www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(3): 3370-3374

www.thepharmajournal.com
Received: 01-12-2022
Accepted: 01-01-2023

Vedashri L
Department of Fruit Science, College of Horticulture, Bagalkote, Karnataka, India

Venkat Rao
Associate Professor, Department of Fruit Science, College of Horticulture, Bengaluru, Karnataka, India

Mangala KP
Assistant Professor, Department of Agricultural Economics, College of Horticulture, Mysore, Karnataka, India

Corresponding Author:
Vedashri L
Department of Fruit Science, College of Horticulture, Bagalkote, Karnataka, India

Study on cost effectiveness of banana cv. Nanjangud Rasabale (AAB) planting materials produced through macropropagation

Vedashri L, Venkat Rao and Mangala KP

Abstract
India is the largest producer of banana in the world. A common limiting factor for large-scale production of bananas and plantains and or expansion of existing plantation is the difficulty in obtaining planting material, due to its poor suckering ability. 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. Cost of production of planting materials produced using growth chemicals and bioagents through macropropagation technology in banana cv. Nanjangud Rasabale (AAB) was estimated in this experiment. On the basis of the results obtained during the course of investigation, it is concluded that, use of bioagents (AMF, *T. asperellum*, *P. fluorescens*) in combination with phytohormones (IBA 0.25% and BAP 40ppm) are suggested for enhanced quality plantlet production in a shorter time period and the technology offers better scope and option for the small and marginal farmer.

Keywords: Macropropagation, Bioagents, Growth chemicals, Cost of production

Introduction

Banana is one of the important largely traded commercial tropical fruit crop in the world and is regarded as the world's largest monocotyledonous herb. It is also referred to as 'Apple of Paradise', 'Adam's fig' and 'Kalpataru' (in India). In India, it is cultivated in an area of 8.84 lakh hectares with the production of 30.80 million tonnes in 2017-2018 (Anon., 2018) [2].

The cultivated banana differ from their wild relatives by being seedless (reproductive features of flower are dysfunctional) and parthenocarpic (Heslop-Harrison and Schwarzacher, 2007) [6]. It 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) [1].

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, B_1, B_2 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) [3].

Banana is a powerhouse of nutrients and claims many health benefits such as acts as energy source, protects heart and digestive system health, boosts mood, manages blood pressure, lowers blood sugar levels, fights anaemia, peel is used against skin allergies and some cultivars like kunnan can be fed to infants. Banana can be easily processed to several value added products like banana puree, dried banana blossoms, banana flour, banana chips, banana wine, banana vinegar, banana figs, banana sauce, paste and vinegar from banana peelings (Emaga *et al*., 2007) [5]

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 Nanjungud 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.

Macropropagation

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).

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.

In 2005, the International Institute of Tropical Agriculture (IITA) introduced and demonstrated a new macropropagation technology for multiplication of banana plants at Namulonge Agricultural Research Institute (NARI). Trials were being carried out using local varieties to improve macropropagation as an alternative method for producing clean planting material that would be affordable to small-scale farmers. The technology was first developed and established in Nigeria (2000) and Cameroon (2002) with the support of IITA, USAID, and the Ministry of Agriculture of Cameroon (Sengendo *et al.*, 2010) [9].

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.

Principle: Production of more number of suckers by encouraging the lateral buds which can be accomplished by repression of hormone mediated apical dominance exerted by the mother corm by providing suitable environment in terms of substrates and exogenous hormones.

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

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 estimate the cost of production of planting material.

Material and Methods

The investigation entitled, “Studies on macropropagation of banana cv. Nanjangud Rasabale (AAB)” 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 1-1.5 kg were collected from research field at College of Horticulture, Yelachahalli, Mysuru and was utilized in the experiment. The procedure involves, collected sword suckers were decapitated to 3cm above collar region which were pared to remove all the roots and superficial layers surrounding it. Then the meristem was scarified by decorticating to a depth of 2-3 cm and 3cm diameter to remove apical dominance exerted by it. Later, 4 to 6 longitudinal criss-cross incisions of 2cm depth were made on the decapitated corm in order to activate the lateral buds and these were sterilized in fungicidal (0.2% each of Monocrotophos and Carbendazim) solution for 20 minutes. The sterilized corms were shade dried for 24 hours and planted in respective treatments. The same decapitation and decortication techniques were again imposed on primary plantlets to obtain secondary buds as means to mass multiply. Once the secondary plantlets attained 3-5 leaf stage measuring 20-40 cm in height, they were detached from the mother corm, acclimatized and rooted in FYM, Red soil and Sand (2:1:1) weaning media for a month. The entire experiment was carried out under a green shade net condition.

Preparation of plant growth regulator solution

For the present experiment, two phytohormones namely, 6-Benzylaminopurine (BAP) and Indole-3-butyric acid (IBA) were utilized at 0.04% and 0.25% concentrations respectively. The detailed procedure for preparing these concentration solutions are as follows.

Preparation of 6-Benzylaminopurine (BAP)

Initially 6-Benzylaminopurine (BAP) solution was prepared at the concentration of 40ppm by dissolving 8mg of BAP powder in 10ml of ethanol and incorporated 5 pellets of Sodium hydroxide (NaOH) for complete dissolution and the final volume was made up to 200ml with distilled water. This solution of about 4ml was pipetted out and poured into a cavity made by removing the apical meristem on the corm of respective treatments. The same procedure was followed for preparing the BAP 40ppm solution during second decapitation on primary plantlets as and when required.

Preparation of Indole-3-butyric acid (IBA)

A stock solution of 10,000 ppm Indole-3-butyric acid was prepared by first dissolving 10g of IBA powder in 150ml of ethanol and 10 pellets of NaOH and later final volume was made up to 4 litres with distilled water. This solution was used for soaking the rhizomes of respective treatments for 20 minutes which were later planted in the polybags containing media (Cocopeat).

Bioagents

Three bioagents *viz.* AMF, *T. asperellum* and *P. fluorescens* were applied at the rate of 30g each in respective treatments.
The experiment comprises of fifteen treatments and the details are given below.

Treatments

T_1 – AMF; T_2 - *T. asperellum*; T_3 - *P. fluorescens*; T_4 – AMF + *T. asperellum*; T_5 – AMF + *P. fluorescens*; T_6 – AMF + *T. asperellum* + *P. fluorescens*; T_7 - IBA 0.25% + AMF; T_8 - IBA 0.25% + *T. asperellum*; T_9 - IBA 0.25% + *P. fluorescens*; T_{10} - IBA 0.25% + AMF + *T. asperellum* + *P. fluorescens* ; T_{11} - BAP 40ppm + AMF; T_{12} - BAP 40ppm + *T. asperellum*; T_{13} - BAP 40ppm + *P. fluorescens*; T_{14} - BAP 40ppm + AMF + *T. asperellum* + *P. fluorescens* (30g); T_{15} – Control (Untreated suckers)

Cost economics

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 further calculated by dividing the gross return by total cost. Benefit-cost ratio reviews the consistency of utilizing this technology. Total cost was estimated by considering all the variable costs and net returns was calculated by subtracting the production cost from gross income.

Results and Discussion

Influence of growth chemicals and bioagents on cost of production of planting material is presented here. The mean data regarding the economics of cost under different treatments have been worked out and presented in Table 1. Among the fifteen treatments studied, the gross and net returns were maximum in BAP 40 ppm + AMF + *T. asperellum* + *P. fluorescens* (T_{14}) followed by BAP 40ppm + *T. asperellum* (T_{12}). This was because of the highest number of plantlets obtained from those treatments consisting of BAP which has enhanced the cell division and proliferation rate (Kindimba, 2013) [7] in the corms. Gross returns per plantlet were calculated at selling price of Rs. 15/- per plantlet for all the treatments. In case of B:C ratio, treatment (T_{12}) BAP 40ppm + *T. asperellum* recorded highest (2.45) indicating, for one rupee investment, additional 1.45 rupee was gained which was followed by T_{14}, T_{11} and T_{13} indicating the benefit obtained over one rupee cost incurred was high in treatments composed of BAP due to the highest number of plantlets obtained, whereas, the lowest gross income, net returns and B:C ration was reported from treatment (T_8) IBA 0.25% + *T. asperellum* because of the generation of less number of plantlets (Table 1).

Table 1: Calculation of cost economics for effect of growth chemicals and bioagents 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	115	1725	935.12	789.88	1.84
T_2	135	2025	973.12	1051.88	2.08
T_3	120	1800	948.12	851.88	1.89
T_4	135	2025	1018.12	1006.88	1.98
T_5	130	1950	1008.12	941.88	1.93
T_6	160	2400	1112.12	1287.88	2.16
T_7	140	2100	1319.62	780.38	1.59
T_8	105	1575	1255.62	319.38	1.25
T_9	130	1950	1300.62	649.38	1.49
T_{10}	130	1950	1390.62	559.38	1.40
T_{11}	155	2325	1015.06	1309.94	2.29
T_{12}	170	2550	1040.36	1509.64	2.45
T_{13}	155	2325	1015.06	1309.94	2.29
T_{14}	190	2850	1171.05	1678.95	2.43
T_{15}	120	1800	903.12	896.88	1.99

Estimation of Cost of production of planting material through macropropagation using growth chemicals and bioagents

Cost of production was calculated on the basis of prevailing market rates of the inputs used in the experiment. The treatment wise cost incurred in producing macropropagated banana plantlets using growth chemicals and bioagents presented in table 2. The least cost expenditure was noticed in T_{15} – Control (Rs. 903.12/-) followed by T_1 – AMF (Rs. 935.12/-) and T_3 – *P. fluorescens* (Rs. 948.12/-). However, the cost of production was highest for the treatment T_{10} – IBA 0.25% + AMF + *T. asperellum* + *P. fluorescens* (Rs. 1390.62/-). Cost of production was lowest for the treatment control (untreated suckers) because no growth chemical and bioagent costs were involved in the same. It was highest in treatment (T_{10}) – IBA 0.25% +AMF + *T. asperellum* + *P. fluorescens* which was due to the highest cost of IBA and cost of all the three bioagents included in the treatment.

Table 2: Cost of production of macropropagated banana plantlets using various growth chemicals and bioagents.

Treatments	Number of plantlets / treatment	Total cost / treatment (Rs.)
T_1	115	935.12
T_2	135	973.12
T_3	120	948.12
T_4	135	1018.12
T_5	130	1008.12
T_6	160	1112.12
T_7	140	1319.62
T_8	105	1255.62
T_9	130	1300.62
T_{10}	130	1390.62
T_{11}	155	1015.06
T_{12}	170	1040.36
T_{13}	155	1015.06
T_{14}	190	1171.05
T_{15}	120	903.12
Total	2090	16405.80

An overall cost estimated for producing banana plantlets of cv. Nanjangud Rasabale through macropropagation using various growth chemicals and bioagents was Rs. 16405.8/-. Over 60% of the cost is going towards procurement of planting materials, polybags and cocopeat 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. However, the average cost of production of single plantlet was only Rs. 7.84/- which was due to high number of plantlet production (Table 3).

Table 3: Cost of inputs in the production of macropropagated banana plantlets using growth chemicals and bioagents.

Sl. No.	Influence of growth chemicals and bioagents on production of quality planting material through macropropagation					
I.	**Variable cost**					
	Particulars		**Required quantity**	**Cost (Rs.)**	**Cost in %**	**Cost per single plantlet (Rs.)**
a.	Planting material/ Suckers		225	3375.00	20.57	1.61
b.	Polybags	42x40 cm	9kg	1260.00	19.08	0.60
		15x10 cm	17kg	1870.00		0.9
c.	Cocopeat		1125 kg	3093.75	18.86	1.48
d.	*Pseudomonas fluorescens*		3.15 kg	315.00	1.92	0.15
e.	*Trichoderma asperellum*		3.15 kg	315.00	1.92	0.15
f.	AMF		3.6 kg	360.00	2.19	0.17
g.	Plant growth hormone	BAP 40ppm	53 mg	9.06	8.28	0.004
		IBA 0.25%	12.5 g	1350.00		0.64
h.	Plant protection chemicals	Bavistin 0.2%	100g	144.00	1.03	0.08
		Monocrotophos 0.2%	100ml	24.00		
i.	Weaning/Hardening media		2090	2090.00	12.74	1
j.	Labour charge (8 Man days)		-	2200.00	13.41	1.05
	Total variable cost			16405.81		7.84
II.	Fixed cost (*)					
	-		-	-		-
	Total cost (I + II)			16405.81		7.84

(*) – Fixed cost remains zero

Conclusion

Experiment was carried out to estimate the cost of production of macropropagated banana plantlets through the use of growth chemicals and bio agents. On the basis of the results obtained, it can be concluded that, use of bioagents (AMF, *T. asperellum*, *P. fluorescens*) in combination with phytohormones (IBA 0.25% and BAP 40ppm) are suggested for enhanced quality plantlet production. The cost of growth chemicals are high but when considered the number of plantlets generated, 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. 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.

References

1. Ali KS, ELhassan AA, Ehiweris SO, Maki HE. Embryogenesis and plantlet regeneration via immature male flower culture of banana (*Musa* sp.) cv. Grand

Nain. J Forest Prod. Indus. 2013; 2(3):48-52.
2. Anonymous. Horticultural statistics at a glance 2018, Horticulture Statistics Division Department of Agriculture. Cooperation & Farmers' Welfare Ministry of Agriculture and Farmers' Welfare Government of India, 2018, p.145.
3. Anonymous. Annual Report 1999, INIBAP Networking Banana and Plantain, France; c1999. p. 29-30.
4. Baiyeri KP, Ajayi AR. Status and constraints of *Musa* spp. production in a sub-humid zone of Nigeria. Acta Hortic. 2000;540:73-77.
5. Emaga TH, Andrianaivo RH, Wathelet B, Tchango JT, Paquot M. Effects of the stage of maturation and varieties on the chemical composition of banana and plantain peels. Food Chemistry. 2007;103(2):590-600.
6. Heslop-Harrison JS, Schwarzacher T. Domesticated, Genomics and Future for the banana. Annals of botany. 2007;100(5):1073-1084.
7. Kindimba GV. Effect of Benzylaminopurine on *in vivo* multiplication and genetic stability of plantain (*Musa* spp. AAB) cv. 'Itoke Sege'. M. Sc. (Crop Science) Thesis, Sokoine University of Agriculture, Morogoro, Tanzania, 2013.
8. Robinson JC. Bananas and Plantains. CAB Interanational, UK; c1996. p. 238.
9. Sengendo S, Nalukwago J, Mwangi M, Nakato V. Reducing food insecurity through technology transfer: Macropropagation, Experience in BXW Worst Hit Areas of Uganda, C3P: Crop Crisis Control Project; c2010. p. 1-12.