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Effect of different levels of planting distance and fertilizers on growth, yield and quality of banana cv. Grand Naine

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Abstract

An experiment was carried out in banana cv. Grand Naine to evaluate the effect of four different planting distances with three levels of fertigation which was laid out in Split Plot Design with three replications on growth, yield and quality parameters of banana. Growth parameters like plant height and stem girth were found significantly higher with planting distance 2.0 X 2.0 m two plants per hill (S₂). Plants grown under planting distance 1.2 X 1.2 X 2.0 m pair row (S₁) showed significantly higher yield (t/ha) as compared to other planting distance. The maximum numbers of fingers per hand and bunch weight (kg) were found significantly with conventional method of planting 1.8 X 1.8 m (S₄). Quality parameters like TSS and total sugar were found significantly higher with planting distance 2.0 X 2.0 m two plants per hill (S₂). In case of fertilizer application is concerned, there was no significant result obtained for growth, yield and quality parameters of banana. For combined effect of spacing and fertilizer S₁ X F₁ (1.2 X 1.2 X 2.0 m planting with 10 kg FYM and 300-100-200 g NPK/plant) was found superior than other combinations.

Keywords: Planting distance, fertilizer, banana

Introduction

Banana (*Musa* sp.) is the second most important fruit crop in India next to mango. Its year round availability, affordability, varietal range, taste, nutritive and medicinal value makes it the favourite fruit among all classes of people and has good export potential. Banana evolved in the humid tropical regions of South East Asia with India as one of its centres of origin. Modern edible varieties have evolved from the two species *Musa acuminata* and *Musa balbisiana* and their natural hybrids, originally found in the rain forests of South East Asia. At present banana is being cultivated throughout the warm tropical regions of the world between 30° N and 30° S of the equator.

Bananas with year round availability provide a permanent source of income not only to the farmers and rural populations, but also to the traders and retailers, thus playing an important role in poverty alleviation. The fruit is composed of mainly water and carbohydrates and provides energy (104 K calories per 100g). In addition to being a rich source of carbohydrates, edible fibre, vitamins, potassium, phosphorus, calcium and with minimum fat, bananas are the safest and cheapest fruit ensuring nutritional security to people of all age groups and economic status.

Area under banana crop in Gujarat is 66500 hectare with annual production of 42.26 lakh MT and productivity is 63.5 MT/ha (Anon., 2015) ^[1]. Farmers of Gujarat adopted recommended spacing 1.8 x 1.8 m for banana with accomended 3086 plants/ha. A modified planting system to increase the plant density by planting one or more than one plants per hill at wider space is a recent and novel concept. This system proved its effectiveness along with fertilizer application through drip irrigation method for increasing banana productivity (Mahalaxmi, 2000) ^[2].

In many banana growing states of India, there has been a steady increase in area, production and productivity which is partly due to increased area under cultivation and largely due to adoption of high yielding varieties like Grand Naine, Robusta and other Cavendish clones, virus free quality planting material and improved production technologies *etc.*

There is a need to focus on standardization of improved production technologies suitable for different systems of cultivation to realize potential yields in many commercial cultivars for targeted banana production. Selection of high yielding varieties, healthy and disease-free planting material, choosing the right planting density, need-based and timely application of irrigation water, nutrients, maintenance of weed-free conditions *etc.* are important to bridge the gap between actual yield and potential yield per unit area.

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There is no database information regarding a modified planting system to increase the planting density with a good qualitative higher production adjoin with use of organic manure and chemical fertilizer under drip irrigation system. Keeping this in view, the experiment is proposed on banana with following objectives.

Objectives

- 1) To study the effect of different planting system on growth, yield and quality of banana
- 2) To study the efficacy of chemical fertilizers and organic manures on growth, yield and quality of banana

- 3) To find out the combined effect of different spacing along with chemical fertilizers and organic manures on growth, yield and quality of banana

Materials and Methods

The experiment was conducted during 2011-12, 2013-14 and 2015-16 at Horticultural Research Farm, Department of Horticulture, Bansilal Amrutlal College of Agriculture, Anand Agricultural University, Anand. The experiment was laid out in Split Plot Design with 12 treatment combinations replicated thrice.

Treatment details

(A) Spacing:	Plants per hectare	Plants per plot	Plot size
(S ₁) 1.2 x 1.2 m x 2.0 m (Pair row)	5208	24	6.4 x 7.2 m
(S ₂) 2.0 x 2.0 m (Two plants per hill)	5000	32	8.0 x 8.0 m
(S ₃) 2.0 x 3.0 m (Three plants per hill)	4998	24	6.0 x 8.0 m
(S ₄) 1.8 x 1.8 m (Single plants per hill) (Conventional methods)	3086	16	7.2 x 7.2 m
(B) Fertilizers:			
(F ₁) Recommended Dose of Fertilizers (RDF) i. e. 10 kg FYM & 300 - 100 - 200 g NPK per plant in form of chemical fertilizers			
(F ₂) 50 % RDF + 10 kg FYM + 5 kg Castor Cake + Azotobacter @ 1 l/ha + PSB @ 1 l/ha			
(F ₃) 50 % RDF + 10 kg FYM + 5 kg Neem Cake + Azotobacter @ 1 l/ha + PSB @ 1 l/ha			

The soil of experimental plot was sandy loam prepared to a fine tilth by cross wise ploughing followed by harrowing. Farm yard manure (FYM) 10 kg, castor cake 5 kg and neem cake 5 kg mixed for each hill in respective treatment at basal. Tissue culture plants of banana cv. Grand Naine were used as planting material. Banana planting was done during last week of July of 2011, 2013 and 2015 and thereafter biofertilizers like Azotobacter (*Azotobacter chroococcum*) and PSB (*Bacillus coagulans*) @ 1 l/ha in respective treatment was given as basal dose. The special horticultural practices viz., earthing up, desuckering, propping and removal of floral buds etc. were carried out as usual. Chemical fertilizers (water soluble) were given through drip in six equal splits at 90, 105, 120, 135, 150 and 165 days after planting. Irrigation was applied through drip at alternate day @ 0.8 pan evaporation fraction (PEF). The data recorded on growth, yield and quality parameters were analyzed statistically using various techniques as described by Panse and Sukhatme, 1978^[7].

Results and Discussion

The efforts were made to identify growth, yield parameters related to spacing and fertilizers, the data present in Table 1 indicated that there was a significant difference on plant height and stem girth with regards to different spacing. Maximum plant height and stem girth were observed in S₂ (2.0 x 2.0 m two plants per hill) i. e. 2.06 m and 51.98 cm, respectively.

Similarly, plant height with regard to different fertilizer treatments was recorded significantly maximum with F₁ (10 kg FYM and 300-100-200 g NPK/plant) i. e. 2.05 m. This recommended dose of fertilizer may further prove that it helps to better nourish the plant with drip and fertigation system was found better for vegetative growth.

The yield parameters like number of fingers per hand and bunch weight were found significant and recorded maximum with conventional spacing 1.8 x 1.8 m (S₄) i. e. 20.44 and 24.91 kg, respectively. But yield (t/ha) was found significantly maximum in S₁ (1.2 x 1.2 x 2.0 m) i.e. 117.81 t/ha. Increase the number of plants per unit area resulted in higher yield (Mandal and Sharma,1999)^[4] and when compared to conventional planting, all the HDP treatments registered a reduction in number of fingers, number of hands and bunch weight (Nalina *et al.*, 2003)^[5].

Fertilizer application is concerned, girth of fingers was found significant and recorded higher value in recommended dose of fertilizer 10 kg FYM and 300-100-200 g NPK/plant (F₁) i. e. 11.48 cm. This may be due to proper nourishment of plant with drip and fertigation system better the girth of fingers and yield attributing characters. With reduced fertilizer rates significantly reduction in bunch character (Nalina *et al.*, 2000)^[6]. In the present investigation also a definite trend was observed between vegetative growth and yield parameters. Similar findings were reported by Mahmoud, 2013^[3] and Mahalaxmi, 2000^[2].

Table 1: Influence of spacing and fertilizer on growth and yield of banana (3 years pooled)

Treatments	Plant height (m)	Stem girth (cm)	Bunch length at harvest (cm)	Number of fingers per hand	Length of finger (cm)	Girth of finger (cm)	Bunch weight (kg)	Yield (t/ha)
Spacing								
S ₁	2.05	50.65	83.60	19.54	19.71	11.50	22.62	117.81
S ₂	2.06	51.98	80.93	18.78	19.54	11.40	21.61	108.03
S ₃	1.98	49.96	80.61	18.98	19.93	10.93	20.67	103.33
S ₄	2.03	50.85	83.09	20.44	20.04	10.93	24.91	76.86
S. Em. ±	0.01	0.32	1.67	0.28	0.22	0.21	0.38	3.83
C. D. at 5 %	0.05	0.96	NS	0.83	NS	NS	1.28	13.25
C. V. %	3.93	3.32	4.53	7.45	5.78	9.80	10.14	8.40
Fertilizers								
F ₁	2.05	51.19	83.31	19.92	19.93	11.48	23.14	104.71

F ₂	2.02	50.77	81.80	18.96	19.75	11.08	22.09	99.64
F ₃	2.01	50.62	81.06	19.42	19.74	11.01	22.13	100.17
S. Em. ±	0.009	0.26	0.74	0.38	0.19	0.11	0.36	1.50
C. D. at 5 %	0.03	NS	NS	NS	NS	0.31	NS	NS
C. V. %	2.69	3.10	5.42	7.20	5.69	5.77	4.45	4.23
Interaction (S x F)								
S. Em. ±	0.02	0.52	1.48	0.47	0.38	0.21	0.33	1.43
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	4.07
YS	NS	NS	3.68	NS	NS	NS	2.25	8.45
YF	NS	NS	NS	1.15	NS	NS	0.82	3.52
YSF	NS	NS	NS	NS	NS	NS	NS	NS

Table 1.1: Interaction effect (Y x S) on bunch length at harvest (cm) of banana

	S ₁	S ₂	S ₃	S ₄
Y ₁	76.14	68.69	69.83	75.59
Y ₂	86.22	81.22	82.67	82.22
Y ₃	88.44	92.89	89.33	91.44
S. Em. ±	1.24			
CD at 5 %	3.68			

Table 1.2: Interaction effect (Y x F) on number of fingers per hand of banana

	F ₁	F ₂	F ₃
Y ₁	20.16	17.97	18.50
Y ₂	18.89	18.72	18.58
Y ₃	20.72	20.20	21.19
S. Em. ±	0.40		
CD at 5 %	1.15		

Table 1.3: Interaction effect (Y x S) on bunch weight (kg) of banana

	S ₁	S ₂	S ₃	S ₄
Y ₁	21.80	20.49	18.22	25.82
Y ₂	21.97	21.26	19.80	24.13
Y ₃	24.09	23.07	24.00	24.77
S. Em. ±	0.76			
CD at 5 %	2.25			

Table 1.4: Interaction effect (Y x F) on bunch weight (kg) of banana

	F ₁	F ₂	F ₃
Y ₁	22.97	20.83	20.95
Y ₂	22.47	21.60	21.30
Y ₃	23.98	23.84	24.13
S. Em. ±	0.29		
CD at 5 %	0.82		

Table 1.5: Interaction effect (S x F) on yield (t/ha) of banana

	F ₁	F ₂	F ₃
S ₁	121.40	115.70	116.32
S ₂	112.38	102.73	108.98
S ₃	106.33	103.12	100.53
S ₄	78.71	77.00	74.86
S. Em. ±	1.43		
CD at 5 %	4.07		

Table 1.6: Interaction effect (Y x S) on yield (t/ha) of banana

	S ₁	S ₂	S ₃	S ₄
Y ₁	113.53	102.44	91.08	79.69
Y ₂	114.44	106.30	98.97	74.46
Y ₃	125.46	115.35	119.93	76.43
S. Em. ±	2.84			
CD at 5 %	8.45			

Table 1.7: Interaction effect (Y x F) on yield (t/ha) of banana cv. Grand Naine

	F ₁	F ₂	F ₃
Y ₁	102.80	93.18	94.07
Y ₂	101.78	97.22	96.62
Y ₃	109.54	108.51	109.83
S. Em. ±	1.24		
CD at 5 %	3.52		

The data of quality parameters like pulp-peel ratio, TSS (⁰Brix), reducing sugar, non-reducing sugar, total sugar and shelf life (Table 2) showed that there were no significant results obtained in respect to spacing and fertilizer application for pulp-peel ratio, reducing sugar, non-reducing sugar and shelf life. Total Soluble Solids and total sugar with regard to different spacing showed significantly higher with S₂ (2.0 x 2.0 m two plants per hill) *i. e.* 21.29 (⁰Brix) and 24.47 %, respectively. Fertilizer application for quality traits was found non-significant.

Economics in Table 3 showed that highest gross income, net realization was obtained in S₁ X F₁ (1.2 X 1.2 X 2.0 m pair

row planting with 10 kg FYM and 300-100-200g NPK/plant). But, higher benefit cost ratio (1.94) was obtained with S₄ X F₁ followed by S₁ X F₁.

From the study, it can be concluded that under different planting system S₁ (1.2 X 1.2 X 2.0 m pair row) showed significantly higher yield (t/ha) as compared to other planting distance. In case of fertilizer application is concerned, there was no significant result obtained for yield and quality of banana. For combined effect of spacing and fertilizer as well as economic S₁ X F₁ (1.2 X 1.2 X 2.0 m pair row planting with 10 kg FYM and 300-100-200 g NPK/plant) was found superior than other combinations.

Table 2: Influence of spacing and fertilizer on quality of banana (3 years pooled)

	Pulp : peel ratio	TSS (^o Brix)	Reducing sugar (%)	Non-reducing sugar (%)	Total sugar (%)	Shelf life (days)
Spacing						
S ₁	3.09	19.97	14.56	9.45	24.01	6.93
S ₂	3.08	21.29	14.81	9.66	24.47	6.93
S ₃	3.11	20.21	14.54	9.24	23.78	7.15
S ₄	3.14	20.88	14.49	9.20	23.69	6.85
S. Em. ±	0.06	0.30	0.17	0.17	0.16	0.09
C. D. at 5 %	NS	0.90	NS	NS	0.46	NS
C. V. %	9.69	7.65	5.92	9.41	3.84	7.05
Fertilizers						
F ₁	3.16	20.30	14.62	9.23	23.84	6.75
F ₂	3.08	20.79	14.62	9.47	24.10	7.17
F ₃	3.08	20.67	14.56	9.47	24.03	6.97
S. Em. ±	0.04	0.19	0.13	0.18	0.23	0.26
C. D. at 5 %	NS	NS	NS	NS	NS	NS
C. V. %	6.94	5.60	5.21	6.62	3.33	13.04
Interaction (S x F)						
S. Em. ±	0.072	0.38	0.25	0.21	0.40	0.30
C. D. at 5 %	NS	NS	NS	0.59	NS	NS
YS	NS	NS	NS	NS	NS	NS
YF	NS	NS	NS	NS	NS	NS
YSF	NS	NS	NS	NS	1.31	NS

Table 2.1: Interaction effect (S x F) on non-reducing sugar (%) of banana

	F ₁	F ₂	F ₃
S ₁	8.93	9.54	9.88
S ₂	9.89	9.94	9.16
S ₃	9.10	9.29	9.32
S ₄	8.98	9.11	9.52
S. Em. ±	0.21		
CD at 5 %	0.59		

Table 2.2: Interaction effect (Y x S x F) on total sugar (%) of banana

	F ₁	F ₂	F ₃
Y ₁ S ₁	23.67	24.73	24.63
Y ₁ S ₂	25.60	24.73	23.07
Y ₁ S ₃	23.40	24.30	24.57
Y ₁ S ₄	22.87	23.53	25.13
Y ₂ S ₁	23.57	24.53	24.70
Y ₂ S ₂	25.30	25.03	25.07
Y ₂ S ₃	23.73	24.30	23.83
Y ₂ S ₄	23.90	24.13	23.97
Y ₃ S ₁	23.03	23.63	23.63
Y ₃ S ₂	23.60	24.03	23.80
Y ₃ S ₃	23.78	23.03	23.03
Y ₃ S ₄	23.63	23.17	22.90
S. Em. ±	0.46		
CD at 5 %	1.31		

Table 3: Economics as influenced by different treatments

Sr. No.	Treatments	Banana Yield (t ha ⁻¹)	Gross Income (Rs. ha ⁻¹)*	Total Cost (Rs. ha ⁻¹)	Net Realization (Rs. ha ⁻¹)	BCR
1	S ₁ X F ₁	121.40	1092600	599268	493332	1.82
2	S ₁ X F ₂	115.70	1041300	727102	314198	1.43
3	S ₁ X F ₃	116.32	1046880	792202	254678	1.32
4	S ₂ X F ₁	112.38	1011420	576956	434464	1.75
5	S ₂ X F ₂	102.73	924570	699696	224874	1.32
6	S ₂ X F ₃	108.98	980820	762196	218624	1.29
7	S ₃ X F ₁	106.33	956970	576780	380190	1.66
8	S ₃ X F ₂	103.12	928080	699471	228609	1.33
9	S ₃ X F ₃	100.53	904770	761946	142824	1.19
10	S ₄ X F ₁	78.71	708390	366064	342326	1.94
11	S ₄ X F ₂	77.00	693000	441911	251089	1.57
12	S ₄ X F ₃	74.86	673740	480486	193254	1.40

*Selling price: Banana Rs. 180 per 20 kg

References

1. Anonymous. Indian Horticulture Database 2014, National Horticulture Board, Gurgaon, 2015, 38.
2. Mahalaxmi M. Water and fertigation management studies in banana cv. Robusta (AAA) under normal and high density planting systems. Ph. D. thesis, Horticulture College and Research Institute, Coimbatore. 2000.
3. Mahmoud HH. Effect of different levels of planting distances, irrigation and fertigation on yield characters of main banana crop cv. Grand Naine. Global J. Pl. Ecophysio., 2013; 3:115-121.
4. Mandal BK, Sharma SB. Growth and yield responses of Robusta banana (*Musa* AAA) at high densities. Prog. Hort., 1999; 31:138-143.
5. Nalina L, Kumar N, Sathiamoorthy S. Studies on high density planting in banana cv. Robust (AAA) II. Influence on bunch and fruit quality traits. Indian J. Hort., 2003; 60:307-311.
6. Nalina L, Kumar N, Sathiamoorthy S, Muthuvel P. Effect of nutrient levels on bunch characters and vegetative characters of banana cv. Robust under high density planting system. South Indian Hort., 2000; 48:18-22.
7. Panse VG, Sukhatme PV. Statistical Methods for Agricultural Workers, Indian Council of Agricultural Research, New Delhi, 1978, 381.