Second Year Banana Cultivar Trial in South Georgia

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The development of the annual cropping production system (ACP) and more cold-tolerant cultivars has allowed commercial banana production outside the traditional production belt. This evaluation of 32 cultivars was initiated to determine the feasibility and suitability of Annual Cropping Production (ACP) for niche/ethnic markets under Georgia weather conditions; determine the growth performance, fruit quality, and marketability; and determine which cultivars have sufficient cold hardiness for ornamental landscape use.

Traditional corn and tobacco farmers are gradually switching to new ventures in fruits and vegetables. Limited-resource and part-time farmers are also seeking alternative crops to diversity their farming practices and take advantage of the increasing demand for ethnic products and emerging ethnic markets. The adoption of Agro-tourism in Georgia is further escalating the need for diversifying agriculture. The U.S. is the largest net importer of bananas. U.S. companies spend approximately $1.1 billion each year on banana imports, purchasing 31.1% of total world imports. Recent studies have shown that a negligible quantity of bananas are being produced and marketed in Hawaii (Hawaii Agricultural Statistics Service 2001, 2002) and Florida, generating an annual income of about $10 million and $2.5 million, respectively, during the past half a decade (Fonsah 2003, 2004).

Material and Methods

This experiment is being conducted at the University of Georgia Bamboo Farms and Coastal Gardens in Savannah, Georgia. The environmental conditions and experimental design are described in Fonsah, Krewer, and Rieger (2004).

Cultural Practices

A solid-set irrigation system that can spray a 30-ft. overlap was installed on April 19, 2004 to replace the initial double drip-line irrigation system. Irrigation was applied three times per week and/or when necessary (Fonsah and Chidebelu 1995). Fertilizer application was increased to 2.4 lbs of 10-10-10 and 0.78 lbs of muriate of potash per plant. The same amount was applied each month from May to October. Deleafing was performed four times per year starting in April 2004. Sucker pruning and general sanitation was done three times starting in April 2004. Weed control was done three times starting in May 2004.

Data Collection

A data logger—Model CR7 from Campbell Scientific, Logan, Utah—was installed in January 2004 to collect rhizome and air temperatures and to determine which cultivars have sufficient cold hardiness. Phenological data such as planting to shooting time and shooting to harvest time were collected. Pomological data such as bunch emergence, bunch quality, size, and hand-class were collected. Vegetative morphological data such as plant height, pseudo-stem circumference, number of leaves, length and width of leaves, and number of suckers were also collected.

Data Analysis

The Mean Separation by Proc Mixed was used to analyze the vegetative morphological characteristics/data.

Results and Discussions

Figure 1 shows how small the plants were on arrival to the University of Georgia Bamboo Station and Coastal Gardens, Savannah, Georgia. They were about 10 cm. tall (approximately 4 inches)

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and were in 72-cell packs. Each plantlet had 4 or 5 leaves and a well-developed root system. The environmental conditions and cultural practices in the greenhouse were explained in Fonsah, Krewer, and Rieger (2004).

These plantlets were grown in the greenhouse for about six weeks before transplanting to the field as shown in Figure 2. The soil characteristics were explained in Fonsah, Krewer, and Rieger (2004). The plantlets were about 30 cm tall (~1 ft) during transplanting. Ideally, these plants would have been grown in the greenhouse for about 12 weeks prior to field transplant (Fonsah and Chidebelu 1995; Stover and Simmons 1987).

Seven month later, the plants were fully grown (Figure 3). All cultural practices such as weed control, fertility application, sucker pruning, and deleafing were explained in the experimental design by Fonsah, Krewer, and Rieger (2004), Fonsah and Chidebelu (1995), and Robinson (1996).

After the first frost, all the plants had scorched leaves as shown in Figure 4 below. Another freezing temperature was observed on 23 March 2004. Low air temperature for the winter was -6.6^{o}C on 21 December 2003. Surprisingly many of the plants had pseudostems that survived the winter and showed green leaves on 18 March 2004, but were killed by the very late frost on 23 March (-1.4^{o}C).

Figure 1. Tissue Culture Banana Plants Donated And Utilized In Research, March 05, 2003.

Figure 2 Tissue Culture Plants Transplanted in the Field, April 24, 2004.

Figure 3. Condition of the Experimental Plot Seven Months Later, November 12, 2003.

Figure 4. Condition of the Experimental Plot During Winter, December 16, 2003.

Nothing was done to protect the plants during the winter season.

The condition of the experimental plot immediately after winter is shown in Figure 5. Some plants already showed resistance to cold. However, no conclusion can be drawn at this stage until further research is conducted. The installed data logger showed that the rhizome temperature dropped to about - 6^{o}F.

Annual Cropping Production

Phenological Characteristics

One of our specific objectives was to investigate phenological characteristics such as planting to shooting time, shooting to harvest time and shooting to shooting time in the ratoon crop (second growth). As early as May 2004—exactly 13 months after

Figure 5. Condition of the Experimental Plot Immediately After Winter, April 19, 2004.

Figure 6. Choked Throat on Brazilian Banana Cultivar, May 27, 2004.

planting—the cultivar Musa 1780 had already shot its first bunch. But because of the serious frost that hit the experimental plot in March (the second in four months), this plant had only three leaves during shooting time. Consequently, the bunch was cut down (using the bell-chopping technique) because three leaves are not sufficient to carry the bunch into full maturity (Robinson 1993; Robinson 1995). The plant was cut midway six weeks later and the decayed portion was subsequently cut during each sucker pruning exercise. Interestingly, the first ratoon (F1) shot in October, five months later. Nine other cultivars that followed this trend were three Brazilians, Orinoco, Dwarf Namwah, Ice Cream, and three Musa 1780.

Bunch Characteristics, Quality, and Marketability

The plants that shot within three months of the March frost were either choked, malformed, or stunted, with very few hands and fingers (Figure 6). Some plants had very few leaves or no leaves at all for fruit development. Some bunches of choked

Figure 7. Two Weeks Old Shot Bunch from the Cultivar Dwf. Namwah, October 23, 2004.

plants emerged through the pseudostem. The quality, shape of the fingers, and curvature of the bunches did not meet marketability standards.

Pomological Characteristics, Quality, and Marketability

The bunches that emerged four months or more after the March frost were normal even though their emergence was drastically delayed. Twenty-nine plants shot as of October 23, 2004. Figure 7 shows a beautiful Dwf. Namwah cultivar two weeks after shooting. No quality problems as discussed by Fonsah (2003) were observed. If these bunches could reach maturity, they would meet the quality specification of most banana markets. This cultivar has a huge ten-hands bunch with beautiful fingers seventeen months after planting. The nine choked cultivars/bunches mentioned earlier shot between 12 and 15 months after planting. Without the inhibited growth caused by winter, these bunches would have shot earlier (Robinson 1993; Robinson 1996).

Replication 5 had the most shot bunches. Table 1 shows that all the Raja Puri and Manzano cultivars shot in our experiment. At the time of submission of this paper, it was impossible to collect further information on hand class, number of fingers, and bunch weight and size, since some of the bunches were still at the peeping or bending stage. It is also not clear at this time if the growing season in South Georgia is of sufficient length to mature a ratoon crop.

Plant Height and Growth Performance

A comparison of plant height was conducted from April to August in 2003 and 2004 for all the cultivars. The plants were ranked into three categories—Tall, Medium, and Short. Tall was defined in 2003 as plants from 1.5 to 2.0 meters in height, Medium from 1.0 to 1.49, and Short was any plant less than 1 meter in height. However, in 2004 the dynamics in the plant growth rate changed drastically and we redefined Tall as plants from 2 to 2.5 meters in height, Medium from 1.5 to 1.9 meters, and Short as any plant less than 1.5 meters in height.

Table 2 shows that due to the change in plant-growth performance, Kofi and Kummunaba dropped off the Tall category in 2004 while cultivars such as Frank Unknown and Pace were included in this category. In the 2003 Medium category, Hua Moa, Pace, FHIA 17, Super Plantain, Cardaba, Ele Ele, FHIA 23, Burmese, and Frank Unknown lost their medium status. Frank Unknown and Pace joined the 2004 Tall category (2 to 2.5 meters in height), while Hua Moa, FHIA 17, Super Plantain, Cardaba, Ele Ele, and FHIA 23 joined the Short category ($\leq$ 1.5 meters) in 2004.

Table 1. Shot Cultivars From April to October 2004, by Replication.

Replication 1	Replication 2	Replication 3	Replication 4	Replication 5
Sweet Heart	Manzano	Manzano	Manzano	Sweet Heart
Manzano	Gold Finger	Raja Puri	Sweet Heart	Manzano
Gold Finger	Raja Puri	Orinoco	Raja Puri	Brazilian
Frank Unknown	Dwf. Namwah	FHIA 1780	Saba	Kummunaba
Raja Puri	Pace		Frank Unknown	Pisang Celong
Musa 1780				Dwf. Namwah
				FHIA 18
				FHIA 1780
				Raja Puri

Table 2. Comparison and Classification of Banana Cultivars by Height From April to August of 2003 and 2004.

Tall Category 2003	Tall Category 2004	Medium Category 2003	Medium Category 2004	Short Category 2003	Short Category 2004
Kandarian	Belle	Hua Moa	Namwah	Grain Nain	Burmese
Musa 1780	Frank Unknown	Namwah	FHIA 18*	Williams	Cardaba
Saba	Ice Cream	Pace	Kalela	SumXCross	Ele Ele
Ice Cream	Kandarian	Orinoco	Kumunaba	Kru	FHIA17*
Kummunaba	Manzano	Mysore	Brazilian	Dwf Nino	FHIA23*
Belle	Musa 1780	Pisang Ceylon	Goldfinger	Sikkimensis	Sikkimensis
Manzano	Pace	Kalela	Musa Kofi		SumXCross
Kofi	Saba	FHIA 18*	Mysore		Super plantain
		FHIA 17*	Orinoco		Hua Moa
		Goldfinger	Pisang Ceylon		
		Sweet Heart	Raja Puri		
		Super Plantain	Sweet Heart		
		Cardaba			
		Ele Ele			
		FHIA 23*			
		Brazilian			
		Raja Puri			
		Burmese			
		Frank Unknown			

*Fundacion Hondurena de Investigacion Agricola (FHIA) is a banana breeding program created in Honduras in 1959 by United Fruit Company and donated to the Honduran government in 1984.

Conclusions

The tissue-culture planting materials for this study were about 10 cm tall (approximately 4 inches) and were in 72-cell packs when they arrived. Each plantlet had 4 or 5 leaves and a well-developed root system. The plantlets were grown in the greenhouse for about six weeks before transplanting to the field. Under ideal conditions, these plants would have been grown for at least 12 weeks but because of late arrival of the plants, the nursery time was cut by half. All cultural practices carried out in a semi-modern cultivation system and as explained by Fonsah and Chidebulu (1995) were carried out (sucker pruning, deleafing, weed control, fertility application, etc.).

The plants grew rapidly after planting, until seven months later when all the plants had been scorched by frost. Many plants had pseudostems that survived the winter, but most were killed by the frost of 23 March. Some plants already showed cold hardiness, but we have not generated enough data to substantiate that claim. A few months after the winter, the first bunch emerged on the Musa 1780 cultivar, exactly 13 months after planting. Due to the serious frost that hit the experimental plot in March, the plant had only three leaves during shooting time, which was insufficient to support the bunch until maturity. The plants that shot between one and three months after the March frost were either choked, malformed, or stunted, with very few hands and fingers. Some plants had very few leaves or no leaves at all for fruit development. Some bunches of choked plants emerged through the pseudostem.

A comparison of plant height was done from April to August in 2003 and 2004 for all the cultivars. The plants were ranked in tall, medium, and short categories. Tall was defined in 2003 as plants from 1.5 to 2.0 meters in height; Medium from 1.0 to 1.49, and Short was any plant less than 1 meter in height. However, in 2004 the dynamics in the plant growth rate changed drastically and we redefined Tall as plants from 2 to 2.5 meters in height, Medium from 1.5 to 1.9 meters, and Short as any plant less than 1.5 meters in height.

Further research is necessary to determine the plants with sufficient cold hardiness and the cultivars suited for Annual Cropping Production (ACP) under Georgia weather conditions. These important studies have not been carried out due to lack of funding.

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