

Study on macro propagation of banana cv. Nanjangud Rasabale (AAB) using growth media

Abstract:

Banana is a major food crop globally grown and consumed in more than 100 countries throughout the tropics and subtropics. Banana (*Musa* spp.) is the world's fourth most important food crop after rice, wheat and maize. Banana is usually propagated vegetatively, since sexual reproduction is difficult due to its vegetative parthenocarpic nature. Traditionally, it is been propagated using suckers, as these are easy to obtain. But the factors limiting the adoption of this method are lower regeneration capacity of sucker, lack of year round availability of mother sucker, fear of transmission of pests and diseases to the succeeding generation, etc. To overcome these issues and to enable production of feasible amount of planting material, macropropagation technology came into existence. Macropropagation through the use of growth media has accounted lower cost and higher net returns, on an average cost of production of single plantlet was only Rs. 6.58/-. From the present study, it is inferred that, a feasible amount of healthy and quality planting materials can be produced with minimum expenditure, harnessing good profitability within shorter time span.

Keywords: Macropropagation, growth media, Cost of production, BC ratio.

Comment [A1]: Without ,

Comment [A2]: Their

Comment [A3]: The lower

Comment [A4]: The

Comment [A5]: The

Comment [A6]: we cannot write etc.

Comment [A7]: the

Comment [A8]: a

Comment [A9]: for lower

Comment [A10]: a

Comment [A11]: the shorter period time

Introduction

Banana is a major food crop globally grown and consumed in more than 100 countries throughout the tropics and subtropics. Banana (*Musa* spp.) is the world's fourth most important food crop after rice, wheat and maize (Ali *et al.*, 2013).

The pulp of a ripe banana is essentially a sugar rich, easily-digested food. The cooked banana is nutritionally similar to that of potato. It contains about 70% water; solid material is mostly carbohydrate (27%), protein (1.2%) and fat (0.3%) contents are generally low. In energy terms, each gram provides one calorie. Eleven vitamins have been recorded and the fruit is considered as a good source of vitamins A, B₁, B₂ and C. It is also rich in carbohydrates and fibres and has very low content of fat. The main difference between a banana and a plantain is moisture content. The plantain averages about 65% moisture and the banana about 83%. Although bananas and plantains do not provide a particularly good source of several important minerals in human nutrition, such as calcium, iron and iodine, they are notably high in potassium and low in sodium (Anon., 1999).

Banana is one of the major fruit crops grown in Karnataka. Almost half of the state comes under banana cultivation, since it is a fruit which has demand throughout the year. It is a fruit which has a wide variability in appearance and taste. The popular banana varieties cultivated in Karnataka are Grand Naine, Ney Poovan, Rajapuri, Red Banana (Kamalapur of Gulbarga district), Boodh bale and Kari bale (Mangaluru), Nendran (Kodagu) and Nanjangud Rasabale (Mysuru). Nanjangud Rasabale is known for its unique qualities in terms of taste, pulp quality and aroma that are due to the black clay alluvial saline soil found in its place of origin, Devarasanahalli, Nanjangud. Owing to these properties, it was given the Geographical Indication (GI) protection tag in 2005 under the Goods (Registration and Protection) Act, 1999. The bunches are small to medium in size of below 10kg with 80-120 medium sized fruits weighing around 150g each.

Banana is usually propagated vegetatively, since sexual reproduction is difficult due to its vegetative parthenocarpic nature. Traditionally, it is been propagated using suckers, as these are easy to obtain. But the factors limiting the adoption of this method are lower regeneration capacity of sucker, lack of year round availability of mother sucker, fear of transmission of pests and diseases to the succeeding generation, etc.. In recent years, the demand for disease free planting material has given tissue culture tremendous scope. However, tissue culture plants are not affordable by small and marginal farmers. To overcome these issues and to enable production of feasible amount of planting material, macropropagation technology came into existence.

Macropropagation is a technology, in which regeneration of many plants from a single vegetative part can be done in a short span. In banana, sucker is used as the macro part (explant as in micropropagation) for production of more number of plantlets. It is a simpler and cost effective technology that could be easily implemented after brief training and requiring only little resources. In India, research on this technology has been done on different varieties of banana at NRCB (National Research Centre for Banana), Trichy and other institutes. In Karnataka, Kittur Rani Chennamma College of Horticulture (KRCCH), Arabhavi is working on macropropagation technology in various cultivars of banana.

Comment [A12]: a

Comment [A13]: a

Comment [A14]: fibers

Comment [A15]: a

Comment [A16]: that has

Comment [A17]: that has

Comment [A18]: of

Comment [A19]: their

Comment [A20]: the

Comment [A21]: the

Comment [A22]: to

Comment [A23]: the

Comment [A24]: a

Comment [A25]: the

Comment [A26]: the

Comment [A27]: the

Comment [A28]: requires

Comment [A29]: a

Importance of Macropropagation

Sucker multiplication is possible at farm level through macropropagation, as it is relatively easy and can be implemented in a shed or open field to meet ~~out~~ the *in situ* requirement of planting material. It is a simple technique and is easily affordable by even those with limited access to resources such as small scale farmers. The technique requires minimum skill and could be easily implemented after brief training. The plantlets obtained through macropropagation are relatively healthy, if source of suckers are from disease free healthy mother plants and produces uniform plantlets that are relatively at par with micropropagated plantlets. Since it is carried out within nursery, minimum shade of about 50% is to be provided and regular watering is recommended

Comment [A30]: the

Comment [A31]: the

Comment [A32]: is

Comment [A33]: produce

Comment [A34]: a

Comment [A35]: the

Comment [A36]: the

The demand for banana is increasing due to population explosion which is not being met in recent years due to the lack of availability of economically affordable planting material by small and marginal farmers who contribute most area under banana cultivation. Therefore, there is a need for increasing research and development in this field to yield potential results that can be easily adopted and operated by all the stakeholders especially on farmers preferred banana varieties. With this background the present research work was carried out in banana cv. Nanjangud Rasabale (AAB) with the objective to analyse the influence of growth media on production of quality planting material and to estimate estimate the cost of production of planting material.

Comment [A37]: increased

Comment [A38]: analyze

Comment [A39]: the

Material and methods:

The investigation entitled, "Study on macropropagation of banana cv. Nanjangud Rasabale (AAB) using growth media" was carried out at College of Horticulture, Mysuru, during the year 2019-2020. The disease free, healthy, sword suckers of cv. Nanjangud Rasabale, whose corm weight ranging 1-1.5kg were collected from research field at College of Horticulture, Yelachahalli, Mysuru and was utilized in the experiment. The entire experiment was carried out under a green shade net.

Comment [A40]: ranged

Comment [A41]: was

Comment [A42]: the

Comment [A43]: the

Preparation of media

Substrate media used in this experiment was cocopeat, farmyard manure (FYM) and sawdust. FYM was available in the College of Horticulture, Mysuru and sawdust and cocopeat were procured from sawmill and nearby cocopeat production unit respectively. Since sawdust harbours certain insects and micro-organisms, it was steam sterilized in an autoclave at 121°C and 15psi pressure for 15 minutes by packing the sawdust in thermo-stable plastic covers. Cocopeat was pre-sterilized in the production unit itself.

Comment [A44]: the

Comment [A45]: harbors

Planting material / Sucker

The required quantity of planting material for research studies was procured from COH, Mysuru for the price fixed by UHS, Bagalkote. The selection of suckers play a crucial role as the quality of planting materials produced depends on suckers. The suckers were authentic, healthy and free from pests and diseases.

Comment [A46]: plays

Cost economics (Rs.)

Cost economics was calculated in order to study the production cost incurred for each treatment considered in this experiment to review the efficiency of adopting macropropagation technology which was illustrated by calculating Benefit-Cost (B:C) ratio which was calculated by

Comment [A47]: the

dividing gross return by total cost. Benefit-cost ratio reviews the consistency of utilizing this technology. Total cost includes the cost of sawdust, cocopeat, red soil, sand and farm yard manure used in the production of planting material through macropropagation technology from their respective source of procurement.

Treatments: 7 treatments were imposed

T₁ - Sawdust (3kg/bag)

T₂ - FYM (5kg/bag)

T₃ - Cocopeat (5kg/bag)

T₄ - Sawdust + FYM (1:1)

T₅ - Sawdust + Cocopeat (1:1)

T₆ - FYM + Cocopeat (1:1)

T₇ - Sawdust + FYM + Cocopeat (1:1:1)

Experimental design	CRD
Number of Treatments	7
Number of replications	3
Number of corms per treatment	30 (10/replication)

Results and discussion:

Influence of growth media on production of quality planting material and cost of production of planting material through macropropagation in banana cv. Nanjangud Rasabale are presented in this chapter.

The mean data regarding the economics of cost under different treatments has been worked out and presented in Table 1. The selling price of banana plantlets of cv. Nanjangud Rasabale obtained through macropropagation technology was kept at the rate of Rs. 15/- per plantlet. Among the seven treatments studied, the best treatment in respect of net returns and B:C ratio was T₇ – Sawdust + FYM + Cocopeat (Rs. 3100.79/- and 2.68 respectively) followed by T₆ – FYM + Cocopeat (Rs. 2650/- and 2.43 respectively). This was due to the highest number of plantlet production in the media combination treatments. Lowest gross and net returns are reported in T₁ – Sawdust treatment and lowest B:C ratio in T₃ – Cocopeat treatment due to the least plantlet production and high cost spent on cocopeat over sawdust respectively .

Comment [A48]: is

Comment [A49]: have

Comment [A50]: the

Comment [A51]: the

Table 1. Calculation of cost economics for effect of growth media on macropropagation in banana cv. Nanjangud Rasabale (AAB)

Treatments	Number of plantlets / treatment (A)	Gross return / treatment (B=Ax15)	Total cost / treatment (C)	Net return / treatment (D=B-C)	B:C ratio / treatment (E=B/C)
T ₁	220	3300	1522.71	1777.29	2.17

T ₂	260	3900	1718.71	2181.29	2.27
T ₃	245	3675	1805.21	1869.79	2.03
T ₄	230	3450	1601.71	1848.29	2.15
T ₅	240	3600	1683.96	1916.04	2.13
T ₆	300	4500	1849.96	2650.04	2.43
T ₇	330	4950	1849.21	3100.79	2.68

Note: The selling price of banana plantlets is Rs. 15/- per plantlet

Cost of production of planting material through macropropagation using various growth media.

The cost incurred treatment wise in producing macropropagated banana plantlets using growth media is depicted in Table 2. The least cost expenditure was noticed in T₁ – Sawdust (Rs. 1522.71/-) followed by T₄ – Sawdust + FYM (Rs. 1601.71/-). However, the cost of production was highest for the treatment T₆ – FYM + Cocopeat (Rs. 1849.96/-) and T₇ – Sawdust + FYM + Cocopeat (1849.21).

Comment [A52]: the

Comment [A53]: the

Table 2. Cost of production of production of macropropagated banana plantlets using various growth media

Treatments	Number of plantlets / treatment	Total cost / treatment (Rs.)
T ₁	220	1522.71
T ₂	260	1718.71
T ₃	245	1805.21
T ₄	230	1601.71
T ₅	240	1683.96
T ₆	300	1849.96
T ₇	330	1849.21
Total	1825	12031.50

Treatment wise detailed cost of production is provided in Appendix II

Cost of production was calculated on the basis of prevailing market rates of the inputs used in this experiment. The cost calculated for producing banana plantlets of cv. Nanjangud Rasabale through macropropagation using various growth media was Rs. 12031.5/- . Over 70% of the cost is going towards procurement of planting materials, polybags and media (Cocopeat, FYM and Sawdust) which are the major inputs necessary for production of planting material. This is due to the high cost of suckers of cv. Nanjangud Rasabale which was Rs. 15/- and the production of many secondary plantlets increased the need for more ~~number of~~ polybags and media, where the highest 26.2 per cent of the cost was going towards initial planting materials (suckers) procurement followed by polybags and different media (23.35 per cent and 17.32 per cent respectively). However, the average cost of production of single plantlet was only Rs. 6.58/- which was due to high number of plantlet production (Table-3).

Comment [A54]: the cost

Comment [A55]: plantation

Comment [A56]: percent

Comment [A57]: a

Comment [A58]: a

Table 3. Cost of inputs in the production of macropropagated banana plantlets using various growth media

Sl. No.						
I. Variable cost						
	Particulars	Required quantity	Cost (Rs.)	Cost in %	Cost per single plantlet (Rs.)	
a.	Planting material/ Suckers	210	3150.00	26.20	1.73	
b.	Polybags	42x40 cm	8.4kg	1176.00	23.35	0.64
		15x10 cm	14.8kg	1630.00		0.89
c.	Cocopeat	350 kg	962.5.00	8.00	0.53	
d.	Sawdust	210kg	420.00	3.50	0.23	
e.	FYM	350kg	700.00	5.82	0.38	
d.	Plant protection	Bavistin 0.2%	100g	144.00	1.04	0.09
		Monocrotophos	100ml	24.00		
i.	Weaning/Hardening media	1825	1825.00	15.20	1	
j.	Labour charge (7 Man days)	-	2000.00	16.62	1.09	
	Total variable cost		12031.50		6.58	
II. Fixed cost (*)						
	-	-	-		-	
	Total cost (I + II)		12031.50		6.58	

(*) – Fixed cost remains zero

Per unit costs has been mentioned in Appendix I

Conclusion

India is the largest producer of banana in the world. A common limiting factor to large-scale production of bananas and plantains and or expansion of existing plantation is the difficulty in obtaining planting material (Baiyeri and Ajayi, 2000), due to its poor suckering ability (Robinson, 1996). In recent years, the demand for disease free planting material has given tissue culture tremendous scope. However, tissue culture plants are not affordable by small and marginal farmers. To overcome these issues and to enable production of feasible amount of planting material, macropropagation technology came into existence.

Study on macropropagation of banana cv. Nanjangud Rasabale (AAB) using growth media was carried out with the objective to estimate the cost of production of macropropagated banana plantlets. Macropropagation through the use of growth media has accounted lower cost and higher net returns. From the present study, it is inferred that, a feasible amount of healthy and quality planting materials can be produced with minimum expenditure, harnessing good profitability within shorter time span. Further investigations are suggested to confirm the consistency of the results obtained.

Comment [A59]: to

Comment [A60]: the

Comment [A61]: a

Comment [A62]: for lower costs

Comment [A63]: the

On the basis of the results obtained during the course of investigation, macropropagation technology offers better scope and options for ~~the~~ small and marginal farmers, since it is economical, easy and produces ~~the~~ acceptable number of healthy plantlets and can be considered ideal for taking up by agricultural enterprise for commercialization. However, a large scale application of this technology is hindered by lack of awareness among growers.

Comment [A64]: an

Comment [A65]: a

References:

- Ali, K. S., ELhassan, A. A., Ehiweris, S. O. and Maki, H. E., 2013, Embryogenesis and plantlet regeneration via immature male flower culture of banana (*Musa* sp.) cv. Grand Nain. *J. Forest Prod. Indus.*, **2**(3): 48-52.
- Anonymous, 1999, Annual Report 1999, INIBAP Networking Banana and Plantain, France, p. 29-30.
- Baiyeri, K. P. and Ajayi, A. R., 2000, Status and constraints of *Musa* spp. production in a sub-humid zone of Nigeria. *Acta Hortic.*, **540**: 73-77.
- Robinson, J. C., 1996, Bananas and Plantains. *CAB Interanational*, UK, p. 238.

Appendix I

Cost economics of banana cv. Nanjangud Rasabale through macropropagation using growth media

Sl. No.	Particulars	Unit rate (Rs.)	
1.	Planting material/sucker (per)	15	
2.	Polybags	42*40 cm	140/kg
		15*10 cm	110/kg
3.	Sawdust	2/kg	
4.	Cocopeat	2.75/kg	
5.	FYM	2/kg	
6.	<i>Trichoderma asperellum</i>	100/kg	
7.	<i>Pseudomonas fluorescens</i>	100/kg	
8.	Arbuscular Mycorrhizal Fungi (AMF)	100/kg	
9.	6-Benzylaminopurine (BAP)	853/5g	
10.	Indole-3-butyric acid (IBA)	2700/25g	
11.	Plant Protection Chemical	Bavistin	144/100g
		Monocrotophos	240/L
12.	Labour (15 Man days)*	4200	

*: 6 men (Rs. 300/person) and 9 women (Rs. 250/person) + Rs. 150 (Miscellaneous)

Appendix II

Treatment wise cost of production of plantlets of banana cv. Nanjangud Rasabale through macropropagation using growth media

Sl. No.	Input	T1	T2	T3	T4	T5	T6	T7	Total (A)	Per plantlet
Initial (30suckers)										
1.	Planting material/ Suckers @ Rs. 15/sucker	450	450	450	450	450	450	450	3150	1.73
2.	Polybags (large) @ Rs. 5.6/bag	168	168	168	168	168	168	168	1176	0.64
3.	Cocopeat @ Rs. 2.75/kg	0	0	412.5 (5kg/bag)	0	206.25 (2.5kg/bag)	206.25 (2.5kg/bag)	137.5 (1.667kg/bag)	962.5	0.53
4.	Sawdust @ Rs. 2/kg	180 (3kg/bag)	0	0	90 (1.5kg/bag)	90	0	60(1kg/bag)	420	0.23
5.	FYM @ Rs. 2/kg	0	300 (5kg/bag)	0	150 (2.5kg/bag)	0	150 (2.5kg/bag)	100 (1.667kg/bag)	700	0.38
6.	Bavistin 0.2%, ~0.4897g/sucker @ Rs.1.4/g	20.57	20.57	20.57	20.57	20.57	20.57	20.57	143.99	0.08
7.	Monocrotophos 0.2%, ~0.476ml/sucker @ Rs. 0.24/ml	3.43	3.43	3.43	3.43	3.43	3.43	3.43	24.01	0.01
8.	Labour charges ~ Rs.9.5236/plantlet	285.71	285.71	285.71	285.71	285.71	285.71	285.71	1999.97	1.09
For final secondary plantlets produced										
9.	Weaning media @ Rs. 1/plantlet	220	260	245	230	240	300	330	1825	1
10.	Polybas (small) @ Rs. 110/kg, 1kg~124 bags	195	231	220	204	220	266	294	1630	0.89
	Number of Plantlets produced (No.)	220	260	245	230	240	300	330	1825 (B)	

Average number of plantlets produced (No.)	7.33	8.67	8.16	7.67	8	10	11	60.83	
Treatment wise total cost (Rs.)	1522.71	1718.71	1805.21	1601.71	1683.96	1849.96	1849.21	12031.47	
Treatment wise cost per single plantlet (Rs.)	6.92	6.61	7.36	6.96	7.01	6.16	5.60	6.58	6.58

UNDER PEER REVIEW