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Effect of Organic Substrates on Macro-propagation of Banana under Island Conditions

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Banana is an important tropical fruit crop grown globally and is the world's most important agricultural food commodity. Plantation crops take a major share of cultivated area in Andaman and Nicobar Islands. Banana is one of the important fruit crops that is highly suitable to grow as intercrop in plantation based cropping system. Local varieties of banana like Korangi, Mitta Champa, Khatta Champa and Cheenakela are cultivated by the farmers traditionally to meet the local demand. However, in recent past growing commercial varieties of banana has become popular in the Island due to consumer demand. Traditionally banana is propagated by suckers and wide variability was observed in sucker production among the commercial varieties. Due to this large scale multiplication of banana through suckers could not meet the planting material demand in

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the Island. Hence, a study was undertaken during 2020-2022 to standardize the macro-propagation technology using different organic substrates in the commercial variety 'Poovan'. Nine different organic substrate combinations were used in the present study to enhance the efficacy of lateral bud development and plantlet production. Suckers weighing 1.0 to 1.5 kg were used as the propagule. Among all the organic media combinations tested, significant differences were observed in terms of plantlet production, root and shoot growth. The treatment T8 (Coircompost: sawdust: FYM: vermicompost (1:1:1:1) with Arka microbial consortia @10 kg) produced maximum number of primary (5.60) and secondary buds (12.07) during primary and secondary capitation of decorticated mother rhizome. Early bud emergence (11.5 days), maximum number of plantlets (12-13 per mother rhizome), maximum shoot length (46.43 cm), maximum shoot girth (3.03 cm) and maximum number of leaves (4.50) were also observed in the treatment T 8. Minimum number of days was taken (52.70 days) for plantlet separation during secondary capitation in the same treatment T 8 suggesting that the treatment combination (Coircompost: sawdust: FYM: vermicompost (1:1:1:1) with Arka microbial consortia @10 kg) was effective for macro-propagation of banana Cv. Poovan under Island ecosystem.

Keywords: Banana; macro-propagation; Poovan; Andaman and Nicobar Islands.

1. INTRODUCTION

Banana is the second important and popular fruit crop after mango in India. The area under banana is increasing and there is a requirement of large quantity of planting material. The Andaman and Nicobar Islands is a biodiversity rich hotspot and is mostly dominated by plantation crops. The cultivable land area is very limited in the Island and it accounts to about 40,000 ha. Coconut and arecanut are the major plantation crops grown in the Island. There is only a possibility of vertical expansion of the cropped area. Banana is one of the important crops that can fit as an intercrop in plantation based cropping system and can generate additional income to farmers. In Andaman and Nicobar Islands, only traditional varieties like Cheenakela, Khattachampa, Mittachampa and Korangi are grown in homestead gardens and also as an intercrop in plantation-based cropping system. The commercial banana varieties like Poovan, Ney Poovan, Red banana and Grand Naine are grown in very few pockets due to limited availability of planting material. Banana is propagated commercially by sword suckers and the number of suckers produced per plant varies from 2 to 6 in Andaman and Nicobar region, whereas the sucker production ranges from 5-15 depending on the varieties in mainland India [1]. Of the several propagating units in banana, sword sucker is the best for better crop stand.

Natural regeneration in banana is very slow due to the apical dominance nature of the main plant or mother plant [1]. Most of the local banana and varieties grown in Bay Islands show shy suckering habit and this is a constraint in planting material production of banana. The propagation of banana through the suckers will not be able to meet the demand of planting material requirement of different stakeholders [2,3]. Additionally, conventional propagation through suckers is not preferred because removal of suckers will damage the production capacity of mother plants and also will encourage the secondary infection by nematodes, rhizome weevils is a cumbersome process and also it may cause spread of diseases like *Fusarium oxysporum* f.sp. cubense (Foc), which causes wilt of banana, *Xanthomonas campestris* pv. *Musacearum* causing Xanthomonas wilt of banana, commonly known as BXW or BBW (for banana bacterial wilt), *Ralstonia solanacearum* causing Moko disease, *Pseudocercospora spp*. causing Sigatoka leaf spot and other viral diseases when exchanged between farmers and this may lead to reduced production and productivity of the newly established field of banana [4].

Micropropagation assures rapid production of healthy, vigorous, and disease-free planting material. However, due to the large capital investments required for tissue culture facility, the plantlets produced are fairly expensive and beyond the reach of resource poor farmers. Furthermore, the Andaman and Nicobar Islands is bestowed with humid tropical climatic condition where the relative humidity is high and this may result in easy secondary infection of the plantlets in the process of tissue culture and which in turn may increase the production cost. Thus, tissue culture as a method of generating planting material is not an option for small-scale farmers especially for the Andaman and Nicobar Island

region and hence there is a need for simple and easy cost effective technique for planting material production of banana. One such technique is the macro-propagation technology in banana which is cheap, simple and a rapid technique for vegetative multiplication of *Musa species* that could be amenable to the small and medium scale farmers as this method does not involve high cost and with less technical skill its easily adapted [5].

2. MATERIALS AND METHODS

The trial was undertaken in the experimental field of ICAR-CIARI, Port Blair during 2020-2022. The Andaman and Nicobar islands receive an annual rainfall of 3100 mm with the mean maximum and minimum temperature of 32°C to 22°C, respectively. The relative humidity varies from 68 to 86%.

The macro-propagation technique was tried during different months of year and in one set plantlets separated after secondary decapitation and in another set allowed upto tertiary sprouting. However, when allowed till tertiary sprouting, the multiplication rate was less and the duration was also extended. The effective time for macro-propagation was observed to be July to September due to the prevailing monsoon in the Island and high humidity favoured the multiplication process. By repeating the technique for two years (2020-2021 and 2021-2022), the technology of macro-propagation was standardized for Island condition (Fig. 1). The mother rhizomes of the variety Poovan were detached during last week of June to first week of July and the detached rhizomes after treatment with fungicide are prepared for primary bud sprouting in different media combinations. For every treatment, long unused tanks are used in three replicates and different media are filled in the closed containers as per treatment details given in Table 1. Detached corms after decapitation of apical dominance are planted in nine different treatment media combinations and allowed for primary bud sprouting. Plantlets resulting from these primary buds are decapitated and allowed for secondary bud sprouting. The plantlets arising from these secondary buds are separated and allowed for acclimatization. After acclimatization, the plantlets were ready for transplanting to the mainfield. The experiment was laid in Randomized Block Design and the analysis was done using the statistical software www. https://kaugrapes.com [6].

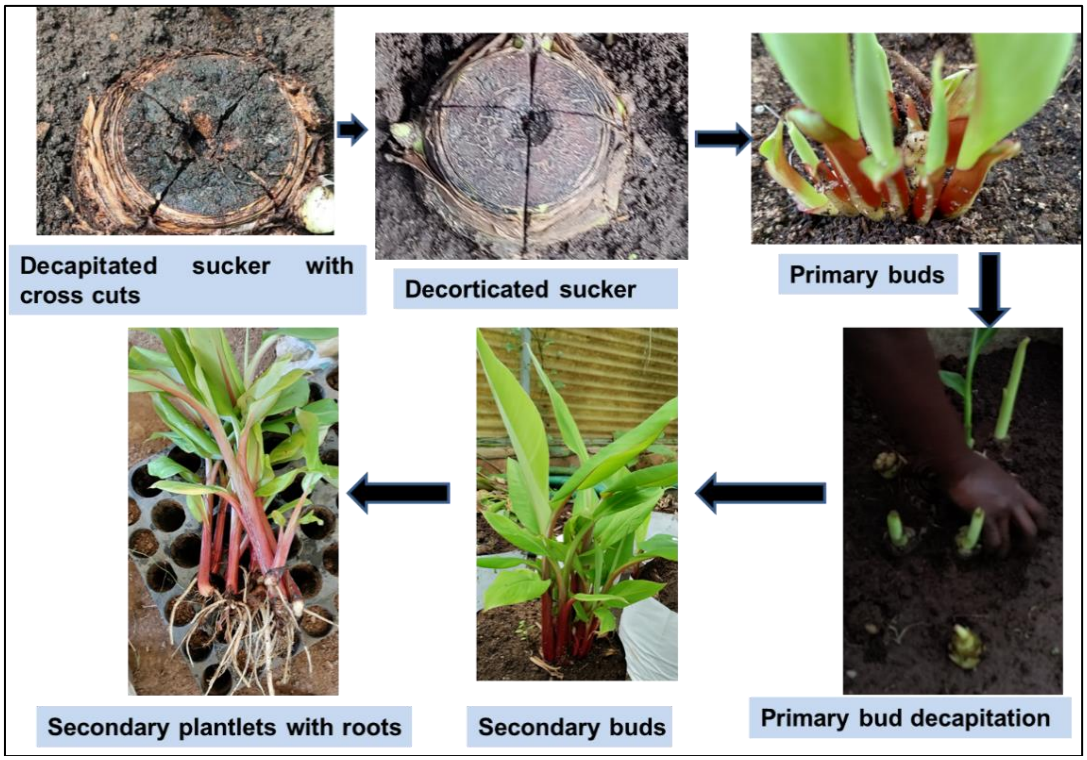

Fig. 1. Macro-propagation technology of banana adaptable to Island condition

Table 1. Treatment details of different media combinations used for macro-propagation of banana

T1	Coir compost	T4	Coir compost: saw dust: FYM: vermicompost (1:1:1:1)	T7	Coircompost: sawdust:FYM:Vermicompost: soil(1:1:1:1:1:1)
T2	Saw dust	T5	Coircompost:saw dust (1:1)	T8	Coircompost: sawdust:FYM:vermicompost(1:1:1:1) +Arka microbial consortia (10 Kg)
T3	Coir compost: saw dust: FYM (2:1:1)	T6	Coircompost: sawdust:FYM:vermicompost: soil (1:1:1:1:1) + EM sol (1 litre)	T9	Coircompost: sawdust:vermicompost: soil (1:1:1:1) + Arka actinoplus (10 kg)

3. RESULTS AND DISCUSSION

The results of the experiment conducted on macro-propagation in the variety 'Poovan' are presented in Table 2. Significant variations occurred among the different treatments Among the nine different treatments used, early bud emergence (11.5 days) was observed in the treatment T8 (Coircompost: sawdust: FYM: vermicompost (1:1:1:1) +Arka microbial consortia (10 Kg)) followed by the treatments T3 [Coir compost: saw dust: FYM (2:1:1)] and T7 [Coircompost: sawdust: FYM: Vermicompost: soil (1:1:1:1:1:1)]. Maximum number of primary buds was also observed in the treatment T8 (5.60) whereas least was observed in the treatment T9 (2.03). Malemba et al. [7] reported the early bud emergence in sand media which was at par with saw dust alone and soil alone in which single media is used as each treatment. In our study, the combination of different media like vermicompost, coircompost, sawdust, FYM and Arka microbial consortia produced positive effect on the propagation efficiency and hence early sprouting and more number of primary buds emergence was observed in the media T8. In the medium supplemented with Arka microbial consortia may be due to the production of plant growth promoting substances which were known to cause enhanced cell division [8] and this might have caused more production of primary buds.

Maximum number of secondary buds (12.07) were produced in the treatment T8 and the least was recorded in the treatment T9 (4.73). Similar results were reported by Sajith et al, 2014. The substrate media when supplemented with microbial consortia enhanced the production of both primary buds and also the secondary buds. The decapitation methods involve stimulating lateral bud production by destroying the active growing (apical meristem) in the pseudostem [9,10,11,12,13]. In the present study complete decapitation method is followed and the decapitation was done only till production of secondary buds. Similar results were also reported in wild banana, *Musa laterita* [14] with co-inoculation of microbial inoculants. The highest number of suckers produced upto tertiary capitation ranged from 26-30 in various studies conducted [15]. However, at Island condition we were able to produce plantlets only till secondary capitation. The initial standardization studies showed that the months from July to September were highly suitable for macro-propagation technology under Island condition due to the high relative humidity prevailing during those months. Hence, we have standardized the macro-propagation technology upto secondary capitation, which is best suited to the Island condition. The rate of suckering ranged from 9-14 per rhizome per annum which will enable to fulfill the demand of planting material requirement of banana. The plantlets took minimum number of days for separation (52.70) to secondary nursery in the treatment T8 when compared to other media treatment combinations. The media enriched with microbial consortia along with saw dust, coir compost, FYM and vermicompost is highly suited for vigorous growth of plantlets due to the physical characteristics of the medium and the enhanced microbial activity. The quality of nursery potting medium is important to the successful growing of plants in containers [16]. The physical composition has a profound effect on the supply of water and air to the growing plants [17], as well as affects anchorage, and nutrient and water-holding capacity. Soil is mostly used as medium, but most soils when used alone as a growing medium shows very poor response. Soil has been indicated as the easiest way through which seedlings become infected by diseases such as root knot nematode and seedling root rots [18]. Besides, soils have the attribute of heavy weight when large volumes are used to

raise containerized plants, and nursery men may have the problem of bulkiness in transporting them [16]. Hence a substituted medium will serve as an efficient substrate for macro-propagation of banana. The shoot length, shoot girth and number of leaves were also recorded maximum in the treatment T8 and hence the plantlets were vigorous. The use of organic substrate offers a greater advantage over the conventional medium [19,20]. Macro-propagation through the use of growth media has accounted lower cost and higher net returns [21]. Organic substrates provide better root-substrate relation than conventional soil mix, adequate nutrients for the seedling, better moisture retention and also less prone to pests and diseases [22]. Macro-propagation of banana corms for inducing sucker is a suitable alternative to tissue culture since it is and less expensive and farmer friendly [23].

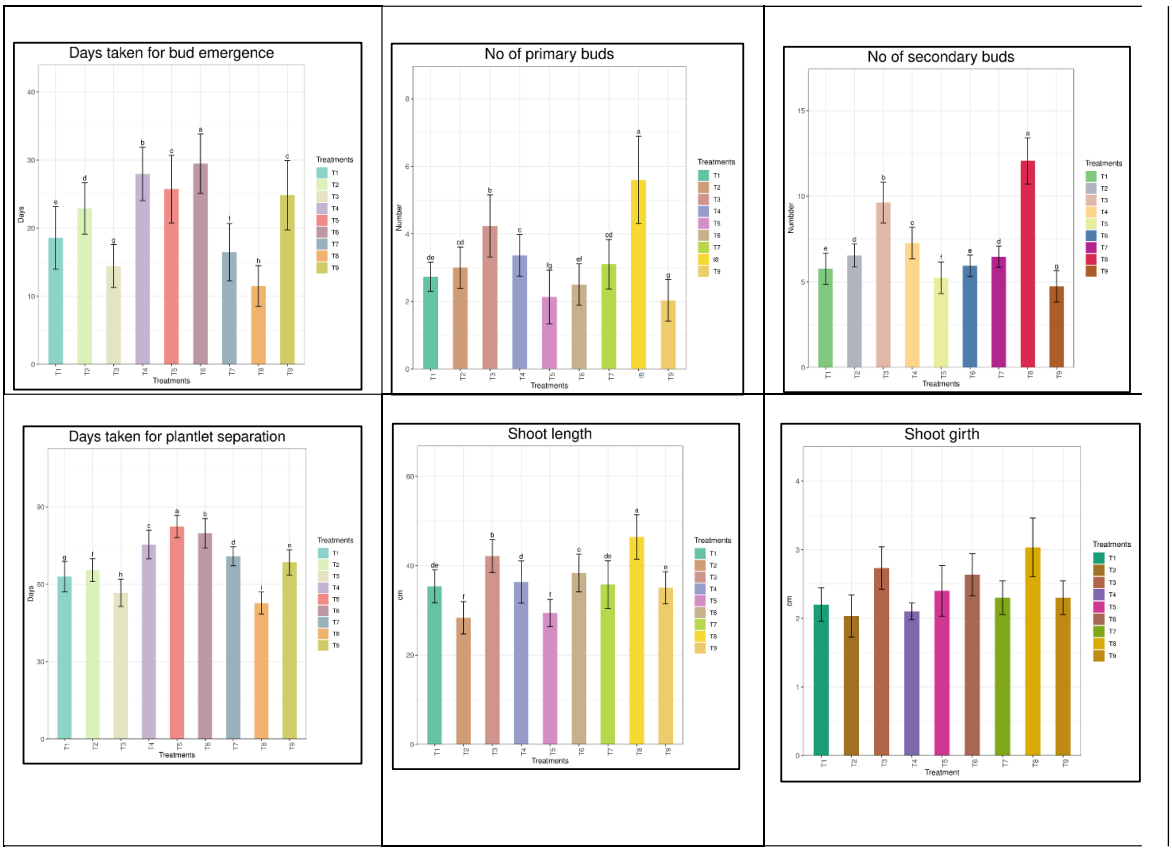

Fig. 2. Graphical presentation showing different growth parameters

Table 2. Effect of organic substrates on macro-propagation on banana variety 'Poovan'

Trts	Ds taken for bud emergence	No of primary buds	No of secondary buds	Plantlet separation (days)	Shoot length (cm)	Shoot girth (cm)	No of leaves
T1	18.57	2.73	5.77	62.97	35.40	2.20	4.00
T2	22.90	3.0	6.53	65.43	28.33	2.03	3.27
T3	14.43	4.23	9.63	56.70	42.17	2.73	4.23
T4	27.97	3.37	7.27	75.40	36.33	2.10	3.50
T5	25.73	2.13	5.23	82.40	29.40	2.40	3.77
T6	29.47	2.50	5.93	79.77	38.37	2.63	4.00
T7	16.47	3.10	6.47	70.83	35.80	2.30	4.17
T8	11.50	5.60	12.07	52.70	46.43	3.03	4.50
T9	24.83	2.03	4.73	68.50	35.07	2.30	3.97
CD at 5%	1.074	0.385	0.37	1.253	1.136	0.125	0.565
CV (%)	2.909	6.973	3.026	1.06	1.805	2.995	8.303

4. CONCLUSION

Macro-propagation offers the cheap and efficient alternative for quality planting material production in banana. Along with organic media supplementation with Arka microbial consortia enhanced the regeneration of primary and secondary buds and also promoted the development of vigorous plantlets thereby resulting in easy establishment in the main field. The media optimized in the present study is based on the local availability in the Island and can be practiced by small and marginal farmers of the Island to meet the planting material requirement of commercial banana varieties.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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