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Parent Planting Materials' Effect On Sucker Multiplication Of Plantain

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Abstract: Getting enough planting materials for a year round production has been one of the major problems in plantain production in Ghana. Plantain suckers multiplication is a new technology to solve the problem of low planting materials. The planting-material-type may have effect on the ability of a sucker to give enough plantain plantlets. This research work was carried out to identify the sucker-types effect of two cultivars of plantain on the multiplication technique. The cultivars of plantain used included Apantu (False horn) and Apem (French horn) cultivars. The four main types of suckers used included buds, peepers, sword and maiden suckers in sawdust substrate. The experiment was laid out in 4 x 2 factorial randomized complete block design (RCBD) with three replications. Data were collected on sprouting rate of explants, number of plantlets sprouted; height, girth and fresh weight of harvested plantlets and average number of roots of harvested plantlets. The Apantu genotype recorded 1.08 sprouts per day as compared to the Apem genotype which recorded 0.97 sprouts per day. The sword suckers among the sucker types gave the highest sprout rate of 1.28 and 1.16 sprouts per day. Plantlets harvested from Sword suckers recorded the best physical parameters of 85.9g of fresh weight, 56.4cm of plantlets height, and 1.9cm of stem diameter in three weeks after planting. The results indicated that all the sucker-types could be selected for sucker multiplication technology. However, the number of plantlets a sucker produced with the use of the tissue manipulation technique was largely based on the size and age of the parent suckers. The Apantu genotype produced more vigorous sprouts among the genotypes while the sword suckers gave the best sprouts among the sucker types.

Keywords: Plantain, Sword Suckers, Peepers, Maiden Suckers, Buds, 'Apantu' (False Horn), 'Apem' (French Horn)

I. INTRODUCTION

Plantain, also known as cooking banana in some parts of the world, is one of the major staples in the world (Moffat, 1999). It contributes to about 13.1% to the agricultural domestic product in Ghana (Buah *et al.,* 2010). In 2007, Ministry of Food and Agriculture (MOFA) of Ghana reported that the national production of plantain increased by 230%. FAOSTAT (2013) recorded a production quantity of 3.6 billion kilograms of plantain harvested in an area of 3.3 billion square meters. Locally, the crop ranks high in food preference with about 95% consumed locally, a clear demonstration that the crop is overwhelmingly important as a food crop for local consumption than as an export commodity (Buah *et al.*, 2010). The crop, being rich in iron and other essential nutrients, is noted for the production of many local dishes such as 'fufu', 'kelewele', 'red red', 'eto', 'mpotompoto', 'oguor', 'borededwo' and other important dishes that are of economic value. Not only use as food for humans, the peels and leaves are also rich source of nutrients for domestic animals. The

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leaves as well as the pseudostem also perform other roles in the society such as the production of fabrics, cover for cocoa fermentation, medicinal formulations, regalia for festivities etc. The production of this important crop recently has not seem more light mainly due to other factors such as planting materials acquisition. As the crop is pathernocarpic (Simmonds, 1955; Okoro *et al*., 2011), the only available planting materials are the vegetative parts. Hence propagation typically involves removing and transplanting part of the underground stem or the corm (Courteau, 2012). Usually this is done by carefully removing a sucker which is a vertical shoot that develops from the base of the plantain pseudostem. Available suckers mostly used by farmers include peepers (young suckers bearing scale leaves only), sword suckers (suckers bearing narrow sword leaves), maiden suckers (large but non fruiting ratoon with foliage leaves) (Swennen *et al.*, 1984; Blomme *et al*., 2008 and Crane *et al*., 2013) and sometimes water suckers (suckers with weak connections to parent pseudostem that develop broad leaves at earlier stage) (Robinson, 1996 and Nelson *et al.*, 2006). Since farmers mostly rely on suckers for planting, scientists have developed various innovations to multiply plantain suckers to make plantain materials more accessible to farmers and also to ensure the commercial production of the crop. Some of these techniques include; false decapitation, true decapitation, bending over, split corm, the use of ex-plants, tissue culture and tissue manipulation technique (Singh *et al.*, 2011; FAO, 2010; Lefranc, *et al.*, 2010). Although the use of tissue culture technique has proven to be more effective, it is very expensive to set up a laboratory or prepare a media for the technique. It requires expertise in biotechnology to work on this method. Furthermore, plants are delicate and therefore special skills are needed to handle them. Losses can also be severe due to contamination. Farmers cannot use this technique so far as they do not have the technical know-how. This means that the biotechnology techniques are not catalytic enough to be truly transformational in the agricultural sector. This is especially evident in the rural areas of a developing country, such as Ghana, where most of the farmers mainly practice subsistence agriculture who cannot afford suckers from the research institutes. The new technique recently developed is the tissue manipulation technique which offers huge potential to produce adequate planting materials (Dzomeku and Osei, 2006). This technique is based on the idea that plantain consists of underground stem known as the corm. The corm consists of a central bud or apical meristem, from which the leaves and the flowers are initiated. Thus it is from the corm that the bunch is initiated. The corm of the plantain also has lateral buds which grow as suckers. When the apical bud is killed and the lateral buds are given the right environmental conditions, they sprout as new suckers. Thousands of healthy plantain seedlings could be produced within the shortest possible time with the technique. The number of suckers produced varies considerably according to the genotype or the parent material (Doublegist, 2013). The main aim of this research was to identify the sucker type that would respond more positively to this technique.

II. MATERIALS AND METHODS

EXPERIMENTAL DESIGN AND TREATMENTS **-** The experiment was laid-out in a 4 x 2 factorial randomized complete block design (RCBD) with three replications. The factors and their levels studied were: types of suckers [(i) buds, (ii) peepers, (iii) sword suckers and (iv) maiden suckers] and genotypes [(i) Apem, and (ii) Apantu]. There were eight (8) treatments with three (3) replications. A total of one hundred and ninety two (192) plantain suckers were used with eight (8) suckers for each treatment.

BUILDING THE SPROUTING CHAMBER **-** A sprouting chamber measuring 6 m by 2 m was built using locally available materials. The base was covered with slabs of 30 cm across breadth and then filled with fine sawdust to 30 cm thick. The chamber was divided into sub-plots and then built air-tight with translucent poly-ethylene sheets. A shed was then raised on the sprouting chamber to provide 50% shade.

PLANTING AND HARVESTING **-** Healthy planting materials with well-developed underground stems were collected and cleaned. The leaf sheaths were removed 2 mm above the leaf collar systematically until the apical meristem was reached. The apical meristem was then destroyed and washed with tap water. The ex-plants were buried in the sprouting media at a depth of 3 cm. A nematicide (Fura 3g) was broadcasted on the two sprouting chambers a day after planting at a rate of 10 g/m^2. Sprouted plantlets were harvested three weeks after planting. These were carefully detached from the main underground stem by the use of kitchen knife.

DATA TAKEN AND ANALYSIS- Number of plantlets sprouted were determined by counting. Sprouting rate was calculated as the ratio of sprouted plantlets to total number of planted materials. Plantlets height, width and weight were measured using a graduated measuring pole, electronic scale (Scout Pro electronic Scale, capacity - 2000g), and vernier caliper respectively. Number of leaves and roots for each harvested plantlets were counted and recorded. Data were subjected to Standard Analysis of Variance using GenStat Release 10.3DE (PC/Windows 7). The means were separated using Least Significant Difference (Lsd) at $p \leq 0.05$.

III. RESULTS

The results showed that the total number of plantlets sprouted revealed significant differences ($P \leq 0.05$) among genotypes and sucker types (Table 3). Peepers and sword suckers performed significantly higher ($P \leq 0.05$) than the buds and maiden suckers for the two genotypes. Apantu suckers recorded approximately 65 sprouts which was significantly higher ($P \leq 0.05$) than the Apem suckers (Table 3). The peepers, sword and maiden suckers recorded significantly ($P \leq 0.05$) higher sprouting rate than the buds. The average fresh weight of sucker-types used showed significant genotype x sucker-type interactions (Table 1). The Apantu suckers were significantly heavier ($P \leq 0.05$) than the Apem suckers and similar differences were observed among sword suckers of both genotypes. The buds were less than 0.5 kg whereas the peepers, and maiden suckers were approximately 1kg for the Apantu suckers (Table 1).

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Generally, a differential pattern observation observed was; the older the sucker, the heavier the weight. This might be due to effect of growth regulators and therefore increasing the weight of the plantlets at different stage of growth (Harms and Oplinger, 1988; Gray, 2004). Plantlets developed from sword suckers and peepers also recorded very high fresh weight than plantlets taken from maiden suckers and buds. Similarly, plant height and stem girth of Apantu was higher than Apem genotypes (Table 3). Plantlets generated from sword suckers and peepers comparatively recorded faster growth rate than those of buds and maiden suckers (Table 3). Plantlets height of Apantu and Apem ranged between 25 cm to 80 cm and 10 cm to 55 cm (Figures 1 and 2) while the stem diameter ranged between 1.17 cm to 1.70 cm and 0.66 cm to 1.22 cm (Table 4) respectively. Among the sucker types, Apantu sword suckers recorded the highest height of about 79.0 cm at 96 days after planting. The number of leaves developed increased with time and averaged between 5 to 6 leaves per plantlet within 96 days (Table 5).Leaves on average increased by one (1) per 14 days during the monitored growth time of the plantlets. There was no significant difference among genotypes and the sucker types for number of root per plantlet. However plantlets from sword suckers and peepers recorded slightly greater number of roots per plants than those of buds and maiden suckers (Table 3).

TABLES AND FIGURES

Sucker type	Weight of Suckers(g) Apantu	Apem
Buds	0.41±0.2	0.22±0.1
Peepers	0.98±0.4	0.37±0.1
Sword	1.65±0.3	0.49±0.1
Maiden	1.19±0.3	0.77± 0.2

Table 1: Average Fresh Weight of the Different Sucker-types Used for the Research

	Sprout rate [number of plantlets sprouted/day] in 30 days after planting Apantu	Apem
Sucker-types		
Buds	0.88	0.66
Peepers	1.05	1.01
Sword	1.28	1.16
Maiden	1.14	1.04
$Lsd_{(0.05)}$	0.35	0.35
Genotypes	1.08	0.97
$Lsd_{(0.05)}$	0.50	0.50

Where $Lsd_{(0.05)}$ – Least significantly different; Sword suckers gave the highest sprouting rate among the four sucker-types.

Table 2: Sprouting Rate of Suckers

	Total Number of Sprouts	Fresh Weight [g]	Plantlets Height [cm]	Plantlets Girth [cm]	Roots Per Plantlets
Genotype					
Apantu	64.8	85.9	56.4	2.0	2.6
Apem	35.4	36.0	40.3	1.2	2.6
$Lsd_{(0.05)}$	7.3	8.8	4.3	0.1	0.5
Sucker-type					
Buds	45.1	28.9	38.2	1.1	2.4
Peepers	55.7	69.2	51.9	1.8	2.7
Sword	58.3	89.4	55.5	1.9	2.8
Maiden	41.2	56.2	47.8	1.5	2.5
$Lsd_{(0.05)}$	10.3	12.4	6.1	0.2	0.7

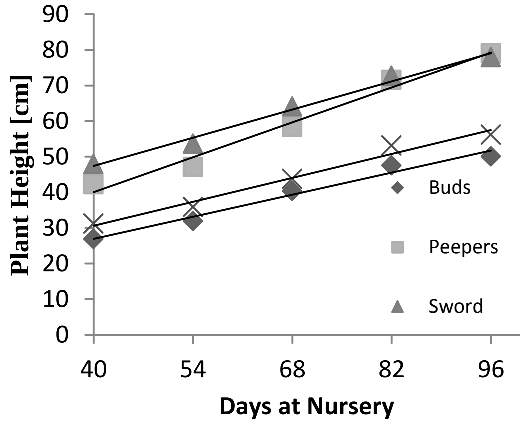
Plantlets from Apantu genotype responded well to growth; the plantlets from sword suckers among the sucker types also outperformed the other plantlets

Table 3: Physical Parameters of Plantlets Harvested

DAH	40	54	68	82	96DAH
Genotype					
Apantu	1.17	1.31	1.47	1.60	1.70
Apem	0.66	0.77	0.92	1.09	1.22
$Lsd_{(0.05)}$	0.12	0.05	0.05	0.06	0.07
Sucker-types					
Buds	0.68	0.80	0.96	1.09	1.21
Peepers	0.93	1.08	1.24	1.38	1.53
Sword	1.15	1.27	1.42	1.60	1.79
Maiden	0.90	1.0	1.17	1.32	1.43
$Lsd_{(0.05)}$	0.17	0.08	0.07	0.09	0.10

Table 4: Increase in Stem Diameter of Plantlets Forty Days after Harvesting

(A) Increase in Height of Apantu at Nursery



(B) Increase in Height of Apem at Nursery

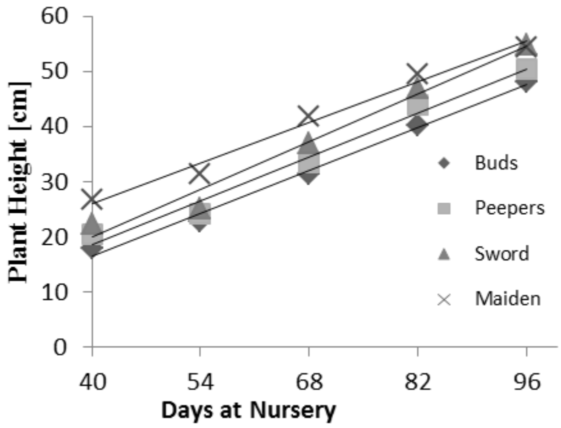


Figure 1: Increase in Height of Apantu and Apem Plantlets Forty Days after Harvest as Influenced by Sucker Types

DAH	40	54	68	82	96DAH
Genotype					
Apantu	3.0	3.9	4.8	5.3	5.6
Apem	3.1	4.0	4.7	5.3	5.6
$Lsd_{(0.05)}$	0.3	0.3	0.4	0.5	0.4
Sucker-type					
Buds	3.0	3.9	4.8	5.4	5.8
Peepers	3.0	3.8	4.7	5.3	5.7
Sword	3.1	4.0	4.7	5.1	5.3
Maiden	3.3	4.0	4.9	5.3	5.7
$Lsd_{(0.05)}$	0.4	0.4	0.6	0.7	0.6

Table 5: Number of Leaves Produced Forty Days after Harvest

IV. DISCUSSION

Development of efficient and inexpensive plantain sucker multiplication technique is an important step and contribution to improve plantain production. All the sucker types used for this study responded to the multiplication technology. This agrees with Vuylsteke (1989) who reported that all plantain plant parts that contain a shoot meristem can be used to multiply plantain suckers. However, Swennen *et al.* (1984) and Blomme *et al.* (2008) reported that suckers available for plantain plantations include peepers, sword and maiden suckers and this is reflected in the Data at Table 2 where peepers, sword and maiden suckers responded earlier to sprouting than the buds. Sword suckers comparatively recorded the highest sprouting rate as compared to the other sucker types mainly due to their large corms and therefore more lateral buds to sprout with enough preserved food for the developing mini-suckers (Hardy Tropicals, 2010). Manoharan (2012) observed that larger explants had the merits of consisting of a shoot apex bearing more lateral buds which rapidly develop into shoots. This observation also agrees with Board (2005) who reported that sword suckers produce many plantlets after planting and it is the best sucker for planting. Selecting vigorous sword sucker from superior and true-to-type mother plant is good to reduce somaclonal variation and therefore increase sucker multiplication in tissue culturing (Janick and Paul, 2008).

The maiden suckers, although had larger corm and responded earlier to sprouting, did not produce more suckers as the other sucker types. The sprouting rate of maiden suckers was similar to the peepers and the sword suckers within the first thirty (30) days after planting (Table 2). However, their performance reduced during the subsequent harvest. Fewer yields were recorded from maiden suckers as compared to the other suckers. The sprouting ability of the sucker types might be due to three main factors; strong and persistent apical dominance, availability of meristematic cells, and size of the corm (Robinson, 1996; Blomme *et al.* 2008; Yildiz, 2012; Farzana *et al.* 1998; Sime, 2013). Corms from maiden suckers were large alright but might have less meristematic cells and strong apical dominance due to age effect. In their study to determine the effect of age of seedlings and phytormones on micropropagation of *Indica rice* (*Oryza sativa* L.) from meristem culture, Farzana *et al.* (1998) observed that 4 - day old seedlings gave highest regeneration than the 5- and the 7-day old seedlings, and noted that a fast regeneration may be due to the presence of meristematic cells in 4 - day old seedlings. Aging could cause internal change like accumulation of growth inhibitors, metabolic and enzymatic depletion of essential enzymes, denaturation of proteins and damaging to synthesizing ability and increasing sensitivity to stress conditions and field pathogens (Sime, 2013). The buds had the meristematic cells to divide for faster growth but were slowed by few reserved food in the corm. This may indicate that the sucker size may serve as a contributing factor to the growth performance of the plantlets. Similarly, Rajan and Markose (2007) reported that size of sucker is important since it contains reserved food for early growth of future plants. The size of the corm is important in split corm technique; the larger the size of the corm the more the physical performance of the plantlets (Ferris, 1998).

Among the genotypes studied the plantlets from the Apantu genotype performed better than the plantlets from the Apem genotype which might be due to varietal effect and the differences in the sizes of the available parent materials. Yildiz (2012) elaborated that factors such as genotype, physiological stage of donor plant, explants source, explants age and explants size are some of the factors that affect explants regeneration. Similar genotypic differences in yield were also observed by Khadiga *et al.* (2009) when they studied the effect of genotype and growth regulator on *in-vitro* micro propagation of potato (*Solanum tuberosum* L). Beeds *et al*. (2008) reported that a positive correlation exists between mother crop and sucker growth characteristics across most genotypes of plantain, with fast-growing mother plants having better developed suckers. Several authors have encountered variation among genotypes in the degree and pattern of shoot bud proliferation *in-vitro* and that the varying degrees of *in-vitro* bud proliferation suggest that levels of endogenous growth regulators differ between genotypes (Vuylsteke, 1989).

V. CONCLUSION

Four main sucker types of two types of plantain were grown in sawdust media. The results indicated that all the sucker types could be selected for sucker multiplication technology – i.e. the tissue manipulation technique. The number of plantlets a sucker produced with the use of the tissue manipulation technique was largely based on the size of the corm and age of the suckers. Middle age suckers, such as the peepers and sword suckers had good sprouting ability and good seedlings performance than the maiden suckers and the buds. The Apantu genotype produced more vigorous sprouts than the Apem genotype, which may be due to varietal effect and initial weight of the parent materials.

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