Cultivation of Phoenix dactylifera L. (Date Palm) for Combating Desertification and Enhanced Livelihood: Nacgrab R and D Focus.

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Abstract

Nigeria is a country, with diverse landscapes and climatic conditions that result in a corresponding high diversity of biological niches harbouring many plant species. The country is equally endowed with several ecological zones, having on its far south mangrove/swamp while the far north is defined by its almost desert-like climate. Most of the states in this axis are Jigawa, Bornu, Kebbi, Yobe, Sokoto, Katsina and Zamfara. The vegetation cover of these areas is mostly Sudan savannah and Sahel savannah and the desert encroachment in these front line states is so fast and growing at an alarming rate. The resultant effect of this has been mass displacement of inhabitants, farms and their animals thus inflicting hardship and poverty. Meanwhile, studies has shown that few tree crops do relatively well in these areas and one of them identified is Phoenix dactylifera (Date palm). Date palm has high nutritive and commercial value and as well play an important role in the ecology of various desert and semi-desert environments. Date palm, which is an irreplaceable tree in irrigable desert lands, provides protection to under-crops from the harshness of the climate (heat, wind and even cold weather), reduces damage caused by sand storms and wind erosion. It is therefore noted with keen research interest that despite the huge potentials of the Date fruit the availability of planting materials has been the major challenges of the

cultivation and production of this very important desert crop due to the heterozygous and dioecious nature of the plant. The National Centre for Genetic Resources and Biotechnology (NACGRAB) – the national focal point on genetic resources conservation and utilization – in one of her recent germplasm exploration and collection exercises in the affected front line states, is collecting several accessions of Dates which could be subjected to in-vitro propagation techniques using shoot tips and embryos in a modified Murashige and Skoog medium containing adenine, naphthalene acetic acid (NAA) and activated charcoal. The generated plantlets could be sub-cultured into a liquid multiplication media using the Temporary Immersion Bioreactor systems (TIBs). The resultant products are expected to have higher multiplication quotient than when the conventional solid multiplication media is used, thereby increasing the availability of planting materials for Date palm estate establishment in Northern Nigeria.

Keywords: Phoenix dactylifera L, Germplasm, In-vitro, TIBs.

Fig. I

Introduction

Nigeria is situated in the West African coast with a land mass of 923, 768 Sq.Km which is characterised with diverse landscapes and climatic conditions that result in a corresponding high diversity of biological niches harbouring many plant species. Out of this, 600 meters of the arable Landmass is loss yearly to fast desert encroachment (www.thisdayonline.com, 26th Jan., 2009), especially, in the northern region which is characterised by the Sudan and Sahel savannah vegetation types, thus displacing the inhabitants, farms and their animals and thereby inflicting hardship and poverty, and eventual threat to the Country's food base. Recent studies has shown that few tree crops do relatively well in these areas and one of them identified is Phoenix dactylifera (Date palm).

Date palm, Phoenix dactylifera L. (Family: Palmaceae), is a monocotyledonous, dioecious palm, and is considered the most important fruit tree in many Arab countries, such as Saudi Arabia and Iraq (Badawy et. al., 2005). The Date palm is a very beautiful, elegant and tall palm. It slowly grows about 1 foot a year to a height of 80-100 feet and can live for more than 200 years. Only a female tree can produce dates. Usually it starts producing fruits after 5-8 years. The date fruit consists of 70 % carbohydrates (mostly sugars), making it one of the most nourishing natural foods available to man (FAO, 2002). The flesh of dates contains 60 to 65 % sugar, about 2.5 % fibre, 2 % protein and less than 2 % each of fat, minerals, and pectin substances. Date fruits are also a good source of iron, potassium and calcium, with a very low sodium and fat content thus making it good for anaemia treatment. In addition, moderate quantities of chlorine, phosphorous, copper, magnesium, silicon and sulphur are also found in the date fruit (FAO, 2002). Seeds may be ground for animal feed and the oil is used in soap and cosmetics. The Date

Fig. II

Fig. III

palm tree leaves are used for basketry and wickerwork. The leaves may be used for making huts while the leaves fibres may be made into nets. The trunk may be used for timber works as well as fuel. The trimmed fruit stalks are used as brooms. They are also used for making ropes and belts. The high tannin content of the fruit can also provide medicinal benefits to man, like laxative food and treatment of constipation.

The selenium in date fruit helps enhance the immune system and also lower the risk of cancer and heart diseases. The Date palm syrup and infusion is a good remedy for cough, fever, flu and bronchial catarrh. The roots of the Date palm are used to fight toothaches. Dates are a very good food source for babies. It is an effective medicine for diarrhoea and dysentery during teething time.

All the above enumerated minerals and benefits are the basic ingredients needed for the physical, mental and social development of man. In terms of commerce both national and international trade on Dates are very impressive, FAOSTAT 2002, reported that the world average export trade stands at US$258million as at year 2000 with countries in the middle east dominating the world market. In addition to the dates' high nutritive and commercial value it is also one of the main trees used for ornamental and landscape (Badawy et. al., 2005). The date palm could play an important role in the ecology of various desert and semi-desert environments. Date palm, which is an irreplaceable tree in irrigable desert lands, provides protection to under-crops from the harshness of the climate (heat, wind and even cold weather), reduces damage caused by sand storms and wind erosion.

Tissue culture is a technique mainly used for rapid propagation of several perennial fruit trees, including date palm (Dass, H.C et al., 1989). However, adequate availability of planting materials has been the major challenges of the cultivation and production of this very important desert crop in Nigeria. Plant in vitro regeneration is a biotechnological tool that offers a potential solution to this problem as it provides a means of putting the plants onto the market at lower prices.(Afolayan and Adebola, 2004). Problems of planting materials and propagation of date palm arise from the fact that the tree has a long life cycle (Ammar and Badeis, 1983), and that the number of off-shoots produced by them is limited to a certain period in the life of the tree (Barret, 1973). Also, the tree is dioecious and heterozygous. Abo EL-Nil(1986) and AL-Ghamdi (1993) The success of date palm cloning by tissue culture methods, based on organogenesis and somatic embryogenesis, has been investigated by many workers. Organogenesis in date palms has a low efficiency due to the low number of explants that form plantlets in-vitro, the long time required for the initiation phase, the low multiplication rate and the strong influence of the variety (Poulain et al., 1979; Beauchesne, 1982). Somatic embryogenesis has been obtained from shoot tips which were excised from off shoots, Tisserat (1979 and 1982), Sharma et al. (1984, 1986 and 1991), Zaid and Tisserat (1983), Mattar (1986a), Daguin and Letouze (1988),

Diwaker et al. (1998), Djamila and Bougedoura (1988)], with the resulting embryo regenerating into plantlets Bekheet et al, 2000; Badawy et al. (2005).

To meet the increasing demand for date palms, it is necessary to complement the tissue culture techniques with Temporary Immersion Bioreactor system (TIBs) to enhance the commercial production of date palms seedlings.

Mass propagation of plants by tissue culture is laboured intensive and costly; this therefore calls for a need to advance on the technique. TIBs is the use of liquid medium for in vitro culture and it is a relatively recent micro propagation procedure that allows connotation increase of multiplication and automation quotient. It is an automated micro propagation process through the use of bio reactors which have been designed to provide maximum opportunities for monitoring and controlling environmental condition, immersion time, i.e. duration or frequency, which is the most critical parameter for system efficiency.

TIBs is comprised of two glass flasks of variable capacity, one for the growth of the explants and another as deposit of the culture media. These flasks are connected by silicone tubes by means of the connectors (either 'T', 'L' or straight/parallel). In the second connector of each flask similar tube is placed with a hydrophobic filter of 0.22 micron in the other end of these tubes, to guarantee the sterility of the air. In the internal part of each cover two tubes are also placed to one of the connectors, one that has as function to extract the culture media in both recipients. The means of circulation from a flask to another dependence on the opening or closing of the electro valves (solenoids), which

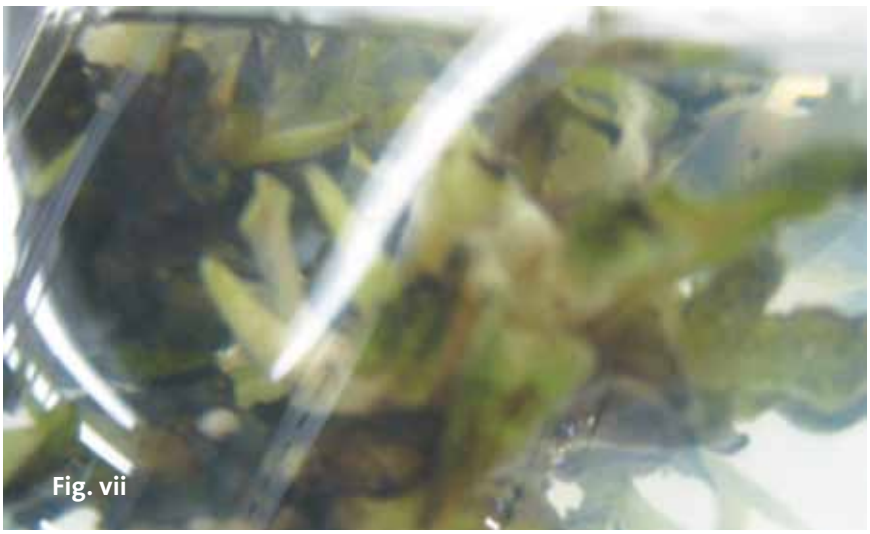

Fig. IV


Fig. V

are connected to a programmable timer to regulate the frequency and the duration of the immersion. The pressure of air is regulated by a gauge coupled to the air compressor, and also controlling its automatic ignition.

The plants are exposed to the liquid medium intermittently rather than continuously and as the plants are not always in contact with the medium, nutrients absorption and growth rate are thus stimulated, therefore it has greater feasibility of producing higher plantlets volume.

Temporary Immersion systems for plant micro-propagation can be described and grouped into 4



Figs. vi and vii show growing plantlets submerge in liquid medium.

categories according to operation: i) Establishment of the plant on a solid medium, machines, ii) partial immersion of plant material and renewal of nutrient medium, by gradual reduction of the agar concentration, iii) partial immersion on a liquid nutrient renewal mechanism, iv) complete immersion by pneumatic driven transfer of liquid medium and without nutrient medium renewal. It has also frequently been considered an ideal technique for mass production as it reduces production costs, followed by a reduction in shelving area requirement and the number of containers used; manual labour and facilitates changing the medium composition. Complete atmosphere renovation inside the recipient at regular intervals, which means there is no large accumulation of gases like "ethylene. Agitation due to air flow during the immersion phase, causes scattering of vegetative tissues

Plant material propagated by temporary immersion performs better during the acclimatization phase than material obtained on semi-solid or liquid media. Hyperhydricity, which seriously affects cultures in liquid medium, is eliminated with these culture systems or controlled by adjusting the immersion times, quite little immersion time, in which most of the tissues are covered with a film of media.

Figs. i- v TIBs shelve, showing the principal components, Timers, Bottles, and solenoids valves.

Thus, the aim of this study is to investigate how to complement the tissue culture techniques with the TIBs for commercial production of date palms seedlings for possible establishment of its estates in the front line states through participatory approach with the farmers and the communities.

Materials and methods

This study will be conducted at the Tissue Culture Lab of the National Centre for Genetic Resources and Biotechnology (NACGRAB) Ibadan, Nigeria. It will involve the collection of offshoot of date palm from across its geographic range.

Plant material

Two years old offshoots of Phoenix dactylifera will be carefully separated from their mother plants (female date palm) when they will be 60-80 cm tall, with 8-12 leaves and used as a source of explants. The shoot tip and axillary bud will be the explants to be used.

Preparation of explants

Sterilization and culturing of explants

In the laboratory, Offshoot leaves will be removed acropetally till the tender portion will be reached. It will be further trimmed to completely remove the woody tissues and keep the succulent shoot – tip intact. The tips obtained will be kept in an anti-oxidant solution .The date palm shoot

tips (1-2 cm long, with a diameter of approximately 0.5-1.0 cm), including the apical meristem will be excised and cut into 4. The explants (the tips and axillary buds) will be washed with liquid detergent under running tap water, and then it will be surface sterilized by immersing in 70% Ethanol for 5minutes and in a solution of sodium hypochlorite (20% V/V) containing few drops of Tween 20 for 20 minutes. This will be followed with rinsing thrice in sterile distil water. Then, using a simple microscope under a lamina flow hood, the young leaflets and part of the core's tissue will be removed gradually till reaching the top bud and will be inoculated on a Murashige and Skoog (1962) medium (MS).

Culture media

The initiation media consist of MS medium containing 100 mg /l 2, 4-D + 3mg /l 2ip. The pH of the medium will be adjusted to 5.7 before the addition of agar. The culture medium will be distributed into culture jars (150 ml), each containing 25ml of the prepared medium. The jars will be covered and autoclaved at121 ° C under a pressure of 0.15 psi for 20 minutes. The shoot tips and axillary buds (explants) will be inoculated for a period of 18 weeks to obtained callus formation, as reported by (Badawy et. al., 2005). The callus obtained will be transferred into a medium without hormones and activated charcoal to enhance embryo production and development. Tisserat (1979), using sucrose concentration of 30 g/l, and incubating the explants on the culture medium for 24weeks for the formation of somatic embryo and subsequently plantlets regeneration from the embryogenic callus (Bekheet et. al., 2000). These developed shoot and buds will then be transferred into TIBs in a liquid medium under a control condition for further multiplication.

The shoots will be regenerated and rooted on a cultured medium containing 40 g sucrose/l, 9 g/l charcoal (AC) and 1.5 mg/l of NAA for a period of 18 weeks. The rooting of date palm was favourably influenced by the presence of activated with increase in the number of roots and root length.

Acclimatization and Establishment.

The rooted plantlets will be acclimatized under the green house condition. The plantlets will be rinsed in water in water to remove the adhering agar. These will be planted in prepared moist soil medium consisting of sterile peat and vermiculite mixture in small perforated polythene bags. These will be transfer to the humidity chamber for hardening. The hardened plants will be transfer to the nursery for some weeks before establishment on the field.

Expected results and Conclusion

Availability of planting materials usually faced by the farmers in the adjoining communities in the front line states.

The farmers will also be trained in the seedlings handling, plantation establishment, sustainable fruits harvesting and marketing thereby addressing both the desertification menace and poverty alleviation

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