Large scale micropagation of date palm: The Moroccan experience

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Summary. The lack of rapid, large scale clonal propagation of commercially valuable date palm cultivars is one of the biggest obstacles to the expansion of this crop species in many date growing régions of the world. In Morocco, reviving the oases by extensive replantation of date palms with disease résistant and high quality producing plants is the only way to restore, expand and revitalise the ecosystems devastated by the Bayoud disease. Tissue culture is an idéal alternative with which to propagate date palm where the other techniques available such as through offshoots are inadéquate or limited. The commercial laboratory El Bassatine (Domaines Agricoles) plays a key role within the National Date Palm Program, by providing farmers with thousands of "elite" date palm plants obtained *in vitro*. This communication présents the role of Domaine El Bassatine Laboratory in the development of the oasis ecoystems and describes the technology developed over the years for the propagation of selected date palm cultivars. The current strategy and future prospects of date palm development are discussed.

Key words : Morocco, Date palm, Oasis, Clonal propagation, *In vitro*

Botanical descriptions of date palm

The date palm (*Phoenix dactylifera* L.) is a woody perennial monocotyledonous species. It belongs to the family Arecaceae which is composed of about 200 genera and includes more than 2,500 species (Moore, 1973). There are 11 other species in *Phoenix* genus, some of which are widely used as ornamental plants.

The date palm, like other species of *Phoenix* genus, is dioecious with male and female flowers produced on separate palms. It is also polycarpic, heterozygous and diploid. The trunk consists of cortical layers arranged in a helical pattern with dispersed numerous bundles and fibres. The stem terminates in a single shoot tip that gives rise to alternating leaves with encircling sheath tissue.

Along the trunk, the buds are generally inhibited by a very strong apical dominance, but some of them may grow and give aerial offshoots up to several meters above ground level. Inflorescences consist of numerous sessile flowers. The inflorescence originates from the axils of leaves on top of the tree. As many as eight to ten inflorescences may be produced at any one time by the same tree, giving bunches of fruit.

The fruits of date palm "dates" are berries each containing a single embryo. The date is made up of a chunky mesocarp protected by a thin pericarp. The endocarp is a very thin membrane covering the seed. The latter is elongated with a characteristic ventral line and an embryo situated in a dorsal position. The flesh of dates ranges in texture from a very soft to hard consistencies.

Date palms in Morocco

The main areas of date palm production in Morocco are situated in the southern part of the country in 11 provinces: Figuig, Errachidia, Ouarzazate, Tata, Tiznit, Guelmim, Tan Tan, Laayoun, Smara, Boujdour and Oued Eddahab. These zones cover an area of 471,000 km2

(Anon, 1986). The average production per annum is estimated at 72,000 tonnes from approximately 4.2 million trees (Anon, 1986).

The major date palm groves are aligned from East to West, in the southern part of the High Atlas mountains. The only palm grove situated in the North Atlas is located at Marrakech thus giving it some special characteristics and particular significance. It is isolated, well away from the nearest date palm production zone at Draa Valley, separated from it by the high Atlas Mountains. Although most of the commercial varieties from the Draa Valley do not mature when grown at Marrakech, this zone constitutes a significant site for germplasm collection away from the main areas devastated by the Bayoud disease.

Table 1: Distribution of date palm trees in different zones in south Morocco

Regions	Number of trees
Ouarzazate	1 800 000
Errachidia	1 200 000
Tata	850 000
Tiznit	141 600
Guelmim	135 500
Figuig	120 000
Other	3 100
Total	4 250 200

The total population in these zones is above two millions relying on agriculture for 80% of their subsistence (Sabbari, 1989). The date is a major currency exchange for other indispensable products not provided by the oasis systems. In the Draa Valley, date palm production ensures two thirds of the date growers' income (Anon, 1986).

In addition to their economic value, date palm trees have been recognised in Morocco as playing a major role in creating oasis microecosystems and in providing shade under which other crops can grow. When the balance of this ecosystem based on date palm is disrupted by the disappearance of trees, the process of desertification takes over rapidly and fertile garden areas are irretrievably lost.

The Bayoud disease problem, consequences and control

This vascular wilt disease is caused by a soil-borne fungus, Fusarium oxysporum f.sp. Albedinis (Malencon, 1950). It is without doubt the most serious and lethal disease of date palm in Morocco.

At the beginning of the century, Morocco was in third position in the world rankings for numbers of palms at more than 15 million trees (Anon, 1986). Today, only 4.2 million are left (Sabbari, 1989) because of the devastation of the Bayoud disease. The most valuable varieties were the most affected. "Mejhoul" for example, considered as one of the best varieties in the world, the fruit of which used to be exported to London markets in the 18th century (Anon, 1986) is today on the verge of extinction. It appears that all the most highly considered date palm varieties show some degree of susceptibility to Bayoud (Saaidi, 1992).

The devastation of date palms by Bayoud has considerable negative impacts at the economical, ecological and social levels. The progressive disappearance of high quality varieties in favour of seedlings (variously known "Sairs" or "Khalts") with less commercial value, affects directly the farmers' incomes, and one of the first social consequences is the accentuation of the problem of rural emigration.

The chemical control of Bayoud using general soil fumigation although efficient in certain conditions and in a small scale (Djerbi, 1988) can not be used as a general method for many reasons. First it is not practical since the areas to treat are enormous and it is not guaranteed to eradicate permanently and totally all the fungus population because spores can be found up to 1m depth (Saaidi et al., 1981). The possibility of reinfestation, even after treatment, is also very likely because the fungus can be spread in several ways, e.g. via soil, water, unaffected date tissues or by symptomless carriers such as henna (Lawsonia inermis l.) and alfalfa (Medicago sativa L.). Most of all, the chemical that was found to be efficient (methyl bromide) is extremely toxic, being dangerous for both the user and the fragile ecosystems of oases. To tackle the problem and rehabilitate the date palm groves, a national program was established by the ministry of agriculture involving a research institution, extension bodies and a commercial laboratory.

The national program for the development of date palm groves

This program was initiated by the Ministry of Agriculture in the early eighties. It involves institutions working on date palm such as the National Research Institute (INRA-Morocco) in charge of all aspects of research. Extension services based in date cultivation areas of the country (pour inclure également les DPA et les inspections de Protection des végétaux qui se trouvent hors Errachidia et ouarzazate), and a commercial laboratory belonging to the Domaines Agricoles.

The date palm program set up in Morocco has as a high priority: the selection of resistance or tolerance to bayoud in varieties with a high quality fruits. One of the main problems encountered in this program is the question of whether or not the plantlets obtained through tissue culture are true-to-type.

The selected plant material needs to be propagated and the choice of tissue culture is the only option because the traditional means of multiplication are inadequate as described below.

Propagation of date palms

Conventional practices (seeds, offshoots)

Sexual propagation is the most convenient method by which to propagate date palm: seeds can be stored for years, they germinate easily and are available in large numbers. However, this method can not be used commercially for propagating the cultivars of interest in a true-to-type manner for several reasons. The most obvious is the heterozygous characteristics of seedlings which are related to the dioecious nature of the date palm: half of the progeny are generally male, which produce no fruits, and large variations in phenotype can occur in progeny. Another important drawback of seed propagation is that the growth of the seedlings is very slow. For all of these reasons, propagation by seed is not practised by the growers and is used only in exceptional cases when supplies of offshoots are unavailable. Seedlings, however, provide essential materials for breeders in their attempts to develop new superior cultivars with agronomically interesting traits.

The offshoots have been used for vegetative propagation of the best varieties with a high commercial value. These offshoots are produced from axillary buds situated on the base of the trunk during the juvenile life of the palm. The use of offshoots to propagate date palm has all the advantages of vegetative propagation but it also has a number of limitations; offshoots develop slowly, their numbers are limited and are produced only within a certain period in the mother palm's life. Offshoots have to be large enough to survive when transplanted in the field, a process of regeneration that can take years. The limited number of trees available in the case of high quality date palm varieties escalates the costs of offshoots.

Tissue culture potential

Due to the limitations of the offshoot system, there is a need for a more efficient vegetative propagation. Application of tissue culture techniques presents one of the best opportunities. Date palms are now propagated by several laboratories and there are two main routes of propagation:

- Somatic embryogenesis: this technique is based upon the formation of a callus that will evolve into nodular structure which will "germinate" as somatic embryos giving rise to complete plants.
- Organogenesis is exploring the potential of the base of young leaves on the heart of an offshoot to give buds. The buds are multiplied and then will evolve depending on the media to give complete plants.

In our micropropagation program, it is of paramount importance to produce true-to-type planting material, somaclonal variation of any kind is undesirable, especially for clones that where selected over so many years by the National Research Institute (INRA-Morocco). For this reason, In Morocco, the choice was given to the organogenesis technique because theoretically it shows good chances of avoiding somaclonal variations and therefore having true-to-type plantlets.

Description of the technique used by the Domaines Agricoles

Offshoots are selected from healthy mother plants and collected carefully avoiding any damage to the apical dome.
After surface sterilisation, the explants will go trough different phases of development known as buds initiation, multiplication, elongation and rooting (Fig.1). Once the plants are fully rooted they are taken to a greenhouse where temperature and humidity are controlled for the acclimatization phase.

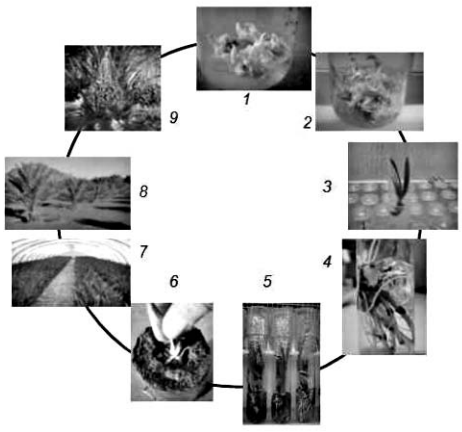

Figure 1: Summary of the steps involved in date palm tissue culture

Hundred thousands of plants have been obtained through this technique from a series of date palm varieties and selected clones (selected by INRA-Morocco). The plants are distributed to farmers by the extension services of the Ministry of Agriculture within the framework of the national program.

The choice made by INRA to propagate date palm by tissue culture using organogenesis, followed after by our laboratory in an agreement framework, was shown to be a good strategy.

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