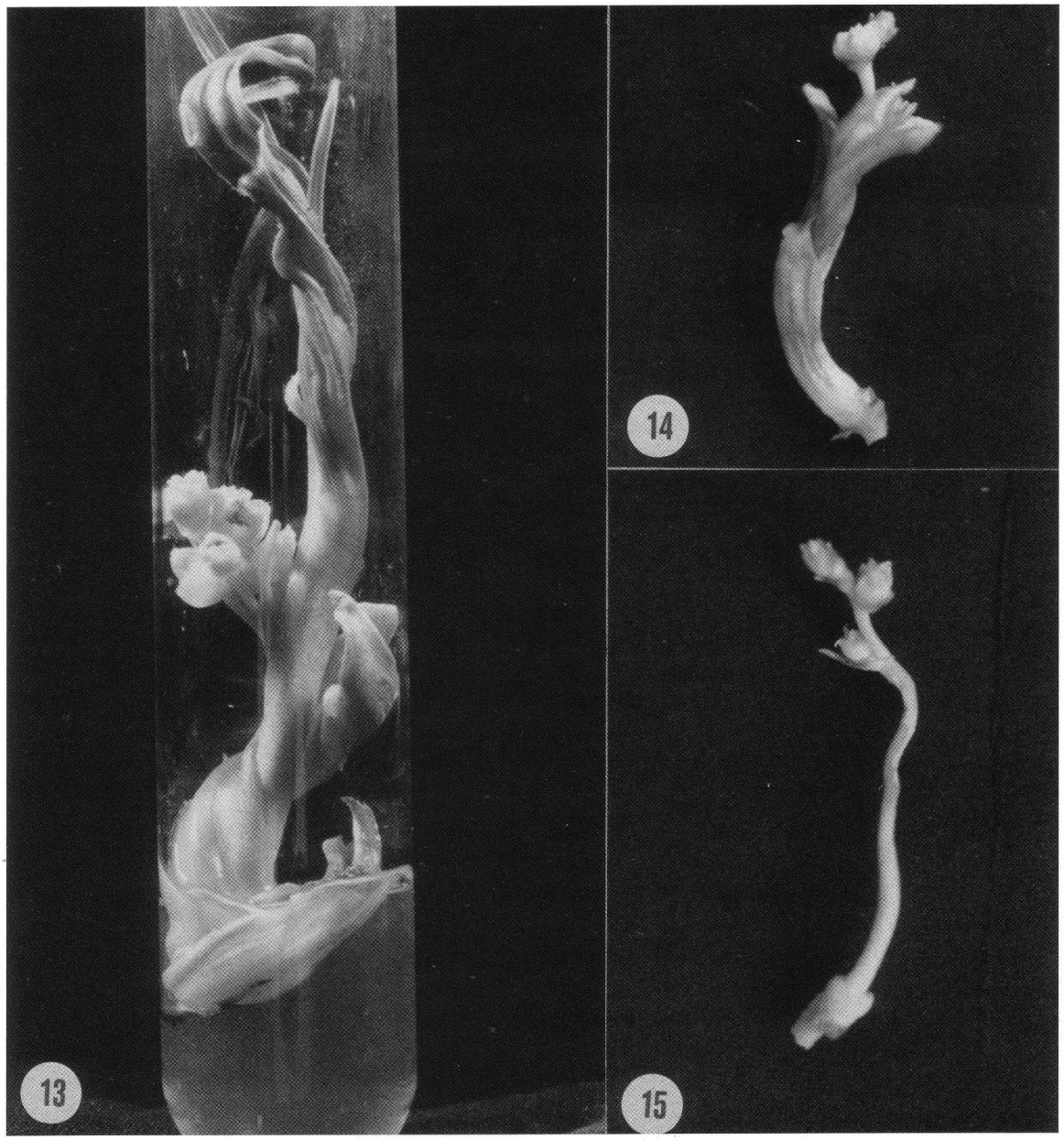
1. Tissue culture date palm showing hapaxanthic axillary shoot. 2. Hapaxanthic axillary shoot showing inflorescence produced at the basal leaf axil.



3. Isolated hapaxanthic axillary shoot. 4. Partly dissected out hapaxanthic shoot. 5. Dissected out leaves.



6. Seedling date palm with hapaxanthic axillary shoot. 7. Hapaxanthic axillary shoot with terminal inflorescence. 8. Dissected out shoot with terminal inflorescence. 9. Hapaxanthic axillary shoot with inflorescence at its basal leaf axil. 10. Inflorescence axis scale leaf and a small inflorescence branch with flower bud. 11. Inflorescence axis showing female flower at its basal swollen node. 12. Terminal inflorescence with flowers.



13. Date palm plantlet showing normal inflorescence produced in culture. 14. *In vitro* grown plantlet with terminal inflorescence. 15. Dissected out *in vitro* plantlet showing terminal inflorescence with flowers.

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