Comparative study of shoot and root development in micro-propagated and sucker-derived banana and plantain (*Musa* spp.) plants

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Introduction

Plantains and bananas are perennial monocotyledonous tropical herbs that belong to the *Eumusa* series of the genus *Musa*. Different types of propagules, including sword and maiden suckers, are used by farmers to establish banana and plantain fields. Preparation of conventional suckers consists of detaching the sucker from the mother plant, removing the upper part of the pseudostem and paring the corm. This conventional planting material however is usually contaminated with soil-borne pests and is bulky with a low multiplication rate. Commercial production of banana and plantains and horticultural crop experiments use *in vitro*-derived planting material. Though the past field studies highlight advantages of *in vitro*-derived planting materials over conventional suckers, the studies were restricted to the above ground parts. As the corm and roots are key components for the development of the pseudostem and leaves as well as the next cycle, a detailed comparative study between *in vitro* plants and sucker-derived plants was necessary as more and more in vitro plants are being used to establish banana fields.

Materials and Methods

This study was carried out at the IITA High Rainfall station at Onne (4°42' N, 7°10' E, 5 m asl) in south-eastern Nigeria. The average annual rainfall is 2,400 mm distributed monomodally from February until November. *In vitro* and sucker-derived plants of eight genotypes, consisting of 5 landraces and 3 hybrids, were assessed (Table 1). Plantlets were established in the field at a spacing of 2 m x 2 m, except for plants evaluated at flower emergence, which were spaced 4 m x 4 m to avoid overlapping of the roots of neighbouring plants. Data was collected on the following shoot and root traits during the vegetative and the early reproductive phase : leaf area (LA, cm²), number of leaves (NL), plant height (PH, cm), pseudostem circumference (PC, cm), corm weight (CW, g), corm height (CH, cm), widest width of the corm (WW, cm), corm width half way between widest width and the apical meristem (CAW, cm), corm width half way between the widest width and the basal point of the corm (CBW, cm), number of suckers on the corm (NS), height of the tallest sucker (HS, cm), root dry weight (DR, g), the number of roots (NR), root diameter (AD, mm), total root dry weight of the mat (TD, g) and total cord root length (TL, cm) of the mat. In addition, days to flower (DTFL, days) emergence were recorded. Data analysis was carried out using the SAS statistical package.

Results

No significant differences were observed at flower emergence between the propagule types for leaf area, corm fresh weight, root traits, height of the tallest sucker and days to flower emergence (Table 2). Hence the larger amount of roots at planting of *in vitro*-derived plants seems not to have a particular advantage during the first cycle.

Few significant correlations between the same plant growth traits of *in vitro* and sucker-derived plants were observed during the vegetative phase. However, significant correlations between both types of propagule were observed at flower emergence, for leaf area, plant height, pseudostem circumference, corm weight and corm size, and root dry weight. This indicates that plants originating from different propagules tend to behave similarly at flower emergence.

During the mid-vegetative phase, sucker-derived plants produced a larger root system, possibly due to the larger corm, which bears the root initiation zone. However, leaf area or pseudostem size were similar at this stage for both types of propagules (Table 2).

Table 1. Name, genome, ploidy level and type of genotypes evaluated

Name	Genome#	Ploidy level	Type
Yangambi km5	AAA	3	Dessert banana
Valery	AAA	3	Dessert banana
Obino l'Ewai	AAB	3	Plantain
Fougamou	ABB	3	Cooking banana
Cardaba	ABB	3	Cooking banana
TMPx 548-9	AAB x AA	4	Plantain hybrid
TMPx 1658-4	AAB x AA	4	Plantain hybrid
FHIA3	ABB x AA	4	Cooking banana hybrid

#: A: *Musa acuminata*; B: *Musa balbisiana*

Table 2. Overall mean values and t-test for shoot and root system traits of *in vitro*-derived (IV) and sucker-derived (SD) plants at 6, 12, 16 and 20 weeks after planting (WAP) and at flower emergence (FL)

	6 WAP			12 WAP			16 WAP			20 WAP			FL		
Trait#	IV	SD	P	IV	SD	P	IV	SD	P	IV	SD	P	IV	SD	P
LA	979	1,103		2,799	6,391	***	9,825	8,470		22,120	22,680		89,664	93,667	
NL	7	2	***	7	6		10	7	***	11	10	*	11	13	**
PH	24	23		26	34	*	50	43		80	79		246	220	**
PC	6	11	***	10	16	***	20	19		32	29		65	58	**
CW	na	1,105	na	34	1,043	***	183	1,136	***	507	1,932	***	5,449	5,980	
CH	na	11	na	3	13	***	6	13	***	8	16	***	21	29	**
WW	na	13	na	4	12	***	7	12	***	10	14	***	20	18	**
NS	na	0	na	0.3	0	na	1.1	0	**	3.0	0	***	10	12	*
HS	na	0	na	0.6	0	na	4.0	0	*	10	0	***	119	122	
DR	1	2	***	7	14	**	19	22		54	84	*	322	310	
NR	12	14		27	50	***	50	56		71	98	**	170	176	
LR	276	193	**	542	763		1,143	877	*	2,389	2,950		6,486	7,767	
AD	2.9	3.6	***	3.6	4.0	**	4.5	3.9	**	5.4	4.9	**	5.6	5.2	*
TD	1	2	***	7	14	**	19	22		58	84	*	509	485	
TL	276	193	**	541	763		1,168	877	*	2,607	2,950		11,499	12,591	
DTFL	na	na	na	na	na	na	na	na	na	na	na	na	325	338	

#: LA: leaf area (cm2), NL: number of leaves, PH: plant height (cm), PC: plant circumference (cm), CW: corm fresh weight (g), CH: corm height (cm), WW: corm widest width (cm), NS: number of suckers, HS: height of the tallest sucker (cm), DR: root dry weight (g), NR: number of adventitious roots or cord roots, LR: cord root length (cm), AD: average basal cord root diameter (mm), TD: total root dry weight of the mat (i.e. plant crop and suckers) (g), TL: total cord root length of the mat (cm), DTFL: days to flower emergence
*, **, *** Significant at P<0.05, 0.01 and 0.001, respectively.
na: not applicable

Discussion

This research suggests that the major advantage to grow *in vitro*-derived plants would be their more homogenous growth, which is particularly important for research and timing of field practices. Despite their higher phytosanitary status, *in vitro* plants did not display a better growth than sucker-derived plants.

Reference

SAS Institute, Inc. 1989. SAS/STAT user's guide, version 6, 4th edition, volume 1. Cary, N.C.: SAS Institute Inc.

Vuylsteke, D. 1989. Shoot-tip culture for the propagation, conservation, and exchange of *Musa* germplasm. Practical manuals for handling crop germplasm *in vitro*. International Board for Plant Genetic Resources, Rome. pp. 56.

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