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RESPONSE OF SELECTED LOCAL PLANTAIN CULTIVARS TO PIBS (PLANTS ISSUS DE BOURGEONS SECONDAIRES) TECHNIQUE

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Abstract: One major constraint to plantain production has been inadequate healthy planting materials at the time of planting. Several technologies for multiplying healthy planting materials exist but could not meet farmers' demand. A study was conducted to assess the performance of various landraces plantain to plants *issus de bourgeons secondaires* (PIBS) technique. Five cultivars of *Musa sapientum* (Apantu (False Horn), Asamienu (True Horn), Oniaba (intermediate French plantain) and FHIA-21 (tetraploid hybrid plantain) were tested to determine their response to the PIBS technique. Sword suckers of each cultivar with weight of between 0.2-0.5 kg were prepared and buried in fine sawdust in a humidity chamber built using transparent polyethylene sheets. Results at harvest showed that removal of rooted sprouts started three weeks after planting and every week thereafter for eight weeks. The intermediate French plantain cultivar (Oniaba) produced the least average number (about 20) of healthy planting. Apantu (False Horn) produced an average of about 75 healthy planting materials. The hybrid FHIA-21 on the other hand generated an average of about 85 healthy planting materials. Asamienu (True Horn) produced the highest healthy seedlings of about 90 healthy planting materials. The results revealed that the leaf scar carries a primary bud at the intersection of each leaf sheath and several eyes along the entire length of the leaf sheath which could not have developed into suckers. However, with this technique the eyes could be activated to sprout as healthy planting materials. The technique proved as an efficient method of multiplying healthy planting materials for plantain and could thus be recommended for adoption not only by peasant farmers but also to others who could become commercial seed producers. But there will be a need for certification guidelines for seed growing systems.

Keywords: *Musa*, plantain, macro-propagation, planting material, PIBS

Introduction

Plantains and bananas are classified according to genome group. Majority of cultivated plantains are triploid (2n = 3x = 33), that are derived from intra-specific crosses within *Musa acuminata* Colla (A genome) and inter-specific crosses between *M. acuminata* and *Musa balbisiana* Colla (B genome). The remainder is mostly diploid, while tetraploid clones are naturally rare. The tetraploid plantains are often as a result of breeding programmes by research. They are also classified as belonging to False Horn, True Horn and French plantain groups based on the morphology of the fruits. Local landraces of plantain a member of the AAB subgroup is among Africa's most important starchy food and cash crops [STOVER & SIMMONDS, 1987]. Nearly 30 million tons of plantain is produced yearly in Africa, mostly by small holders and consumed locally [FAO, 2010]. It is

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a crop suitable for the humid forest zones with high rainfall conditions. Despite the economic potential of plantain, farmers are confronted with high yield losses caused by pest and disease constraints such as nematodes [FOGAIN, 2000], banana weevils, and foliar diseases such as black leaf streak (*Mycosphaerella fijiensis*) and invasive weeds [ROBINSON, 1996] such as *Chromolaena odorata*, *Panicum maxima*, etc [HAUSER & MEKOA, 2009]. In the traditional low input systems, no pesticides are used and integrated control methods are still not user friendly for farmers.

Plantains are a perennial tropical and subtropical crop, which grow in a wide range of environments. However, the plantain production systems can be divided into three broad categories depending on the number of cultivars grown and the intensity of management. Plantains are starchy even when ripe compared to banana and are only eaten when cooked.

Though the average yield of local plantain in Ghana is 11.0 metric tons per hectare (mt/ha) [SRID-MOFA, 2011], the potential achievable yield of the landraces is 20.0 mt/ha. The yield gap of 9.0 mt/ha could be attributed to several factors. Nonetheless, the achievable yield potential of the crop could be attained if research efforts are geared toward using high-yielding landraces which are already tolerant to the adverse biotic and abiotic factors complemented with elite materials and other agronomic practices.

Plantain as parthenocarpic (produces fruit without fertilization) and seedless, it is propagated traditionally by planting corms and suckers (daughter plants that grow from the rhizomes at the base of the mother plants). Due to the unavailability of disease- and pest-free or clean planting materials, farmers in sub-Saharan Africa traditionally plant suckers derived from their own plantations, most of which are affected with pests and diseases. The morphology of the crop shows that each leaf scar carries a bud [SWENNEN & ORTIZ, 1997]. The quality of the planting material is one of the major factors for successful crop production [TENKOUANO & al. 2006]. In plantain production, farmers use planting material from old plantain fields, irrespectively of the health status of the mother plant. Often planting materials derived from these infected mother stocks results in perpetuation of diseases (e.g. viruses such as banana bunchy top, banana streak) and pests (e.g., nematodes and weevils) leading to low yields and poor quality fruits.

It is evident that farmers have no strong concept of infectious plant pests and diseases that are propagated by infested suckers. Poor sucker quality leads to high plant losses [HAUSER, 2000], and shortened plantation longevity [GOCKOWSKI, 1997] with occasional complete failure of the ratoon crop [HAUSER, 2007]. These could subsequently lead to over 50% yield losses.

The poor quality and inadequate planting materials is threatening plantain production. Unlike grains and legumes, plantain is vegetatively propagated. It is evident that quality planting material coupled with good agronomic practices could contribute to achieving the productive potential of plantain in Ghana. Bioversity International with their partners Latin America in their study reported that high quality planting material (genetic and phytosanitary) has been shown to contribute significant gains in productivity in smallholder systems in Latin America. Intra-varietal variability is well known to occur naturally in plantains, but only recently is this being considered as an opportunity for selecting improved planting materials [CÔTE & al. 2008]

Also, developing techniques for the rapid propagation of clean, healthy planting material through *in vitro*, which yield high performing and true-to-type plantlets through somatic embryogenesis, has been successful [CÔTE & al. 1993; VULSTEKE, 1998]. Simplified macro-propagation techniques and more traditional sanitation techniques of suckers have not been overlooked [AUBOIRON, 1997; KWA, 2002, 2003; TENKOUANO

& al. 2006; HAUSER & MESSIGA, 2010]. However, the high cost and low availability of planting material, especially healthy, good quality material with varietal traceability, is viewed as a major constraint and key obstacle for improved plantain productivity [NKENDAH & AKYEAMPONG, 2003]. While traditionally heavy emphasis has been placed on breeding activities, agronomic and pest management constraints have also received significant attention [SWENNEN & VUYLSTEKE, 1993; ORTIZ & VUYLSTEKE, 1998; BAIYERI & TENKOUANO, 2008].

In field production of plantain, numerous types of planting materials exist. They are classified into sword, maiden, peeper, and water suckers. The sword and maiden suckers are generally considered the most productive planting materials. Nonetheless, any type of sucker could be used for planting. Furthermore, corms of harvested plants could also be cut into small pieces and planted. This, however, would lengthen the crop cycle of the plant crop.

An important condition for the optimization of yield of any crop is the use of healthy planting material [DAS & BORA, 2000]. The planting material used in banana and plantain cultivation is mainly confined to its vegetatively propagated suckers because plantains and bananas are parthenocarpic and seeds are sterile.

Five methods are commonly employed to obtain planting material for the establishment of new planting material of plantain: (i) suckers extracted from plantain fields which are in production; (ii) suckers reproduced in field sucker multiplication plots; (iii) plants from micro-corms grown out in a nurseries; (iv) plants originating from secondary buds (PIBS), produced in a humidity chamber, seedbeds and grown in nurseries; and (v) tissue culture plants grown in two-phase nurseries [TEZENAS DU MONTCEL, 2005; FAO, 2010].

Tissue culture technique can produce large quantities of uniform disease-free healthy planting materials within a short time. The technique also requires small space. However, this is not accessible to farmers, as it requires sophisticated laboratory facilities. The micro-corm grown and sucker produced in field sucker multiplication plots on the other hand could be used by farmers but require space. These techniques could produce about four (4) suckers from a medium size sucker of about 0.2-0.5 kg. Some buds are also destroyed by these techniques. Planting materials produced from these techniques also require paring before planting. They also pass through a lag phase during transplanting compared to tissue culture-derived plants. The quality of planting materials produced from these processes is always of concern to the buyer and quality controllers.

The PIBS is the latest *in vivo* technology developed to optimize sucker production [KWA, 2002]. Like all other plants each plantain leaf bears an axillary (primary) bud at the point of overlapping of the leaf sheath. However, the architecture of the plant is such that several secondary buds occur along the entire length of the base of a leaf sheath [KWA, 2002]. Most of these buds remain dormant and never become suckers in the lifetime of the plant. These dormant buds could be activated to produce healthy planting materials within a short time. The entire potential of the corms and suckers could thus be exploited to produce large quantities of healthy planting materials within a short period. However, information on the amount of healthy planting materials that could be produced from an average sucker is scanty. Demand for plantain suckers in large quantities is currently very high. The objective of this study was to evaluate the response of the various cultivars to the new technique (PIBS).

Materials and methods

Plantain (*Musa* spp. AAB group) are triploid (2n = 33 chromosomes) starchy bananas, whose seedless parthenocarpic fruits are eaten cooked because they are unpalatable when raw. The Apantu, Asamienu and Oniaba used in this study are all triploid plantains. The FHIA- 21 belongs to the genome group AAAB with a ploidy level of 4x. The hybrid is cross between AAB Plantain cv. AVP-67 (French Plantain) x SH-3142.

Ten (10) sword suckers each of Apantu (False Horn), Asamienu (True Horn), Oniaba (Intermediate French) and FHIA-21 (Tetraploid hybrid) were removed, cleaned and pared. Suckers weighing between 0.2 kg and 0.5 kg were used for the experiment. The leaf sheaths were removed (de-sheathing) 2 mm above the collar till the apical meristem was exposed [KWA, 2002]. The materials generated (now called explants) were kept in a clean and cool environment until all the explants were ready. The apical dominance was destroyed with crosswise incision made to the collar of the first leaf from the base. The explants were planted 3cm deep in smooth redwood sawdust in a locally made humidity chamber. The experiment was set up in a Complete Block Design (CBD) and replicated three times and repeated three times. The column was watered regularly to maintain moist environment. Harvesting of sprouts began three weeks after planting (WAP) in sawdust. Harvesting of sprouts was done once a week from the third week to the eighth week after planting in the sawdust. The harvested sprouts were transplanted in polyethylene pots filled with sterile loamy soils and placed under 60% shade net. Data was collected on number of sprouts harvested, sources of sprouts, survival of sprouts in polyethylene bags, establishment six weeks after harvesting from sawdust. Data was analyzed using ANOVA.

Results and discussion

Sprouting was observed two weeks after planting in the sawdust. Harvesting of the proliferations started four weeks after planting and planted in polyethylene bags. The rooted plantlets and plantlets without roots were removed at weekly intervals for five weeks. Healthy rooted seedlings became ready for field planting after six weeks in the polybag.

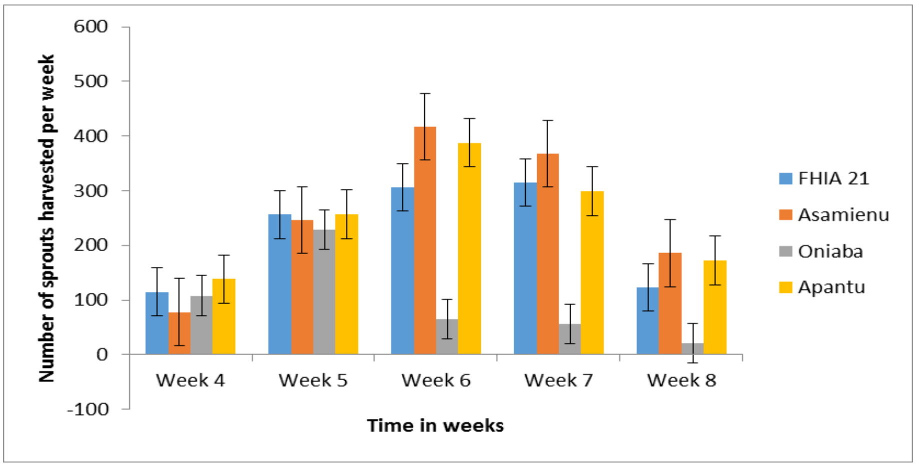

Fig. 1. Local plantain cultivars' response to PIF technique

The PIBS technique is an on-farm macro-propagation approach developed for mass propagation of healthy planting materials of plantains and bananas. The technique is applicable to other vegetatively propagated crops like cocoyams and pineapples. The technique is applicable all-year round and farmers can schedule to raise their planting materials to meet the planting season.

The results of the investigation revealed a significant effect of the chamber on healthy planting material production. Asamienu (True Horn) produced the largest number (92) of healthy suckers (Fig. 1). There was a significant increase in the number of sprouts harvested from week four to week six for Asamienu and Apantu and then declined after that. With regard to Oniaba, there was a sharp decline five weeks after planting in the chamber (Fig. 1). On the other hand, FHIA-21 produced constant numbers during the fourth and fifth weeks.

Asamienu produced the largest number of healthy seedlings with the highest harvested during the sixth week. However the number dropped drastically (Fig. 1). FHIA-21 (hybrid plantain) produced proliferations faster compared to all the other cultivars (Fig. 1).

Average production per sucker was at 86±7 for FHIA-21. Apantu produced consistent planting materials for the fifth and sixth weeks (Fig 1). Sucker production by Oniaba was the least (24±5) among the cultivars (Fig. 1). This result quite agrees with the study of SINGH & al. (2011) who estimates about 50 seedlings per sucker. In another study, [CTA & ISF, 2011] reported an average of 10 harvested sprouts per sucker using this technique.

The study discovered that each leaf scar on the corm, in addition to carrying a primary bud [SWENNEN & ORITZ, 1997], also has several latent secondary buds that will never have developed into daughter suckers.

It was evident that a high percentage (65%) of the sprouts was produced from the apical meristematic region (Plate 1 (a) and (b)).

Plate 1 (a and b). Sprouting meristems

Often it is only few of the primary buds that develop into daughter suckers when the apical dominance is removed at flowering. However, with this technique, several of these latent eyes could be activated to sprout as healthy seedlings for planting. The study further revealed that the ability of the secondary buds to sprout was also dependent on the removal of the leaf sheaths very close to the leaf collar (about 2 mm above the leaf collar). The ability of the eyes to sprout could be attributed to the high temperature (about 50 ºC) generated within the growth chamber. The harvested sprouts when planted in the direct sun got scorched. The seedlings had to be acclimatized under 60% shade (Plate 2).

The study showed that the ability of the technology to exploit the full potential of the sucker planted in the sawdust was dependent on some key factors. Notable among them include (i) ability to remove the leaf sheath at two millimeters above the leaf collar. Inability to remove the leaf sheath at the appropriate level results in a situation where the sheaths continue to grow hence prevents the sprouting of the buds. (ii) ability to destroy the apical dominance. Inability to break the apical dominance results in the apical tissue continue to grow. Also inability to bury the explants in the sawdust enough (3 cm) exposes the surface leading to surface dryness with not sprouts.

In a similar experiment, MANZUR MACIAS (2001) superimposed the technique on the suckers while still attached to the mother plant in the field and injected them with 4ml of benzylaminopurine (BAP). The results showed that second generation suckers were observed after three months.

Under field conditions, Asamienu (True Horn) could produce several buds, however, only few could develop into healthy planting materials. Similar behavior was exhibited under the PIBS nonetheless the warm condition within the humidity chamber forced the buds to develop into healthy planting materials.

Sucker production by Oniaba in the field was reflected in the PIBS. Under the field conditions, sucker production by Oniaba (intermediate French) is normally low. The results showed that the technology could exploit the entire potential of plantain to generate sufficient planting materials. In the field, False Horn plantain could produce about 39 leaves during its crop cycle; French plantain could produce over 50 leaves during the crop cycle. It presupposes that if each leaf produces one axillary bud, then the crop could generate several suckers, however, they produce only about 10 suckers during the crop cycle due to apical dominance. This technology could therefore break apical dominance hence activate all the dormant buds to become healthy planting material.

Plate 2. Acclimatization of plantain Seedlings from growth chamber

Conclusions

The technique is an effective on-farm method that could generate large quantities of healthy planting materials of plantain from any type of sucker. Latent eyes that would not have sprouted could be activated to generate healthy planting materials. The number of suckers produced using the technology and time period showed that the technique was efficient. The technology does not require any sophisticated equipment for its application but only skills; hence could be used by anyone for sufficient healthy planting material production.

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