

Original Research Article

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Influence of different Plant Densities and Fertilizer Levels on Growth and Yield Parameters in Banana cv. Grand Naine

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ABSTRACT

An experiment was carried out in banana cv. Grand Naine to evaluate the effect of three different plant densities with three levels of fertilizer which was laid out in factorial RCBD design with three replications. During all the stages of growth, except plant height, all the vegetative growth parameters were higher in lowest plant density (2.0 x 2.0 m) and lower in higher plant density (1.5 x 1.5 m). The highest plant height (207.67 and 205.61 cm) and yield (108.33 and 101.95 tons/ha) was registered in higher plant density in both the plant and ratoon crop respectively. While, the lowest plant height (197.25 cm and 194.19 cm) and yield (74.26 and 69.38 tons/ha) was observed in lower plant density in both the seasons respectively. In case of fertilizer application, the significant result was obtained for growth and yield of banana. The highest growth and yield parameters was found in F₂ (125 % RDF) whereas the lowest was registered in F₃ (75 % RDF). For combined effect of plant density and fertilizer on growth and yield parameters, the treatment S₃ x F₂ (2 x 2 with 125 % RDF) recorded higher values except plant height and yield than other combinations.

Keywords

Plant density,
Fertilizer, cv. Grand
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Introduction

In the world of fruits, banana (*Musa spp*) is a complete food fruit packed with all the necessary energy and health giving elements (Anon, 1969). It is an important crop of sustenance and farmers can ensure year-round production and income. In recent years more

emphasis is being given to higher production per unit area by adopting various means. 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 (Aphsara and Sathiamoorthy, 2003). Recent studies on increased plant density in

banana plantations either by reduced spacing or by increasing the number of plants per hill have revealed that high plant density can be beneficial in many ways. In case of fertilizer, it has been commonly observed that banana growers emphasize more on nitrogen application followed by phosphorus and almost ignore potassium. In this way, imbalance or deficiencies of these major nutrients cause considerable damage to the plant in terms of quality, stress response and yield. Moreover, application of nutrients in readily available form rapidly enhance the availability of that nutrient in the soil but all is neither taken up by plants nor remain permanently in available form (Lodhi *et al.*, 2009). So, it is necessary for the growers to know the nutrient status of the banana plants and soils for better plant nutrition management and achieving better production.

Keeping this in view, this experiment was undertaken to identify an optimum plant density and fertilizer levels in relation to better vegetative growth and yield parameters in banana *cv.* Grand Naine.

Materials and Methods

The experiment was laid out with tissue cultured banana *cv.* Grand Naine as a test crop in Factorial Randomized Block Design (FRBD) at three varied plant densities and three fertilizer levels which is consisted of 9 treatments and 3 replications. The treatments were imposed in the month of September 2018. Pits of size 45 x 45 x 45 cm were dug two months before the planting at a spacing of 1.5 x 1.5 m – 1.8 x 1.8 m and 2.0 x 2.0 m and the pits were applied with 10 kg of FYM before planting. Fertilizer application schedule followed with a dose of 200:100:300 g NPK (Urea, P₂O₅ and K₂O) per plant as per the package of practices of UAS, Bengaluru recommended for tissue cultured banana (Anon, 2017). Fertilizer doses calculated for

banana at different growth stages according to treatments *i.e.* 100%, 125% and 150% recommended. A drip irrigation system was installed at the experimental site with placement of emitters at 40 cm distance. The emitters' water discharge rate was 4 lit/h. Protective irrigation was given as per the need of the crop and followed the recommended production practices. The treatment details are furnished as below.

T₁ (S₁F₁) 100% RDF at 1.5 x 1.5 m² + 40cm Emitters Placement

T₂ (S₁F₂) 125% RDF at 1.5 x 1.5 m² + 40cm Emitters Placement

T₃ (S₁F₃) 75% RDF at 1.5 x 1.5 m² + 40cm Emitters Placement

T₄ (S₂F₁) 100% RDF at 1.8 x 1.8 m² + 40cm Emitters Placement

T₅ (S₂F₂) 125% RDF at 1.8 x 1.8 m² + 40cm Emitters Placement

T₆ (S₂F₃) 75% RDF at 1.8 x 1.8 m² + 40cm Emitters Placement

T₇ (S₃F₁) 100% RDF at 2 x 2 m² + 40cm Emitters Placement

T₈ (S₃F₂) 125% RDF at 2 x 2 m² + 40cm Emitters Placement

T₉ (S₃F₃) 75% RDF at 2 x 2 m² + 40cm Emitters Placement

Results and Discussion

Significant difference was registered among the treatments with different plant densities and fertilizer levels on growth parameters like pseudostem height and girth, number of leaves and leaf area per plant, number of functional leaves at flowering and number of functional

leaves at harvest in both the plant and ratoon crop (Table 1).

During all the stages, the highest plant height was noticed in high plant density S₁ (1.5 x 1.5 m), while, it was lowest in lower plant density S₃ (2 x 2 m). Similarly, plant height with regard to different fertilizer levels was found significantly highest with F₂ (125 % RDF) and lowest in F₃ (75 % RDF). The highest growth parameters *viz.*, pseudostem girth, number of leaves and leaf area per plant, number of functional leaves at flowering and number of functional leaves at harvesting were registered in lower plant density S₃ (2 x 2 m) and higher fertilizer percentage (125 % RDF), while the lowest were found in higher plant densities S₁ (1.5 x 1.5 m) and lower fertilizer level F₃ (75 % RDF). However, significant differences except plant height were found in interaction effect between varied plant densities and fertilizer levels (S x F) on growth parameters. The highest was registered in treatment S₃F₂ (2 x 2 with 125 % RDF) and the lowest was noticed in S₁F₃ (1.5 x 1.5 with 75 % RDF).

The yield parameters like bunch weight, number of hands per bunch and number of fingers per bunch were found significant and were registered highest in both plant and ratoon crop with lower plant density S₃ (2 x 2 m) and higher fertilizer percentage F₂ (125 % RDF) respectively and it was found lowest in S₁ (1.5 x 1.5) and F₃ (75 % RDF) (Table 2). But yield (tons/ha) was found significantly highest in S₁ (1.5 x 1.5 m) and F₂ (125 % RDF). However the yield (tons/ha) was found lowest with lower plant density S₃ (2 x 2) and lower fertilizer percentage (75 % RDF) (Table 3).

The highest pseudostem height in higher plant density and higher fertilizer percentage is due to high interplant competition for light within the plot with the advancement of growth stages and more competition for nutrients

compared to other treatments resulting in tall and lanky growth as a result pseudostem height was more. Similar results were also reported by Naik, (2016) and Patel *et al.*, (2018). The highest pseudostem girth was registered in low plant density might be due to good canopy architecture which was benefited for highest photosynthetic assimilation, considerably reduced the height which led to increase in girth. The higher levels of nutrient application had a significant influence on pseudostem girth especially nitrogen and potash which help in formation of complex nitrogenous substances such as proteins and amino acids which are the building blocks of tissues. Similar results were also noticed in Ney Poovan (Murugan, 2003 and Panjavarnam *et al.*, 2018), Srinivas *et al.*, (2001) and Ashok *et al.*, (2009). The highest numbers of leaves was registered in low plant density which is due to sufficient space for more light interception and good congenial weather conditions favor. Hence, it indicates that sufficient reserve assimilation is a prerequisite for higher leaf production in widely placed. In case of fertilizer the different workers on banana have reported that higher levels of nitrogen, phosphorus and potash promote production of more leaves. These findings are in conformity with Grand Naine (Naik, 2016; Gaonkar, 2018) and Quintal Nendran (Sindhupriya *et al.*, 2018). The highest leaf area was observed in low plant density might be due to increase in leaf size by cell division, cell enlargement, cell expansion and metabolic processes involving synthesis of macromolecules during the growth stage. The different workers on banana have reported that higher levels of nitrogen and potash promote production of more leaves resulting in increased leaf area which has positive correlation with bunch weight. These findings are in conformity in Red Banana (Suganthi, 2002) and Ney Poovan (Murugan, 2003; Pandey *et al.*, 2001 and Srinivas *et al.*, 2001).

Table.1 Influence of different plant densities and fertilizer levels on growth parameters in Banana cv. Grand Naine

Treatments	Plant height at shooting (cm)		Pseudostem girth at shooting (cm)		Total Number of leaves per plant		Number of functional leaves at flowering		Number of functional leaves at harvest		Leaf area at shooting (m ²)	
	Plant crop	Ratoon crop	Plant crop	Ratoon crop	Plant crop	Ratoon crop	Plant crop	Ratoon crop	Plant crop	Ratoon crop	Plant crop	Ratoon crop
Factor-01	Spacing											
S₁	207.67	205.61	45.42	43.16	28.65	27.17	8.63	8.40	7.06	6.93	8.90	8.25
S₂	203.48	202.07	52.01	49.38	31.11	29.03	10.35	10.09	8.65	8.46	11.88	10.49
S₃	197.23	194.19	55.30	51.35	31.59	29.98	11.23	10.97	9.16	8.83	12.86	11.43
S.Em ±	1.02	0.79	0.74	0.88	0.33	0.28	0.161	0.07	0.08	0.12	0.12	0.10
C.D. at 5%	3.10	2.38	2.24	2.67	1.02	0.86	0.48	0.21	0.26	0.36	0.37	0.30
Factor-02	Fertilizers											
F₁	202.57	200.74	50.84	48.32	29.62	28.34	9.93	9.63	8.27	7.99	10.93	10.05
F₂	211.89	209.72	55.34	52.96	33.16	30.98	10.94	10.70	8.79	8.53	13.18	11.50
F₃	193.92	191.41	46.55	42.61	28.57	26.85	9.34	9.13	7.81	7.70	9.52	8.61
S.Em ±	1.02	0.79	0.74	0.88	0.33	0.28	0.16	0.07	0.08	0.12	0.12	0.10
C.D. at 5%	3.10	2.38	2.24	2.67	1.02	0.86	0.48	0.21	0.26	0.36	0.37	0.30
Interaction effect (S X F)												
S₁F₁	207.94	205.41	45.36	42.74	27.70	27.01	8.41	8.13	7.05	6.9	8.84	8.13
S₁F₂	216.71	215.65	47.17	45.22	30.41	28.53	9.20	9.03	7.21	7.06	9.77	8.62
S₁F₃	198.35	195.79	43.73	41.53	27.83	25.96	8.30	8.05	6.93	6.77	8.17	8.01
S₂F₁	202.98	203.09	51.91	49.45	30.75	28.53	10.21	10.01	8.55	8.20	11.67	10.53
S₂F₂	214.12	211.98	57.59	55.43	34.20	31.88	11.50	11.18	9.25	9.03	14.23	12.41
S₂F₃	193.35	191.14	46.53	43.26	28.40	26.68	9.35	9.08	8.16	8.16	9.73	8.52
S₃F₁	196.80	193.73	55.25	52.77	30.41	29.48	11.18	10.75	9.23	8.83	12.29	11.50
S₃F₂	204.85	201.55	61.28	58.22	34.86	32.55	12.13	11.88	9.91	9.51	15.55	13.47
S₃F₃	190.05	187.29	49.39	43.06	29.50	27.91	10.38	10.27	8.35	8.16	10.73	9.31
S.Em ±	1.77	1.36	1.28	1.53	0.58	0.49	0.278	0.124	0.154	0.20	0.213	0.175
C.D. at 5%	NS	NS	3.89	4.64	NS	NS	NS	0.376	0.466	NS	0.64	0.53

NS: Non Significant

Table.2 Effect of different plant densities and fertilizer levels on bunch parameters in Banana cv. Grand Naine

Treatments	Bunch weight (kg)		Number of hands per bunch		Number of fingers per bunch	
	Plant crop	Ratoon crop	Plant crop	Ratoon crop	Plant crop	Ratoon crop
Factor-01	Spacing					
S ₁	24.37	22.94	8.77	7.44	200.08	156.44
S ₂	29.70	27.75	9.44	8.00	244.05	188.92
S ₃	30.35	28.89	9.44	8.33	255.34	206.56
S.Em ±	0.52	0.74	0.27	0.19	9.28	6.69
C.D.at 5%	1.59	2.25	NS	0.59	28.07	20.24
Factor-02	Fertilizers					
F ₁	29.44	27.83	9.11	7.77	232.55	174.46
F ₂	31.60	30.24	9.83	8.66	273.47	219.79
F ₃	23.39	21.50	8.72	7.33	193.45	146.55
S.Em ±	0.52	0.74	0.27	0.19	9.28	7.13
C.D.at 5%	1.59	2.25	0.84	0.59	28.07	21.58
Interaction effect (S X F)						
S ₁ F ₁	25.77	24.96	8.83	7.33	189.16	153.94
S ₁ F ₂	27.11	25.30	9.00	7.66	244.58	178.83
S ₁ F ₃	20.23	18.56	8.50	7.33	166.50	136.56
S ₂ F ₁	30.91	28.57	9.33	7.66	249.75	186.44
S ₂ F ₂	34.16	33.61	10.00	9.00	274.16	228.62
S ₂ F ₃	25.97	24.50	9.00	7.33	208.25	151.69
S ₃ F ₁	31.63	29.98	9.16	8.33	258.75	216.34
S ₃ F ₂	33.51	31.83	10.50	9.33	301.66	251.93
S ₃ F ₃	23.97	21.44	8.66		205.62	151.41
S.Em ±	0.91	1.29	0.48	0.33	16.08	11.59
C.D.at 5%	NS	NS	NS	NS	NS	NS

NS: Non Significant

Table.3 Effect of different plant densities and fertilizer levels on yield (tons/ha) in Banana cv. Grand Naine

Treatments	Yield (tons/ha)	
	Plant crop	Ratoon crop
Factor-01	Spacing	
S ₁	108.33	101.95
S ₂	93.62	91.41
S ₃	74.26	69.38
S.Em ±	1.69	2.03
C.D.at 5%	5.11	6.16
Factor-02	Fertilizers	
F ₁	96.35	93.58
F ₂	103.21	98.58
F ₃	76.67	70.58
S.Em ±	1.69	2.03
C.D.at 5%	5.11	6.16
Interaction effect (S X F)		
S ₁ F ₁	114.55	110.92
S ₁ F ₂	120.513	112.44
S ₁ F ₃	89.93	82.50
S ₂ F ₁	95.40	94.87
S ₂ F ₂	105.33	103.73
S ₂ F ₃	80.15	75.63
S ₃ F ₁	79.09	74.94
S ₃ F ₂	83.78	79.58
S ₃ F ₃	59.93	53.61
S.Em ±	2.93	3.53
C.D.at 5%	NS	NS

NS: Non Significant

The highest number of functional leaves at flowering and functional leaves at harvest per plant was registered in low plant density and higher fertilizer percentage *i.e.* S₃ and F₂ (2 x 2 m, 125 % RDF) could be due to less competition in soil moisture nutrient and active imbibitions light intensity leads to more green leaves. With respect to fertilizer, higher number of leaf production at flowering and at harvest per plant at high levels of fertilizer indicates that enough reserve resources or assimilation of resources is a pre-requisite for higher leaf production Srinivas, (2001). During the present investigation, in plant and

ratoon crop, the bunch weight, number of hands and number of fingers per bunch were registered highest in S₃, F₂ (2 x 2, 125 % RDF). It might be due to high light intensity and plants were more exposed to sun light and indirectly got greater amount of assimilates accumulated in the various organ and led to good bunch size and its parameters. Similar results were also obtained in Robusta (Kulapathi *et al.*, 2000) and Jahaji (Gogi, 2015). The highest yield (tons/ha) was registered in S₁ (1.5 x 1.5 m) and F₂ (125 % RDF). It can be attributed to increase in plant population per unit urea (Ahmad and Manan,

1970). But in case of low plant density S₃ (2 x 2 m) was registered the highest morphological and physiological characters, therefore it was recorded the highest yield in individual levels of plant, but number of plants occupied per hectare area was low. With respect to different doses of fertilizer the higher fertilizer percentage led to highest yield per hectare, it provides the highest amount of nutrients to fulfill the requirement of N, P and K which is essential to physiological and morphological growth of plant, which could lead to increase the yield per unit area.

Adoption of three different plant densities and three levels of fertilizer greatly influenced on vegetative growth and yield parameters. The highest growth parameters except plant height in S₁ (1.5 x 1.5 m), was registered in treatment S₃, F₂ (2 x 2, 125 % RDF). With respect to reproductive characteristics, the highest bunch weight, number of hands and number of fingers per bunch was registered in S₃, F₂ (2 x 2 m, 125 % RDF). Whereas the yield (tons/ha) was found highest in S₁, F₂ (1.5 x 1.5, 125 % RDF) which is due to more plant population per unit area. But yield in case of S₃ (2 x 2 m) was registered the highest morphological and physiological characters, therefore, the highest yield was observed in individual levels of plant, but number of plants occupied per hectare area was low. However, long-term studies are needed to determine the effect of different plant densities and residual effects of fertilizer application on soil and plants as well as its interaction with other factors such as irrigation, desuckering and management practices.

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