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A novel and cost-effective hardening technology for tissue-cultured banana

Micropropagation of banana has attained industrial status and millions of plants are produced every year using this technology. However, acclimatization of tissue cultured plants is the most crucial step where 5-8% mortality is observed. Primary hardening is usually done in portrays and each tray can accommodate around 98 plants. This system of primary hardening not only allows higher mortality rate but it adds to cost of transportation and leave carbon foot print. We describe a cost-effective and less time consuming hardening technology of tissue-culture banana using polypropylene bags which are not only handy in operation and transport but they are cost effective and gives up to 98% survival during long distance transport.

A LARGE number of banana plantlets can be produced within a short period of time with *in-vitro* propagation as compared to the conventional methods which produce only 5-10 suckers in a year. The advantages of *in vitro* propagation include a high multiplication rate, physiological uniformity, and availability of disease-free material. In response to the rising demand for tissue-cultured banana plants, commercial enterprises have become increasingly interested in cultivating *in vitro* banana plants. Due to rising consumer demand for healthy, disease-free plantlets, tissue-culture technology is no longer restricted to research institutions. This technology is adopted by numerous commercial firms. During *in vitro* conditions, plantlets grow under special conditions in relatively airtight vessels where humidity is higher and irradiance is lower than in conventional culture. Microshoots, upon transfer to *ex vitro* conditions are exposed to abiotic stress (altered temperature, light intensity and humidity conditions) and biotic stress conditions, i.e. soil microflora. High mortality is observed (5-8%) upon transfer of microshoots to *ex vitro* conditions as the cultured plants have nonfunctional stomata, weak root system and poorly developed cuticle. The physiological and anatomical characteristics of micro-propagated plantlets necessitate that they should be gradually acclimatized to the environment of the greenhouse or field. Most commercial tissue culture laboratories are equipped with high end primary and secondary hardening facilities which enhances survival of tissue cultured plantlets. The time duration for primary and secondary hardening is around 90 days which requires high energy input and human resource to complete the hardening process in banana. Tissue cultured plants are hardened (primary) in portrays made of black plastic sheet and then they are transferred in polybags for second hardening. Each portray can contain maximum 90 plants. They are not flexible and transporting micro plants in portrays requires significantly high space which is expensive. Whereas polypropylene bags are flexible, light in weight and contains about 30 plants in 484 cm^2 area. Therefore an innovative, low cost technology for hardening of banana plantlets which can be completed in less time is need of the day.

Technology

Rooted tissue cultured plants of banana having 4-6 leaves were transferred in PP (22cm × 22 cm) bags filled with autoclaved cocopeat fortified with MS salt solution. The bags were sealed and maintained at 4,000 lux light at 25±5°C for 30 days. Each bag can accommodate 30 plants. Once the leaf start touching the top portion of bag, the bags were transferred to shade net house (75% shade) for 15 days. Five to six holes are made on top of bag for proper gaseous exchange. In 45 days, plants are ready for transfer to field directly. These bags can be transported directly by train to long distances. Hardening in PP bags improves physical attributes of plants such as plant height, number of leaves, shoot girth, leaf area, root numbers, biomass of plant, root and overall survival as compared to traditional system of pro-trays hardening. Plants acclimatized in PP bag require less energy input as optimal humidity is maintained inside the bag creating conducive micro-climate for growth of the plants. Long distance transportation of tissue cultured plants in pro-trays is cumbersome and requires large space which adds to transportation cost. Usually, portrays are transported through train or truck. The mortality rate in portrays ranges from 5-8%, whereas those in polypropylene bags range 2-3%. High mortality at primary hardening (5-8%) can increase cost of production. Polypropylene bags can

Hardening during *in vitro* stage (left) and under shade net condition (right)

Packing of hardened plants in carton boxes for long distance transport (left), hardened plants ready for transfer (right)

Treatment	Plant height (cm)	No. of leaves	Fresh wt. of plant (g)	Dry wt of plant (g)	Shoot diameter (mm)	Leaf area	No. of roots	Root length (cm)	Fresh wt of root (g)	Dry wt of root (g)	Plant survival (%)
Pro-trays	14.96 cm	4.00	2.83 g	0.89 g	5.09 mm	7.36	8.66	11.33 cm	2.01 g	0.127 g	95%
PP Bags	18.10 cm	5.30	3.60 g	0.89 g	7.40 mm	8.92	9.66	14.86 cm	1.75 g	0.170 g	98%
CD 5 %	1.743	0.925	NS	NS	2.051	1.314	NS	2.417	NS	NS	2.267

reduce cost of production in terms of higher survival as well as low transportation cost.

Polypropylene bags are autoclavable and can be utilized 5-6 times which reduces their cost. Polypropylene bags are transparent and air tight which helps in higher survival and better plant grafts.

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Tractor-operated raised-bed former-cum-planter for multiplier onions

A tractor-operated raised-bed former-cum- onion bulb planter has been developed for planting multiplier onions. The drive to the metering unit is derived from the ground wheel. A shoe-type furrow opener is fitted to the planting frame in front of onion bulb delivery tube. A funnel-shaped box was also fitted at the bottom of the seed delivery tube to prevent spillage of the onion bulb outside the furrow. This ensures an uninterrupted free-fall of the onion bulb from metering disc to furrow. The furrow opener assembly was mounted independent to the planter unit hence it can be positioned as required to ensure proper row spacing. The effective field capacity of the machine was 0.3 ha/h with field efficiency of 75%.

Source: ICAR Annual Report 2022-23