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A farmer friendly nursery technology for banana

Seed or planting material is an important input for agricultural production and productivity. In banana, 15-20% of the planting material requirement is fulfilled by the tissue culture technique. The rest is catered by naturally regenerated suckers, which is not sufficient to meet the increasing demand and also spread threatening diseases. Tissue cultured planting material for varieties other than Grand Naine is relatively expensive and not readily accessed by resource-poor farmers, who contribute to a greater proportion of banana production. Thus, a simple, inexpensive, and easily accessible nursery technology has been developed and disseminated to farmers/women SHGs for the multiplication of banana plantlets in their farm-gate. The technology also offers rural enterprise development opportunities in banana growing regions of the country.

BANANA is an important horticultural crop, which provides starchy food with nutraceuticals and livelihood for millions of rural people in India. India is the largest producer of banana, with 30 million tonnes per annum from an area of 0.80 million ha, contributing 20.1% to global production. It has been estimated that the local demand in the year 2050 is approximately 60 million tonnes per year. There is also a potential scope for international markets, which further enhances the demand which necessitates improving the production. The area under banana cultivation has remained stable from the year 2010 to 2020 even with various factors such as urbanization, climate change, threatening diseases, etc. Hence, enhancement of productivity can play an important role to fulfill the requirements. Tissue cultured planting material, better irrigation system, high-density planting, and nutrient management practices have been evident in the enhancement of productivity in cultivar Grand Naine. Similarly, for the adaption of improved practices in other cultivars, tissue-cultured planting material is essential. The availability of tissue-cultured planting material for varieties other than Grand Naine is crucial and expensive due to the low genetic ability of meristem multiplication in the tissue culture process. The meristem multiplication potential of bananas is cultivar-specific. Generally, a mother plant (an explant) can yield a minimum of 400 to 1600 plantlets, which are genetically uniform, since production and productivity depend on the genetic potential of the mother plant used. It has been observed that the cultivar Grand Naine showed variation in productivity and is justified as it depends on the mother plant used for the multiplication of plantlets. Hence, the small-scale industries prefer to import mother cultures from different sources.

Tissue cultured plants of banana cultivars other than Grand Naine did not reach all the banana-growing regions of the country due to various reasons particularly tissue culture process which requires specific weather conditions to acclimatize the plantlets. Moreover, the establishment of a tissue culture facility in a specific location with weather conditions of more than 37°C is not commercially feasible due to the consumption of high electric energy, survival of plants during acclimatization, planting in the canal irrigation system, etc. It has been reported that several small-scale establishments have not been successful due to poor management of recurring expenses, weather factors, low multiplication rate etc. However, most of the banana (Except Grand Naine) growing regions of the country have insufficient tissue culture industries and there was no availability of certified public/private nurseries to supply a certified planting material. Hence, the farmers in such regions usually depend on the natural regeneration of side suckers for the planting material requirement. At present, the side suckers are being transported from neighbouring fields or districts or states to meet the planting material

Uncertified suckers used as planting material


Poor quality fruits

Types of suckers

3-months old sword suckers

requirement. There is a high risk of spread of diseases through infected planting material, which starts showing symptoms from the fourth month onwards and eventual crop loss or poor-quality fruits. The production of disease-free planting material is one of the main strategies to manage the spread of threatening soil-borne diseases and enhance the productivity of the local varieties. Hence, it is necessary to multiply the banana plantlets in the farm gates, where bananas are being cultivated.

Macropropagation is a traditional plant propagation technique, which utilizes plant parts such as stem, leaves, tubers etc. to meet the demand of planting material. It is a relatively easy technique that is carried out in a shed or in the field. ICAR-National Research Centre for Banana has developed an improved nursery technology using macropropagation technique for local banana cultivars. This technology is being disseminated to rural areas to address the challenges in availability of affordable healthy planting material by the support received from Seed Division, Department of Science and Technology, Government of India and National Bank for Agriculture and Rural Development (NABARD). A field evaluation trial was conducted by the All India Coordinated Research Project centres, and the results showed that the plants propagated by this technique exhibited improved growth, and yield parameters compared to conventional sucker propagated plants. It is a simple technique that can be easily adopted by rural women and generate additional income besides offering rural enterprise development opportunities in banana-growing regions of the country.

Principle of the banana nursery technology

Apical dominance is a complicated fundamental phenomenon in plants, which determines the genetic makeup of a plant. The removal or incision of the apical dominance affects further development and simultaneously regulates lateral buds by suppressing the auxin synthesis and promoting cytokinin synthesis. Multiplication of plants from healthy suckers by removing the apical dominance has great scope to generate affordable number of lateral shoots and is being used as planting material. The technology includes, selection of healthy sword suckers, preparation of suckers, humidity tunnel establishment, grow bed preparation, decapitation of primary shoots, harvesting of plantlets and hardening.

Selection of superior mother suckers

Suckers contain a rich source of carbohydrates, which provide necessary nutrients to grow further. The growth and yield traits of a plant mainly depend on the genetic features of the suckers. It is very important to select superior mother suckers for the propagation of banana which should mainly be disease-free and high yielding. Banana develops two types of suckers viz. sword sucker and water sucker. Sword suckers appear close to the stem and produce leaves with a very narrow lamina. Water sucker produces broad leaves, poorly connected with the main stem is often structurally weak and may not be suitable for mass propagation of plants. At least three-month-old (1.5-2.0 kg), pest and disease-free sword suckers should be selected from the healthy mother plant. (Fig. 2)

Sucker preparation

In banana, every leaf base of a sucker consists of several lateral buds. This technique is based on the promotion of lateral buds as a plant. It is essential to facilitate the lateral buds to grow further for obtaining maximum numbers of plantlets and hence the leaf sheaths should be removed serially one by one carefully without any damage to the lateral buds. It is necessary to sterilize the surface of the suckers, since the soil may contain several non-beneficial microorganisms. The suckers should be washed in running tap water to

Decorticated suckers

Hot water treatment

Fungicide treatment

Apical dominance removed suckers

remove soil debris, followed by hot water treatment (60-65°C) for 2 minutes to ensure freeness from any pests. The suckers are allowed to cool for 20 minutes and the layers of dead cells were removed with a sharp knife up to the cortex region and the apical dominance should be removed completely. The suckers are then treated with antimicrobial chemical agents (Carbendazim/ Mancozeb, Cefotaxime/ Ampicillin) or biocontrol agents (arbuscular mycorrhiza fungi/ *Trichoderma viride/ Azospirillum/ Bacillus subtilis* etc.), to control microbial contamination. It has been observed that the suckers treated with Carbendazim (2% w/v) for 20 minutes were sufficient to control fungal contaminations.

Establishment of humidity tunnel

Most of the banana-growing regions in India reach a maximum of 42°C and relative humidity falls under 55%. This condition does not favour lateral buds induction as it immediately dehydrates the meristem region and hence, it is essential to maintain optimum temperature and humidity. Humidity tunnels main aim is to hold high humidity and provide optimum conditions for plant growth. The tunnel can be constructed using wooden (Damaged in short duration due to high humidity inside the tunnel) or Galvanized iron (GI) pipe frames and polythene sheets can be used as a cladding material. The GI pipe frames should be movable, as the land use pattern differs from time to time. It is also recommended to establish the humidity tunnel under a tree shade or a 90% shade net with sufficient aeration. The process requires minimum light. After the development of plantlets, optimum light condition is required. To maintain high humidity (>75%), it is recommended to construct a tunnel of small area coverage (20 feet Length × 10 feet Width × 6 feet Height) for the production of 1,000 to 2,000 numbers of plants (varietal specific). The tunnel must be closed all the time to maintain the humidity. If the inside temperature increases above 35°C, the tunnel may be opened for some time to reduce the temperature. Commercial-scale production requires more number of tunnels. This humidity tunnel can be extended for the use of other crops for seed germination and vegetative propagation practices.

Humidity tunnel

Grow bed preparation

Grow bed/Raised bed is a basic element for the propagation of banana plantlets, which works as a substrate, provides optimum moisture and aeration to the mother suckers. Two grow beds (18 feet length × 4 feet width × 1 foot height covered by hollow block stones/ wooden planks) can be accommodated in the humidity tunnel. Each bed can hold about 100 mother suckers. The

Grow beds

grow bed consists of two layers, the base layer, and the top layer. The base consists of farm soil (4-inch height) used to initiate the prepared mother suckers while the top layer (8-inch height) is used to cover the mother suckers. Different substrates can be used based on availability namely sawdust/coir dust/paddy husk etc. The role of the top layer is to hold moisture and provide optimum aeration to the mother suckers. The sawdust/paddy husk should be sterilized (by boiling) to avoid fungal contamination and plant growth can be improved by addition to the top layer, vermicompost/ *Trichoderma viride/ Bacillus subtilis/ Pseudomonas fluorescens/ Azospirillum* etc. could be used to improve the lateral bud formation, physiological growth of plants etc. to maintain the beds with rich moisture content. Weekly 3 to 4-times watering by a sprayer is needed, to maintain the beds with optimum moisture content.

Decapitation of primary shoots

After planting the suckers in the grow beds, from the 7th day onwards, 2-4 lateral buds called primary shoots will emerge. The primary shoots attain the three-leaf stage within 3- 4 weeks. Three leaf stage primary shoots should be decapitated above the leaf base and the meristem region should be disturbed by scooping, and the central portion of the stem should be partitioned into four parts. If the leaf base is removed during the decapitation, the mother sucker will not produce multiple shoots because every leaf base contains several lateral buds, which develop into plantlets. If the decapitation of shoots is not done properly, multiple shoot formations will not

Development of primary shoots

Decapitation of primary shoots

occur. The development of multiple shoots formation is based on the practice and genetic potential of the mother suckers. About 60 to 85% of the suckers produce multiple shoots by this technique in banana which varies depending on cultivars types and age of the suckers.

Sequential development of multiple plants (A to D)

Harvest of plantlets and hardening

Multiple shoots start within 10 days after decapitation of primary shoots. The plantlets with 2 to 3 leaves or 15 – 45 cm height, with adequate rooting, are the optimum stage for harvest. The mother suckers with multiple shoots should be plug out from the substrate and washed with tap water. The plantlets are easily detachable from the shoot clumps, as they are poorly connected with each other and the mother sucker. The plantlets with less number of roots require auxin treatment. The basal portion of the harvested shoots is dipped in a solution (2 minutes) containing Indole 3 butyric acid- a rooting hormone (10 mg/l). The commercial feasibility of the technique in some cultivars such as Poovan, Ney Poovan, Monthan, Red Banana necessitate the rooting hormone treatment. Usually, the rooting hormone treatment enhances lateral root induction immediately in bananas. The shoots/ plantlets harvested from the mother suckers must be acclimatized before field establishment. The potting mixture plays an important role in the development of healthy planting material. The coir dust has been recognized globally as a suitable substrate for acclimatization of plants that hold moisture and provide optimum aeration and microclimate condition for the development of lateral roots. Vermicompost/ *Trichoderma viride* can be added to the substrate to improve the physiological growth of the plant. The plants should be maintained in high humidity (>80%) and partial shade conditions for 14 to 21 days for the development of functional roots and leaves. These plants can be maintained under a shade condition till field planting.

Advantages of the technology

A minimum of 6 to 15 healthy plants per sucker (varietal specific) can be obtained within the period of three months. This technique can be executed at the

Banana cultivars	Multiplication response (%)	Plants per suckers (Min-Max Numbers)
Rasthali	75-85	15 - 60
Nendran	60-70	10 - 25
Monthan	50-65	10 - 20
Red Banana	45-55	8 - 20
Ney Poovan	50-60	8 - 15
Poovan	45-60	6 - 12
Karpooravalli	55-65	15 - 30

Table 1. Cost estimation for the production of plantlets

Material	Quantity	Estimate (₹)#
Saw dust/Coir dust	500 kg	2500
Hollow block stone	100 Nos	2500
Polythene sheet	800 Sq. foot	1500
Green net (50% shade)	200 Sq. foot	500
GI pipes 20 feet lengths (A)	12 Nos	10000
Welding charges	Wages	5000
Suckers	200	1000
Poly bags	2000	2000
Total		**25000**

#This is calculated based on the rate of materials purchased during 2020.

farm-gate where bananas are being cultivated and hence transportation costs can be reduced. The plants can be propagated throughout the year without seasonal requirements. Plants are genetically uniform and therefore a good alternative for tissue culture plants.

Cost estimation

The essential requirements and approximate cost estimation for the production of plantlets are given in Table 1. A humidity tunnel could yield about 1,000 to 2,000 plants (varietal specific) per cycle and three to four-cycle of production can be done per year. A plant can be sold at a minimum rate of ₹ 10.

Plants per suckers

Hardened plants ready for field establishment

SUMMARY

The demand for planting material can be fulfilled in the farm gate by using this technology. For the reach of the technology at the grass-root level, the State Horticulture Agencies could promote this technology by providing technical know-how and through a subsidization programme to the banana farming community. Monoculture of bananas with a single variety is highly vulnerable to pests and diseases, and hence it is essential to practice multi-clonal cultivation. To promote the multi-clonal cultivation of bananas where there is no availability of tissue culture planting material, this technique is a great intervention for sustainable banana production.

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