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Effect of subsurface drip fertigation on growth, yield attributes and microbial population of banana cv. Rasthali

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Field experiment was carried out during 2010-2011 at All India Coordinated Research Programme Water Management block, Agricultural College and Research Institute, Madurai. There were eleven treatments replicated three times in randomized block design using banana cv. Rasthali as a test crop. In recent years, fertigation a technique of application of both water and fertilizers via an irrigation system was shown to be very effective in achieving higher water and fertilizer use efficiency. In this method, both water and fertilizer are delivered precisely in the crop root zone as per the crop need and according to crop developmental phase. Increased growth and yield with sub surface drip irrigation has been reported earlier in several crops. The current results revealed that pseudostem girth increased markedly with nitrogen and potassium fertigation levels. Significantly higher plant height was observed with the application of nitrogen and potassium each at the rate of 200 g per plant. The increase in plant height and girth could be largely due to regular supply of nutrients through fertigation. The 75% RDF through drip fertigation increased plant height (278.8 cm) and stem circumference (68.54 cm) of banana as compared to a plant height of 253.7 cm and stem circumference of 64.23 cm observed under soil application.

Key words: Subsurface drip fertigation, growth, yield, banana.

INTRODUCTION

Banana (*Musa* sp.) is the fourth most important global food commodity after rice, wheat and milk in terms of gross value of production. It is grown in more than 130 countries across the world. India is the largest producer of banana in the world with the production of 97.38 mt of banana from an area of 8.25 mha. Among the horticultural crops, banana contributes the maximum to the agricultural gross domestic product (GDP) of India to the tune of 1.99% (Palwe et al., 2007). Balanced nutrient management is the key to increased plant use efficiency and to achieve the required crop yield in an efficient, economical and sustainable manner. This may indicate the need for the application of different nutrients at specific times, in a particular order to derive the maximum benefit from the application of a given quantity of nutrients.

Banana being a gross feeder requires high amount of nutrients for proper growth, development and optimum

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production.

Subsurface drip system is potentially more efficient in arid and semiarid regions of India because it provides water directly to the root zone, minimizing evaporative losses. Adoption of advanced and efficient methods of application of fertilizers through drip irrigation system would go a long way in economizing the scarce inputs and increasing the area and productivity. Fertilizer application through drip irrigation system, that is, fertigation is the most advanced and efficient practice of fertilization.

Fertigation, a technique of application of both water and fertilizers through drip irrigation system during the recent years was shown to be very effective in achieving higher water and fertilizer use efficiencies. In this method, both water and fertilizer are delivered precisely in the effective crop root zone as per the crop needs and crop developmental phases. Increased growth and yield with drip fertigation has been reported in several crops and the yield increase ranged between 7-112% depending on the crops, varieties and methods of irrigation. The water and fertilizer saving through drip fertigation system have been reported to be 40-70 and 30-50%, respectively (Rekha et al., 2008).

The aim of this investigation was to study the effect of subsurface drip fertigation on growth, yield and economics of banana cv. Rasthali variety having good fruit quality with higher yield and multiple ratooning capacity.

MATERIALS AND METHODS

Field experiment was carried out at AICRP- Water Management block, Agricultural College and Research Institute, Madurai during 2010 - 2011 as follows:

Treatments details

T_1- Surface irrigation with soil application of RDF
T_2- Subsurface drip fertigation of 100% RDF (P as basal, N and K through drip as urea and white potash)
T_3- Subsurface drip fertigation of 100% RDF as WSF (WSF – Urea, 13: 40: 13, KNO_3)
T_4- Subsurface drip fertigation of 100% RDF (50% P and K as basal, remaining N, P and K as WSF)
T_5- Subsurface drip fertigation of 75% RDF (P as basal, N and K through drip as urea and white potash) + LBF
T_6- Subsurface drip fertigation of 75% RDF as WSF (WSF – Urea, 13: 40: 13, KNO_3) + LBF
T_7- Subsurface drip fertigation of 75% RDF (50% P and K as basal, remaining N, P and K as WSF) + LBF
T_8- T_2 + LBF
T_9- T_3 + LBF
T_{10}- T_4 + LBF
T_{11}- Subsurface drip irrigation with LBF alone (no inorganic).

Note:
Recommended dose of fertilizer (RDF): 200:35:330 g NPK/plant; Source of P: Di ammonium phosphate and 13:40:13; Source of K: White potash and KNO_3; Source of water soluble fertilizers (WSF): Urea, 13:40:13 and KNO_3; LBF - liquid biofertilizers (Azospi + Phosphofix + Potash activa each @ 2.5 L/ha at 2nd, 3rd, 4th, 5th and 6th months after planting through drip irrigation).

RESULTS AND DISCUSSION

Effect of subsurface drip fertigation on growth parameter (Table 1)

As the crop stage advanced, subsurface drip fertigation of 100% RDF as WSF (WSF – Urea, 13: 40: 13, KNO_3) + LBF (T_9) was found to record higher pseudostem height (234.63 cm), stem girth (69.89 cm) and maximum number of leaves (20.68). The treatment subsurface drip irrigation with LBF alone (no inorganic) (T_{11}) registered the least pseudostem height (198.38), stem girth (52.50) and number of leaves (14.36), similar finding was earlier reported by Lahav and Kalmar (1988). Increased cell elongation and cell multiplication due to enhanced nutrient uptake by plants following inoculation of biofertilizers probably caused the increased plant height (Preethi et al., 1999).

Effect of subsurface drip fertigation on physiological parameter

The results on physiological parameter (Table 1) indicated that subsurface drip fertigation of 100% RDF as WSF (WSF – Urea, 13: 40: 13, KNO_3) + LBF (T_9) was found to record the highest chlorophyll content (52.40), specific leaf weight (0.095) and leaf area index (4.75). The treatment subsurface drip irrigation with LBF alone (no inorganic) (T_{11}) registered the least chlorophyll content (42.30), specific leaf weight (0.046) and leaf area index (2.79). Turner (1970) was also of the opinion that banana leaf production depends upon nutritional, genetic as well as climatic factors.

Effect of subsurface drip fertigation on yield attributes

The results on yield parameters (Table 2) indicated that subsurface drip fertigation of 100% RDF as WSF (WSF – Urea, 13: 40: 13, KNO_3) + LBF (T_9) was found to record the highest number of hands per bunch (7.68) number of finger per bunch (84.38) bunch weight (14.42 kg), yield (44.51 t/ha), finger length (15.64 cm), finger weight (156.67 g) and finger circumference (13.45 cm). The treatment subsurface drip irrigation with LBF alone (no inorganic) (T_{11}) registered the least number of hands per bunch (5.58), number of finger per bunch (60.70) and bunch weight (3.71 kg), yield (11.45 t/ha), finger length (12.47 cm), finger weight (52.56 g) and finger circumference (10.16 cm). Application of nutrients through surface drip irrigation system favoured the

Table 1. Effect of subsurface drip fertigation on banana growth attributes at the stage of shooting.

Treatment	Pseudostem		Number of leaves	Chlorophyll content (SPAD-value)	Specific Leaf Weight (mg cm^{-2})	Leaf area index
	Height (cm)	Girth (cm)				
T_1	200.38	58.34	16.05	45.43	0.056	3.16
T_2	211.96	60.80	19.16	47.26	0.085	3.74
T_3	228.53	67.16	19.95	47.33	0.067	4.30
T_4	211.86	63.95	18.80	46.47	0.084	4.20
T_5	226.20	60.35	18.65	46.70	0.068	3.68
T_6	220.70	62.63	20.30	48.10	0.076	3.82
T_7	215.33	59.82	19.08	46.84	0.057	3.91
T_8	223.09	61.60	19.95	51.28	0.091	4.39
T_9	234.63	69.89	20.68	52.40	0.095	4.75
T_{10}	228.68	65.28	20.30	48.55	0.088	4.47
T_{11}	198.38	52.50	14.36	42.30	0.046	2.79
SEd	6.22	1.96	0.49	1.80	0.0019	0.11
CD (P=0.05)	12.98	4.10	1.03	3.76	0.0040	0.23

Table 2. Effect of subsurface drip fertigation on banana yield attributes at the stage of shooting.

Treatment	Number of hands per bunch	Number of fingers per bunch	Bunch weight (kg)	Yield (t/ha)	Finger length (cm)	Fresh finger weight (g)	Finger circumference (cm)
T_1	6.10	70.70	6.72	20.73	13.07	99.77	11.12
T_2	6.45	72.50	9.80	30.25	13.36	118.48	11.22
T_3	7.52	76.90	13.56	41.85	15.14	153.25	12.35
T_4	7.25	76.35	11.39	35.15	13.39	130.45	12.26
T_5	6.67	73.83	8.76	27.06	13.62	101.86	11.86
T_6	7.01	79.27	11.07	34.16	14.21	121.86	12.50
T_7	6.75	74.53	10.23	31.58	13.69	120.09	11.57
T_8	7.24	78.30	10.16	31.36	13.48	114.56	12.21
T_9	7.68	84.38	14.42	44.51	15.64	156.67	13.45
T_{10}	7.35	80.39	12.21	37.67	14.29	135.83	12.90
T_{11}	5.58	60.70	3.71	11.45	12.47	52.56	10.16
SEd	0.19	2.53	0.41	1.21	0.37	2.93	0.36
CD (P=0.05)	0.39	5.27	0.86	2.51	0.75	6.08	0.76

growth and development of bunches with better fruit filling resulting in increased finger weight, length and mid circumference of fingers in banana (Yadav et al., 1988; Mahalakshmi et al., 2001). Savings in the consumption of fertilizers upto 50% by fertigation AS compared to soil application have been reported by Satyendra et al. (2008) in onion and Soumya et al. (2008) in tomato.

Effect of subsurface drip fertigation on microbial population

The soil treated with inorganic along with liquid biofertilizers showed an increased population of bacteria, fungi and actinomycetes. Subsurface drip fertigation of 75% RDF (P as basal, N and K through drip as urea and white potash) + LBF (T_5) increases bacterial (159.2 x 10^7 CFU g^{-1}), fungal (88.14 x 10^3CFU g^{-1}) and actinomycetes (53.00 x 10^5 CFU g^{-1}) population. Subsurface drip fertigation of 75% RDF (50% P and K as basal, remaining N, P and K as WSF) + LBF (T_7) recorded also high bacterial, fungal and actinomycetes population (Table 3). The similar results were achieved by Patil et al. (2010).

Conclusion

This study clearly reveals that subsurface drip fertigation

Table 3. Effect of subsurface drip fertigated liquid bio fertilizers on the microbial population.

Treatment	Bacterial population (x 10^7CFU g^{-1})	Fungi population (x 10^3CFU g^{-1})	Actinomycetes population (x 10^5 CFU g^{-1})
T_1	132.50	61.14	32.21
T_2	141.7	77.00	41.25
T_3	130.5	63.72	36.50
T_4	131.3	68.00	33.00
T_5	159.2	88.14	53.00
T_6	157.1	87.25	52.10
T_7	157.0	78.12	50.15
T_8	142.0	76.15	42.00
T_9	154.3	75.10	40.00
T_{10}	140.5	74.10	45.00
T_{11}	149.0	65.04	34.24
SE d	2.79	1.49	0.88
CD (P = 0.05)	5.84	3.12	1.83

of 100% RDF (50% P and K as basal, remaining N, P and K as WSF) + LBF (T_{10}) and subsurface drip fertigation of 100% RDF as WSF (WSF – Urea, 13: 40: 13, KNO_3) + LBF (T_9) were comparable and recorded the highest pseudostem height at various growth stages of banana. The yield parameters of banana like number of hands and number of fingers per bunch and bunch weight were significantly higher in subsurface drip fertigation of 100% RDF as WSF (WSF – Urea, 13: 40: 13, KNO_3) + LBF (T_9). Similarly, other fertigation treatments (T_3, T_4, T_8 and T_{10}) also increased the yield attributes as compared to surface irrigation with soil application of recommended dose of fertilizers (T_1). Finger characters of banana were significantly influenced by the fertigation levels. Finger length, fresh finger weight and finger circumference were higher in subsurface drip fertigation of 100% RDF as WSF (WSF – Urea, 13: 40: 13, KNO_3) + LBF (T_9) and subsurface drip fertigation of 100% RDF as WSF (WSF – Urea, 13: 40: 13, KNO_3) (T_3). Improved fruit development contribute to increased hands/bunch fingers/hand and bunch weight, successful utilization of water for irrigation due to micro-leaching effect in the wetted volume.

Conflict of Interests

The author(s) have not declared any conflict of Interests.

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