African Journal of Biotechnology Vol. 4 (3), pp. 223-228, March 2005
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 © 2005 Academic Journals

Full Length Research Paper

Response of *Musa* species to macro-propagation. I: Genetic and initiation media effects on number, quality and survival of plantlets at prenursery and early nursery stages

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Accepted 17 November, 2004

Ricehull and sawdust were evaluated as *Musa* sucker plantlet initiation media using five genotypes as test plants. Sword-sucker-corms whose apical dominance was physically destroyed were planted and evaluated for plantlet production during a period of about five months. The number, quality and pattern of plantlets produced and their survival were studied. Results showed that initiation media had statistically similar effects on most parameters measured. However, number of days to the emergence of the second and third plantlets was significantly (P<0.05) earlier in ricehull. Variable genotypic responses to measured traits were in most cases significant. Days to emergence of the first and fifth plantlet were shortest in 'FHIA 17' (a dessert banana hybrid) and longest in 'PITA 25' (a plantain hybrid). Emergence of the first three plantlets in landrace plantain ('Agbagba') was earlier than in dessert banana landrace ('Nsukka Local'). A higher proportion of plantlets excised from landrace genotypes had roots than those from the hybrids. Similarly, higher percentage of plantlets initiated in sawdust had roots (irrespective of genotypes). Survival of plantlets varied with genotypes, initiation media and rooting status of plantlets at the time of excision. In most cases plantlets excised with roots had higher percentage of survival. However, all plantlets of 'Nsukka Local' initiated in sawdust but were rootless survived. Slightly higher proportion of plantlets initiated in sawdust (irrespective of rooting status) survived than those initiated in ricehull. However, evidences from the study showed that either ricehull or sawdust could be used for generating plantlets from corm of *Musa* species.

Key words: *Musa* genotypes, plantlets initiation media, survival in nursery.

INTRODUCTION

Bananas and plantains (*Musa* species) are one of the world's most important food crops. In West and Central Africa about 70 million people are estimated to depend on *Musa* fruits for a large proportion of their daily carbohydrate intake (Rowe, 1998). In Nigeria plantains and bananas are both important staples and as sources of income for subsistence farm families. There has been increasing trend towards large-scale production of the

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crop (Obiefuna, 1986) in the traditional humid rainforest production zone, and some emergent production zones are located in the sub-humid areas of southeastern Nigeria (Baiyeri and Mbah, 1994; Baiyeri and Ajayi, 2000).

Progressive decline in plantain and banana production over the years has been attributed to a high susceptibility to pathogens (Persley and de Langhe, 1987), weeds (Ndubizu, 1983), drought and organic matter status of the soil (Rasheed, 2003), poor suckering ability (Ndubizu, 1985), pest and diseases, labour shortage, poor agronomic practices and post harvest constraints (Robinson, 1996).

A common limiting factor to large-scale production of bananas and plantains and or expansion of existing plantation is the difficulty in obtaining planting material (Baiyeri and Ajayi, 2000), due to poor suckering ability (Robinson, 1996). Nevertheless, there are several types of planting materials (which include the maiden sucker, water sucker, sword suckers, butt, peeper, and bits) used for the establishment of plantations, but they vary in their degree of suitability (Ndubizu and Obiefuna, 1982; Baiyeri and Ndubizu, 1994, Baiyeri et al., 1994). These conventional propagating materials are usually in short supply and may be inadequate to meet the needs of medium to large-scale production at the recommended population of 1600-2500 plants ha^{-1} (Rasheed, 2003).

Micro-propagation (i.e. meristem/tissue culture) assures more rapid production of planting materials. These planting materials are healthy, vigorous, and free from pests and diseases (Swennen, 1990) but require a more sophisticated technique, skill and care to handle (Vuylsteke and Talengera, 1998). Tissue culture as a method of generating planting materials is still poorly developed in Nigeria and so, grossly unavailable to the subsistence farmers who are the major stakeholders in the production of bananas and plantain in Nigeria. The *in vitro* plant is not an option for traditional producers so there is a need for cheap and simple techniques (Lopez, 1994).

Recently, the Plantain and Banana Improvement Program of the International Institute of Tropical Agriculture (IITA), Nigeria, advanced the use of a macro-propagation method for increasing sucker multiplication at farm level. The method generates plantlets from sword-sucker corm utilizing sawdust as plantlet initiation medium. However, variable genetic response to plantlet initiation utilizing different initiation media has not been established. In this study therefore, we compared ricehull and sawdust as initiation media, and five *Musa* genotypes with variable genetic background (different ploidy levels and genome complement) as test crops.

MATERIALS AND METHODS

The experiment was conducted in the research farmland of the Department of Crop Science, University of Nigeria, Nsukka (UNN), between October 2003 and April 2004. The experiment was set up under palm-frond-shade.

Plant material

Five *Musa* genotypes comprising of landraces (3x) and hybrids (4x) belonging to the plantains (AAB) (‘PITA 22’ (4x); ‘PITA 25’ (4x) and ‘Agbagba’ (3x)) and dessert bananas (AAA) (‘FHIA 17’ (4x) and ‘Nsukka Local’ (3x)) genomic groups were evaluated. Corms of sword suckers of each genotype (except ‘Nsukka Local’) were obtained from the UNN/IITA collaborative research farm located in the University. ‘Nsukka Local’ was obtained from a local farmer in Nsukka.

Initiation media

Ricehull and sawdust were compared as plantlet initiation media. Both materials were locally sourced from the adjoining villages to the University town. Each medium was moistened and allowed to compost for 3 weeks in two separate wooden boxes (measuring 2 m x 1 m x 0.3 m) before planting the corms. The composting was necessary to dissipate the heat build-up during decomposition of organics in the media, especially in the ricehull. Watering was done twice a week since both media have high moisture retention capacity (thus not warranting more frequent watering).

Corm preparation and planting

Corms were partially pared to remove all roots and psuedostem remains. Thereafter the growing point (i.e. apical meristem) was excised using a sharp knife. The corms were then washed in sterile water (0.35% a.i, sodium hypochlorite (NaOCl)) and allowed to air dry and cured for three days before planting. Ten corms per genotype were planted (completely buried) in each initiation medium. Each corm per genotype was monitored for plantlet initiation until completely rotten.

Data collection and analysis

The weight of each corm prior to planting, days to emergence of the first five plantlets, number of roots developed on each corm at 2, 3, 4, 5 and 6 weeks after planting, number of shoots initiated on each corm at 2, 3, 4, 5, 6 and 20 weeks after planting, rooting status of plantlets at the time of excision, and early nursery survival count of excised plantlets were collected and subjected to analysis of variance to test for the significance of treatment effects. Data were analyzed as factorial in completely randomized design using GENSTAT 5.0 Release 4.23DE (GENSTAT 2003, Lawes Agricultural Trust (Rothamsted Experimental Station). On Figure 2 each genotype was denoted as P22, P25, F17, AGB and NLK for ‘PITA 22’, ‘PITA 25’, ‘FHIA 17’, ‘Agbagba’, and ‘Nsukka Local’, respectively.

RESULTS

The initiation media had fairly similar pH. Ricehull was denser and had more pore spaces for root aeration than sawdust. Sawdust however, had higher water holding capacity thus retains more moisture than ricehull (Table 1).

Ricehull and sawdust had similar effects on most

Table 1. Aspect of physicochemical properties of the initiation media.

Media	pH	Bulk density (g/cm^3)	Total porosity (%)	Water holding capacity (glg)
Ricehull	6.2	0.41	67.16	1.63
Sawdust	6.6	0.26	56.72	2.16

Table 2. The main effect of initiation media on number of days to plantlet emergence and total corm rot.

Initiation media	Corm weight (kg)	Days to specific plantlet emergence					Days to total corm rot
		1st	2nd	3rd	4th	5th	
Ricehull	1.21	39.2	44.4	54.6	77.7	100.3	145.9
Sawdust	1.31	40.5	54.9	64.8	82.5	94.7	151.6
$LSD_{(0.05)}$	NS	NS	6.1	7.7	NS	NS	NS

NS: Non-significant

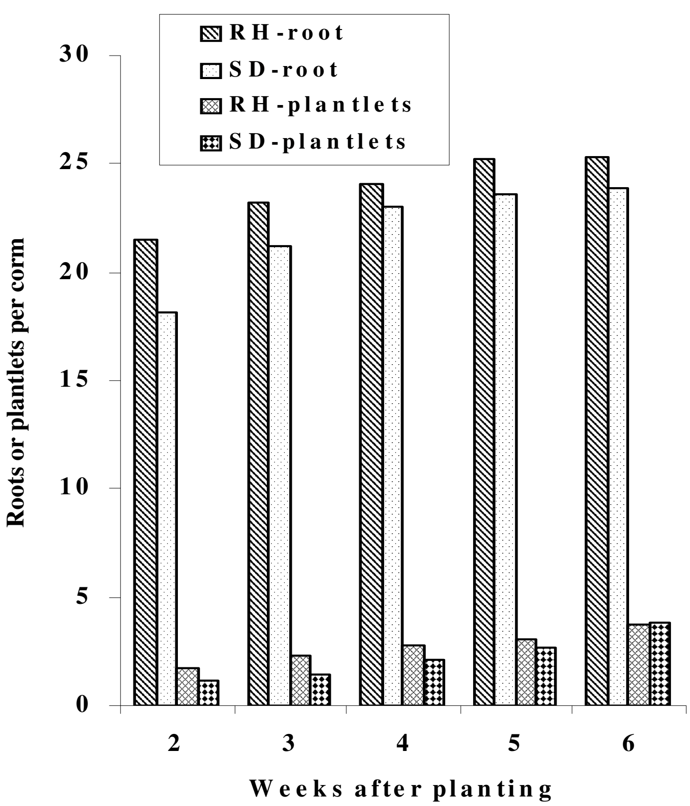

Figure 1. The effects of initiation media (ricehull (RH) and sawdust (SD)) and weeks after planting on number of roots and or plantlets per corm.

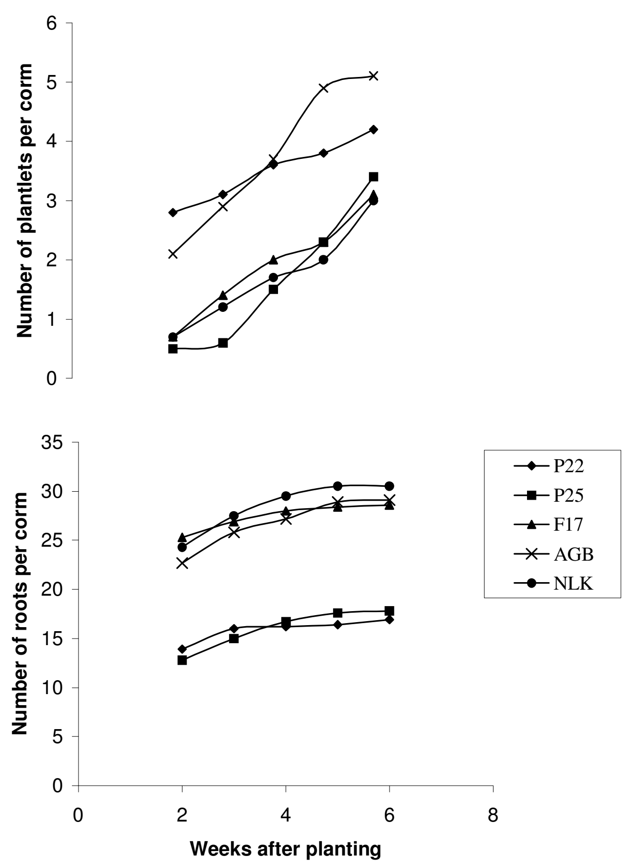

Figure 2. The effects of genotypes and weeks after planting on number of roots and plantlets per corm.

sucker plantlets initiation parameters measured (Table 2 and Figure 1). Number of days to specific plantlet emergence was in most cases similar except the second and third plantlets that were significantly ($P<0.05$) earlier in ricehull. Root formation by the corm and number of plantlets excised over time followed a similar trend in both media (Figure 1), although corms planted in ricehull showed higher values in most cases.

The genotypes showed significant differences in most of the parameters measured (Table 3 and Figure 2). Although weight of corms used was statistically similar, number of days to the emergence of the first five plantlets varied significantly ($P<0.05$) among the genotypes. 'PITA

Table 3. The main effect of genotype on number of days to plantlet emergence and total corm rot.

Genotypes	Days to specific plantlet emergence						Days to total corm rot
	Corm weight (kg)	1st	2nd	3rd	4th	5th	
PITA 22	1.06	33.7	39.6	53.0	62.4	85.4	125.0
PITA 25	1.49	52.2	66.1	74.4	118.0	151.6	156.9
Nsukka Local	1.36	45.8	55.3	65.7	73.6	84.6	147.1
Agbagba	0.94	36.3	45.8	55.6	83.0	96.1	156.8
FHIA 17	1.45	31.3	41.4	49.9	62.9	69.8	158.0
$LSD_{(0.05)}$	NS	7.1	9.6	12.2	18.8	26.8	18.7

NS: Non-significant

Table 4. Percentage of rooted and rootless plantlets at the time of excision as influenced by initiation media and genotypes.

Genotypes	Ricehull		Sawdust	
	Rooted (%)	Rootless (%)	Rooted (%)	Rootless (%)
PITA 22	44.4	55.6	55.9	44.1
PITA 25	28.6	71.4	63.2	36.8
Nsukka Local	76.5	23.5	88.0	12.0
Agbagba	83.0	17.0	85.7	14.3
FHIA 17	68.0	32.0	71.4	28.6
Mean	60.1	39.9	72.8	27.2

22' and 'FHIA 17' were the fastest in plantlet production whereas 'PITA 25' (a plantain hybrid) had the longest duration to the emergence of plantlets. The first, third and fifth plantlets were emerged at earliest time in 'FHIA 17' (a hybrid dessert banana). Plantain landrace 'Agbagba' had shorter duration than the dessert banana landrace 'Nsukka Local' to the emergence of the first three plantlets. Number of plantlets excised over time was consistently highest in 'PITA 22' (a 4x plantain) and 'Agbagba' (a 3x plantain) (Figure 2). Roots formed per corm varied significantly but had differing trend than the number of plantlets excised. 'Nsukka Local' and 'PITA 22' produced the highest and lowest number of roots per corm, respectively.

More than 80% of 'Agbagba' plantlets initiated in either ricehull or sawdust had roots compared with only 44.4% and 56% of 'PITA 22' initiated in similar medium. Generally, proportion of plantlets with roots was higher in sawdust irrespective of genotypes (Table 4). Table 5 showed that higher proportion of plantlets of hybrid genotypes initiated in sawdust that had roots at the time of excision survived at the early nursery stage. In contrast higher proportion of 'Agbagba' and 'Nsukka Local' initiated in ricehull that had roots at the time of excision survived. Higher proportion of the rootless plantlets of the landrace genotypes ('Agbagba' and 'Nsukka Local') survived than the hybrids. Generally, about 72% of plantlets with roots that were initiated in sawdust survived compared with about 64% of those initiated in ricehull; however, proportion of rootless plantlets that survived in the nursery was similar.

DISCUSSION

The initiation media essentially served for anchorage, moisture supply and proper root aeration. Similarity of their effects on sucker plantlets initiation might be associated with their relative similarity in amounts of pore spaces and moisture retention capacity. Besides, Butler (1960) showed that sucker corm is a nutrient reserve, which could support growth for sometimes prior to foliage development. Also, in a three-month greenhouse study Baiyeri (1996) reported that the development of plantain peepers to sucker for field planting did not respond to nitrogen fertilizer treatment. Thus, sucker plantlets initiation from corm as observed in this study would be dependent on factors other than media for initiation (at least within the limit of the two media compared).

Significant genotypic response was interesting, and could probably be due to variable ploidy level and genomic complements. Ploidy level influences the size of

Table 5. Effects of initiation media, genotypes and rooting status of plantlets at the time of excision on percent survival of plantlets at early nursery stage.

Genotypes	Rooting status	Ricehull		Sawdust	
		Survived (%)	Dead (%)	Survived (%)	Dead (%)
PITA 22	Rooted	33.3	66.7	68.2	31.6
	Rootless	6.7	93.3	33.3	66.7
PITA 25	Rooted	50.0	50.0	75.0	25.0
	Rootless	50.0	50.0	21.4	78.6
Nsukka Local	Rooted	80.8	19.2	63.6	36.4
	Rootless	37.5	62.5	100.0	0.0
Agbagba	Rooted	84.6	15.4	75.0	25.0
	Rootless	75.0	25.0	25.0	75.0
FHIA 17	Rooted	70.6	29.4	76.0	24.0
	Rootless	37.5	62.5	30.0	70.0
Mean	Rooted	63.9	36.1	71.6	28.4
	Rootless	41.3	58.7	42.0	58.0

different plant parts in *Musa* species. Generally, with increasing ploidy level, the magnitude of plant characteristic tends to increase e.g. the tetraploids had the highest values for leaf area, plant height, corm fresh weight, root traits and their respective daily growth rates (Stover and Simmonds, 1987; Vandenhout et al., 1995). Statistical similarity in weight of corm used in this study, may not necessarily translate to similarity in nutrient reserve, besides, genotypes that produce several roots per corm did not necessarily translate to several plantlets, and significant genotypic effect on earliness and duration for initiating the first five plantlets might be associated with physiological-genetic behavior peculiar to each genotype. Genome complement seemed more important than ploidy level in the number of plantlets; number of plantlets excised over time was consistently highest in 'PITA 22' (a 4x plantain) and 'Agbagba' (a 3x plantain) (Figure 2). The percentage survival of plantlets without roots was higher in the landrace genotypes than the hybrids, probably because the landraces are hardier.

Genotypic differences in *Musa* species root traits have been investigated under hydroponics conditions (Swennen et al., 1986) with the conclusion that dessert bananas had a larger root system than plantains. This was similarly observed in this study, although higher root formation by the dessert banana corms did not translate to more plantlets. In a study comparing the response to in-vitro multiplication and the specificity of *Musa* varieties, Hirimburegama and Gamage (1997) reported that multiplication rate was found to be variable among cultivars, and it appeared that genome B had the lowest multiplication rate whereas the cultivars of the AAA group have the highest rate. The current *ex vitro* multiplication study confirmed variable cultivars effect but observed that AAB genome group had more plantlets than the AAA genome group.

The study had shown variable genetic response of *Musa* species to sucker plantlets initiation through macropropagation. Besides, the study demonstrated that in the absence of sawdust, which IITA originally advanced, ricehull could equally serve as initiation media.

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