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Impact of precision farming on fruit nutrient content of banana cv. Rajapuri (AAB)

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Abstract
The present study was carried out to evaluate the impact of precision farming on fruit nutrient content of banana cv. Rajapuri (AAB) during 2020-2021 and 2021-2022. The experiment was laid out in Randomized Complete Block Design with thirteen treatments which are replicated thrice. Significant differences was observed among treatments tested for fruit nutrients. The results revealed that application of application of 100 per cent RDF through fertigation at weekly intervals along with polythene mulch with foliar spray of micronutrient mixture recorded the highest nitrogen (1.36%), phosphorous (0.19%), potassium (1.83%), calcium (0.71%), magnesium (0.56%) and iron content (33.62 ppm) in banana fruits which was on par with application of 75 per cent RDF through fertigation at weekly intervals along with polythene mulch with foliar spray of micronutrients.

Keywords: Precision farming, rajapuri, fertigation and polythene mulch

Introduction
Banana (*Musa paradisiaca* L.) is one among the world's most important tropical fruit crops and a member of the Musaceae family. It is thought to be one of the prime fruit crops cultivated by humans at the dawn of civilization. Banana culture dates back to Indian civilization and is well-known and popular among Indians. It is the inexpensive fruit grown in the country with high energy, affordability and year-round availability as opposed to other seasonal fruits. India is the largest producer of banana in the world and contributes 26.04 per cent to global production from 14.87 per cent area followed by China and Philippines (Anon., 2017) [1]. It is an important nutrient-rich fruit crop cultivated for local consumption and export. Banana is a great lover of nutrient elements and it exhausts major and micronutrients from the soil in large quantities and banana soils require a continuous replenishment. It requires a continuous supply of water and nutrients at proper growth stages for enhanced yield and it responds well to applied nutrients. (Mustaffa and Kumar, 2012) [7]. Non-scientific 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) [14].
Nutritionally, the fruit is rich in carbohydrates and vitamins *viz.*, vitamin A, thiamine (B_1), riboflavin (B_2), niacin (B_3), pyridoxine (B_6), biotin, folic acid and vitamin C. It is also rich in minerals such as potassium, sodium, calcium, magnesium, zinc, chloride, manganese, phosphorus, iron, copper and iodine (Robinson, 1996) [12]. Inadequate intake of vitamins and minerals leads to nutritional disorders in the people. Promoting consumption of bananas with enhanced nutrient content could go a long way in preventing nutrient deficiencies, since bananas are widely consumed staple (Smith, 1989) [15]. This paper elaborates the nutrient composition of cv. Rajapuri which is a popular local variety among the growers and consumers of North Karnataka.

Material and Methods
The experiment 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 (500g cowdung + 7.5g urea + 7.5g 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 (500g cowdung + 7.5g urea + 7.5g 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 (500g cowdung + 7.5g urea + 7.5g 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 (500g cowdung + 7.5g urea + 7.5g 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 + 7.5g urea + 7.5g 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 cow dung + 7.5g urea + 7.5 g SOP) after denavelling.

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

The recommended dose of fertilizer followed in the experiment is 200:100:300g NPK/plant/year (As per the Package of Practice of UHS, Bagalkot, Karnataka). For fruit nutrient analysis, three uniform fingers (fruits) at green stage are taken from third hand in all treatments and peel of the fruits was removed. The pulp was cut into thin slices with slicer to facilitate easy drying. These slices were dried in cabinet drier (or easy drier) at 60±3ºC for about 10-12 hours. These dried slices were ground into fine powder using a laboratory mixer/grinder. The powder was then used for estimation of nutrients (Narayana *et al*., 2017) [9]. 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 of fruit was estimated by Kjeldahl method (Piper 1966) [11]. Phosphorus content was analysed by Vanadomolybdate method (Piper 1966) [11]. The potassium content in the fruit was estimated using flame photometer by method outlined by (Jackson 1973) [4]. Calcium and Magnesium content in the fruit 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 fruit was recorded by using the atomic absorption spectrometer and values are expressed in ppm.

Results and Discussion

The observations concerning to impact of precision farming on macronutrient content in fruits of banana cv. Rajapuri was recorded and the results are furnished in Table 1. From the pooled data, it was observed that, amidst all the treatments, treatment T_7 recorded the highest nitrogen content in banana (1.36%) which was statistically equivalent to T_5 (1.31%) and T_{11} (1.29%) while, the least nitrogen content (0.85%) was recorded in T_{13} (Control). The maximum phosphorous content in the fruits (0.19%) was recorded in T_5 which was statistically at parity with T_7 (0.18%), T_{11} (0.18%) and T_9 (0.17%) as against the minimum phosphorous content (0.09%) noted in T_{13} (Control). Numerically, the highest potassium content in the fruits was recorded in T_7 (1.83%) which was comparable with T_5 (1.78%), T_{11} (1.76%) and T_9 (1.74%). On the contrary, the minimum potassium content (1.28%) was noted in T_{13} (Control). T_5 and T_7 recorded the maximum calcium content in the fruits (0.71%) as against the minimum calcium content (0.40%) exhibited in control (T_{13}). However, T_5 and T_7 were at parity with T_9 (0.70%) and T_{11} (0.66%). With respect to magnesium, treatment T_5 and T_7 recorded the highest magnesium content (0.56%) which was statistically similar to T_9 (0.54%) and T_{11} (0.51%) while, the lowest magnesium content in the fruits (0.27%) was noticed in T_{13} (Control). All the treatments with mulch were found statistically superior when compared to treatments without mulch at corresponding fertigation levels.

Adequate water is prerequisite for plant growth and nutritional composition hence, application of polythene mulching helps in moisture conservation and uptake of applied nutrients which ultimately leads to better nutritional composition of fruits. The results obtained from present study are in conformity with the findings of Olaniyi *et al.* (2010) [10]. Additionally, application of fertilizers through fertigation reflects in higher nutrient use efficiency due to timely and judicious application of required amounts of nutrients directly to the crop root zone there by improving the fruit nutrient content. 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 per cent RDF may be due to the availability of nutrients beyond its requirement might probably cause the negative effect. Application of 125 per cent 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 leaves and thus in fruits. Similar observations were recorded by Bolanos *et al*. (2003) [3] and Santhosh and Tiwari (2017) [13]. Fruit nutrient composition in the control (T_{13}) is lower than other treatments because, soil under control was not covered with any mulch material which resulted in the loss of moisture and poor uptake of applied nutrients. These results are in conformity with the research findings of Berad *et al.* (1998) [2] and Nalina *et al.* (2000) [8].

Further, the higher amount of nutrients in fruits might be due to increased absorption and translocation of nutrients in the available form. The nutrients present in readily available form are used for many plant physiological processes like respiration, photosynthesis, translocation, protein synthesis and enhanced enzyme activities as reported by Yadav *et al.* (2010) [16] in cv. Grand Naine. Increase in nutrient composition of the fruits due to distal stalk end feeding with urea and SOP along with 500 g fresh cow dung confirms the upward movement of applied nutrients through De-Navelled distal stalk end which results in higher nutrient composition of fruit (Kotur and Murthy, 2010 [6] in banana cv. Ney poovan).

The data regarding the influence of precision farming on micronutrient content in banana cv. Rajapuri is presented in Table 2. The pooled data with respect to zinc content in fruits was found significant. Statistically, the maximum zinc content in the fruits over all other treatments was observed in T_{11} (21.02 ppm). Meanwhile, the minimum zinc content (14.50 ppm) in the fruits was noted in T_{13} (Control). Numerically, the higher manganese content in the fruits (43.82 ppm) was noticed in T_{11} as against the least manganese content (27.48 ppm) noted in T_{13} (Control). Regarding the iron content in the fruits, it was observed that, treatment T_7 recorded the higher iron content in the fruits (33.62 ppm) followed by T_{11} (32.77 ppm), T_5 (32.54 ppm) and T_9 (31.10 ppm) which were statistically on par with each other. In contrast, the minimum iron content in the fruits (20.63 ppm) was observed in T_{13} (Control). The pooled mean with respect boron and iron content in fruits did not show significant difference among the treatments (Table 2).

Increased micronutrient content in the fruits is due to higher micronutrient content in the leaves as the photoassimilates are transferred from source (leaves) to sink (fruits) thereby, increasing the micronutrient content in the fruits. Foliar application of 0.5 per cent Arka banana special and 2 per cent banana shakthi enhance the micronutrient content in the fruits. Similar results were observed in earlier findings of Jeyabaskaran and Pandey (2008) [5] in cv. Karpuravalli and Yadav *et al.* (2010) [16] in cv. Grand Naine.

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

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	1.22	1.05	1.14	0.15	0.15	0.15	1.69	1.52	1.61	0.64	0.55	0.60	0.52	0.38	0.45
T_2	1.07	0.90	0.99	0.12	0.11	0.12	1.50	1.34	1.42	0.55	0.43	0.49	0.40	0.31	0.36
T_3	1.24	1.07	1.16	0.14	0.14	0.14	1.71	1.55	1.63	0.62	0.57	0.60	0.50	0.40	0.45
T_4	1.10	0.92	1.01	0.12	0.10	0.11	1.52	1.37	1.45	0.53	0.45	0.49	0.41	0.32	0.36
T_5	1.41	1.22	1.31	0.20	0.19	0.19	1.87	1.69	1.78	0.75	0.68	0.71	0.61	0.50	0.56
T_6	1.21	1.05	1.13	0.16	0.15	0.15	1.70	1.50	1.60	0.64	0.55	0.60	0.51	0.39	0.45
T_7	1.47	1.26	1.36	0.19	0.18	0.18	1.91	1.75	1.83	0.78	0.65	0.71	0.63	0.48	0.56
T_8	1.25	1.08	1.17	0.15	0.14	0.15	1.68	1.54	1.61	0.65	0.53	0.59	0.47	0.40	0.43
T_9	1.33	1.15	1.24	0.17	0.16	0.17	1.84	1.65	1.74	0.76	0.64	0.70	0.65	0.43	0.54
T_{10}	1.13	1.00	1.07	0.14	0.13	0.13	1.65	1.44	1.55	0.63	0.51	0.57	0.44	0.32	0.38
T_{11}	1.38	1.20	1.29	0.18	0.17	0.18	1.86	1.67	1.76	0.71	0.61	0.66	0.56	0.46	0.51
T_{12}	1.15	1.02	1.08	0.15	0.12	0.14	1.67	1.48	1.57	0.62	0.52	0.57	0.43	0.35	0.39
T_{13}	0.94	0.77	0.85	0.09	0.08	0.09	1.35	1.20	1.28	0.45	0.35	0.40	0.30	0.24	0.27
S. Em ±	0.05	0.04	0.03	0.01	0.01	0.01	0.04	0.04	0.04	0.02	0.02	0.02	0.03	0.02	0.02
CD at 5%	0.15	0.11	0.10	0.03	0.02	0.02	0.12	0.11	0.11	0.06	0.06	0.06	0.08	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-Cow dung.

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

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	20.53	18.10	19.31	44.80	37.55	41.18	32.51	27.00	29.75	7.95	6.34	7.15	3.87	3.12	3.50
T_2	18.47	16.43	17.45	40.14	33.48	36.81	28.82	24.75	26.78	6.83	5.12	5.98	3.41	2.95	3.18
T_3	20.38	18.05	19.22	43.88	36.70	40.29	33.80	28.04	30.92	7.62	6.68	7.15	3.80	3.31	3.55
T_4	17.80	16.87	17.34	39.69	35.00	37.34	29.91	23.70	26.81	6.47	5.50	5.98	3.32	2.83	3.08
T_5	21.80	19.00	20.40	45.92	38.28	42.10	35.33	29.75	32.54	8.10	6.82	7.46	3.95	3.55	3.78
T_6	19.32	17.77	18.54	42.29	37.17	39.73	31.98	26.02	29.00	7.08	5.90	6.49	3.63	3.04	3.34
T_7	22.21	19.14	20.68	46.54	39.50	43.02	36.33	30.91	33.62	8.75	7.31	8.03	4.00	4.03	4.02
T_8	20.00	17.05	18.53	41.40	36.61	39.01	33.00	27.24	30.12	7.44	6.28	6.88	3.70	3.22	3.46
T_9	21.80	19.78	20.79	46.33	40.83	43.58	34.00	28.20	31.10	8.45	7.97	8.21	4.10	3.76	3.93
T_{10}	19.50	17.65	18.58	41.10	37.25	39.18	30.22	26.52	28.37	7.16	6.74	6.95	3.57	3.11	3.34
T_{11}	22.64	19.40	21.02	47.00	40.63	43.82	34.51	31.03	32.77	9.10	7.15	8.13	3.90	3.68	3.79
T_{12}	19.80	17.50	18.65	42.08	38.02	40.05	31.03	25.64	28.34	7.48	6.14	6.81	3.49	3.30	3.40
T_{13}	15.64	13.35	14.50	30.43	24.53	27.48	22.20	19.05	20.63	4.97	4.16	4.56	2.50	2.01	2.25
S. Em ±	0.97	1.12	0.82	3.00	2.13	1.58	1.74	1.52	1.44	0.73	0.72	0.65	0.33	0.34	0.30
CD at 5%	2.83	NS	2.39	NS	6.23	4.61	5.09	4.45	4.21	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 per cent RDF through fertigation at weekly intervals along with polythene mulch with foliar spray of micronutrient mixture resulted in higher nutrient content in the banana fruits which was on par with 75 per cent RDF through fertigation at weekly intervals along with polythene mulch with foliar spray of micronutrients. Overall, it can be concluded that, application of 75 per cent RDF through fertigation with polythene mulch and foliar application of micronutrients seemed to be optimum which resulted in achieving higher nutrient content in banana fruits.

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