

Through Biotechnology...

Overcoming complexities in coconut improvement

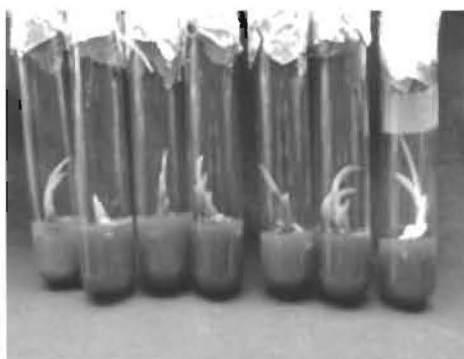
Given the long duration and heterozygous nature of coconut palm, application of traditional breeding techniques are cumbersome and time consuming in coconut. There exists a tremendous potential for utilization of biotechnological tools for improvement of coconut especially in the areas of embryo culture for safe germplasm exchange, cryopreservation for conservation of germplasm and molecular markers for diversity studies and hybrid authentication.

BEING a long duration palm with large phenotypic diversity, low multiplication rate, highly heterozygous nature and lack of vegetative propagation, biotechnological tools can contribute significantly in overcoming complexities associated with coconut breeding.

BIOTECHNOLOGICAL ACHIEVEMENTS

Embryo Culture

In coconut, production of planting material for propagation is solely through seed nuts. The size of the seed nut, short dormancy period, presence of water in nut, stringent phytosanitary requirements, increased risk of pests and diseases and high cost for transportation are some of the major constraints faced during collection, transport and storage of coconut germplasm as seed nuts. The collection and transportation of coconut germplasm through embryos, instead of seed nuts, is recommended by FAO/IPGRI as it is safe, cheap and effective. The coconut embryo culture protocol developed at CPCRI, Kasaragod, has been instrumental in introduction of exotic germplasm (45 accessions from eight countries) into the country. The protocol also finds use for embryo



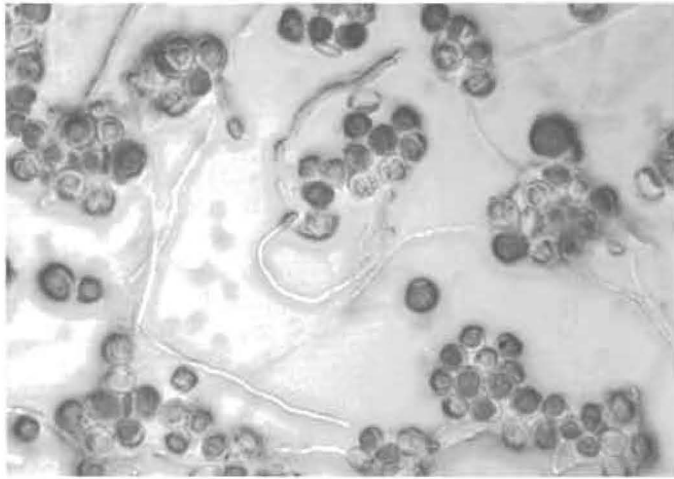
rescue in coconut with special traits like coconut with sweet kernel, horned coconut and *Makapuno* type of coconut, which do not germinate naturally, for collection of rare germplasm, as well as for developing cryopreservation techniques utilizing coconut zygotic embryos.

Cryopreservation

The popular mode of conservation of coconut genetic diversity is through establishment of field gene banks. A complementary conservation strategy, which involves a combination of diverse approaches, has been envisaged for safe and effective conservation of entire gene pool of coconut. Cryopreservation of coconut zygotic embryos and pollen has been successfully employed as an adjunct technique for long-term conservation of coconut germplasm, thereby shielding valuable genetic resources from biotic and abiotic



Embryo rescue of sweet kernelled genotypes



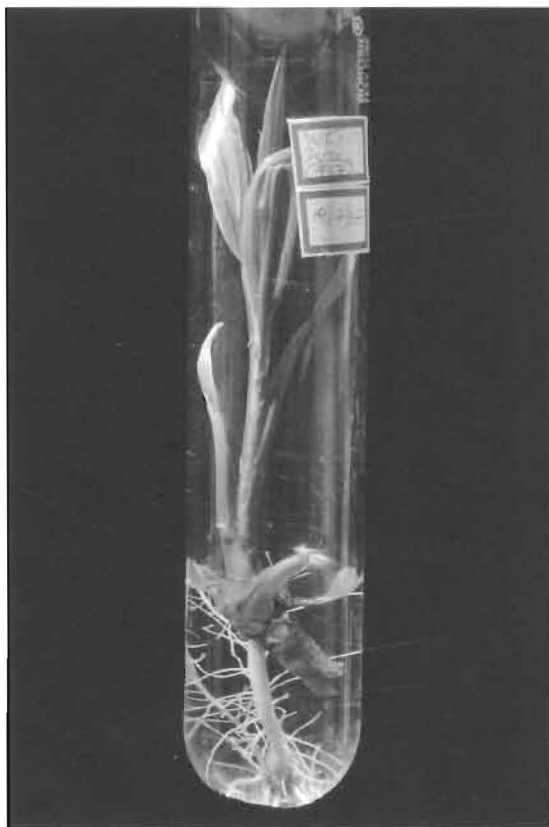
Germination of cryopreserved coconut pollen

threats. For pollen, its collection, processing and storage in liquid nitrogen have been assessed and found to be successful in terms of pollen viability and fecundity for long term storage upto a period of eight years of study, which substantiates its efficacy in long term conservation. An interesting field for future research will be the application of cryopreservation in somatic embryogenic cell cultures. The successful preservation of such cultures would enable the production of many more coconut plants from one initial explant as well as providing a new way to transfer germplasm around the globe.

***In vitro* culture**

One of the major constraints in coconut productivity

is the production and distribution of homogeneous quality planting material to farmers. The present annual production of coconut seedlings, through conventional techniques, is unable to meet the annual requirement of quality planting materials. Rapid multiplication of coconut through *in vitro* techniques, therefore, is vital. However, coconut has remained highly recalcitrant to *in vitro* interventions. Plumular regions are juvenile tissues which have responded best to *in vitro* culture. The *in vitro* regeneration protocol from plumular explants has been improvised using shoot meristematic tissues excised directly from the fresh embryo. Early callus induction and significantly greater embryogenic potential and subsequent plantlet development has been achieved (12 somatic embryos/plumular tissues on an average). Even though plantlets have been regenerated and successfully established in the field, a large-scale clonal propagation of coconut is yet to be accomplished with conversion of somatic embryos into plantlets remaining one of the major bottlenecks. It is necessary to consider and then employ procedures that are successfully used for other species to help drive future improvements in coconut *in vitro* culture. The literature suggests that it may be possible to generate highly efficient embryogenic cell suspension cultures, derived from selected callus lines, to help overcome contemporary challenges, and to develop a rapid clonal propagation system for coconut. Therefore, future research should be focused on an optimization of *in vitro* conditions to increase the production of somatic embryos using media additives and a cell suspension culture system. Subsequent development and



Normal plantlet growth after cryopreservation of zygotic embryos



Plantlets derived from somatic embryos

acclimatization could be further improved using temporary immersion systems.

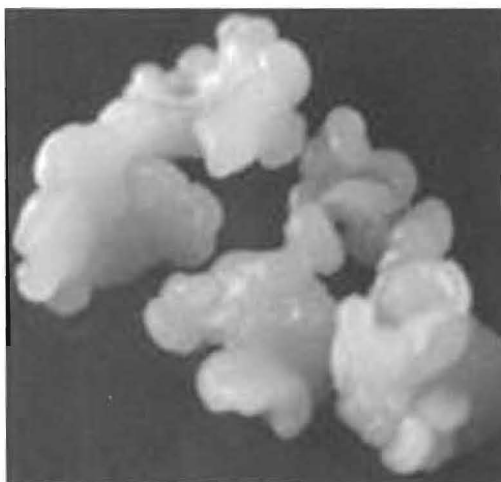
Molecular Markers

The use of molecular marker may improve breeding efficiency in different ways: germplasm characterization and management, linkage mapping and identification of quantitative trait loci (QTL) markers for marker-assisted selection (MAS). Origin of coconut palm had remained an enigma for many decades. Molecular marker studies have unequivocally provided evidences for two independent origins of coconut, in Pacific and Indian Ocean basins.

Studies, utilizing molecular markers, have revealed genetic distinctiveness of tall and dwarf coconut accessions, which is mainly due to the differences in their breeding behaviours: the autogamous dwarf coconut accessions display less phenotypic diversity and genetic diversity in contrast to allogamous tall.

Molecular Markers for Desirable Traits

Markers associated with important traits can increase the breeding efficiency and save time in a perennial crop like coconut. Molecular markers have been identified for differentiating tall (T) and dwarf (D) cultivars of coconut. These markers have also been utilized for confirming the hybridity of D × T hybrids



Embryogenic callus obtained from plumular explants of coconut

which will ensure supply of genuine hybrids to farmers. Selected alleles of SSR or RAPD markers have been associated with resistance to eriophyid mite and lethal yellowing disease which would allow for selection of these traits in the seedling stage itself. QTL mapping of important traits such as early flowering, yield, fruit components and composition of cuticular wax have been identified so far. Strong QTLs and saturation of coconut linkage map with an additional set of markers can increase the breeding efficiency of coconut for the traits of interest.

SUMMARY

By implementing the latest biotechnological techniques, there is immense potential of development of new useful coconut varieties with the available diverse germplasm to overcome problems like reducing time needed for developing a new variety. A combination of classical breeding methods with modern techniques will lead to the rapid improvement which is required to supply material for urgent replanting programmes.

For further interaction, please write to:

Drs Anitha Karun and M K Rajesh (Scientists), Dr P Chowdappa (Director), CPCRI, Kasaragod 671 124.

Attention Readers

The ICAR brings out a number of publications on Agriculture, Animal Husbandry, Horticulture, Fisheries and its allied subjects. To project its publications among students, research scholars, extension workers, scientists and faculty members, the Business Unit of the Directorate of Knowledge Management in Agriculture (DKMA) of the ICAR arranges Book Exhibitions in the campuses of the Agricultural Universities.

If you want to hold a Book Exhibition, you may send your request through your Department Head/Dean to the Business Manager of the ICAR, preferably 1 month in advance, so that a good Book Exhibition could be arranged in time. The students can avail a handsome discount on the ICAR publications including journals.

For further details, contact:

Business Manager

Directorate of Knowledge Management in Agriculture

Indian Council of Agricultural Research

Krishi Anusandhan Bhavan, Pusa, New Delhi 110 012