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COMPARATIVE STUDY ON THE FIELD PERFORMANCE OF FHIA-01 (HYBRID DESSERT BANANA) PROPAGATED FROM TISSUE CULTURE AND CONVENTIONAL SUCKER IN GHANA

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Abstract: Micro-propagated plants of FHIA-01 (exotic hybrid dessert banana) were grown and their shoot-tip cultures were produced following standard method. Suckers were taken from the same plants as with the shoot-tip culture samples. The design was the randomly complete block. The plant density was 1667 plants/ha. Plants were fertilized at the rate of 40 t/ha poultry manure per year split over 3 equal applications. Statistical analysis of data was performed with ANOVA. The field performance of *in vitro* propagated (tissue culture) tetraploid banana (FHIA-01) plants was compared with that of sucker-derived plants. In vitro-propagated plants established and grew faster, taller (240 cm) and bigger than the conventional sucker-derived plants. The former produced heavier bunches (39.1 t/ha) and could be harvested earlier. They however produced smaller number of fingers than the conventional sucker-derived plants. Significant differences were observed between the plant height and plant girth (48.6 cm) (at one meter above ground) at harvest. No significant difference was observed in bunch weight, number of hands, number of fingers and the number of leaves at harvest. The nutrient used in the Tissue culture medium may have played a significant role in the growth vigour of FHIA-01. It may also be having an influence on the performance of the hybrid. This influence may improve the yield of the crop thus improving the economy of farmers.

Key words: Banana (*Musa* spp.), micro-propagated, sucker-derived, *in vitro*

Introduction

Banana is a very important fruit in world commerce and is probably only surpassed by citrus in this regard [SAMSON, 1986]. In terms of gross value of production, banana is the fourth most important global food crop [TRIBE, 1994]. Export bananas are the fourth most important commodity and, as a fruit rank first [FRISON & al. 1997]. Bananas and plantains constitute a major staple food crop for millions of people in developing countries of the tropics [FAO, 1995]. They are grown over a harvested area of approximately 10 million hectares with annual production of about 86 million metric tons [FAO, 1995].

Bananas are asexually propagated by either separating the daughter suckers from the mother plant or by forcing the growth of the buds on the mother plant by stripping the older leaf sheaths (tissue culture) [BAKER, 1959]. Tissue culture method, however require sophisticated equipment and skills that are not easily accessible to farmers in developing countries. Tissue culture unlike the sucker-derived planting material has various advantages. These include producing uniform planting materials at the same time; clean, disease-free materials and many plants in a small space. *In vitro* micro-propagation of banana plants has been reported to be faster than the conventional propagation with sucker-

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derived plants [DREW & SMITH, 1990]. However, there seems to be variety-dependency. For example, ZAMORA & al. (1989) reported that the yield from *in vitro*-propagated plants was significantly higher than that from sucker-derived plants in Lacatan banana (AAA), but the reverse was the case in Bungulan banana. DIRK & ORTIZ (1996) reported that *in-vitro* propagated *Musa* plants grew faster but the yield was not significantly different from that of the sucker-derived plants.

FHIA-01 hybrid banana is one of the breakthroughs in *Musa* international breeding programmes against the devastating fungal disease black sigatoka leaf spot (*Mycosphaeralla fijiensis* Morelet). In response to these production constraints efforts aimed at the genetic improvement of Musa have made significant strides [PERSLEY & DE LANGHE, 1987]. However, germplasm enhancement is burdened with obstacles typical of vegetative propagated crops, among which are low reproductive fertility and slow propagation are most conspicuous. One technique that has been identified for *Musa* germplasm handling and improvement is biotechnology [INIBAP, 1993]. Application of *in vitro* culture technique has significantly improved the germplasm handling. Large numbers of *in vitro* plants have been produced for rapid establishment of hybridization blocks and for international multi-site evaluation [VUYLSTEKE & al. 1993]. However, it has been observed that plants generated from *in vitro* culture exhibit various morphological and biochemical variations due to genetic change that LARKIN & SCOWCROFT (1981) termed somaclonal variation. Somaclonal variation rate of 0%-70% have been recorded in *Musa* produced from shoot - tip culture [SMITH, 1988; VUYLESTEKE & al. 1991].

FHIA-01 is hybrid banana from a cross between the wild banana and the domesticated banana. It was bred against black sigatoka and nematodes. It was introduced into Ghana in early 1990 from Hunduras to be evaluated and disseminated. Sufficient evaluation has been done and it has been released to farmers under the cultivar name *Kwedu bempa*.

This study was carried out to compare the field performance of the hybrid using conventional suckers and tissue cultured plantlets.

Material and methods

In-vitro derived planting materials (tissue culture) and conventional suckers taken from already growing FHIA-01 (*Musa* sp. AAA group) were chosen for the study. The conventional suckers were produced using the split corm techniques. The trial was planted in the rainy season of 2008 at Fumesua near Kumasi in the semi-deciduous forest zone of Ghana. The soil was yellowish-red, moderately drained gritty clay-loam containing quartz gravels. The annual rainfall averaged 2400 mm from (bimodal). Plants were spaced at 3 m x 2 m, providing a density of 1667 plants/ha. Plants were established in a randomized complete block design with three replications. Plants were fertilized at the rate of 40 t/ha poultry manure per year split over three equal applications. Field maintenance was the usual slashing with machete.

Twenty plants from each plot were tagged for data collection. Data was taken on growth parameters at two months after planting and thereafter. At harvest, the following parameters were considered plant height, yield, and number of leaves at harvest, number of daughter suckers, plant girth at one meter above ground, number of hands, number of fingers and the crop cycle. Statistical analysis of data on growth was done with ANOVA.

Results and discussions

The results of the study revealed that there was no significant difference in the number of leaves both at flowering and harvest between sucker-derived and tissue culture-derived plants (Tab. 1).

Tab. 1. Growth characteristics of in vitro-propagated and sucker-derived banana plants under field conditions

Planting Materials	Number of leaves at flowering	Number of leaves at harvest	No. of suckers
Sucker- derived	13.2	7.4	4.3
In vitro- Propagated	14.1	7.5	5.2
P< 0.01	ns	ns	ns

ns = not significantly different n = 20

The number of functional leaves on a banana plant at flowering plays a significant role in the yield at harvest. The higher number of leaves (about 12) is an indication of a heavy bunch. The high number of leaves at flowering compared favorably with the results of ALVAREZ (1997). In banana and plantain agronomy total number of functional leaves that a plant has at flowering time is a good indicator of its tolerance or susceptibility to diseases, with correlation existing between number of leaves and bunch weight.

There was a significant difference in the days to flowering, fruit filling and days to harvest between sucker-derived and *in-vitro*-derived plants (Tab. 2). The *in-vitro*-derived plants flowered earlier and also matured earlier than the sucker-derived plants.

Tab. 2. Yield characteristics of in vitro-propagated and sucker-derived banana plants under field conditions

Planting Material	Days to flowering	Days for fruit filling	Days to harvest	Bunch weight (t/ha)	No. of hands	No. of fingers
Sucker-derived	299.5±3	98.5±1	392.3±2	38.0±1	7.4±1	107.1±2
In vitro-Propagated	286.2±1	90.3±4	376.5±5	39.1±2	7.5±1	104.2±3
P< 0.01	**	**	**	ns	ns	ns

ns = not significantly different ** significantly different at P< 0.01 n=20

There was significant difference in plant height with the tissue-cultured plants producing taller plant (2.40 m) than the conventional sucker (2.14 m). Fig. 1 and 2 showed that the *in vitro*-propagated banana plants grew faster and their pseudostem circumference increased faster than that of the conventional sucker-derived plants. Plant height and pseudostem circumference increased more rapidly in the *in vitro*-propagated plants than the sucker-derived plants during the vegetative growth period. Optimum growth was observed at about the sixth month for the in vitro-propagated plants whereas the sucker-derived occurred at 5.7 months (Fig. 3). This may be a factor contributing to the earliness in the harvest of the in vitro-propagated plants. The number of hands per bunch and the number of fingers did not show any significant variation. The *in vitro*-propagated plants flowered about two weeks earlier than the sucker-derived plants. This was also reflected in the days

to harvesting as the *in vitro*-propagated were harvested about sixteen days earlier than the sucker-derived plants.

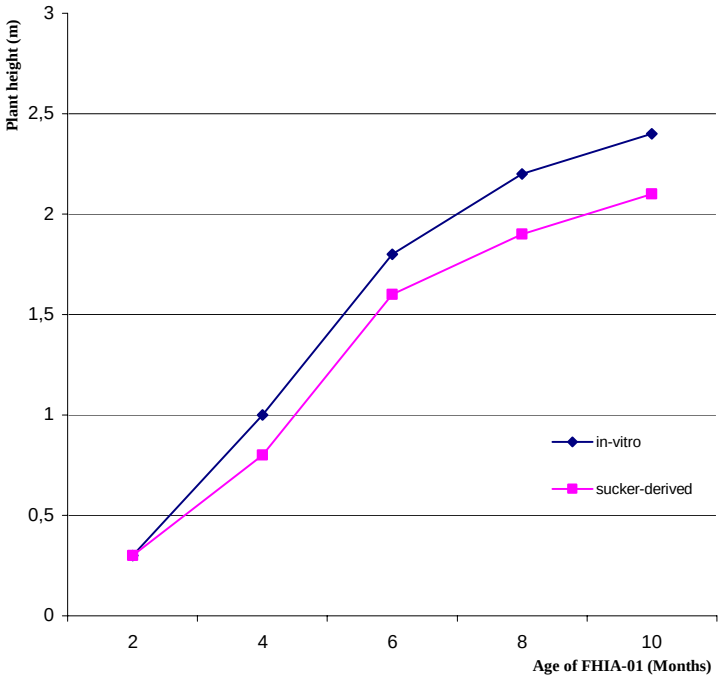

Fig. 1. Plant height of in vitro-propagated and sucker-derived banana plants grown in the field

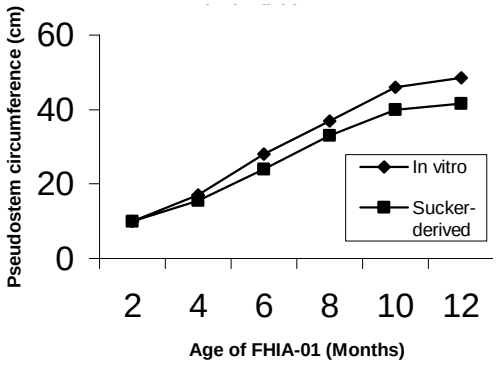

Fig. 2. Pseudostem circumference of in vitro-propagated and sucker-derived banana plants grown in the field

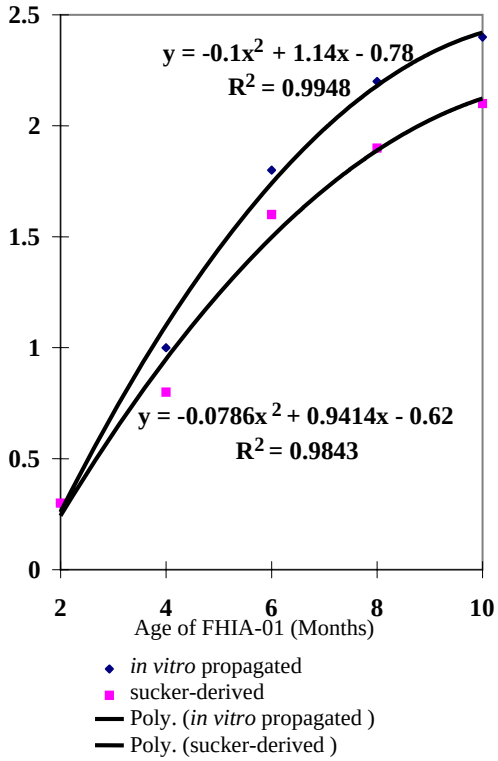

Fig. 3. Relationship between height and age of FHIA-01

The yield characteristics are presented in Tab. 2. The *in vitro*-propagated plants grew faster that the sucker-derived plants. This was reflected in the shorter crop cycle in the *in vitro*-propagated plants than the sucker-derived plants. The number of fingers in the *in vitro*-propagated plants was smaller compared to those of the sucker-derived plants yet they weighed heavier. This may be due to the bigger finger sizes observed in the *in vitro*-propagated plants.

Several authors have reported the superior growth and yield of *in vitro*-propagated banana plants compared to the conventional sucker-derived plants in various types of bananas and plantains [DREW & SMITH, 1990; ROBINSON & al. 1993]. These results are in agreement with their findings. DIRK & ORTIZ (1996) however could not find any significant different in yield between tissue culture and sucker-derived banana plants. These results seemed to follow the trend observed by DIRK & ORTIZ (1996). ROBINSON & ANDERSON (1991) also reported that faster growth and high yields were not always observed in the *in vitro*-propagated banana. However, pseudostem circumference and height of the *in vitro*-propagated plants were significantly higher than those of sucker-derived plants. The low yield of *in vitro*-propagated plants according to these authors was attributed to high incidence of diseases.

The faster growth of *in vitro*-propagated plants could be attributed to their intact active roots and shoot systems that can function almost immediately after planting. Unlike in the conventional method where paring is done on the sucker before planting the *in vitro*-propagated plants continue to photosynthesize immediately after planting. There is therefore a lag phase in the sucker-derived plants. This lag phase may take two weeks or more for the sucker to recover. Also the *in vitro*-propagated plants might have some carry-over nutrient stock upon which they could depend. The factors described above could explain the differences observed between the *in vitro*-propagated and the sucker-derived plants.

Conclusion

The study has revealed that tissue culture application in banana planting material production contributes significantly to crop performance. Tissue culture produced plantlets become robust in the field. It could be concluded that tissue culture produced planting materials perform agronomically better than conventionally produced materials.

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