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REGULAR ARTICLE

EFFECT OF ORGANIC MANURES, INORGANIC FERTILIZERS AND BIOFERTILIZERS ON THE NUTRIENT CONCENTRATION IN LEAVES AT DIFFERENT GROWTH STAGES OF BANANA CV POOVAN

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SUMMARY

Banana (*Musa* spp) and plantain are known for their antiquity and are interwoven with Indian heritage and culture and it is one of the most important fruits grown and consumed worldwide. A field experiment was laid out in randamised block design with ten treatments and three replications consisting recommend dose of fertilizers (RDF) and RDF combined with organic manures (Farm yard manure, Vermicompost and Neem cake) and bioferlizers (VAM, *azospirillum*, PSB, *T. harizianum*) at different combinations to know their nutrient concentration in banana leaves and soil at different growth periods viz., vegetative stage, flowering stage and harvesting stage. Sample preparation was performed with closed vassal microwave digestion. The major and micronutrients were analysed using the ICP-OES (Optima 2000). E-Merck multi-elemental standard used as a reference standard and ultra pure 2% HNO_3 was applied as an internal standard. T8 treatment (50 percent RDF through inorganic fertilizers, organic manures with bio ferlizers) recorded significantly highest leaf nitrogen and potassium (3.24 and 0.44%) during vegetative stage, flowering (3.58%) and harvesting stages(2.68 %) than untreated plants T1 (2.02,2.12 and 1.51%). Highest Leaf phosphorus (0.42,0.43 and 0.38 %), sodium (0.40, 0.44 and 0.32) magnesium (1.61.1.81, and 0.81 %). Significantly lowest concentration was found in untreated plants. The highest micro nutrients were noted in T8 followed by T10 treatment in all the stages.

Keywords: Banana, Organic Manures, Nitrogen, Vermicompost.

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1. Introduction

India stands first in both area and production of the crop with a share of 19.71 per cent of the global production (16). But, India is placed second with regard to the productivity (34.0 t/ha) of the crop behind Costa Rica whose mean productivity is 52.5 t/ha. Banana being a great lover of applied nutrients requires enormous amount of essential plant nutrients for its vigorous growth and much higher yield and biomass production. Poovan is the popular

variety grown commercially in different regions due to its wider adaptability and high degree of tolerance to drought in a perennial cropping system and is the leading commercial cultivar of Tamilnadu. It bears heavy bunches weighing 20-24 kg each with closely packed short and stout fruits having a conspicuous beak (4). The present study was initiated to determine the elemental levels in leaves at different maturity stages. Banana being an exhaustive crop, the proper manuring and fertilizer application has to be resorted for obtaining highest yields. However, these fertilizers are energy intensive, costly and moreover, continuous use of chemical fertilizers affects the soil health, by reducing the organic matter content and beneficial soil microorganisms. Use of biofertilizers for crop production is gaining momentum as they are environmentally safe when compared to chemical fertilizers. The availability and uptake of inorganic nutrients by plants influenced by microorganisms that are involved in the uptake of essential plant nutrients (17).

2. Materials and Methods

The present investigation was carried out in farmer's field, Thanjavur district, Tamil Nadu during 2006-2008 with Banana (Musa AAB) cv. Poovan. The different treatment manipulated as follows : T1-100 percent RDF through inorganic fertilizers – control,T2-100 percent RDF through inorganic fertilizers +Biofertilizers,T3-75 Percent RDF through inorganic fertilizers +25 kg FYM +Biofertilizers, T4-75 Percent RDF through inorganic fertilizers+ 6 kg vermicompost +Biofertilizers, T5-75 Percent RDF through inorganic + 1.5 kg Neem cake fertilizers +Biofertilizers, T6-50 Percent RDF through inorganic fertilizers +25 kg FYM +3 Kg vermicompost + Biofertilizers,T7- 50 Percent RDF through inorganic fertilizers + 25 kg FYM +1.5 kg Neem cake +Biofertilizers, T8-50 percent RDF through inorganic fertilizers +15.2 kg FYM + 3kg vermicompost +1.0 kg Neem cake + Biofertilizers, T9- 25 Percent RDF through inorganic fertilizers +25 kg FYM +3 kg vermi compost +1.5 kg Neem cake + Biofertilizers and T10- 100 percent RDF through organic fertilizers +Bio fertilizers. The treatments were arranged in a randomized block design with ten treatments in three replications. Plants were spaced at 1.8m apart in each direction. Under each treatment, there were ten plants, out of which four plants were used for recording biometric observations till harvest and the rest were nutrient uptake studies. Guard rows were provided both lengthwise and breathe wise between the plots Fertilizer schedule was followed using Urea (110g N plant^{-1}), single super phosphate (30g P_2O_5 plant^{-1}) and moriate of potash (110g K_2O plant^{-1}). Recommended dose of organics and inorganics from 25% to 100 percent were measured and applied in 3 splits at the time of 3rd, 5th and 7th month according to the treatment. Biofertilizers as VAM, *Azospiriluum*, Phosphate solublizing bacteria and *Tichaderma hazrianum* was applied in two split doses at basal and 120 days after planting. The elemental analysis was performed with optima 2000 ICP-OES (Perkin Elmer Lab India Switzerland). The mineral content were analyzed using ICP-OES (Inductively Coupled Plasma Optical Emission Spectrometer) made by Per kin Elmer instruments, Switzerland (Optima2000)(5,7). The analysis was done using WINLAB 32 software, package and MS Excel 2000.

3. Results and Discussion

The minimum, maximum mineral contents were recorded and presented from table 1 to 4. In the present study indicated that, the leaf nitrogen content gets significantly changed

among the treatments at different growth stages. At vegetative stage, Available N content was highest in the treatment T8 (368.5 kg ha-1) followed by T10 (354.6 kg ha -1). At flowering and harvesting stages T8 recorded maximum (458.1 kg ha -1 and (256.2 kg ha^{-1})) followed by T10 (457.0 and 205.0 kg ha^{-1}), while the lowest value recorded in T1 (320.1, 410.4 and 190.40 kg ha^{-1}) . The leaf nitrogen content was increased at early development stages 5th MAP and 7th MAP. During the shooting and harvesting stages the leaf nitrogen content was reduced due to the movement of nutrients to shooting and fruit development. This is in accordance with the findings of (8, 10, 14) in banana.

In present study, The highest available soil P content values were recorded in T8 (43.32 kg ha^{-1}) followed by T10 (40.00 kg ha^{-1}) while the lowest value was recorded in T1 (33.80 kg ha^{-1}). At flowering and harvest stages, T8 and T10 (28.75 and 24.93 kg ha_{-1} respectively) while the lowest value recorded in T1 (24.89 and 21.00 kg ha^{-1}). Phosphorus content in the leaf was positively increased with organics and bio-inoculants application. The leaf phosphorus also follows the same tread as in nitrogen. The highest phosphorus content was recorded in treatment T8. The increase in phosphorus content was due to the fact that increased levels of phosphorus application and also supplemented with bio-inoculants. This might be due to enhanced phosphorus activities that mobilize sparingly the available nutrient sources and ectozymes resulting in improved phosphate uptake (9).

The mechanism involved in solubilizing phosphorus was due to acid production and enzyme activity viz., dehydrogenase activity, phosphate activity and urenase activity. Thus, due to transport of solublized phosphorus through hyphae to the roots there was an efficient increase in phosphorus uptake (1) resulting in high leaf phosphorus content. In the present study, AM fungi also play a major role in increasing the phosphorus content in leaf. The increased nutrient content in the mycorrhizal plants has been attributed to the greater solublization, spread of root surface to volume and permeation of hyphal pads beyond the explored by root hairs (2).

In the present study, potassium content was the highest at early stages i.e., 5th MAP and 7th MAP, after that there was reduction in leaf potassium levels. At 150 DAP, The highest value was observed in T8 (885.3 kg ha^{-1}), while the lowest value was observed in T1, (668.2 kg ha^{-1}). At flowering and harvest stages also, T8 recorded the highest value (1241.5 and 761.2 kg ha^{-1} respectively). While the lowest soil potassium content (1001.8 and 863.5 kg ha^{-1}) was observed in T1. In the confirmatory trial crop, the soil available K was found to be influenced by the treatments. T8 registered the maximum at all the stages followed by T10, while T1 registered the minimum value. The reason for reduction of leaf potassium levels might be the nutrient transportation to fruit development. The highest leaf potassium content was recorded in treatment T8. Increase in potassium content in the leaf was due to the fact that increased levels of potassium which lead to higher content of leaf potassium and attributed to the decomposition and liberation of potassium as a organic matter in to soil leading to better potassium uptake, there by adding leaf potassium content (15,18) Increased potassium content might be also due to better utilization of applied inorganic fertilizer and also better mineralization of unavailable potassium due to root exudates produced by bio inoculants. Thus addition of biofertilizers in any form helps in maintaining soil fertility level, thereby improving the efficiency in utilization of applied fertilization by the plants (2, 6, 19). Similar trends were observed in confirmatory trial crop also.

Table 1. Effect of organic and inorganic nutrition on leaf nutrient concentrations at different growth stages in banana cv. Poovan. VS:Vegetative stage FSS: Harvest stage

Treatments	Leaf N (per cent)			Leaf P (per cent)			Leaf K (per cent)			Leaf Na (per cent)			Leaf Ca (per cent)			Leaf Mg (per cent)		
	VS	FS	HS	VS	FS	HS	VS	FS	HS	VS	FS	HS	VS	FS	HS	VS	FS	HS
T_1	2.02	2.12	1.25	0.24	0.32	0.25	2.29	2.42	1.58	0.20	0.22	0.11	1.34	1.60	1.33	0.26	0.85	0.46
T_2	2.16	2.29	1.42	0.39	0.39	0.35	3.33	3.49	2.52	0.25	0.33	0.14	3.34	3.52	2.40	1.50	1.78	0.56
T_3	2.35	2.43	1.49	0.38	0.41	0.36	3.40	3.49	2.55	0.26	0.34	0.23	1.78	1.93	1.72	0.71	0.95	0.72
T_4	2.38	2.56	1.63	0.39	0.42	0.36	3.42	3.85	2.6	0.27	0.34	0.23	2.31	2.79	2.36	0.87	1.01	0.73
T_5	2.38	2.68	1.66	0.39	0.42	0.37	3.53	3.93	2.69	0.27	0.36	0.26	2.59	2.88	2.43	0.88	1.26	0.75
T_6	2.47	2.78	1.92	0.40	0.42	0.37	3.57	3.96	2.74	0.28	0.42	0.26	2.63	3.10	2.48	1.50	1.34	0.77
T_7	2.86	2.93	2.07	0.41	0.43	0.37	3.63	3.98	2.75	0.39	0.42	0.28	2.82	3.13	2.73	1.51	1.68	0.77
T_8	3.18	2.53	2.68	0.42	0.43	0.38	3.59	3.73	2.75	0.40	0.44	0.32	3.36	3.94	3.26	1.66	1.81	0.88
T_9	3.21	3.48	2.67	0.42	0.43	0.38	4.02	4.43	2.86	0.28	0.41	0.30	2.78	3.90	3.17	1.59	1.35	0.85
T_{10}	3.10	3.25	2.57	0.41	0.43	0.37	3.65	4.00	2.84	0.39	0.43	0.28	2.87	3.47	2.93	1.56	1.68	0.79
SE_D	0.16	0.36	0.22	0.04	0.02	0.04	0.15	0.48	0.08	0.04	0.04	0.07	0.41	0.73	0.21	0.25	0.32	0.03
CD (P=0.05)	0.36	0.89	0.52	NS	NS	NS	0.34	1.09	0.18	0.09	0.10	0.14	0.95	NS	0.48	0.58	0.75	0.07
Confirmatory trial																		
T_1	2.04	2.06	1.35	0.21	0.29	0.25	1.26	1.20	1.58	0.19	0.20	0.14	1.20	1.83	1.23	0.98	0.85	0.56
T_7	2.38	2.28	2.38	0.38	0.39	0.35	3.40	3.20	2.60	0.26	0.29	0.22	1.96	2.83	2.23	0.89	1.12	0.73
T_8	3.10	3.24	3.00	0.43	0.45	0.38	4.01	4.00	3.06	0.39	0.37	0.36	2.80	3.94	2.93	1.56	1.50	0.77
T_9	2.47	2.420	2.70	0.42	0.42	0.36	3.53	3.23	2.75	0.35	0.36	0.30	2.63	2.13	1.90	0.66	1.28	0.45
T_{10}	2.83	2.56	2.81	0.41	0.41	0.35	3.65	3.47	2.86	0.37	0.35	0.33	2.68	3.10	2.73	1.50	1.48	0.74
SE_D	0.02	0.03	0.10	0.01	0.03	0.32	0.20	0.15	0.15	0.01	0.006	0.01	0.067	0.12	0.032	0.07	0.78	0.006
CD (P=0.05)	0.05	0.07	0.23	NS	NS	NS	NS	0.20	0.36	0.04	0.014	0.04	0.154	0.28	0.073	0.179	NS	0.014

Table 2. Effect of organic and inorganic nutrition on leaf nutrient concentrations at different growth stages in banana cv.Poovan. VS: Vegetative stage FS: Flowering stage HS: Harvest stage

Treatments	Zn (ppm)			Cu (ppm)			Fe (ppm)			Mn (ppm)		
	VS	FS	HS	VS	FS	HS	VS	FS	HS	VS	FS	HS
T_1	14.11	23.30	16.40	4.12	9.29	6.49	90.1	144.2	99.08	122.3	148.81	155.4
T_2	16.98	40.31	20.91	6.10	11.12	8.73	105.3	169.7	99.73	163.8	180.3	195.2
T_3	20.53	29.20	16.35	11.99	12.30	10.01	115.6	173.3	106.6	230.4	240.1	210.1
T_4	20.91	31.50	18.92	12.19	13.37	10.90	120.8	180.3	119.2	236.4	249.7	222.3
T_5	38.01	43.62	31.26	12.20	13.60	11.27	179.4	205.4	164.2	268.2	288.4	243.6
T_6	38.23	45.12	35.70	12.40	13.62	11.86	200.4	210.4	180.3	270.4	290.0	248.5
T_7	55.63	61.30	39.32	12.76	14.21	13.20	205.3	220.1	207.1	271.2	293.0	252.3
T_8	68.20	72.22	60.13	16.01	19.20	16.27	210.2	230.4	215.3	281.0	300.2	280.2
T_9	57.47	67.28	40.42	14.89	16.78	13.86	207.9	223.0	210.1	280.0	299.0	263.5
T_{10}	56.80	66.13	40.41	12.86	14.76	13.22	207.3	221.3	210.0	272.1	293.3	253.1
SE_D	0.85	3.92	1.59	0.34	0.35	0.69	1.15	1.81	2.55	3.42	2.85	3.92
CD (P=0.05)	1.97	9.00	3.67	0.79	0.79	1.58	2.66	4.17	5.89	7.88	6.57	9.00
Confirmatory trial												
T_1	16.18	27.20	21.47	6.19	11.22	9.47	100.1	164.3	102.0	160.3	179.82	162.7
T_7	53.67	61.49	41.35	12.82	14.17	14.30	205.3	220.7	206.1	271.2	282.0	253.3
T_8	67.29	72.22	58.73	16.23	19.53	17.29	210.2	230.5	216.3	281.0	295.8	270.9
T_9	56.89	67.18	42.56	13.11	14.79	14.72	207.3	231.9	215.0	271.1	288.9	251.1
T_{10}	56.12	67.02	41.43	14.84	16.82	14.96	207.9	223.2	212.1	280.0	293.1	261.5
SE_D	0.85	0.85	0.34	0.34	0.68	0.77	6.89	3.92	0.35	0.78	1.81	3.42
CD (P=0.05)	1.97	1.97	0.79	0.79	1.59	1.51	15.8	9.00	0.79	1.56	3.63	7.88

Table 3. Effect of organic and inorganic nutrition on soil nutrient concentration at Different growth stages of banana cv. Poovan. VS: Vegetative stage FS: Flowering stage HS: Harvest stage

Treatments	Soil N (kg/ha)			Soil P (kg/ha)			Soil K (kg/ha)		
	VS	FS	HS	VS	FS	HS	VS	FS	HS
T_1	320.1	410.4	190.4	33.80	24.79	21.00	668.2	1001.8	706.8
T_2	322.7	417.3	199.8	37.83	28.01	24.09	886.7	1262.1	768.1
T_3	324.2	421.8	202.9	38.07	28.31	22.02	863.5	1078.3	726.4
T_4	330.7	422.8	205.5	38.51	28.34	22.63	693.9	1085.0	728.1
T_5	335.0	423.8	206.8	38.87	28.35	22.98	709.2	1087.3	728.6
T_6	336.8	424.3	207.6	39.11	28.47	23.03	836.8	1090.0	729.4
T_7	337.1	428.9	232.4	39.52	28.53	23.12	853.1	1100.0	745.3
T_8	368.5	458.1	256.0	43.32	28.81	24.93	885.3	1241.5	761.2
T_9	338.9	457.0	205.0	39.00	28.75	24.12	860.3	1010.0	745.7
T_{10}	354.6	442.7	244.8	40.01	28.53	23.40	868.1	1113.0	757.9
SE_D	7.83	11.21	12.32	3.462	1.23	0.683	11.18	26.73	9.92
CD (P=0.05)	18.06	25.85	28.41	NS	NS	NS	25.78	61.63	22.83
Confirmatory trial									
T_1	339.89	425.1	230.1	30.86	25.40	20.14	701.63	1091.0	710.4
T_7	343.76	440.5	240.6	32.10	27.53	23.26	815.96	1101.7	736.2
T_8	347.82	451.1	245.2	31.82	28.72	23.57	694.85	1240.5	760.1
T_9	343.14	444.7	241.0	32.81	27.71	23.22	707.43	1012.1	745.8
T_{10}	337.06	428.9	252.3	32.42	28.88	24.95	723.56	1115.2	759.3
SE_D	1.77	1.65	0.66	0.35	0.02	0.992	1.89	1.70	0.69
CD (P=0.05)	4.09	3.81	1.59	0.80	0.06	2.28	4.37	3.92	1.60

Table 4. Effect of organic and inorganic nutrition on soil nutrient concentrations at different growth stage of banana cv. Poovan. VS: Vegetative stage FS: Flowering stage HS: Harvest stage

Treatments	Zn (ppm)			Cu (ppm)			Fe (ppm)			Mn (ppm)		
	VS	FS	HS	VS	FS	HS	VS	FS	HS	VS	FS	HS
T_1	4.03	8.26	3.79	3.21	6.29	3.43	9.83	11.01	9.42	3.20	9.73	7.99
T_2	4.78	9.01	4.89	3.78	7.86	5.89	10.82	20.99	13.22	4.92	10.01	6.57
T_3	4.90	9.13	5.03	3.99	8.07	4.53	11.85	21.92	12.99	3.83	10.83	6.82
T_4	4.80	9.03	4.51	3.82	7.90	3.92	11.81	21.92	10.80	2.60	10.28	8.00
T_5	4.99	9.22	6.02	4.20	8.28	5.08	13.98	22.31	14.01	4.00	11.26	8.94
T_6	4.90	9.13	5.70	4.00	8.08	5.01	13.01	21.98	13.42	3.92	11.15	8.96
T_7	5.02	9.25	6.21	4.39	8.47	6.38	14.99	22.38	15.73	4.60	12.24	9.50
T_8	5.28	9.51	8.34	4.45	8.53	7.43	15.82	22.87	17.42	5.78	13.01	12.48
T_9	5.02	9.25	6.43	4.41	8.49	6.44	15.00	22.83	16.40	4.71	12.25	9.78
T_{10}	5.00	9.23	7.04	4.43	8.51	8.34	15.09	22.45	17.21	4.02	12.37	11.20
SE_D	0.09	0.04	0.08	0.46	0.64	0.44	0.08	0.02	1.29	0.03	0.28	0.62
CD (P=0.05)	NS	0.10	NS	NS	NS	0.10	NS	0.06	2.99	NS	0.66	1.43
Confirmatory trial												
T_1	4.00	7.91	3.60	4.26	7.23	5.43	10.79	19.07	9.43	4.81	10.77	7.90
T_7	5.30	9.23	6.11	4.32	8.42	6.39	14.72	22.36	15.70	4.62	12.23	9.52
T_8	5.37	9.45	6.53	4.45	8.51	8.40	15.87	22.85	17.43	5.71	13.06	12.41
T_9	5.02	9.19	7.09	4.43	8.45	6.55	15.01	22.81	16.42	4.75	12.28	9.73
T_{10}	5.22	9.29	8.28	4.44	8.47	7.29	15.08	22.42	17.22	4.09	12.39	11.28
SE_D	0.12	0.25	0.35	0.02	0.03	0.22	0.47	0.66	0.03	0.10	0.01	0.21
CD (P=0.05)	0.24	0.51	0.72	0.05	0.06	0.45	0.96	1.36	0.07	ns	0.02	0.44

The concentration of micronutrients viz., Zn, Cu, Fe and Mn were significantly influenced by the different combination of organics and inorganics combined with biofertilizers. T8 registered the maximum content while T1 registered the minimum content. In the confirmatory trial crop, micronutrients of the soil was found to differ significantly at shooting and harvesting stages of sampling. In general, increasing the levels of micronutrient content of the soil at harvest stage indicates the enrichment nutrients in soil (3, 13). Organic matter to enhance the chemical, biological and physical properties of the soil and increasing the input use efficiency at each step of the farm operation (11-12). The results clearly showed that supply of nutrients trough organic manures with inorganic fertilizers and biofertilizers helped significantly out yielded and indicate the beneficial effect of integration of biofertilizers when supplemented through inorganic fertilizers alone.

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