

Studies on Phenological Characters of Different Banana Cultivars (*Musa*) in Visakhapatnam, Andhra Pradesh

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Abstract: The investigation on “Studies on growth and yield of different cultivars of banana” was carried out during 2014-15 at 3 different mandals of Visakhapatnam district, Andhra Pradesh, India. Six banana cultivars were taken viz., Karpura Chakkarakeli, Dwarf Cavendish, Robusta, Rashtali, Thella Chakkarakeli and Yenugubontha. The experiment was conducted in field with three replications. The six different banana cultivars were selected for various metric and non metrical observations on vegetative and yield attributing characters were recorded and statistically analyzed. Maximum plant (pseudostem) height, pseudostem girth PCA, Number of suckers at harvest and petiole length was recorded in Yenugu bontha. The highest leaf length, width and total leaves per plant were recorded in Robusta. Similarly, more leaf area, LAI was registered in Robusta. The highest bunch weight and per ha yield was recorded in Robusta whereas, finger length, girth, weight and finger volume were maximum in Yenugu bontha.

Keywords: Banana, cultivars, phenology, growth, yield

1. Introduction

Banana is the fourth most important food crop in world as well as in India [3]. It is considered as “poor man’s apple”. It is a staple food and export commodity. It contributes to the food security of millions of people in the developing world and, when traded in local markets, provides income and employment to the rural populations [11]. India leads the world in banana production with an annual output of about 26509.0 M.T from an area of 776.0 ha (Department of Agriculture and Cooperation Horticulture Division 2013). In India, major banana producing states are Tamil Nadu, Maharashtra, Karnataka, Gujarat, Andhra Pradesh, Assam and Madhya Pradesh. Andhra Pradesh being one of the important states in India growing banana, harbors a wide diversity of crop in both culinary and dessert cultivars. In Andhra Pradesh, the farmers are cultivating local cultivars which are low yielders and the productivity of banana is also low i.e. 35 t/ha as against 65 t/ha in Maharashtra. Therefore to improve productivity, a varietal trial in banana with different cultivars was proposed. Banana and plantain is one of the most important fruit crops grown in Andhra Pradesh as well as in Visakhapatnam. Banana is so predominant and popular among people that it is liked both by poor and rich alike. It is also cheap, highly nutritive and easily digestible fruit having refreshing aroma. It has also high production potentiality and profitability. In banana, fruit yield is of great important though consumer acceptance varies from place to place. Commercial banana cultivars are known to be larger in size, weight, length and overall shape and have higher consumer acceptability. Banana owing to its large size and rapid growth rate require relatively large amount of nutrients for high yields of quality fruits.

The present study is on Phenology, refers to the vegetative and reproductive development cycles of different banana cultivars as determined by climate and in particular temperature. Leaf area is an important component that is

closely related to the physiological processes controlling dry matter production and yield. Leaf area has been shown to influence the radiant energy interception, an important photosynthetic parameter in crop plants, showing positive relationship with net photosynthetic activity [20]. Leaf area is one of the growth parameters also indicates the size of photosynthesizing apparatus. Leaf area (LA) is a fundamental determinant of the total photosynthesis by plant. Leaf area showed a positive relationship with net photosynthetic activity. In banana, higher amount of LA on shoot coincide with the emergence of bunches (inflorescence) from the top of the pseudo stem. After this no new leaves are produced on that shoot because the bunch is terminal as the older leaves senescence [22]. Leaf area index (LAI) is an important source in manufacturing photo assimilates for determining dry matter accumulation and crop yield. An increase in LAI results in better utilization of solar energy. It is a positive index with direct influence of on plant growth. Specific leaf weight (SLW) is useful in understanding the means of assimilates in leaf expansion. The SLW is a measure of LA per unit dry weight and it varies with cultivar, leaf position, growth stage and environmental condition by Veerawirdh [24]. There is no authentic information available on morphological, phenological and yield attributing variations required for an ideal production by the different banana cultivars under Visakhapatnam agro climatic conditions, so, the investigation was under taken on banana cultivar varieties to describe various phenological characters and to work out correlation of different characters with yield.

2. Materials and Methods

A. Experimental Site

An experiment was conducted to study the growth and development of different cultivars of banana for recommending suitable cultivar with higher yield for

cultivation under coastal areas of Andhra Pradesh. The study was carried out during 2014-15 at 3 different mandals (Anandapuram, Payakaraopeta and S. Rayavaram) of Visakhapatnam district, Andhra Pradesh, India. Six banana cultivars were collected viz., Karpura chakkerakeli/ poovan, Dwarf Cavendish/ potti arati, Robusta/ pedda pacha ariti/ Grand naine, Rashtali/ Amrutha pani, Tella chakkerakeli and Yenugu bontha/ Monthan which are commercially cultivated throughout India. The studies consisted of the plants were randomly selected and biometrical observation on vegetative and yield attributing characters were recorded and statistically analyzed. Observations were taken from the second month after planting at 15 days interval. An experiment was conducted to study the growth and development of different cultivars of banana for recommending suitable cultivar with higher yield for cultivation under coastal areas of Andhra Pradesh. The experiments were conducted under Flood furrow irrigated system (Weekly once in monsoon and Weekly twice in summer) conditions. Throughout the experiment, the mean rainfall was 538.8mm and 742.5 for 2014 and 2015 respectively. The mean maximum and minimum temperatures recorded were 34.8⁰ C and 18.5⁰ C in 2014 and 36.4⁰ C and 19.3⁰ C in 2015. The mean maximum and minimum relative humidity was 89.7 and 62.5 % during 2014 and 87.5 and 61.7 % during 2015. Mean bright sunshine hours per day was 4.35 during the experimental period.

The soil type was sandy loam in texture. The soils were neutral (pH 7.05 and 7.16) with low soluble salts (EC 0.264 and 0.253 d Sm⁻¹), medium in organic carbon content (0.52 and 0.45%), low in available nitrogen (208 and 232 kg/ha), medium in available phosphorus (14.6 and 15.2 kg/ha) and high in available potassium (610 and 650 kg/ha) for 2014 and 2015, respectively.

B. Data collection

1) Morphological properties

Pseudo stem height was measured from the base of the plant to the top of the plant and girth of pseudo stem was measured around the circumference using meter tape. The pseudo cross sectional area (PCA) were measured by $\text{girth}^2 / 4 \pi$. Number of leaf per plant at harvest was counted in each plant at the time of harvest while number of suckers until time of shooting was recorded by counting the number of suckers produced by each plant upto shooting. Leaf length was measured from leaf blade base to the tip of the leaf and leaf width was measured at the point where the maximum breadth exists in the leaf at the time of flowering in each plant using tape meter. Time interval between successive leaf emergences was recorded in days taking into consideration the emergence day of preceding leaf. Total leaf area was estimated nondestructively by multiplying the product of length and breadth of the third leaf by the factor 0.8 and number of leaves and expressed as m²/plant. The leaf area index of functional leaves was obtained by leaf area per plant divided by ground area occupied by the plant. Phyllochron, the time interval between the appearances of two successive leaves (day's leaf⁻¹) on the developing pseudostem was recorded. The specific leaf weight (mg

cm⁻²) was obtained by leaf dry weight divided by leaf area per plant. At harvest stage, total crop duration (planting to harvest) was recorded and expressed in days.

2) Fruit Yield and Yield Components

Bunches were harvested at the green maturity stage. Bunch weight was measured using field balance after taking the bunch from the banana plant and peduncle length, width was measured. The number of hands per bunch was recorded after counting hands in each bunch. Then after hands were separated from bunches and hands were weighted in Kilograms and fingers per hand in each hand were counted. All fingers are separated from a hand weighted and divided to the number of fingers counted in each hand to obtain finger weight in grams and fruit yield per hectare was obtained by multiplying number of fruits produced in a hectare by mean weight of fingers and converted to ton per hectare. Finger length and finger diameter were measured in centimeter using ruler taking randomly selected ten fingers from each bunch obtained from each plant in each replication. The data obtained was analyzed statistically.

3. Results and Discussion

A. Growth Characters

Table 1: Growth (pseudo stem) Characters of different cultivars of banana

Cultivars	Pseudo stem height (m)	Pseudo stem girth (cm)	PCA (cm ²)	No of suckers at harvest
Karpura chakkerakeli	2.78	54.16	234.6	7.10
Dwarf Cavendish	2.63	52.33	218.2	6.75
Robusta	2.84	56.50	254.3	7.33
Rashtali	3.25	61.50	301.3	5.54
Tella chakkerakeli	2.96	58.50	272.6	5.25
Bontha	3.46	62.33	309.5	7.50
SE m±	0.8	0.89	2.76	0.14
CD(P=0.05)	0.25	2.74	5.53	0.19

In banana plants, moderate height and more girth rate desirable as these traits reflect on the bunch size and other related characters, apart from providing better anchorage. It is evident from the data (table I) that pseudostem height ranged from 2.63m to 3.46m. Yenugu Bontha (3.46m) recorded higher pseudostem height and it was on par with Rashtali (3.25m), Robusta (3.18m), Thella chakkerakeli (2.96m) and Karpura chakkerakeli (3.36m). The lowest plant height was recorded in Dwarf Cavendish (2.63m). Among different varieties tested, Bontha (62.33cm) recorded significantly higher pseudostem girth followed by Rashtali (61.50cm), Thella chakkerakeli (58.50cm), Robusta (56.50cm), Karpura chakkerakeli (54.16cm) and Dwarf Cavendish (52.33cm) showed lowest pseudostem girth at shooting stage. The maximum PCA was recorded in Yenugu Bontha (309.56cm²) followed by Rashtali (301.37cm²), (272.68cm²), Robusta (254.36 cm²), Karpura chakkerakeli (234.66cm²) and minimum PCA was in Dwarf Cavendish (218.20cm²). The utmost number of suckers at harvest was recorded in Yenugu bontha (7.50) followed by Robusta (7.33), Karpura chakkerakeli (7.10), Dwarf Cavendish

(6.75), Rashtali (5.54) and least was in Thella chakkerakeli (5.25). Similarly, significantly higher number of total leaves was recorded in Robusta (29.25). The intermediate values were recorded in Rashtali (27.23), Karpura chakkerakeli (26.23), Dwarf Cavendish (25.16) and Bontha (24.60) at shooting stage which was at par with each other. The lowest number of total leaves was obtained in Thella chakkerakeli (23.50). The maximum petiole length was recorded in Bontha (37.50cm) and the minimum was in Karpura chakkerakeli (33.56cm).

Table 2: Growth (leaf) Characters of different cultivars of banana

Cultivars	Leaf length (cm)	Leaf width (cm)	Total leaves/plant	Leaf area (m ² /plant)	LAI	Phyllochron (days)	Specific leaf weight (g/m ²)
Karpura chakkerakeli	143.2	39.6	26.23	12.17	3.04	7.0	1.15
Dwarf Cavendish	142.2	38.2	25.16	11.19	4.97	6.6	1.20
Robusta	159.1	43.0	29.25	16.07	5.02	7.3	1.28
Rashtali	154.2	43.2	27.23	14.83	3.70	6.9	1.18
Tella chakkerakeli	155.6	40.6	23.50	11.32	3.53	6.7	1.22
Bontha	152.3	42.4	24.60	12.71	3.17	7.1	1.24
SEm+-	2.48	0.72	0.21	0.32	0.16	0.18	0.18
CD(P=0.05)	5.98	2.63	0.64	0.98	0.74	0.58	0.63

The maximum leaf length and width was recorded in Robusta (159.12, 43.09). The minimum was recorded in dwarf Cavendish (142.25, 38.26) respectively. Robusta (16.07 sq.m plant⁻¹) recorded significantly higher leaf area over other cultivars followed by Rashtali (14.83sq.m plant⁻¹), Bontha (12.71), Karpura chakkerakeli (12.17 sq.m plant⁻¹) and Thella chakkerakeli (11.32sq.m plant⁻¹). The lowest leaf area (11.19sq.m plant⁻¹) was recorded in Dwarf Cavendish. Similarly, LAI was higher in Robusta (5.02) followed by Dwarf Cavendish (4.97), Rashtali (3.70), Thella chakkerakeli (3.53), Bontha (3.17) and the lowest LAI was recorded in Karpura chakkerakeli (3.04). Phyllochron or rate of leaf production is an important factor to be considered during vegetative growth [7]. The maximum phyllochron was observed in Robusta (7.3) and the minimum was in Dwarf Cavendish (6.6). The highest Specific leaf weight (SLW) was observed in Robusta (1.28g/m²) and lowest SLW content was observed in Karpura chakkerakeli (1.15 g/m²) (table II).

B. Crop Duration

Table 3: Crop duration and plant crop cycle of different cultivars of banana

Cultivars	Days to shooting (days)	Flower emergence to harvest (days)	Total crop duration (days)
Karpura chakkerakeli	224.3	108.2	332.5
Dwarf Cavendish	229.3	116.4	345.7
Robusta	230.6	117.9	348.5
Rashtali	239.2	115.3	353.5
Tella chakkerakeli	228.50	109.3	337.8
Bontha	243.50	102.1	345.6
SEm+-	1.64	1.46	1.82
CD(P=0.05)	5.02	4.86	5.65

In crop duration of different banana cultivar plants (presented in table 3), early shooting (days to planting to inflorescence emergence) was observed in Karpura chakkerakeli (224.3) whereas, late shooting was recorded in Bontha (243.50). With regards to days taken to harvest (from inflorescence emergence to harvesting) significantly early harvest was observed in Bontha (107.1) whereas Robusta (117.9 days) recorded significantly late harvest. The highest Total crop duration in Robusta (353.5 days) and lowest were recorded in 332.5 during crop cycle of different banana cultivars. The present results confirmed the report of Patel [13], Rajmanickam and Rajmohan [14], Hazarika and Ansari [4], Kavitha et al. [5], Badgujar et al. [1], Raskar [16], Orellana [12], Sirisena [18].

C. Inflorescence or male bud Characters

In table 4 the maximum peduncle length (56.70cm) and peduncle width (19.50cm) was recorded in Bontha. The minimum peduncle length was recorded in Karpura chakkerakeli (45.50 cm) and peduncle width was recorded in Dwarf Cavendish (15.75cm). The highest male bud size (23.90 cm length and 34.75 cm girth) was observed in Bontha and the lowest male bud size (20.75 cm length and 28.25cm girth) was observed in karpura chakkerakeli. Similar finding has also been reported by Rajmanickam and Rajmohan [10], Tenkovano [21], D. Kumar [6], Singh [19], Mandal [8] and Uma et al., [23].

Table 4: Inflorescence or male bud of different banana cultivars

Cultivars	Peduncle length(cm)	Peduncle width(cm)	Male bud length(cm)	Male bud girth(cm)
Karpura chakkerakeli	45.50	16.75	20.75	28.25
Dwarf Cavendish	46.25	15.75	21.55	29.50
Robusta	52.65	18.50	23.50	33.50
Rashtali	48.35	17.75	22.65	30.25
Tella chakkerakeli	51.25	16.50	22.45	31.25
Bontha	56.70	19.50	23.90	35.75
SEm+-	1.86	0.69	0.75	1.21
CD(P=0.05)	4.10	1.44	1.57	2.31

Table 5: FRUIT Yield and yield characters of different cultivars of banana

Cultivars	Bunch weight (Kg)	Bunch length (cm)	Bunch girth (cm)	Number of hands/ bunch	Fingers per Hand(2 nd)	Total fruits per bunch	Finger length (cm)	Finger girth (cm)	Finger weight (g)	Finger volume (cc)	Yield (t/ha ⁻¹)
Karpura chakkerakeli	19.71	42.2	114.5	9.57	15.76	150.8	14.2	12.5	95.25	103.2	37.35
Dwarf Cavendish	24.40	41.5	119.4	9.21	14.36	132.2	16.5	11.8	105.6	117.2	35.62
Robusta	28.50	48.5	124.5	10.25	15.98	162.7	19.5	13.8	142.6	162.2	39.42
Rashtali	23.42	46.3	122.4	9.46	12.90	122.0	15.7	14.2	135.5	148.5	36.12
Tella chakkerakeli	18.71	39.8	121.6	7.42	12.33	91.4	15.2	13.5	129.7	142.7	34.57
Bontha	21.50	40.6	128.5	7.66	11.46	87.7	22.5	18.7	248.0	252.5	38.16
SEM+-	0.34	0.46	0.36	0.44	0.54	5.06	0.39	0.30	3.03	2.56	1.25
CD(P=0.05)	1.06	1.23	1.28	1.36	1.65	15.23	1.20	0.92	9.14	8.45	3.63

D. Yield characters

It is evident from the data (table 5) that among all the cultivars, Robusta produced more number of hands (10.25) and lowest numbers of hands were recorded in Thella chakkerakeli (7.42). Bunch weight ranged from 28.50kg to 18.71kg. The highest bunch weight (28.50kg) was observed in Robusta and the lowest bunch weight (18.71kg) was observed in Thella chakkerakeli. The maximum bunch length (48.50cm) and bunch girth 128.5cm was recorded in Bontha. The minimum bunch length (39.80 cm) was recorded in Thella chakkerakeli and bunch girth (114.5cm) was recorded in karpura chakkerakeli. Robusta (15.98) significantly recorded highest number of fingers per hand. Bontha (11.46) recorded lesser number of fingers per hand.

Finger length ranged from 14.2cm to 22.5cm. Higher finger length was observed in Bontha (22.5cm). Thella chakkerakeli (15.2cm) and Karpura chakkerakeli (14.2cm) recorded minimum finger length. Significance difference was observed among the different cultivars. Lowest finger girth was recorded in Dwarf Cavendish (11.8cm) and maximum finger girth was recorded in Bontha (18.7cm). Total number of fingers per bunch was significantly highest in Robusta (162.7) and lowest fruits per bunch were recorded in Bontha (87.78). Finger weight was significantly highest in Bontha (248.08g) followed by Robusta (142.64g), Rashtali (135.50g), Thella chakkerakeli (123.73g) and Dwarf Cavendish (105.63g). Minimum finger weight was recorded in Karpura chakkerakeli (95.25g). The yield per hectare ranged from 34.57t/ha to 39.42t/ha. Robusta (39.42t/ha) recorded significantly higher yield than other cultivars and followed by Bontha (38.16t/ha), Karpura chakkerakeli (37.35t/ha), Rashtali (36.12t/ha), and Dwarf Cavendish (35.62t/ha) which were at par with each other. The lowest yield was recorded in Thella chakkrakeli (34.57t/ha). The results obtained in the present study with respect to yield and yield attributes corroborate with the results of Robinson and Nel [17], Medhi [9], Kumar [7] Baruah *et al.* [2], Njuguna *et al.* [10], Rajmanickam and Rajmohan [15] who reported similar variation among different culinary cultivars.

4. Conclusion

Keeping the higher productivity in view, banana cv. Robusta and Bontha can be recommended for commercial cultivation in Visakhapatnam, Andhra Pradesh. The Robusta has become one of the most popular desert varieties for

commercial plantations. Its characteristic medium height and large fruit yields make it an ideal for commercial agriculture.



Figure 1: Karpura chakkerakeli



Figure 2: Dwarf cavendish



Figure 3: Robusta



Figure 4: Rashtali



Figure 5: Thella chakkerakeli



Figure 6: Yenugu Bontha

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