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Effect of Plant Density and Fertigation on Growth and Productivity of Banana cv. Martaman (AAB)

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Abstract—*For improving the productivity of local banana cv. Martaman syn. Bengal Amruthapani, an experiment was conducted at three planting densities (S_1-2500 plants/ha, S_2- 3200 plants/ha and S_3- 4800 plants/ha) with three fertigation levels of (F_1-100%, F_2- 75% and F_3-50% RDF) recommended N and K_2O under coastal Andhra Pradesh conditions. The results of the experiment clearly indicated that closer spacing with 100% recommended N and K_2O applied through drip (S_3F_1) exhibited improved plant morphology in terms of plant height and girth. The treatmental combinations S_1F_1andS_1F_2 resulted in increased growth parameters like green leaves, total leaves, leaf area and recorded earlier shooting, higher bunch weight, more number of fingers and hands per bunch with maximum fruit girth. In terms of productivity, S_3F_1 recorded highest per hectare yield and it was on par with S_3F_2 while highest B:C ratio was obtained in S_3F_3 (2.5 × 1.25 × 1.25 m spacing and 50% RDF) as compared to normal plant density.*

Keywords*: Fertigation, High density planting (HDP).*

1. INTRODUCTION

Banana is considered as one of the most important fruit crops in tropical and sub-tropical zones of the world. About 11 per cent of world's banana is produced in the country. In India the area under banana is 8.30 lakh ha with production of 297.79 lakh tonnes. The average productivity of banana in India is 35.9 MT/ha. In India, A.P occupies about 9.3% of total production. In Andhra Pradesh, local banana cv. Martaman (AAB) is well known to the people for its excellent taste and flavour. Though it is a paying crop but its low productivity is a limiting factor commercial cultivation in this region.

Population growth and the consequent demand for more food have encouraged the search for innovative methods of production that can obtain higher sustainable yields. High density planting (HDP) can significantly increase yield per unit area as the plants are planted closer than that in banana of traditional plantings (Mahalakshmi, 2000). Water and fertilizer are the most crucial basic sources in crop production. Management of these resources in an efficient way is the need of hour. Fertigation offers the opportunity for precise application of fertilizers to the crop, improves nutrient use efficiency, saves labour and energy in application, reduces the cost of production and also reduces environment pollution and maintains the soil health. Taking productivity into consideration, the present experiment was conducted to study the effect of plant density and fertigation level on growth and productivity of banana cv. Martaman under coastal Andhra Pradesh conditions.

2. MATERIALS AND METHODS

The field experiment was conducted during 2011-2012 at Horticultural Research Station, Kovvur. Banana suckers (cv. Martaman) were planted in plots of 15m × 7m on 28th October, 2011 at three different spacings. The soil of experimental field was black alluvial with a pH of 7.6 and an EC of 0.42 dSm^{-1}. The experiment was laid out in factorial randomized block design with three replications.

The treatments were laid out in Factorial Randomized Block Design with three replications. The treatment details are as follows:

Plant densities	Fertigation levels
S1- 2 × 2 m (2500 plants/ ha)	F1–100 % Recommended dose of fertilizers (RDF)
S 2- 2.5 × 1.25 m (3200 plants/ ha)	F2–75 % Recommended dose o f fertilizers (RDF)
S3- 2.5 × 1.25 ×1.25m (4800 plants/ ha)	F3–50 % Recommended dose of fertilizers (RDF)

A common dose of P @ 50g/plant was applied as basal dose in the form of SSP for all the treatments. Recommended dose of fertilizers (RDF) indicates 200: 200 g/plant N and K_2O.For fertigation, straight fertilizers like urea and MOP (granular form) are used and they were scheduled in 30 splits at weekly intervals starting from 45th day after planting.

Observations were made on morphological characters (plant height, pseudostem girth number of green leaves, total leaves and leaf area), crop durationand yield parameters (bunch weight, number of hands and fingers in 2nd hand, finger length and girth). Cost economics were worked out to find out feasibility of the high density planting with optimum fertigation level.

3. RESULTS AND DISCUSSION

Adoption of high density planting (HDP) though registered lower values of growth (Number of leaves and leaf area) and individual bunch characters, it produced higher bunch yield (t/ha) than normal planting due to increased plant population under high density planting as yield in banana is a function of bunch weight and bunch number/ha. In the present investigation, among different density levels, planting suckers at a spacing of 2.5 × 1.25 × 1.25 m (S_3) resulted in significant increase in pseudostem height and girth as compared to other treatments. This could be attributed to higher interplant competition for light within a plot with the advancement of growth stages.

In the present study, at higher density levels, there was a marginal reduction in number of green leaves, total leaves and leaf area due to mutual shading effect and reduced temperature inside the canopy reported by Robinson and Nel (1988). Similar results were also recorded by Nalina*et al*. (2003), Nankinga*et al*. (2005),Athani*et al*. (2009) and Sarrwy*et al*. (2012).They reported that all the vegetative growth parameters were higher in the wider spacing and lower in the closer spacing. The closer spacing recorded maximum plant higher; while, the wider spacing recorded minimum plant height.

The application of higher level of nutrients (F_1-100% RDF) 200: 200g N and K_2O per plant through drip increased the plant height, girth, number of green leaves, total leaves and leaf area and it was on par with 75% RDF (F_2– 150: 150 g N and K_2O per plant) The higher levels of nutrient application had a significant influence on growth characters 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 reported by Apshara and Sathiamoorthy (1997), Pandey *et al*. (2001), Srinivas *et al*. (2001) and Ashok *et al.* (2009).

Wider spacing S_1 (2 × 2 m) recorded early shooting and significantly higher values for number of hands per bunch (8.86), fingers in 2nd hand (15.89) finger girth (11.92) and highest bunch weight/plant (19.89 kg).

Treatments	Bunch Weight(Kg)			
	S1	S2	S3	Mean
F1	20.40	18.87	16.67	18.64
F2	20.33	18.82	16.57	18.57
F3	18.80	18.67	16.20	17.89
Mean	19.89	18.78	16.48	
	SE m ±		CD (P=0.05)	
S	0.0305		0.0914	
F	0.0305		0.0914	
S X F	0.0528		0.158	

Treatments	Yield(t/ha)			
	S1	S2	S3	Mean
F1	40.80	48.30	64.00	51.03
F2	40.67	48.17	63.61	50.82
F3	37.60	47.79	62.21	49.20
Mean	39.69	48.09	63.27	
	SE m ±		CD (P=0.05)	
S	0.0945		0.2835	
F	0.0945		0.2835	
S X F	0.1638		0.491	

With respect to yield per hectare the significantly highest yield was recorded in closer spacing S_3 (2.5 × 1.25 × 1.25 m) (63.27 t/ha) as compared to S_1 (2 × 2 m) and S_2 (2.5 × 1.25 m). Under closer spacing S_3 (2.5 × 1.25 × 1.25 m) there was a 59.41% increase in yield per hectare over normal spacing S_1 (2 × 2 m). The finger filling is comparatively poorer in high density treatment as pronounced by lower finger girth. During finger development phase the growing bunches act as a heavy sinks and better assimilate partitioning will result only if the physiological efficiency is maximized. Better development of the finger results with high assimilates flow from the built-up reserves, primarily from the pseudostem and from the leaves. Lower number of functional leaves and lower functional area of leaves can be the responsible factors for reduced photosynthetic efficiency and subsequent bunch weight per plant in plants under high density. Reduction in leaf number by pruning caused poor filling and low bunch weights in cv. Williams (Robinson, 1996). However, the per hectare yield was reduced under normal spacing (S_1) due to lesser plant density as compared to closer spacing (S_3). The increase in yield per unit area under HDP can be attributed to increase in plant population per unit area (Ahmed and Mannan, 1970).Similar results were also reported by Nalina *et al*. (2003), Nankinga*et al*. (2005),Athani*et al*. (2009) and Sarrwy*et al*. (2012).

Higher fertigation level 100% RDF (F_1- 200: 200g N and K_2O $plant^{-1}$), recorded the early shooting, harvest, highest per hectare yield(51.03 t/ha) , bunch weight (18.64 kg), maximum fruit girth (10.99 cm) and maximum number of fingers in 2nd hand(14.96) and it was on par with F_2 (75% RDF - 150: 150g N and K_2O $plant^{-1}$).

Treatments	Number of hands			
	S1	S2	S3	Mean
F1	9.12	8.12	8.27	8.50
F2	9.00	8.36	8.10	8.49
F3	8.47	8.90	7.98	8.45
Mean	8.86	8.46	8.12	
	SE m ±		CD (P=0.05)	
S	0.095		0.2847	
F	0.095		N.S	
S X F	0.1645		0.493	

There was 4.2 per cent increase in bunch weight over 50% RDF (F_3- 100: 100g N and K_2O plant^{-1}). The increase in bunch weight in F_1 and F_2 treatments may be attributed to increase in number of fingers and finger girth. The increased growth parameters such as plant height, number of leaves, leaf area and nutrient uptake also positively correlated for higher yields in F_1 and F_2 treatments. The higher yield in F_1 and F_2 treatments may be attributed to constant and continuous supply of nutrients in solution form at optimum level to the wetted area of the root zone. The scheduling of potash in different splits at optimum level in the present study was also helpful in increasing bunch weight. This was in confirmation with the findings of Reddy *et al*. (2002), Murugan (2003) and Ashok *et al*. (2009). The low yields at lower levels of nitrogen and potash was probably due to the low uptake of nutrients (Martin-Prevel, 1973).

Treatments	Fingers per 2nd hand			
	S1	S2	S3	Mean
F1	16.47	15.13	13.27	14.96
F2	16.37	14.72	13.07	14.72
F3	14.83	14.37	12.86	14.02
Mean	15.89	14.74	13.07	
	SE m ±		CD (P=0.05)	
S	0.1021		0.3062	
F	0.1021		0.3062	
S X F	0.1769		0.530	

The improvement in plant growth and productivity with 75% RDF (F_2) through fertigation on par with 100% RDF (F_1) might be due to reduced loss of applied fertilizers by leaching thereby improving the fertilizer use efficiency (Rolston *et al*., 1986). Similar findings were also reported by Hegde and Srinivas (1991); Srinivas (1998) and Srinivas *et al*. (2001). Thus the 75% level of RDF applied through drip was found equally productive to that of 100% level of RDF indicating 25% fertilizer saving.

4. CONCLUSION

Among various treatment combinations, highest productivity was obtained in S_3F_1 (2.5 × 1.25 × 1.25 m spacing and 100% RDF) (64.0 t/ha) followed by S_3F_2 (2.5 × 1.25 × 1.25 m spacing and 75% RDF) (63.61 t/ha). However, the highest B:C ratio with higher productivity was obtained in S_3F_1 (2.5 × 1.25 × 1.25 m spacing and 100% RDF).

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