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Field Performance of Micropropagated East African Banana (*Musa* AAA East Africa) in the Eastern Zone of Tanzania

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Abstract: This study was conducted to evaluate yield performance of micro-propagated (MPd) East African cooking banana (Musa AAA East Africa) cv. Uganda and cv. Bukoba in the Eastern zone of Tanzania. Plant size of MPd cv. Bukoba was significantly bigger ($p<0.05$) with pseudostem height, girth and height to girth ratio of 425.4, 67.0 cm and 6.4 compared to 370.6, 59.5 cm and 6.1 of the conventionally propagated (CPd) banana, respectively. Moreover, plant crops of MPd cv. Uganda and Bukoba were harvested 29 and 27 days earlier compared to the plant crops of CPd banana, respectively. On the other hand, plant crop of MPd cv. Bukoba produced smaller ($p<0.05$) bunches and fruits weighing 14.4 kg and 138.5 g compared to 23.9 kg and 146.2 g of the plant crop of CPd banana, respectively. Similarly, ratoon crops of MPd cv. Bukoba produced lower bunch and fruit weight than those of CPd banana. The low bunch yield of the MPd cv. Bukoba could be due to reduction in fruit weight. Plant crop of MPd cv. Uganda produced more uniform fruits in terms of weight, length and girth whereas that of MPd cv. Bukoba produced more uniform fruits in terms of weight and girth. Fruit size uniformity was insignificantly different in subsequent ratoon crops of both cultivars. Further studies are required to determine causes and bases of lower yield in MPd cv. Bukoba.

Key words: Micropropagated East African banana, yield performance, eastern zone of Tanzania

INTRODUCTION

Banana shoot tip culture can lead to mass production within a short period of time of pest-free planting materials (Banerjee and De Langhe, 1985; Lee, 2003). However, the field performance of banana micropropagation-derived suckers has not always correlated with their initial quality (Daniells, 1988; Israel *et al*., 1988; Robinson *et al*., 1993; Skirvin *et al*., 1994; Vuylsteke, 2001). For instance, micro-propagated AAB French-type plantain cv. Superplatano showed severe symptoms of banana streak virus, the incidence of which was associated with an activation by tissue culture conditions of a viral genome integrated into the banana genome (Krikorian *et al*., 1999). Moreover, micropropagation-derived off-type banana cv. Lady Finger showed slow plant growth and produced smaller bunches and fruits in comparison to the conventionally propagated banana (Smith *et al*., 1999).

East African highland (EA) bananas (*Musa* AAA East Africa) are uniquely cultivated in East Africa and represent over 70% of the total cooking bananas in the region (INIBAP, 1994). In Tanzania, the most popular EA cooking banana includes cv. Bokoba (synonym Enshakara) and cv. Uganda (synonym Enchoncho). Cultivar Bukoba is higher yielding but meal (matoke) prepared from its mature green fruits is less palatable than that of cv. Uganda. Consequently, farmers appreciate cv. Bukoba while consumers prefer cv. Uganda to the former. Unfortunately, most of EA banana cultivars suffer from major banana pests, including the black sigatoka and weevils (IPGRI, 1998). The application of microprogation technique for mass production of disease-free planting materials has widely been reported since 1972 (Ma and Shii, 1972). Micropropagation of EA bananas with focus on suitable growth media started recently (Talengera *et al*., 1994; Arinaitwe *et al*., 2000). Maerere *et al*. (2003) successfully *in vitro*-propagated cv. Bukoba and Uganda in Tanzania but the field performance of *in vitro* derived suckers of these cultivars has not yet been evaluated in the country. The objective of this study was to evaluate the yield performance of micropropagation-derived suckers of EA banana cv. Uganda and Bukoba in the Eastern zone of Tanzania.

MATERIALS AND METHODS

In vitro suckers of banana cv. Bukoba and Uganda were produced according to Maerere *et al*. (2003). Briefly, the growth media consisted of Murashige and Skoog

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(1962) salts and vitamins at 4.4 g L^{-1} supplemented with L-cystein at 40 mg L^{-1}, sugar at 30 g L^{-1}, 6-benzylaminopurine at 6 mg L^{-1}, indole-3-acetic acid at 2 mg L^{-1} and agar at 8 g L^{-1}. Plantlets at the fifth subculture were transferred to the rooting media devoid of BAP but supplemented with naphthaleneacetic acid at 2 mg L^{-1}. *In vitro* suckers were acclimatised under shades of 60 and 30% each for four weeks, respectively (Smith *et al*., 1999; Lee, 2003; Maerere *et al*., 2003). Holes of 100×100×100 cm size at a spacing of 3×4 m were prepared and filled with each forty liters of well-decomposed farmyard manures. *In vitro* suckers (treatment) and conventional suckers (control) of each cultivar were planted in two replicates each consisting of five plants in a randomised complete block design. Field experiment was conducted at Sokoine University of Agriculture in Eastern zone of Tanzania. Sokoine University of Agriculture lies at an altitude of about 500 m above sea level and experiences average annual temperatures ranging from 16 to 34°C and rainfall of 700 to 900 mm. The area is considered to be marginal for banana cultivation. The crop received appropriate managerial practices including desuckering, application of farmyard manure, irrigation during dry season and removal of old and diseased leaves.

Data collection and analysis: Data on pseudostem height, girth, earliness to bunch harvest, bunch weight, number of hands per bunch, number of fruits per hand, fruit weight, length, girth and uniformity were taken from the plant to second ratoon crops according to Swennen and De Langhe (1985). In summary, pseudostem height was measured from the root collar to the level of the inflorescence emergence and its girth at 100 cm from the root collar. On the other hand, earliness to bunch harvest was recorded as the number of days from the date of planting to that of the bunch harvest. Fruit length was measured from its tip to the base and its girth at the widest part of the second and third hand of the bunch. Hand and fruit uniformity was determined based on Standard Deviation (SD) of fruit size in terms of weight, length and girth. Analysis of parametric (pseudostem height, girth, pseodustem height to girth ration, bunch weight, fruit weight, length and girth) and nonparametric (number of days to bunch harvest, number of hands per bunch and number of fruits per hand) data was performed using SPSS 12.0 for Windows based on Student and Mann-Whitney tests ($p<0.05$), respectively (Zar, 1997). Fruit size uniformity was descriptively analysed.

RESULTS AND DISCUSSION

Plant size and number of days to bunch harvests: Pseudostem height, girth and height to girth ratio of micropropagated (MPd) cv. Uganda were insignificantly ($p<0.05$) different from those of the conventionally propagated (CPd) banana. On the contrary, pseudostems of the plant and ratoon crops of MPd cv. Bukoba were significantly taller ($p<0.05$) with pseudostem height, girth and height to girth ratio of 425.4, 67.0 cm and 6.4 compared to 370.6, 59.5 cm and 6.1 of the CPd banana, respectively. The increased plant height is detrimental because it could enhance plant breakage in windy areas and during bunching stage. Moreover, longer stakes, which are more expensive, would be requited to support such plants.

Bunches of the plant crop of MPd cv. Bukoba were harvested earlier ($p<0.05$) at 384 days from the date of planting whereas those of the CPd banana were harvested at 411 days (Table 1). Similarly, the plant crop of MPd cv. Uganda was harvested earlier at 320 days compared to 349 days of the CPd banana (Table 2). The number of days to bunch harvest of ratoon crops of MPd and CPd banana of both cultivars were insignificantly ($p<0.05$) different. The earliness to bunch harvest of the plant crop of 29 and 27 days of the MPd cv. Uganda and Bukoba agrees with Vuylsteke (2001) who also reported a reduction in time to bunch harvest of one month of MPd African plantain cv. Agbagba. This earliness might be associated with fast plant growth as *in vitro* suckers are planted in the field with well-developed roots and leaves while conventional suckers form new roots and leaves later after planting.

Marketable yield: Plant and ratoon crops of MP and CP cv. Uganda produced equal ($p<0.05$) yield with bunch weight of plant crop of 14.7 and 15.6 kg and ratoon crops of 14.0 and 14.9 kg, respectively (Table 2). Several studies have also reported equal yield between the MPd and CPd banana cv. Giant Cavendish (Hwang *et al*., 1984), ABB cooking banana cv. Cardaba (Espino *et al*., 1992) and AAB plantains cv. Maringo, Enano, Comun, Congo and Agbagba (Liu *et al*., 1989; Vuylsteke, 2001). Conversely Mpd banana cv. Bukoba produced lower ($p<0.05$) yield with bunch of the plant and ratoon crops of 14.4 14.0 kg compared to 23.9 and 20.5 kg of CPd banana, respectively and Similarly, plant crop and ratoon crops of MPd cv. Bukoba produced smaller fruits weighing 138.5 and 135.7 g compared to 146.2 and 142.5 g of CPd banana, respectively. (Table 1). The reduction in bunch weight could be associated to the decline in fruit weight of MPd cv. Bukoba. Israel *et al.* (1988) also reported a lower yield of the MPd Cavendish banana cv. Grand nain during spring season in Israel.

Fruit size uniformity: Plant crop of MPd cv. Bukoba produced more uniform fruits with SD of fruit weight and girth of 10.5 and 0.8 compared to 13.9 and 1.3

Table 1: Yield performance of micropropagated (MPd) and conventionally propagated (CPd) East African banana cv. Bukoba in the Eastern zone of Tanzania (±SD)

Yield component	CPd plant crop	MPd plant crop	CPd ratoon crops	MPd ratoon crops
Pseudostem height (cm)	370.6±56.5a	425.4±16.9b	370.6±56.5a	425.4±16.9b
Pseudostem girth (cm)	59.5±8.0a	67.0±5.5a	59.5±8.0a	66.0±6.2a
Pseudostem height to girth ratio	6.1±1.3a	6.4±0.5b	6.2±1.4a	6.4±1.5b
Number of days to harvest	411.0±14b	384.0±2.0a	411.0±14a	413.0±13.0a
Bunch weight (kg)	23.9±8.3b	14.4±3.8a	20.5±12.1b	14.0±4.8a
Number of hands/bunch	8.8±1.2a	8.5±1.2a	8.6±1.2a	8.5±1.2a
Number of fruits/hand	14.9±2.6a	14.1±1.9a	14.6±2.6a	14.4±1.9a
Fruit weight (g)	146.2±13.9b	138.5±10.5a	142.5±13.9b	135.7±10.5a
Fruit length (cm)	21.3±2.4a	20.4±2.1a	21.3±2.4a	22.0±5.1a
Fruit girth (cm)	12.2±1.3a	11.7±0.8a	12.2±1.3a	11.8±1.5a
Fruit length: girth ratio	1.8±0.2a	1.7±0.2a	1.7±0.5a	1.6±0.4a

a, b: Numbers within each pair (CPd plant crop vz. MPd plant crop or CPd ratoon crop vz. MPd ratoon crop) bearing the same letters are insignificantly ($p<0.05$) different according to Student and Mann-Whitney tests. SD: Standard deviation of the mean

Table 2: Yield performance of micropropagated (MPd) and conventionally propagated (CPd) East African banana cv. Uganda in the Eastern zone of Tanzania (±SD)

Yield component	CPd plant crop	MPd plant crop	CPd ratoon crops	MPd ratoon crops
Pseudostem height (cm)	243.3±25.5a	248.0±14.3a	249.0±20.5a	248.0±18.0a
Pseudostem girth (cm)	48.4±4.6a	46.5±5.3a	49.0±8.6a	47.3±7.3a
Pseudostem height to girth ratio	5.0±0.3a	5.3±0.8a	5.1±0.3a	5.2±0.7a
Number of days to harvest	349.10±8.0b	320.0±3.0a	346.1±5.0a	348.0±6.0a
Bunch weight (kg)	15.6±6.8a	14.7±2.8a	14.0±7.5a	14.9±6.8a
Number of hands/bunch	7.9±1.5a	8.4±1.3a	7.5±3.2a	8.0±3.5a
Number of fruits/hand	18.3±2.3a	17.6±1.7a	18.0±4.3a	16.9±2.8a
Fruit weight (g)	114.9±8.1a	93.9±4.1a	115.5±8.1a	94.9±7.5a
Fruit length (cm)	16.0±2.5a	17.5±1.6ab	17.9.0±3.2a	17.7±2.9a
Fruit girth (cm)	12.0±1.2a	11.6±0.9a	11.9±1.5a	11.5±1.2a
Fruit length: girth ratio	1.3±0.2a	1.5±0.2b	1.5±0.2a	1.5±0.2a

a, b: Numbers within each pair (plant vz. plant crops or ratoon vz. ratoon crops) bearing the same letters are insignificantly ($p<0.05$) different according to Student and Mann-Whitney tests. SD: Standard Deviation of the mean

of the CPd banana, respectively (Table 1). Similarly, the plant crop of MPd cv. 'Uganda' produced more uniform fruits in terms of weights, lengths and girth with SD of 4.1, 1.6 and 0.9 compared to 8.1, 2.5 and 1.2 of the CPd banana, respectively (Table 2). The consistency in fruit size could partly be due to uniformity in size and growth rate of *in vitro* suckers. Fruit grade quality is an important quality aspect during packaging, especially in banana export market. It is traditionally achieved by manual removal of male buds, rachis and distal hands (Walker, 1975; Amma *et al*., 1986; Kurien *et al*., 2000). Thus, the increase in fruit uniformity of the MPd banana could reduce the production cost incurred during removal of male buds, rachis and distal hands.

CONCLUSIONS

Micropropagation reduces the production cycle and increases fruit uniformity of plant crop of EA banana cv. Bukoba and cv. Uganda but bunch yield depends on cultivars. The technique results in low bunch yield of field-grown cv. Bukoba. The low yield of MPd cv. 'Bukoba would affect the commercial application of the technique despite reduced plant crop cycle and increased fruit uniformity. Further studies are required to determine causes and bases of the yield loss in MPd cv. Bukoba.

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REFERENCES

Amma, S.P., A.K. Babylatha and T.M. Kurien, 1986. Studies on the effects of removing terminal hands and male buds on yield and fruit size of banana Musa (AAB group) cv. Palayankodan. S. Ind. Hortic., 34: 204-209.

Arinaitwe, G., P.R. Rubaihayo and M.J.S. Magambo, 2000. Proliferation rate effects of cytokinins on banana (*Musa* sp.) cultivars. Scientia Hortic., 86: 13-21.

Banerjee, N. and E. De Langhe, 1985. A tissue culture technique for rapid clonal propagation and storage under minimal growth conditions of *Musa* (banana and plantain). Plant Cell Rep., 4: 351-354.

Daniells, J.W., 1988. Comparisons of growth and yield of bananas derived from tissue culture and conventional planting materials. Banana Newslett., 11: 2.

Espino, R.R., O.C. Pascua, L.V. Magnaye and L. Loguias, 1992. Performance of tissue culture and sucker-derived planting materials of banana cv. Cardaba, Latundan and Lakatan. Acta Hortic., 321: 226-248.

Hwang, S., C.L. Chen, L.C. Lin and H.L. Lin, 1984. Cultivation of banana using plantlets from meristem culture. Horti. Sci., 19: 231-233.

INIBAP, 1994. Annual Report. INIBAP, Montpellier, France.

IPGRI, 1998. Banana research Network for Eastern and Southern Africa (BARNESA). Strengthening banana research in Eastern Africa, a 5 year Draft Plan, 1988-2003.

Israel, Y., O. Reuven and N. Nameri, 1988. Genetic variability and performance of *in vitro* propagated banana plants. In: Memorias 1986 de la IV Reunion sobre agrofisiologia del banano. Chaves, J.A. and R.R. Calderon (Eds.). Associacion Bananera Nacional, San Jose, Costa Rica, pp: 97-104.

Krikorian, A.D., H. Irazarry, R. Goenaga, M.E. Scott and B.E.L. Lockhart, 1999. Stability in plant and bunch traits of a 'French-type' dwarf plantain micro-propagated from the floral axis tip and five lateral corm tips of a single mother plant: Good news on the tissue culture and bad news on banana streak virus. Scientia Hortic., 81: 159-177.

Kurien, S., B.K. Anil, P.K. Rajeevan, V. Bharathan and S. Krishnan, 2000. Phosphorus mobilisation to uneconomic tissues and effects of bunch trimming regimes in banana. Scientia Hortic., 83: 25-32.

Lee, S.W., 2003. Micro-Propagation of Cavendish Banana in Taiwan. [http://www.micro-pro-banana-cavendish.htm] site visited on 12 December, 2004.

Liu, L.J., E. Risa, E. Lizardi, A. Arocho, N. Diaz and J.A. Rodriquez, 1989. *In vitro* propagation of plantain (*Musa* ABB) and banana (*Musa* AAA) in Puerto Rico. J. Agric. Univ. Puerto Rico, 73: 51-58.

Ma, S.S. and C.T. Shii, 1972. *In vitro* formation of adventitious buds in banana shoot apex following decapitation. J. Chinese Soc. Hortic. Sci., 18: 135-142.

Maerere, A.P., P.M. Kusolwa, T.J. Msogoya and L.T. Nsemwa, 2003. Evaluation of the effective *in vitro* regeneration and multiplication potential of local banana cultivars in Tanzania. In: Proceedings of the Second Collaborative Research Workshop on Food Security held on 28-30 May 2002, Morogoro, Tanzania.

Murashige, T. and F. Skoog, 1962. A revised medium for rapid growth and bioassay with tobacco tissue cultures. Physiol. Plant, 15: 473-497.

Robinson, F.C., C. Fraser and K. Eskstein, 1993. A field comparison of conventional suckers with tissue culture planting material over three crop cycles. J. Hortic. Sci., 68: 831-836.

Skirvin, R.M., K.D. McPheeters and G. Norton, 1994. Source and frequency of somaclonal variation. Hortscience, 29: 1232-1237.

Smith, M.K., S.D. Hamill, V.J. Doogan and J.W. Daniells, 1999. Characterisation and early detection of an off-type from micro-propagated lady finger bananas. Austral. J. Exp. Agric., 39: 1017-1023.

Swennen, R. and E. De Langhe, 1985. Growth parameters of yield of plantains (Musa AAB cv. Agbagba). Ann. Bot., 56: 197-204.

Talengera, D., M.J.S. Magambo and P.R. Rubaihayo, 1994. Testing for a suitable culture medium for micro-propagation of East African Highland bananas. Afr. Crop Sci. J., 2: 17-21.

Vuylsteke, D., 2001. Strategies for utilisation of genetic variation in plantain improvement. Ph.D Thesis, Leuven, KU Belgium, pp: 207.

Walker, L., 1975. The effects of debudding and pre-harvest dehandling on bunch weight and fruit quality. Annual Report 1974. Jamaica Banana Board R and F Department, pp: 116.

Zar, J.H., 1997. Biostatistical Analysis. Prentice-Hall International Inc., Upper Saddle River. 3rd Edn., pp: 659.