Original Research Article

Impact of precision farming on shelf life and organoleptic evaluation of banana (*Musa paradisiaca* L.) cv. Rajapuri.

Abstract

Consumers choose the fruits that look good, firm and offer good flavour and has nutritive value. Producers and handlers are first concerned with appearance and textural quality along with long post harvest shelf life. Present experiment was undertaken at ICAR-AICRP on Fruits, Kittur Rani Channamma College of Horticulture, Arabhavi to know the impact of precision farming on shelf life and organoleptic evaluation of banana cv. Rajapuri during 2019-20 and 2020-21 in the laboratory, Department of Fruit Science, KRC College of Horticulture, Arabhavi, Karnataka (India). The experiment was carried out in Randomized Complete Block Design with thirteen treatments and three replications. Among all the treatments, application of 100 per cent RDF through fertigation at weekly intervals along with polythene mulching with foliar spray of micronutrient mixture and bunch nutrition recorded the highest shelf life (10.00 days) and the least physiological loss in weight (8.45 %). The analyzed results for overall acceptability were in higher preference level in T_5, T_7 and T_9 (9.00) while minimum was noticed in T_{13} (7.00).

Keywords: Precision farming, fertigation, organoleptic evaluation and overall acceptability

Introduction

Banana (*Musa* spp.) is one of the world's most important tropical fruit crops which belongs to Musaceae family. It is one of the prime fruit crops cultivated by humans at the dawn of civilization. It has a great socio economic significance and is closely interwoven in our national heritage. Banana is one of the major commodities in international trade and is more important as starchy staple crops in local food economies (Stover and Simmonds, 1987). It is a very popular fruit due to its low price

and high nutritive value. It is consumed in fresh or cooked form both as ripe and raw fruit (Robinson, 1996).

Globally, the leading countries in banana production are India, China, Brazil, Philippines, and Ecuador. India contributes more than 20 per cent of global production but has very less (< 0.05 %) contribution to the international banana market. (Anon, 2017). In India, it is cultivated in an area of 8.78 lakh ha with an annual production of 315.04 lakh MT and productivity of 34.89 MT/ha (Anon, 2020). It is a multipurpose plant because most of its parts can be used in various ways, depending on the species. Nutritionally, the fruit is rich in carbohydrates, vitamins A, B, C, and potassium. Pulp of well ripen banana is rich in sugars and easy to digest (Smith, 1989).

Banana is a fast growing plant that requires high, continuous nutrient and water supply for year long sustainability and ensures economically high yield (Mustaffa and Kumar, 2012). Unscientific management practices adopted in banana by growers lead to poor utilization of water and nutrients resulting in less productivity. In this context, efficient and rational use of fertilizers and water is necessary for obtaining higher yield. Precision farming practices like mulching, drip irrigation, fertigation and foliar nutrition helps in enhancing the productivity of banana as it gives a new solution for today's agricultural problems such as the need to balance productivity keeping in view the environmental concerns (Shimi and Sheela, 2017).

The cultivar Rajapuri (*Musa* AAB) is also called as Jawari bale locally, cultivated mainly in districts of North Karnataka. It is a hardy crop with thick stem and it can withstand to strong winds. The fruits are medium sized, extremely sweet flavour with sweet and acid blend taste. Sensory quality refers to composite of product characteristics that impart value to the buyer and consumer. Consumers prefers the fruits that look good, firm and offer good taste and has nutritive value. Producers and handlers are first concerned with appearance and textural quality of the fruit along with the longest shelf life (Kader, 2012). This study aims at assessing the shelf life, organoleptic traits and sensorial acceptance of the banana fruit.

Material and methods

The experiment was conducted at ICAR- AICRP on Fruits, KRC 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 carried out in Randomized Complete Block Design with thirteen treatments which are replicated thrice *viz*.,

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

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

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

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

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

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

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

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

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

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

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

T_{12} - 75 % RDF through fertigation without polythene mulch + foliar spray of 2 % banana shakthi at 6, 7, 8, 9 and 10 MAP + 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)

Tissue culture plants procured from Kalpavruksha Biotech, Terdal, Bagalkot, Karnataka were used for the study. The experimental site was ploughed with the help of tractor-drawn implement followed by harrowing and a planking to give fine tilth to the soil. To facilitate proper treatment imposition, drip irrigation system was installed in the experimental block. Fertilizers were supplied through drip irrigation method by using ventury system. The recommended dose of fertilizer (RDF) followed in the experiment is 200:100:300 gram NPK/plant/year (As per the Package of Practice of University of Horticultural Sciences, Bagalkot, Karnataka). Fertigation schedule was started from 1st month after planting and continued up to 7th month after planting at weekly interval. Micronutrient mixture like ‘Arka banana special’ and ‘Banana Shakthi’ are used for foliar spray. For bunch nutrition, bunch spray and bunch feeding was carried out according to treatment design.

The observations include shelf life, physiological loss in weight and sensory observations like colour and appearance of peel and pulp, texture, taste, flavour and overall acceptability using five randomly selected and fully ripened fingers from all the treatments and the data was subjected to statistical analysis to get the meaningful inferences.

Shelf life of fruits was recorded from day of ripening till the last edible stage and the mean was recorded (Turner, 1997). To calculate physiological loss in weight (PLW), the fruits in each replication of specific treatment were weighed at the beginning of storage and recorded as initial weight at mature green stage. Later, at complete ripe stage final weight was taken. Per cent physiological loss in weight was calculated using the formula given below.

$$\text{Physiological loss in weight (\%)} = \frac{P_0 - P_1}{P_0} \times 100$$

Where,

P_0 = Initial weight in gram

P_1 = Final weight in gram

Good and healthy bunches were selected, in that bunch, middle hand from the top and bottom rows was taken and kept in the laboratory for natural ripening and ripened fruits were used for the organoleptic study (Fig 1). Sensory evaluation of ripe banana fruits was carried out by a semi-trained panel of 15 judges consisting of professors and post-graduate students of KRC College of Horticulture, Arabhavi, UHS, Bagalkot. The fruit characters like colour and appearance of pulp and peel, texture, taste, flavour, and overall acceptability of banana fruits were evaluated on a nine point hedonic scale using score card mentioned below (Ranganna, 2003).

Table 1. Score card of the study.

Hedonic scale	Colour and appearance of peel	Colour and appearance of pulp	Texture	Taste and flavour	Overall acceptability

Like extremely	9	9	9	9	9
Like very much	8	8	8	8	8
Like moderately	7	7	7	7	7
Like slightly	6	6	6	6	6
Neither like nor dislike	5	5	5	5	5
Dislike slightly	4	4	4	4	4
Dislike moderately	3	3	3	3	3
Dislike very much	2	2	2	2	2
Dislike extremely	1	1	1	1	1

Fig 1. Organoleptic evaluation of banana cv. Rajapuri

Results and Discussion

The data on shelf life and physiological loss in weight of banana cv. Rajapuri as affected by different treatments in precision farming stored under ambient storage condition is displayed in Table 2. Data showed significant difference in the shelf life among the different treatments. In the plant crop, The shelf life of fruits varied from 7.02 to 10.43 days. The maximum shelf life (10.43 days) was recorded in T_5 which was statistically comparable with T_7 (10.30 days), T_9 (10.04 days) and T_{11} (9.89 days) while, the minimum shelf life of 7.02 days was registered in T_{13} (Control) fruits. In the ratoon crop, irrespective of the treatments, the shelf life in banana varied from 6.01 to 9.57 days. Amongst the different treatments, treatment T_5 registered the longer shelf life (9.57 days) as against the shorter shelf life (6.01 days) noticed in control. However, T_7 was found on par with T_5 (9.40 days), T_9 (9.20 days) and T_{11} (9.07 days). All the treatments exhibited significantly maximum shelf life than the control.

Increase in shelf life of the fruit is due to potassium supplied as post shooting bunch spray as it enhances storage and shipping quality of bananas (Mengel, 1997). Potassium application reduced rate of respiration and ethylene production (Singh and Chuhan, 1982). Kumar and Kumar (2010) noticed extended shelf life and lesser physiological loss in weight by post shooting bunch sprays with sulphate of potash.

The observations regarding the per cent physiological loss in weight of banana cv. Rajapuri studied under ambient storage was found significant. In the plant crop, Minimum PLW of 8.00 per cent was noticed in treatment T_5. T_5 was followed by T_7 (8.21 %), T_9 (8.68 %) and T_{11} (8.79 %) which were found on par with each other. However, the higher PLW (11.70 %) was recorded in T_{13} (Control). In the ratoon crop, as depicted in the table, significantly minimum PLW of 8.90 per cent was observed in treatment T_5 which was statistically equivalent to T_7 (9.03 %), T_9 (9.21 %) and T_{11} (9.32 %). Conversely, the maximum PLW (12.87 %) was exhibited in T_{13} (Control).

The loss in weight is an important index in post harvest storage life of the bananas. It is mainly due to loss of water during the metabolic processes like respiration and transpiration. Transpiration in banana fruits is mainly by loss of moisture through

Table 2. Effect of precision farming on shelf life and physiological loss in weight of banana cv. Rajapuri

Treatments	Shelf life (days)			Physiological loss in weight (%)		
	Plant crop	Ratoon crop	Pooled	Plant crop	Ratoon crop	Pooled
T_1	9.23	8.34	8.78	9.18	10.12	9.65
T_2	8.11	7.13	7.62	10.45	11.40	10.93
T_3	9.15	8.18	8.66	9.30	10.26	9.78
T_4	8.07	7.09	7.58	10.61	11.55	11.08
T_5	10.43	9.57	10.00	8.00	8.90	8.45
T_6	9.21	8.28	8.75	9.35	10.18	9.77
T_7	10.30	9.40	9.85	8.21	9.03	8.62
T_8	9.13	8.19	8.66	9.46	10.30	9.88
T_9	10.04	9.20	9.62	8.68	9.21	8.94
T_{10}	8.57	7.82	8.20	9.84	10.43	10.13
T_{11}	9.89	9.07	9.48	8.79	9.32	9.06
T_{12}	8.26	7.60	7.93	10.05	10.59	10.30
T_{13}	7.02	6.01	6.51	11.70	12.87	12.28
S. Em ±	0.35	0.35	0.25	0.32	0.36	0.26
CD at 5%	1.03	1.02	0.73	0.94	1.06	0.75

Treatment details:

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

RDF- Recommended dose of fertilizer, PM- Polythene mulch, FS- Foliar spray, ABS- Arka Banana Special, BS- Bunch spray, SOP- Sulphate of Potash, BN S- Banana Shakthi, BF- Bunch feeding, CD- Cowdung

the stomata present in peel results in loss of weight. Similarly, the respiration is by utilization of reserved foods results in reduction of weight. The carbon atom is lost from the fruit each time a carbon dioxide molecule is produced from an absorbed oxygen molecule and evolved into atmosphere results in decreased physiological loss in weight during the storage of banana fruits. Reduced physiological weight loss could be due to stabilization and consolidation of both cell wall integrity and the permeability of the tissues as it forms the linkage between cell membranes. Potassium not only improves yields but also benefits in various aspects like improves quality and induce longer shelf life. (Kumar and Kumar, 2010).

Organoleptic evaluation of ripe fruits of banana cv. Rajapuri was conducted by a panel of ten judges using a nine point Hedonic scale. Result regarding sensory evaluation is furnished under Table 3. In the plant crop, the mean colour and appearance score for fruit peel ranged between 7.00 to 9.00. Maximum colour score was recorded in T_5, T_7 and T_9 (9.00) while, the minimum score was recorded in T_{13} (7.00). In the ratoon crop, the mean colour and appearance score for peel varied from 7.00 to 9.00. The highest score was recorded in T_5 (9.00) as against the minimum score (7.00) recorded in T_{13} (Control). With respect to colour and appearance of the pulp, In the plant c rop, amongst all the treatments, the maximum score (9.00) was recorded in T_5 whereas, the minimum mean score (7.00) was recorded in control (T_{13}). In the ratoon crop, All the treatments recorded the maximum score of 8.00 except control (T_{13}) which recorded the minimum mean score (7.00). However, the data on colour and appearance of the peel and pulp was found non significant in plant crop, ratoon crop and in the pooled data respectively.

The sensory scores concerning the fruit texture of banana cv. Rajapuri was collected, analysed and respective data is documented in Table 3. No considerable variations was observed among the treatments in both the seasons. In the plant crop, the

score ranged from 7.00 to 9.00. Maximum score for texture was recorded in $T_{5,}$ T_7 and T_9 (9.00) and minimum score was recorded in T_{13} (7.00). However, In the ratoon crop, the sensory scores of all the treatments were in a range of 7.00 to 9.00. The maximal score for fruit texture (9.00) was noted in $T_{5.}$ On the other hand, the least score of 7.00 was observed in control (T_{13}).

The observations related to sensory score for taste and flavour in plant crop of banana cv. Rajapuri showed significant difference among the thirteen treatments with the sensory scores ranging from 7.00 to 9.00. Significantly, the highest score for taste and flavour (9.00) was recorded in $T_{5,}$ T_7, T_9 and T_{11} as against the least score (7.00) noticed in control. However, in the ratoon crop, no considerable difference was noticed among the treatments. The mean score for taste and flavour ranged from 7.00 to 9.00. Statistically, treatment T_9 recorded the highest score for taste and flavour (9.00). On the other hand, the least score was noticed in T_{13} (7.00).

The perusal data on the organoleptic scores for overall acceptability in banana cv. Rajapuri is documented. In the plant crop, ratoon crop and in the pooled data, it was revealed that there was no statistical difference among the treatments with respect to organoleptic evaluation for overall acceptability. In the plant crop, amongst all the treatments, the maximum score of 9.00 was recorded in treatment $T_{5,}$ T_7 and T_9 as against the least score of 7.00 observed in control (T_{13}). In the ratoon crop, among all the treatments, the maximum score of 9.00 was witnessed in treatment T_5 while, the least score of 7.00 was noted in control (T_{13}). In the pooled data, Amongst all the treatments, the maximum score of 9.00 was observed in treatment $T_{5,}$ T_7 and T_9 indicating the fruits were extremely liked by panel of judges. Meanwhile, the least score of 7.00 was observed in control (T_{13}) which indicates the the fruits were moderately liked by panel of judges.

Table 3. Effect of precision farming on organoleptic evaluation of banana cv. Rajapuri

Treatments	Colour and appearance (Peel)			Colour and appearance (Pulp)			Texture			Taste and flavor			Overall acceptability		
	Plant crop	Ratoon crop	Pooled	Plant crop	Ratoon crop	Pooled	Plant crop	Ratoon crop	Pooled	Plant crop	Ratoon crop	Pooled	Plant crop	Plant crop	Plant crop
T_1	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
T_2	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
T_3	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
T_4	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
T_5	9.00	9.00	9.00	9.00	8.00	9.00	9.00	9.00	9.00	9.00	8.00	9.00	9.00	9.00	9.00
T_6	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
T_7	9.00	8.00	9.00	8.00	8.00	8.00	9.00	8.00	9.00	9.00	8.00	9.00	9.00	9.00	9.00
T_8	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
T_9	9.00	8.00	9.00	8.00	8.00	8.00	9.00	8.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
T_{10}	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
T_{11}	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	9.00	8.00	9.00	8.00	8.00	8.00
T_{12}	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
T_{13}	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
S. Em ±	0.46	0.49	0.35	0.47	0.48	0.47	0.48	0.46	0.45	0.40	0.46	0.36	0.40	0.40	0.40
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	1.18	NS	1.04	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)

RDF- Recommended dose of fertilizer, F- through fertigation, PM- Polythene mulch, FS- Foliar spray, ABS- Arka Banana Special, BS- Bunch spray, SOP- Sulphate of Potash, BN S- Banana Shakthi, BF- Bunch feeding, CD- Cowdung NS- Non significant

Conclusion

Based on the results of this investigation, it can be concluded that application of 100 per cent recommended dose of fertilizers through fertigation at weekly intervals along with polythene mulching with foliar spray of micronutrient mixture recorded the highest shelf life and the least physiological loss in weight which was on par with application of 75 per cent recommended dose of fertilizers through fertigation at weekly intervals along with polythene mulching with foliar spray of micronutrients. In the present experiment, overall acceptability is considered as a summary of sensory evaluation. The analyzed results for all the sensory attributes were in higher preference level in T_5, T_7 and T_9 indicating the fruits were extremely liked by panel of judges.

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