Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2021; 10(1): 549-552
Received: 24-11-2020
Accepted: 26-12-2020

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Influence of calcium and boron application on quality of tomato

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Abstract
A field experiment on "Influence of calcium and boron application on quality of tomato" was conducted during *kharif* 2018-19 at Kuduragere village (Karnataka, India). The experiment was laid out in Randomized Complete Block Design (RCBD) with ten treatments and three replications. It consists of three levels of calcium (0, 5 & 10 kg ha^{-1}) and boron (0, 1.1 & 2.2 kg ha^{-1}) along with RDF and FYM. The results of the study revealed that application of calcium @ 10 kg ha^{-1}+ B @ 2.2 kg ha^{-1} along with RDF and FYM (T_{10}) recorded significantly higher TSS (5.20 °Brix), reducing sugar (1.06%), ascorbic acid (46.96 mg 100 g^{-1}), lycopene (116.21 mg kg^{-1}) and shelf life (17.54 days) when compared to absolute control TSS (2.91 °Brix), reducing sugar (0.29%), ascorbic acid (15.66 mg 100 g^{-1}), lycopene (49.96 mg kg^{-1}) and shelf life (6.33 days) (T_1).

Keywords: Tomato, calcium, boron, lycopene, ascorbic acid and shelf life

Introduction
Nutrient management is important for improving crop production, improving fruit quality and profitability (Ganeshamurthy *et al.*, 2011) [9] of any vegetable crops. Tomato is a major vegetable crop commonly grown in and around Bengaluru (Srividya *et al.*, 2014) [17] and is very much responsive to Ca and B application. Tomato is a good source of vitamin A, vitamin C, Ca, Fe, protein, antioxidants and carotenoids (Di Masico *et al.*, 1989) [4] which also helps in preventing cancer and degenerative diseases (Giovannucci, 1999) [10].
Boron deficiency is widespread (Gupta *et al.*, 1985) [11] and can cause significant reduction in yield and uneven maturity of tomato fruit (Adams, 1978) [1]. Hence its recommendation is also necessary for improving fruit quality. It functions in cation and anion absorption relationships, water relationships, pollen viability, nitrogen metabolism, carbohydrate and fat. It also affects cell division, cell wall synthesis, membrane division, functioning, sugar transport, differentiation, plant hormone control levels, root elongation and plant hormone growth.
Deficiency of calcium is also more pronounced in tomato crop. Blossom end rot is the most known symptom of Ca deficiency in tomato that reduces fruit quality. Calcium is very important for meristematic activity in the root tip, providing a basis for the neutralization of organic acids and other plant-based toxins. It plays a part in mitosis and helps to maintain the chromosome structure. It is a co-factor or activator of range of enzymes, such as phospholipase hydrolases, arginine kinase, amylase and tri-phosphatase adenosine enzymes. It promotes the assimilation of nitrogen into organic constituents, especially proteins. Literature pertaining to quality of tomato by the application of Ca and B is very scanty hence the present study was undertaken to evaluate the effect of Ca and B on tomato fruit quality.

Material and Methods
A field experiment entitled " Influence of calcium and boron application on quality of tomato" was conducted in Kuduragere village, northern transect of Bengaluru, Karnataka (India), by taking tomato as a test crop in *kharif* 2018-19. The experimental site was located at 13.1833° N latitude and 77.6011° E longitude. Three levels of calcium (0, 5 and 10 kg ha^{-1}) and boron (0, 1.1 and 2.2 kg ha^{-1}) were supplied to tomato growing soils. The experiment was laid out in Randomized Complete Block Design with ten treatments which were repeated thrice. In order to prevent transplantation shock, the recommended dose of fertilizer *viz.*, 250:250:250 kg ha^{-1} of N, P_2O_5, K_2O supplied through urea, SSP and MOP to all treatments one week after transplanting except control. The different levels of Ca and B were supplied through burnt lime and borax as per treatment details at the time of fertilizer application. Seedlings were produced in pro-trays containing coco-peat as potting mixture. After 20 days of sowing, healthy plants were transplanted to main field.

Before imposing the treatments initial soil sample was collected and analysed for different parameters. The texture of the soil was sandy loam and soil was acidic (5.37), low in organic carbon (4.6 g kg^{-1}), medium in available nitrogen (280.83 kg ha^{-1}) and phosphorus (35.07 kg ha^{-1}), high in potassium (253.81 kg ha^{-1}) and deficient in exchangeable calcium and available boron (1.39 meq $100g^{-1}$ & 0.31 mg kg^{-1}, respectively).

At harvest stage fruit samples were collected and analyzed for different quality parameters *viz.*, TSS (Dong *et al.*, 2001 & Dongare *et al.*, 2014) [5, 6], reducing sugar (Michal Kaczmarek, 1952) [13], ascorbic acid (AOAC, 1999) [2] and lycopene (Scott, 2001 & Fish *et al*., 2002) [16, 7] by using standard analytical procedures.

Results and Discussion

Effect of calcium and boron application on fruit quality

The calcium and boron levels had shown significant effect on fruit quality parameters and it is presented n Table 1 and Fig 1.

TSS and Reducing sugar

Among the treatment combinations, significantly higher TSS and reducing sugar content of 5.03 °Brix and 1.06 per cent was recorded in T_{10} (Ca @ 10 kg ha^{-1} + B @ 2.2 kg ha^{-1} + RDF + FYM) followed by T_7 with application of Ca @ 5 kg ha^{-1} + B @ 2.2 kg ha^{-1} + RDF + FYM (4.82 °Brix & 1.05 per cent, respectively) compared to absolute control (T1) which recorded significantly lower TSS (2.91 °Brix) and reducing sugar (0.29%) (Table 1). Highest TSS and reducing sugar might be due to the supply of B and Ca along with FYM and mineral fertilizers as compared to control. Application of boron recorded higher TSS compared to calcium application which may be due to the role of boron in translocation of sugar from source to sink thereby improving the quality parameters. Similar findings were reported by Paithankar *et al*., (2004) [14]. Further, they also reported that boron played an important role in pigment formation.

Ascorbic acid content

Significantly higher ascorbic acid content of 46.96 mg 100 g^{-1} was recorded in T_{10} (Ca @ 10 kg ha^{-1} + B @ 2.2 kg ha^{-1} + RDF + FYM) followed by T_9 (Ca @ 10 kg ha^{-1} + B @ 1.1 kg ha^{-1} + RDF + FYM) which recorded 44.71 mg 100 g^{-1}. This might be due to the addition of organic manure along with mineral fertilizers compared to T_1 (Table 1). Application of Ca increased the ascorbic acid content in the fruit. It plays a vital role in the metabolism of carbohydrate, protein, meristematic activity, cell division and cell elongation. Therefore, the application of Ca helps to increase the quality content. It also plays a physiological role in the synthesis of enzymes, total carbohydrates, proteins and lipids in tomato (Arthur *et al*., 2015). Higher concentration of B (2.2 kg ha^{-1}) helps in the regulation of carbohydrate balance leading to the increase of TSS content (Uziak and Nurznski, 1964) [18]. Significantly lower ascorbic acid of 15.66 mg 100 g^{-1} was recorded in control might be due to non-addition of inputs.

Lycopene content

Among treatment combinations, T_1 (Absolute control) recorded significantly lower lycopene content (49.96 mg kg^{-1}) compared with other treatments which might be due to non-addition of inputs (Table 1). Significantly higher lycopene content of 116.21 mg kg^{-1} was recorded in T_{10} with application of Ca @ 10 kg ha^{-1} + B @ 2.2 kg ha^{-1} + RDF + FYM followed by T_9 which received Ca @ 10 kg ha^{-1} + B @ 1.1 kg ha^{-1} + RDF + FYM (116.09 mg kg^{-1}) which might be due to addition of Ca and B along with organic manure and mineral fertilizers. The reason for the enhancement of lycopene is due to the nutrition of Ca and other micro-elements (B) which involves in carbohydrate metabolism and its positive and close relationship with the formation of lycopene content in fruits. The Ca plays a physiological role in the synthesis of enzymes, total carbohydrates, proteins and lipids in tomato (Irfan *et al.*, 2015) [12].

Shelf life

Among the treatment combinations, T_{10} recorded higher shelf life in the treatment combination of Ca @ at 10 kg ha^{-1} + B @ 2.2 kg ha^{-1} along with RDF + FYM (17.54 days) which was on par with T_9 which received Ca @ 10 kg ha^{-1} + B @ 1.1 kg ha^{-1} along with RDF + FYM (16.28 days) compared to control (6.33 days) (Fig. 1 & plate 1). Loss of shelf life in control might be due to rapid increase in ethylene production and respiration due to the climacteric nature of tomato which leads to increased transpiration through the surface of the fruit causing shrivelling of fruit (Sabir *et al.* 2004 & Bhattarai and Gautman, 2006) [15, 3]. Higher shelf life in calcium and boron treated fruits could be due to its accumulation in the cell wall which facilitates the cross-linking of the pectic polymers increasing wall strength and cell cohesion (White and Broadly, 2003).

Table 1: Effect of calcium and boron on fruit quality parameters of tomato

Treatment details	TSS (°Brix)	Reducing sugar (%)	Ascorbic acid (mg 100 g^{-1})	Lycopene (mg kg^{-1})
T_1-Absolute control	2.91	0.29	15.66	49.96
T_2- Ca_0B_0 + RDF + FYM	3.61	0.71	20.92	87.12
T_3- Ca_0B_1 + RDF + FYM	4.11	0.91	22.83	93.51
T_4- Ca_0B_2 + RDF + FYM	4.71	1.01	24.73	96.45
T_5- Ca_1B_0 + RDF + FYM	3.69	0.69	27.88	101.75
T_6- Ca_1B_1 + RDF + FYM	4.24	0.94	36.96	108.13
T_7- Ca_1B_2 + RDF + FYM	4.82	1.05	37.32	115.89
T_8- Ca_2B_0 + RDF + FYM	3.75	0.93	31.90	105.42
T_9- Ca_2B_1 + RDF + FYM	4.51	0.93	44.71	116.09
T_{10}- Ca_2B_2 + RDF + FYM	5.03	1.06	46.96	116.21
SE.m±	0.21	0.05	1.94	3.51
LSD (p=0.05)	0.62	0.15	5.76	10.44

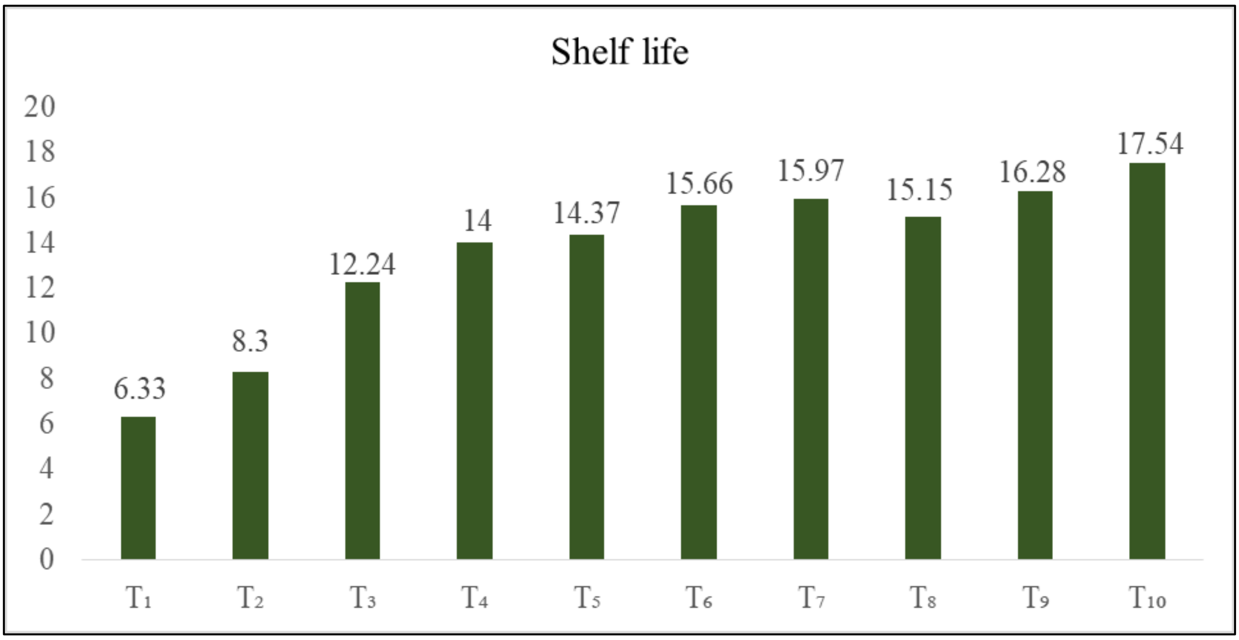

Fig 1: Impact of Ca and B application on shelf life of tomato fruit

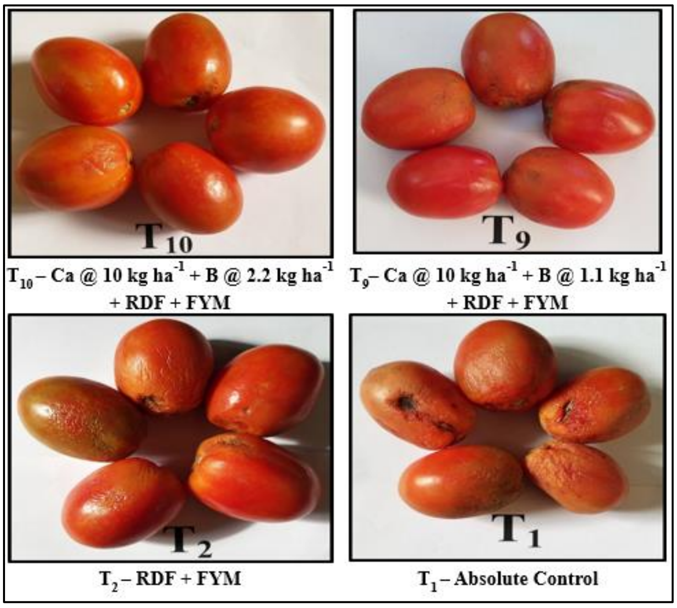

Plate 1: Shelf life of tomato fruit as influenced by calcium and boron (15 days after storage)

Conclusion

Combined application of calcium and boron improved the fruit quality parameters when compared with absolute control. Application of 10 kg ha^{-1} of Ca and 2.2 kg ha^{-1} of B along with RDF and FYM significantly increased fruit quality followed by application of Ca @ 10 kg ha^{-1} and B @ 2.2 kg ha^{-1} along with RDF and FYM compared with other treatments.

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