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FIELD PERFORMANCE OF TISSUE-CULTURED GIANT CAVENDISH BANANA (MUSA AAA GROUP) UNDER DIFFERENT FERTILIZER, NEMATICIDE AND PLANTING TREATMENTS ON ST. CROIX, V.I.

A. Gonzalez and C. Ramcharan

Agr. Expt. Station, College of the Virgin Islands
P.O. Box 920, Kingshill, St. Croix, V.I. 00850

ABSTRACT

The feasibility of using imported propagules of Giant Cavendish Banana for field production is described. Best yield of 28.2 t ha^{-1} or 245, 070 fruits ha^{-1} in the plant were obtained with chicken manure at 3.5kg $plant^{-1}$ without any nematicide. In the 1st Ratoon crop overall production was better with a maximum yield of 37.1 t ha^{-1} or 272,181 fruits ha^{-1} in plots treated with chicken manure and Temik 10%G at 84g $plant^{-1}$. Use of tissue culture material apparently did not increase crop production time with plants requiring 285 days from planting to flowering and an additional 75 days to harvesting. Both vegetative and fruiting characteristics of plants were very uniform with no apparent variability. Soil assays showed significant absence of the burrowing nematode and yield data indicated that nematicide application may not be required until the first ratoon crop. In comparison with plants produced from traditional suckers, tissue cultured palnts had thicker pseudostems more leaves and produced heavier bunches (16kg vs. 12kg) with more fruits per bunch (127 vs. 101).

RESUMEN

Se describe la viabilidad de la utilización de propágulos importados de banano del tipo Giant Cavendish para la producción de campo. Se obtuvo el mejor rendimiento de 28,2 t/ha o 245 070 frutos/ha, usando la gallinaza en una relación de 3,5 kg/planta sin nematicida. En la primera cosecha de retoños, se obtuvo una producción global mejor - un rendimiento máximum de 37,1 t/ha o 272 818 frutos/ha en los semilleros tratados con gallinaza y Temik 10%G en una relación de 84 g/planta. El uso de culitvos de tejido no parecía mejorar la duración de producción del cultivo, puesto que las plantas necesitaron un período de 285 dias desde la plantación hasta la floración, y unos 75 días más hasta la cosecha. Las características vegetativas y fructíferas permanecieron uniformes sin variación aparente. Los ensayos del suelo presentaron una ausencia significante del nematodo horadador; y los datos sobre el rendimiento indicaron que la aplicación de la nematicida no sería necesaria hasta la primera cosecha de retoños. Comparadas con las plantas producidas de retoños tradicionales, les plantas producidas de cultivos de tejido tenían seudocabezas más gruesas y más hojas; y produjeron racimos más grandes (16 kg contra 12 kg), con más frutos por racimo (127 contra 101).

Although bananas are an important part of the diet of many Virgin Islanders, most of the bananas consumed are imported from the U.S. (via Florida) or other Caribbean islands (Table 1). Planting material used in the Virgin Islands is usually brought in from neighbouring Caribbean islands creating transportation and quarantine problems.

Propagation by tissue culture is a method of producing large numbers of pest-free material (Debergh and Maewe, 1983, Hughes *et al.*, 1978 and Murashige, 1974) that can be conveniently shipped between countries. Lui *et al* (1984) used meristem aspices of banana for rapid clonal multiplication and recovery of specific pathogen-free plants. Ramcharan (1983)

Table 1. Amount and value ($US) of banana and plantains imported into the US Virgin Islands for selective years.

Item	Quantity ('000kg)	Value $	Country of origin	Year
Plantain	1.5	594	Honduras	1980
Plantain	23.3	7,092	Costa Rica	1980
Plantain	34.0	12,288	Dom. Republic	1980
Plantain	1.9	577	St. Lucia	1980
Plantain & Banana	661.0	296,935	US (via Miami)	1980
Plantain & Banana	237.0	125,986	US (via Miami)	1983

Source: Bureau of Statistics, Dept. of Commerce, Charlotte Amalie St. Thomas, U.S. Virgin Islands.

developed a suitable method of transplanting and a container for use in hardening-off Giant Cavendish banana propagules shipped into St. Croix. Pool (1984) in Puerto Rico obtained excellent yields with tissue cultured clones of Ziv and Dwarf Cavendish cultivars introduced from Israel.

The Giant Cavendish banana is now a major commercial cultivar and like the rest of the Cavendish group is resistant to the Fusarium wilt but susceptible to nematodes (Rowe and Richardson, 1975). In St. Lucia (Holder and Gumbs, 1983), Giant Cavendish was found to have comparable yields to other Cavendish types, but was shorter and more wind resistant.

This paper describes an experiment to evaluate the feasibility of importing Giant Cavendish propagules and their subsequent field performance using different cultural treatments.

Materials and methods

The study was conducted at the Virgin Islands Agricultural Experiment Station on St. Croix, U.S. V.I. The climate is tropical with an annual average maximum and minimum temperature of 30 °C and 23 °C, respectively. The average annual rainfall is 1092mm. The soil is a Fredensborg clay loam characterized by an underlying layer of limestone or marl (Lugo-Lopez and Rivera, 1980). Soil chemical characteristics of the experimental plot are shown in Table 2.

Table 2. Soil chemical analysis of the experimental plot

C.E.C. meq/100g	pH	O.M. %	P ug/ml	K meq/100g	Ca meq/100g	Mg meq/100g	Fe ug./ml
35.6	7.9	2.9	14.6	0.36	38.9	2.7	1.8

The experiment was initiated on 1 December, 1982, using Stage III plantlets of Giant Cavendish bananas air-freighted into St. Croix from Oglesby Nursery of Holiday, Florida. The plantlets were hardened-off and established according to methods previously described (Ramcharan, 1984).

Plants were spaced at 2.4m x 2.1m (about 1945 plants ha^{-1} in a 2 x 2 x 3 factorial experiment using a completely randomized design with three replicate plots, each containing six plants. Treatments used were: method of planting – either tractor dug or hand dug holes; fertilizer – chicken manure or ammonium sulfate and nematicides – Temik (Aldicarb) 10%G, Furadan (Carbofuran) 5%G and a control without nematicide. Chicken manure was applied initially at 3.5kg. of well rotted manure in the planting holes but broadcast around the plants in the subsequent yearly applications. Ammonium sulphate was applied at a rate of 1.7kg. $plant^{-1}$ yr^{-1} divided into six applications. Potassium sulfate was applied at an overall rate of 800kg K_2O ha^{-1}. Temik 10%G at 84g $plant^{-1}$ and Furadan 5%G at 56g $plant^{-1}$ were incorporated at the time of planting and again at 6 and 4 months intervals respectively on the soil surface.

A trickle irrigation system consisting of 1.25cm black polyethylene tubes, one 3.8 l hr^{-1} emitter $plant^{-1}$ and battery operated timers (Water Watch Corp, Seattle, Washington) was used to apply water and FE 138 sequestrene chelate (Ciba Geigy, Greensboro N.C.) at 60g ha^{-1} wk^{-1}.

Weed growth was controlled with post-emergent applications of Paraquat at 0.3kg a.i ha^{-1}.

The bunches were harvested when the fruit reached the light full or full ¾ stages.

Results and discussion

Of major significance in this study was the good uniformity both in the vegetative and fruiting phases of banana plants. Unlike a previous field study using tissue cultured plantain (Ramcharan and Gonzalez, 1984), the Giant Cavendish bananas showed no variability problems.

Yield data are represented in Tables 3 and 4. In the plant crop (Table 3) overall mean yield and fruits

Table 3. Yield (t/ha) and fruits/ha of the plant crop of tissue-cultured Gaint Cavendish banana

Nematicide	Mean yield (t/ha) [1] NH_4SO_4	Chicken manure	Fruits/ha NH_4SO_4	Chicken manure
		Tractor-dug holes		
Without	22.2b[2]	24.9 ab	203,641 b	233,400 ab
Furadan 5%G	23.5 ab	24.5 ab	208,115 ab	232,816 ab
Temik 10%G	23.5 ab	26.4 ab	223,091 ab	232,030 ab
		Hand-dug holes		
Without	20.9 c	28.2 a	202,280 b	245,070 a
Furadan 5%G	24.5 ab	24.3 ab	221,146 ab	227,565 ab
Temik 10%G	23.0 b	23.1 ab	209,476 ab	227,954 ab
Mean	22.9	25.2*	211,291	233,139*

[1] Based on a plant population of 1945 plants/ha

[2] Mean separation within columns by Duncan's multiple range test, 5% level

*Significant at the 0.05 probability level

ha^{-1} of the chicken manure treatments were significantly higher than the ammonium sulphate treatment. In the 1st ratoon crop (Table 4) there were no significant differences although overall yields were higher than in the plant crop.

With respect of nematicides and method of planting treatments, no significant difference was found within the treatments. Although using a tractor for preparing planting holes did not improve yields, this method would certainly reduce labour costs for planting.

The average yield and fruits ha^{-1} between the treatments were 24.1 and 33.75t ha^{-1} with 222, 315 and 272, 818 for the plant crop and second crop respectively.

Table 4. Yield (t/ha) and fruits/ha of the 1st ratoon crop of tissue-cultured Gaint Cavendish banana

Nematicide	Mean yield (t/ha)[1] NH_4SO_4	Chicken manure	Fruits/ha NH_4SO_4	Chicken manure
		Tractor-dug holes		
Without	35.5[2]	30.4	258,685	275,412
Furadan 5%G	30.1	31.2	278,718	270,938
Temik 10%G	35.3	34.6	258,685	294,473
		Hand-dug holes		
Without	32.4	35.7	258,685	275,421
Furdan 5%G	36.5	35.2	278,718	270,938
Temik 10%G	31.0	37.1	258,685	294,477
Mean	33.5	34.0	265,362	230,274

[1] Based on a plant population of 1945 plants/ha.

[2] Means without a letter do not differ significantly (p=.05) according to Duncan's multiple range test.

The maximum yield in the plant crop was 28.2t ha^{-1} obtained with chicken manure and without nematicide. In the second crop the maximum yield was 37.1t ha^{-1} obtained with chicken manure and Temik 10%G. Chicken manure therefore appears to be superior to ammonium sulfate, particularly in the plant crop, when the plants are relatively free of nematode infestation. Soil OM content and CEC were low (Table 2) and better yields with chicken manure may have been mainly due to soil amelioration properties of the manure itself. It would therefore be interesting to observe effects of chicken manure used in combination with ammonium sulphate.

In the 1st ratoon crop, when soil nematode populations had built up, the use of Temik with chicken manure appeared to increase yields. This interaction between chicken manure and nematicide is therefore an important one that has so far not been reported.

In data not presented, it was shown that Giant Cavendish bananas originating from tissue culture took 285 days to shooting and an average of 75 days from shooting to harvesting.

Table 5 presents the total populations of major nematodes found in soil assays. These data corresponded to the second year of the experiment. Because the method of planting has no effect on the number of nematodes, this information was compiled to simplify data.

The F value in the analysis of variance showed no interaction between fertilizer and nematicides treatments. Also, the data in general showed that neither nematicide application nor fertilizer had any significant effect on the number of nematodes.

Of major significance was the total absence of the burrowing nematode *(Radopholus similis)* which is a common pest of the Giant Cavendish banana. Although high pH is known to suppress nematode population (pers. comm ., G. Goseco, United Fruits, Honduras), the use of tissue-cultured material may partly be responsible for this notable absence of *Radopholus.* Tissue culture may therefore afford a practical and effective means of excluding the burrowing nematodes from areas such as the Virgin Islands where this pest has so far not been extensively found.

Table 5. Total population of nematodes* extracted from 100cc of soil from rhizosphere on banana grown from explants and treated with different fertilizer and nematicides[1]

	No nematicide	Furadan 5%G	Temik 10%G
Chicken manure	291.2[2]	253.2	366.5
NH_4SO_4	276.0	277.0	306.5
Total	567.2	480.2	673.0

[1] Furadan applied at 4 month and Temik at 6 month intervals

[2] Means without a letter do not differ significantly (P.05) according to Duncan's multiple range test

*Including spiral, root-knot, and reniform types

Since the use of nematicides apparently had no effect on the number of nematodes at least in the plant crop, when using tissue-cultured plantlets, it may be possible to recommend that nematicides not be used locally until the 1st ratoon crop.

Table 6 shows comparative characteristics between Giant Cavendish grown from tissue culture and from suckers in the same soil type. The superiority of tissue-cultured Giant Cavendish is evident. The thicker pseudostem of the tissue-cultured plants is well suited to the windy conditions in the Virgin Islands. Also the apparent larger bunch and numbers of fruits produced from cloned plants could significantly increase total banana production in the islands.

Table 6. Comparative growth and yield characteristics of regular & tissue cultured Giant Cavendish banana.

	Planting material	
Parameter	Regular sword suckers	Tissue-cultured propagules
Height at shooting (m)	1.8	1.7
Pseudostem diameter * (cm)	13.2	16.5
Bunch weight (kg)	12.0	16.0
Fruit/bunch	101.0	127.0
Hands/bunch	7.0	7.6
Functional leaves	8.3	9.5

*measurement taken about 0.6 m above soil level.

In summary, the feasibility of using Giant Cavendish banana from tissue culture as planting material was established. The mature plants from tissue culture showed good uniformity in both the plant and succeeding crops and comparatively higher yields than traditionally grown plants. Tissue culture may therefore afford an effective means of excluding the burrowing nematode from the Virgin Islands, reduce the dependence on the use of chemical pesticides and generally increase production from the present acreage under banana cultivation.

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