Short Communication

Macropropagated plantlets in banana: Performance evaluation with suckers and tissue culture plants in Grand Naine and Nendran

P. R. Manju* and P. B. Pushpalatha

Banana Research Station, Kerala Agricultural University, Kannara 680 652, Kerala, India.

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Abstract

Macropropagation is a cost effective vegetative propagation technique, whereby 20-25 plants can be produced from a single corm in a matter of 3-4 months depending upon the variety. The technique involves the repression of apical meristem ultimately stimulating the regeneration of lateral meristem. The present study conducted at Banana Research Station, Kannara, attempted to evaluate the performance of macropropagated plantlets of banana varieties Grand Naine (AAA) and Nendran (AAB) compared to suckers and tissue culture plants. Macropropagated plantlets of both Grand Naine and Nendran responded as well as tissue culture plants and significantly better than suckers in terms of bunch weight, hands per bunch, fingers per bunch and finger weight. In Grand Naine, macropropagated plantlets recorded a bunch weight of 28.29 kg/plant, while in Nendran, it was 12.25 kg/plant. Sucker derived plants recorded 18.13 and 9.78 kg bunch weight in Grand Naine and Nendran respectively. An additional yield of 56% and 25% was obtained from macropropagated Grand Naine and Nendran respectively. Fruit quality in terms of TSS, acidity and shelf life remained on par among the treatments. No significant difference was observed among the treatments for days to bunching, days to harvest and crop duration.

Key words : Banana, Grand Naine, Macropropagation, Nendran, Planting materials.

India is the largest producer of banana in the world, with an average production of 29 million tonnes per year. Bananas and plantains are the most widely cultivated and consumed fruit crop in Kerala. The annual production of banana and plantain in the state is 1.14 lakh ha with a production of 8.82 lakh tons (FIB, 2019). A major constraint to the expansion of banana and plantain cultivation is the scarcity of healthy planting material (Nkendah and Akyeampong, 2003). The lack of formal systems for producing and distributing quality planting material force the farmers to depend on natural regeneration of plants. More than 95% of banana are vegetatively propagated through suckers. This is usually a very slow process, and produces less planting materials that are likely to be contaminated with soil-borne pathogens, insect pests and nematodes. Also, transplanting of the contaminated material often spreads diseases and shortens the lifespan of plantations (Njukwe et al., 2013). Huge number of quality planting materials can be made available by tissue culture technique. However, tissue culture plants are costlier and small and marginal farmers cannot afford the higher cost. Under the above circumstances, the new technology *viz*., macropropagation of banana has been advocated as an effective alternative method which requires less capital and skill to produce large numbers of quality banana seedlings (Sajith et al., 2014). Recently, the Plantain and Banana Improvement Program of the International Institute of Tropical Agriculture (IITA), Nigeria, advanced the use of macropropagation method for increasing sucker multiplication at farm level. Studies conducted under the ICAR-AICRP (Fruits) at Banana Research Station, Kannara have led to the

*Author for correspondences : Phone : +91 9446331330, Email: manjupr.nair@gmail.com

standardization of macropropagation technique in banana varieties Grand Naine and Nendran (Patil et al., 2016). The present study was undertaken to assess the performance of these macropropagated plantlets in the field as compared to conventional planting materials like suckers and tissue culture plants.

The study was carried out at Banana Research Station, Kannara, Thrissur, Kerala Agricultural University, Thrissur, Kerala during 2018-19 as part of the project under ICAR-AICRP (Fruits). Nendran (AAB) and Grand Naine (AAA) were subjected to macropropagation as described below to produce secondary plantlets for field planting.

Sucker preparation: 2-3 months old healthy sword suckers (1 kg) without any weevil or nematode infestation were selected and detopped just above the juncture of the corm and aerial shoot. The remains of the pseudostem and roots were removed and external layer of the corm was scraped using a sharp knife. After washing in clean water, the pared corms were scarified by removing the apical meristem to a depth of 2 cm and given 6 to 8 cross cuts depending on the size of the suckers. The corms were then soaked in Carbendazim (0.2%) for 30 minutes to prevent any soil borne fungal diseases, and allowed to dry.

Preparation of substrate and planting of suckers: Decorticated and decapitated suckers were planted individually in pots (30 cm diameter and height), with sawdust as substrate (2 kg) which was initially moistened and decomposed for a period of 2-3 weeks prior to use. Sawdust was supplemented with VAM (30 g per corm) and *Bacillus subtilis* (30 g per corm) at the time of planting. Benzyl Amino Purine (BAP 40 ppm @ 4 ml/corm) was applied to corms, followed by complete burial of the corms to a depth of 3-5 cm.

Bud formation and decapitation: Primary plantlets which emerged were allowed to grow for 25-30 days. At 3 leaf stage, with a height of 15-20cm and a stem girth of 2.5cm, the primary plantlets were decapitated as done with the mother corm and covered with sawdust and watered. From each primary plantlet, secondary plantlets developed were allowed to grow for another 20-30 days, after which they were carefully removed along with the root system and planted in poly bags filled with potting mixture (1:1:1 soil, sand and farm yard manure) for establishment. At the end of 45 days of hardening they were field planted for evaluation, along with tissue culture plants and suckers. For this, pest and disease free sword suckers (3-4 months old) and 2 ½ to 3 months old hardened tissue culture plants (virus indexed) of Grand Naine and Nendran were used.

The treatments included plantlets produced by macropropagation (secondary seedlings) (T1), 3-4 month old pest and disease free sword suckers (T2), and 2 ½ to 3 months old hardened virus indexed tissue culture plants (T3). The varieties were V1 - Grand Naine (AAA) and V2 - Nendran (AAB), and there were six treatment combinations, viz., Grand Naine (T1V1, T2V1, T3V1), and Nendran (T1V2, T2V2, T3V2). Randomized Block Design (RBD) was adopted with seven replications, and there were 15 plants per replication, adopting a spacing of 2 x 2m. Cultural practices were given as per the Package of Practices recommendations of Kerala Agricultural University (KAU, 2016). The treatments were evaluated for a single season (plant crop) for growth, yield, fruit quality and Eumusae leaf spot incidence.

Plant height (m), pseudostem girth (cm), suckers per plant, leaves per plant and leaf area were recorded at bunching. Plant height was measured from the base of the plant to the point of emergence of peduncle using a measuring scale. The girth of the pseudostem at 1m height from the base of the plant was measured using measuring tape and expressed in cm. Leaf area (m^2) was estimated using the formula:

Leaf area = L x B x Number of leaves x 0.755,

where, L was the length of standard leaf in metres (3rd leaf from the top), and B was the maximum width of the standard leaf in metres.

Days to bunching was taken as the number of days from planting to bunching, while days to harvest was recorded as the days for maturity of the fruits from bunching to harvest. Crop duration was the number of days taken from planting to harvest.

Bunch weight (kg/plant) and yield (t/ha), hands per bunch, fingers per bunch, finger weight (g), pulp weight (g), finger length (cm) and finger girth (cm) were observed at harvest. The middle finger on the top row of the second hand from the basal end of the bunch was used for recording finger characters. Total Soluble Solids (TSS) was measured using a hand refractometer, while fruit acidity was determined as per the method suggested by Ranganna (1997) at ripening. Shelf life was the number of days from the date of ripening to a stage unfit for consumption. Disease severity index (PDI %) of Eumusae leaf spot was calculated as per Gauhl's modification of Stover's severity scoring system (Gauhl et al., 1995; Carlier et al., 2002) using the formula:

Infection index (PDI) = $\Sigma nb/(N-1)T \times 100$ where, n = number of leaves in each grade, b = grade, N = number of grades used in the scale and T= total number of leaves scored.

Analysis of variance for each parameter was done as per Panse and Sukhatme (1967). Comparison of parameters between macropropagated plantlets, sucker and tissue culture plants was made within each variety.

Macropropagated plantlets performed significantly better than suckers and was on par with tissue culture plants in both Grand Naine and Nendran with respect to bunch weight and yield. In Grand Naine, macropropagated plants recorded the greatest bunch weight (Table 1) of 28.29 kg which was on par with tissue culture plants (26.75 kg) and significantly higher than suckers (18.13 kg). A similar trend was also observed in Nendran, with macropropagated plantlets and tissue culture plants performing equally well with a bunch weight of 12.25 and 12.08 kg respectively, but significantly better than suckers (9.78 kg bunch weight). This gave an additional yield of 56% from Grand Naine macropropagated plants, while in Nendran, an additional yield of 25% was observed compared to suckers. Macropropagated plantlets of Grand Naine and Nendran recorded the highest B:C ratio of 3.11 and 3.33 respectively, compared to tissue culture plants and suckers. Suryanarayana (2017) compared the performance of macropropagated plantlets with suckers in banana varieties Champa, Bantal, Patkapura and Grand Naine and observed no significant difference between them. In Nendran banana, 25.63 per cent additional yield was recorded in tissue culture plants as compared to suckers (Sheela and Nair, 2001). Increased bunch weight in macropropagated as well as tissue culture plants was attributed to better bunch characters *viz*., hands per bunch and fingers per bunch compared to suckers in both varieties. Finger weight and pulp weight was also significantly higher in macropropagated Nendran compared to suckers (Table 2). Sheela and Nair (2001) observed that in Nendran banana, length of bunch and fingers per bunch are attributes responsible for yield improvement.

Table 1. Effect of propagules and varieties on bunch weight and yield of banana

Treatment	Bunch weight(kg/plant)	Yield (t/ha)	B : C ratio
T1V1	28.29	70.73	3.11
T2V1	18.13	45.33	2.00
T3V1	26.75	66.87	2.94
SEm±	0.77	1.92	-
LSD at 5%	3.09	7.72	-
T1V2	12.25	30.62	3.33
T2V2	9.78	24.46	2.66
T3V2	12.08	30.00	3.28
SEm±	0.31	0.68	-
LSD at 5%	1.26	2.76	-

There was no difference between the treatments with respect to plant height, pseudostem girth, leaves per

Table 2. Effect of propagules and varieties on fruit characters of banana

Treatment	Hands per bunch	Fingers per bunch	Finger weight (g)	Pulp weight(g)	Finger length (cm)	Finger girth (cm)
T1V1	9.45	163.68	161.45	102.68	20.06	12.53
T2V1	8.12	130.51	143.04	93.98	18.90	11.77
T3V1	9.62	167.27	149.00	100.69	19.03	12.15
SEm±	0.11	3.74	5.71	2.45	0.59	0.19
LSD at 5%	0.46	15.17	NS	NS	NS	NS
T1V2	5.80	61.51	161.97	111.84	21.30	12.26
T1V2	4.99	50.59	156.12	96.43	20.30	11.97
T3V2	5.58	58.68	158.59	108.70	20.57	11.96
SEm±	0.14	0.69	1.24	2.27	0.56	0.13
LSD at 5%	0.56	2.78	NS	NS	NS	NS

Table 3. Effect of propagules and varieties on growth characters (at bunching)

Treatment	Plant height(m)	Pseudostem girth (cm)	Leaves/ plant	Suckers/ plant	Leaf Area (m^2)	Days to bunching(days)	Days to harvest(days)	Crop duration(days)
T1V1	2.61	54.09	11.15	4.12	15.95	238.96	92.55	331.36
T2V1	2.33	52.56	10.56	3.98	14.97	248.74	88.96	337.86
T3V1	2.60	54.29	11.97	4.09	16.42	249.03	91.88	342.86
SEm±	15.73	1.18	0.16	0.21	0.33	1.95	1.54	2.25
LSD at 5%	NS	NS	0.66	NS	NS	7.86	NS	NS
T1V2	3.20	48.07	11.52	3.72	7.66	253.07	89.56	342.62
T2V2	2.92	46.84	10.05	3.44	7.64	249.25	88.43	337.60
T3V2	3.16	47.75	11.07	3.94	7.97	260.92	89.17	350.33
SEm±	4.77	0.31	0.67	0.22	0.49	7.22	2.09	7.54
LSD at 5%	19.24	NS	NS	NS	NS	NS	NS	NS

plants, suckers per plant and leaf area (Table 3). Kasyoka (2013) evaluated macropropagated plantlets and observed that they responded similar to tissue culture plants. No significant difference was also observed between treatments with regard to days to bunching, days to harvest and crop duration.

Macropropagated plantlets, tissue culture plants and suckers behaved similarly with respect to TSS, acidity and shelf life, showing that there was no influence on quality parameters by planting material (Table 4). Reaction to Eumusae leaf spot incidence also showed a similar trend (Table 5).

Table 4. Effect of propagules and varieties on quality characters of banana

Treatment	TSS (Brix)	Fruit acidity (%)	Shelf life(days)
T1V1	25.74	0.33	5.81
T2V1	24.69	0.29	5.85
T3V1	24.00	0.26	5.52
SEm±	0.64	0.02	0.23
LSD at 5%	NS	NS	NS
T1V2	26.76	0.35	5.80
T1V2	25.33	0.32	5.50
T3V2	27.00	0.30	5.90
SEm±	0.55	0.01	0.11
LSD at 5%	NS	NS	NS

Table 5. Effect of propagules and varieties on reaction to Eumusae leaf spot in banana

Treatment	Infection Index
T1V1	16.17
T2V1	17.12
T3V1	17.59
SEm±	2.31
LSD at 5%	NS
T1V2	32.08
T1V2	28.13
T3V2	29.26
SEm±	1.74
LSD at 5%	NS

Natural regeneration in banana is through propagating material such as maiden suckers, water suckers, sword suckers, butt, peeper and bits. Among them, sword suckers are the most widely used as they have a well-developed base, pointed tip and narrow leaf blades, while water suckers are

small, less vigorous, broad leaved and emerge in clumps (Singh et al., 2011). Natural regeneration has been in existence for decades as it is comparatively cheap and does not require any sophisticated skills for production. However, suckers are often the ource of banana corm weevil (*Cosmopolites sordidus*), viruses, nematodes and pathogens such as *Fusarium oxysporum* fsp. *cubense,* the causal agent of *Fusarium* wilt. In addition, natural regeneration cannot produce enough planting materials for medium and large-scale producers. Growth of suckers is also very slow due to hormone-mediated apical dominance of the mother plant. A banana plant produces only 5-20 suckers during its life time (Singh et al., 2011). Tissue culture (TC) propagation technique is yet to benefit majority of small scale farmers because of the high costs and sophisticated skills associated with the technology (Sahijram et al., 2003). Therefore, to increase banana production, there is need for affordable and simple technique for seedling production at farm level. Macropropagation is one such technique that can greatly boost banana production. It is user friendly, requiring minimum skill and expertise and suitable for adoption by farmers at the farm level. The present study also signifies that macropropagated plantlets perform as well as tissue culture plants. Compared to micropropagated plantlets, macropropagation derived plantlets are more adaptable to the field conditions because they are photosynthetically active as they are regenerated under *in vivo* conditions, while tissue cultured plants are partially photosynthetic and hence are very delicate and do not establish easily under field conditions (Tenkouano et al., 2006). By maintaining a disease-free mother block as the source of healthy and high yielding planting materials, macropropagated plantlets offer a cheap alternative with tremendous potential for increasing the production of banana. In the present study, the sword suckers selected for macropropagation were taken from disease free and healthy mother plants. Further the regeneration of macropropagated plantlets was carried out in soil less media, namely, saw dust, which had been inoculated with VAM and *Bacillus subtilis*, both of which are known biocontrol agents against *Fusarium* wilt. *Bacillus subtilis* when present in the immediate vicinity of plant roots, can maintain stable contact with higher plants and promote their growth. In addition, due to its ability to form endospores and produce different biologically active compounds having broad spectrum activity, *Bacillus subtilis* serve as a potential biocontrol agent (Nagorska et al., 2007). Hence by ensuring the quality of mother corms taken and by the use of bioinoculants, pest and disease free propagules can be obtained through macropropagation.

Sajith et al. (2014) described macropropagation as a cost effective technique that could be made accessible to small and marginal farmers without compromising on quality. Again, when most of the tissue culture labs multiplied only commercially leading varieties of the region, macropropagation technology could be used to multiply elite / rare banana varieties according to the interest of the farmer. Dayarani et al. (2013) found macropropagation involving decapitation of rhizome and treatment with BAP (0.04%) as a promising technique for regeneration of ornamental banana, *Musa laterita*.

The study pointed out the possibility of using macropropagated plantlets as quality planting materials for enhancing yield in banana cultivars Grand Naine and Nendran. Macropropagation technology provided cheap, simple and relatively rapid method for vegetative multiplication of banana that could be amenable to low income, unskilled small and marginal farmers who were the stake holders of bananas and plantains in the humid tropics.

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