International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print) 2222-5234 (Online)
http://www.innspub.net
Vol. 17, No. 1, p. 238-244, 2020

RESEARCH PAPER OPEN ACCESS

Exogenous foliar application of calcium chloride on the incidence of blossom end rot of Tomato (*Solanum Lycopersicum*) under High Tunnel in Punjab

M. Irfan Ashraf[1], Bakhatawar Liaqat*[2], Laraib Anam[2], Shazia Kiran[2], M. Bilal Shaukat[1], Zohaib kaleem[3]

[1]*Institute of Horticultural Sciences, University of Agriculture, Faisalabad, Pakistan*

[2]*Department of Botany, University of Agriculture, Faisalabad, Pakistan*

[3]*Continuing Education, University of Agriculture, Faisalabad, Pakistan*

Key words: Tomato, Blossom end rot, Saandal F_1, Calcium chloride

http://dx.doi.org/10.12692/ijb/17.1.238-244 Article published on July 30, 2020

Abstract

Tomato (*Solanum lycopersicum*) is among the most important vegetables all around the world. Blossom end rot is a disorder that is caused by deficiency of calcium that deficiency gradually leads to the necrosis of tissues and ultimately stopped the plant growth. In tomato, fruit appears as sunken, dry and decaying areas at the blossom-end of the fruit. This Study was conducted to find out the impact of foliar application of various concentrations of Calcium Chloride ($CaCl_2$) on tomato hybrid "Saandal F_1". Different concentrations of Calcium Chloride ($CaCl_2$) were prepared with distilled water ($CaCl_2$ 0.5g L-1 of water), ($CaCl_2$ 0.75g L-1 of water) and ($CaCl_2$1.0g L-1 of water) and sprayed three times during plant growth by 20 days interval with a sprayer. The Exogenous application of Calcium chloride ($CaCl_2$) showed a significant effect on plant height, number of fruits/plant, flower clusters/plant, Fruit weight, Fruit TSS, fruit set percentage, fruit pH, number of diseased fruits and blossom end rot incidence. Calcium chloride ($CaCl_2$) at concentration pf 1.0g L-1 of water showed significant results. Hence, tomato growers can adopt this simple management tool for improving quality and yield of tomato in the world.

* **Corresponding Author:** Bakhatawar Liaqat ✉ bakhatawarliaqat777@gmail.com

Introduction

Tomato (*Solanum lycopersicum*) is an important and highly nutritious vegetable consumed all over the world in raw as well as cooked form. Tomato is a healthy source of minerals like phosphorus, iron, vitamins A and C and many other dietary fibers, sugars and essential amino acid especially lycopene and salicylate (Afzal *et al.*, 2013). Global production of tomato was recorded in 2017 that was 182,301,395 metric tonnes, an enhanced from 179,508,401 tonnes (1.6%) in 2016. Among all countries China is the largest producer of tomato, producing 33% of total world production (FAOSTAT, 2017). Production of Tomato in Pakistan was recorded in 2015 that was 57094 tons generated by 150 thousand hectare of area. Among the provinces of Pakistan, Sindh is producing more production by an area of 67.46 thousand hectares and Balochistan with 31.38 thousand hectare of area while Punjab is cultivating 18.29 thousand hectare of area (Qasim *et al.*, 2018). Production of tomato is a valuable source of income in urban and rural areas of developing countries of the world. Despite that in various parts of the world profit can be taken, postharvest is unprofitable in most parts of the world due to low production. Growers suffers and also the country trade due to low return in foreign exchange (Arah *et al.*, 2015). The foliar spray is quickly taken by the tomato plants, it enhance the color of fruit. The nutrition depend upon the amount of chemical sprayed by this method (Afzal *et al.,* 2015).

Blossom end rot is a disorder that is caused by deficiency of calcium that deficiency gradually leads to the necrosis of tissues and ultimately stopped the plant growth. In tomato, fruit appears as sunken, dry and decaying areas at the blossom-end of the fruit (Vinh *et al.*, 2018). Furthermore, to cure this disorder different treatments are used including application of agricultural lime to maintain pH at 6.5, organic matters, calcium nitrate and calcium chloride (*Fake, Cindy 2010)*. Calcium plays important role in various plant functions including but not limited to biotic and abiotic signals and other developmental process including intracellular messengers and mediating responses to hormones (Reddy and Reddy 2004). Fruit yield and quality depend on the variety, management practices and environmental factors during crop span (Ahmad *et al.*, 2011). Blossom end rot in tomato is reduced by the application of calcium (Taylor and Locascio 2004). Calcium application is reported to improve tomato firmness and shelf life. Calcium chloride also softens the fruit which is previously irradiated (Ritenour *et al.*, 2006). The calcium chloride solution improved the shelf life of tomato (Prakash *et al.*, 2007). Hence, present study was conducted to evaluate the effect of foliar application of $CaCl_2$ on incidence of blossom end rot fruit quality and yield of tomato under high tunnel.

Materials and methods

This Study was conducted at the Vegetable Research Area, Institute of Horticultural Sciences, University of Agriculture Faisalabad. The variety Sandal F_1, commercially recommended tomato hybrid for high tunnel in Punjab was taken from Vegetable Research Institute, Faisalabad. Research was accompanied subsequent Randomized Complete Block Design (RCBD) with three replications and each replication contain five plants. Data was analyzed statistically using Fisher's study of alteration method (Steel *et al.*, 1997).

Different concentrations of $CaCl_2$ T_0: (Water spray as control), T_1: ($CaCl_2$ 0.5g L-1 of water), T_2: ($CaCl_2$ 0.75g L-1 of water) and T_3: ($CaCl_2$ 1.0g L-1 of water) were prepared with distilled water and sprayed three times by 20 days interval between treatments with a sprayer. After transplantation of seedlings first irrigation was applied through drip. Later on irrigation's were applied as per crop requirements, usually at interval of two to three days. Moreover, crop was fertigated using 5Kg NPK (17:17:17) per kanal, three times upto March, 2018. Ammonium Nitrate (AN) @ 15Kg per kanal was applied three times in furrows. Hoeing and weeding was practiced frequently only in furrows between beds. Weeding practice was performed as per requirement. Dual Gold weedicide was applied in furrows in between the beds once in whole season. Plastic sheet was adjusted vertically during spray near tomato plants to keep the plants away from herbicide fumes. Tomato plants were sprayed twice with fungicide (2.5g Mancozeb L^{-1}. of water) at ten to fifteen days interval for controlling of fungal diseases, while insecticides (Imidacloprid and Match) were applied to protect the crop from fruit borer and aphid attack, respectively.

Data was recorded for various parameters including; plant height(cm), fruit/plant, diseased fruits/plant, fruit weight (g), fruits weight/plant(g), fruit size (mm), fruit set percentage (%), flower cluster/plant, compound leaves/plant, dry weight (g), fruit Firmness and bio-chemical parameters; Total Soluble Solids (Brix^o), Titratable Acidity (gL^{-1}), Electrical Conductivity (Sm^{-1}), Vitamin C (mg100g), fruit pH and Blossom End rot %. Data was recorded by using following methods.

Plant Height (cm)

It was measured after third picking with the help of measuring tape.

Number of Fruit per Plant

Number of Fruit per plant was determined by counted the fruits from each selected plant.

Number of diseased fruit per plant

Number of diseased fruit plant was counted from the selected plants.

Individual fruit weight (g)

It was measured by using electrical weighing scale.

Size of fruit (mm)

Digital Vernier Caliper was used to determine fruit diameter of tomato fruits from central widest point of the fruit.

Fruit set percentage (%)

The number of total female flower and fruit set on the selected plants were counted and their percentage was calculated as:

$$\text{Fruit set percentage} = \frac{\text{Number of fruits per vine}}{\text{Number of male flower per vine}} \times 100$$

Fruit Weight per plant (g)

Weight of five randomly selected fruits from each treatment (second picking) was measured in the laboratory with the help of electrical balance.

Number of flower cluster per Plant

Number of flower cluster was counted from selected plants and then average values were calculated. It was when 50% clusters were opened.

Number of compound leaves per plant

Number of compound leaves per plant were counted from selected plant in each treatment and average value was calculated.

Dry weight (g)

The fruit of tomato were dried under sunlight until moisture content was removed. The dry matter was calculated by using electrical weighing scale.

Fruit Firmness (lb)

Fruit firmness of five fresh red fruits from each treatment was determined with the help of Texture Analyzer (Model BTIFBOOSTN. D14, Zwick GmbH & Co. Germany) in postharvest lab, University of Agriculture, Faisalabad. Speed of the instrument was 400mm.

Total Soluble Solids (Brix^o)

Total soluble solids (TSS) were determined using the standard method described in (AOAC 1998).

Titratable Acidity (g/L)

Titratable acidity (TA) was estimated by Mohammadi Aylar *et al.*, 2010.

Electrical Conductivity (Sm^{-1})

Electrical conductivity was determined by using digital EC meter.

Vitamin C ($mg100g^{-1}$)

Vitamin C contents were measured by Ruck Analysis (Ruck, 1969) and method of Association of Official Analytical Chemists was used for quantitative determination of ascorbic acid by using a dye 2, 6-dichlorophenolindophenol as an indicator. (AOAC, 2006).

Fruit pH

Determination of pH was done by pH meter.

Blossom end rot incidence (%)

The incidence of Blossom end rot (%) was estimated by count the total number of fruits and fruits showing symptoms of blossom end rot in each plot. The blossom end rot incidence is expressed as a percentage of total fruits.

Results and discussion

Maximum plant height was obtained from T_3 ($CaCl_2$1.0g L-1 of water) as compared to T_0 (control) treatment. The plant height in T_3 ($CaCl_2$1.0g L-1 of water) treatment increased up to 106.67cm which was maximum. Similar results were reported by Sathya *et al.*, 2010. Treatment T_3 ($CaCl_2$ 1.0g L-1 of water) increased number of fruit up to 29 fruit/plant which was maximum while control treatment T_0 (water spray) produced 25 fruit/plant which was less than all treatments Desouky *et al.*, 2009. Results showed the number of fruits/plant significantly increased by the application $CaCl_2$ from control.

Treatment T_0 (control) showed the large number of diseased fruit/plant whereas T_3 ($CaCl_2$ 1.0g L-1 of water) showed minimum number of diseased fruit/plant. Similar result were described by Coolong *et al.*, (2014) that average number of diseased fruit/plant decreased significantly by foliar spray of “name and concentration of salt”.

Moreover, treatment T_0 produced fruits with minimum fruit diameter of 13.2mm in given experimental conditions. Abd-el Hamied *et al.*, (2018) showed the similar results that size of fruits (mm) was increased with $CaCl_2$ application.

Maximum fruit set percentage was recorded in T_3 ($CaCl_2$1.0g L-1 of water) treatment 77% while minimum fruit set percentage was observed in treatment T_0 (control) 40%. Maximum number of flower per cluster up to 14 from T_3 ($CaCl_2$1.0g L-1 of water) treatment which was maximum while control treatment T_0 produced 8.7 flower cluster per plant which was less than all treatments.

Treatment T_3 ($CaCl_2$1.0g L-1 of water) produced fruits with highest dry weight of 8.9 g while treatment T_0 produced fruits with minimum fruit weight of 7.8g. The results found are in agreement with the findings of Kashif *et al.*, (2007).

Treatment T_3 ($CaCl_2$1.0g L-1 of water) exhibited highest value 3.4 of pH value and treatment T_0 (water spray) was recorded to have minimum pH value of 2.8. Senevirathna and Daundasekera (2010) experiment showed that fruit firmness increased with higher $CaCl_2$ levels according to % TA values, fruit firmness was reduced to significant levels with the decreased level of $CaCl_2$.

Total Soluble Solids (Brix°) were recorded maximum (6.3 Brix°) in treatment T_3 ($CaCl_2$1.0g L-1 of water) and minimum in treatment T_0 (4.3 Brix°). Senevirathna and Daundasekera (2010) experiment shows the similar result TSS content in fruits significantly increased with $CaCl_2$ treatment.

Maximum Titratable acidity was recorded 0.52gL^{-1} in treatment T_3 while minimum level of TA was observed 0.47gL^{-1} in treatment T_0. Senevirathna and Daundasekera (2010) result showed that TA values increased with higher $CaCl_2$ levels and gave significant results. However, treatment T_3 ($CaCl_2$1.0g L-1 of water) exhibited highest value 4.4Sm^{-1} of Electrical conductivity and treatment T_0 was recorded to have minimum EC 2.9Sm^{-1}. Abdel-Hameed and El-hady (2018) experiment showed the same result that electric conductance in fruits significantly increased with $CaCl_2$ treatment.

Treatment T_3 ($CaCl_2$1.0g L-1 of water) exhibited highest value (25.6mg 100g^{-1}) of ascorbic acid and treatment T_0 was recorded to have minimum vitamin C contents (18 mg 100g^{-1}). Kazemi *et al.*, (2014) experiment shows the similar result vitamin C in fruits significantly increased with $CaCl_2$ treatment.

However, treatment T_0 exhibited highest value 4.2 of pH value and treatment T_3 ($CaCl_2$1.0g L-1 of water) was recorded to have minimum pH value of 3.2. Senevirathna and Daundasekera (2010) experiment shows result that pH would increase with higher

$CaCl_2$ levels according to % TA values, pH was reduced to insignificant levels with the increased level of $CaCl_2$ concentration.

Table 1. Effect of exogenous foliar application of concentrations of calcium chloride on the vegetative attributes of Tomato.

Treatments	Diseased fruit/plant	Individual fruit weight (g)	Fruit weight/ plant (g)	Size of fruit (mm)	Fruit set percentage (%)	Fruit Firmness
T_0	2.33aa	53.09d	1365.4d	13.25d	40.56c	2.84c
T_1	2.00abc	56.33bc	1599.2c	14.45bc	53.00bc	3.30ab
T_2	1.67bcd	58.75ab	1629.3ab	15.48ab	62.80ab	3.37ab
T_3	1.00d	64.41a	1658.7a	15.92a	77.00a	3.40a

Table 2. Effect of exogenous foliar application of concentrations of calcium chloride on the vegetative attributes of Tomato.

Treatments	Plant height (cm)	Dry fruit weight (g)	No. of Compound Leaves	Flower cluster/plant	Fruit/plant
T_0	84.33c	7.89c	21.32c	8.77c	25.00b
T_1	94.67bc	8.81abc	25.16ab	9.50bc	27.66ab
T_2	103.33ab	8.84ab	30.90ab	11.66ab	28.33ab
T_3	106.67a	8.90a	33.26a	14.06a	29.66a

Table 3. Effect of exogenous foliar application of concentrations of calcium chloride on the biochemical attributes of Tomato.

Treatments	Total Soluble Solids (Brix°)	Titrateable acidity	Electrical Conductivity (Sm^{-1})	vitamin C	Fruit pH
T_0	4.30c	0.47c	2.99c	18.50c	4.26a
T_1	5.30bc	0.49b	3.030c	22.33bc	3.96ab
T_2	5.86ab	0.51ab	3.80ab	23.66ab	3.60bc
T_3	6.30a	0.52a	4.40a	25.62a	3.26c

Treatment T_0 (water spray) shows the large number of fruit with blossom end rot 7.1% whereas T_3 ($CaCl_2$1.0g L-1 of water) shows minimum number of fruit with blossom end rot 5.8%. Tonetto de Freitas *et al.,* (2013) performed an experiment and found similar findings.The blossom end rot content decreased with increase the concentration of application of calcium chloride. Taylor *et al.*, (2004) also find similar results and reported that blossom end rot decrease by foliar spray of calcium chloride.

Conclusion

It can be concluded from these results that exogenous application of $CaCl_2$ on tomato plants under high tunnel results in a significant increase in plant height, fruits per plant, cluster of flower per plant, and fruit set percentage as well as a decrease in fruit pH, number of diseased fruit and blossom end rot incidence. Application was more effective in increasing the, flowers per cluster, fruits per cluster, fruit weight, and TSS content of the fruit. For the various parameters studied, the high concentration of $CaCl_2$ resulted in significantly superior performance compared to either of the concentrations. Among all the concentrations of calcium chloride the T_3 shows significant results. This study also indicates that growers can adopt this simple management tool for improving quality and yield of tomato in the world.

References

Abdel-hameed A, El-Hady MA. 2018. Response of tomato plant to foliar application of calcium and potassium nitrate integrated with different phosphorus rates under sandy soil conditions. Egypt. J. Soil Sci **1,** 45-55.

Afzal I, Munir F, Ayub CM, Basra SMA, Hameed A, Shah F. 2013. Ethanol priming: an effective approach to enhance germination and seedling development by improving an-tioxidant system in tomato seeds. Acta Sci. Pol., Hortorum Cultus **12,** 129-137.

Ahmad I, Asif M, Amjad A, Ahmad S. 2011. Fertilization enhances growth, yield, and xanthophyll contents of marigold. Turk. J. Agric **35,** 641-648.

Akhtar A, Abbasi NA, Hussain AZH. 2010. Effect of calcium chloride treatments on quality characteristics of loquat fruit during storage. Pak. J. Bot **1,** 181-188.

Arah IK, Kumah EK, Anku EK, Amaglo H. 2015. An overview of post-harvest losses in tomato production in Africa: causes and possible prevention strategies. J. Biol. Agric. Healthcare **5,** 78-88.

Beckles DM. 2012. Factors affecting the postharvest soluble solids and sugar content of tomato (*Solanum lycopersicum* L.) fruit. Postharvest Biol. Technol **63,** 129-140.

Coolong T, Mishra S, Barickman C, Sams C. 2014. Impact of supplemental calcium chloride on yield, quality, nutrient status and postharvest attributes of tomato. J. Plant Nutr **14,** 2316-2330.

Desouky IM, Haggog LF, Abd-El-Migeed MMM, Kishk YFM, Hadi ES. 2009. Effect of boron and calcium nutrients sprays on fruit set, oil content and oil quality of some olive cultivars. World J Agric Sci **5,** 180-185

Fake, Cindy. 2010. Managing Blossom-End Rot in Tomatoes and Peppers. Horticulture and Small Farms Advisor, Nevada and Placer Counties. UCANR.

Hussain SA, A Haleema B, Rab and Hussain SA. 2018. Effect of calcium, boron and zinc foliar application on growth and fruit production of tomato. Sarhad J. Agric **1,** 19-30.

Kashif SR, Yaseen M, Arshad M, Abbas M. 2007. Evaluation of response of Calcium carbide as a soil amendment to improve nitrogen economy of soil and yield of okra. Soil and Environ **26,** 69-74.

Kazemi M. 2014. Effect of foliar application of humic acid and calcium chloride on tomato growth. Bull. Environ. Pharmacol. Life Sci **3,** 41-46.

Malik AM, Mughal KM, Mian SA, Khan AU. 2018. Hydroponic tomato production and productivity improvement in Pakistan. Pak. J. Agric. Res **31,** 133-135.

Prakash A, Chen PC, Pilling RL, Johnson N, Foley D. 2007. 1% calcium chloride treatment in combination with gamma irradiation improves microbial and physiochemical properties of diced tomatoes. Foodborne Pathog. Dis **4,** 89-98.

Qasim M, Farooq W, Akhtar W. 2018. Preliminary Report on the Survey of Tomato Growers in Sindh, Punjab and Balochistan. Policy and Institutional Reforms to Improve Horticultural Markets in Pakistan (ADP/2014/043).

Rab A, Haq IU. 2012. Foliar application of calcium chloride and borax influences plant growth, yield, and quality of tomato (*Lycopersicon esculentum*) fruit. Turk. J. Agric. Forest **6,** 695-701.

Reddy VS, A.S.N. Reddy ASN. 2004. Proteomics of calcium-signaling components in plants. Phytochem **65,** 1745-1776.

Ritenour MA, Stoffella PJ, He Z, Narciso JA, Salvatore JJ. 2006. Postharvest calcium chloride dips of whole tomato fruit reduce postharvest decay under commercial conditions. Hort. sci **4,** 1016-1017.

Sathya S, Mani S, Mahedran PP, Arulmozhiselvan K. 2010. Effect of application of boron on growth, quality and fruit yield of PKM1 tomato. Indian J. Agric. Res **44,** 274-280.

Senevirathna PA, Daundasekera WAM. 2010. Effect of postharvest calcium chloride vacuum infiltration on the shelf life and quality of tomato. Cey. J. Sci **1,** 35-44.

Steel RGD, Torrie JH, Dickey DA. 1997. Principles and procedure of statistics: A biometrical approach, (3rd ed.) McGraw Hill Book Co., New York, USA.

Tahir A, Shah H, Akhtar M, Sharif W, Akmal N. 2012. An overview of tomato economy of Pakistan: comparative analysis. Pak. J. Agric. Res **25,** 288-294.

Taylor MD, Locascio SJ. 2004. Blossom-end rot:a calcium deficiency. J. Plant Nutri **271,** 123-139.

Tonetto FS, Mc-Elrone AJ, Shackel KA, Mitcham EJ. 2013. Calcium partitioning and allocation and blossom-end rot development in tomato plants in response to whole plant and fruit specific abscisic acid treatments. J. Exp. Bot **1,** 235-247.

Vinh T. Duy Y, Yuichi, Mitsuo O, Tanjuro G, Ken-ichiro Y, Yoshiyuki T. 2018. Comparative Analysis on Blossom-end Rot Incidence in Two Tomato Cultivars in Relation to Calcium Nutrition and Fruit Growth. Hort. J. **87,** 97-105.

Wójcik P, Lewandowski M. 2003. Effect of calcium and boron sprays on yield and quality of “Elsanta” strawberry. J. Plant Nutr **26,** 671-682.