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Effect of Nutrient Formulation on Shelf Life and Quality Attributes of Papaya (*Carica papaya* L.)

Moganapathi B.[1], C. Kavitha[2]*, L. Pugalendhi[3] and M.K. Kalarani[4]

[1]M.Sc. (Hort.) in Fruit Science, Department of Fruit Science, HC & RI, TNAU, Coimbatore (Tamil Nadu), India.
[2]Assistant Professor (Hort.), Department of Fruit Science, HC & RI, TNAU, Coimbatore (Tamil Nadu), India.
[3]Professor and Head, Department of Vegetable Science, HC & RI, TNAU, Coimbatore (Tamil Nadu), India.
[4]Director, Directorate of Crop Management, TNAU, Coimbatore (Tamil Nadu), India.

(Corresponding author: C. Kavitha)*
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ABSTRACT: Papaya is a nutritionally rich fruit crop containing more of vitamins and nutrients and requires proper nutrient management for enhancing shelf life and quality of the fruits. A field experiment was conducted to study the effect of nutrient formulation on shelf life and quality attributes of papaya at College Orchard, Horticultural College and Research Institute, TNAU, Coimbatore during 2021-2022. The current study involved four treatments *viz.,* T_1- Recommended dose of NPK + Foliar application of nutrient formulation at bimonthly interval (3rd, 5th and 7th month after planting), T_2 - Recommended dose of NPK + Foliar application of nutrient formulation at monthly interval (3rd, 4th, 5th, 6th and 7th month after planting), T_3 - Recommended dose of NPK + Foliar spray of Zinc sulphate (0.5%) + Boric acid (0.1%) + Calcium nitrate (0.5%) + Potassium sulphate (0.25%) at bimonthly interval (3rd, 5th and 7th MAP), T_4- Control (Recommended dose of NPK alone) with five replications in randomized block design. The results indicated that the foliar application of nutrient formulation at monthly interval (T_2) was significantly superior over rest of the treatments. The fruits obtained from T_2 had increased shelf life and quality attributes.

Keywords: Papaya, Nutrient formulation, Foliar application, Shelf life, Quality parameters.

INTRODUCTION

Papaya (*Carica papaya* L.) often described as the "Wonder fruit of the tropics," is a member of the Caricaceae family. Papaya originated from Tropical America and was brought to India in the 16th century through Philippines and Malaysia. A total of 57.80 MT of papaya is produced in India from 1.44 lakh hectares, contributing to 48% of the total papaya production in the world. Due to its year-round production, high productivity, greater economic returns and nutritional and therapeutic values, papaya cultivation is becoming more important in the recent past. India, Brazil, Nigeria, Indonesia, Thailand, Taiwan and Mexico are the major papaya producing countries in the world and in India leading producers are Andhra Pradesh, Gujarat, Karnataka, West Bengal, Madhya Pradesh, Maharashtra and Tamil Nadu (NHB, 2020).

Papaya fruit is highly nutritious and is rich in vitamins (A, C, folate, riboflavin), calcium and fibre and the ripe fruit is highly suitable for dessert purpose. In India, pickles and salads are made from the mature but unripe fruit. Further, fruits are processed into candies, smoothies, tutti-frutti, jam, nectar, wine, syrup, dehydrated flakes and infant meals. The proteolytic enzyme papain, which is used in the pharmaceutical, beer, meat, dairy, textile, photographic, optical, tanning, cosmetic, food and leather industries for its antibacterial, antiulcer and anti-carcinogenic properties, is present in the latex tapped from the stem and immature fruit surface.Due to its multifaceted uses, this fruit is becoming more popular in the domestic and international markets and thereby its global trade is growing (Ali *et al.,* 2015). However, papaya marketing is restricted due to extreme short shelf life connected with quick weight loss, pulp softening and susceptibility to postharvest infections, which is the greatest concern of papaya growers (Ayón-Reyna *et al.,* 2015; Madani *et al.,* 2014; Ong *et al.,* 2013).

For production of high-quality fruits, application of nutrients at various appropriate growth and development stages is considered to be necessary. For proper crop growth and for production of good quality fruits, application of major nutrients such as nitrogen, phosphorus, potassium and micronutrients such as zinc and boron are necessary. In addition, foliar application of calcium and sulphur was found to have a pronounced effect on quality of papaya (Monika *et al.,* 2018).

Besides having a rich source of vitamins and carotenoids, papaya has a relatively shorter shelf life and is characterized by increased respiration and ethylene evolution during ripening which leads to fruit softening and easy susceptibility to postharvest diseases as well as losses. Postharvest loss in papaya is reported to be 40-100%. Thus, there is a need to improve the shelf-life and quality attributes of papaya through crop management practices. In view of this, a study was conducted to understand the effect of nutrient formulation containing cow dung, neem cake, *Bacillus subtilis* along with macro and micronutrients through foliar application for the production of quality fruits.

MATERIALS AND METHODS

The field trial was conducted at the College Orchard, Horticultural College and Research Institute, TNAU, Coimbatore to assess the effect of foliar application of nutrient formulation on shelf life and quality attributes of papaya variety CO 8 during the year 2021-22. Soil type of the field was sandy clayey loam with pH, EC,, available Nitrogen, Phosphorus and Potassiumof7.74, 0.67dS/m, 217 kg/ha, 11 kg/ha and 685 kg/ha respectively. The study was conducted with four treatments replicated five times as detailed below.

T_1	Recommended NPK dose (50:50:50 g/plant) at bimonthly interval from 3rd MAP + Foliar spray of nutrient formulation at bimonthly interval (3rd, 5th and 7th MAP)
T_2	Recommended NPK dose (50:50:50 g/plant) at bimonthly interval from 3rd MAP + Foliar spray of nutrient formulation at monthly interval (3rd, 4th, 5th, 6th and 7th MAP)
T_3	Recommended NPK dose (50:50:50 g/plant) at bimonthly interval from 3rd MAP + Foliar spray of Zinc sulphate (0.5%) + Boric acid (0.1%) + Calcium nitrate (0.5%) + Potassium sulphate (0.25%) at bimonthly interval (3rd, 5th and 7th MAP)
T_4	Control (Recommended NPK dose (50:50:50 g/plant) at bimonthly interval from 3rd MAP)

The papaya seedlings of 45 days old were transplanted to the main field adopting a spacing of 1.8m×1.8m. Regular cultural operations were followed as per the recommendations given in TNAU Crop Production Guide. The nutrient formulation and micronutrients were given through foliar application as per the treatment. The fruits were harvested at colour break stage and analysed for various quality parameters *viz.,* shelf life, physiological loss in weight (PLW), TSS, acidity, ascorbic acid, total sugars, reducing and non-reducing sugars, β-carotene and lycopene content. The fruits were kept at ambient condition (temperature: 25±2°C, RH: 75±5%) to estimate the shelf-life (days) and physiological loss in weight (%). The TSS was measured using hand refractometer, total sugars (%) was determined by the method of Hedge and Hofreiter (1962) while reducing sugars (%) and non- reducing sugars (%) were determined by the method as suggested by Somogyi (1952). Acidity, ascorbic acid (mg/100 g), lycopene content (mg/100 g), β-carotene (mg/100 g) content were estimated by A.O.A.C method (1960); Rosenberg (1945); Rodriguez Amaya *et al*. (1983); Ranganna (1977) methods respectively. Statistical analysis of data was done by adopting statistical procedures as per the methods outlined by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

The present study was undertaken to assess the influence of foliar spray of nutrient formulation at monthly and bimonthly interval from 3rd to 7th MAP to assess the shelf life and quality attributes *viz*., shelf life, physiological loss in weight, total soluble solids, titrable acidity, ascorbic acid, total sugars, reducing sugars, non-reducing sugars, lycopene and carotenoid in papaya and the results are furnished in Table 1.

In the present study, the application of different treatments significantly influenced the shelf life and it ranged from 3.4 to 6.6 days under ambient storage. The maximum shelf life of 6.6 days was registered in the fruits obtained from the treatment with foliar spray of nutrient formulation at monthly interval (T_2), followed by bimonthly interval (T_1). The minimum duration of 3.4 days shelf life was observed in control. Shelf-life is an important parameter that implies the storage life of fresh fruits. In the present study, an increase in shelf-life was observed in the treatment T_2 and the direct or indirect influence of calcium on fruit ripening attributes such as respiration and ethylene production might be the reason for improving shelf life in papaya (Picchioni *et al.*, 1996). The similar results were reported by earlier workers in papaya (Monika *et al.,* 2018; Reena, 2022).

The physiological loss of weight during the storage of fruits was studied at two different days of storage period *viz.,* 3rd and 5thday.The different treatments significantly influenced the loss of weight during the storage of fruits. The highest weight loss of 7.03 % and 9.48 % was observed in control (T_4) at 3rd and 5th day respectively. Minimum loss of weight was observed in the treatment receiving foliar spray of nutrient formulation at monthly interval (T_2) (6.20%) which was comparable with bimonthly interval (T_1) (6.34). The physiological loss of weight at 3rd and 5th day of storage clearly indicated that the loss was more at 5th day than at 3rd day and this may be due to the contribution of calcium and potassium in reducing weight loss. Calcium nitrate has a vital role in delayed senescence, preserving cellular organization and retarding respiration rate and maintaining cell turgor potentials and all these factors might have contributed for fruit firmness (Faust and Shear 1972).

Total soluble solids differed significantly among the treatments and the values ranged from 10.23 to 12.46°Brix. The foliar spray of nutrient formulation at monthly interval (T_2) recorded the highest TSS of 12.46 °Brix and was on par with T_1 (11.76 °Brix). The lowest TSS of 10.23 °Brix was recorded by control (T_4). The different treatments also significantly influenced titrable acidity in papaya fruits and the titrable acidity ranged from 0.12 to 0.14%. The lowest titrable acidity of 0.12% was recorded in (T_2) and was followed by (T_1) and (T_3) (0.13%). The highest titrable acidity of 0.14 % was recorded in control (T_4). It is well reported that acidity decreases in fruits during respiration due to fermentation or break up of acids to sugar (Ball, 1997). In the present study, application of nutrient formulation at monthly interval had maintained lower titrable acidity (0.12 %) compared to the control (0.14 %). This may be due to delayed generative processes because of the presence of calcium. Similar findings were reported by Naik and Sri Hari Babu (2005), who opined that the lowest titrable acidity was recorded with the application of farm yard manure in guava.

In the present study, significant influence of different treatments was observed for ascorbic acid content of the fruits and the results are presented in Table 1. The ascorbic acid content ranged from 39.98 to 48.55 mg/100g among the different treatments. The foliar spray of nutrient formulation at monthly interval (T_2) registered the highest ascorbic acid content of 48.55 mg per 100g of fruits followed by T_1 (44.26 mg/100g) which was found to be on par with T_3 (42.84 mg/100g). The lowest ascorbic acid content of 39.98 mg per 100g of fruits was registered in control (T_4) which clearly indicated that foliar spray of nutrient formulation at monthly interval (T_2) was significantly superior over rest of the treatments. Kumar and Kumar (2008) reported that sulphate of potash (SOP) improved the quality of banana as it contains more sulphur, which improved the quality of fruits by enhancing the starch accumulation and better protein synthesis. Potassium and sulphur may have supported the plants in accumulating more ascorbic acid in the fruits by slowing down the enzyme system that stimulate the oxidation of ascorbic acid. In the present study, higher ascorbic acid content was observed due to foliar spray of nutrient formulation at monthly interval from 3rd to 7th MAP (T_2)(48.55 mg/100g). The combined application of zinc and iron sulphate significantly increased the quality of pomegranate fruit (Balakrishnan *et al.,* 1996). Similar observations in sweet orange and banana were also reported by Tariq *et al.* (2007); Kumar and Kumar (2008) respectively.

The analytical results of papaya fruits with respect to total sugars are given in Table 1. The different treatments influenced significantly, the total sugars content and it ranged from 10.15% to 12.8% among the treatments. The highest total sugars of 12.8 % was recorded in T_1 followed by T_2 (11.68%) and T_3 (10.8%). The treatment T_4 (10.15%) registered the lowest content of total sugars. The analysis of reducing sugars in of papaya fruits revealed that application of different treatments significantly influenced reducing sugars and it ranged from 10.04 to 11.10 %. The highest content of reducing sugars was registered in the treatment T_1 (11.1%) followed by T_2 (10.91%) and were on par with each other. The lowest reducing sugars content of 10.04 % was recorded in the fruits of the treatment T_4. The different treatments did significantly influencen on reducing sugar content. The highest content of non-reducing sugars registered in the treatment T_1 (1.7%) followed by T_2 (0.77 %), T_3 (0.41 %), and T_4 (0.11%). The lowest reducing sugar content of 0.11 % was analysed in the fruits of T_4.

The combination of sugars and acidity in the fruits contribute to the taste. In the present study, an increase in TSS and total sugars was observed due to the foliar spraying of nutrient formulation at monthly (12.46°Brix; T_2) and bimonthly interval (12.8 %; T_1) from 3rd to 7th MAP respectively. This might be due to the influence of potassium, which may have been involved in the translocation of sugars, increasing the sugar content owing to the efficient translocation of available photosynthetic constituents from the leaves to the fruits. This results are corroborated with the findings of Wallace (1962) who reported that TSS content in strawberries could be increased by the application of potassium sulphate. The increase in TSS and sugars could be attributed to the conversion of carbohydrates into sugars upon ripening of fruits, while later there is a consumption of sugars and organic acids for respiration. The greater TSS in guava was recorded with animal manures (Naik and Sri Hari Babu 2005). Similar results of increased TSS in papaya fruits with application of poultry manure and farm yard manure were recorded by Ray *et al*. (2008); Ravishankar and Karunakaran (2008).

The application of different treatments did significantly influence the β–carotene content and it ranged from 2.91 to 2.21 mg per 100g of fruits. The highest β –carotene content was registered in the treatment receiving foliar spray of nutrient formulation at monthly interval (T_2) (2.91 mg/100g) followed by T_1 (2.76 mg/100g).The lowest β –carotene content of 2.21 mg per100g fruits was recorded in the treatment T_4. In the present study, β –carotene content was comparatively higher in all the treatments when compared with the control. This can be attributed to the synergistic influence of zinc and boron in the accumulation and activation of key enzymes involved in the β-carotene formation (Rath *et al.*, 1980).

The lycopene content of papaya was significantly influenced by different treatments and the content ranged from 1.94 to 2.24 mg per100g of fruits. The highest content of lycopene was registered in the treatment T_1 (2.24 mg/100g) followed by T_2 (2.18 mg/100g) and were on par. The lowest lycopene content of 1.94 mg per100g fruits was registered in the control (T_4). The lycopene content was the highest in treatment T_1 (2.24 mg/100g). This may be due to potassium sulphate or zinc sulphate involved in the study. The application of sulphur significantly increases the content of lycopene and the red colour in tomato (Zelena *et al.*, 2009). Reddy *et al.* (2014) reported an increase of lycopene content in papaya due to organic practices over the recommended dose of fertilizers.

Table 1: Effect of different treatments on shelf life and quality attributes of papaya.

Treatments	Shelf-life (days)	Physiological loss in weight (PLW) (%)		TSS (°Brix)	Titrable acidity(%)	Ascorbic acid(mg/100g)	Total sugars (%)	Reducing sugars (%)	Non-Reducing sugars (%)	β – carotene (mg/100g)	Lycopene (mg/100g)
		3rd day	5th day								
T_1	5.6	6.34	7.64	11.76	0.13	44.26	12.8	11.1	1.7	2.76	2.24
T_2	6.6	6.20	7.21	12.46	0.12	48.55	11.68	10.91	0.77	2.91	2.18
T_3	5.2	6.87	8.32	11.46	0.13	42.84	10.8	10.39	0.41	2.51	2.01
T_4	3.4	7.03	9.48	10.23	0.12	39.98	10.15	10.04	0.11	2.21	1.94
SE d	0.35	0.26	0.33	0.44	0.004	1.71	0.47	0.31	0.03	0.1	0.08
CD (p=0.05)	0.76*	0.57*	0.73*	0.96*	0.01*	3.73*	1.02*	0.67*	0.06*	0.22*	0.17*
CV (%)	10.68	6.36	6.54	6.16	5.13	6.21	6.51	4.65	6.24	6.17	6.14

CONCLUSION

The results from the present study clearly indicated that foliar application of nutrient formulation, had a positive effect in enhancing the biochemical constituents and directly contributed for enhancing the quality attributes and shelf life of papaya fruits. Hence the experiment could be concluded that foliar application of nutrient formulation at monthly interval (3^{rd}, 4^{th}, 5^{th}, 6^{th} and 7^{th}MAP)] along with the application of recommended dose of fertilizer improves the shelf life and quality attributes of papaya fruits.

FUTURE SCOPE

Standardization of the nutrient formulation will enhance the shelf life and quality attributes of papaya.

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Conflict of Interest. None.

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