Methodologies for Safe Movement of Highly Perishable Plant Germplasm during International Exchange

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Occurrence of outstandingly rich diversity of wild relatives, landraces and primitive cultivars of cultivated plants in their centers of origin has led to global interdependence of countries for germplasm to sustain the present day crop improvement programs. This has led to transport of diverse plant materials, primarily primitive forms and released varieties or cultivars across international borders. This introduction and exchange of plant germplasm on a worldwide basis has led to development of well-defined procedures for import and export because unregulated germplasm exchange activity may result in introduction of weeds, insects, nematodes and pathogens exotic to the country and harmful to its agriculture.

Seeds, vegetative propagules and whole plants have been transported across international borders since times immemorial. However, maintenance of viability of material, especially highly perishable non-orthodox seeds and vegetative propagules has been a formidable task as considerable time is taken during transit and also during quarantine inspection and clearance. Use of *in vitro* techniques has improved the phytosanitary aspects of plant introductions as it has a built-in capacity for early detection of pests and pathogens. This feature is the biggest advantage of this procedure for supply compared to field propagated material.

Several economically important tree species produce non-orthodox seeds, which are large in size and perishable due to high moisture contents. In addition, they are short-lived; longevity in some cases is as short as 7-10 days. Short distance transport of such seeds can be accomplished by mixing the seeds with saw dust, charcoal powder or sand and sending the consignment through air mail or courier but these additives are not permitted across international borders. In addition, international exchange of such seeds pose problems due to big seed size, incidence of pathogen contamination, precocious germination and loss of viability during transit, which can take few days to few weeks to reach the destination through proper channel. Valuable genetic stocks of such species can be safely transported using *in vitro* cultures of seeds, embryos and embryonic axes as has been shown in cassava (*Manihot esculenta*) seedlings for transport from Columbia to Nigeria (Guevara *et al.*, 1998) and coconut for transport of germplasm collected during explorations from Mauritius, Madagascar and Seychelles to India (Kumaran *et al.*, 1998). In coconut, there are problems and constraints for exchange of germplasm because of occurrence of diseases in coconut growing areas. In some cases viz. lethal yellowing disease, the symptoms need one year to express. Hence, embryo culture in sterile conditions needs to be maintained for one year before releasing or exporting the material to a country free of this disease (Assy Bah and Engelmann, 1993). *In vitro* method thus ensures minimum phytosanitary risks, high rate of seedling establishment and avoidance of seed borne diseases.

Propagules of vegetatively propagated crops such as cuttings, bulbs, suckers and tubers are again highly perishable, bulky and are difficult to transport over long distances. Moreover, transport of such bulky material is limited due to space requirement. Regeneration capacity of such propagules may be adversely affected during transit over long distances. Axillary and apical meristems, dormant buds (in case of temperate crops) cultured *in vitro* and proliferating shoot cultures can be considered for transport of such crops maintaining high survival rates and minimum space requirement. In addition, the germplasm can be supplied irrespective of the season and without waiting for availability of regenerative propagules thus facilitating quick and easy distribution of germplasm. *In vitro* regenerated storage organs like tubers, bulbs and rhizomes can also be used for international distribution of germplasm (Agarwal, 2003). Alginate encapsulated somatic embryos (synseeds), buds, bulbs or meristems which can develop into plantlets can also be used for exchange of tissue cultured plants (Rao *et al.*, 2000). *In vitro* cultured nodal cuttings of yams are frequently used for its transport worldwide (Malaurie *et al.*, 1998).

Pollen grains form another alternative for international exchange of germplasm since they are generally free from pathogens (Hoekstra, 1995). No fungal or bacterial diseases have been reported to be transmitted through pollen exchanges (Shivanna,and Rangaswany, 1992) hence they are subjected to less stringent quarantine restrictions. The binucleate pollen which has considerably longer life span compared to trinucleate pollen, can be transported to long distances without loss of viability. Their viability has been extended to as long as 10-14 years (Shivanna,and Rangaswany, 1992). Large amount of pollen can be transported packed in small vials and directly used for breeding at different locations.

Hence germplasm can be transported across international borders in the form of *in vitro* cultures of seeds, embryos, embryonic axes, apical and axillary meristems, dormant buds, proliferating shoot cultures or encapsulated propagules as well as in the form of pollen grains maintaining minimum phytosanitary risks, space economy and high regeneration values.

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The Exotic Shrubs and Trees in Indian Arid Regions

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The Indian deserts comprising mostly of arid regions are characterized by sandy plains more or less devoid of vegetation except in the rainy season where multitudes of ephemerals come up and transform the barren lands into green carpet. The perennial components of these habitats comprising of scrubby, xerophytic vegetation characterized chiefly by *Salvadora oleoides, Prosopis cineraria, Capparis decidua* and *Zizyphus* spp. occur in open clumps. The exotic *Acacia tortilis* and *Prosospis juliflora* introduced long ago have been naturalized and they now occupy a significant place in the ecology and economy of these deserts and its inhabitants respectively.

Efforts to systematically introduce useful genetic material of exotic perennials by the Station date back to almost four decades now (the Station was a part of the Plant Introduction Division, IARI, New Delhi). Since then a large number of accessions have been introduced (Bhandari *et al.*, 2000). Some of these successful introductions are bound to have significant role if introduced on a large scale.

The seed material after being received through the Germplasm Exchange Division, NBPGR, New Delhi is subjected to required/recommended pre-treatment and is sown in pots for raising saplings. The data on germination percentage and early vigor is recorded and the 3-4 month old sapling is transplanted in pits in the field at specified distance. Periodic data on morphological characters of plant habit, reproductive