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Effect of Rate and Frequency of Micronutrient Application on Soil Chemical Properties for Production of Banana under Drip Irrigation

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The two year field experiment "effect of rate and frequency of micronutrient application on production of banana under drip irrigation" was carried out using banana as a test crop and as ratoon crop at Soil and Water Management Research Unit, NAU, Navsari. Present experiment was conducted at fixed site, for plant crop a set of 8 treatments were tried and subsequently the same set of treatments were super imposed on ratoon crop. The different rate of multi-micronutrients mixture, grade-V(M_1= 25 gm/plant, M_2= 50 gm/plant, M_3= 75 gm/plant) and the frequency of application (S_1= Basal and S_2= 50 per cent each as basal and 50 per cent two month after planting) was used in different treatments in present investigation. Total eight treatments like 60% RD of N &

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K and 100% RD of P (PFDC) (T_1), PFDC+M_1S_1(T_2), PFDC+M_1S_2(T_3),PFDC+M_2S_1(T_4), PFDC+M_2S_2(T_5),PFDC+M_3S_1(T_6), PFDC+M_3S_2(T_7) and 100% RDF only (T_8) for plant as well as ratoon banana crops were tested using randomized block design with four replications. The application of micronutrient under treatment T_7 {micronutrient application @ 75 g/plant applied as 50% basal + 50 % after 2 month planting (M3S2) along with PFDC practices} gave significantly highest DTPA-Fe, Mn, Zn and Cu content in soil during different periodical soil analysis at 3, 6 and 9 (MAP) and at harvest of banana crop in both the years 2012-13 (plant) and 2013-14 (ratoon) compared to control and it was at par with T_6. The application of micronutrient gave the non-significant effect on soil pH. The treatment T_7 showed significant effect on soil EC (dS m^{-1}). Whereas, highest available N, P_2O_5 and K_2O content significantly increased in 100% RDF treatments compared to other treatments at 3, 6, 9 MAP of the plant banana as well as at 3, 6 and 9 MAR (month after ratooning). The treatment T_6, T_7 and T_8 were found more remunerative than the remaining treatments as these treatments recorded higher BCR values of 1:2.20, 1:2.34 and 1:2.19, respectively.

Keywords: Banana; PFDC; multi-Micronutrients mixture; ratoon and RDF.

1. INTRODUCTION

Banana (*Musa paradisiaca L*.), which belongs to the family Musaceae in the order Scitamineae, have been associated with the mankind for centuries and is considered as one of the most important fruit crops of the world. It is also known as “Apple of Paradise”. About 24 bananas each weighing around 100 gm would provide the energy requirement (2400 calories per day) of a sedentary man [1]. In India banana is fourth important food crop in terms of gross value exceeded only after paddy, wheat and milk products. In India, banana ranks first in production and third in area among other fruit crops. It accounts for 13 per cent of the total area and 33 per cent of the production of fruits. India leads the world in banana production with an annual output of about 14.2 million tones [2]. In India, Madhya Pradesh, Tamil Nadu, Maharashtra, Kerala, Gujarat and Karnataka are the leading banana producing states. In term of area and production of banana in India are 7.76 lakh hectares and 265.09 lakh tonnes, respectively [3]. The micronutrients like Fe, Zn, Mn, Cu and B are not only essential but they are equally important like other macro nutrients, in spite of their requirement in micro quantities. Micronutrients are key elements in plants growth and development. The multi micronutrients fertilizers mixture grades prepared on the basis of micronutrients deficiency status of Gujarat soils proved beneficial in increasing yield of different crops under varied agro-climatic conditions and different types of soils. Among the different micronutrient grades, the multi micronutrients mixture (grade-V) having Fe 2, Mn 0.5, Zn 5, Cu 0.2 and B 0.5 per cent is recommended for soil application @ 20 kg ha^{-1} . Improvement of micronutrient in food parts will help to correct malnutrition problems of Fe and Zn in human beings [4]. Application of nutrients through drip irrigation system can increase the fertilizer use efficiency, allows flexibility in timing of fertilizer application, minimizes leaching losses by excessive irrigation and rain and reduces the labor requirements for fertilizer application [5].

2. MATERIALS AND METHODS

Geographically, Navsari is located at 20^0 57’ N latitude and 72^0 54’ E longitudes at an altitude of 10 m above the mean sea level. According to agro-climatic zonalization, Navsari falls in agro-ecological situation III of South Gujarat heavy rainfall agroclimatic zone-I, which is typically characterized by humid and warm monsoon with heavy rainfall (average 1495 mm), moderately cold winter and fairly hot and humid summer. The field experiment was carried out using banana as a test crop during 2012-2013 (plant) and 2013-2014 (ratoon) at Soil and Water Management Research Unit, NAU, Navsari. According to the Seventh Approximation, the soils of the experimental field is classified under the order ‘*Inceptisols*’ comprising members of fine, montmorillonitic, isohyperthermic family of *Vertic Ustochrepts* and soil series Jalalpore. These soils are mainly derived from basalt, augite, granite, gneiss and lime stone. The soil develops deep cracks and become extremely hard when dry, while plastic and sticky when wet. The average thickness of solum ranges from 2.5 to 3.0 m. The rooting depth is extended up to 1.0 m. The colour of dry soil is dark brown and texture is clay.

For experiment study was conducted at fixed site, a set of 8 treatments were tried and

subsequently the same set of treatments were super imposed on ratoon crop. The different rate of micronutrient (M_1= 25 gm/plant, M_2= 50 gm/plant, M3= 75 gm/plant) and the frequency of application (S_1= Basal and S_2= 50 per cent each as basal and 2 month after planting) was used in different treatments for plant as well as ratoon crops were tested using randomized block design with four replications. The two sets of treatments were tested in sequential manner at fixed site. The details of experimental materials used, methods followed and the techniques adopted are described as under in treatment details:-

Treatments details

T1 = Control (PFDC)
T2 =T1 + M1S1 (T1+25 gm/plant micronutrient with basal)
T3 =T1 + M1S2 (T1+50 gm/plant with 50 % each as basal and 2 MAP)
T4 =T1 + M2S1 (T1+50 gm/plant with basal)
T5 =T1 + M2S2 (T1+50 gm/plant with 50 % each as basal and 2 MAP)
T6 =T1 + M3S1 (T1+75 gm/plant with Basal)
T7 =T1 + M3S2 (T1+75 gm/plant 50 % each as basal and 2 MAP)
T8 = Only RDF

Recommended dose of fertilizers (RDF) is 300: 90: 200 NPK g/plant, fertilizers were applied according to treatments in plant crop and in ratoon banana crop [6]. The micronutrient status of experimental plot was in deficient in nature. PFDC (Precision Farming Development Centre) packages mean is a practice in which 60% nitrogen, 100% phosphorus and 60% potassium of recommend dose of fertilizer (RDF) is applied in banana crop. In this practice 20 % N and K of total amount was applies as basal and 20% N and K was applied after two month of planting as split application as soil application. Remaining 60 % amount of N and K was applied through the drip application at periodical interval of 15 days. P was applied as 50% basal and 50 % 2 MAP. In case of 100% RDF (T_8), the 40% N and K was applied as basal and 40% at 2MAP as soil application and remaining amount was applied through drip application. Weed management was done by hand weeding or by rotary power tiller at regular intervals.

For micronutriment application Grade V fertilizer (Fe-2.0, Mn-0.5, Zn- 5.0, Cu- 0.2 and B- 0.5 per cent) were used. The standard method of analysis of variance technique appropriate to the Randomized Block Design (RBD) with Factorial concept as described by Panse and Sukhatme (1967) was used. The Collected soil samples were dried and grind in stainless steel jar grinder and sieved through 0.2 mm sieve and used for estimation. The soil samples were analyzed by using standard methods.

Table 1. Applied quantity for routinely used fertilizer treatments in banana

Fertilizer quantity	N	P	K
RDF of Banana g/plant	300	90	200
PDFC practices	180	90	120
Per cent content of routinely used fertilizer			
Urea	46	0	0
Diammonium phosphate (DAP)	18	46	0
Muriate of Potash (MOP)	0	0	60
Requirement of fertilizers in g/plant			
Urea	652	0	0
Diammonium phosphate (DAP)	0	150	0
Muriate of Potash (MOP)	0	0	333

Table 2. Physical and chemical properties of the experimental plot

Parameters	(Soil depth 0-22.5cm)
A. Physical parameters	
1. Sand (%)	12.75
2. Silt (%)	22.58
3. Clay (%)	59.23
4. Textural class	Clayey
B. Chemical Properties	
5. Organic carbon (%)	0.52
6. Available N (kg ha^{-1})	265.00

Parameters	(Soil depth 0-22.5cm)
7. Available P_2O_5 (kg ha^{-1})	44.38
8. Available K_2O (kg ha^{-1})	452.00
9. Soil pH (1:2.5)	8.12
10. $EC_{1:2.5}$ (dS m^{-1})	0.23
11. Micronutrients	
DTPA-extractable-Fe (mg kg^{-1})	7.30
DTPA-extractable-Mn (mg kg^{-1})	14.50
DTPA-extractable-Zn (mg kg^{-1})	0.72
DTPA-extractable –Cu (mg kg^{-1})	3.42

Table 3. Methods used for soil analysis

Sr.No.	Determination	Method employed
1.	pH (1:2.5)	Potentiometry [7]
2.	EC (1:2.5)	Conductometry [7]
3.	Available N (kg ha^{-1})	Alkaline permanganate oxidation method
4.	Available P_2O_5 (kg ha^{-1})	Spectrometric method
5.	Available K_2O (kg ha^{-1})	Flame photometric method
6.	Micronutrients (mg kg^{-1})	Atomic Absorption Spectrophotometry)

3. RESULTS AND DISCUSSION

Micronutrients are required by plant in very small quantities, yet they are very effective in regulating plant growth as they form plant enzyme system and thus regulate plant life, micronutrients like Fe, Mn, Zn and Cu having the minor role to governing the productivity of banana. In order to judge the impact of different treatments on periodical fertility status of soil, treatment wise soil samples were taken at 3MAP, 6 MAP, 9MAP and at harvest in plant banana and for ratoon banana soil samples were taken at 3MAR, 6 MAR, 9MAR and at harvest. These samples were analyzed for available N, P_2O_5 and K_2O as well as DTPA extractable Fe, Mn, Zn and Cu. Similarly the collected soil samples were also analyzed for EC and pH in addition to the fertility parameters.

DTPA-extractable micronutrients in plant banana and ratoon banana:-

The data on DTPA- extractable micronutrients (mg kg^{-1}) at different stages and at harvest of plant banana as well as ratoon banana influenced by different treatments of rate and frequency of micronutrient application through drip irrigation are given in Table 4 to Table 7.

The results revealed that the application of micronutrient @ 75 g/plant as 50% basal + 50 % after 2 month planting of 75 g/plant (M_3S_2+ treatment T_1 (T_7) gave significantly highest DTPA-Fe status in soil at 3MAP, 6MAP, 9 MAP and at harvest of plant banana (12.63, 17.92, 10.44 and 7.43 mg kg^{-1}), respectively. This was at par with treatment T_6 at 9 MAP and at harvest. While in ratoon banana, the results revealed that the treatment T_6 gave significantly highest DTPA-Fe status in soil at 3MAR, 6MAR, 9 MAR and at harvest of plant banana (12.18 14.92, 9.32 and 6.57 mg kg^{-1} respectively). This was at par with treatment T_7 in all cases of ratoon.

The treatment T_7 gave significantly highest DTPA-Mn status in soil at 3MAP, 6MAP, 9 MAP and at harvest of plant banana (15.87, 20.37, 13.90 and 11.52 mg kg^{-1}), respectively. This was at par with treatment T_6 at 3MAP. In all cases the lowest DTPA- Mn status (9.44, 12.52, 8.56 and 7.36 mg kg^{-1}) respectively, in soil was recorded under treatment T_1 (control). The treatment T_6 gave significantly highest DTPA-Mn status in soil at 3MAR, 6MAR, 9 MAR and at harvest of ratoon banana (14.89 17.23, 12.29 and 10.14 mg kg^{-1} respectively). This was at par with treatment T_7 at 3MAR and 6MAR of ratoon. However, the lowest DTPA- Mn status in soil was recorded under treatment T_1 (control).

The significantly highest DTPA-Zn status in soil at 3MAP, 6MAP, 9 MAP and at harvest of plant banana was recorded in treatment T_7 (1.20, 1.33, 1.07 and 0.92 mg kg^{-1}), respectively. However this treatment was at par with T_6 treatment (T_1 +M_3S_1) at 6 MAP, 9 MAP and after harvest of banana. While treatment T_6 gave significantly highest DTPA-Zn status in soil at 3MAR, 6MAR, 9 MAR and at harvest of ratoon banana (1.08, 1.12, 0.94 and 0.81 mg kg^{-1} respectively). This was at par with treatment T_7 and T_5 in all cases

of ratoon. However, the lowest DTPA- Fe status in soil was recorded under treatment T_1 in both cases.

The results revealed that the significantly highest DTPA-Cu status in soil at 3MAP, 6MAP, 9 MAP and at harvest of plant banana was recorded in treatment T_7 (4.06, 5.11, 4.04 and 3.26 mg kg^{-1}), respectively. However this treatment was at par with T_6 at 3MAP and with T_5 and T_6 treatment at 9 MAP. The treatment T_7 also gave the significantly highest DTPA-Cu status in soil at 3MAR, 6MAR, 9 MAR and at harvest of ratoon banana (3.90, 4.29, 3.58 and 2.86 mg kg^{-1} respectively). This was at par with treatment T_6 at 9MAR and after harvest of ratoon. In all cases the lowest DTPA- Cu status (2.59, 3.26, 2.42 and 2.08 mg kg^{-1}) respectively, in soil was recorded under treatment T_1 in both cases.

In general, the DTPA-extractable Fe, Mn, Zn and Cu status in soil were found highest in plot treated with T_7 (T_1 +M_3S_2) treatment in both the years as compare to control. This treatment was at par with T_6 (T_1 +M_3S_1). This may be due to higher dose of micronutrient application in these treatments as compared to other treatments. The same findings were also reported by Ghanta and Mitra [8] in banana, Durgadevi et al. [9] in citrus, Lal et al. [10] in guava, Aggrawal et al. [11] in grape and Afria et al. [12] in pomegranate. Kannan et al. [13] also reported that accumulation of Fe, Zn, Mn and Cu was significantly increased in soil due to micronutrient addition [14].

Table 4. Effect of different treatments on periodical DTPA-Fe status (mg kg^{-1}) in soil during plant banana and ratoon banana

Treatments	Plant crop				Ratoon crop			
	Months after planting			At harvest	Months after planting			At harvest
	3	6	9		3	6	9	
T_1	8.06	10.37	6.44	4.41	7.81	8.84	5.67	3.88
T_2	8.97	11.28	7.18	4.92	8.55	9.85	6.31	4.33
T_3	9.39	11.71	7.50	5.14	9.14	10.31	6.60	4.52
T_4	10.17	12.75	8.12	5.57	9.93	11.16	7.15	4.90
T_5	11.27	14.56	9.01	6.17	10.96	12.37	7.93	5.43
T_6	11.72	14.99	10.17	7.10	12.18	14.92	9.32	6.57
T_7	12.63	17.92	10.44	7.43	11.89	13.85	9.05	6.27
T_8	9.10	11.37	7.27	4.98	8.89	9.99	6.33	4.38
S.Em. ±	0.18	0.53	0.30	0.30	0.23	0.60	0.26	0.26
C.D. at 5 %	0.54	1.56	0.89	0.88	0.68	1.76	0.77	0.78
C.V. %	3.58	8.10	7.28	10.53	4.66	10.52	7.19	10.48

Table 5. Effect of different treatments on periodical DTPA-Mn status (mg kg^{-1}) in soil during plant banana and ratoon banana

Treatments	Plant crop				Ratoon crop			
	Months after planting			At harvest	Months after planting			At harvest
	3	6	9		3	6	9	
T_1	9.44	12.52	8.56	7.36	9.06	10.52	7.53	6.47
T_2	10.52	13.96	9.54	8.20	10.10	11.73	8.39	7.22
T_3	10.99	14.59	9.97	8.57	10.55	12.25	8.77	7.54
T_4	11.91	16.55	11.30	9.28	11.43	14.03	10.00	8.17
T_5	13.20	18.27	12.47	10.29	12.67	15.47	11.03	9.06
T_6	14.67	18.97	12.95	10.70	14.89	17.23	12.29	10.14
T_7	15.87	20.37	13.90	11.52	14.53	16.05	11.45	9.42
T_8	10.66	14.89	10.18	8.31	10.23	12.63	9.00	7.31
S.Em. ±	0.45	0.47	0.30	0.08	0.47	0.43	0.27	0.07
C.D. at 5 %	1.31	1.38	0.90	0.23	1.39	1.25	0.79	0.22
C.V. %	7.32	5.78	5.49	1.67	8.09	6.20	5.47	1.80

Table 6. Effect of different treatments on periodical DTPA-Zn status (mg kg^{-1}) in soil during plant banana and ratoon banana

Treatments	Plant crop				Ratoon crop			
	Months after planting			At harvest	Months after planting			At harvest
	3	6	9		3	6	9	
T_1	0.71	0.85	0.68	0.59	0.68	0.71	0.60	0.52
T_2	0.79	0.95	0.76	0.65	0.76	0.80	0.67	0.58
T_3	0.83	0.99	0.80	0.68	0.80	0.83	0.70	0.60
T_4	0.90	1.07	0.86	0.74	0.86	0.90	0.76	0.65
T_5	1.01	1.19	0.96	0.82	0.96	1.00	0.84	0.72
T_6	1.04	1.24	0.99	0.85	1.08	1.12	0.94	0.81
T_7	1.20	1.33	1.07	0.92	1.07	1.04	0.90	0.75
T_8	0.80	0.96	0.77	0.66	0.77	0.81	0.68	0.58
S.Em. ±	0.04	0.05	0.03	0.03	0.04	0.04	0.03	0.03
C.D. at 5 %	0.11	0.14	0.08	0.08	0.12	0.12	0.09	0.09
C.V. %	7.94	9.16	6.38	7.20	9.19	9.22	8.25	8.97

Table 7. Effect of different treatments on periodical DTPA-Cu status (mg kg^{-1}) in soil during plant banana and ratoon banana

Plant crop					Ratoon crop			
Treatments	Months after planting			At harvest	Months after planting			At harvest
	3	6	9		3	6	9	
T_1	2.59	3.26	2.42	2.08	2.49	2.74	2.13	1.83
T_2	2.89	3.64	2.69	2.32	2.77	3.05	2.39	2.04
T_3	3.02	3.8	2.82	2.42	2.9	3.19	2.48	2.13
T_4	3.27	4.12	3.30	2.62	3.14	3.46	2.93	2.31
T_5	3.63	4.56	3.63	2.91	3.42	3.73	3.23	2.56
T_6	3.77	4.74	3.77	3.02	3.62	3.99	3.34	2.66
T_7	4.06	5.11	4.04	3.26	3.90	4.29	3.58	2.86
T_8	2.93	3.68	2.98	2.35	2.81	3.09	2.65	2.07
S.Em. ±	0.10	0.11	0.15	0.06	0.07	0.08	0.14	0.08
C.D. at 5 %	0.30	0.33	0.45	0.18	0.20	0.24	0.41	0.24
C.V. %	6.17	5.42	9.52	4.78	4.35	4.67	9.71	7.11

In both the years, the micronutrients status in soil at 6 MAP was more as compared to 3MAP in all the treatments. This may be due to release of micronutrients by mineralization of FYM and green manure in first year. Then the available micronutrients status in the soil decreased at 9MAP and after harvest, which may be due to uptake of micronutrients by plant or may be loss due to leaching.

Macro nutrients status (kg ha^{-1}) in Plant banana and ratoon banana:-

The data pertaining on available N, available K_2O and available P_2O_5 (kg ha^{-1}) in soil at various sampling stages (3MAP, 6MAP, 9MAP and after harvest) of plant and ratoon banana was significantly influenced due to different treatments are given in Table 8 to 10.

The results revealed that application of 100 per cent RDF gave significantly the highest available N status (274.38, 360.00, 397.92 and 227.43 kg ha^{-1}) at 3MAP, 6MAP, 9MAP and after harvest respectively, but it was also at par with control condition (T_1) in all cases and also at par with treatment T_5 to T_7 at 6MAP. However, the lowest available N status (226.97, 312.55, 331.61 and 191.13 kg ha^{-1}) in soil at various sampling stages respectively was recorded in treatment T_2. Similar trend was found in ratoon banana.

The available P_2O_5 status in soil, the application of 100 per cent RDF gave significantly the highest available P_2O_5 status (49.52, 68.71, 55.28 and 36.63 kg ha^{-1}) at 3MAP, 6MAP, 9MAP and after harvest respectively, but it was also at par with control condition (T_1) in all cases and also at par with treatment T_6 and T_7 at 9MAP and

T_6 at 6MAP. The application of 100 per cent RDF gave significantly the highest available P_2O_5 status (44.35, 52.26 and 28.59 kg ha^{-1}) at 3MAR, 9MAR and after harvest respectively, but it was also at par with control condition (T_1) in all cases and also at par with treatment T_6 and T_7 at 9MAR and after harvest.

With respect to periodical available K_2O status of soil, the treatment T_8 (100% RDF only) was found to be significant higher value of available K_2O status (372.50, 404.59, 492.31 and 428.38 kg ha^{-1}) at 3MAP, 6MAP, 9MAP and after harvest respectively, but it was also at par with control condition (T_1) in all cases except 9 MAP and also at par with treatment T_7 at 3MAP. However, the lowest available K_2O status in soil was found at 3MAP, 6 MAP, 9MAP and at harvest of plant banana (316.14, 323.40, 410.97 and 338.75 kg ha^{-1}) respectively in treatment T_2. The treatment T_8 (100% RDF only) was found to be significant highest value of available K_2O status (381.09, 353 and 388.48 kg ha^{-1}) at 3MAP, 6MAP and after harvest respectively, but it was also at par with control condition (T_1) in all cases except 9MAP and also at par with treatment T_7 at 3MAP. However, the lowest available K_2O status (302.93, 308.77, 365.95 and 328.09 kg ha^{-1}) in soil at 3MAP, 6 MAP, 9MAP and at harvest of plant banana respectively in treatment T_2.

The periodical soil sampling and analysis showed significantly highest available the N, P_2O_5 and K_2O (kg ha^{-1}) under T_8 (100% RDF) treatment in all the cases *viz.* 3MAP, 6MAP, 9MAP and after harvesting in both plant and ratoon. This may be due to higher N and K nutrient application in this treatment as compared to other treatments. The macronutrients status in soil at 6MAP was more as compared to 3 MAP in all the treatments. This may be due to decomposition of green manures and FYM as well as split application of N and K fertilizer. Whereas, it was found that macronutrients status was decreased at 9MAP and after harvest. It may be due to increased physiological processes of the leaves which in turn lead to repaid absorption and utilization of nutrients for primary metabolic processes. The same findings were also reported by Ghanta and Mitra [8] in banana, Durgadevi et al. [9] in citrus, Lal et al*.* [10] in guava, Aggrawal et al*.* [11] in grape and Afria et al. [12] in pomegranate.

Soil pH and soil EC:-

The results revealed that application of different treatments gave the non-significant effect on soil pH at 3, 6, 9 month after planting (MAP) and after harvesting of banana crop. In term of EC, the results revealed that in treatment T_7 gave significantly the highest EC (0.98 0.94, 0.81 and 0.55 dSm^{-1}) at 3, 6, 9 month after planting (MAP) and after harvesting of banana plant respectively.

The results also revealed that application of different treatments gave the non-significant effect on soil pH after 3, 6, 9 month after ratooning (MAR) and after harvesting of banana crop. In term of EC, the results revealed that in treatment T_7 gave significantly the highest EC (0.93, 0.84, 0.66 and 0.48 dSm^{-1}) at 3, 6, 9 month after ratooning (MAR) and after harvesting of banana plant respectively.

Table 8. Effect of different treatments on periodical available N (kg ha^{-1}) in soil during plant banana and ratoon banana

Treatments	Plant crop				Ratoon crop			
	Months after planting			At harvest	Months after planting			At harvest
	3	6	9		3	6	9	
T_1	264.22	354.86	396.75	214.74	253.34	297.14	349.83	189.56
T_2	226.97	312.55	331.61	191.13	215.98	248.51	304.22	175.42
T_3	230.49	313.40	342.17	183.43	218.81	249.06	314.01	168.67
T_4	241.01	322.04	348.14	192.68	221.53	255.01	326.33	181.67
T_5	245.21	337.86	354.39	196.19	235.53	280.19	304.61	177.82
T_6	247.06	346.87	359.62	205.93	239.62	285.43	340.12	177.34
T_7	247.29	355.62	367.65	223.30	241.43	283.54	341.40	179.51
T_8	274.38	360.00	397.92	227.43	269.46	309.64	365.69	207.42
S.Em. ±	9.20	11.56	12.68	7.58	9.27	13.43	12.99	7.40
C.D. at 5 %	27.06	34.00	37.31	22.30	27.26	39.51	38.22	21.75
C.V. %	7.43	6.84	7.00	7.42	7.82	9.73	7.85	8.12

Table 9. Effect of different treatments on periodical available P_2O_5 (kg ha^{-1}) in soil during plant banana and ratoon banana

Treatments	Plant crop				Ratoon crop			
	Months after planting			At harvest	Months after planting			At harvest
	3	6	9		3	6	9	
T_1	47.79	66.38	53.03	32.59	41.4	55.06	50.61	27.94
T_2	42.74	53.38	41.12	28.30	36.63	50.57	43.62	24.46
T_3	41.16	56.65	49.14	28.61	37.4	50.96	44.67	25.22
T_4	42.85	55.56	49.99	29.52	39.11	52.12	45.01	25.98
T_5	43.41	57.66	50.17	29.62	41.06	52.76	47.08	26.08
T_6	44.13	61.27	50.62	29.72	43.12	55.42	49.84	26.60
T_7	44.54	61.01	50.92	29.96	40.13	50.58	47.41	24.55
T_8	49.52	68.71	55.28	36.63	44.35	57.83	52.26	28.59
S.Em. ±	1.67	2.61	2.01	1.58	1.54	1.92	1.71	0.70
C.D. at 5 %	4.91	7.69	5.10	4.65	4.53	NS	4.85	1.98
C.V. %	7.49	8.69	8.81	10.32	7.61	7.21	7.17	6.15

Table 10. Effect of different treatments on periodical available K_2O (kg ha^{-1}) in soil during plant banana and ratoon banana

Treatments	Plant crop				Ratoon crop			
	Months after planting			At harvest	Months after planting			At harvest
	3	6	9		3	6	9	
T_1	360.82	390.66	441.42	410.33	345.1	343.71	390.79	367.56
T_2	316.14	323.40	410.97	338.75	302.93	308.77	365.95	328.09
T_3	321.99	329.59	412.14	346.25	309.51	309.80	366.68	332.84
T_4	324.42	345.63	418.17	352.50	329.25	317.98	376.40	340.88
T_5	322.67	354.09	424.41	376.25	340.42	320.71	382.32	344.06
T_6	333.63	353.99	428.11	383.75	341.23	309.65	379.61	342.24
T_7	350.09	358.25	429.03	386.24	352.85	317.38	385.59	349.82
T_8	372.5	404.59	492.31	428.38	381.09	353.00	430.65	388.48
S.Em. ±	12.86	15.57	16.46	14.12	12.46	10.49	12.28	12.26
C.D. at 5 %	37.83	45.80	48.41	41.54	36.65	30.86	36.14	36.06
C.V. %	7.61	8.71	7.62	7.48	7.41	6.5	6.39	7.02

Table 11. Effect of different treatments on periodical pH of soil during plant banana and ratoon banana

Treatments	Plant crop				Ratoon crop			
	Months after planting			At harvest	Months after planting			At harvest
	3	6	9		3	6	9	
T_1	7.62	8.05	7.90	8.24	7.47	7.66	8.33	8.05
T_2	7.73	8.03	7.89	8.21	7.58	7.58	8.32	8.04
T_3	7.67	7.98	7.82	8.14	7.52	7.50	8.25	7.97
T_4	7.65	7.96	7.81	8.12	7.50	7.49	8.23	7.96
T_5	7.67	7.88	7.73	8.04	7.98	7.41	8.15	7.87
T_6	7.56	7.87	7.72	8.03	7.86	7.38	8.12	7.85
T_7	7.59	7.85	7.70	8.15	7.89	7.59	8.14	7.98
T_8	7.71	8.02	7.87	8.18	8.02	7.54	8.30	8.02
S.Em. ±	0.05	0.07	0.05	0.05	0.14	0.08	0.05	0.05
C.D. at 5 %	NS	NS	NS	NS	NS	NS	NS	NS
C.V. %	1.4	1.82	1.23	1.29	3.62	2.21	1.26	1.30

Table 12. Effect of different treatments on periodical EC of soil during plant banana and ratoon banana

Plant crop					Ratoon crop			
Treatments	Months after planting			At harvest	Months after planting			At harvest
	3	6	9		3	6	9	
T_1	0.74	0.64	0.52	0.35	0.71	0.57	0.42	0.31
T_2	0.84	0.71	0.57	0.39	0.81	0.63	0.47	0.35
T_3	0.88	0.74	0.60	0.41	0.84	0.66	0.49	0.36
T_4	0.88	0.80	0.65	0.45	0.84	0.71	0.53	0.39
T_5	0.92	0.82	0.72	0.49	0.88	0.73	0.59	0.43
T_6	0.96	0.84	0.75	0.51	0.92	0.75	0.61	0.45
T_7	0.98	0.94	0.81	0.55	0.93	0.84	0.66	0.48
T_8	0.93	0.72	0.58	0.40	0.89	0.64	0.48	0.35
S.Em. ±	0.04	0.02	0.02	0.02	0.02	0.02	0.02	0.01
C.D. at 5 %	0.11	0.07	0.05	0.05	0.06	0.07	0.06	0.04
C.V. %	8.56	6.05	5.72	7.41	4.82	6.72	7.98	9.43

4. CONCLUSION

Based on the trends of yield, nutrient removal and soil fertility observed in the present study, it is concluded that for getting viable yield of banana, the application of miLcronutrient in treatment T_7 @75 g/plant as 50% basal + 50 % 2 month after planting (M_3S_2) gave maximum net realization (₹ 5,69967) followed by treatment T_6 (T_1+ M_3S_1) and Treatment T_8 (100% RDF only). The treatment T_6, T_7 and T_8 were found more remunerative than the remaining treatments as these treatments recorded higher BCR values of 1:2.20, 1:2.34 and 1:2.19, respectively. For obtaining higher banana yield and net realization along with improvement in micronutrient status of the soil under plant - ratoon banana sequence, application of treatment T_6 (T_1+ M_3S_1) and T_7 (T_1+ M_3S_2) receiving 60% RD of N and 60% RD of K and 100% RD of P (PFDC) along with micronutrient application through @ 75 g plant^{-1} can be beneficial for production of banana under drip irrigation system.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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