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Macropropagation in Banana: Response to Hormone and Genome in Sucker Production

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Authors' contributions

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

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ABSTRACT

Banana (*Musa spp*.) is the most important fruit crop of the world. The production of banana propagules for different scales of its cultivation by local farmers is still an important researchable issue as micropropagation is the only available source for plantlets production. An experiment on macro-propagation of banana belonging to three different genomic groups (AAA, AAB, ABB) was conducted at the Department of Plant Physiology, BCKV Mohanpur, West Bengal to study the induction of sucker through application of BAP @40 ppm. The substrate used for planting the corms were a mixture of sawdust + *Trichoderma* @ 15 g kg^{-1} of sawdust + vermicompost @ 15 g kg^{-1} of sawdust. Observations recorded were weight of the corm, days to appearance of the first primary suckers, number of primary suckers, number of secondary suckers, number of tertiary suckers and total number of suckers. The number of primary suckers induced ranged between 1.67 in Dwarf Cavendish (AAA) to 5.33 in Lacaton (AAA), while the number of secondary suckers induced ranged between 0.67 in Srimanti (AAA) to 22.00 in Manohar (AAB). The number of tertiary

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suckers induced were only observed in the genomic composition AAB with 4.00 and 0.67 in both the genotypes Madhurangbale and Manohar respectively. Days to bud appearance varies from 7.33 in Madhurangbale (AAA) to 29.33 days in Basrai (AAA). The weight of the corm also varied from 5.56 kg in Madhurangbale (AAA) and 2.06 kg in Kothia (ABB).

Keywords: AP; corms; genomic group; genotypes; macro-propagation.

1. INTRODUCTION

Banana (*Musa spp)* is a very popular fruit due to its low price and high nutritive value. In India, banana is mostly a crop of marginal framers and it is mostly propagated through vegetative propagation as cultivated varieties of banana are seedless. Propagation techniques in banana can be broadly classified into macro-propagation (conventional) and *in-vitro* or micro-propagation (tissue culture) methods [1]. Banana plantlets produced using the tissue culture technology are more vigorous and higher yielding [2] but it is constrained by high capital, skill requirements and specialized equipment [3]. Even though tissue culture produces more plantlets than macro-propagation, the number of plantlets, shoot height and percentage survival of plantlets from macro-propagation technique makes it a suitable alternative to tissue culture since it is farmer friendly and less expensive [4].

A **sucker** is a shoot that develops from a lateral bud on the rhizome (corm). It is a form of vegetative reproduction that developed and emerged next to the mother pseudostem at the base of the plants, with strong vascular connection to the mother corm. Removal of these sucker from the corm can promote rapid vegetative propagation and sprouting [5]. Thus, shoots produced are removed and hardened in the nursery to obtain small plants. Up to 60 plantlets, depending on the banana cultivar used can be obtained from a single corm within four months [6]. The advantages of propagation through suckers are mainly the low planting material cost, lesser input requirements and easiness in conserving native and rare varieties [7,8]. The corm of a harvested plant, also known as a bullhead, can be used for these methods and up to 150 suckers can be harvested per corm [9,10]. Evaluation of macro-propagation practice using sawdust as initiation media, supplemented with various biofertilizers results in highest number of uniforms sized tertiary bud production [11].

Cytokinins are adenine-derived plant hormones that stimulate cell division and cell differentiation. Natural Cytokinins are produced by tissues that are still active, especially in the roots, embryos and fruit. Benzyl Amino Purine (BAP) a synthetic cytokinin is known to reduce apical dominance and thus promotes the formation of lateral shoots and adventitious root growth [12,13].

2. MATERIALS AND METHODS

The investigation presented was carried out during March to August, 2022 at the Nutrio-physiology laboratory, Department of Plant Physiology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal. The geographical location of Mohanpur is 22.95^{o}N and 88.53^{o}E. Eight banana genotypes belonging to three different genomic composition (Table 1) were taken for the experiment. Corms were collected from banana plantation garden of AICRP – Fruit Crops, Horticulture Research Station, Mandouri Farm, Bidhan Chandra Krishi Viswavidyalaya.

After harvesting of the banana bunch, the corms (rhizome) were removed from a well-watered field and detopped just above the juncture of the corm and aerial shoot (Fig. 1 A) followed by proper washing under running tab water. The external layer and the roots of these corms were removed together with any dead tissue to reduce nematode infestation [14] (Fig. 1 B). The apical meristem of the corm was then punctured by making a cross-like (+) incision (Fig. 1 C). The

Table 1. list of the eight Banana genotypes with their genomic composition

Genomic composition→	**AAA**	**AAB**	**ABB**
Cultivar Name→	Lacaton Srimanti Basrai Dwarf cavendish	Madhurangbale Manohar	Pantharaj Kothia

corms were then further treated with a systemic fungicide, carbendazim @ 4 g $L^{-1}$for 15 minutes and air-dried in shade for 2 hours. The substrate used for planting of these corms were a mixture of sawdust + Trichoderma @ 15 g kg^{-1} of sawdust + vermicompost @ 15 g kg^{-1} of sawdust. Corms were planted in a wooden tray and covered fully with sawdust. The corms were then watered immediately after planting.

BAP @ 40 ppm were given as a treatment at weekly intervals through foliar mode of application. The substrate was watered every alternate day to linger moisture. The newly produced suckers (Fig. 1 D) were excised from the mother corm at a weekly interval after development of the sprouts. The sucker that came out directly from the corm were considered as primary suckers (Fig. 1D). On excision of the primary suckers from the corm, the apical meristem was again punctured with a cross incision to promote lateral sprouting from this primary bud. New suckers that came out from the surface of the cut wound on the corm were considered as secondary suckers (Fig. 1 E) as they were not directly connected with the corm tissue, their connection with the corm tissue were via basal remnant tissues. The sucker that came out from the remnants of the secondary sucker were considered as the tertiary suckers (Fig. 1 F). Total number of primary, secondary and tertiary buds formed at the end of 3rd month was recorded. Other parameters measured were days to appearance of the first and subsequent primary suckers and weight of the corm.

The Mean, CD and SE data in all the cases were subjected to statistical analysis following Completely Randomized Design with three replications using OPSTAT version 7.1 software.

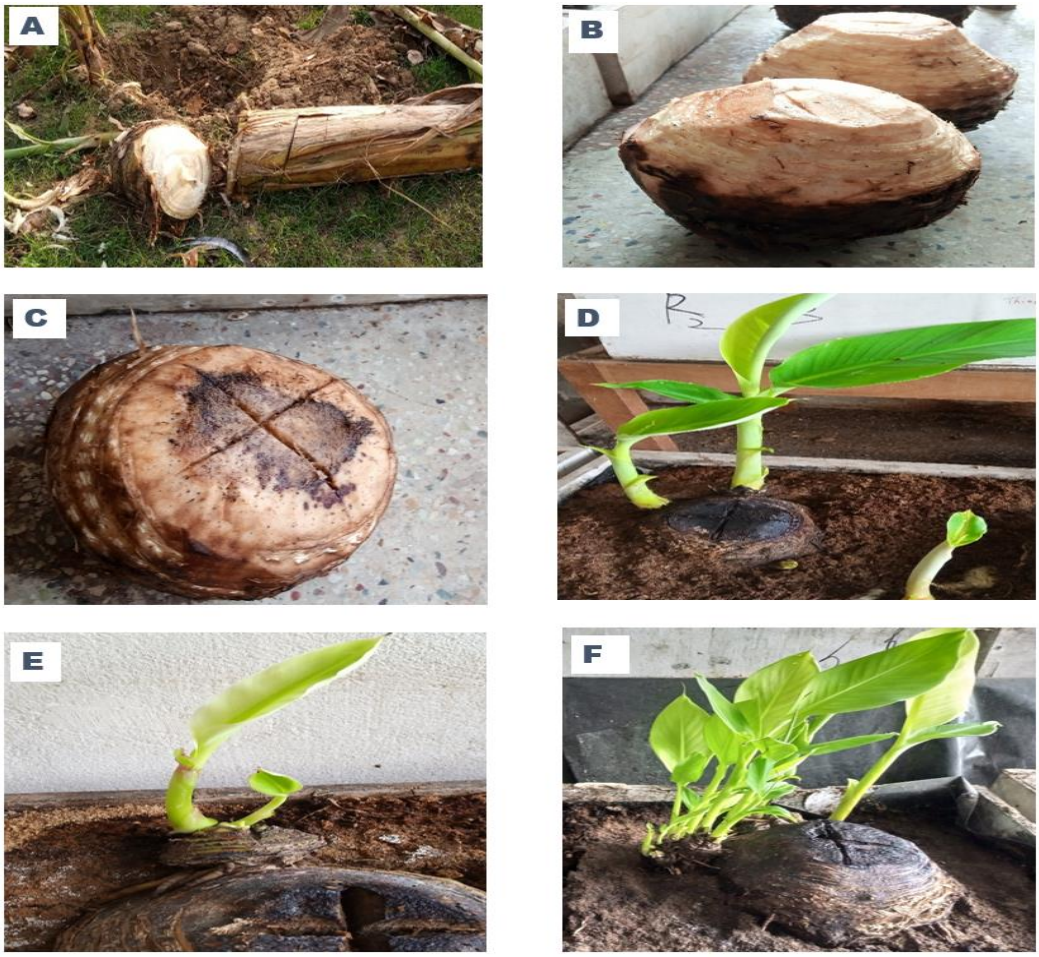

Fig. 1. (A) Detopped banana corm after removal from the field. (B) Removal of leaf sheet and roots followed by proper cleaning. (C) Cross incision marks on the apical meristem of a corm. (D) Development of primary sucker from the corm. (E) Development of secondary sucker from the corm. (F) Development of tertiary sucker from the corm

3. RESULTS AND DISCUSSION

3.1 Effect of BAP on Primary Sucker Induction

Sucker induction in all the genotypes varied with their genomic composition (Table 2). The response to BAP treatment in generating highest number of primary sucker were observed in Lacaton (AAA) followed by Madhurangbale (AAB) which are on par and having mean values of 5.33 and 5.00 respectively. Whereas, the lowest number of primary suckers induced were observed in Dwarf cavendish (AAA) and Kothia (ABB) with 1.67 and 2.33 respectively. Bhende and Kurien [1] claimed that hormonal methods like application of Ethrel, GA_3, Paclobutrazol, BAP and IAA etc. might have positive effect on sucker induction.

3.2 Effect of BAP on Secondary Sucker Induction

The number secondary sucker generated was observed to be highest in the genomic composition of AAB in both the genotypes Manohar and Madhurangbale (Table 2) with 22.00 and 15.33 respectively, whereas, the other two genomic composition were observed to generate a smaller number of secondary suckers, the lowest being recorded in Srimanti (AAA) and Dwarf cavendish (AAA) with 0.67 and 1.67 respectively.Banana in such cases only produced secondary sucker but BAP plays a significant role in the banana genomic composition (AAB) for inducing profuse number of secondary suckers.

3.3 Effect of BAP on Tertiary Sucker Induction

The tertiary sucker induction was found to occur only in the genomic composition AAB with 4.00 and 0.67 in Madhurangbale and Manohar respectively (Table 2) while the rest of the genotypes does not have the capacity to generate tertiary suckers.

3.4 Total Number of Suckers

The total number of suckers generated from the post-harvest banana corms of all the eight genotypes was most efficacious in the genomic composition AAB (Table 2). Manohar and Madhurangbale were observed with the highest total number of suckers generated at 26.00 and 24.33 respectively. While, the genomic composition of AAA was observed to be the lowest in generating sucker with 3.34 in Dwarf cavendish, 4.00 in Srimanti, 4.34 in Basrai and with an exception of 9.00 total sucker generated in Lacaton. The Genomic composition ABB were found to perform slightly better than the genomic composition AAA with the total number of suckers generated 7.67 and 5.66 in Pantharaj and Kothia respectively. In most of the sucker induction studies BAP was reported to enhance the number suckers in all tiers: primary, secondary and tertiary [15,2,11]. Cytokinin of course induces axillary buds but source of that cytokinin may be internal or external. Plant material respond to external application of the hormone when internal status is low but. When internal supply is high the external application of it may be toxic what probably happened in the corms of Srimanti and Dwarf cavendish of the genomic composition AAA where only few suckers was generated.The variation of sucker emergence of different banana genotypes in responses to BAP may be attributed to some genetic variability as well as the constituent content of auxins and cytokinins in the plant tissue [16]. Msogoya and Mwakisitu [17] demonstrated that relatively low concentrations of thidiazuron, a diphenyl urea based cytokinin, effectively induced multiple shoots in banana. Similar shoot proliferation responses to BAP were reported by Thiemele et al, [18] and Muhammad et al, [19].

3.5 Days to Response of BAP

Times taken for the banana post-corm to generate first primary sucker from the day of planting varied from 7.33 in Madhurangbale (AAA) to 29.33 days in Basrai (AAA) (Table 3). BAP applications had no effect on the number of days to lateral shoot emergence [12]. Early response of the post-harvest corm to BAP may stimulate numerous suckers as observed in the experiment. This may be due to the active metabolic activity of the corm that when BAP is treated cell division occur rapidly and both organic and inorganic reserved in the corm were utilized at the earliest. The corms that took longer time to response maybe due to the corm dormant stages where in most cases corm after harvesting of a bunch tend to goes dormant for a period of time. The varietal difference among the banana cultivars in respect of duration required for bud activation was also reported by Baiyeri and Aba [14].

Table 2. Effect of BAP on Sucker Induction

Genomic composition	Banana Genotype	Primary sucker (mean)	Secondary Sucker (mean)	Tertiary sucker (mean)	Total sucker
	Lacaton	5.33	3.67	0	9.00
AAA	Srimanti	3.33	0.67	0	4.00
	Basrai	2.67	2.33	0	4.34
	Dwarf cavendish	1.67	1.67	0	3.34
AAB	Madhurangbale	5.00	15.33	4.00	24.33
	Manohar	3.33	22.00	0.67	26.00
ABB	Pantharaj	3.00	4.67	0	7.67
	Kothia	2.33	3.33	0	5.66
	Mean	**3.33**	**6.71**	**0.58**	**10.54**
	CD	**1.234**	**1.671**	**0.203**	**N/A**
	SE	**0.408**	**0.553**	**0.067**	**2.862**

Table 3. Effect of BAP on the days to response with total number of suckers produce with reference to the weight (kg) of the corms

Genomic composition	Banana genotype	Weight of corm (kg) (mean)	Days to response (mean)	Total Sucker
AAA	Lacaton	3.44	19.67	9.00
	Srimanti	3.73	15.00	4.00
	Basrai	2.73	29.33	4.34
	Dwarf cavendish	3.15	12.33	3.34
AAB	Madhurangbale	5.56	7.33	24.33
	Manohar	5.22	23.33	26.00
	Pantharaj	5.31	29.00	7.67
ABB	Kothia	2.06	28.67	5.66
	Mean	**3.90**	**20.58**	**10.54**
	CD	**0.838**	**3.904**	**N/A**
	SE	**0.277**	**1.291**	**2.862**

3.6 Weight of the Corm

The post-harvest banana corm also varied in their fresh weight (Table 3). The genotypes Madhurangbale (AAB) and Manohar (AAB) were found to weigh 5.56 kg and 5.22 kg respectively and this may state that banana corm of higher fresh weight produces a greater number of suckers which may be due to the greater capacity of the large corms to supply basic substances for the sucker production, Similar result was also reported by Tchoa et al. [20]. However, the genotype Pantharaj (ABB) with 5.31 kg generated only 7.67 number of total sucker and this may be due to the genotypic condition in which the cultivar Kothia of same genomic composition with 2.06 kg were also found to generate 5.66number of total sucker [21]. This applies the same with the genomic composition AAA where corms of dwarf cavendish and Srimanti weight 3.15 kg and 2.723 kg respectively generates only 3.34 and 4.00 number total sucker each.

4. CONCLUSION

Post-harvest banana corms were mostly found to be shy in response in production of sucker from the corm at the tray with substrate (saw dust/rice husk) without intervention of any bioregulators or plant hormones. The Banana with genomic composition AAB was found to be the best for induction of sucker production through application of BAP. It induces highest number of primary secondary and tertiary sucker. Macro-propagation of banana corms for inducing sucker is a suitable alternative to tissue culture since it is and less expensive and farmer friendly, and healthy corms left in the field after harvesting could therefore be recovered and produce suckers.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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