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Effect of Spacing on Growth and Yield of Banana Cv. Grand Naine and Bantala

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Abstract: *A field experiment was carried out during 2013-14 to study the effect of spacing and variety on growth and yield of banana under Bhubaneswar agro-climatic condition. The experiments was laid out in Randomized Block Design with six treatments comprising of two varieties banatala and grand Naine with three spacing (2mx3m, 1.8mx3.6m and 1.8mx1.8m) and replicated four times. Vegetative parameters like plant height (273.27cm) and number of leaves(13.60) were recorded highest in T_1 (variety Bantala with spacing 2m×3m). Earliest shooting (242.12 days) and harvesting(351.56 days) observed in T_6 (variety Grand Naine with spacing 1.8m×1.8m).The yield of Banana was recorded highest(87.8 t ha^{-1}) in variety Grand Naine with spacing 2m×3m (T_4) followed by variety Grand Naine with 1.8m×3.6m (T_5) and the least was in variety Bantala with normal spacing 1.8m×1.8m (T_3). There was 4.37% higher yield in T_4 over T_5.*

Keywords: *Growth, yield, spacing, Banana, variety*

INTRODUCTION

Banana (*Musa spp.*) is one of the oldest tropical fruit cultivated by man from prehistoric time in India with a great socio-economic significance, interwoven in the cultural heritage of the country. It is also fourth important food crop in terms of gross value after paddy, wheat, and milk products. Banana ranks first in production and second in area among the fruit crops grown in India accounting for an area of 776 thousand hectare and total production of around 26509 thousand MT and the total productivity is around 34.2 MT/ha (Indian Horticulture Database NHB 2013). In Odisha the area under banana cultivation is around 27.49 thousand hectare and total production is around 521.31 thousand MT and productivity is around 19.00 MT/ha (Indian Horticulture Database NHB 2013).

High density planting (HDP) as an intensive system of cultivation in banana not only provides high production and net returns but also facilitates efficient utilization of solar energy, nutrients and water (Apshara and Sathiamoorthy, 2003). HDP results in significant yield increase and optimization of costs leading to higher profitability with increased efficiency and exploitation of production factors related to land, work and capital (Rosales *et al.,* 2010). In HDP, the yield per unit plant reduces but the total yield per unit area is always increased as the number of plants per unit area is more in case of high density planting. Besides higher yield, HDP also helps to reduce labour cost and increase the efficiency of input utilization. Planting of three suckers per pit under high density planting consumed less water than normal planting of one sucker per pit, thus enhanced the water productivity in banana cultivation. Thus, present investigation aimed to accesses effect of spacing and variety on Banana in terms of growth and yield and yield attributing characters.

MATERIALS AND METHODS

The experiment entitled was carried out at Horticultural Research Station (HRS), Orissa

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University of Agriculture and Technology (O.U.A.T.), Bhubaneswar, Odisha during the year 2013-14. It is situated at the latitude of $20^0$15′ N and longitude of $85^0$52′E. It is about 60km away from Bay of Bengal having an altitude of 25.5m above mean sea level. Maximum rainfall during the cropping period was about 720.1mm which was received in October 2013. The maximum temperature observed during the cropping period was 39.8^0C (2013-2014).

The experiment consisting of six treatments was laid in randomized block design with four replications. The treatments included T_1- variety Bantala with spacing 2m×3m,planting 3 plants per pit (5001 plants/ha), T_2- variety Bantala with spacing 1.8m×3.6m, planting 3 plants per pit (4629plants/ha), T_3- variety Bantala with spacing 1.8m×1.8m, single plant per pit(3086plants/ha) (Normal spacing or control), T_4- variety Grand Naine with spacing 2m×3m, planting 3 plants per pit (5001 plants/ha), T_5- variety Grand Naine with spacing 1.8m×3.6m, planting 3 plants per pit (4629plants/ha), T_6- variety Grand with spacing 1.8m×1.8m(3086plants/ha) (Normal spacing or control). All cultural operations were followed which were necessary for good crop.

Observations on vegetative parameters like plant height (cm), pseudostem girth (cm) and number of leaves, days taken to shooting, days to harvesting, yield parameters like bunch weight (kg), bunch length (cm), bunch girth (cm), number of hands per bunch, number of fingers per bunch, finger length(cm), finger girth(cm) and finger weight (g) etc. were recorded in each replication of all treatments. Economics of the treatments were calculated as per prevailing market price.

RESULTS AND DISCUSSION

Vegetative parameters: From Table 1, it was revealed that the variety Bantala showed significantly higher plant height as compared to the variety Grand Naine. Banana under treatment with 2mX3m recorded the highest height in both varieties i.e. Banana (273.27 cm) and Grand Naine (184.10cm). They differed significantly from each other. However there was no significant difference noticed under different spacing within the variety. The lowest plant height was recorded under the treatment T_6 (178.79cm). The treatment T_3 (V_1P_3) recorded highest pseudostem girth (69.11cm) followed by the treatment T_2 (V_1P_2) (67.57cm) and they remained at par. The lowest plant girth (58.78cm) was recorded in T_4 (V_2P_1). As far as the varieties were concerned the variety Bantala showed higher pseudostem girth compared to Grand Naine. In both the cases due to placement of three plants per pit the competition for space and light might have made the plants taller and lanky as a result of which the plant height recorded was more and girth was the least under the spacing accommodating highest number of plants/ha (Apshara and Sathiamoorthy, 2003; Kumar and Kumar, 2011; Murugan, 2003). The number of leaves per plant was also found to be more (14.22 number of functional leaves) under the high density planting (T_4) and the lowest number of leaves was 11.69 under the treatment T_3. In both the varieties the plants with higher spacing with three plants per pit gave the highest number of leaves where as under wider spacing of 1.8m×1.8m with one plant per pit the number of leaves was less (Nalina *et al*., 2000).

Shooting and harvesting : In the present investigation the shooting and harvesting duration did not show significant differences. However early shooting and harvesting was observed under the treatment with closer spacing (1.8m×1.8m)with single plant per pit in Grand Naine (249.27 and 358.33days) and also in Bantala (242.12 and 351.56 days) respectively. It may be due to wider leaf spread and receipt of more sunlight under 1.8m×1.8m spacing more food materials were produced and supplied to the plant as a result of which the plant's physiological process could be maintained properly and timely shooting could take place. Under the high density planting i.e. in the treatments T_1, T_2, T_3, T_4, T_5 the number of leaves were more as compared to 1.8m×1.8m spacing and shading effect might have caused some hindrances' in the reduction of photosynthetic activities, but owing to more number of might have resulted in production of food materials and supply to the plants to enable to complete its physiological activities. As a result of this the shooting and

Table 1
Effect of variety and spacing on vegetative character of Banana

Treatments	*Plant height (cm)*	*Pseudostem girth (cm)*	*Number of leaves*
T1-V_1P_1	273.27	66.83	13.60
T2-V_1P_2	264.55	67.57	12.24
T3-V_1P_3	264.2	69.11	11.69
T4-V_2P_1	184.10	58.78	14.22
T5-V_2P_2	182.11	60.51	13.98
T6-V_2P_3	178.79	63.83	13.18
SEm(±)	7.84	2.27	0.55
CD at 5%	23.63	6.85	1.68

Table 2
Effect of spacing and variety on days taken for shooting and harvesting

Treatments	*Days taken for shooting*	*Days taken for harvesting*
T_1-V_1P_1	252.53	363.5
T_2-V_1P_2	250.31	360.21
T_3-V_1P_3	249.27	358.33
T_4-V_2P_1	249.35	360.12
T_5-V_2P_2	243.56	356.66
T_6-V_3P_3	242.12	351.56
SEm(±)	7.47	8.98401
CD at 5%	22.52	27.0709

harvesting although have been delayed by a short period but have remained at par with the treatment producing earliest shooting and harvesting (Athani and Hulamani, 2000 and Sarrwy *et al.,* 2012).

Yield attributing characters: The result of the experiment conducted to study the effect of spacing and variety on bunch weight of banana (Table-3) revealed that the highest bunch weight (20.5 kg) was recorded under the treatment T_6 (i.e. Grand Naine with single plant/pit at 1.8m×1.8m spacing) followed by T_5 (18.11kg) which was Grand Naine banana planted at a spacing of 1.8m×3.6m (three plants/pit). It was also observed from the data that the bunch weight of Grand Naine (T_4, T_5 and T_6) was 38.48 %, 38.13 % and 44.26% more than the corresponding spacing maintained under Bantala variety(T_1,T_2 and T_3). Present results are in accordance with Kumar and Kumar, 2011.

It was revealed from the results that the bunch length was highest under T_6 (102.05cm) followed by T_3 (99.12cm) which were under Grand Naine and Bantala varieties with wider spacing (1.8m×1.8m) respectively. The lowest bunch length were recorded under T_1 (92.51cm) i.e. Bantala variety followed by T_4 (93.5cm) i.e. Grand Naine both having similar spacing i.e. 2m×3m with three plants/pit. Over all it was observed that with increase in the spacing and planting three plants/ pit there was increase in total number of plants/ha but bunch length were reduced as compared to 1.8m×1.8m spacing with single plant per pit. The length of bunch under T_6 recorded 10.22% increase in bunch length over T_1. Similar trend as in case of bunch length was observed under the bunch girth too. The highest bunch girth was recorded under the treatment T6 (99.85cm) followed by T_3 (95.34cm), T_5 (93.67cm), T_2 (91.67cm), T_1 (90.53cm) and T_4 (90.12cm). The plants under 1.8m x 1.8m spacing recorded higher plant girth as compared to the treatments with increased plant densities. However the T6 recorded 10.29% higher bunch girth as compared to T_1.

The result on number of hands per bunch (Table 3) revealed non-significant effects among the treatments. The highest hand per bunch was observed under the treatment T_6 (7.95) followed by T_5 (7.07), T_4 (7.01), T_3 (6.33). T_2 (5.98) and T_1 (5.67). However, Grand Naine variety produced higher number of hands per bunch than Bantala variety. Normal spacing (1.8m×1.8m) with one plant per pit showed more number of hands per bunch as compared to high density planting i.e. in spacing 2m×3m (5001plants/ha) and 1.8m×3.6m (4629 plants/ha) [7].

The treatment T_6 (120.51) recorded the highest number of fingers and was followed by T_5 (117.33) and T_4 (115.57). It was observed that the variety Grand Naine recorded significantly higher values for finger number as compared to the Bantala variety for all corresponding spacing tested. In both the varieties the spacing 1.8m x 1.8m recorded higher number of fingers as compared to wider spacing

Table 3
Effect of spacing and variety on bunch character and yield of banana

Treatments	*Bunch weight (kg/plant)*	*Bunch length (cm)*	*Bunch girth (cm)*	*Number of hands/ bunch*	*No. of fingers/ bunch*	*Finger length (cm)*	*Finger girth (cm)*	*Finger weight (g)*	*Yield (t/ha)*
T_1-V_1P_1	12.68	92.51	90.53	5.67	60.56	18.11	15.51	191.500	63.4
T_2-V_1P_2	13.11	94.33	91.67	5.98	61.78	18.55	16.1	194.230	60.68
T_3-V_1P_3	14.21	99.12	95.34	6.33	64.5	21.33	17.2	197.300	43.85
T_4-V_2P_1	17.56	93.5	90.12	7.01	115.57	18.88	13.21	135.460	87.8
T_5-V_2P_2	18.11	95.11	93.67	7.07	117.33	19.36	13.56	137.520	83.83
T_6-V_2P_3	20.50	102.05	99.85	7.95	120.51	21.23	14.23	145.700	63.26
SEm(±)	1.86	3.86	3.34	0.51288	2.74	1.03	1.19	4.892	2.04219
CD at 5%	5.61	11.65	10.08	1.54542	8.27	3.12	3.61	14.742	6.15361

Table 4
Economics of banana production as influenced by spacing and variety

Variety	*Spacing*	*Cost of cultivation (Rs)*	*Total return (Rs)*	*Net Return (Rs)*	*Benefit :cost ratio*
V_1 - Bantala	P_1 - 2m x 2m	6,00,000	12,68,000	6,68,000	1.11
	P_2 - 1.8m x 3.6m	5,67,000	12,13,600	6,46,600	1.14
	P_3 - 1.8m x 1.8m	3,67,000	8,77,000	5,10,000	1.38
V_2 - Grand Naine	P_1 - 2m x 2m	6,00,000	14,92,600	8,92,600	1.48
	P_2 - 1.8m x 3.6,	5,67,000	14,25,110	8,58,110	1.51
	P_3 - 1.8m x 1.8m	3,67,000	10,75,420	7,08,420	1.93

with three plants per pit. T_6 (V_2P_3) recorded 4.27% higher than T_4 (V_2P_1). Present results are in accordance with Kumar and Kumar, 2011.

Length of the fingers in different treatments did not vary significantly and were at par with each other. However, the treatment T_3 (21.33 cm) recorded the highest length of the fingers followed by T_6(21.23 cm).The treatments under the closer spacing (1.8mx1.8 m) with single plant per pit recorded higher values for the finger length as compared to the higher spacing with three plants per pit, i.e. 2m x3m and 1.8m x 3.6m.The highest girth of the finger was recorded under the treatment T_3 (17.2 cm) i.e. in Bantala variety with 1.8m x1.8m spacing followed by T_6 (14.23cm) i.e. Grand Naine under 1.8m x1.8m spacing with single plant per pit. The lowest girth was obtained under the treatment T_4 (13.21cm) i.e. Grand Naine variety under 2m x 3m spacing with three plants per pit. It was revealed from the result that the highest finger weight was recorded under the treatment T_3 (197.3g) followed by T_2 (194.5g) and T_1 (191.23g) which were under the variety Bantala in which T_3 varied significantly from T_1 and remained at par with T_2. The treatments under the variety Grand Naine recorded lower values for the fruit weight as compared to the Bantala and varied significantly from all the treatments of Bantala for all the spacing. T_3 recorded 35.41% higher weight than the T_6 and 45.65 % higher weight than the T_4 which recorded the lowest weight of fingers.

Taking the plant population and bunch weight in account, it was observed that the yield (t ha^{-1}) varied significantly. The variety Grand Naine recorded highest yield (t ha^{-1}) as compared to Bantala and varied significantly from it. The highest yield was recorded under the treatment with 2m x 3m spacing with three plants per pit accommodating 5001 plants in both the varieties i.e. in Bantala (T_1- 63.4t ha^{-1}) and in Grand Naine (T_4 - 87.8 t ha^{-1}). However the yield of both the varieties varied significantly. Grand Naine under this treatment recorded 38.48% increase in yield over Bantala. It

recorded 100.2 % and 38.48% increase in yield over T_3& T_6. Although the single plant per pit at 1.8m x 1.8m spacing recorded the highest bunch weight, the highest yield was recorded under 2m x 3m with three plants per pit. (Dinesh et al., 2008; Dinesh et al.,2013; pujari et al.,2010; Ray et al., 2001and Thippesha et al. 2007). Close spacing plants produced more yield per unit area but wider spacing produced heavier bunches. Flowering and fruit maturity were delayed in close spacing which is in agreement with the present findings (Ahmed and Mannan, 1970).

ECONOMICS OF PRODUCTION

The data obtained revealed that variety Grand Naine was more suitable for high density planting compared to variety Bantala as it resulted maximum net return as well as benefit cost ratio irrespective of spacing. Total return was maximum in the treatment T_4 (V_2P_1) i.e., 14,92,600/- followed by T_5 (V_2P_2) '14,25,110/- and T_1 (12,68,000) and maximum net return was also obtained in the treatment T_4 ('.8,92,600/-) followed by T_5 ('.8,58,110) and T_6 ('.7,08,420). Benefit-cost was maximum in the treatment T_6 (1.93) followed by T_5 (1.51) and T_4(1.48) and lowest was in T_1 (1.11). However, variety Bantala recorded lowest net return as well as benefit-cost ratio compared to variety Grand Naine.

CONCLUSION

Banana is a fruit crop which will be in demand for all times to come owing to its importance in day to day life. Both dessert and culinary types have their own demand in local markets as well as in processing industries. Hence there is always a need for attempting to achieve higher yields adopting modern techniques. In the present investigation attempt was made to find out suitable spacings for both Grand Naine and Bantala varieties of banana which fetch premium prices in the market for dessert and culinary purpose respectively. 2m x 3m with three plant per pit has proved to be the best spacing for getting maximum yield.

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