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Research Article

Effect of Foliar Application of Nutrients and Silicon on Yield and Quality Traits of Tomato (*Lycopersicon esculentum* L.)

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ABSTRACT

*A field experiment was carried out to study the effectiveness of foliar application of nutrients on yield and quality traits of tomato (*Lycopersicon esculentum *L.) at Tamil Nadu Agricultural University, Coimbatore. Foliar application of nutrients like potassium, calcium and silicon were administered during flowering stage and twenty days after the first spray. Silicon sources such as calcium silicate and potassium silicate were used. The experiment was performed in randomized block design (RBD) with nine treatments and three replications. The quality parameters like lycopene and titrable acidity were significantly increased by calcium silicate @ 1%, while total sugars and ascorbic acid were influenced by Potassium silicate @ 1% application. The shelf life and firmness were recorded high in calcium chloride (0.5%). Potassium silicate @ 1% had shown significant increase in number of flowers, fruits and yield per plant, while fruit weight was positively affected by potassium sulphate 1%. Thus, the study showed that nutrient and silicon application through foliage showed significant effect.*

Key words: *Tomato, Calcium silicate, Potassium silicate, Quality and Yield.*

INTRODUCTION

Tomato (*Lycopersicon esculentum* L.), a member of nightshade family is one of the most chief vegetable crop grown for its nourishing quality and tremendous popularity all around the globe. Tomato has an indispensable constituent in balanced diet, as it is a source of carbohydrate, fats, proteins and minerals. Tomato is one of the most important horticultural crops occupying second rank after potato in the world commerce[14]. Tomato has acquired special attention in current years with the discovery of lycopene's anti-oxidative activities and anti-most cancers functions[12].

Tomato is one of the most important crops extensively grown, but its yield discrepancy was experimented in varied agro ecological zones. Technological innovations are highly developed to accomplish higher productivity and better nutrient use efficiency. The plant nutrition is a prerequisite for the proper growth and development of the plants.

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Plant supply with ample nutrients possibly will have significant role in enhancing the nutritional assessment of tomatoes[10]. The foliar application of macro and micro-nutrients have very significant role in improving fruit set, productivity and quality of fruits. It has also beneficial role in recovery of nutritional and physiological disorders in fruit crops.

Balanced supply of nutrients is crucial for optimal yield and fruit quality. Potassium (K) plays foremost function in fruit quality and flavour. The vitamin C content in tomato also depends on K nutrition[11]. The tomato plants which do not take up sufficient potassium will have poor blossoming, resulting a reduce in fruit number. Calcium is an indispensable nutrient that plays a major role in the cell wall and membrane structure, cell wall stability, fruit growth, and development, with fruit quality[18].

The function of calcium is to regulate plant senescence and fruit ripening[21]. The function of silicon in plants is to reduce multiple stresses including biotic and abiotic stresses. Silicon spraying enhanced growth and physiological indices and hence it could increase the ability of plants to resistance water stress. Silicon application reduces transpiration leads to water stress tolerance[4]. Silicon nutrient can increases potassium content, ratio of purity degree, protein, nitrogen, total sugar, and makes the quality higher. Based on this background, the present investigation was focussed on quality and yield traits of tomato by foliar application of nutrients.

MATERIAL AND METHODS

A field experiment was conducted in field No. NA 6, Eastern Block Farm, Tamil Nadu Agricultural University, Coimbatore during kharif (2018) with tomato hybrid Sivam. The experimental field was fertilized with recommended doses of NPK fertilizers at 200, 250, and 250 kg ha^{-1}, respectively. A net 15 m^2 plot contained 36 plants planted in 60 x 45 cm spacing. The experiment was performed in randomized block design with nine treatments and three replications.The treatments were T_1 (Control), T_2 (Calcium silicate - 0.5%), T_3 (Calcium silicate - 1%), T_4 (Potassium silicate - 0.5%), T_5 (Potassium silicate - 1%), T_6 (Potassium chloride -1%), T_7 (Potassium sulphate -1%), T_8 (Calcium chloride - 0.5%), T_9 (Calcium nitrate -0.5%). Different sources of calcium, potassium and silicon were sprayed during flowering stage and twenty days after the first spray.

The freshly harvested tomato fruits were used for analysis. Lycopene content in tomato fruits was calculated by adopting the protocol and expressed in $mg100g^{-113}$. Tomato fruit samples were analysed for the ascorbic acid content, using 2, 6-dichlorophenol indophenol dye titrimetrically and expressed in terms of mg 100 g^{-116}. The total soluble solids content in the pulp was determined by using a Hand Refractometer and expressed as °Brix. Titrable Acidity in tomato was estimated by A.O.A.C.[1] point and expressed in percentage. The fruit shelf life was calculated when the fruits lost 75% of their initial weight and started showing signs of shrivelling and decay.

The crop was grown up to maturity and fruits were harvested at regular intervals and yield recorded as sum total of all pickings. Number of flowers per plant, number of fruits per plant and single fruit weight were recoreded. Data were analyzed using the software SPSS 16, and a comparison of means was done at the 5 % significance level, by Duncan's multiple range test.

RESULTS AND DISCUSSION

In the present study, results showed significant changes in yield and quality traits. Total soluble solids (TSS) significantly increased in T_6: 1% potassium chloride (5.48) when compared to other treatments and control (T_2: 5.10, T_5: 4.86, T_7: 4.70, T_8: 4.55, T_9: 4.38, T_4: 4.28, T_3: 4.15, T_1: 3.69). Results were similar to the findings where, increase of TSS in tomato fruits were due to the higher potassium levels in the nutrient solution which authenticate that potassium serves a significant role in the composition of quality profile in tomato fruits[18]. The maximum firmness was observed in T_8: 0.5% calcium chloride (8.34)

and was significantly greater than other treatments and control (T_2: 8.19, T_6: 7.73, T_7: 7.72, T_5: 7.24, T_4: 6.85, T_9: 6.43, T_3: 6.28, T_1: 5.07). The firmness in tomato fruit is due to calcium chloride applications which are known to retain the fruit texture because calcium chloride solution into the pores of fruit and will work on the bridge galacturonate cell wall on pectin so can make fruit texture is hardness[2,9]. Application of 1% potassium silicate shows higher ascorbic acid content in tomato fruit when compared to control and other treatments (T_5:41.9, T_4: 40.0, T_6: 38.3, T_7: 36.8, T_2: 36.7, T_3: 34.9, T_9:32.9, T_8:30.5, T_1: 29.7).The results of present study were similar to the application of potassium silicate at all growth stages significantly increased ascorbic acid content in cucumber fruits[3]. Calcium chloride @ 0.5 % recorded maximum shelf life of tomato fruits when compared to control and other treatments. **(**T_8:12.86, T_9:11.94, T_5: 11.91, T_7:11.01, T_4:10.94, T_6:10.82, T_2:10.01, T_3:9.89, T_1: 8.98) Previous report also indicate that, shelf life of tomato fruits were due to calcium chloride. The foliar applications of calcium chloride have been reported to delay ripening and retard fungal growth on strawberries[20].

Lycopene content in tomato fruit were found to significantly increase in T_3: 1% calcium silicate (3.97) followed by other treatments and control. (T_8: 3.63, T_2: 3.30, T_5: 3.12, T_4: 3.10, T_7: 3.06, T_6: 2.92, T_9: 2.76, T_1: 2.41) (fig1). The results were in conformity with the findings, that the β-carotene and lycopene contents of fruit were significantly increased by calcium Silicate under nutrient-induced salinity[8,19]. Range of titrable acidity were found to increase in T3: 1% calcium silicate (0.430) when compared to the control and other treatments. (T_9: 0.419, T_8: 0.384, T_2: 0.364, T_7: 0.331, T_6: 0.286, T_4: 0.285, T_5: 239, T_1: 0.207**)** The maximum total sugars were observed in T_5: 1% potassium silicate when compared to control and other treatments (T_5: 5.11, T_4: 5.06, T_6: 4.98, T_7: 4.73, T_3: 4.53, T_8: 4.36, T_2: 4.24, T_9: 3.95, T_1: 3.45) as seen in fig 2. Results were similar to findings of silicon fertilization that significantly improved titrable acidity ratio to total sugars in grapes[6].

Potassium silicate @ 1% application increased the number of flowers (37.72), number of fruits (23.02), and yield per plant (3.27 kg plant $^{-1}$) significantly over control, number of flowers (18.95), number of fruits (13.96), and yield per plant (2.59 kg plant $^{-1}$) Calcium nitrate @ 0.5% shows the highest fruit weight. (132.09 g) when compared to control and other treatments. (Table 2) Results revealed that the foliar application of potassium silicate was effective in stimulating all physical and chemical characteristics of the fruit in relation to the control[15]. These results were also similar to findings[5,7].

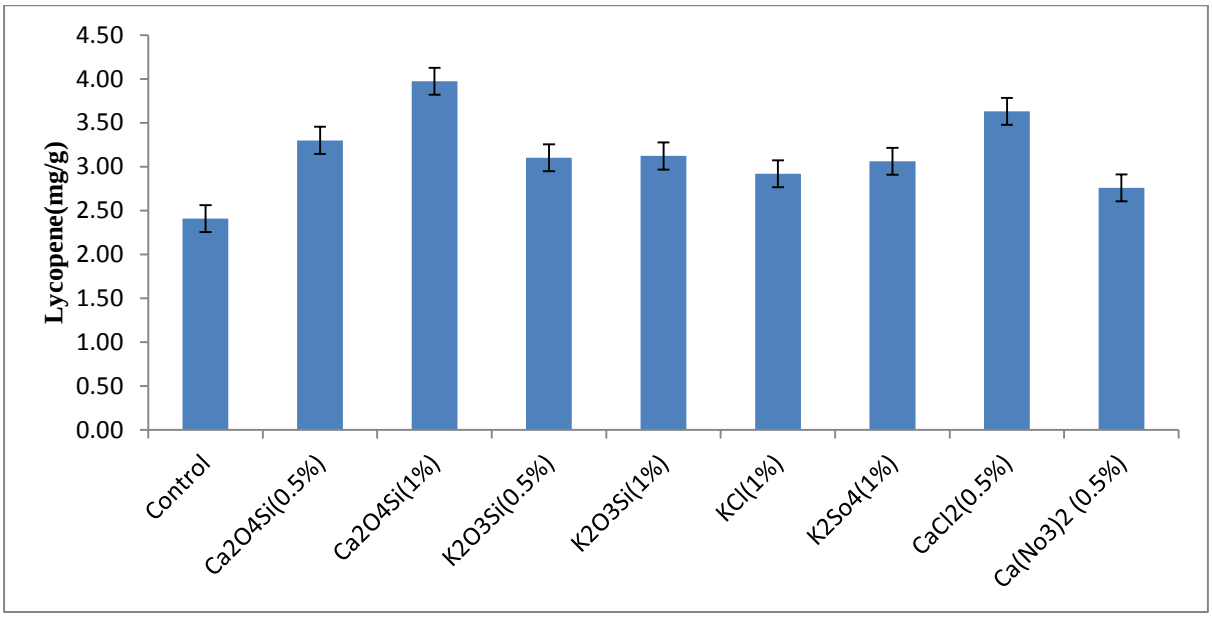

Fig. 1: Effect of foliar spray of nutrients and silicon on lycopene content in tomato

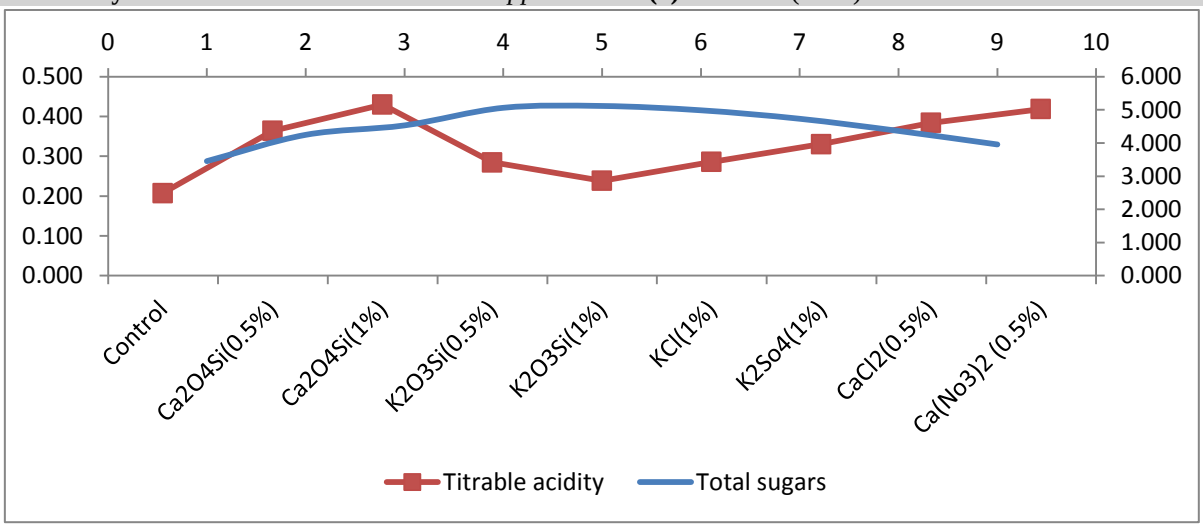

Fig. 2: Effect of foliar spray of nutrients and silicon on titrable acidity and total sugars in tomato

Table 1: Effect of foliar spray of nutrients and silicon on TSS, firmness, ascorbic acid, shelf life

Treatments	TSS (°brix)	Firmness (N)	Ascorbic acid (mg/100g)	Shelf life (days)
Control	3.69	5.07	29.7	8.98
Ca_2O_4Si (0.5%)	5.10	8.19	36.7	10.01
Ca_2O_4Si (1%)	4.15	6.28	34.9	9.89
K_2O_3Si (0.5%)	4.28	6.85	40.0	10.94
K_2O_3Si (1%)	4.86	7.24	41.9	11.91
KCl (1%)	5.48	7.73	38.3	10.82
K_2So_4 (1%)	4.70	7.32	36.8	11.01
$CaCl_2$ (0.5%)	4.55	8.34	30.5	12.86
Ca $(No_3)_2$ (0.5%)	4.38	6.43	32.9	11.94
Mean	4.58	7.05	35.74	10.93
SEd	0.070	0.068	0.311	0.105
CD (P=0.05)	0.149	0.144	0.658	0.22

Table 2: Effect of foliar spray of nutrients and silicon on flower number, fruit number, fruit weight and yield per plant

Treatments	No of flowers /plant	No. of fruits/plant	Fruit weight (g)	Yield per plant (kg)
Control	18.95	13.96	111.95	2.59
Ca_2O_4Si (0.5%)	24.60	15.74	127.74	2.67
Ca_2O_4Si (1%)	36.03	19.85	125.55	3.11
K_2O_3Si (0.5%)	28.02	16.91	117.22	2.68
K_2O_3Si (1%)	37.72	23.02	129.48	3.27
KCl (1%)	32.83	18.79	115.03	2.81
K_2So_4 (1%)	31.83	18.02	129.89	2.80
$CaCl_2$ (0.5%)	33.62	18.90	127.79	2.90
Ca $(No_3)_2$ (0.5%)	22.75	14.83	132.09	2.66
Mean	29.59	17.78	124.08	2.83
SEd	0.288	0.164	1.137	0.028
CD (P=0.05)	0.610	0.347	2.411	0.059

CONCLUSIONS

The maximum quality traits of Sivam hybrid shows positive results on potassium silicate sources. However, the application of calcium sources reported to enhance the shelf life of tomato fruits .It may also be concluded that, the yield attributes of tomato Sivam hybrid shows positive results for spraying of T_5:1% potassium silicate two times foliar spray at 25 days interval followed by T_3: 1% calcium silicate. Thus, the foliar application of potassium silicate @1% at different growth stages influence the yield and quality traits in tomato. The foliar application of nutrients and different sources of silicon or the combination of nutrients consortia might help other horticultural crops and agricultural crops to have improved quality traits under different environmental conditions.

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