



RESEARCH ARTICLE

**PROPAGATION AND ESTABLISHMENT OF HIGH YIELDING BANANA PLANTS (ROBUSTA SP)
FROM SHOOT TIP BY PLANT TISSUE CULTURE METHOD**

1,*Saravanan, R., 2Dhachinamoorthi, D. and 3Sudhakar, Y.

1Research scholar, JNTU Kakinada and Faculty, QISCP, Ongole Andhra Pradesh-533 003, India

2QIS College of Pharmacy, Ongole, Andhra Pradesh-523 272, India

3GovtPolytechnique College, Tirupathi, Andhra Pradesh-517 501, India

ARTICLE INFO

Article History:

Received 13th July, 2017

Received in revised form

23rd August, 2017

Accepted 18th September, 2017

Published online 17th October, 2017

Key words:

Banana plant, MS Media,
Plant tissue culture, Robusta sp,
Sucker propagation, Shoot tip.

ABSTRACT

Plant Tissue culture has advanced the knowledge of fundamental Biotechnology especially in the field of agriculture, horticulture, plant breeding, forestry, somatic cell hybridization, phytopathology and industrial production of plant metabolites, etc. During the last two decades plant cell, tissue and organ culture have developed rapidly and become a major biotechnological tool in agriculture, horticulture, forestry and industry. That problem which was not feasible through conventional technique, now have been solved via plant tissue culture techniques. In recent years growing of tissue culture banana becoming popular in this area. Banana is an economically important crop, which is extensively cultivated in tropical and subtropical countries. The *in-vitro* banana plants are superior to the conventional suckers due to their vigorous growth, precocity and higher yields. An attempt was made to standardize the production of tissue cultured banana (Robusta sp) compare to conventional sucker propagation method.

Copyright©2017, Saravanan et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Citation: Saravanan, R., Dhachinamoorthi, D. and Sudhakar, Y. 2017. "Propagation and establishment of high yielding Banana plants (Robusta sp) from shoot tip by plant tissue culture method", *International Journal of Current Research*, 9, (10), 58446-58453.

INTRODUCTION

The potential value of plant tissue culture technology is being commercially exploited by various organizations all over the world. The Horticulture Industry responded very quickly to the micro propagation research. At present more than 400 million plants are produced through tissue culture in different parts of the world (Atique Akbar and Shyamal, 2006; Huang Yonghong *et al.*, 2006; Michael W. Bairuet *et al.*, 2006; Thomas Happi Emaga *et al.*, 2007; Dennis Thomas, 2008). There is potential market for billions of US dollars per year worldwide for tissue culture products. There are more than 65 laboratories all over the world producing more than a million plants per year. The total production of North Indian laboratories probably exceeds 50 million plants per year (Akin-Idowu *et al.*, 2009; NafeesAltaf *et al.*, 2009). The production in Asian countries is nearing 100 million plants, which include orchids, temperature and tropical flowering crops, foliage plants and plantation crops. (Harish *et al.*, 2008) To boost up these areas ICGEB in a workshop recommended the need of more research in developing countries on plant cell culture, differentiation, regeneration and transformation in tropical grain legumes,

woody legumes and cereals. (Masoud Sheidai *et al.*, 2010; Amornwat Srangsam and Kamnoon Kanchanapoom, 2003) The emphasis was laid to improve growth under stress condition, pest and disease resistance, improved nutritional quality, nitrogen fixation and the control of partitioning within the plant. (Wirakarnain *et al.*, 2008) The changes in the life-style of people have shifted their consumption pattern towards nutritious foods like fruits. The production of fruits through conventional methods is not sufficient to meet the growing demand. (Juliet Akello *et al.*, 2009; Shongwe *et al.*, 2008) Hence, there is a need of using modern technologies like tissue culture to fill-up the gap between the demand and supply of banana seedlings. Such plants are being cultivated at select places in the state of Andhra Pradesh. It is being promoted mainly by the private companies through supplying of seed materials. At this juncture, it is important to study the performance of tissue cultured banana over that of sucker-propagated banana (Francois Lecompte and Loic Pages, 2007; Juliet Akello *et al.*, 2007; LianJie *et al.*, 2009; Daniel Coyneet *et al.*, 2010). Plant tissue culture techniques are essential to many types of academic inquiry, as well as to many applied aspects of plant science (Muhammad Youssef *et al.*, 2010). Currently, tissue-cultured plants that have been genetically engineered provide insights into plant molecular biology and gene regulation. Plant tissue culture techniques are also central to innovative areas of applied plant science, including plant

*Corresponding author: Saravanan, R.

Research Scholar, JNTU Kakinada and Faculty, QISCP, Ongole Andhra Pradesh-533 003, India.

biotechnology and agriculture (Hathra Taskin *et al.*, 2013; Kothari *et al.*, 2010). Tissue culture is a biotechnology technique that has been extensively and productively used in the banana industry. It has revolutionized the export banana industry and has proven to be a major component in rehabilitating the banana industry of some countries in Asia (Ahsan A. Kadhim *et al.*, 2014). Yet many other countries have not exploited the full usefulness and what it can bring to the improvement of banana production. The ability to produce big number of planting materials in relatively short period of time had allowed growing bananas in a bigger parcel of land in a given timeframe, which otherwise be limited by limited availability of suckers (Munguatosha Ngomuo *et al.*, 2014; Shongwe *et al.*, 2008). With this technology, one can plan to plant the desired number of plants, in a desired area of land. This project aims to discuss the uses and importance of tissue culture in banana (Venkatachalam Lakshmanan *et al.*, 2007). The main objective is to standardize the type of explant for in vitro mass propagation of *Musa accuminata* compare to conventional sucker propagation method.

MATERIALS AND METHODS

Collection of banana plants

The banana plants *Musa accuminata* (Robusta sp) collected from the banana fields, Andhra Pradesh Horticulture Research Station, Kovvur, West Godavari, Andhra Pradesh. From this, suckers were isolated aseptically which going to be used as explants.

Designing of MS- Medium and Preparation

A nutrient medium is defined by its mineral salt composition, Carbon source, Vitamins, Phytohormones and other organic supplements. The basic nutritional requirements of cultured plant cells are very similar to those utilized by plants (Meenakshi Sidha *et al.*, 2007; Murashige and Skoog, 1962). The designing of media mainly aims to provide all the essential requirements needed for the growth of plant. The MS medium is most suitable for the culturing Banana (Murashige, 1974). The stock solutions of inorganic nutrients, trace elements, vitamins and plant growth regulators, as indicated in table 1 were prepared. To prepare 1 lit of medium, pipette the required volume of each stock solution in to a 1 lit glass beaker, on a magnetic stirrer. The additives were added 950 ml of distilled water. The pH was adjusted to 5.8 to 5.9 with 0.5 M NaOH and 0.8 % Agar was added. The medium was then transferred in to a 1 lit measuring cylinder and made up to 1 lit with distilled water. Transfer the medium into 75- 100 ml sterile screw capped container and autoclave it for 15 min at 121°C (15 LB).

Sterilization of media and Maintenance of Aseptic condition

All the culture tubes containing medium were plugged with non-absorbent cotton. These were sterilized by autoclaving at 121°C for 20 minutes (15 lb). This medium was cooled down to room temperature and used for tissue culture work. The most preferred arrangement for aseptic transfer is, a separate air conditioned, dust free room equipped with the requisite number of laminar airflow clean benches, fitted with ultraviolet lamps. A high level of cleanliness ensures reduced risk of contamination. All working surface is thoroughly cleaned and disinfected prior to sterile transfer. It is done by using ethanol (95%) solution. It is desirable that the transfer

room and the laminar flow hood be used exclusively for aseptic manipulations. Other equipment needed for sterile manipulations include scalpels with removable blades, forceps of varying lengths, an ethanol dip and Bunsen burner. These also should be washed with ethanol for disinfection prior to use.

Selection and sterilization of Explant (Aishmuhammad *et al.*, 2004)

The explant (*Musa accuminata*) used for shoot induction was collected from the meristematic shoot apex, (4mm size) from the suckers by cutting with a clean knife. The suckers collected from the banana plants should be free from diseases. The suckers were carefully removed from field and were washed thoroughly in tap water. These were washed with tween 20. All traces of tween and the extraneous rhizome tissue were carefully chopped with a stainless steel knife. Further operations were all carried out under laminar air flow chamber. The suckers were treated with citric acid solution (0.2%) to prevent the phenolic secretions. Trimmed suckers were then soaked in a solution of 0.5% of a suitable fungicide and streptomycin antibiotic for 30 min to 1 hour. Now the suckers were washed with sterile distilled water for 3 times. These were treated with the sodium hypochlorite (0.2%) solution and were thoroughly washed with sterile distilled water. Now the suckers are treated with Magnesium chloride (0.1%) solution, then treated with distilled water for 3 times to remove the traces of MgCl₂. Shoot tips containing rhizome tissue and measuring 2.5 to 3.5cm in length were isolated, surface sterilized with chlorine-saturated distilled water for 15 to 20 min. All traces of chlorine were removed by washing several times with autoclaved, sterile distilled water. Sterilized shoot tip, explants are handled using sterilized stainless steel scalpels. Cut surfaces of the rhizomatous tissue and leaf bases are further trimmed so that shoot tips finally contain at least six to eight overlapping leaf bases enclosing auxiliary buds (Hamide and Mustafa Pekmezcu, 2004). The explants are now ready for inoculation and measures 1 to 2 cm. It is then immersed into the sterile solid medium present in the culture vessel.

Inoculation of explants (Mustaffa, 2011; Daniells, 1997)

After surface sterilization meristematic tissues were inoculated in to culture tubes containing MS medium with different growth supplements using sterile forceps which was immersed in 70% ethanol and flamed. An average of one meristematic tissue was inoculated per culture tube. After inoculation the tubes were closed with tight cotton plugs. After inoculation the culture tubes were maintained in a BOD incubator at a temperature of 18-20 °C with light intensity of 1000 lux. The explants are sub-cultured regularly in a new culture medium.

Induction of growth

Cultures should be incubated in the MS nutrient media supplemented with plant growth regulators. There upon the healthy, contamination free explants should be taken for next multiplication stage. Contamination free explants were further cultured on multiplication media supplemented with plant growth hormones which help in proliferation of axillary buds (cytokinins) into multiple shoots. These shoots are divided and multiplied to bulk up the multi culture stock. The multiplication cycles are restricted to 8 because Banana is genetically highly unstable.

Shooting and Rooting

Multi cultures are further divided and transferred to shooting media which is composed of auxins (PGR) to get the elongation. In this stage leaves will develop and the whole plant will grow up to 4 to 5 cm. Plantlets from shooting media are separated and single plantlets are transferred to media containing charcoal and auxins. In this stage roots will develop and plants will be ready for dispatch from laboratory. Well developed plantlets produced, were taken from the bulk and grown individually on separate culture media. After a month, the rooted plantlets are ready for hardening. To minimize somatic variation, the sub culturing is restricted to a maximum of seven cycles when each bottle contains 25-30 plantlets with well developed shoots and roots. Experiments have demonstrated that proliferating shoots can be transferred to polybags (10-20 cm size) having rooting media under green house. This reduces cost and enhances better establishment. Polybag provides enough space for plant growth and natural light enhances the process of hardening.

Primary Hardening (*Hamidegubbuk et al., 2004*)

Once the plantlets are ready for shifting outside the laboratory, they are carefully acclimatized to adapt to the green house and later to least protected field conditions. During hardening, the plantlets undergo physiological adaptation to changing external factors like water, temperature, relative humidity and nutrient supply. The plantlets from culture vessels/bottles are moved from the laboratory to a room at ambient temperature and kept open for 4-6 days. Later they are shifted to greenhouse for primary hardening where they are first gently washed free of agar medium. This is important as sucrose in agar encourages microorganisms. 8 cm shoots with 3-4 ramified roots are planted in individual micropots in a tray. In places where weather is conducive (24-26 °C temperature and more than 80 % humidity), the plantlets are hardened for 4-6 weeks in mini-sand beds. During this period, 90-95 % humidity is maintained for the initial 6-8 days under diffused light. The humidity is slowly reduced to 70 %, light intensity raised to normal and temperatures brought to 26 °C by the end of 6 weeks. Structures used for primary hardening vary with the climatic conditions. These can be highly sophisticated with UV-stabilized polysheet covering, multiple misting options, and thermal shade net and auto-monitoring of light intensity, temperature and humidity. On the other hand, the structures can be simple with polycarbonate roofing, shade net on all sides with fogger facilities. Temperature, RH and light intensities are monitored manually using thermometer, hygrometer and lux meter, respectively. Planting media for primary hardening range from sieved sand augmented with nutritions to mixtures of cocopeat and Soilrite with fine sand in equal proportions. NPK is provided in liquid form on weekly basis.

Secondary hardening: (*Ummey Habiba et al., 2002*)

After primary hardening for 5-6 weeks, the plantlets are transferred from micropots to polybags. Base substrate is generally soil and sand along with low cost materials like coir pith, sawdust or rice husk. Organic manure is either in the form of farmyard manure or poultry manure. In Andhra Pradesh, India, Press mud, a by-product of sugar factories, has been found to provide best substrate for secondary hardening along with soil. Plantlets from micropots are, dipped in fungicide solution (0.1% Bavistin) and planted in polybags containing

suitable substrate. Initially, these are maintained in low light intensity shade nets and 70 % RH. The plants are hardened by gradually increasing the light intensity and reducing RH (40 %). After 5-6 weeks, the plants become ready for field planting having 3-5 well developed leaves and a good mass of fibrous roots. During both primary and secondary hardening, the stocks should be rogued for variants at weekly intervals. These could include vegetative deformities like dwarfism, leaf variegation, rosette foliage and leaf crinkiness.

Manuring and plant protection in nursery: (*Sathiamoorthy et al., 1998*)

Plantlets should be 2-3 weeks old before any fertilizer is applied. 100 ml water containing 0.5 g urea, 2 g superphosphate and 1 g muriate of potash can be applied per plant. The manuring is repeated by doubling the dosage after three weeks. Spraying of commercially available micronutrient mixtures during sixth week helps in better establishment both in nursery and field. Strict sanitary measures are adopted in the nursery to avoid the risk of damage by pests and diseases either through substrate or irrigation water.

Field planting and initial management

20-30 cm tall plants with 3-5 broad leaves are ready for field planting. At the time of planting, 10 g of Carbofuran is applied per plant. Watering is done soon after field planting as young micropropagated plants are sensitive to dry weather and heat. Since these are also highly susceptible to bacterial rot (*Erwinia* rot), within 3 days of planting the soil around the plants is drenched with 500 ml of 0.1 % Emissone (methyl ethoxy mercuric chloride). Recommended package of practices is strictly followed to achieve successful field establishment and subsequent vigorous growth.

Collection of conventional suckers

The conventional suckers purchased from the local farmers, Guntur, Andhra Pradesh. The suckers planted were of uniform size (2.5 kg), healthy and free from diseases. They were exposed to sunlight for a week prior to their planting. The pseudostem and leaves were cut off and basal sort skin was removed to expose the adventitious root initials so that they come in contact with the soil easily. The suckers were dipped in Bavistin solution (1%) to prevent rhizome rot. Suckers were then kept under the shade for a week before planting.

Plantation of Plantlets and Suckers (*Vasane et al., 2006*)

The conventional suckers and tissue culture plantlets were planted separately. Ten plants each of tissue culture plantlet and conventional suckers were planted separately to compare their performance through growth and yield parameters. The experimental field was thoroughly ploughed and harrowed by repeating cross-wise twice by a power tiller to obtain a levelled land with good till. Simultaneously, laddering was done for breaking clods and removing weeds. Pits of 45 cm × 45 cm × 45 cm size were dug with a spacing of 2 m × 2 m. Well rotten farm yard manure (thoroughly mixed with top soil) at the rate of 5 kg per pit and 300 gm single super phosphate (SSP) was used at the time of planting as basal dose. Afterwards urea (675 g) and MOP (636 g) each was applied in four equal split doses per plant. The first split of urea and MOP was applied 45 days after planting. The second urea and MOP split

was applied 100 days after the first split while the third urea split was applied 100 days after the second split application. The fourth urea and third MOP split was applied together nine months (reproductive stage) after planting while the fourth MOP split was applied 60 days thereafter. Before the initiation of shooting, NPK complex (19:19:19) was sprayed while potassium nitrate (KNO_3 @ 5 g per litre) was sprayed on bunches to improve the quality. Extra dose of 100 g urea and 200 g MOP was applied in case of tissue culture banana plantlets because of their faster growth. Micronutrient mix (Transco 5® i.e. micro mix with B, Zn, Mn and Cu @ 2 g per litre) was foliar sprayed 5th and 7th month after planting. The crop was flood irrigated as when necessary i.e. four irrigations 5, 7, 9 and 13 months after planting were applied to plants under experiment no 2 and 3. Weeds were controlled by three manual (1, 8 and 11 months after planting) and two weeding with power tiller (3 and 6 months after planting).

Data on plant growth and yield characters (Linsmaier and Skoog, 1975)

The Yield and growth parameters were taken after bunch harvesting. The harvested bunches were weighed. The number of hands per bunch was counted. Finger length was determined by measuring the outer curve of individual fruit of the second hand of bunches. Bunch weight was used as an index of fruit yield. The average value of these parameters

were tested for their significance with paired t-test and F-test. Table value at 9 degrees of freedom in T test is 2.093, p value tested for their significance with paired t-test and F-test. Table value at 9 degrees of freedom in T test is 2.093, p value 0.05. Table value at (9, 9) degrees of freedom in F test is 0.314, p value 0.05. If calculated value is more than table value the difference between the means is considered significant and otherwise, it is non-significant.

RESULTS AND DISCUSSION

The growth parameters yield attributes, yield and benefit cost ratio were significantly higher in tissue culture plants than the sucker grown plants (Table 2). Tissue culture plantlets were superior to conventional suckers in terms of yield and income with better growth and yield parameters. The highest pseudostem height (224.49 cm), pseudostem girth (71.21 cm), number of suckers (9.25), number of leaves (24.48), leaf length (165.12 cm), leaf breadth (44.00 cm), leaf area (1.02 m²), and yield attributes like bunch length (79.96 cm), bunch diameter (38.76 cm), bunch weight (25.16 kg), hands per bunch (10.71), fingers per bunch (152.17), finger length (18.45 cm), finger diameter (24.57 cm) and finger weight (311.02 g) were also significantly higher in tissue culture plants than the sucker grown plants. The lengthened phyllochron (14.05 days), days taken to shooting (345.67 days) and shooting to maturity (100.65 days) was noted in plantation raised with conventional sucker.

Table 1. MS media composition

S.No	Medium	Ingredients	Quantity	Stock standard	Working standard (for 1 lit)
1	Stock solution (A)	1. Ammonium nitrate 2. Potassium nitrate 3. Calcium chloride 4. Magnesium sulphate	16.5 g 19.0 g 4.4 g 3.7 g	500ml	50ml
2	Stock solution (B)	1. Potassium di hydrogen phosphate	1.7 g	100 ml	10 ml
3	Stock solution (C)	1. Boric acid 2. Manganese sulphate 3. Zinc sulphate 4. Disodium molybdate	62 mg 223 mg 86 mg 2.5 mg	100 ml	10 ml
4	Stock solution (D)	5. Copper sulphate 6. Cobalt chloride 1. Ferrous sulphate 2. Disodium EDTA	0.25 mg 0.25 mg 0.278 mg 0.373 mg	100 ml	10 ml
5	Stock solution (E)	1. Nicotinic acid 2. PyridoximHCl 3. ThiaminHCl	50 mg 50 mg 10 mg	100 ml	1 ml
6	Stock solution (F)	1. Potassium iodide	83 mg	100 ml	1 ml
7	Additives: (Directly added to the medium)	1. Myoinositol 2. Glycine 3. Sucrose 4. Cysteine mono HCl			100 mg 2 mg 30 g 40 mg
8	Plant growth regulator	Cytokinin hormone Benzylamino purine			5 mg 5mg

Table 2. Growth parameters

S. No	Parameters	Growth characters (At shooting)			
		Tissue culture	Suckers	T test	F Test
1	Number of leaves	24.48	22.59	1.67 (S)	0.86 (NS)
2	Number of sucker plant	9.25	11.68	1.63 (S)	0.03 (S)
3	Leaf length (cm)	165.12	183.99	1.21 (S)	0.13 (S)
4	Leaf breadth (cm)	44	51.25	1.83 (S)	0.38 (NS)
5	Leaf area (m ²)	1.02	0.84	0.003 (S)	0.001 (S)
6	Pseudostem height (cm)	224.49	201.15	5.19 (NS)	0.096 (S)
7	Pseudostem girth (cm)	71.21	67.13	1.51 (S)	0.033 (S)
8	Phyllochron (days)	14.5	15.91	1.25 (S)	0.82 (NS)
9	Days to shooting	345.67	367.07	5.04 (NS)	0.6 (NS)
10	Days taken from shooting to maturity	100.65	122.59	2.21 (NS)	0.85 (NS)
11	Crop duration (days)	100.45	122.68	3.87 (NS)	0.7 (NS)

S- significant, NS- Non Significant, For T test, Table value 2.093, p(0.05), dF(9), For F test, Table value 0.314, p(0.05), dF(9, 9)

Table 3. Yield characters

S. No	Parameters	Yield characters			
		Tissue culture	Suckers	T test	F test
1	Finger length (cm)	18.45	14.662	1.12 (S)	0.18 (S)
2	Finger diameter (cm)	24.57	23.68	0.003 (S)	0.57 (NS)
3	Finger weight (g)	311.02	250.48	1.89 (S)	0.42 (NS)
4	Fingers/bunch	152.17	140.5	9.69 (NS)	0.61 (NS)
5	Bunch length (cm)	79.96	59.74	4.49(NS)	0.16 (S)
6	Bunch diameter (cm)	38.76	35.62	3.05 (S)	0.004 (S)
7	Bunch weight (Kg)	25.16	20.2	1.11 (S)	0.73 (NS)
8	Hands/bunch	10.71	8.17	1.48 (S)	0.3 (S)
9	Yield (t/ha)	65.85	44.26	1.33 (S)	0.5(NS)
10	Cost of cultivation (lakh/Hec)	1.12	0.88	3.72(NS)	0.04(S)
11	Benefit cost ratio	2.52	1.36	2.70(NS)	0.64(NS)

S- significant, NS- Non Significant

For T test, Table value 2.093, p (0.05), dF(9)

For F test, Table value 0.314, p(0.05), dF(9, 9)

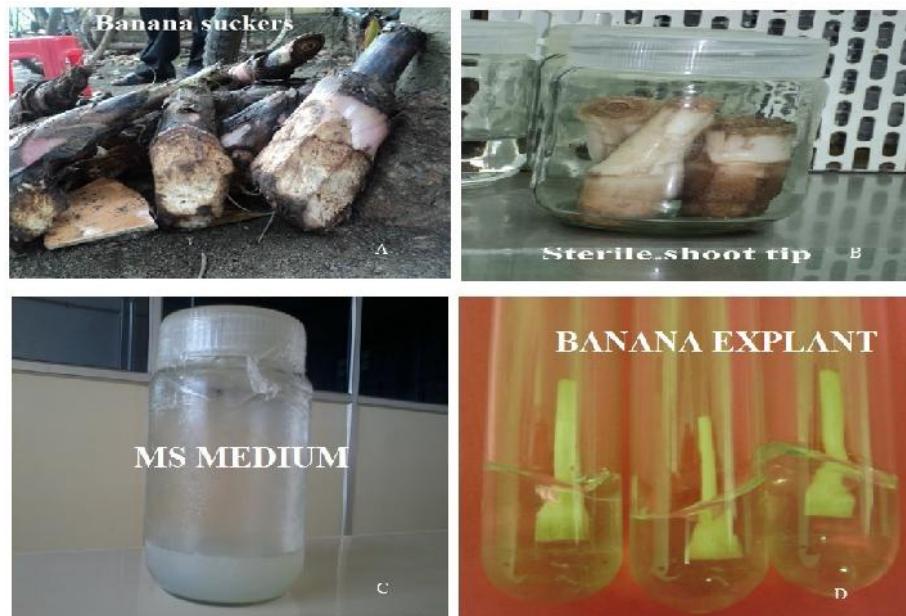
**Figure 1. A. Banana suckers from healthy plant, B.Sterile Shoot tip for Explants preparation, C.Sterile MS medium for Explants inoculation and D.Inoculated Banana Explant****Figure 2. A. Banana Explant, B.Shoot initiation in Banana plant, C.Root initiation in banana plant and D.Transplantable plantlets**



Figure 3. Plantlets under Green house



Figure 4. A. Banana plantlets ready for field, B. Banana plant on the field and C.Matured Banana plant and ready for harvest

Tissue culture crop yielded 65.85 t/ha, which was 67.21 % higher than the yield of conventional sucker (44.26 t/ha) grown crop and as a result crop grown with tissue culture plantlets had a benefit cost ratio of 2.52 as compared to 1.36 of crop grown with conventional suckers. At shooting the height and girth recorded for tissue culture Comparative plants were 224.49 cm and 71.21 cm, which was 23.34 and 4.08 cm, respectively higher than the plants developed through suckers. At shooting there were 24.48 leaves per plant in tissue culture plant which was on an average 1.89 leaves per plant higher than sucker developed plant. Leaf area of tissue culture plants did not significantly differ at vegetative stage but differed significantly at shooting stage i.e. tissue culture plants had higher leaf area than the conventional sucker plants. Tissue culture plants requires on an average 21.4 and 21.94 days, respectively lesser than sucker developed plants to reach shooting and then shooting to maturity which is significantly lesser. The bunch and finger characters were superior in case of tissue culture plantlets. Tissue culture crop yielded 65.85 t/ha which was 66.5 % higher than the yield of conventional sucker grown crop and as a result crop grown with tissue culture plantlets had a benefit cost ratio of 2.52 as compared to 1.36 of Crop grown with conventional suckers.

Thus, it is clear that Banana (*Robusta* sp) crop grown with tissue culture plantlets than Banana (*Robusta* sp) grown with conventional suckers are superior in yield, income, better growth and yield parameters. Similarly, it was reported that *in-vitro* banana plants of Giant Cavendish (Brown *et al.*, 1995) Dwarf Cavendish and Grand Naine (Kwa and Ganry, 1990) Nendran (Robinson and Anderson, 1995) Basrai banana (Sheela and Nair, 2001) and Dwarf Cavendish and Robusta (Badgujar *et al.*, 2005) were superior to conventional suckers due to their vigorous growth. There is difference in growth and physiology of tissue culture plants compared to plants from suckers throughout the crop growth stages, which was recorded significantly better in case of tissue culture plantlets as compared to its sucker produced plants.

Summary and Conclusion

Banana (*Musa* spp.) is the earliest crop plants having been domesticated by humans. Bananas are consumed as ripe fruit, whereas plantains, which remain starchy even when fully ripe, need cooking for palatability and consumption. Originally range of climatic conditions. While bananas have come to crops from humid tropics, they have acclimatized to a broad have remained a staple food of many ethnic groups. Occupy the

status of a high value, commercial crop, plantains Irrespective of their commercial status, banana and plantains are referred as 'Poor man's apple'. Banana is globally ranked fourth, next to rice, wheat and maize in terms of gross value of production. It is a major staple food crop for millions of people as well as provides income through local and international trade. Among the starchy staple food crops, banana ranks third with respect to the total production. Though cassava and sweet potato are positioned as first and second, banana and plantain have almost equal importance in all the tropical regions of the world. Traditional bananas and other species of family *Musaceae* have been the major calorie source of many ethnic tribes of Africa and Pacific Islands. Plant Tissue Culture is culturing of any part of the plant in a specially defined growth media under aseptic laboratory condition. Banana plants produced from Tissue Culture Techniques are prepared, free from diseases and they give high yields since they are regenerated from selected high yielding mother plants (Mustaffa and Kumar, 2012). In vitro propagation of bananas provides excellent advantages over traditional propagation, including a high multiplication rate, physiological uniformity, the availability of disease-free material all the year round, rapid dissemination of new plant materials throughout the world, uniformity of shoots, short harvest interval in comparison with conventional plants, and faster growth in the early growing stages compared to conventional materials. In banana, the difficulty to obtain large number of uniform disease free plants with high yield potential by the conventional propagation of techniques is one of the major limiting factors in increasing productivity. Another important problem faced by the growers is the staggered flowering (variability in time of flowering) (Strosse *et al.*, 2006; Alagumani, 2005). Tissue culture technology enabling the rapid production of a large quantity of uniform disease free plants from a single plant showing good genetic potential and high yield. This research paper explains the production of Banana plantlets from shoot tip and how it is superior then conventional sucker propagation method.

Acknowledgements

The author thanks the SNES management, Ongole, Sri Sai Soma Biotech, Guntur (AP), Tamilnadu Agricultural University, Madurai and Andhra Pradesh Horticulture Research Station, Kovvur, West Godavari, Andhra Pradesh for providing Research facilities and funding to carry out this work.

REFERENCES

- Ahsan A. Kadhim, Arshad NajiAlhasnawi, Azhar Mohamad, Wan Mohtar Wan Yusoff and CheRadziahBintiCheMohd Zain. 2014. Tissue culture and some of the factors affecting them and themicropropagation of strawberry. *Life Science Journal*, 11(8): 1-5.
- Aishmuhammad, Iqbal hussain, S.M. Saqlannaqvi and Hamid Rashid. 2004. Banana plantlet production through Tissue culture. *Pak. J. Bot.*, 36(3): 617-620.
- Akin-Idowu. P. E., Ibitoye, D. O. and Ademoyegun, O. T. 2009. Tissue culture as a plant production technique for horticultural crops. *African Journal of Biotechnology*, 8(16): 3782-3788.
- Alagumani T. 2005. Economic Analysis of Tissue-cultured Banana and Sucker-propagated Banana. *Agricultural Economics Research Review*, 18: 81-89.
- Amornwat Srangsam and KamnoonKanchanapoom. 2003. Thidiazuron induced plant regeneration in callus culture of triploid banana (*Musa* sp.) 'Gros Michel', AAA group. *J. Sci. Technol.*, 25(6), 689-696.
- Atique Akbar M and ShyamalK. Roy. 2006. Effects of Liquid Medium on Rooting and Acclimation of Regenerated Microshoots of Banana (*Musa sapientum* L.) cv. Sagar. *Plant Tissue Cult. & Biotech.*16(1): 11-18.
- Badgjar, C. D., Deshmukh and Dusane. 2005. A field comparison of conventional suckers with in-vitro derived planting material of basrai banana. *Agricultural ScienceDigest*.25: 149-150.
- Brown, D.C.W., Finstad, K.I. and Watson, E.M. 1995. Somatic embryogenesis in herbaceous dicots. In: Thorpe, T.A. (Ed). *In vitro embryogenesis of plants*. Kluwer Academic Publishers. Dordrecht, The Netherlands, pp. 345-416.
- Daniel Coyne, Arthur Wasukira, Jolly Dusabe, IdowuRotifa, Thomas Dubois. 2010. Boiling water treatment: A simple, rapid and effective technique for nematode and banana weevil management in banana and plantain (*Musa spp.*) planting Material. *Crop Protection*, 29: 1478-1482.
- Daniells, J. W. 1997. Beware the potential hazards of tissue culture. *Infomusa*, 62: 17-18.
- Dennis Thomas T. 2008. The role of activated charcoal in plant tissue culture. *Biotechnology Advances*, 26: 618–631
- Francois Lecompte, Loic Pages, 2007. Apical diameter and branching density affect lateral root elongation rates in banana. *Environmental and Experimental Botany*, 59, 243–251.
- Hamide G.BB.K, Mustafa Pekmezcu. 2004. In Vitro Propagation of Some New Banana Types (*Musa spp.*).*Turk J Agric.*, 28: 355-361.
- Hamidegubbuk, Mustafa pekmezci, A. Naci onus and Mustafa erkan. 2004. Identification and selection of superior banana Phenotypes in the cultivar dwarf Cavendish Using agronomic characteristics and rapid markers. *Pak. J. Bot.*,36(2): 331-342.
- Harish S, M. Kavino, N. Kumar, D. Saravanakumar, K. Soorianathasundaramb andR. Samiyappan, 2008. Biohardening with Plant Growth Promoting Rhizosphere and Endophytic bacteria induces systemic resistance against Banana bunchy top virus. *Applied soil Ecology*, 39: 187–200.
- HathraTaskin, GokhanBaktemur, Mehmet Kurul, and SaadetBuyukalaca. 2013. Use of Tissue Culture Techniques for Producing Virus-Free Plant in Garlic and Their Identification through Real-Time PCR. *The Scientific World Journal*, Article ID 781282:1-5.
- Huang Yonghong, Yi Ganjun, Zhou Birong, Zeng Jiwu and Wu Yuanli. 2006. Progress of Methodology of Genetic Transformation of Banana. *Molecular Plant Breeding*, 4(3): 79-84.
- Juliet Akello, Thomas Dubois, Clifford S. Gold, Daniel Coyne, Jessica Nakavuma and Pamela Paparu. 2007. *Beauveriabassiana* (Balsamo) Vuillemin as an endophyte in tissue culture banana (*Musa spp.*). *Journal of Invertebrate Pathology*, 96, 34–42.
- Juliet Akello, Thomas Dubois, Daniel Coyne and Samuel Kyamanywa. 2009. The effects of *Beauveriabassiana* dose and exposure duration on colonization and growth of tissue cultured banana (*Musa* sp.) plants. *Biological Control*, 49, 6–10.
- Kothari,SL, A. Joshi, S. Kachhwaha and N. Ochoa-Alejo. 2010. Chilli peppers - A review on tissue culture and transgenesis. *Biotechnology Advances*, 28: 35–48.

- Kwa, M. and J. Ganry. 1990. Agronomic use of banana in vitro plants. *Fruits*. 107-111 (spl.).
- LianJie, Wang Zifeng, Cao Lixiang, Tan Hongming, InderbitzinPatrik, Jiang Zide and Zhou Shining. 2009. Artificial inoculation of banana tissue culture plantlets with indigenous endophytes originally derived from native banana plants. *Biological Control*.51: 427–434.
- Linsmaier, E.M. and Skoog, F. 1975. Organic growth factor requirements of tobacco tissue cultures. *Physiologia Plantarum*, 18: 100.
- Masoud Sheidai, HeywaAminpoor, Zahra Noormohammadi, Farah Farahani. 2010. Genetic variation induced by tissue culture in Banana (*Musa acuminata* L.) cultivar Cavendish Dwarf. *Gene conserve*, 9: 1-10.
- MeenakshiSidha, P. Suprasanna, V. A. Bapat, U.G. Kulkarni and B.N. Shinde. 2007. Developing somatic embryogenic culture System and plant regeneration in banana. 285: 153 - 161.
- Michael W. Bairu, Catherine W. Fennell and Johannes van Staden. 2006. The effect of plant growth regulators on somaclonal variation in Cavendish banana (*Musa AAA* cv. 'Zelig'). *ScientiaHorticulturae*, 108: 347–351.
- Muhammad Youssef, Andrew James, Alberto Mayo-Mosqueda, Jose Roberto Ku-Cauich, Rosa Grijalva-Arango and Rosa Maria Escobedo-GM. 2010. Influence of genotype and age of explant source on the capacity for somatic embryogenesis of two Cavendish banana cultivars (*Musa acuminataColla*). *African Journal of Biotechnology*, 9(15): 2216-2223.
- MunguatoshaNgomuo, Emerald Mnene, Patrick A. Ndakidemi, 2014. The *In Vitro* Propagation Techniques for Producing Banana Using Shoot Tip Cultures, *American Journal of Plant Sciences*, 5: 1614-1622.
- Murashige T, Skoog F. 1962. A revised medium for rapid growth and bioassays with tobacco tissue cultures. *Physiol. Plant.*, 15: 473-497.
- Murashige, T. 1974. Plant propagation through tissue culture. *Annual Review of Plant Physiology*,25: 135.
- Mustaffa, M. M. 2011. Vision (2030) National research Centre for Banana, Tiruchirapalli, India.
- Mustaffa, M. M. and V. Kumar. 2012. Banana production and productivity enhancement through spatial, waterand nutrient management. *Journal of Horticultural Sciences*, 7: 1-28.
- NafeesAltaf, Abdul rehman khan, Liaqatali and Inksarahmad Bhatti. 2009. Tissue culture of gerbera. *Pak. J. Bot.*, 41(1): 7-10.
- Robinson, J. C. and T. Anderson. 1995. Tissue culture banana plants versus conventional sucker-component of yield.
- Citrus and Sub-Tropical Fruit Research Station, Information Bulletin No. 210.
- Sathiamoorthy, S., Uma, S., Selvarajan, R., Shyam, B. and Singh, H.P. 1998. Multiplication of Virus Free Banana Plants through Shoot Tip Culture. NRCB, Tiruchirapalli, Tamil Nadu, India. pp. 60.
- Sheela, V. L. and S. R. Nair. 2001. Growth, flowering and yield potential of tissue culture banana (*Musa AAB* cv. Nendran). *Journal of Tropical Agriculture*, 39: 1-4.
- Shongwe, R. Tumber, M.T. Masarirambi and A.N. Mutukumira. 2008. Soil water requirements of tissue-cultured Dwarf Cavendish banana (*Musa spp. L*). *Elsevier Physics and Chemistry of the Earth*, 33, 768–774.
- ShongweV.D, R. Tumber, M.T. Masarirambi and A.N. Mutukumira. 2008. Soil water requirements of tissue-cultured Dwarf Cavendish banana (*Musa spp. L*). *Elsevier Physics and Chemistry of the Earth*, 33: 768–774.
- Strosse H, H. Schoofs, B. Panis, E. Andre, K. Reyniers and R. Swennen, 2006. Development of embryogenic cell suspensions from shoot meristematic tissue in bananas and plantains (*Musa spp.*). *Elsevier Plant Science*, 170: 104– 112.
- Thomas HappiEmaga, RadoHerinavalonaAndrianaivo, Bernard Wathelet, Jean Tchangotchango and Michel Paquot, 2007. Effects of the stage of maturation and varieties on the chemical composition of banana and plantain peels. *Food Chemistry*, 103: 590–600.
- UmmeyHabiba, Sharmin Reza, MihirLalSaha, M. R. Khan and Syed Hadiuzzaman. 2002. Endogenous Bacterial Contamination during *In vitro* Culture of Table Banana: Identification and Prevention. *Plant Tissue Cult*, 12(2): 117-124.
- Vasane, R., Shailesh R.M. and Kothari. 2006. Optimization of secondary hardening process of banana plantlets (*Musa paradisiacal* L. var. Grand Naine). *Indian Journal of Biotechnology*, 5: 394-399.
- Venkatachalam Lakshmanan, Sreedhar Reddampalli Venkataramareddy and Bhagyalakshmi Neelwarne; 2007. Molecular analysis of genetic stability in long-term micropropagated shoots of banana using RAPD and ISSR markers, *Electronic Journal of Biotechnology*, 10 (1), 106-113.
- Wirakarnain, S., A.B.M.S. Hossain and S. Chandran. 2008. Plantlet Production through Development of Competent Multiple Meristem Cultures from Male Inflorescence of Banana, *Musa acuminata*cv. 'Pisang Mas' (AA). *AmericanJournal of Biochemistry and Biotechnology*, 4(4), 325-328.
