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Response of *Musa* species to macro-propagation. II: The effects of genotype, initiation and weaning media on sucker growth and quality in the nursery

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Sucker plantlets of five *Musa* genotypes were derived from sword-sucker-corms using ricehull and sawdust as initiation media. Plantlets initiated were transferred to three weaning/rooting media formulated with ricehull (RH), sawdust (SD) and poultry manure (PM). Weaning media and genotypes had significant ($P<0.05$) effects on most of the sucker plantlet growth parameters studied. There was variable adaptation pattern of genotypes to weaning/rooting media. RH+PM (3:1 v/v) enhanced the best sucker quality in terms of number of photosynthetically active leaves, plant height, plant girth and plant vigor in four ('PITA 22', 'Agbagba', 'FHIA 17' and 'Nsukka local') out of the five genotypes evaluated. Except 'PITA 25' all other genotypes had the poorest performance in SD+PM (3:1 v/v). Medium SD+RH+PM (1.5:1.5:1 v/v/v) supported good quality sucker in 'Agbagba', 'FIHA 17', 'Nsukka Local' and 'PITA 25'. Percent survival in each weaning medium was influenced by genotype and the rooting status of plantlets at the time of excision. However, from the study RH+PM was adjudged the best medium for raising plantlets to vigorous suckers for field planting.

Key words: Sucker-plantlets, weaning media, genotypic responses, growth quality.

INTRODUCTION

The quality of nursery potting medium is important to the successful growing of plants in containers (Bunt, 1988). It is easy to think of soil as a good medium, but most soils when used alone are very poor growing medium. Soil has been indicated as the easiest way through which seedlings become infected by diseases such as root knot nematode and seedling root rots (Egunjobi and Ekundare, 1981).

The use of organic substrate (compost) offers a great advantage over the conventional topsoil (Adams et al., 2003; Akanbi et al., 2002). Organic substrates, according to these authors, provide adequate nutrients to the seedlings, better root substrate relation than conventional soil mix and less pre-dispose the seedlings to soil borne pests and diseases.

While a wide range of crop residues, organic wastes and other industrial by-products could be used as organic growing medium, preference of any should largely be determined by considerations of availability, economics, physical and chemical characteristics (Akanbi et al., 2002) . Sawdust is the most commonly and widely used wood residue in agriculture for potting mixes (Albery, 1975). However, decomposition of sawdust causes nitrogen deficiency as microflora deplete available nitrogen in the decomposition process (Wootton et al., 1981). Consequently a well-composted sawdust is preferred in any nursery mix. Ricehull is obtained as waste product of rice; it is light in weight, has uniform quality, resistant to decay and depletion of available nitrogen by microorganisms. Ricehull have the advantage of being easily incorporated into media for improved drainage and aeration.

The physical composition of the nursery potting medium can have a profound effect on the supply of water and air to the growing plant (Beardsell and Nichols, 1982) as well as affect anchorage, and nutrient and water holding capacity of the medium. These physical characteristics of growth medium directly affect the emergence and vigor of seedling with consequent effect on quality of seedling produced (Baiyeri, 2003). Quality of seedling transplanted will influence their re-establishment in the orchard (Baiyeri and Ndubizu, 1994) and consequently the future productivity of the orchard.

In this study therefore, three potting media formulated

Table 1. An outline of initiation and weaning media treatment combination.

Media notation	Remarks
SD SD + PM	Plantlets initiated in sawdust transplanted to sawdust plus poultry manure.
SD RH + PM	Plantlets initiated in sawdust transplanted to ricehull plus poultry manure.
SD SD + RH + PM	Plantlets initiated in sawdust transplanted to sawdust plus ricehull plus poultry manure.
RH SD + PM	Plantlets initiated in ricehull transplanted to sawdust plus poultry manure.
RH RH + PM	Plantlets initiated in ricehull transplanted to ricehull plus poultry manure.
RH SD + RH + PM	Plantlets initiated in ricehull transplanted to sawdust plus ricehull plus poultry manure.

Table 2. Indices for monitoring the growth vigor of plantlets.

Score	Interpretation
0	Dead, wilting or obviously sick.
1	Stunted growth, dull but alive.
2	Brightly looking but photosynthetically active leaves 5.
3	Brightly looking, vigorous growth evident and photosynthetically active leaves > 5.

from sawdust, ricehull and poultry manure were evaluated for weaning/rooting sucker-plantlets of five *Musa* genotypes initiated from sword-sucker-corm previously planted in sawdust and or ricehull.

MATERIALS AND METHODS

Sucker plantlets generated from 'PITA 22' (4x), 'PITA 25' (4x), 'FHIA 17' (4x) 'Agbagba' (3x), and 'Nsukka Local' (3x) using sawdust and ricehull as initiation media were weaned on three nursery media. The weaning/rooting media were formulated from ricehull, sawdust and poultry manure.

Media Formulation

Three weaning/rooting media were formulated from the base materials (ricehull, sawdust and poultry manure) on volume ratios as follows:
RH + PM: Ricehull plus poultry manure (3:1, v/v)
SD + PM: Sawdust plus poultry manure (3:1, v/v)
SD + RH + PM: Sawdust , ricehull, poultry manure (1.5:1.5:1, v/v/v).

These media were composted for at least four weeks in polybag with regular turning for aeration.

Experimental treatments

Three factors comprising of two initiation media, five genotypes and three weaning media, giving 30 treatment combinations were evaluated. The outline of initiation and weaning media combination is shown in Table 1. The five genotypes under study were completely randomized on the above six media combinations.

Transplanting and handling of plantlets

The plantlets were transplanted at the third leaf stage and at about 10-15cm in height, to a 3-litre plastic bucket containing the weaning/rooting media. These were kept in a humid but air-permeable translucent nylon encasement for the first one week after transplanting to enhance stabilization of transplants. The floor of the encasement was lined with moist sawdust and misting was carried out at least twice daily to prevent desiccation. The plantlets were later transferred to the main nursery under a shade made of translucent blue polythene material. This helped the plantlets to survive the dry harmattan period, though the shading was later supplemented with palm fronds. Media had high water holding capacity (see Table 3); watering was done at two days interval.

Parameters measured and data analysis

The height, girth, number of photosynethically active leaves at 10, 12, and 14 weeks after transplanting (WATP) were measured. The height was measured from the base of the psuedostem to the V-junction of the last two unfurled leaves whereas girth was measured at the base of the plant. Visual scoring of plant vigor was done at 10, 12, and 14 weeks after transplanting following a four-point scoring index shown in Table 2. Percent survival of plantlets as influenced by the initiation media, genotypes and weaning media was estimated. Aspect of physicochemical properties of the weaning media were determined and shown in Table 3. All data collected were 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).

RESULTS

The physiochemical properties of the weaning/rooting media are shown on Table 3. The three media had fairly similar organic matter content and pH but differ in cations exchange capacity (CEC). Bulk density and total porosity were lower in SD+PM, but it has higher moisture holding capacity than SD+RH+PM and RH+PM. RH+PM had the highest pore spaces hence more aggregated than the other two media.

The main effect of initiation media of the plantlets did not significantly influenced the growth parameters

Table 3. Aspect of physicochemical properties of the weaning media.

Media	pH	CEC (meq/100g)	Organic carbon (%)	Organic Matter (%)	Bulk density (g/cm^3)	Total porosity (%	Water holding capacity (glg)
RH+PM	7.4	29.6	2.31	3.98	0.30	63.14	2.09
SD+PM	7.6	40.0	2.35	4.06	0.27	60.10	2.19
SD+RP+PM	7.4	38.0	2.55	4.40	0.30	63.05	2.09

Table 4. The main effect of weaning/rooting media on growth parameters of *Musa* genotypes' plantlets over time.

Growth parameters	Weeks after planting	RH+PM	SD+PM	RH+SD+PM	$LSD_{(0.05)}$
Number of PAL	10	6.0	4.2	4.7	0.42
	12	6.6	5.2	5.9	0.34
	14	7.5	5.8	6.8	0.29
Plant girth (cm)	10	7.0	5.8	6.2	0.59
	12	8.1	6.5	6.8	0.56
	14	8.9	7.1	7.5	0.42
Plant height (cm)	10	30.4	20.6	22.2	3.04
	12	35.6	25.7	28.2	2.84
	14	41.9	28.9	37.1	2.86
Plant vigor	10	2.6	2.0	2.3	0.19
	12	2.9	2.3	2.6	0.14
	14	3.0	2.6	2.9	0.12

PAL: Photosynthetically active leaves.

Table 5. The main effect of genotypes on growth parameters of sucker plantlets grown in three weaning/rooting media over time.

		Genotypes					
Growth parameters	Weeks after planting	P22	P25	F17	AGB	NLK	$LSD_{(0.05)}$
Number of PAL	10	4.5	5.4	4.7	5.5	4.7	0.55
	12	5.7	6.4	5.6	5.9	5.9	0.44
	14	6.2	7.1	6.4	6.7	6.7	0.38
Plant girth (cm)	10	6.5	6.0	5.5	6.3	7.2	0.76
	12	7.1	7.2	6.5	7.1	7.8	0.59
	14	7.8	7.7	7.2	7.9	8.4	0.55
Plant height (cm)	10	28.1	21.7	20.2	23.5	28.3	3.93
	12	32.9	25.9	24.8	30.6	34.9	3.66
	14	38.1	29.3	33.2	38.7	40.6	3.70
Plant vigor	10	2.3	2.5	2.2	2.4	2.2	0.24
	12	2.6	2.8	2.4	2.7	2.6	0.18
	14	2.8	2.9	2.7	2.9	2.8	NS

Genotypes code: P22, P25, F17, AGB and NLK respectively for 'PITA 22', 'PITA 25', 'FHIA 17', 'Agbagba', and 'Nsukka Local'.
PAL: Photosynthetically active leaves; NS: Non-significant.

measured at the nursery stage. Also, first order interaction between initiation media and weaning/rooting media or genotypes were in most cases only significant at the early growth stage of the plantlets (data not shown), an indication that the initiation media had no prolong carry over effects on the performance of plantlets at the nursery stage.

The weaning/rooting media significantly ($P<0.05$) influenced all the growth parameters measured on the sucker plantlets in the nursery (Table 4). Plantlets grown

Table 6. The effects of weaning/rooting media by genotype interaction on growth parameters of sucker plantlets over time.

		Number of PAL			Plant girth (cm)			Plant height (cm)			Plant vigour		
		Weeks after transplanting plantlets											
Weaning media	**Genotypes**	**10**	**12**	**14**	**10**	**12**	**14**	**10**	**12**	**14**	**10**	**12**	14
SD+PM	P22	4.2	4.8	5.3	6.0	6.4	6.6	23.2	27.7	30.8	2.2	2.3	2.5
	P25	5.2	6.2	6.5	6.9	8.5	8.8	26.7	29.6	30.6	2.2	2.9	3.0
	F17	3.4	4.5	5.3	4.3	4.9	5.6	10.0	14.8	18.9	1.7	1.9	2.4
	AGB	4.4	5.2	6.0	5.1	5.6	6.7	16.9	23.1	28.0	2.0	2.2	2.6
	NLK	3.8	5.1	5.5	6.5	7.2	7.7	26.1	33.3	36.4	1.8	2.2	2.3
RH+PM	P22	5.9	6.8	6.9	8.9	9.2	10.2	40.5	46.2	52.5	2.5	3.0	3.0
	P25	6.6	6.7	8.0	5.8	6.6	7.5	18.3	21.4	23.4	2.9	2.9	3.0
	F17	5.6	6.5	7.2	5.9	7.3	8.2	26.4	30.4	42.0	2.4	2.7	2.9
	AGB	6.9	6.2	7.2	7.6	8.5	9.2	31.5	40.2	47.2	3.0	2.9	3.0
	NLK	5.1	7.0	7.3	6.9	8.6	9.3	35.1	39.9	44.3	2.3	3.0	3.0
RH+SD+PM	P22	3.5	5.5	6.4	4.7	5.6	6.6	20.6	24.7	31.0	2.1	2.6	2.9
	P25	4.5	6.2	6.8	5.5	6.3	6.9	20.2	26.6	33.7	2.3	2.6	2.6
	F17	5.1	5.7	6.4	6.2	7.4	7.9	24.2	29.2	38.6	2.4	2.5	2.9
	AGB	5.2	6.2	7.0	6.3	7.2	7.9	22.2	28.7	41.0	2.2	2.9	3.0
	NLK	5.2	5.7	7.3	8.2	7.6	8.3	23.6	31.6	41.2	2.5	2.6	3.0
$LSD_{(0.05)}$		0.95	0.75	0.67	1.32	1.03	0.95	6.80	6.34	6.40	0.42	0.31	0.26

Genotypes code: P22, P25, F17, AGB and NLK respectively for 'PITA 22', 'PITA 25', 'FHIA 17', 'Agbagba', and 'Nsukka Local'.
PAL: Photosynthetically active leaves.

in RH+PM were significantly taller, had thicker psuedostem carrying more photosynthetically active leaves (PAL), and were generally more vigorous. Plantlets raised in SD+PM had lowest values for all the growth measurements. Sucker plantlets grown in RH+SD+PM were better than those grown in SD+PM but not as good as those raised in RH+PM.

Genetic effect on measured growth traits was significant ($P < 0.05$) (Table 5). The number of PAL was highest in 'PITA 25' and 'Agbagba' (a 4x and 3x, respectively, belonging to plantain genome group). But 'Nsukka Local' (a 3x AAA) was consistently taller and had thicker psuedostem than other genotypes. The general vigour index was highest for 'PITA 25' and lowest for 'FHIA 17'.

Variability in growth indices of the five *Musa* genotypes as influenced by the weaning/rooting media is shown in Table 6. There were significant ($P<0.05$) media by genotype interaction on all the growth measurements. Growth parameters were generally highest (irrespective of genotypes) when plantlets were raised in RH+PM than the other media. For example, 'PITA 25' had 6.6 PAL ten weeks after transplanting when raised on RH+PM but produced only 5.2 and 4.5 PAL when grown on SD+PM and RH+SD+PM respectively. Similarly, 'PITA 22' was tallest and had thickest psuedostem when grown on RH+PM than any other genotype grown on similar medium or the other media. General vigour rating for all the genotypes was, in most cases, highest when grown on RH+PM than the other two media.

The patterns of plantlets survival in the nursery as influenced by the initiation media, rooting status of plantlets at transplanting, weaning/rooting media and genotypes are shown in Table 7. As expected, higher proportion of plantlets that had roots survived at the nursery stage than those without roots. There were no definite genome complement or ploidy level effects on survival pattern. However, there was higher propensity for survival when plantlets (with roots) initiated in sawdust was planted in SD+PM or initiated in ricehull and planted in RH+PM. All (100%) plantlets without roots at excision (except those of 'PITA 25') initiated in sawdust and raised in RH+SD+PM medium survived. Similarly, all rootless plantlets of 'FHIA 17' initiated in ricehull but weaned on RH+SD+PM survived. Genotype specific survival pattern of plantlets that had roots at excision revealed that the highest sucker survival was obtained when:

'PITA 22' initiated in sawdust was weaned on SD+PM (71.4%)
'PITA 25' initiated in ricehull was weaned on RH+PM (100%)
'FHIA 17' initiated in ricehull was weaned on RH+PM (100%)
'Agbagba' initiated in ricehull was weaned on RH+PM (100%)
'Nsukka Local' initiated in ricehull was weaned on RH+PM (100%)

Generally, survival trend irrespective of genotype showed that higher proportion of plantlets (rooted or rootless) initiated in ricehull and weaned on RH+PM

Table 7. The effects of plantlet initiation media, rooting status of plantlets and genotypes on percentage survival of plantlets in three weaning/rooting media at the nursery stage.

		Plantlet initiation media					
		Sawdust			Ricehull		
Genotypes	Physiological status	SD+PM	RH+PM	RH+SD+PM	SD+PM	RH+PM	RH+SD+PM
PITA 22	RD	28.6	33.3	33.3	62.5	100.0	66.7
	RS	71.4	66.7	66.7	37.5	0.0	33.3
	RLD	80.0	75.0	0.0	100.0	50.0	100.0
	RLS	20.0	25.0	100.0	0.0	50.0	0.0
PITA 25	RD	33.3	25.0	20.0	50.0	0.0	100.0
	RS	66.7	75.0	80.0	50.0	100.0	0.0
	RLD	50.0	100.0	100.0	100.0	50.0	42.9
	RLS	50.0	0.0	0.0	0.0	50.0	57.1
FHIA 17	RD	25.0	36.4	0.0	50.0	0.0	28.6
	RS	75.0	63.6	100.0	50.0	100.0	71.4
	RLD	0.0	100.0	0.0	100.0	75.0	0.0
	RLS	100.0	0.0	100.0	0.0	25.0	100.0
Agbagba	RD	25.0	33.3	20.0	33.3	5.0	20.0
	RS	75.0	66.7	80.0	66.7	95.0	80.0
	RLD	100.0	100.0	0.0	NA	0.0	33.3
	RLS	0.0	0.0	100.0	NA	100.0	66.7
Nsukka Local	RD	37.5	37.5	33.3	26.7	0.0	14.3
	RS	62.5	62.5	66.7	73.3	100.0	85.7
	RLD	NA	NA	0.0	40.0	NA	100.0
	RLS	NA	NA	100.0	60.0	NA	0.00
Mean	RD	29.9	33.1	21.3	44.5	21.0	45.9
	RS	70.1	66.9	78.7	55.5	79.0	54.1
	RLD	57.5	93.8	20.0	85.0	43.8	55.2
	RLS	42.5	6.2	80.0	15.0	56.2	44.8

RD: Explants had roots but died in the nursery;
RS: Explants had roots and survived in the nursery;
RLD: Explants had no roots and died in the nursery
RLS: Explants had no roots but survived in the nursery.

survived. But when plantlets were initiated in sawdust, survival was highest when plantlets were weaned on RH+SD+PM medium.

DISCUSSION

The physical composition of the growing medium have a profound effect on the supply of water and air to the growing plant (Beardsell and Nichols, 1982) as well as affect anchorage, and nutrient and water holding capacity of the medium. These physical characteristics of growth medium indirectly influence seed germination but directly affect the emergence and vigour of seedling with consequent effect on quality of seedling produced (Baiyeri, 2003), thus, the significant weaning/rooting media effects on all the growth parameters measured and the survival count of plantlets agrees with earlier report of Baiyeri (2003). The significant first order interaction between genotypes and weaning/rooting media interaction indicated that specific genotype grew and survived differently in the three media evaluated. Thus recommendation of the best weaning/rooting medium could not be generalized but genotype specific. The existence of genotype by environment interaction in field grown *Musa* genotypes has been reported in Baiyeri (1998).

The root system is the link between the plant and the soil. It is responsible for the absorption of water and nutrients, anchorage, synthesis of some plant hormones and storage (Stover and Simmonds, 1987; Price, 1995). Thus it was understandable that plantlets that had roots at transplanting survived better in the nursery irrespective of weaning media or genotypes. The implication is that plantlets with roots at transplanting would be more reliable and so, cultural practice that could enhance rooting at the initiation medium should be adopted.

Ploidy level influences the size of different plant parts in

Musa species. Generally, with increasing ploidy level, the magnitude of plant characteristic tend to increase; the tetraploids had the highest values for leaf area, plant height, corm fresh weight, plant crop root traits and their respective daily growth rates (Stover and Simmonds, 1987; Vandenhout et al., 1995). This was not clearly evident in this study probably because, the plants were still at the nursery stage. There was however, a definite genetic effect on all measured traits.

The three weaning/rooting media had the same volume of poultry manure as nutrient source during formulation, thus consistently poorer quality of plantlets raised on SD+PM was likely due to immobilization of nitrogen. Wootton et al. (1981) reported that decomposition of sawdust causes a depletion of available nitrogen within the pot mixture. Quality of seedling transplanted will influence their re-establishment in the orchard (Baiyeri and Ndubizu, 1994) and consequently the future productivity of the orchard. As such SD+PM would not be a good medium for weaning *Musa* plantlets.

The study showed variable genotypic responses to weaning/rooting media. Also, there was a very definite trend of the effect of media on the quality of the suckers raised and their survival in the nursery. For most genotypes (irrespective of medium for initiating the plantlets) vigorous suckers were raised when plantlets were grown on RH+PM.

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