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Foliar application of calcium and micronutrients for yield, quality and fruit shelf life enhancement in papaya var. Surya

P. ANJU, B. BINDU, M. RAFEEKHER, L. NAVEEN, R. SAJITHA AND R. ANUJA

Department of Fruit Science, Kerala Agricultural University, College ofAgricultureVellayani-695522, Keral
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ABSTRACT

An experiment was carried out to assess the effect of foliar application of micronutrients (boron and zinc) and calcium on yield characteristics, quality attributes and fruit shelf life of papaya (Carica papaya L.) var. Surya at College of Agriculture Vellayani during 2019-20.The field experiment was laid out in randomized block design with nine treatments and three replications. Among different treatments, foliar application of borax (0.5%), zinc sulphate (0.5%) along with calcium nitrate (0.5%) had most favorable effect in increasing the yield characters likefruit weight (722 g), fruit length (21.0 cm), fruit girth (39.8 cm), fruit volume (709.3cc), pulp percentage(82.1%), flesh thickness (3.2cm), number of fruits plant^{-1} (50.5) and total yield plant^{-1} (36.5kg), qualitative attributes like TSS (14.5ºbrix), total carotenoids (2.2 mg 100g-1), ascorbic acid (65.3 mg 100g-1), total sugar (9.8 %)and shelf life of papaya fruits (7.0 days). The control plants showed the lowest values for fruit weight (384.2 g), fruit length (14.5 cm), fruit girth (26.8 cm), fruit volume (309cc), pulp percentage(61.3%), flesh thickness (1.8cm) and total yield plant^{-1} (13.6kg), qualitative attributes like TSS (11.1ºbrix), total carotenoids (1.4mg 100g^{-1}), ascorbic acid (43.2mg 100g^{-1}), total sugar (6.6%) and shelf life of papaya fruits (4.2 days). water spray recorded lowest value for number of fruits plant^{-1}(35.2).

Key words: foliar spray, micronutrients, papaya, quality, shelf life, yield

INTRODUCTION

Papaya (*Carica papaya* L.) is an important fruit crop grown widely in tropical and subtropical regions of the world belonging to the genus *Carica* of the family Caricaceae. Papaya is one of the major fruit crops suited for both commercial orchards and nutrition gardens. Short pre-bearing period, high nutritive value, year-round fruiting behaviour and high yielding potential make papaya unique among fruit crops. Papaya which has been remained as a backyard crop now has became an emerging nutraceutically important fruit crop.It is largely consumed as a fresh dessert fruit, and the green fruit is often used as salad and cooked vegetable. Papain, a proteolytic enzyme is recovered from the latex of green fruit has importance in international markets because it has various uses in the beverages, cosmetics, food and pharmaceutical industries. Papaya is a nutritious fruit containing proteins, carbohydrates and minerals in particular calcium, iron and phosphorus. Among micronutrients, zinc and boron deficiencies are commonly observed in papaya orchards. Boron deficiency in papaya causes bumpy fruits having uneven shape, retard the growth of apical growing point and reduction in fruit set where, zinc deficiency reduces the growth, yield potential, fruit size and fruit number (Manjunatha*et al.*, 2014). Foliar sprays of zinc and boron in papaya increases plant growth, fruit yield, latex yield apart from improving the fruit quality traits (Saini *et al.*, 2019). Zinc is an essential element for several enzyme systems that regulate various metabolic activities in plant. Calcium has a great role in enhancing the post harvest quality of papaya fruits (Bhalerao and Patel, 2015) and its deficiency is responsible for premature ripening, softening of the fruit pulp and peel, which results in problems in transportation and a short commercial shelf life of fruits (Madani*et al.*, 2016). Therefore, considering the above mentioned issues, the present study was proposed to find out the effect of foliar application of micronutrients and calcium on yield, quality and shelf life of papaya.

MATERIALS AND METHODS

The present investigation was conducted at College of Agriculture Vellayaniduring 2019-20 using two month old seedlings of Surya, a gynodioecious variety released from IIHR. Healthy seedlings with 4 to 6 leaf stage were

Corresponding author address: anju.raveendran.ar5@gmail.com

transplanted in the main field. The pits of 50 cm^3 were taken at a spacing of 2m × 2m. Seedlings were planted in pits after 1 week of application of lime to correct the pH. Organic manure (10 kg FYM $plant^{-1}$) was given uniformly to all treatments as basal application. Basal dose N, P and K were applied through urea, rajphos and MOP, respectively. These fertilizers were applied in six splits at an interval of 2 months to obtain 240:240:480 g NPK $plant^{-1}$ $year^{-1}$. Design of the experiment was RBD, with nine treatments replicated thrice. Treatments were: T_1 - borax (0.5%), T_2 - zinc sulphate(0.5%), T_3 - calcium nitrate(0.5%), T_4 - borax (0.5%) + calcium nitrate(0.5%), T_5 - borax (0.5%) + zinc sulphate(0.5%), T_6 - zinc sulphate(0.5%) + calcium nitrate(0.5%), T_7 - borax(0.5%) + calcium nitrate(0.5%) + zinc sulphate(0.5%), T_8 - water spray and T_9 - control. Borax, calcium nitrate, zinc sulphate and water spray were given individually and in combination according to the treatment details at 4^{th} and 7^{th} month after planting as foliar spray. Spraying was done during morning hours. Yield, quality and shelf life characters were noted during the study period.Fruit length was measured after cutting the fruits longitudinally and measuring from the stalk end to the floral end using thread while Fruit girth was measured at the centre of longitudinally cut fruit and average value expressed in centi meter. Volume of fruits in each treatment were calculated using water displacement method. Thickness of the pulp was measured at the centre of selected fruits using a scale after making it into halvesand average was worked out where,pulp percentage was found using the formula, weight of the pulp to weight of fruit and expressedin percentage. For fruit weight, individual fruit weight of five randomely selected fruits wasmeasured and average calculated. Total number of fruits obtained from eachplant was calculated and average was worked out.For getting total yield per plant, the total fruit number harvested from individual plant was counted and multiplied it with average fruit weight and it is expressed in kilogram $plant^{-1}$. The quality parameters like TSS were estimated byhand refractometer and expressed in terms of ^{0}Brix. Ascorbic acid content of fruit was estimated by 2, 6-dichlorophenol indophenol dye method (Ranganna, 1997) and expressed in terms of mg 100^{-1}g. total carotenoids was estimated using petroleum ether-acetone extraction method (Ranganna, 1997).Total sugar was determined according to the procedure described by A.O.A.C (1975) using Fehling's solution and expressed as gram of glucose per 100 grams of pulp and assessment of shelf life of fruit was done by counting the number of days for which the fruit retained the edible qualities without decaying at normal atmospheric condition. Data obtained from the study were statistically analyzed by adopting standard procedure.

RESULT AND DISCUSSION

Yield characters

A perusal of data (Table 1.) revealed that the yield characters were significantly influenced by the use of micronutrients and calcium at different concentrations. Foliar application of borax (0.5%) and zinc sulphate (0.5%) along with calcium nitrate (0.5%) had most favourable effect in causing highest fruit weight (722.0g), fruit length (21.0cm), fruit girth (39.8cm) and fruit volume (709.9cc) over other treatments followed by foliar application of borax (0.5%) and calcium nitrate (0.5%) which resulted in fruit weight (690.9g), fruit length (19.2cm), fruit girth (36.7cm) and fruit volume (593.6 cc).Enhancement in fruit weight, length, girth and volume may be due to the accumulation of more dry matter in the fruit by the translocation of carbohydrates from the leaf to fruit and rapid synthesis of protein in the developing fruits regulated by zinc and boron (Singh *et al.*, 2010) or movement of more water into fruits through semi permeable cell membrane regulated by zinc thus resulting increase in fruit size (Bhalerao and Patel, 2015). These results were confirmed with the reportsof Manjunatha*et al.* (2014).

The pooled data (Table 1) indicated that the micronutrients and calcium spray significantly increased the pulp percentage and flesh thickness over control. The highest values of pulp percentage of fruits (82.1) and flesh thickness (3.2cm) were recorded with borax (0.5%), zinc sulphate (0.5%) and calcium nitrate (0.5%) foliar spray where as foliar application of borax (0.5%) and calcium nitrate (0.5%) resulted in flesh thickness 47.5 cm and pulp percentage (78.7). The results are in line with the reports of Singh *et al.* (2010) and Waskela*et al.* (2013). **P.**

Table 1: Effect of foliar application of micronutrients and calcium on yield characters of papaya

Treatments	Fruit weight (g)	Fruit volume (cc)	Fruit length (cm)	Pulp percent	Flesh thickness (cm)	Fruits plant^{-1}	Fruit girth (cm)
T_1	592.3	503.6	17.6	72.0	2.5	41.6	33.3
T_2	567.3	492.0	17.4	71.2	2.4	41.5	32.7
T_3	605.0	519.0	17.8	72.5	2.6	42.5	34.0
T_4	690.9	593.6	19.2	78.7	3.1	47.5	36.7
T_5	644.3	571.6	18.4	75.6	2.9	45.8	36.0
T_6	665.7	583.3	18.6	76.6	3.0	46.6	36.2
T_7	722.0	709.3	21.0	82.1	3.2	50.5	39.8
T_8	433.9	340.0	16.0	63.6	1.9	35.2	29.3
T_9	384.2	309.0	14.5	61.3	1.8	35.5	26.8
SEm(±)	4.81	1.30	0.18	0.24	0.04	0.45	0.21
CD (0.05	14.42	3.91	0.54	0.72	0.13	1.35	0.62

T_1 - Borax (0.5%) , T_2 - Zinc sulphate (0.5%), T_3 - Calcium nitrate (0.5%) , T_4 - Borax (0.5%) + Calcium nitrate (0.5%), T_5 - Borax (0.5%) + Zinc sulphate (0.5%), T_6 - Zinc sulphate (0.5%) + Calcium nitrate (0.5%), T_7 - Borax (0.5%) + Calcium nitrate (0.5%) + Zinc sulphate (0.5%),T_8 - Water spray, T_9 - Control (KAU, POP)

Number of fruits per plant was recorded with foliar spray of borax (0.5%) and zinc sulphate (0.5%) along with calcium nitrate (0.5%).Highest yield per plant (36.5kg) and total yield (91.2 tonnes per ha) were recorded with foliar spray of 0.5% borax + 0.5% zinc sulphate + 0.5% calcium nitrate. Findings of Bhalerao and Patel (2015) and Rawat*et al.* (2010) corroborated the present study. More number of fruit production may be due to the presence of more number of flowers and high fruit set. Synthesis of more protein and IAA as influenced by zinc or higher fruit setting, fruit retention, fruit growth and development (Shekher*et al.*, 2010) also leads to more fruit number. Fruit drop decreased with increasing leaf Zn content and supplemental foliar sprays of micronutrients during flowering as reported by Modi *et al.* (2012). Zinc stabilizes membrane permeability by increasing the mobility of calcium to fruits. Calcium being a main constituent of cell wall in the form of calcium pectate plays an important role in the strengthening of pedicel attached to the proximal end of fruit resulted in less fruit drop. Boron reduces the activity of abscisic acid due to the indirect action in auxin synthesis that delayed the formation of abscission layer during early stages of fruit development. Role of zinc in regulating the semi-permeability of cell wall thus mobilizing more water into the fruits and it is helpful in chlorophyll synthesis which increases photosynthetic activities of leaves. In case of boron, it is due to cell elongation, cell division as well as increases in cavity index and also the beneficial effect on fertilization and faster fruit development by increasing pollen producing capacity of the anthers, the viability of pollen grains and as well as it also stimulates germination of pollen tube growth (Modi *et al.*, 2012)

Table 2: Effect of foliar application of micronutrients and calcium on yield and fruit qualityof papaya

Treatments	Total yield plant^{-1} (kg)	Shelf life of fruit (Days)	TSS (ºbrix)	Total sugar (%)	Carotenoids (mg 100 g^{-1})	Ascorbic acid (mg 100 g^{-1})	Yield per hectare (tonnes)
T_1	24.6	5.2	13.13	8.53	1.80	57.27	61.5
T_2	23.5	5.3	13.13	8.27	1.78	56.90	58.7
T_3	25.7	5.6	13.27	8.63	1.83	57.53	64.2
T_4	32.8	6.1	13.87	9.33	2.14	61.73	82.0
T_5	29.5	6.0	13.73	9.07	1.98	59.03	73.9
T_6	31.0	6.2	14.00	9.40	2.04	60.73	77.6
T_7	36.5	7.0	14.50	9.83	2.27	65.30	91.2
T_8	15.2	4.4	11.93	7.03	1.47	45.43	38.2
T_9	13.6	4.2	11.17	6.60	1.40	43.20	34.1
SEm(±)	0.33	0.12	0.08	0.04	0.01	0.21	0.29
CD (0.05	0.98	0.32	0.25	0.12	0.04	0.62	0.82

Fruit quality characters

The data (Table 2.) clearly indicated that the foliar spray of borax (0.5%), zinc sulphate (0.5%) along with calcium nitrate (0.5%) significantly increased the TSS (14.5ºbrix), total carotenoids (2.27 mg 100g-1), ascorbic acid (65.30mg 100g-1) and total sugar (9.83%) in papaya fruits. The increased biosynthesis of metabolites, translocation of photosynthates and minerals into developing fruits promoted by zinc and boron might have resulted in higher total soluble solids in fruits. Micronutrient application may enhance the carotene content of papaya fruit by improving the carotene synthesis. The higher ascorbic acid content in papaya fruits might be due to the conversion of sugars into ascorbic acid influenced by boron and zinc or low oxygen permeability of tissues stimulated by calcium by inhibiting the action of oxidizing enzymes which delay oxidation reaction of vitamin C and reduce the vitamin C loss (Madani*et al.*, 2016). Zinc application also increased the ascorbic acid content because of more accumulation of total soluble solids or availability of more metabolites for ascorbic acid synthesis.More accumulation of sugars might be due to carbohydrate transformation, hexokinase activity and breakdown of starch to sugar by the role of zinc, which acts as a catalyst in oxidation-reduction processes in plants (Bhalerao and Patel, 2015).

Shelf life of fruits

Highest shelf life of papaya fruit (7.0 days) was obtained with borax (0.5%), zinc sulphate (0.5%) and calcium nitrate (0.5%) spray and it differed significantly from other treatments. This was followed by foliar spray of zinc sulphate and calcium nitrate (6.22 days) and lowest shelf life was identified for control (4.2 days). Increased shelf life of papaya var. Taiwan Red Lady was found with the foliar application of calcium nitrate 1000 mg L^{-1}, borax 30 mg L^{-1}, zinc sulphate 200 mg L^{-1} and ferrous sulphate 200 mg L^{-1} (Bhalerao and Patel, 2015). Longer shelf life may be due to increased stability and strength of cell walls due to enhanced calcium content in the tissue which provides resistance to harmful enzymes produced during microbial infestation and also delays the aging of fruits. Resistance may be due to the formation of cross-links between the free carboxyl group within the pectin-polysaccharide matrix as influenced by the calcium ions or calcium may affect the osmotic balance in the microbial cells and thereby inhibiting the pectinolytic enzymes or calcium application may reduce the spore germination, sporulation and growth of pathogens, finally reduces the decay of fruits during storage (Madani*et al.*, 2014). Low calcium concentration in fruits leads to inferior quality and short storage life.

From the results of the present experiment, it may be cocluded that spray of different levels of borax, zinc sulphate, calcium nitrate and their different combinations improved the yield, quality characteristics and shelf life of papaya fruits. Among various treatments, foliar application of borax (0.5%), zinc sulphate (0.5%) and calcium nitrate (0.5%) at 4 and 7 month after planting gave highest values for fruit and yield characters.

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