International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(4): 2728-2730

Received: 01-05-2018
Accepted: 05-06-2018

Monika G
Department of Fruit Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

K Soorianathasundaram
Department of Fruit Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

J Auxcilia
Department of Fruit Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

T Chitdeshwari
Department of Soil Science and Agricultural Chemistry, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

C Kavitha
Department of Fruit Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Correspondence
K Soorianathasundaram
Department of Fruit Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Effect of foliar nutrition of calcium and sulphur on pulp quality attributes and shelf-life of papaya (*Carica papaya* L.)

Monika G, K Soorianathasundaram, J Auxcilia, T Chitdeshwari and C Kavitha

Abstract
The present experiment involved the foliar application of calcium (Ca $(NO_3)_2$) and sulphur (K_2SO_4) independently or in combination at two levels (0.25 % and 0.5 %) with micronutrients (zinc sulphate @ 0.5% and boric acid @ 0.1%)) at 3rd, 5th and 7th months after planting along with the recommended dose of fertilizers (50:50:50 g NPK /plant @ bimonthly interval). The present study revealed that the foliar application of both calcium (0.5%), sulphur (0.5%) and micronutrients (zinc sulphate @ 0.5% and boric acid @ 0.1%) along with the recommended dose of fertilizers (T_7) increased the lycopene (3.36 mg/100g) and β-carotene content (2.36 mg/100g) of the papaya fruits. Shelf-life of the fruits was extended upto 6.20 days in T_3 (0.5 % Ca $(NO_3)_2$) followed by 6.00 days in T_7 (0.5 % Ca $(NO_3)_2$+ 0.5 % K_2SO_4). The treatment, T_7 (0.5 % Ca $(NO_3)_2$+ 0.5 % K_2SO_4) recorded low PLW (7.28 %) at the end of 5th day. Based on the overall results, the foliar application the secondary nutrients (Ca $(NO_3)_2$ (0.5 %) + K_2SO_4 (0.5) %) and micronutrients (zinc sulphate (0.5%) + boric acid (0.1%) along with recommended dose of NPK at 50g at bimonthly intervals improved the quality attributes and shelf-life of papaya.

Keywords: Papaya, foliar spray, calcium nitrate, potassium sulphate, quality, shelf-life

Introduction

Papaya (*Carica papaya* L.), also known as 'wonder fruit of the tropics' is native of Tropical America (Singh, 1990) [18] and it belongs to the family Caricaceae. It was introduced to India in the 16th century from Malacca. It is an important fruit crop occupying an area of about 1.36 lakh hectares with an annual productivity of 44.86 MT/ ha (NHB, 2018) [10] in India. In India, papaya is widely distributed in Andhra Pradesh, Gujarat, Karnataka, West Bengal, Madhya Pradesh, Maharashtra and Tamil Nadu.

Papaya is known for its rich source of carotenoids, vitamin A content (2020 IU/100g) along with the minerals mainly the iron, calcium and phosphorus. In addition, it also has lower sugar levels when compared to many other tropical fruits. Papaya is highly valued for the proteolytic enzyme 'papain' extracted from immature fruits. Apart from direct consumption, papaya fruits are also widely used in preparation of various value added products such as jam, jelly, tutti-frutti, marmalade, nectar, wine, syrup, dehydrated flakes and baby foods. Thus, it is highly appreciated as a favourite fruit among the consumers.

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 leading 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 intervene certain techniques to improve the shelf-life and quality attributes of papaya. Calcium is an important secondary nutrient known to improve the cell wall integrity, thereby reducing the postharvest losses. On the other hand, sulphur is a component of various enzymes and vitamins. The application of sulphur also plays a key role in delaying the ripening process (Kumar and Kumar, 2007) [6] and also it has a limited role in enhancing the lycopene content of the fruits to a certain extent (Zelena *et al*., 2009) [22]. Mohammed *et al*. (2015) [9] reported that sulphur had positive effect on the red colouration of tomato fruits. Therefore, to investigate the influence of these two secondary nutrients, attempts were made in the present study through foliar application on quality and shelf life of papaya.

Materials and Methods

A field experiment was conducted at the College orchard, Horticultural College and Research Institute, TNAU, Coimbatore to assess the influence of foliar application of calcium and sulphur on quality and shelf life of papaya during the year 2015 – 2016. Soil type of the experimental field was sandy clayey loam with pH, EC, available N, P and K of 7.93, 0.69 dS/m, 213 kg/ha, 11 kg/ha and 705 kg/ha respectively. Calcium nitrate and potassium sulphate were used as the source for calcium and sulphur, respectively. The study involved eight treatments *viz*., T_1 - Recommended NPK dose (bimonthly dose of 50:50:50 g /plant) + Micronutrients (zinc sulphate @ 0.5% and boric acid @ 0.1%), T_2 - T_1+ 0.25 % Ca $(NO_3)_2$, T_3 - T_1+ 0.5 % Ca $(NO_3)_2$, T_4 - T_1+ 0.25 % K_2SO_4, T_5 - T_1+ 0.5 % K_2SO_4, T_6 - 0.25 % Ca $(NO_3)_2$+ 0.25 % K_2SO_4, T_7 - 0.5 % Ca $(NO_3)_2$+ 0.5 % K_2SO_4 and T_8 - NPK – RDF alone, with three replications in randomized block design. The seedlings of papaya (45 days old) were transplanted in the field adopting a spacing of 1.8m X 1.8m. Regular cultural operations were followed as per the recommendations given in the Crop Production Guide (TNAU, 2014). The micronutrient sprays as well as calcium and sulphur were given through foliar application at 3rd, 5th and 7th month after transplanting.

Observations were taken on yield parameters such as fruit yield (kg/plant). The fruits were harvested at colour break stage and were subjected to estimation of various yield and quality parameters *viz*., TSS, acidity, ascorbic acid, total sugars, reducing and non-reducing sugars, ß-carotene and lycopene content. The fruits were kept at ambient condition (temperature: 27±3°C, RH: 60±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) [4] while reducing sugars (%) and non- reducing (%) were determined by the method as suggested by Somogyi (1952) [19]. Acidity was estimated as per A.O.A.C method (1960) [1]. Ascorbic acid (mg/100 g) content of the fruit was estimated as per the method of Rosenberg (1945) [17]. ß-carotene (mg/100 g) was estimated by the method as suggested by Rodriguez-Amaya *et al.* (1983) [16] while lycopene content (mg/100 g) of the fruit was estimated as per the method by Ranganna (1977) [14]. The data recorded on the above mentioned attributes were analysed statistically (Panse and Sukhatme, 1967).

Results and Discussion

Yield and quality attributes

In this study, the application of 0.5 % Ca $(NO_3)_2$ +0.5 % K_2SO_4 (T_7) along with micronutrients registered higher fruit yield per plant (47.54 kg/plant) (Table.1). Increase in yield in this treatment (T_7) may be due to the enhanced photosynthetic assimilation favoured by higher leaf number and leaf area, improved flowering, improved fruit set and fruit retention.

In the present study, the effect of foliar application of secondary nutrients had a significant influence on the quality attributes of papaya fruits (Table. 1). The increase in TSS (13.12 ° Brix), total sugars (12.24 %) and non-reducing sugars (1.96 %) was observed due to the foliar application of 0.25 % K_2SO_4. This might be due to the influence of potassium, which may have involved in the translocation of sugars from the leaves to the fruits. Potassium also plays an important role in carbohydrate synthesis, breakdown and translocation and synthesis of protein and neutralization of physiologically important organic acids. Besides, K is involved in loading and unloading of sucrose and amino acids through phloem, and storage in the form of starch in developing fruits by activating the enzyme starch synthase (Mengel and Kirkby, 1987) [8]. Foliar K application also favours the conversion of starch into simple sugars during ripening by activating the sucrose synthase enzyme. The results in this study are similar with the findings of Venkatarayappa *et al*. (1979) [20] and Kumar and Kumar (2007) [6] who reported that the application of potassium sulphate increased the TSS content in strawberries and banana respectively. Higher ascorbic acid content (Table. 1) observed in T_7 (48.02 mg/100g), may be due to the effect of calcium nitrate involved in gradual changes in metabolism of carbohydrate and biosynthesis of glucose as per the findings of Rajkumar *et al*., (2006) [13] though not much variation due to the treatments can be seen in ascorbic acid levels in the present study.

The lycopene content was higher in the treatment T_7 (3.36 mg/100g) and was followed on par with T_6 (3.28 mg/100g). In other treatments also the lycopene levels were higher than control. This may be due to the application of potassium sulphate or zinc sulphate in the present study. In tomato, Lopez *et al*. (1996) [7] reported that colouration in tomato fruits decreased due to reduction in supply of sulphur. Thus, sulphur may be involved in enhancing the lycopene content of fruits by possibly modulating the processes involved in its biosynthesis as it is shown to significantly increase the content of lycopene and red colour in tomato (Zelena *et al*., 2009) [22].

Further, in this study, β –carotene contents were higher in all the treatments when compared with the control. Similar to lycopene, the treatments T_6 and T_7 recorded higher β –carotene levels in the study and this can be attributed to the synergistic influence of zinc and boron in accumulation and activation of key enzymes involved in the β-carotene formation (Rath *et al*., 1980) [15]. In sugar beet, reduction in carotenoids was observed in S-deficient plants (Hoffmann *et al*., 2004) [5]. Deficiency of sulphur may result in reduction of terpenes, which are precursors of lycopene, carotene and carotenoids as reported in tomato (Mohammed *et al*., 2015) [9].

Shelf-life

The present study revealed that increase in shelf-life (Table. 2) was observed in the treatment T_3 (6.20 days) and T_7 (6.00 days) compared to control (T_8) which had a shelf-life of 3.03 days. This may be due to the direct or indirect influence of calcium on fruit ripening attributes such as respiration and ethylene production (Picchioni *et al*., 1996) [12]. Softening of fruit during ripening occurs due to the dissolution of the middle lamella (made up of calcium pectate) and modifications in the composition, structure and linkages between cell wall polysaccharides (Vicente *et al*., 2007) [21]. Minimum loss in weight was observed in T_6 (5.23 %), T_7 (6.05 %) and T_5 (6.35 %) after 3 days of storage. After 5 days of storage, lowest loss in weight was observed in T_7 (7.28 %) and T_3 (7.48 %). This may be due to the effect of Ca or K in reducing the weight loss. Calcium nitrate has also found to be effective in increasing the firmness of fruits by delaying senescence, preserving cellular organization and retarding respiration rate and therefore maintaining cell turgor potentials (Faust and Shear, 1972) [3]. Application of calcium may have contributed to reducing storage loss by decreasing the activity of enzymes like pectin methyl esterase and polygalacturanase in fruits (Deytieux-Belleau *et al*., 2008) [2]. Application of sulphur may also have contributed in reducing the PLW as reported in banana cv. Ney poovan (Kumar and Kumar, 2007) [6].

Table 1: Influence of different treatments on fruit yield and quality parameters of papaya

Treatments	Estimated yield (kg/plant)	TSS (°Brix)	Titrable Acidity (%)	Ascorbic Acid (mg/100g)	Total sugars (%)	Reducing Sugars (%)	Non-Reducing Sugars (%)	β-carotene (mg/100g)	Lycopene (mg/100g)
T_1	40.70	12.26	0.125	44.99	10.92	9.60	1.32	2.80	2.13
T_2	41.28	11.98	0.129	45.18	11.20	9.85	1.35	2.83	2.16
T_3	42.97	11.84	0.128	45.31	11.52	10.26	1.26	2.98	2.29
T_4	44.02	13.12	0.118	45.81	12.24	10.28	1.96	2.85	2.19
T_5	45.70	13.04	0.117	46.08	11.46	10.47	0.99	3.17	2.25
T_6	46.44	12.42	0.126	47.88	11.64	10.56	1.08	3.28	2.27
T_7	47.54	12.30	0.128	48.02	11.87	10.71	1.16	3.36	2.36
T_8	37.08	13.10	0.110	44.77	10.60	9.33	1.27	2.79	1.93
SE d	0.87	0.26	0.003	0.96	0.28	0.21	0.028	0.10	0.04
CD(p=0.05)	1.86*	0.55*	0.006*	2.05*	0.60*	0.45*	0.06*	0.22*	0.09*
CV (%)	2.46	2.56	2.65	2.54	3.00	2.52	2.64	4.22	2.46

***** Significant at 5% level

Table 2: Influence of different treatments on shelf-life (days) and physiological loss in weight (%) of papaya

Treatments	Shelf-life (days)	PLW (%)	
		3rd day	5th day
T_1	3.20	7.00	9.11
T_2	4.01	6.86	8.35
T_3	6.20	6.46	7.48
T_4	5.00	7.03	8.40
T_5	5.42	6.35	8.30
T_6	5.81	5.23	7.67
T_7	6.00	6.05	7.28
T_8	3.03	7.16	9.26
SE d	0.11	0.14	0.17
CD (p=0.05)	0.24*	0.30*	0.36*
CV (%)	2.84	2.61	2.53

***** Significant at 5% level

Conclusion

The above results from the study showed that foliar nutrition of calcium nitrate and potassium sulphate along with micronutrients (zinc and boron) had a positive effect improving the quality attributes and reducing weight loss and extending the shelf life of highly perishable papaya fruits. Hence, it could be concluded that application of recommended dose of NPK at 50g each at bimonthly interval along with the foliar nutrition of zinc sulphate (0.5%) + boric acid (0.1%) + $Ca(NO_3)_2$ (0.5 %) + K_2SO_4 (0.5) % at 3rd, 5th and 7th month (T_7)) helps to improve quality attributes and shelf-life of papaya fruits.

References

1. AOAC. Official Methods of Analysis. Published by A.O.A.C., Washington, D.C, 1960.
2. Deytieux-Belleau C, Vallet A, Doneche B, Geny L. Pectin methylesterase and polygalacturonase in the developing grape skin. Plant Physiol. Biochem. 2008; 46(7):638-646.
3. Faust M, Shear CB. The effect of calcium on respiration of apples. J Am. Soc. Hort. 1972; 97:437-439.
4. Hedge JE, Hofreiter BT. In: Carbohydrate Chemistry 17 (Eds. Whister R.L and Be Miller, J.N.) Academic Press. Newyork, 1962.
5. Hoffmann C, Stockfisch N, Koch H. Influence of sulphur supply on yield and quality of sugar beet (*Beta vulgaris* L.) determination of a threshold value. Europ. J Agronomy. 2004; 21:69-80.
6. Kumar AR, Kumar N. Sulfate of potash foliar spray effects on yield, quality, and post-harvest life of banana. Better crops, 2007, 22.
7. Lopez J, Tremblay N, Voogt W, Dube S, Gosselin A. Effects of varying growth, physiology sulphate concentrations on and yield of the greenhouse tomato. Scientia Horticulturae. 1996; 67:207-217.
8. Mengel K, Kirkby EA. Principles of plant nutrition. International Potash Institute, Bern, 1987, 436-437.
9. Mohammed KA, Hellal FA, SAA ES. Influence of Sulfur Deprivation on Biomass Allocation, Mineral Composition and Fruit Quality of Tomato Plants. Middle East J. 2015; 4(1):42-48.
10. NHB. Horticulture At a Glance, 2018. http://www.nhb.gov.in. 08 August, 2018.
11. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. ICAR, New Delhi, 1978.
12. Picchioni GA, Watada AE, Whitaker BD, Reyes A. Calcium delays senescence-related membrane lipid changes and increases net synthesis of membrane lipid components in shredded carrots. Postharvest Biol. Technol. 1996; 9(2):235-245.
13. Rajkumar M, Karuppaiah P, Kandasamy R. Effect of preharvest application of calcium on storage behaviour, ripening and shelf-life of papaya (*Carica papaya* L.). Int. J Agric. Sci. 2006; 2(2):480-482.
14. Ranganna S. Manual analysis of fruits and vegetable products (2nd edition). Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1977.
15. Rath S, Singh RL Singh DB. Effect of boron and zinc sprays on the physico-chemical composition of mango fruits. Punjab Hort. J. 1980; 2:33-35.
16. Rodriguez-Amaya DB, Bobbio PA, Bobbio FO. Carotenoid composition and vitamin A value of the Brazilian fruit *Cyphomandra betacea*. Food Chem. 1983; 12:61-65.
17. Rosenberg SR. Chemistry and Physiology of Vitamins. Inter Science Publishers, New York, 1945.
18. Singh ID. Papaya. New Delhi, India: Oxford and IBH Publishing company private Ltd, 1990.
19. Somogyi M. Notes on sugar determination. J. Biol. Chem. 1952; 200:245-247.
20. Venkatarayappa T, Narasimhan B, Venkatesan C. Mysore J Agric. Sci. 1979: 13(4):428-432.
21. Vincente AR, Saladie M, Rose JKC, Labavitch JM. The linkage between cell wall metabolism and fruit ripening: looking to the future. J Sci. Food Agric. 2007; 87:1435-1448.
22. Zelena E, Holasova M, Zeleny F, Fiedlerova V, Novotna P, Landfel A *et al*. Effect of sulphur fertilisation on lycopene content and colour of tomato fruits. Czech J Food Sci. 2009; 29:80-84.