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Investigations on Phenological Responses to Determine Banana Fruit Production Potential in the Coastal Region of Alabama, USA

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Abstract

Bananas have wide adaptability but environmental conditions will affect growth responses and plant vigour. The present study was initiated to determine the potential for banana fruit production in the coastal region of Alabama by comparing phenological parameter responses as a measure of plant vigour of five medium height cultivars: 'Cardaba', 'Gold Finger', 'Ice Cream', 'Raja Puri', and 'Veinte Cohol'. At 150 days after planting (DAP), 'Viente Cohol' and 'Ice Cream' produced significantly more leaves (38.8 and 38.3 leaves/plant, respectively) than 'Cardaba' and 'Raja Puri'. At 150 DAP, 'Cardaba' and 'Ice Cream' had a higher number of leaves present (NLP) than 'Raja Puri' indicating the plant's ability to maintain more leaves at a given time for the accumulation of dry matter. 'Gold Finger' exhibited the lowest height to circumference ratio value (HCR) of 3.28, indicating a stronger pseudostem to withstand lodging due to high winds or heavy crop load. 'Ice Cream' and 'Gold Finger' exhibited the greatest plant vigour and/or pseudostem strength overall and potential for fruit crop production in the region.

Bananas (*Musa* sp.) possess unique potential as a specialty fruit crop for coastal Alabama because they are the leading import fruit crop in the U.S. and the fourth most important crop globally. U.S. banana import value rose from $1 billion in 2006 to nearly $2 billion in 2010 while global banana production was cited at over 100 million metric tons – a 33% increase since 2005 (FAOSTAT, 2013). Moreover, bananas are an important source of food and fibre for many cultures that have a growing presence in the U.S. creating further demand for banana specialty markets within the agricultural sector. More recently, development of cold-tolerant and short-cycled banana cultivars has led to increased adaptability and expansion of banana fruit production into the subtropics; however, sub-optimal conditions due to cultural practices and environment will be manifest as reduced vigour, delayed fruit production, and reduced fruit quality (Robinson, 1996; Vuylsteke et al., 1996; Fonsah et al., 2004; Surendar et al., 2013). The main objective of the present study was to compare phenological parameter responses, as measures of plant vigour, of five medium height cultivars to identify cultivars that are best adapted to the subtropical environmental conditions of coastal Alabama. Variables measured in this study were total leaves produced (TLN), number of leaves present (NLP), leaf emergence rate (LER), leaf area index (LAI), pseudostem height, pseudostem circumference, and height:circumference ratio of the pseudostem (HCR). TLN is an important variable as flowering is believed to occur when a plant has reached 37 to 46 leaves (Var-

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gas et al., 2008), while NLP is a measure of the amount of photosynthesizing leaf surface area maintained by the plant at any moment in time. This variable is especially important during bunch development as no more leaves are produced after flower emergence and a minimum of four leaves is required to mature a bunch (Robinson, 1996). The life span of individual leaves ranges from 71 to 281 days in the subtropics and up to 150 days in the tropics (Summerville, 1944; Stover and Simmonds, 1987). LER is a measure of overall condition of the plant and the rate at which a plant can reach the TLN required for flowering. LAI provides indication of a plant's ability to intercept light energy to sustain photosynthesis and subsequently dry matter accumulation (Tuner et al., 2007). Pseudostem height dictates management practices in the field and, combined with pseudostem circumference, provides the HCR which is a measure of plant strength.

Materials and Methods

Banana plants, propagated from tissue culture (Agristarts Inc., Apopka, FL, USA), were planted at the Gulf Coast Research and Extension Center in Fairhope, AL, USA (30°31'35.018" North, 87°53'44.473" West) on June 6, 2013. Experimental design consisted of six single-plant replications arranged in a completely randomized design (CRD) with cultivar and days-from-planting in a factorial arrangement. Cultivars included were 'Cardaba', 'Gold Finger', 'Ice Cream', 'Raja Puri', and 'Veinte Cohol'.

Phenological and physiological data collected were total leaf number (TLN), number of functional leaves present at sampling time (NLP), leaf emergence rate (LER), and leaf area index (LAI). LAI was calculated by the following equation: TLA x (0.83)/GA where TLA is total leaf area of the plant which is multiplied by a correction factor divided by unit ground area (GA) (Rodrigo et al., 1999; Guimarães et al., 2013). Pseudostem height was measured from the ground to the bifurcation of the top two leaf petiole bases, plant circumference was measured 30 cm above the base, and pseudostem height:circumference ratio (HCR) was calculated.

Fertilizers (10-10-10 and 0-46-0) were applied monthly by hand at rates of 0.72 and 0.2 kg/plant, respectively, as recommended by the University of Georgia Agricultural and Environmental Services Laboratory. Plants were irrigated using drip irrigation and received approximately 50 mm water per week.

Data were analyzed by SAS Version 9.3 (SAS Institute, Inc., Cary, NC, USA) using PROC GLIMMIX.

Results and Discussion

By 150 days after planting (DAP), 'Viente Cohol' and 'Ice Cream' had produced significantly more leaves (38.8 and 38.3 leaves/plant, respectively) than 'Cardaba' and 'Raja Puri' (Table 1). All cultivars produced 37 to 46 leaves indicating that banana plants were close to transitioning from the vegeta-

Table 1. Total leaf number, number of leaves present, leaf emergence rate and leaf area index of medium size banana cultivars at150 days after planting in Coastal Alabama, USA, 2013.

Cultivar	Total leaf number (TLN)[z]	Number of leaves present (NLP)	Leaf emergence rate (LER) (leaves/month)	Leaf area Index (LAI)
Cardaba	36 b[y]	13 a	4.2 a	1.50 a
Gold Finger	37 ab	11 ab	4.3 a	0.99 b
Ice Cream	38 a	13 a	4.6 a	1.56 a
Raja Puri	32 c	10 b	3.7 b	1.15 ab
Veinte Cohol	39 a	12 ab	4.5 a	0.99 b

[z]Data collected 150 days after planting.
[y]Means followed by different letters are significant (p>0.05).

Table 2. Growth indices of medium size banana cultivars planted in Coastal Alabama, USA, 2013.

Cultivar	Pseudostem height (cm)[z]	Pseudostem circumference (cm)	Height:circumference ratio
Cardaba	201.2 ab[y]	57.4 ab	3.20 b
Gold Finger	155.4 c	48.8 c	2.87 c
Ice Cream	225.6 a	65.1 a	3.20 b
Raja Puri	192.0 b	51.7 bc	3.43 a
Veinte Cohol	137.2 c	37 3 d	3.43 a

[z] Data collected 150 days after planting.
[y] Means followed by different letters are significant ($p>0.05$).

tive to the reproductive stage. At 150 DAP, 'Cardaba' and 'Ice Cream' exhibited a higher number of standing leaves (NLP) than 'Raja Puri', which is an important cultivar-specific trait since after floral initiation leaves are no longer produced and a minimum of four leaves are required to mature a developing fruit bunch. Results on leaf emergence rate per month (LER) suggest that 'Raja Puri' was the only cultivar to fall below the expected rate of developing four leaves/month. In general, low height to circumference ratio (HCR) values indicate a strong pseudostem, which allows the banana plant to withstand damage inflicted by high winds. 'Raja Puri' and 'Veinte Cohol' exhibited the highest HCR of 3.71 and 3.68, respectively, while 'Gold Finger' produced the lowest HCR (3.28).

Conclusions

Medium sized banana cultivar phenological and vegetative responses suggest that 'Ice Cream' exhibited the greatest potential for production in the subtropical region of the Gulf Coast of Alabama. 'Ice Cream' produced the highest number of total leaves per plant for the season, maintained a high number of leaves (as indicated in NLP) and a high LAI relative to most other cultivars in this study. Based on the outcomes of the present study, 'Gold Finger' also exhibited potential for production in the Gulf Coast region. 'Gold Finger' had significantly lower HCR than all other cultivars in our test making it least prone to lodging due to crop load or high winds. This is a significant attribute considering the frequent high winds that occur in the Gulf Coast of Alabama. Additionally, plant vigour of 'Gold Finger' measured by TLN, NLP and LER was comparable to the most vigorously growing cultivars tested.

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The effect of two orchard light management practices on the sensory quality of apple: fruit thinning by shading or photo-selective nets

The effects of innovative techniques for orchard light management on the sensory properties and quality of apple (*Malus* × *domestica* Borkh.) fruit were measured using sensory and instrumental techniques. In the first experiment, 'Rosy Glow' fruit, thinned chemically or by shading, were compared. In the second experiment, 'Fuji' fruit were grown under five different coloured photo-selective hail nets and compared. For 'Rosy Glow' fruit, the efficacy of both thinning methods was comparable in terms of crop load, and no sensory differences were perceived between treatments by a trained sensory panel, based on quantitative descriptive profiling, except for the "green flesh" attribute. Nevertheless, 'Rosy Glow' fruit from the shade-based thinning had a higher mean fresh weight (FW; 215 g *vs*. 198 g) and higher titratable acidity (5.3 *vs*. 4.5 malic acid eq. 100 g^{-1} juice). Some significant differences were reported by the trained sensory panel for four out of the ten attributes rated among the 'Fuji' apples produced under the neutral black net (control), and the red, white, yellow, and blue photo-selective hail nets. Differences were greatest between fruit from the red and yellow hail nets. Apples from the red hail net had higher scores for yellow colour perception (average intensity 42.3 *vs*. 28.5, based on a linear scale anchored at 0 as the minimum and 100 as the maximum), sweet taste (score 54.9 *vs*. 42.4), and hardness (i.e., sensory definition for firmness; score 52.0 *vs*. 43.0), and a lower score for green colour (4.6 *vs.* 10.0). In terms of objective instrumental measurements, fruit from the red net treatment had a higher mean FW (217 g), with larger cells and larger intercellular spaces measured in terms of the number of cells mm^{-3} and the percentage of intercellular spaces, and a higher mean dry matter (DM) content [14.7% (w/w)], when compared to fruit from the other photo-selective net treatments. The spectrum of transmitted light influenced fruit growth by affecting cell proliferation and ripening, which changed the sensory perceptions of fruit appearance, taste, and texture. This study demonstrated that it is possible to use sensory panel analysis to measure the impact of new pre-harvest treatments on the quality of harvested apple fruit. Abstract from: M. L. Corollaro, L. Manfrini, I. Endrizzi, E. Aprea, M. L. Demattè, M. Charles, M. Bergamaschi, F. Biasioli, M. Zibordi, L. Corelli Grappadelli and F. Gasperi. The Journal of Horticultural Science & Biotechnology 90(1):99-107.