The Pharma Innovation Journal 2022; SP-11(8): 2067-2070

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(8): 2067-2070

www.thepharmajournal.com
Received: 17-06-2022
Accepted: 21-07-2022

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Effect of precision farming on leaf nutrient content of banana cv. Rajapuri (AAB)

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Abstract
The present study was carried out to evaluate the effect of precision farming on leaf nutrient content of banana cv. Rajapuri (AAB) during 2020-2022. The experiment was laid out in Randomized Complete Block Design with thirteen treatments and three replications. There was a significant difference was observed among treatments tested for leaf nutrients. The results revealed that application of 100 percent RDF through fertigation at weekly intervals along with polythene mulch with foliar spray of micronutrient mixture recorded the highest nitrogen (2.56%), phosphorous (0.26%), potassium (3.13%), calcium (1.13%) magnesium (0.78%), zinc (37.61 ppm) and manganese content (113.08 ppm) in banana leaf which was on par with application 75 percent RDF through fertigation at weekly intervals along with polythene mulch and foliar spray of micronutrients. All the treatments with mulch were found significantly superior over the non-mulched treatments at corresponding fertigation levels.

Keywords: Precision farming, Rajapuri, micronutrient mixture and polythene mulch

Introduction
Banana (*Musa paradisiaca* L.) is one of the major fruit crops in the tropics and subtropics and make a vital contribution to the economy of many countries. It is a herbaceous, perennial, monocotyledonous and monocarpic fruit crop which belongs to the family Musaceae in the order Scitaminae. It is also known by other names like Adam's fig, Kalpataru, Queen of tropical fruits, Tree of wisdom and Apple of the paradise (Garasangi *et al.*, 2018) [3]. It is a desert fruit crop and staple food to millions of people in the world. It provides nutrition, well-balanced diet and contributes to livelihood through crop production, processing and marketing (Robinson, 1996) [10].

Banana is a highly exhaustive crop and readily responds to applied nutrients. It requires a continuous supply of water and nutrients at proper growth stages for enhanced yield (Mustaffa and Kumar, 2012) [7]. Irrational management practices being adopted in banana by farmers lead to poor utilization of water and nutrients resulting in low productivity. In this context, efficient and rational use of fertilizers and water is imperative for attaining higher yield. Precision farming practices like drip irrigation, mulching, fertigation and foliar nutrition help to enhance the productivity of banana as it provides a new solution for today's agricultural issues such as the need to balance productivity keeping in view the environmental concerns (Shimi and Sheela., 2017) [12].

Analysis of total leaf nutrient concentration at specific growth stages is used as an indicator of plant nutrient status. Leaf diagnosis is based on the assumption that leaf is principle site of metabolism and changes in the nutrient supply are reflected in nutrient composition of the leaf. The third leaf in the succession of leaves from the top at the time of shooting is best for leaf analysis. Hence the present study was conducted for diagnosing the nutrient status of the plant (Hewitt, 1955) [4].

Material and Methods
The present investigation was conducted at ICAR- AICRP on Fruits, Kittur Rani Channamma College of Horticulture, Arabhavi, Gokak Taluk, Belagavi District, Karnataka, India for two consecutive years during 2020-2021 and 2021-2022 in plant and ratoon crop of banana. The experiment was laid out in Randomized Complete Block Design with three replications and thirteen treatments *viz.*,

T_1: 125% RDF through fertigation with plastic mulch + foliar spray of 0.5% Arka banana special at 6, 7, 8, 9 and 10 months after planting + bunch spray of 2% SOP + 1% urea after denavelling and 1 month after denavelling

T_2: 125% RDF through fertigation without plastic mulch + foliar spray of 0.5% Arka banana special at 6, 7, 8, 9 and 10 months after planting + bunch spray of 2% SOP + 1% urea after denavelling and 1 month after denavelling

T_3: 125% RDF through fertigation with plastic mulch + foliar spray of 2% banana shakthi at 6, 7, 8, 9 and 10 months after planting + bunch feeding (500 g cowdung + 7.5 g urea + 7.5 g SOP) after denavelling

T_4: 125% RDF through fertigation without plastic mulch + foliar spray of 2% banana shakthi at 6, 7, 8, 9 and 10 months after planting + bunch feeding (500 g cowdung + 7.5 g urea + 7.5 g SOP) after denavelling

T_5: 100% RDF through fertigation with plastic mulch + foliar spray of 0.5% Arka banana special at 6, 7, 8, 9 and 10 months after planting + bunch spray of 2% SOP + 1% urea after denavelling and 1 month after denavelling

T_6: 100% RDF through fertigation without plastic mulch + foliar spray of 0.5% Arka banana special at 6, 7, 8, 9 and 10 months after planting + bunch spray of 2% SOP + 1% urea after denavelling and 1 month after denavelling

T_7: 100% RDF through fertigation with plastic mulch + foliar spray of 2% banana shakthi at 6, 7, 8, 9 and 10 months after planting + bunch feeding (500 g cowdung + 7.5 g urea + 7.5 g SOP) after denavelling

T_8: 100% RDF through fertigation without plastic mulch + foliar spray of 2% Banana shakthi at 6, 7, 8, 9 and 10 months after planting + bunch feeding (500 g cowdung + 7.5 g urea + 7.5 g SOP) after denavelling

T_9: 75% RDF through fertigation with plastic mulch + foliar spray of 0.5% Arka banana special at 6, 7, 8, 9 and 10 months after planting + bunch spray of 2% SOP + 1% urea after denavelling and 1 month after denavelling

T_{10}: 75% RDF through fertigation without plastic mulch + foliar spray of 0.5% Arka banana special at 6, 7, 8, 9 and 10 months after planting + bunch spray of 2% SOP + 1% urea after denavelling and 1 month after denavelling

T_{11}: 75% RDF through fertigation with plastic mulch + foliar spray of 2% banana shakthi at 6, 7, 8, 9 and 10 months after planting + bunch feeding (500 g cowdung + 7.5 g urea + 7.5 g SOP) after denavelling

T_{12}: 75% RDF through fertigation without plastic mulch + foliar spray of 2% banana shakthi at 6, 7, 8, 9 and 10 months after planting + bunch feeding (500 g cowdung + 7.5 g urea + 7.5 g SOP) after denavelling

T_{13}: Control (100% RDF through soil application + basin irrigation)

The recommended dose of fertilizers followed in the experiment is 200:100:300 g NPK/plant/year (As per the Package of Practice of UHS, Bagalkot, Karnataka). The leaf samples are taken at the time of shooting. The laminar structure of the top third leaf is sampled for tissue analysis. The lamina of the third leaf is sampled by removing a strip of tissue 10 cm wide, on both the sides of a central vein. The leaf sample was kept in brown paper bag and is allowed to dry in hot air oven at 60 $\pm$ 3 ºC for about 24 hours. These dried leaf samples were ground into fine powder using a laboratory mixer/grinder. The flour was then used for estimation of nutrients. The observations include estimation of macronutrients (Nitrogen, Phosphorous, Potassium, Calcium and Magnesium) and micronutrients (Zinc, Manganese, Iron, Boron and Copper) and the data was subjected to statistical analysis to draw the meaningful inferences.

The nitrogen content was estimated by Kjeldahl method (Piper, 1966) [9]. Phosphorus content was analysed by Vanadomolybdate method. (Piper, 1966) [9]. The potassium content of leaf was estimated using flame photometer by method outlined by Jackson (1973) [5]. Calcium and Magnesium content in the leaf was estimated by using the atomic absorption spectrometer and values of all macronutrients are expressed in percentage. Micronutrients *viz*, zinc, manganese, iron, boron and copper content in the leaf was recorded by using the atomic absorption spectrometer and values are expressed in ppm.

Results and Discussion

According to the pooled data of both the seasons, the maximum nitrogen content in leaf was registered in T_5 (2.56%) which was on par with T_7 (2.55%), T_{11} (2.41%) and T_9 (2.40%) while, the least nitrogen content (1.64%) was observed in T_{13} (Control). Among all the treatments, T_7 recorded the highest phosphorous content in the leaf (0.26%) which was at parity with T_5 (0.25%), T_9 (0.24%) and T_{11} (0.23%). Meanwhile, the least phosphorous content in the leaf (0.14%) was recorded in T_{13} (Control). In the pooled data with respect to potassium content in the leaf, the maximum potassium content in the leaf (3.13%) was recorded in T_5 which was comparable with T_7 (3.07%) and T_9 (2.96%). On the other hand, the minimum potassium content in the leaf (2.11%) was documented in T_{13} (Control). Likewise, the highest value for leaf calcium content (1.13%) was witnessed in T_7 which was statistically on par with T_5 (1.10%). Conversely, the least calcium content (0.66%) in the leaf was noticed in T_{13} (Control). However, among all the thirteen treatments, T_7 recorded the highest magnesium content in the leaf (0.78%) which was statistically equivalent to T_5 (0.76%), T_9 (0.73%) and T_{11} (0.73%). Contrastingly, T_{13} (Control) witnessed the lowest magnesium content in the leaf (0.44%). It was observed that all the treatments with mulch were found significantly superior over the non-mulched treatments at corresponding fertigation with respect to nutrient content of the leaf (Table 1).

Higher amount of macronutrients is documented in the leaves of polythene mulched treatments, as mulching favoured the plant growth by conserving moisture, maintaining weed free environment and creating a favourable hydro thermal regime of soil that led to higher uptake of applied nutrients from the soil which ultimately resulted in increased macronutrient content in the leaves. Further, higher dose of fertilizer application (125% RDF as in T_1 T_2 T_3 and T_4) recorded less nutrient in the leaf as compared to treatments supplied with 100 and 75 percent RDF which may be due to the availability

of nutrients beyond its requirement might probably cause the negative effect. Application of 125 percent RDF may lead to poor development of root system which is reflected in lesser number of roots that may not be adequate to meet the nutrients required by the aerial parts resulting in less nutrient content in the leaf. Similar observations were recorded by Bolanos *et al*. (2003) [2] and Santhosh and Tiwari (2017) [11].

Micronutrient content in the leaf as influenced by various precision farming aspects showed significant differences among the treatments with the higher zinc (37.61 ppm), manganese (113.08 ppm) content in the leaf recorded in T_7 which was on par with T_5, T_9 and T_{11} while, T_{11} recorded higher iron content in leaf (81.27 ppm). However, boron and copper did not vary significantly among the treatments. While the treatment T_{13} (Control) recorded the least values for all the micronutrients (Table 2). Increased micronutrient content in the leaf of the above said treatments might be due to polythene mulching as it created a favourable microclimate around the plant which boosted the uptake of nutrients from the soil thereby increasing the micronutrient content in the leaves (Singh *et al*., 2020) [13]. Further, external application of 0.5 percent Arka banana special and 2 percent Banana Shakthi as foliar spray to banana plant resulted in increasing zinc, boron, manganese, iron and copper content in leaf and similar results were observed in earlier findings of Jeyabaskaran and Pandey (2008) [6] in cv. Karpuravalli. The treatment T_{13} (Control) recorded the least values for all the nutrients in the leaf as plants are grown without mulching and fertilizers applied through soil application led to low uptake of nutrients and also leaching of nutrients. These results are in conformity with the research findings of Berad *et al.* (1998) [1] and Nalina *et al.* (2000) [8] in banana.

Table 1: Effect of mulching, fertigation and foliar nutrition on leaf nutrient (macronutrient) content of banana cv. Rajapuri at shooting stage

Treatments	Nitrogen (%)			Phosphorous (%)			Potassium (%)			Calcium (%)			Magnesium (%)		
	Plant crop	Ratoon crop	Pooled	Plant crop	Ratoon crop	Pooled	Plant crop	Ratoon crop	Pooled	Plant crop	Ratoon crop	Pooled	Plant crop	Ratoon crop	Pooled
T_1	2.45	2.14	2.30	0.21	0.20	0.21	3.06	2.54	2.80	1.11	0.81	0.96	0.70	0.63	0.67
T_2	2.10	1.72	1.91	0.18	0.16	0.17	2.59	2.20	2.40	0.97	0.63	0.80	0.60	0.48	0.54
T_3	2.39	2.08	2.24	0.22	0.19	0.21	3.00	2.48	2.74	1.12	0.84	0.98	0.72	0.59	0.66
T_4	2.06	1.80	1.93	0.18	0.16	0.17	2.68	2.16	2.42	1.00	0.66	0.83	0.59	0.46	0.53
T_5	2.75	2.36	2.56	0.26	0.24	0.25	3.38	2.88	3.13	1.25	0.94	1.10	0.82	0.70	0.76
T_6	2.43	2.10	2.26	0.22	0.20	0.21	3.02	2.51	2.76	1.13	0.80	0.96	0.71	0.57	0.64
T_7	2.68	2.42	2.55	0.27	0.25	0.26	3.35	2.79	3.07	1.28	0.98	1.13	0.83	0.72	0.78
T_8	2.36	2.02	2.19	0.20	0.20	0.20	2.94	2.45	2.70	1.10	0.77	0.93	0.69	0.60	0.65
T_9	2.60	2.21	2.40	0.25	0.22	0.24	3.25	2.67	2.96	1.20	0.86	1.03	0.80	0.66	0.73
T_{10}	2.23	1.92	2.08	0.19	0.18	0.19	2.79	2.38	2.59	1.05	0.68	0.87	0.66	0.54	0.60
T_{11}	2.54	2.28	2.41	0.24	0.21	0.23	3.20	2.61	2.90	1.16	0.90	1.03	0.77	0.68	0.73
T_{12}	2.17	1.87	2.02	0.19	0.18	0.18	2.87	2.30	2.59	1.03	0.72	0.88	0.64	0.52	0.58
T_{13}	1.78	1.50	1.64	0.14	0.13	0.14	2.32	1.89	2.11	0.80	0.51	0.66	0.49	0.38	0.44
S. Em ±	0.08	0.07	0.07	0.01	0.01	0.01	0.08	0.08	0.07	0.03	0.03	0.03	0.03	0.02	0.02
CD at 5%	0.25	0.21	0.20	0.03	0.03	0.03	0.25	0.24	0.20	0.09	0.10	0.08	0.09	0.06	0.06

Treatment details

T_1 - 125% RDF F with PM + FS of 0.5% ABS + BS of 2% SOP and 1% urea
T_2 - 125% RDF F without PM + FS of 0.5% ABS + BS of 2% SOP and 1% urea
T_3 - 125% RDF F with PM + FS of 2% BN S + BF (500 g CD + 7.5 g urea + 7.5 g SOP)
T_4 - 125% RDF F without PM + FS of 2% BN S+ BF (500 g CD + 7.5 g urea + 7.5 g SOP)
T_5 - 100% RDF F with PM + FS of 0.5% ABS + BS of 2% SOP and 1% urea
T_6 - 100% RDF F without PM + FS of 0.5% ABS + BS of 2% SOP and 1% urea
T_7 - 100% RDF F with PM + FS of 2% BN S + BF (500 g CD + 7.5 g urea + 7.5 g SOP)
T_8 - 100% RDF F without PM + FS of 2% BN S+ BF (500 g CD + 7.5 g urea + 7.5 g SOP)
T_9 - 75% RDF F with PM + FS of 0.5% ABS + BS of 2% SOP and 1% urea
T_{10} - 75% RDF F without PM + FS of 0.5% ABS + BS of 2% SOP and 1% urea
T_{11} - 75% RDF F with PM + FS of 2% BN S + BF (500 g CD + 7.5 g urea + 7.5 g SOP)
T_{12} - 75% RDF F without PM + FS of 2% BN S+ BF (500 g CD + 7.5 g urea + 7.5 g SOP)
T_{13} - Control (100% RDF through soil application + basin irrigation)

F- through fertigation, PM- Plastic mulch, FS- Foliar spray, ABS- Arka banana special, BS- Bunch spray, SOP- Sulphate of Potash, BN S- Banana shakthi, BF- Bunch feeding, CD- Cowdung

Table 2: Effect of mulching, fertigation and foliar nutrition on leaf nutrient (micronutrient) content of banana cv. Rajapuri at shooting stage

Treatments	Zinc (ppm)			Manganese (ppm)			Iron (ppm)			Boron (ppm)			Copper (ppm)		
	Plant crop	Ratoon crop	Pooled	Plant crop	Ratoon crop	Pooled	Plant crop	Ratoon crop	Pooled	Plant crop	Ratoon crop	Pooled	Plant crop	Ratoon crop	Pooled
T_1	38.17	30.67	34.42	108.25	90.90	99.57	80.53	69.68	75.11	13.16	12.00	12.58	8.70	7.05	7.88
T_2	36.00	26.83	31.42	96.35	77.07	86.71	73.30	60.40	66.85	11.75	10.84	11.29	7.62	6.20	6.91
T_3	37.37	28.50	32.93	110.83	91.67	101.25	82.41	65.37	73.89	13.62	12.27	12.94	9.13	7.40	8.26
T_4	35.30	25.73	30.52	98.07	79.08	88.58	75.07	61.54	68.30	12.00	11.03	11.52	7.89	6.35	7.12
T_5	38.80	34.10	36.45	120.18	100.13	110.16	88.05	73.06	80.56	14.54	12.95	13.75	9.65	7.73	8.69
T_6	36.27	31.02	33.64	107.03	88.67	97.85	79.80	67.73	73.77	13.43	11.50	12.47	8.05	7.20	7.63
T_7	40.20	35.01	37.61	123.33	102.83	113.08	92.20	69.83	81.02	15.22	13.02	14.12	9.52	7.68	8.60
T_8	38.00	30.80	34.40	104.78	91.07	97.93	82.68	64.02	73.35	14.17	11.77	12.97	8.11	6.67	7.39
T_9	39.70	33.07	36.38	117.28	94.50	105.89	85.85	76.23	81.04	14.20	13.40	13.80	9.03	8.21	8.62
T_{10}	37.50	29.19	33.35	102.70	83.73	93.21	76.60	65.11	70.85	12.51	11.95	12.23	7.87	7.00	7.43
T_{11}	41.02	32.10	36.56	112.75	96.62	104.68	90.25	72.28	81.27	14.72	12.51	13.62	9.78	7.92	8.85
T_{12}	38.33	28.08	33.21	100.17	84.97	92.57	81.30	63.09	72.20	12.90	11.00	11.95	8.30	6.47	7.38
T_{13}	28.66	20.39	24.53	79.21	62.17	70.69	57.33	45.28	51.31	8.20	8.83	8.52	6.07	4.65	5.36
S. Em ±	1.12	1.45	1.17	5.38	4.99	4.61	3.74	4.60	3.66	1.18	0.85	0.81	0.70	0.66	0.61
CD at 5%	3.26	4.22	3.41	15.69	14.57	13.46	10.91	13.43	10.69	NS	NS	NS	NS	NS	NS

Treatment details

T_1 - 125% RDF F with PM + FS of 0.5% ABS + BS of 2% SOP and 1% urea
T_2 - 125% RDF F without PM + FS of 0.5% ABS + BS of 2% SOP and 1% urea
T_3 - 125% RDF F with PM + FS of 2% BN S + BF (500 g CD + 7.5 g urea + 7.5 g SOP)
T_4 - 125% RDF F without PM + FS of 2% BN S+ BF (500 g CD + 7.5 g urea + 7.5 g SOP)
T_5 - 100% RDF F with PM + FS of 0.5% ABS + BS of 2% SOP and 1% urea
T_6 - 100% RDF F without PM + FS of 0.5% ABS + BS of 2% SOP and 1% urea
T_7 - 100% RDF F with PM + FS of 2% BN S + BF (500 g CD + 7.5 g urea + 7.5 g SOP)
T_8 - 100% RDF F without PM + FS of 2% BN S+ BF (500 g CD + 7.5 g urea + 7.5 g SOP)
T_9 - 75% RDF F with PM + FS of 0.5% ABS + BS of 2% SOP and 1% urea
T_{10} - 75% RDF F without PM + FS of 0.5% ABS + BS of 2% SOP and 1% urea
T_{11} - 75% RDF F with PM + FS of 2% BN S + BF (500 g CD + 7.5 g urea + 7.5 g SOP)
T_{12} - 75% RDF F without PM + FS of 2% BN S+ BF (500 g CD + 7.5 g urea + 7.5 g SOP)
T_{13} - Control (100% RDF through soil application + basin irrigation)

F- through fertigation, PM- Plastic mulch, FS- Foliar spray, ABS- Arka banana special, BS- Bunch spray, SOP- Sulphate of Potash, BN S- Banana shakthi, BF- Bunch feeding, CD- Cowdung

Conclusion

In the present investigation, application of 100 percent RDF through fertigation at weekly intervals along with polythene mulch with foliar spray of micronutrient mixture resulted in higher nutrient content in the banana leaves which was on par with 75 percent RDF through fertigation at weekly intervals along with polythene mulch with foliar spray of micronutrients. Overall, it can be concluded that, application of 75 percent RDF through fertigation with polythene mulch and foliar application of micronutrients seemed to be optimum which resulted in achieving higher nutrient content in the leaves. This could save 25 percent of fertilizers without reducing the yield of banana.

Acknowledgement

Authors extend thanks to ICAR-AICRP on Fruits, KRC College of Horticulture, Arabhavi for providing necessary facilities required for the study.

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