Studies on Planting Density in Banana cv. 'Jahaji' (AAA)

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Abstract

An experiment was conducted to assess the effect of high density planting of banana cv. 'Jahaji' at experimental field, Department of Horticulture, Assam Agricultural University, Jorhat during the year 2003-04. The treatments comprised of T_1 = 2 suckers per pit (2m x 3m), T_2 = 3 suckers per pit (2m x 3m), T_3 = 2 suckers per pit (1.8m x 3.6m), T_4 = 3 suckers per pit (1.8m x 3.6m) and T_5 = 1 sucker per pit (1.5m x 1.5m) accommodating plant population of 3334, 5001, 3084, 4626 and 4444 plants per hectare, respectively. Most of the growth, yield and quality parameters were significantly influenced by plant densities. Considering the growth, yield and yield attributing characters, quality traits and economy of cultivation of banana cv. 'Jahaji' (AAA), the treatment T_2 *i.e.* 3 suckers per pit (2m x3m) as plant crop was found to be most suitable for agroclimatic condition of Assam.

Key words: Banana, planting density, growth character

Introduction

A large number of banana cultivars are grown in Assam, but among all the cultivars, 'Jahaji' is the choicest variety for all the communities in Assam, which fetches high price in the market for good shape, size and delicious taste. Though Assam is naturally blessed with suitable condition for growing banana, yet the average yield of banana is not satisfactory compared to many other states in India due to lack of systematic management practices, more particularly, adequate spacing on proper plant population per unit area. High density planting is assuming importance due to shrinkage of cultivated land. It provides economic use of land, efficient utilization of solar energy, water, fertilizer, pesticides and ultimately leads to increased yield. In Assam, no systematic approach to study growth, development, yield and quality characters of banana cultivar 'Jahaji' (AAA) under high density planting with 2-3 suckers per pit at different spacing has been made so far. Keeping this in view, the present study was undertaken to find out the optimum plant population of banana cv.'jahaji' for yield and quality under Assam condition .

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Materials and methods

Field experiment was conducted in the experimental field, Department of Horticulture, Assam Agricultural University, Jorhat during 2003-04. The experiment was laid out in Randomized Block Design with five treatments combination replicated four times. The details of treatment symbols used in the experiment, spacing and number of plants per hectare are as follows:

T_1 = Planting of two suckers per pit spaced at 2m x 3m = (1667 pits x 2) = 3334 plants per hectare.
T_2 = Planting of three suckers per pit spaced at 2m x 3m = (1667 pits x 3) = 5001 plants per hectare.
T_3 = Planting of two suckers per pit spaced at 1.8m x 3.6m = (1542 pits x 2) = 3084 plants per hectare.
T_4 = Planting of three suckers per pit spaced at 1.8m x 3.6m = (1542 pits x 3) = 4626 plants per hectare.
T_5 = Normal planting 1.5m x 1.5m = (4444 pits x 1) = 4444 plants per hectare.

Three months old uniform sword suckers weighing about two kg each were selected for planting. Suckers were planted 30cm apart in the pit. In all the treatments, nitrogenous, phosphatic and potassic fertilizers @ 110 g N, 33g P_2O_5 and 330 g k_2O per plant in the form of urea, single super phosphate and murate of potash, respectively were applied. Half of the nitrogenous and potassic fertilizers and full dose of phosphatic fertilizer were applied at third month after planting. Remaining halves of nitrogenous and potassic fertilizers were applied after five months of planting. The recommended doses for fertilizers per plant were applied for normal planting whereas

25% increased dose for two suckers per pit and 50% increased dose for three suckers per pit were applied. Hand weeding, earthing up and propping were done uniformly in all the treatments. Desuckering was followed upto harvesting. Male buds and floral remnants were removed at proper time. The plants were sprayed with mixture of 1.0 g Bavistin + 1 ml Ekalux per litre of water at bi-monthly interval upto shooting (emergence of inflorescence) to prevent the crop from insect-pests and diseases.

The fruits were considered to be ready for harvest when the angular girth of skin of the fruit disappeared, and colour turned from dark green to light green. Bunches were harvested during September – October, 2004. Yield (in tonnes per hectare) was calculated by multiplying the average bunch weight with the total number plants per hectare. Fruit quality analysis was performed by taking a fruit sample from the second hand. Total soluble solid was determined by the help of a hand refractometer. Titrable acidity, reducing sugar, total sugar and non reducing sugar were determined by adopting the standard methods of A.O.A.C (1975).

Results and discussion

Growth characters

Plant growth was considered in terms of height and girth of pseudostem, number of leaves and area of green leaves (details presented in Table I). Number of functional leaves which were green and photosynthetically active at the time of observations were counted. The period between two successive leaf emergence, duration between planting to shooting, planting to harvesting and hang duration were also counted. The plant height was measured bi-monthly starting after third months of planting. The plant height differed significantly in different treatments. The highest plant population (T_2) recorded the highest plant height at shooting stage (185 cm.) whereas; the lowest plant height was observed in the lowest plant population (T_3). An increase in plant height with increasing plant population might be due to increased plant population per unit area, which provides less space for individual plant and in search of sunlight perhaps makes the plant upright resulting in tall growth.

Thicker pseudostem girth at shooting (75.85 cm.) was observed in lowest density (T_3), while highest density (T_2) produced thinner plant girth (65cm). The thicker girth in lower density might be due to less competition for soil moisture, nutrient and sunshine. Data pertaining to the total number of leaves produced, showed a decreasing trend with increasing plant density. Highest number of leaves was found in T_1 and the lowest number of leaves was observed in T_2. This was also enunciated by Kohli *et al.* (1980), Mondol (1980) and Chattopadhayay *et al.* (1985) lending ample support to the present study. Number of functional leaves also showed decreasing trend with increasing plant population. At shooting stage, the highest number of functional leaves (14.20) was observed in T3, and the lowest (12.50 leaves) was observed in T_2. Similar trend was also observed at harvesting stage. Highest number of functional leaves in lower plant density may be due to less competition in soil moisture nutrient and light intensity at shooting and harvesting stages as compared to closer spacing with higher plant density. Highest leaf area was recorded in the lowest plant density T_3 while the lowest value in the highest plant density T_2. The higher leaf area at shooting stage is due to a larger number of leaves accompanied with bigger size of leaves. Simmonds (1966) also reported that the leaves attain the maximum size towards the flowering and sharp decline towards the end. Rapid production of leaves in lower plant population might have increased the leaf area (Singh, 1988). The leaf area index increased with the increase in density in T_2. This was also in conformity with the findings of Reynolds and Robinson (1985). Plant density exhibited a marked influence on phyllochron, showing an increasing order with increasing plant population. Highest phyllochron (9.47) was recorded in T2, and the lowest phyllochron (8.25) was recorded in T_3. The lowest phyllochron in the lowest plant population may be due to frequent unfurling of leaves. Low light intensity might have resulted in a decrease rate of leaf production, resulting in an increase in the mean phyllochron (Turner and Hunt, 1986). Number of suckers did not differ significantly at shooting stage, but differed significantly at large and harvesting stage. In the present study, days to shooting, harvesting and hang period were significantly influenced by plant density. These durations were prominently increased with increasing plant population (Table 2). This might be due to more leaf surfaces exposed to light in low density planting, which increased the metabolism of the plant causing early physiological maturity and flowering. Delayed shooting due to closer spacing was also reported by Ahmed and Manan (1970) and Stover (1979).

Yield and yield attributing characters

The influence of plant population on yield and yield attributing characters were markedly observed (Table 3). Highest bunch weight (18.50 kg) was observed in the lesser plant population (T_5: one sucker per pit)which gradually decreased with the increase in plant population. This reduction of bunch weight with increasing plant density may be due to excessive interception of light by the enhanced canopy under high density planting, which might have helped to increase the vegetative character but probably not the bunch character. In contrast, when the plant population was low, more leaf surface was exposed to sunlight and indirectly greater amount of assimilates accumulated in the various organs of the plant leading to increased bunch weight. Interestingly, computation the marketable yield from bunch weight, the present study showed a tremendous increase in yield per unit area with increasing plant population. The highest plant population (T_2: three suckers per pit) recorded the highest yield (74.76 tonnes per hectare), while the lowest yield (45.08 tonnes per hectare) was observed in T_3 (two suckers per pit). Significance of high density planting in augmenting total yield per hectare in banana has already been elucidated by Kohli *et al.* (1976) and Chattopadhayay *et al.* (1985). It was also observed that the number of hands and fingers per bunch were decreased with increasing plant population. Perhaps this may be the reason that also caused a reduction in bunch weight in higher plant population.

In the present, study among the physical parameters of the fruit, the finger length, finger weight and finger volume were found to be influenced significantly except finger girth. Longer, heavier and thicker fingers were borne by the plants in lower plant population compared to higher one. Similar results on 'Robusta' banana were also reported by Nalina *et al*. (2003). A significantly higher harvest index was found in the lower plant population as compared to higher plant population. The high harvest index recorded in lower plant density could be due to efficient supply of water, rapid rate of leaf emergence leading to the development of more functional leaves and leaf area at shooting stage causing early development of the bunch primordia, and efficient partitioning of the assimilates resulting in the development of a healthy bunch. Conversely, the lowest harvest index exhibited by the highest density could be ascribed to the inefficient partitioning of the assimilates to the development of the bunch leading to enormously high dry matter accumulation in the gigantic pseudostem. This view is in tune with the observations of Bhattacharyya and Rao (1984) who had enunciated that the product of total dry weight harvest and harvest index would determine the bunch production in banana.

Quality parameters

It was interesting to know that the plant density exhibited a significant effect on the quality of fruit except T.S.S. (Table 4). In the present investigation, the plant raised under low density exhibited superior fruit quality in terms of T.S.S., reducing sugar, total sugar and sugar acid ratio. They had a tendency to decrease with increasing plant density. However, a reverse trend was observed in case of titrable acidity and non reducing sugar. Higher acidity in higher plant population may be due to shade effect where sugar conversion from organic acid is hampered due to lack of sufficient light. Moreover, lower reducing sugar and higher non reducing sugar in the high density plot may be due to less conversion of sugar from starch. The present study gets ample support from the work of Chundawat *et al.* (1983), Chattopadhayay *et al.* (1985) and Reddy (1991) who recorded higher total sugar and lower acidity with low plant density.

An assessment on economics (Table 5) showed that the treatment T_2 (the highest plant population 5001 plants/ha) recorded the highest benefit cost ratio of 5.20 as compared with other treatments.

References

Ahmed K, Manan A (1970). Effect of size of pit and spacing on the performance of 'Amrit Sagar' banana. Punjab Fruit Journal . 32 : 7-13

Bhattacharyaa R.K, Madhava Rao VN (1984). Schematic model for the effect of soil cover and low soil moisture depletion level on the information of sunk and yield. Banana Newsletter. 7-9

Chattopadhayay PK, Bhowmik DJ, Maiti DC, Bose TK (1985). Optimum planting density for plant

and ratoon crops of 'Giant Governor' Cavendish banana in West Bengal. Indian J. Agriculture Science. 55 : 17- 21

Chundawat BS, Dave SK, Patel NL (1983). Effect of close planting on yield and quality of 'Lacatan', Indian Journal of Agricultural Science 53 : 470-72

Kohli RR, Chacko EK, Randhawa GS (1976). Effect of spacing and nutrition on growth and fruit yield of 'Robusta' banana. Indian Journal of Agricultural Science 46 : 382- 85

Kohli RR, Chacko EK, and Randhawa GS (1980). Growth and yield response of 'Robusta' banana to different spacing and nutritional levels. Nat. sem. Banana Prod. Tech;TNAU, Combatore. pp. 104- 08

Mondol RC (1980). Agrotechniques to increase banana production. Nat. sem. Banana Prod. Tech;TNAU, Combatore. pp. 98-101

Nalina L, Kumar N, Sathiamoorthy S (2003). Studies on high density planting in banana cv. 'Robusta' (AAA). Influence on bunch and fruit quality traits. Indian Journal of Horticulture. 60 (4) : 307-11

Reddy (1991). Effect of spacing, plant density on growth, yield and quality of 'Dwarf Cavendish' banana. AICRP (TF) Res. Rep on Citrus, Banana, Pineapple, Papaya and Sapota, IIHR, Bangalore. pp. 103- 05

Reynolds RE, Robinson JC (1985). Banana plant densities for National Information Bulletin, Citrus and sub trop. Fruit Res. Inst. No. 158 : 14

Simmonds NW (1966). 'Bananas' Longmans, London. 2nd Edition

Singh RKD (1988). Studies on growth and development of some cultivars. M.Sc. (Agri) Thesis, AAU, Jorhat.

Stover RH (1979). Pseudostem growth, leaf and leaf production and flower initiation in the 'Grand Nain' Banana. Bulletin Tropical Agricultural Services; 8 : 37 (Hort Abstr. 50

Turner DW, Hunt N (1986). The relationships between temperature and the rate of appearance of new leaves in thirty banana varieties grown in Sub tropics. Garica De Orta extudis Agromonis. 10 : 91-94

Table 1: Effect of high density planting on pseudostem height , girth, total number of leaves , number of functional leaves, leaf area , leaf area index and phyllochron of banana cv.Jahaji

Treatments	Pseudostem height at shooting (cm)	Pseudostem girth at shooting (cm)	Total number of leaves upto shooting	Number of functional leaves at shooting stage	Leaf area m^2/Plant at shooting state	Leaf area index at shooting stage	Phyllochron
T_1 = 2 suckers per pit (2m x 3m) 3334 pt/ha	164.89	72.81	37.38	13.55	12.36	5.77	8.50
T_2= 3 suckers per pit (2m x 3m) 5001 pt/ha	185.00	65.00	34.00	12.50	11.67	7.03	9.47
T_3= 2 suckers per pit (1.8m x 3.6m) 3084 pt/ha	160.83	75.85	34.88	14.20	12.50	4.00	8.25
T_4= 3 suckers per pit (1.8m x 3.6m) 4626 pt/ha	178.88	67.39	34.11	12.56	11.88	6.31	9.00
T_5= 1 sucker per pit (1.5m x 1.5m) 4444 pt/ha	169.61	70.66	34.85	13.17	12.04	6.29	8.75
CD (p = 0.05)	3.48	2.46	1.97	0.61	NS	0.56	0.10

Table 2: Effect of high density planting on number of suckers, days taken to shooting harvest and shooting harvest interval (hang period) of banana cv. Jahaji

Treatments	Number of suckers			Days to shooting	Days to harvesting	Shooting harvest interval (days)
	Large Stage	Shooting Stage	Harvesting Stage			
T_1 = 2 suckers per pit (2m x 3m) 3334 pt/ha	4.54	9.33	4.54	387.25	474.25	87.00
T_2= 3 suckers per pit (2m x 3m) 5001 pt/ha	5.30	9.14	7.37	396.00	487.50	96.00
T_3= 2 suckers per pit (1.8m x 3.6m) 3084 pt/ha	4.32	9.29	7.32	351.25	441.25	86.37
T_4= 3 suckers per pit (1.8m x 3.6m) 4626 pt/ha	4.33	9.22	7.33	393.75	486.00	90.00
T_5= 1 sucker per pit (1.5m x 1.5m) 4444 pt/ha	5.00	9.48	7.80	391.50	483.75	89.50
CD (p = 0.05)	0.19	NS	0.22	2.02	3.39	2.42

Table 3: Yield and yield attributing characters of banana cv. Jahaji

Treatments	Bunch weight (kg./plant)	Yield (t/ha)	No. of hands/ bunch	No. of fingers/ bunch	Finger length (cm)	Finger girth (cm)	Finger weight (cm)	Finger volume (cc)	Harvest index
T_1 = 2 suckers per pit (2m x 3m) 3334 pt/ha	14.12	47.08	9.75	161.62	17.25	11.62	113.75	123.56	0.37
T_2= 3 suckers per pit (2m x 3m) 5001 pt/ha	12.50	74.76	9.37	154.00	16.25	11.12	105.50	117.26	0.32
T_3= 2 suckers per pit (1.8m x 3.6m) 3084 pt/ha	14.62	45.08	9.87	169.25	18.87	11.75	119.00	126.31	0.37
T_4= 3 suckers per pit (1.8m x 3.6m) 4626 pt/ha	12.87	65.22	9.37	156.37	16.75	11.25	106.25	120.98	0.33
T_5= 1 sucker per pit (1.5m x 1.5m) 4444 pt/ha	18.50	64.38	9.50	161.25	17.12	11.50	113.75	122.78	0.34
CD (p = 0.05)	0.85	3.72	0.55	2.08	1.01	NS	2.83	4.57	0.01

Table 4: Quality parameters of banana cv. Jahaji

Treatments	T.S.S. (%)	Titrable acidity (%)	Reducing sugar (%)	Non reducing sugar (%)	Total sugar (%)	Sugar acid ratio
T_1 = 2 suckers per pit (2m x 3m) 3334 pt/ha	19.25	0.25	8.23	9.42	17.84	69.21
T_2= 3 suckers per pit (2m x 3m) 5001 pt/ha	18.87	0.28	7.94	9.84	17.65	62.98
T_3= 2 suckers per pit (1.8m x 3.6m) 3084 pt/ha	19.56	0.26	8.71	9.12	17.94	69.31
T_4= 3 suckers per pit (1.8m x 3.6m) 4626 pt/ha	18.62	0.27	8.13	9.76	17.70	64.31
T_5= 1 sucker per pit (1.5m x 1.5m) 4444 pt/ha	19.00	0.26	8.09	9.70	17.84	64.20
CD (p = 0.05)	N S	0.01	0.02	0.01	0.01	1.42