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Effect of foliar application of calcium and magnesium on growth and yield of tomato (*Solanum lycopersicum* L.) variety Marglobe

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Abstract
An investigation entitled "Effect of foliar application of Calcium and Magnesium on growth and yield of tomato (*Solanum lycopersicum* L.) Variety Marglobe" was carried out at Vegetable Experimental farm of Division of Vegetable Science SKUAST-Kashmir, Shalimar during Kharif 2017. There were nine treatments *viz*., T_1 (Magnesium @ 0.2%), T_2 (Magnesium @ 0.4%), T_3(Calcium @ 0.3%), T_4(Calcium @ 0.6%), T_5(Calcium @ 0.3% + Magnesium @ 0.2%), T_6 (Calcium @ 0.3% + Magnesium @ 0.4%), T_7 (Calcium @ 0.6% + Magnesium @ 0.2%), T_8 (Calcium @ 0.6% + Magnesium @ 0.4%), T_9 (Control).The experiment was laid out in Randomized Complete Block Design with three replication. The observation on growth, and yield were recorded. Among all the treatments T_8 (Calcium@0.6% + Magneseum@0.4%) recorded maximum plant height (114.45cm), plant spread (64.24cm), number of fruits plant^{-1} (14.15), fruit length (5.60cm), fruit diameter (6.73cm), average fruit weight (63.86g), flesh thickness (1.98cm) fruit yield plot $^{-1}$(14.45kg) and fruit yield ha $^{-1}$(331.22q).Treatment (T_8) recorded the minimum days to first flower (25.82) and days to first fruit set (31.44). Thus, T_8 (Calcium@0.6% + Magneseum@0.4%) was the best treatment among all the nine treatments.

Keywords: Tomato (*Solanum lycopersicum*), calcium chloride, magnesium chloride, growth, yield

Introduction
Tomato (*Solanum lycopersicum* L. 2n = 24) is second most popular and widely grown and consumed vegetable crops, in the world after potato. Tomato belongs to the family Solanaceae and it is believed to have originated in the coastal strip of western South America. Tomato shows a wide climatic tolerance and can be grown in the open wherever there is more than three months of frost free weather. Tomato grows more successfully in areas, where there are long sunny periods. The optimum growing temperatures are 21ºC to 24ºC.Application of proper dose of nutrient can increase the yield and maintaining soil fertility. Generally, a balanced supply of nutrient is essential for optimum growth and yield of tomato. Calcium and magnesium being secondary macronutrient are essential for normal growth and development of tomato. Calcium plays an important role in the structure of cell walls and cell membranes, fruit growth and development (Kadir, 2004) [12]. Calcium has been reported to increase the yield of tomato when used as a fertilizer (Akhtar *et al.*, 2010) [2]. Thus plants need a constant supply of calcium for vigorous leaf and root development and canopy growth (Del-Amor *et al.*, 2003) [6]. Calcium concentration in the nutrient solution, increased leaf area and fruit fresh weight (Rubio *et al.*, 2009). [18].Magnesium is also an important nutrient required by plant as it is a major constituent of cell wall. It is constituent of the chlorophyll molecule and an enzyme activator for a number of energy transfer reactions. Plants inadequately supplied with magnesium show delay in reproductive phases, the shortage of chlorophyll results in poor and stunted plant growth. Foliar application is based on the principle that the nutrients are quickly absorbed by the leaves and transported to different parts of the plant to fulfill the functional requirement of nutrients.

Material and Methods
The present investigation entitled "Effect of foliar application of Calcium and Magnesium on growth and yield of tomato (*Solanum lycopersicum* L.) Var. Marglobe" was carried out at an Experimental Field of Division of Vegetable Science,

SKUAST-Kashmir, Shalimar, Srinagar (J&K). The experimental field (site) was situated at 35.1º North latitude and 74.89º East longitude with an altitude of 1606 meters above mean sea level. Healthy and vigorous seedlings of uniform size were transplanted in well prepared and fertilized plots at a spacing of 60×45 cm. Concentration of treatments was Ca (0, 0.4%, and 0.6%) and Mg (0, 0.2%, and 0.4%). The basal dozes of N @ 120 kg ha 1, P @ 90 kg ha 1 and K 60 kg ha 1 were applied by using urea, diammonium Phosphate (DAP) and murate of potash sources (MOP). Phosphorus, potassium and half nitrogen were mixed with soil before transplantation, while the remaining nitrogen was applied after two weeks of transplantation. During the research all other cultural activities like weeding, hoeing, irrigation were carried out at proper time. Solution of Ca and Mg were prepared for each treatments and replication. The Ca and Mg were applied as a foliar application four time i.e. Vegetative phase, flowering, fruit setting and at mature fruit stage. Sources of Ca and Mg used were $CaCl_2$ and $MgCl_2$, respectively. The height was measured from ground level to the tip of main shoot and the mean was calculated and expressed in centimeters. Plant spread was measured in centimeters as average spread from north to south and east to west direction at final harvest. The number of days taken from transplanting to the appearance of first flower was calculated. The number of days taken from transplanting to the setting of first fruit was calculated**.** The length of fruit from five randomly selected plants of each treatment was measured from the base in centimeters and their average was calculated. Diameter of fully mature fruit was measured with the help of digital vernier calliper in centimeters. Total number of fruits harvested at different pickings from five randomly selected plants in each treatment was added and average was calculated to work out fruit number plant^{-1}. Fresh weight of tomato fruits from each treatment from five randomly selected plants was calculated at maturity and an average was calculated. Flesh thickness of mature fruit was calculated with the help of Vernier Caliper. Fruits from all the plants were harvested and weighed and the fruit yield per plot was worked out.

Results and Discussion

Plant height (cm) and plant spread (cm)

Among different treatments, treatment T_8 (Calcium @ 0.6%+ Magnesium @ 0.4%) recorded maximum plant height of 114.45 cm and maximum plant spread of 64.24 cm.(table 1) Calcium, Magnesium and their interaction significantly increased plant height and plant spread. The superiority of this combination may be attributed to the fact that application of calcium increases plant height and spread by activating enzymes which promotes cell mitosis, division and elongation. Magnesium play a key role in the growth and improvement of new cells and thus with the application of magnesium more growth occurs. These results are similar to Abdur & Ihsan-ul-Haq (2012) [1], Janet *et al.* (2016), El-Hadidi *et al* (2017) [8] and Ilyas *et al.* (2014) [9]. (Table 1)

Days to first flower and Days to first fruit set

Among different treatments, T_8 (Calcium@ 0.6%+ Magnesium@ 0.4%) registered minimum number of days to flower *viz*., 25.82 and minimum number of days to first fruit set *viz*., 31.44 days. It is well established fact that the phase of rapid vegetative enlargement in most annuals is characterised by progressive increase in absolute amounts of inorganic elements. The superiority of the treatment T_8 *viz*. (Calcium @0.6% + Magnesium @ 0.4%) may be attributed to the fact that combination treatment T_8 might have led to better metabolic activity and translocation of nutrient because calcium and magnesium are known to be involved in the metabolic activity, translocation of these nutrients from leaves to the shoot apical meristem. Calcium and magnesium helps to facilitate the rapid division of cells changing the plant growth from a vegetative process to a reproductive phase. Calcium is involved in a wide range of processes in plants including flower induction. Plants inadequately supplied with Magnesium show delay in reproductive phases thus magnesium plays an important role in flower induction. Similar results have been reported by Theresa and Adesh (2018) [19], Bose *et al.* (2006) [4] and Dixit *et al.* (2018) [7]. (Table: 2)

Fruit length (cm), Fruit diameter (cm) Flesh thickness (cm) and Average fruit weight (g)

Among all the treatments, T_8 (Calcium @ 0.6% + Magnesium @ 0.4%) recorded maximum fruit length of 5.60cm, maximum fruit diameter of 6.73 cm, maximum flesh thickness of 1.98 and highest average fruit weight of 63.86g.(table 1) This can be attributed to the role of calcium and magnesium in cellular functions such as activation of enzyme, photosynthesis and carbohydrate metabolism. Calcium activates the enzyme responsible for increasing mitosis, cell splitting as well as to increase the size of the cell also improves mobilization of assimilates to developing fruits. Magnesium also helps in speed up the enzyme activity, play important role in energy transport reactions, carbohydrate metabolism and greater diversion of food material and also increases stimulates the transport of nutrient and modify the strength of sink by stimulating its growth thus increases size, flesh thickness and weight of fruit. Results are in accordance with the findings of Ilyas *et al.* (2014) [9], Ayyub *et al.* (2012) [3], Kashinath *et al.* (2015) [13], Abdur and Ihsan-ul-haq (2012) [1], Peter *et al* (1999) [17], Budak and Erdal (2016) [5]. (Table 1)

Number of fruits per plant, Fruit yield per plot (kg) and Fruit yield per hectare (q ha^{-1})

Among the different treatments, T_8 (Calcium @ 0.6% + Magnesium @ 0.4%) recorded maximum number of fruits plant^{-1} *viz*., 14.15, maximum fruit yield of 14.45 kg plot^{-1} and maximum yield of 331.22 q ha^{-1},(table 2) marking yield increase of 23% over control. Results can be attributed to the fact that Calcium nutrition is involved in increasing mineral contents, flower cluster, fruit set percentage and reducing physiological disorders which may have led to higher yield. The beneficial effect of magnesium on yield and yield parameters may be due to the reason that magnesium is important in the process of photosynthesis and improves plant uptake of nitrogen and phosphorus therefore increases the production. Calcium and Magnesium are involved in enhancing pollen germination, growth, act as activators of enzyme and make available sufficient amount of carbohydrate. Their deficiency may cause abscission of flowers and sufficient amounts increases fruit set percentage due to increased resistance against flower drop in plants which further increase the number of fruits and thus yield. These results are in conformity with finding of Ilyas *et al.* (2014) [9], Ilyas *et al.* (2016) [10], Kashinath *et al.* (2014) [14], Ayyub *et al.* (2012) [3] and Nadeem *et al.* (2013) [16]. (Table 1)

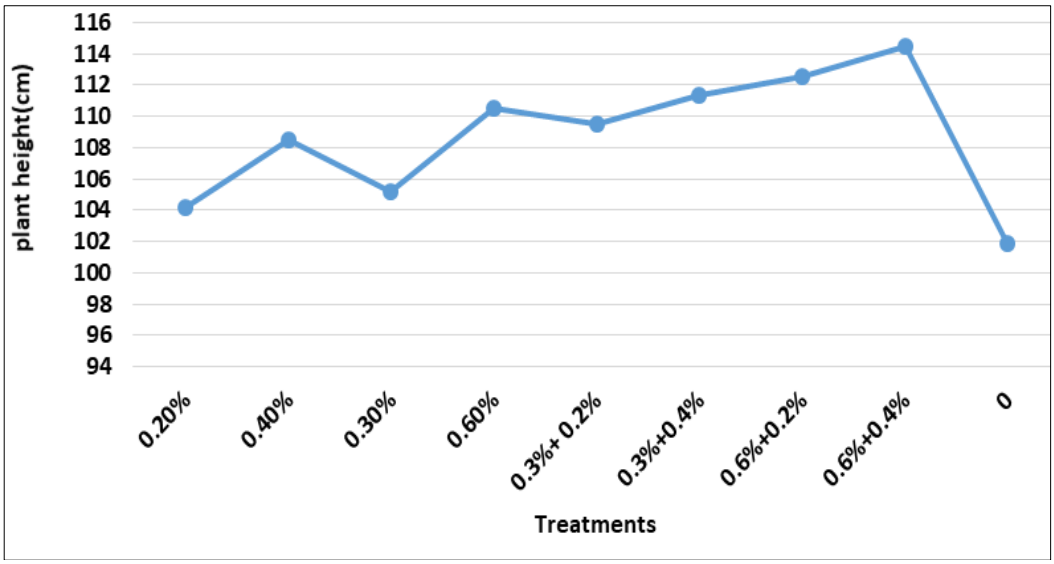
Table 1: Effect of foliar application of Calcium and Magnesium on plant height, plant spread, fruit length, fruit diameter, flesh thickness, average fruit weight.

Treatment code	Treatment Combinations	Plant height	Plant spread	Fruit length	Fruit diameter	Flesh thickness	Average fruit weight
T_1	Mg 0.2%	104.15	57.20	4.13	5.10	1.26	58.09
T_2	Mg 0.4%	108.45	58.10	4.38	5.25	1.38	58.35
T_3	Ca 0.3%	105.19	57.56	4.20	5.12	1.29	58.29
T_4	Ca 0.6%	110.52	59.05	5.00	5.75	1.54	60.84
T_5	Ca0.3% Mg 0.2%	109.52	58.66	4.91	5.58	1.44	59.88
T_6	Ca 0.3% Mg 0.4%	111.36	60.16	5.20	5.89	1.62	61.72
T_7	Ca0.6% Mg 0.2%	112.55	63.03	5.49	6.32	1.85	62.41
T_8	Ca0.6% Mg 0.4%	114.45	64.24	5.60	6.73	1.98	63.86
T_9	Control	101.84	56.90	4.01	5.03	1.03	57.41

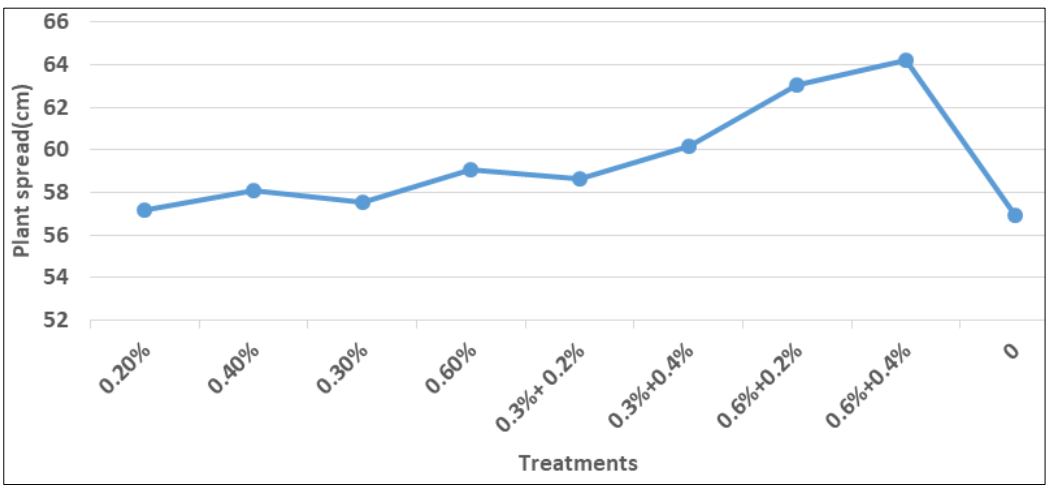
Table 2: Effect of foliar application of Calcium and Magnesium on days to first flower, days to fruit set, no.of fruits per plant, yield/plot(kg), yield/ha(q)

Treatment Code	Treatment Combinations	Days to first flower	Days to first set	No. of fruits per plant	Yield per plot(kg)	Yield per ha (q)
T_1	Mg 0.2%	29.02	36.02	13.01	12.10	277.23
T_2	Mg 0.4%	28.69	35.50	13.35	12.45	285.34
T_3	Ca 0.3%	28.91	35.98	13..06	12.18	279.14
T_4	Ca 0.6%	27.32	33.56	13.76	13.42	305.33
T_5	Ca0.3% Mg 0.2%	28.44	34.11	13.44	12.88	295.60
T_6	Ca 0.3% Mg 0.4%	27.13	33.03	13.91	13.74	314.70
T_7	Ca0.6% Mg 0.2%	26.09	31.81	14.10	14.07	322.34
T_8	Ca0.6% Mg 0.4%	25.85	31.44	14.15	14.45	331.22
T_9	Control	29.68	36.78	12.70	11.66	268.24

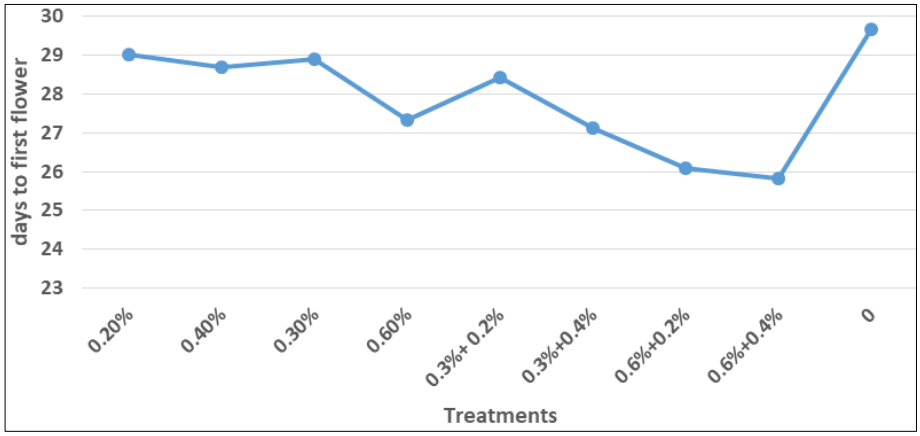
Graphs representing the various parameters



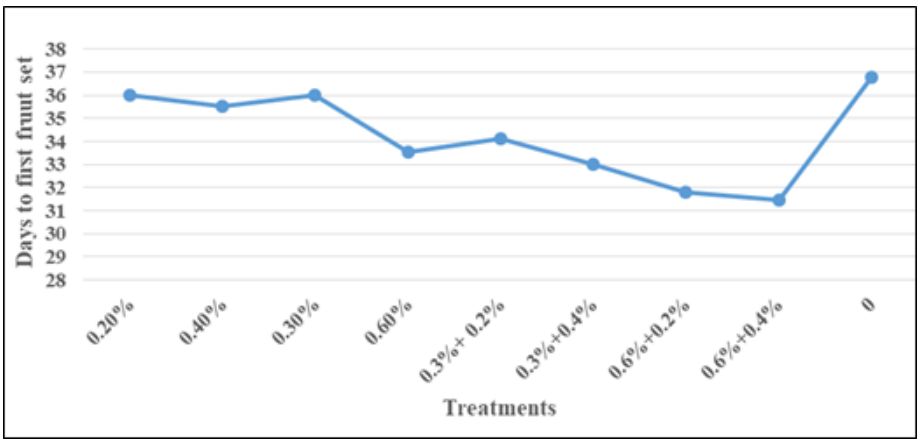
Plant height (cm)



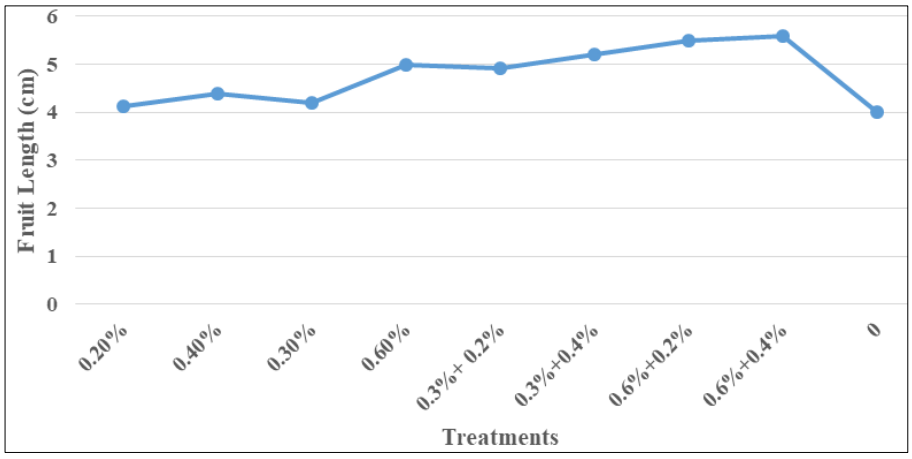
Plant spread (cm)



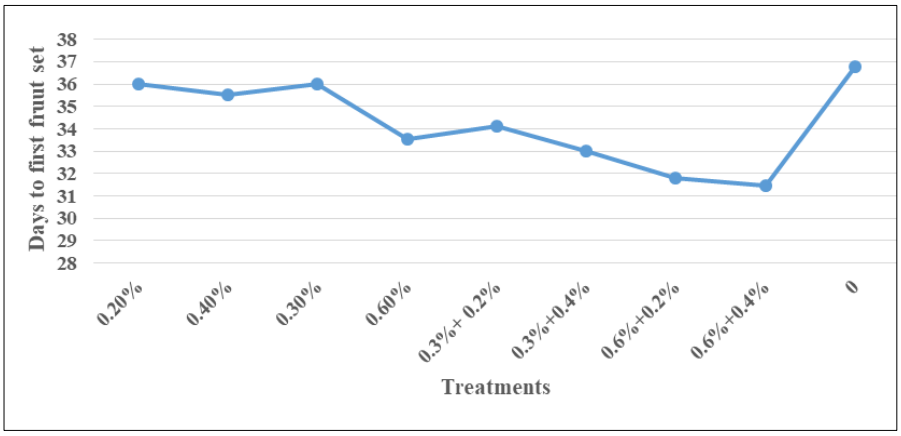
Days to first flower



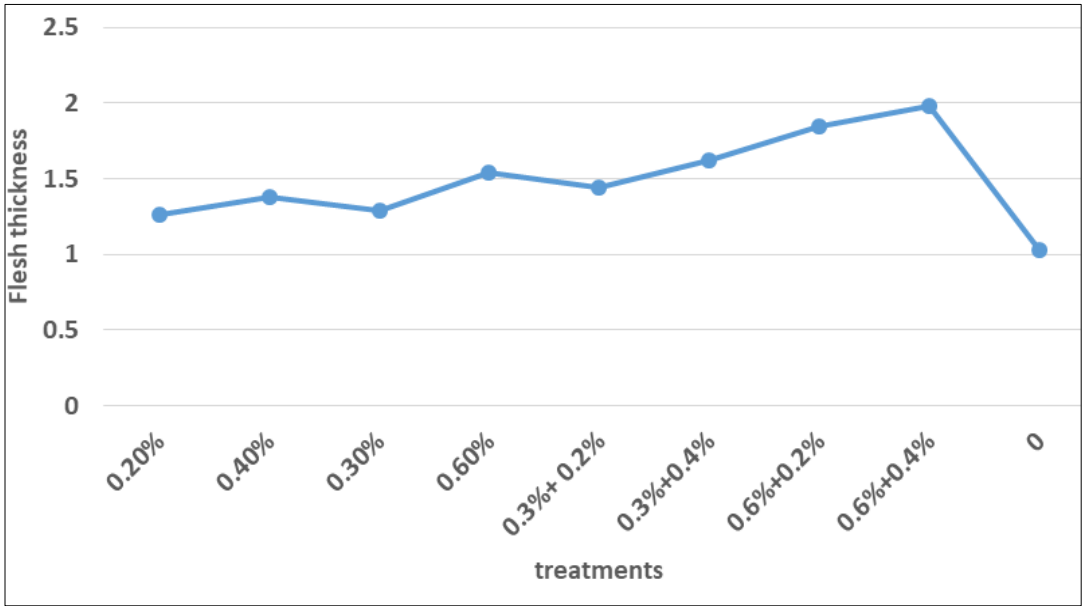
Days to first fruit set



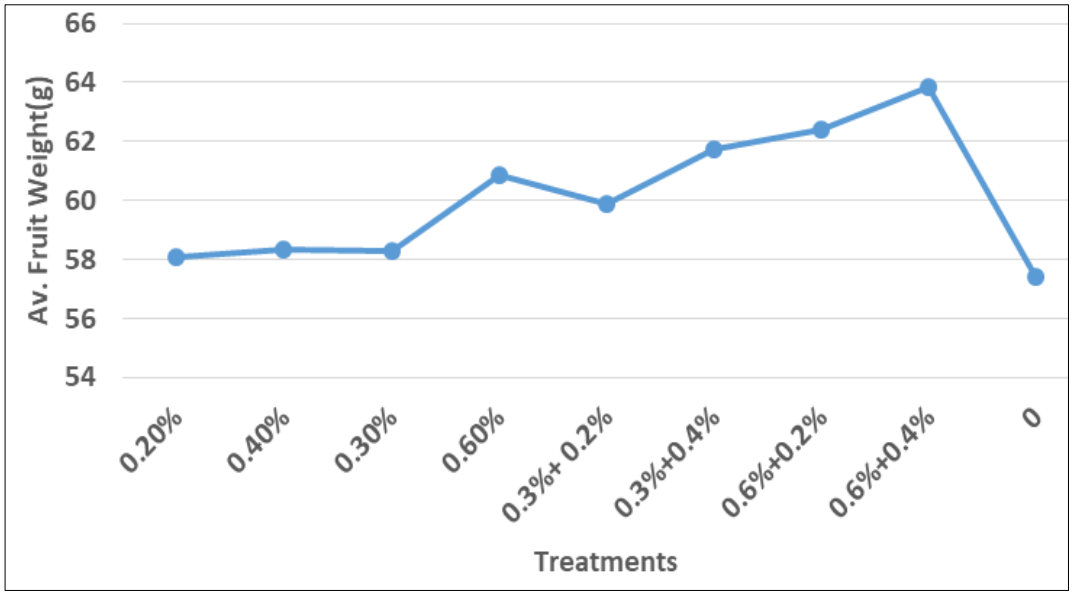
Fruit length (cm)



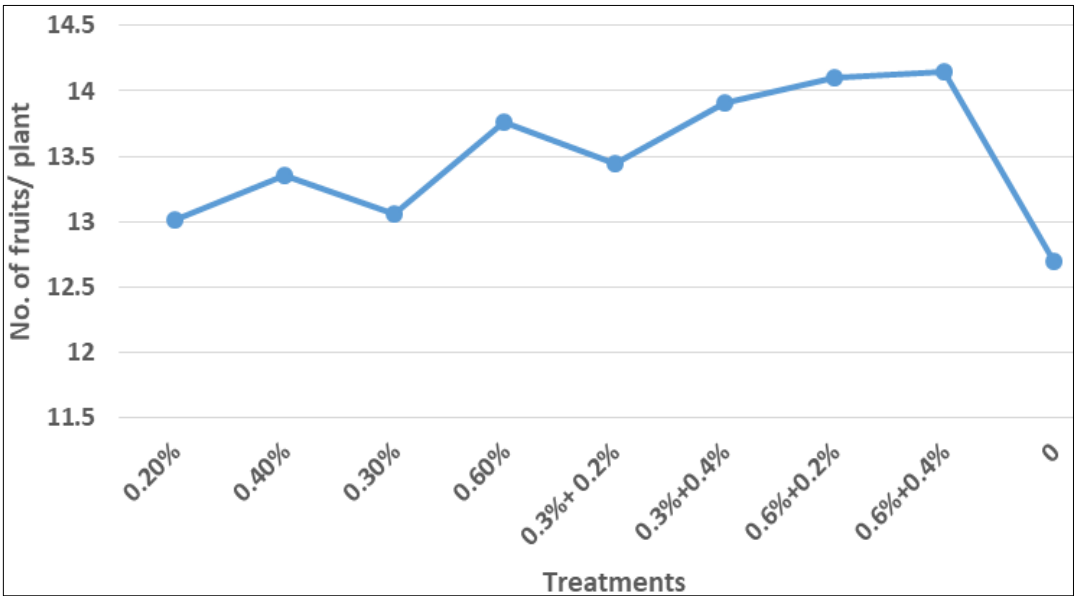
Fruit diameter (cm)



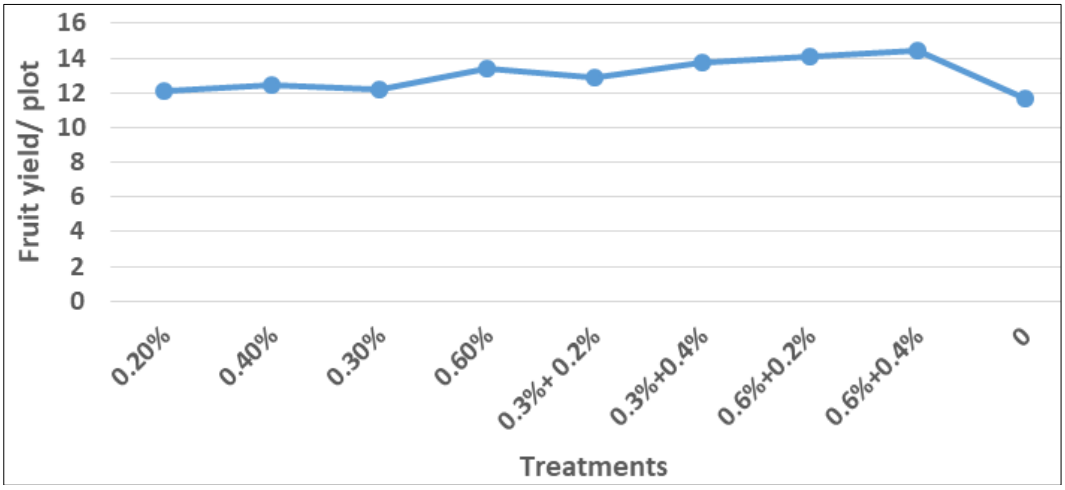
Flesh thickness (cm)



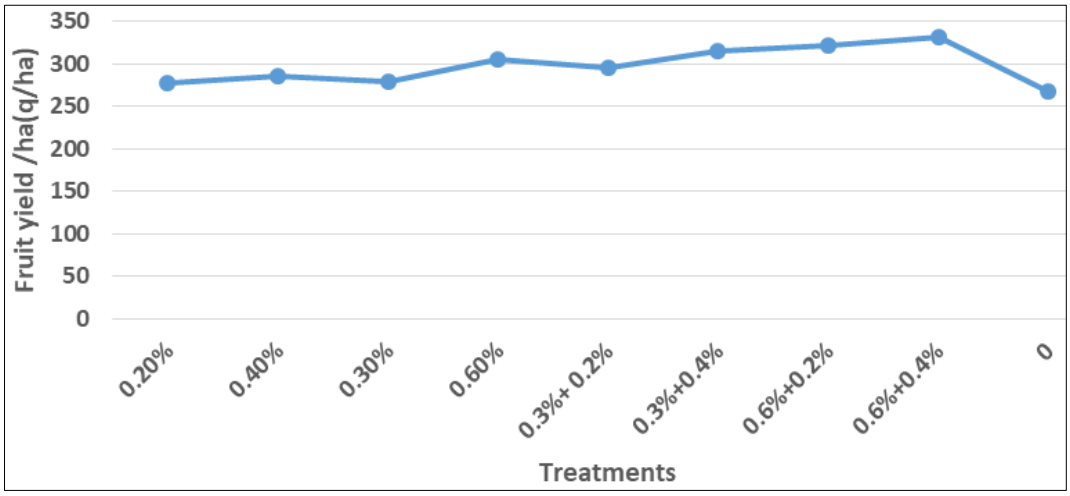
Fruit weight (g)



No. of fruits/plant



Fruit yield/plot



Fruit yield/ha. (q/ha)

Conclusion

It can be concluded that amongst various treatments, applications of treatment,T_8 (Calcium @ 0.6% + Magnesium @ 0.4%) proved better with respect to growth and yield parameters *viz*., plant height (cm), plant spread (cm), days to first flower, days to first fruit set, fruit length (cm), fruit diameter(cm), flesh thickness(cm), average fruit weight (g), number of fruits plant^{-1}, fruit yield plot^{-1} (kg), fruit yield hectare^{-1} (q ha^{-1}).

References

1. Abdur RAB, Ihsan ul Haq. Foliar application of calcium chloride and borax influences. Plant growth, yield and quality of tomato (*Lycopersicon esculentum* Mill.) fruit. Turkish Journal of Agriculture and Forestry. 2012; 36:695-701.
2. Akhtar ME, Khan MZ, Rashis MT, Ahsan Z, Ahmad S. Effect of potash application on yield and quality of tomato (*Lycopersicon esculentum* Mill.). Pakistan Journal of Botany. 2018; 42: 1695-1702.
3. Ayyub CM, Muhammad AP, Muhammad RS, Muhammad IA *et al*. Assessment of various growth and yield attributes of tomato in response to pre-harvest applications of calcium chloride. Pakistan Journal of Life and Social Science. 2010-2012; 10(2):102-105.
4. Bose P, Sanyal D, Majumdar K. Balancing potassium, sulphur and magnesium for tomato and Chilli grown on red lateritic soil. Better Crops. 2006; 90:215-218.
5. Budak Z, Erdal I. Effect of foliar calcium application on yield and mineral nutrition of tomato cultivars under greenhouse condition Journal of Soil Science and Plant Nutrition. 2016; 4(1):1-10.
6. Del Amor FK, Marcelis LFM. Regulation of nutrient uptake, water uptake and growth under calcium starvation and recovery. Journal of Horticulture Science Biotechnology. 2003; 78:343-349.
7. Dixit A, Sharma D, Sharma TK, Bairwa PL. Effect of foliar application of some macro and micronutrients on growth and yield of tomato (*Solanum lycopersicum* L.) cv. Arka Rakshak International Journal of Current Microbiology and Applied Sciences. 2018; 6:197-203.
8. El Hadidi EM, El Dissoky RA, Amal AH, Abd El Hafez. Foliar calcium and magnesium application effect on potato crop grown in clay loam soils. Journal of Soil Science and Agricultural and Engineering Mansoura University. 2017; 8(1):1-8.
9. Ilyas M, Gohar A, Zahid H, Manzoor A, Baseerat B, *et al*. Response of tomato to different levels of calcium and magnesium concentration. World Applied Sciences Journal. 2014; 31(9):1560-1564.
10. Ilyas M, Manzoor A, Zahid H, Saeed A, Begum F, Shah L *et al*. Interactive effect of calcium and magnesium on the growth and yield of tomato (*Lycopersicon esculentum* L.). Pure and Applied Biology. 2016; 5(4):876-882.
11. Janet C, Cole MW, Smith CJ, Penn BS, Cheary K, Conaghan, J. Nitrogen, phosphorus, calcium and magnesium applied individually or as a slow release or

controlled release fertilizer increase growth and yield and affect macronutrient and micronutrient concentration and content of field-grown tomato plants. *Scientia Horticulturae.* 2016; 211:420-430.
12. Kadir SA. Fruit quality at harvest of 'jonathan' apple treated with foliar applied calcium chloride. Journal of Plant Nutrition 2004; 27:1991-2006.
13. Kasinath BL, Ganeshamurthy AN, Nagegowda NS. Effect of Magnesium on plant growth, dry matter and yield in tomato (*Lycopersicon esculantum* L.). Journal of Horticulture Science. 2015; 10:190-193.
14. Kasinath BL, Ganeshmurthy AN, Sadashiva AT. Interaction effect of applied calcium and magnesium on alfisols of Karnataka and its influence on uptake and yield levels of tomato (*Solanum lycopersium* L.). Journal of Horticulture Science. 2014; 9(2):179-184.
15. Nadeem AA, Lubna Z, Aziz HK, Abdul AQ. Effects of naphthalene Acitic acid and calcium chloride application on nutrient uptake, growth, yield and post-harvest performance of tomato fruit. Pakistan Journal of Botany. 2013; 45(5):1581-1587.
16. Peter MA, Toivonen, Bowen PA. The effect of preharvest foliar sprays of calcium on quality and shelf life of two cultivars of sweet bell peppers (*Capsicum annuum* L.) grown in plasticulture Canadian Journal of Plant Science. 1999; 79(3):411-416.
17. Rubio JS, Garcia Sanchez F, Rubio F, Martınez V. Yield, blossom-end rot incidence and fruit quality in pepper plants under moderate salinity are affected by K+ and Ca^{2+} fertilization. Scientia Horticulturae. 2009; 119:79-87.
18. Theresa Manong'a, Adesh Kumar. Effect of growth promoting and resistance inducing chemicals on yield attributing characteristics of tomato. Journal of pure and applied Microbiology, 2018.
19. Wilcox J, Catignani G, Lazarus C. Tomatoes and cardiovascular health. Crit. Rev. Food Science and Nutrition. 2003; 43(1):1-18.