*Available online at* www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.7229

**ISSN: 2320 – 7051**

*Int. J. Pure App. Biosci.* **6 (6):** 952-957 (2018)

*Research Article*

International Journal of Pure & Applied Bioscience

OPEN ACCESS

# Growth and Yield Attributes as Influenced by Calcium Foliar Nutrition Under Polyhouse Condition

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Received: 9.10.2018 | Revised: 16.11.2018 | Accepted: 25.11.2018

## ABSTRACT

*Poly house experiment was carried out at Zonal Agricultural and Horticultural Research Station (ZAHRS), Navile, Shivamogga during kharif 2016 to study the response of tomato fruit to different sources and levels of calcium. Three sources of calcium [$CaCl_2$, $CaNO_3$ and calcium ammonium nitrate (CAN)] with three levels each (0.20, 0.50 and 0.80%) were applied as a foliar spray in a Complete Randomized Design (CRD) with three replications and ten treatments. The results of experiment indicated that foliar application of calcium through different sources increased the growth and yield of tomato significantly over the control (water spray). Among the treatments, treatment receiving 0.5 per cent CAN as foliar spray was recorded higher growth parameters viz., plant height (94.47cm @ 30DAT and 149.21cm @ 60 DAT), number of branches (16.41 @ 30DAT and 24.47 @ 60 DAT), stem diameter (5.17cm @ 30 DAT) and yield attributes of number of fruits per cluster (10.6), number of fruits per plant (58.67), fruit weight (111.89g), fruit diameter (4.72cm), average fruit yield of 91.98 t $ha^{-1}$ followed by foliar spray of 0.5 % CAN and $CaCl_2$ @ 0.8 % compared to control. The next best source of calcium for foliar spray found to be $CaCl_2$ @ 0.8 % which shows higher quality and nutrient content of tomato fruit.*

***Key words:*** *Calcium, Growth parameters, Yield attributes, Tomato, Fruit weight.*

## INTRODUCTION

Tomato (*Solanum lycopersicum* L.), belongs to the family solanaceae, is one of the most important vegetable crops grown throughout the world because of its wider adaptability. The tomato is considered as "Poor man's orange" in India. Calcium plays an important role in tomato. Calcium deficiency in tomato is called as blossom end rot, a most common physiological disorder. It is essential for the formation of cell wall and calcium pectate in the middle lamella of the cell wall which regulates the entry of only those nutrients which are not toxic to plants. It is also very essential for the meristematic activity and provides a base for neutralization of organic acids and other toxins (like Al) produced in plants. The foliar application of calcium is very effective compare to soil application and increases the use efficiency of fertilizers.

**Cite this article:** Tejashvini, A., Thippeshappa, G. N. and Adivappar, N., Growth and Yield Attributes as Influenced by Calcium Foliar Nutrition under Polyhouse Condition, *Int. J. Pure App. Biosci.* **6(6):** 952-957 (2018). doi: http://dx.doi.org/10.18782/2320-7051.7229

Foliar spray of fertilizer, have high absorption of nutrient on leaf surfaces especially immobile nutrients like Ca and B and their efficient utilization leads to significant effect on growth, development and yield of the crop. Keeping these in views and facts in mind, a poly house experiment was conducted at ZAHRS, Navile, Shivamogga during 2016 to study the "effect of foliar application of different sources of calcium on growth, yield and calcium uptake by tomato under poly house condition".

## MATERIAL AND METHODS

An experiment entitled "Effect of foliar application of different sources of calcium on yield and quality of tomato under poly house condition" was conducted at ZAHRS, Navile, Shivamogga, during the period 2016-17. The experiment comprised ten treatment combinations with three calcium sources and levels tried under poly house condition with tomato as test crop (variety: Arka Samrat procured from IIHR, Bangalore). The experiment was laid out in Completely Randomized Design (CRD) with three replications. The recommended doses of fertilizers were applied @ 250: 250: 250 N, $P_2O_5$, and $K_2O$ kg $ha^{-1}$, commonly to all the treatments. The different sources of calcium fertilizer were used as a foliar nutrition namely calcium chloride ($CaCl_2$), calcium nitrate ($CaNO_3$),and calcium ammonium nitrate(CAN) at 0.20, 0.50 and 0.80 per cent concentration. Portrays was used with mixture of finely powdered FYM and coconut coir with sufficient quantity of fine soil for seedling production. After twenty days of sowing healthy plants were transplanted to main raised beds under polyhouse. The treatment details are as follow, $T_1$: Water spray (Control), $T_2$: Calcium chloride ($CaCl_2$) @ 0.20 % Foliar Spray, $T_3$: Calcium chloride ($CaCl_2$) @ 0.50 % Foliar Spray, $T_4$: Calcium chloride ($CaCl_2$) @ 0.8 % Foliar Spray, $T_5$: Calcium nitrate $(CaNO_3)_2$ @ 0.20 % Foliar Spray, $T_6$: Calcium nitrate $(CaNO_3)_2$ @ 0.50 % Foliar Spray, $T_7$: Calcium nitrate $(CaNO_3)_2$ @ 0.80 % Foliar Spray, $T_8$: Calcium ammonium nitrate ($NH_4NO_3.CaCO_3$) @ 0.20 % Foliar Spray, $T_9$: Calcium ammonium nitrate ($NH_4NO_3.CaCO_3$) @ 0.50 % Foliar Spray, $T_{10}$: Calcium ammonium nitrate ($NH_4NO_3.CaCO_3$) @ 0.80 % foliar Spray. Plant growth parameters at 30 and 60 days after transplanting and fruits were harvested at different stages and cumulative yield was recorded. The tomato fruits and entire plant from above the ground portion were taken and analyzed for nutrients content and uptake especially calcium by following standard methods of analysis[8].

## RESULTS AND DISCUSSION

Plant growth parameters at different growth stages ($30^{th}$ and $60^{th}$ days after transplanting) and fruit yield of tomato significantly increased due to foliar spray of all the sources of Ca (Table 1). However, the treatment $T_9$ (Foliar spray of 0.5 % CAN) significantly increased the plant height (94.47cm and 149.21cm) at both $30^{th}$ and $60^{th}$ days after transplanting respectively and stem diameter(5.47cm), higher number of fruits per plant (58.67), fruit yield per plant (9.93 kg), yield(91.98t/ha) followed by the treatment $T_{10}$ with foliar spray of 0.8 % CAN fertilizer. Among the sources of Ca, the next best source of Ca found to be $CaCl_2$ which recorded significantly higher plant height, fruit number and fruit yield per plant and hectare at a concentration of 0.8% foliar spray. The treatment received the water spray ($T_1$) which recorded significantly lower plant height, number of fruits per plant, fruit yield per plant and fruit yield per hectare. This may be attributed to foliar application of Ca produced quick responses in plants as compared to soil application and also due to time lag between uptake of Ca from soil and utilization by plants. The Ca application favored plant growth in accordance with the works of Hao and Papadopoulos[7] reported that significant increase in the plant height, number of branches, fruit yield and reduced the incidence of blossom-end rot (BER) with the low Ca concentration (150 mg $L^{-1}$ and Chauhadry *et al.*[5] recorded the significantly highest fruit set

(69.3 %), fruits per plant (95.33) and fruit weight per plant (6.00 kg) with 0.5 *M* calcium chloride.

The data pertaining to fruit characteristics of tomato like number of fruits per cluster, number of fruits per plant, fruit weight and fruit diameter are presented in Table 2.

The different sources of calcium increased the fruit characteristics like number of fruits per cluster, number of fruits per plant, fruit weight and fruit diameter. As the concentration of foliar spray of $CaCl_2$ and $CaNO_3$ increased, the fruit characters also increased. But, CAN increased the fruit characters up to 0.5 per cent foliar spray and further increase in concentration of CAN no significant effect was noticed. The significant differences were noticed with respect to numbers of fruits cluster$^{-1}$. The treatment $T_9$ with CAN @ 0.5 % foliar spray showed higher number fruits cluster$^{-1}$ (10.6), number fruits plant$^{-1}$ (58.67), fruit girth (4.72cm) fruit weight of 111.89 g followed by the $T_{10}$ treatment (CAN @ 0.8 % foliar spray) $T_4$ (8.0, 51.67, 4.53,110.89g), respectively. The treatment $T_1$ (Water spray) recorded the least number of fruits cluster$^{-1}$ (5.3). The number of fruits per plant is most important yield determining factor in tomato and this was greatly influenced by foliar spray of 0.5 per cent CAN (Table 4). The Ca might have increased the various enzyme activities in the plant tissue, which were responsible for enhanced flower initiation, ultimately increasing the number of fruits per plant. These findings are in agreement with the results obtained by several previous works of Chauhadry *et al.*[5], Santosh *et al.*[11], Mohammad *et al.*[9], Eladeen and Metwally[6], Suganiya *et al.*[13], and Abdur and Ihsan[1]. They revealed that foliar application of $CaCl_2$ (0.6 %) + borax (0.2 %) resulted in increasing number of fruits per plant (96.37), fruit weight (96.33 g) in tomato. And also because of Ca is an essential component and activates many enzymes. It activates phospholipase, arginine kinase, amylase and adenosine tri phosphatase (ATPase) enzymes. All these factors might be helped in the uptake and utilization of nutrients from soil, increasing the photosynthetic activity. The photosynthesis might have helped in better vegetative growth thereby increasing the photosynthate accumulation resulted in increased weight of the fruit. These findings are in agreement with works like Suganiya *et al.*[13], Alia *et al.*[2] and Basavarajeshwari *et al.*[3] in tomato. This might also be due to the Ca application which enhances the enzyme activity in turn triggers the physiological processes like protein and carbohydrate metabolism in plants.

Yield is a complex character which involves the interaction of several intrinsic and external factors. It largely depends upon the production and mobilization of carbohydrates, uptake of water and nutrients from the soil, in addition to several environmental factors to which plant is exposed during the growing period. Apart from the improved cultivars, nutrient management system plays a crucial role on enhancement of yield. The data on yield of tomato was clearly indicated that significant variance in yield was noticed due to different sources and levels of Ca spray.

The data on yield of tomato like fruit yield per plant, fruit yield per plant, fruit yield per hectare and dry matter yield are presented in Table 3. The different sources of calcium significantly increased the fruit yield per plant and also yield per hectare and dry matter yield as the concentration of foliar spray of Ca increased as $CaCl_2$ and $CaNO_3$. But, foliar spray of CAN increased the fruit yield at 0.5 per cent concentration, and further increase in concentration of CAN decreased the yield.

Among the sources of calcium, the foliar spray of CAN @ 0.5 per cent ($T_9$) recorded significantly higher fruit yield with mean fruit yield of 9.93 kg plant$^{-1}$, fruit yield of 20.69 kg plot$^{-1}$, calculated fruit yield of tomato per hectare was of 91.98 t ha$^{-}$1 and dry matter yield of 293.51 kg ha$^{-1}$ followed by treatment 0.8 per cent foliar spray of CAN (9.43 kg plant$^{-1}$, 19.64 kg plot$^{-1}$ , 87.32 t ha$^{-1}$, 283.94 kg ha$^{-1}$ ) and $CaCl_2$ @ 0.8 per cent foliar spray with fruit yield of 9.37 kg plant$^{-1}$, 19.52 kg plot$^{-1}$ 86.77 t ha$^{-1}$and 273.76 kg ha$^{-1}$,

respectively. Which were found on par with each other. All the sources and levels of calcium sprays resulted in increase in yield of tomato except $T_1$ (water spray) which recorded lowest fruit yield of 8.72 kg plant$^{-1}$. The yield increase might be due to the favorable higher nutrient availability and their by nutrients utilization for enhancing yield parameters. It is also due to better translocation of nutrients and photo assimilates and thereby better plant development and yield. This would also have increased efficiency of photosynthesis in plants. The Ca also have increased activity of enzymes like phospholipase, arginine kinase, amylase and Adenosine tri phosphatase (ATPase) enzymes which would have made them effective in better flowering, fruit set and in turn yield of crop. Similar findings are also reported by Tamilselvi *et al.*[14] and Alia *et al.*[2] Cardozo *et al.*[4] and Muhammad[10] in tomato.

**Table 1: Effect of foliar application of different calcium sources on growth parameters of tomato**

| Treatments | Plant height(cm) | | Stem dia.(cm) |
|---|---|---|---|
| | 30DAT | 60DAT | |
| $T_1$ : Control(WS) | 86.06 | 126.64 | 4.16 |
| $T_2$: $CaCl_2$ @ 0.2 % FS | 90.18 | 130.46 | 4.50 |
| $T_3$: $CaCl_2$ @ 0.5 % FS | 90.47 | 131.44 | 4.65 |
| $T_4$: $CaCl_2$ @ 0.8 % FS | 93.47 | 140.35 | 4.92 |
| $T_5$: $CaNO_3$ @ 0.2 % FS | 86.67 | 131.74 | 4.47 |
| $T_6$: $CaNO_3$ @ 0.5 % FS | 90.10 | 132.87 | 4.53 |
| $T_7$: $CaNO_3$ @ 0.8 % FS | 92.61 | 139.03 | 4.79 |
| $T_8$: CAN @ 0.2 % FS | 88.47 | 134.97 | 4.55 |
| $T_9$: CAN @ 0.5 % FS | 94.47 | 149.21 | 5.47 |
| $T_{10}$: CAN @ 0.8 % FS | 93.50 | 140.71 | 5.01 |
| **S.Em ±** | 0.96 | 0.88 | 0.03 |
| **CD @ 5%** | 2.88 | 2.58 | 0.08 |

FS: Foliar Spray, WS: Water spray, CAN: Calcium ammonium nitrate, DAT: Days after transplanting

**Table 2: Effect of foliar application of different calcium sources on fruit characters of tomato**

| **Treatments** | **Fruit characters** | | | |
|---|---|---|---|---|
| | **No. of fruits Cluster$^{-1}$** | **No. of fruits Plant$^{-1}$** | **Fruit weight (g)** | **Fruit diameter (cm)** |
| **$T_1$: Control (WS)** | 5.3 | 32.00 | 86.61 | 3.87 |
| **$T_2$: $CaCl_2$ @ 0.2 % FS** | 5.7 | 36.67 | 87.58 | 3.96 |
| **$T_3$: $CaCl_2$ @ 0.5 % FS** | 6.3 | 46.00 | 92.33 | 4.03 |
| **$T_4$: $CaCl_2$ @ 0.8 % FS** | 7.7 | 51.00 | 107.81 | 4.50 |
| **$T_5$: $CaNO_3$ @ 0.2 % FS** | 5.7 | 34.67 | 94.06 | 3.94 |
| **$T_6$: $CaNO_3$ @ 0.5 % FS** | 5.8 | 35.67 | 100.78 | 4.02 |
| **$T_7$: $CaNO_3$ @ 0.8 % FS** | 7.3 | 49.67 | 106.33 | 4.30 |
| **$T_8$: CAN @ 0.2 % FS** | 6.0 | 38.00 | 105.49 | 4.39 |
| **$T_9$: CAN @ 0.5 % FS** | 10.7 | 58.67 | 111.89 | 4.72 |
| **$T_{10}$: CAN @ 0.8 % FS** | 8.0 | 51.67 | 110.89 | 4.53 |
| **S.Em ±** | 0.30 | 0.55 | 1.26 | 0.07 |
| **CD @ 5 %** | 0.89 | 1.63 | 3.74 | 0.21 |

FS: Foliar Spray, WS: Water spray, CAN: Calcium ammonium nitrate, DAT: Days after transplanting

**Table 3: Effect of foliar spray of different sources and levels of calcium on yield parameters of tomato**

| Treatments | Yield parameter | | | |
|---|---|---|---|---|
| | Fruit yield (kg plant$^{-1}$) | Yield (kg plot$^{-1}$) | Yield (t ha$^{-1}$) | Dry matter yield (kg ha$^{-1}$) |
| **$T_1$: Control (WS)** | 8.72 | 18.17 | 80.75 | 120.06 |
| **$T_2$: $CaCl_2$ @ 0.2 % FS** | 8.95 | 18.53 | 82.87 | 171.60 |
| **$T_3$: $CaCl_2$ @ 0.5 % FS** | 9.04 | 18.85 | 83.79 | 186.11 |
| **$T_4$: $CaCl_2$ @ 0.8 % FS** | 9.37 | 19.52 | 86.77 | 273.76 |
| **$T_5$: $CaNO_3$ @ 0.2 % FS** | 8.99 | 18.73 | 83.27 | 190.43 |
| **$T_6$: $CaNO_3$ @ 0.5 % FS** | 9.17 | 19.12 | 84.99 | 210.80 |
| **$T_7$: $CaNO_3$ @ 0.8 % FS** | 9.33 | 19.43 | 86.39 | 226.54 |
| **$T_8$: CAN @ 0.2 % FS** | 9.18 | 19.13 | 85.03 | 217.28 |
| **$T_9$: CAN @ 0.5 % FS** | 9.93 | 20.69 | 91.98 | 293.51 |
| **$T_{10}$: CAN @ 0.8 % FS** | 9.43 | 19.64 | 87.32 | 283.94 |
| **S.Em ±** | 0.01 | 0.79 | 0.81 | 1.87 |
| **CD @ 5 %** | 0.03 | 2.13 | 2.41 | 5.56 |

FS: Foliar Spray, WS: Water spray, CAN: Calcium ammonium nitrate, DAT: Days after transplanting

## CONCLUSION

It can be concluded from the experimental results that, all the sources of Ca found to be effective and significantly increased growth, fruit character and yield attributes. However, the highest effect and use efficiency was observed due to foliar spray of CAN fertilizer with a concentration of 0.5% followed by foliar spray of $CaCl_2$ at 0.8% compare to other sources and concentrations.

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