

**EFFECT OF MEPIQUAT CHLORIDE ON  
GROWTH, YIELD AND QUALITY OF TOMATO  
(*Solanum lycopersicum* L.)**

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GROWTH, YIELD AND QUALITY OF TOMATO**  
*(Solanum lycopersicum L.)*

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**PALB7276**

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**in**

**HORTICULTURE**

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*Affectionally dedicated  
to Parents, Sisters  
and Brothers*

**DEPARTMENT OF HORTICULTURE  
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**CERTIFICATE**

This is to certify that the thesis entitled “EFFECT OF MEPIQUAT CHLORIDE ON GROWTH, YIELD AND QUALITY IN TOMATO (*Solanum lycopersicum* L.)” submitted by Ms. RUDRAVVA GOUDAR, ID. No. PALB 7276 for the degree of MASTER OF SCIENCE in HORTICULTURE to the University of Agricultural Sciences, Bengaluru, is a record of *bona-fide* research work carried out by her during the period of her study in this University, under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar titles.

BENGALURU  
AUGUST, 2019

  
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Bengaluru  
August, 2019

**(Rudravva Goudar)**

# **EFFECT OF MEPIQUAT CHLORIDE ON GROWTH, YIELD AND QUALITY OF TOMATO (*Solanum lycopersicum* L.)**

**RUDRAVVA GOUDAR**

## **ABSTRACT**

An investigation was carried out at the Department of Horticulture, GKVK, UAS, Bengaluru during 2018-19 to know the effect of mepiquat chloride (MC) on growth, yield and quality of tomato. The investigation comprised of eight treatments with three replications viz, 50 g a.i.ha<sup>-1</sup> of MC at initiation of flowering (T<sub>1</sub>), 62.5 g a.i.ha<sup>-1</sup> of MC at initiation of flowering (T<sub>2</sub>), 125 g a.i.ha<sup>-1</sup> of MC at initiation of flowering (T<sub>3</sub>), 50 g a.i.ha<sup>-1</sup> of MC at initiation of fruiting (T<sub>4</sub>), 62.5 g a.i.ha<sup>-1</sup> of MC at initiation of fruiting (T<sub>5</sub>), 125 g a.i.ha<sup>-1</sup> of MC at initiation of fruiting (T<sub>6</sub>), 50 g a.i.ha<sup>-1</sup> of MC at initiation of flowering and at initiation of fruiting (T<sub>7</sub>) and control. The results have shown that treatment T<sub>3</sub> (125 g a.i.ha<sup>-1</sup> of mepiquat chloride at initiation of flowering) has recorded minimum plant height (82.20 cm) and intermodal length (5.11 cm). Fruit weight (71.75 g), fruit length (5.64 cm), fruit diameter (4.57 cm), number of fruits per plant (49.83), yield per plant (3.58 kg), yield per hectare (85.81 tons), TSS (4.69 °Brix), ascorbic acid (17.05 mg/100g) and fruit firmness (4.17 kg/cm<sup>2</sup>) were maximum in treatment 125 g a.i.ha<sup>-1</sup> of mepiquat chloride at initiation of flowering followed by T<sub>6</sub> fruit weight (70.21 g), fruit length (5.64 cm), fruit diameter (4.56 cm), number of fruits per plant (47.96), yield per plant (3.11 kg), yield per hectare (80.83 tons), TSS (4.64 °Brix), ascorbic acid (16.92 mg/100g) and fruit firmness (4.08 kg/cm<sup>2</sup>). The results of this study shows that the treatment 125 g a.i/ha mepiquat chloride at initiation of flowering is ideal for getting higher yield with better quality fruits.

August, 2019

Department of Horticulture  
UAS, GKVK, Bengaluru

**(B. M. RAMAKRISHNA)**  
Major Advisor

ಟೋಮೆಟೋದ ಬೆಳವಣಿಗೆ, ಇಳುವರಿ ಮತ್ತು ಗುಣಮಟ್ಟದ ಮೇಲೆ ಮೆಪಿಕ್ವಾಟ್ ಕ್ಲೋರೈಡ್‌ನ ಪರಿಣಾಮ  
(ಸೋಲಾನಮ್ ಲೈಕೋಪರ್ಸಿಕಮ್ ಎಲ್.)

ರುದ್ರವ್ಯ ಗೌಡರ

ಪ್ರಬಂಧದ ಸಾರಾಂಶ

ಟೋಮೆಟೋದ ಬೆಳವಣಿಗೆ, ಇಳುವರಿ ಮತ್ತು ಗುಣಮಟ್ಟದ ಮೇಲೆ ಮೆಪಿಕ್ವಾಟ್ ಕ್ಲೋರೈಡ್‌ನ ಪರಿಣಾಮವನ್ನು ಕುರಿತು ೨೦೧೮-೧೯ರ ಅವಧಿಯಲ್ಲಿ ತೋಟಗಾರಿಕೆ ಇಲಾಖೆ, ಗಾಂಧಿ ಕೃಷಿ ವಿಜ್ಞಾನ ಕೇಂದ್ರ, ಕೃಷಿ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಬೆಂಗಳೂರಿನಲ್ಲಿ ತನಿಖೆ ನಡೆಸಲಾಯಿತು. ಮೂರು ಪುನರಾವರ್ತನೆಗಳೊಂದಿಗೆ ಎಂಟು ಉಪಚಾರವನ್ನು ಒಳಗೊಂಡಿದೆ. ೫೦, ೬೨.೫ ಮತ್ತು ೧೨೫ ಗ್ರಾಂ ಆ.ಇನ್/ಹೆಕ್ಟರ್ ಮೆಪಿಕ್ವಾಟ್ ಕ್ಲೋರೈಡ್ ಹೂ ಬಿಡುವಿಕೆಯ ಪ್ರಾರಂಭದಲ್ಲಿ ಮತ್ತು ೫೦, ೬೨.೫ ಮತ್ತು ೧೨೫ ಗ್ರಾಂ ಆ.ಇನ್/ಹೆಕ್ಟರ್ ಮೆಪಿಕ್ವಾಟ್ ಕ್ಲೋರೈಡ್ ಹಣ್ಣು ಬಿಡುವ ಪ್ರಾರಂಭದಲ್ಲಿ ಉಪಚಾರವನ್ನು ಅನ್ವಯಿಸಲಾಗಿದೆ. ಕನಿಷ್ಠ ಗಿಡ ಎತ್ತರ (೮೨.೨೦ ಸೆಂ.ಮೀ) ಮತ್ತು ಅಂತರಪರ್ವ ಉದ್ದ (೫.೧೧ ಸೆಂ.ಮೀ)ವು ಉಪಚಾರ ೧೨೫ ಗ್ರಾಂ ಆ.ಇನ್/ಹೆಕ್ಟರ್ ಮೆಪಿಕ್ವಾಟ್ ಕ್ಲೋರೈಡ್ ಹೂ ಬಿಡುವಿಕೆಯ ಪ್ರಾರಂಭದಲ್ಲಿ ದಾಖಲಿಸಿದೆ ಎಂದು ಫಲಿತಾಂಶಗಳು ತೋರಿಸಿವೆ. ಇದೇ ಉಪಚಾರದಲ್ಲಿ ಗರಿಷ್ಠ ಹಣ್ಣಿನ ತೂಕ (೭೧.೭೫ ಗ್ರಾಂ), ಹಣ್ಣಿನ ಉದ್ದ (೫.೬೪ ಸೆಂ.ಮೀ), ಹಣ್ಣಿನ ವ್ಯಾಸ (೪.೫೭ ಸೆಂ.ಮೀ), ಪ್ರತಿ ಗಿಡಕ್ಕೆ ಹಣ್ಣುಗಳ ಸಂಖ್ಯೆ (೪೯.೮೩), ಪ್ರತಿ ಗಿಡಕ್ಕೆ ಹಣ್ಣುಗಳ ಇಳುವರಿ (೩.೫೮ ಕಿ.ಗ್ರಾಂ), ಪ್ರತಿ ಹೆಕ್ಟರಿಗೆ ಹಣ್ಣುಗಳ ಇಳುವರಿ (೮೫.೮೧ ಟನ್), ಟಿ.ಎಸ್.ಎಸ್ (೪.೬೯ ಿಬ್ರಿಕ್ಸ್), ಆಸೋರ್ಬಿಕ್ ಆಮ್ಲ (೧೭.೦೫ ಮಿಗ್ರಾಂ/ ೧೦೦ಗ್ರಾಂ), ಮತ್ತು ಹಣ್ಣಿನ ಗಡುಸತ್ವ (೪.೧೭ ಕಿ.ಗ್ರಾಂ/ಸೆಂ.ಮೀ<sup>೨</sup>) ನಂತರ ಟಿ ಹಣ್ಣಿನ ತೂಕ (೭೦.೭೧ ಗ್ರಾಂ), ಹಣ್ಣಿನ ಉದ್ದ (೫.೬೪ ಸೆಂ.ಮೀ), ಹಣ್ಣಿನ ವ್ಯಾಸ (೪.೫೬ ಸೆಂ.ಮೀ), ಪ್ರತಿ ಗಿಡಕ್ಕೆ ಹಣ್ಣುಗಳ ಸಂಖ್ಯೆ (೪೭.೯೬), ಪ್ರತಿ ಗಿಡಕ್ಕೆ ಹಣ್ಣುಗಳ ಇಳುವರಿ (೩.೧೧ ಕಿ.ಗ್ರಾಂ), ಪ್ರತಿ ಹೆಕ್ಟರಿಗೆ ಹಣ್ಣುಗಳ ಇಳುವರಿ (೮೦.೮೩ ಟನ್), ಟಿ.ಎಸ್.ಎಸ್ (೪.೬೪ ಿಬ್ರಿಕ್ಸ್), ಆಸೋರ್ಬಿಕ್ ಆಮ್ಲ (೧೬.೯೨ ಮಿಗ್ರಾಂ/ ೧೦೦ಗ್ರಾಂ), ಮತ್ತು ಹಣ್ಣಿನ ಗಡುಸತ್ವ (೪.೦೮ ಕಿ.ಗ್ರಾಂ/ಸೆಂ.ಮೀ<sup>೨</sup>) ದೊರಕಿರುವುದು ಕಂಡುಬಂದಿದೆ. ಈ ಅಧ್ಯಯನದ ಫಲಿತಾಂಶಗಳಿಂದ ೧೨೫ ಗ್ರಾಂ ಆ.ಇನ್/ಹೆಕ್ಟರ್ ಮೆಪಿಕ್ವಾಟ್ ಕ್ಲೋರೈಡ್ ಹೂ ಬಿಡುವಿಕೆಯ ಪ್ರಾರಂಭದ ಉಪಚಾರವು ಉತ್ತಮ ಗುಣಮಟ್ಟದ ಹಣ್ಣುಗಳೊಂದಿಗೆ ಅಧಿಕ ಇಳುವರಿಯನ್ನು ಪಡೆಯಬಹುದೆಂದು ತಿಳಿದುಬಂದಿದೆ.

ಆಗಸ್ಟ್, ೨೦೧೯

ತೋಟಗಾರಿಕೆ ವಿಭಾಗ

ಕೃಷಿ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಬೆಂಗಳೂರು

(ಬಿ. ಎಮ್. ರಾಮಕೃಷ್ಣ)

ಮುಖ್ಯ ಸಲಹೆಗಾರರು

# Effect of Mepiquat Chloride on growth, yield and quality in Tomato (*Solanum lycopersicum* L.)



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## Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most widely grown vegetable crops and popular due to its high nutritive value, taste and versatile use in world. It is a diploid plant with  $2n = 24$  chromosomes, belongs to the diverse family Solanaceae. The fruits are commonly eaten raw in salads, served as a cooked vegetable. Additionally, a large percentage of the world's tomato crop is used for processing; products include canned tomatoes, tomato juice, ketchup, puree, paste and sun-dried tomatoes or dehydrated pulp.

Mepiquat Chloride (N, N-dimethyl piperidinium chloride), well known potential systemic plant growth regulator that has been used globally to control plant geometry as it can be absorbed by the leaves and distributed to the plant. Mepiquat Chloride is an anti-gibberellin and keeps the plant healthy with higher chlorophyll content. It checks vegetative growth and hastens the development of reproductive parts by reducing the plant height. It has also a role to play in disease resistance mechanism in several crops.

## Objectives

➤ To study the effect of Mepiquat Chloride on growth, yield and quality of tomato.

## Material and Methods

**Crop:** Tomato (*Solanum lycopersicum* L.)

**Variety:** Alankar

**Location:** Department Of Horticulture, UAS-B, GKVK

**Number of Treatments:** 8

**Number of Replications:** 3

**Design:** RCBD

**AREA:** 350 Sq m.

**Spacing:** 60 cm × 45 cm.

**Treatments details;**

**T<sub>1</sub>:** 50g a.i/ha Mepiquat Chloride at initiation of flowering.

**T<sub>2</sub>:** 62.5 g a.i/ha Mepiquat Chloride at initiation of flowering.

**T<sub>3</sub>:** 125 g a.i/ha Mepiquat Chloride at initiation of flowering.

**T<sub>4</sub>:** 50 g a.i/ha Mepiquat Chloride after 15 days of initiation of flowering.

**T<sub>5</sub>:** 62.5 g a.i/ha Mepiquat Chloride after 15 days of initiation of flowering.

**T<sub>6</sub>:** 125 g a.i/ha Mepiquat Chloride after 15 days of initiation of flowering.

**T<sub>7</sub>:** 50 g a.i/ha Mepiquat Chloride 1<sup>st</sup> spraying at vegetative stage followed by initiation of flowers.

**T<sub>8</sub>:** Control

## Experimental Results

Table : Effect of Mepiquat Chloride on plant height, leaf area and TSS of Tomato .

| Treatment      | Plant height (cm) at 60 DAT | Leaf area (cm <sup>2</sup> ) | TSS (°Brix) |
|----------------|-----------------------------|------------------------------|-------------|
| T <sub>1</sub> | 85.07                       | 71.64                        | 4.14        |
| T <sub>2</sub> | 83.97                       | 70.77                        | 4.46        |
| T <sub>3</sub> | 82.20                       | 68.74                        | 4.69        |
| T <sub>4</sub> | 85.33                       | 72.91                        | 3.97        |
| T <sub>5</sub> | 84.27                       | 70.81                        | 4.30        |
| T <sub>6</sub> | 82.27                       | 70.43                        | 4.64        |
| T <sub>7</sub> | 83.87                       | 70.58                        | 4.52        |
| T <sub>8</sub> | 88.50                       | 73.74                        | 3.88        |
| SEm±           | 0.40                        | 0.27                         | 0.04        |
| C.D. at 5%     | 1.21                        | 0.82                         | 0.11        |

➤ The maximum (88.50 cm) plant height was recorded under control (T<sub>8</sub>) where as, it was minimum (82.20cm) under T<sub>3</sub> (125 g a.i/ha of Mepiquat Chloride).

➤ The maximum (73.74 cm<sup>2</sup>) leaf area was recorded under control (T<sub>8</sub>) where as, it was minimum (68.74cm<sup>2</sup>) under T<sub>3</sub> (125 g a.i/ha of Mepiquat Chloride).

➤ The maximum (4.69 °Brix) TSS noticed under T<sub>3</sub> followed by T<sub>6</sub> (4.64 °Brix), T<sub>7</sub> (4.52), T<sub>2</sub> (4.46 °Brix) and T<sub>5</sub> (4.30 °Brix). The minimum (3.88 °Brix) TSS under T<sub>8</sub> (control).

➤ The highest (85.81t/ha) yield per ha noticed under T<sub>3</sub> followed by T<sub>6</sub> (80.83 t/ha), T<sub>7</sub> (78.62 t/ha) and T<sub>2</sub> (75.95 t/ha). The lowest (60.43 t/ha) yield per ha was recorded with T<sub>8</sub> (control).

## Discussion

➤ Reduction in plant height and leaf area may be attributed to slowing down of cell division and reduction of expansion as these chemical possess anti-gibberellin quality.

➤ Due to accumulation of carbohydrate by suppressing the apical dominance led to maximum TSS in tomato fruits.

➤ Fruit yield in tomato depends on accumulation of photo assimilates and partitioning in different parts of plant. The growth retardants are capable of redistribution of dry matter in plant thereby bringing improvement in yield.

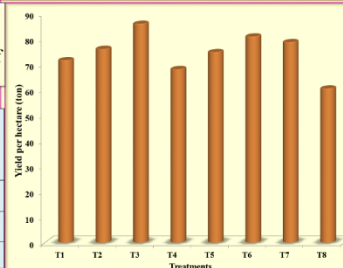


Fig : Effect of Mepiquat Chloride on yield of tomato ( yield per hectare ) .



Plate 1: Field view of experimental plot



Plate 1: Effect of Mepiquat Chloride on fruits

## Summary

➤ The recorded data was subjected to statistical analysis to judge the significance of treatments. The present investigation showed that all the treatments were superior to control. There was good improvement in growth attributes like plant height, leaf area as well as yield attributes like number of fruits and quality parameters like TSS.

➤ Based on the findings present investigation, it is concluded that the 125 g a.i/ha of Mepiquat Chloride applied at initiation of flowering has significant result.

## Advisory committee

**Chairperson:** B. M. Ramakrishna

**Members:** B. G. Hanumanthraya

M. K. Prasanna Kumar

K. Nagaraj

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## LIST OF ABBREVIATIONS

|                |   |                                  |
|----------------|---|----------------------------------|
| %              | - | Per cent                         |
| <sup>0</sup> C | - | Degrees Celsius                  |
| @              | - | At the rate of                   |
| a.i            | - | Active ingredient                |
| AS             | - | Aqueous Solution                 |
| cm             | - | Centimetre                       |
| CCC            | - | Cycocel                          |
| CD             | - | Critical difference              |
| DAT            | - | Days after Transplanting         |
| EC             | - | Electrical conductivity          |
| <i>et al.</i>  | - | And other (etalli)               |
| etc            | - | Et ceter                         |
| Fig.           | - | Figure                           |
| FYM            | - | Farm yard manure                 |
| g              | - | gram                             |
| ha             | - | hectare                          |
| <i>i.e.</i>    | - | that is                          |
| kg             | - | kilogram                         |
| MC             | - | Mepiquat Chloride                |
| mg             | - | milligram                        |
| MT             | - | million tones                    |
| NS             | - | Non-significant                  |
| ppm            | - | Parts per million                |
| RCBD           | - | Randomized complete block design |
| S. No.         | - | Serial number                    |
| TSS            | - | Total soluble solid              |
| <i>viz.,</i>   | - | Videlicet (Namely)               |

## I INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is a short lived perennial plant, grown as an annual plant, in the Solanaceae family, typically grows to 1-3 m tall, with a weak woody stem that usually scrambles over other plants. The fruit is an edible, brightly colored (usually red, from the pigment lycopene) berry, 1-2 cm diameter in wild plants, commonly much larger in cultivated forms. Though it is botanically a berry, a subset of fruit, the tomato is nutritionally categorized as a vegetable.

Tomato is one of the most popular vegetable crops grown all over the world. In India, tomato has wider coverage in comparison to other vegetables and occupies the 3rd position among vegetables in area and production in the world (Sharma, 2004). This crop belongs to the family Solanaceae and the cultivated tomato originated in a wild form in the Peru-Ecuador-Bolivia area of the Andes (South America). It is an important vegetable crop in commercial production and plays a vital role in Indian economy.

Tomato is universally treated as 'Protective food'. Tomato is one of the most adaptable vegetable crops with extensive usage in Indian culinary tradition. Tomato fruits are used for soup, sandwiches, pickles, ketchup, sauces, puree, paste and also used as a salad. Tomato juice is a good appetizer and its soup is good therapy for patients suffering from constipation. The fine ripe tomato (per 100 g of edible portion) contains water (94.1%), energy (23 calories), magnesium (7.0 mg), calcium (1.0 g), vitamin A (1000 IU), ascorbic acid (22 mg), niacin (0.8 mg), thiamin (0.09 mg) and riboflavin (0.03 mg) (Gupta and Naik, 2008).

The tomato has good medicinal properties and its consumption is believed to benefit heart patients among other things. Tomato fruit contains red colour pigment i.e. lycopene and is one of the most powerful natural antioxidants which, especially when cooked, create to help prevent lung, stomach, pancreatic and cervical cancers. Lycopene and bioflavonoid are closely related to beta carotene, are potent antioxidants present in tomatoes and seems to be responsible for its cancer-fighting properties. Cooking

tomatoes helps to double the effectiveness of the lycopene they contain, with a small amount of olive oil, intensifies the protective effect further.

Tomato crop is grown as an annual plant. It has taproot system and growth habit of the plant is determinate and indeterminate. In the determinate types, plants are dwarf where growth is restricted with the appearance of terminal flower, while indeterminate plant, growth continues and there is less initiation of flower and fruit on the stem. The lateral buds always exist to continue vegetative growth (Kalloo *et al.*, 2000).

Plant growth regulators are synthetic or natural substances that can inhibit, stimulate or vary the growth of a plant which are very effective at lower concentration. The naturally occurring substances affecting various physiological processes in a plant are called as plant hormones or phytohormones and the synthetic substances are called as growth regulators (Pal *et al.*, 2017).

The plant growth retardants are synthetic substances, which inhibit, for a period of time, the elongation of stem and shoots, without irreversible blocking the vital metabolic and developmental processes in plants. Besides the growth retardant effect, which, in most cases is the main purpose, some other physiological effects, with beneficial implications may occur. In some cases, the retardant effect may even become of secondary importance. By influencing some metabolic processes, the treatments with retardants can induce the more intense accumulation of compounds that give colour, taste, flavor, thus improving the quality and the commercial value of the products. Such treatments can also manipulate the fruit acidity, the content of sugars, proteins, vitamins, minerals *etc.* The retardants can accelerate and uniform the fruit ripening and promote the defoliation and abscission of fruit.

Mepiquat chloride is an anti-gibberellin that inhibits cell expansion but not cell division. It can check vegetative growth by diverting the plant carbohydrates into reproductive organs. Mepiquat chloride containing products are sold under a variety of trade names and formulations like Pix plus, Pix ultra, pentia, mepex, mepex ginout and mepichlor (Pal *et al.*, 2017).

Mepiquat chloride, 1, 1-dimethylpiperidinium chloride, is a water soluble organic molecule, which is absorbed by the green parts and redistributed all over the plant. Mepiquat chloride inhibits gibberellic acid synthesis by stopping the translation of geranylgeranyl diphosphate to entkaurene, consequently reducing cell enlargement and cell division rate (Srivastava, 2002).

Mepiquat Chloride is used to restrain the bio-synthesis of gibberellic acid within crops when being absorbed by roots and leaves. It can control the elongation of cell, maintain the vegetative growth and these plants are shorter with increased chlorophyll content. It also increases absorption of leaves and adjusts distribution within plants. It can help the translocation of photosynthates to flower and fruit. Avoid abscission of flowers and increase fruit set.

The overall effect of mepiquat chloride on plant growth and development depends on growing conditions after it is applied. Responses to mepiquat depend on rate of absorption, increasing rates usually result in greater suppression of growth; however the actual response is also related to plant size and growth stage.

Considering the above facts, the research work was carried out to study the effect of mepiquat chloride on tomato with the following objectives.

1. To study the effect of mepiquat chloride on growth of tomato.
2. To study the effect of mepiquat chloride on yield and quality of tomato.
3. To study the cost economics as influenced by mepiquat chloride application in tomato.

## II REVIEW OF LITERATURE

Growth retardant as a chemical decreases the cell division and cell elongation in the shoot apex and regulates plant height physiologically without formative effects. The effect of growth retardants varies with plant species, varieties, concentrations used, methods of application, frequency of applications, time of application and various other features, which influence the uptake and translocation of the chemicals. The literature on the effect of plant growth regulators (both promoters and retardants) on various morpho-physiological, quality and yield components in tomato is very meagre.

The results of the earlier investigations pertaining to effect of various growth retardants *viz.*, mepiquat chloride (chamatkar), CCC (cycocel), and paclobutrazol on growth, yield and quality of tomato (*Solanum lycopersicum* L.) as well as other crops are reviewed and presented in this chapter.

### 2.1 Effect of mepiquat chloride on growth parameters

Chhonkar *et al.*, 1977 studied the effects of ethrel and cycocel on growth of okra. They treated seeds of okra cultivar Pusa Sawani with ethrel at 100, 200, 400 and 800 ppm and 125, 250, 500 and 1000 ppm of CCC. At the initial stage, all the plants were of almost similar height and number of branches but at the time of final observation these characters varied markedly due to treatments. At the time of last reading, the ultimate height of plants receiving 1000-ppm cycocel was only 36.56 cm as compared to 64.13 cm of control plants.

Genchev *et al.*, 1979 studied the effect of growth retardant CCC on tomato growth and production. Chloro choline chloride (CCC) was applied at three concentrations (0.025, 0.05 and 0.1%) to the early outdoor hybrid cvs. Lucy and Apolchi. The best results were obtained with treatment at 0.05-0.1 % if applied at 10-12 days before transplanting.

Rahman *et al.*, 1989 found the effect of Paclobutrazol (PP 333) on growth of tomato. Paclobutrazol is an inhibitor of gibberellin biosynthesis was applied as soil

drench to the tomato "Estrella", grown in pots under green house. Drenching was done one week after transplanting @ 0, 200 and 400 ppm. The treatment with 400 ppm significantly reduced the plant height, leaf area and internodal distance.

Dippenaar *et al.*, 1990 observed that application of low concentration of mepiquat chloride as foliar spray at different intervals to a cotton plant, decreased the plant height by 13-18% when sprayed with 6.3-12.5 g a.i./ha at intervals of 14 days as compared to control.

Chetti (1991) reported that the application of mepiquat chloride and lihocin increased chlorophyll content significantly as compared to control in groundnut.

Patel and Singh (1991) observed that Okra cv. Pusa Sawani plants were grown at 4 planting densities (74070, 55550, 49380 or 37030 plants/ha) treated with CCC [chlormequat] at 0, 500, 1000 or 1500 ppm applied either as a seed soaking treatment or as a foliar spray at 20 and 40 days after sowing. Planting density had no significant effect on plant height or pod number and weight but pod yield increased significantly. Plant height was reduced with increasing CCC concentration.

Madalgeri and Ganiger (1993) reported that more number of leaves per plant with CCC at 750 ppm and mepiquat chloride at 150 ppm in potato.

Wallace *et al.*, 1993 reported that reduction in intermodal length with the use of mepiquat chloride at 250 ppm in cotton over control.

Gasti (1994) observed more number of leaves per plant and reduced internodal length in okra with CCC and mepiquat chloride sprayed at 45 days after sowing.

Jeyakumar and Thangaraj (1996) studied the application of mepiquat chloride on growth characteristics of groundnut. Mepiquat chloride was sprayed with 100, 125 and 150 ppm at 25 DAS (days after sowing), 35 DAS and 45 DAS. Among the treatments application, mepiquat chloride (125 ppm) at 35 DAS was found to be the best which

reduced the shoot length and Leaf Area Index (LAI) and enhanced the root length and Crop Growth Rate (CGR).

Rathod and Patel (1996) observed that cycocel at 750 ppm resulted in lowest plant height and the highest number of branches, leaves and fruits/plant. Cycocel treatments were effective in suppressing apical dominance in okra.

Wasnik and Bagga (1996) studied the effect of mepiquat chloride on growth of chickpea varieties and observed that spraying of 50 ppm mepiquat chloride at pre-flowering stage increased the leaf area in both the varieties i.e, Pusa 261 (357.3 cm<sup>2</sup>) and BG 384 (804.5 cm<sup>2</sup>) as compared to control (305.5 cm<sup>2</sup> and 582.8 cm<sup>2</sup> respectively). Chlorophyll content was also found high in both the varieties when sprayed with mepiquat chloride. In BG 384, number of secondary and tertiary branches was increased.

Srinivasappa (1997) observed that the application of mepiquat chloride on growth of diploid and autotetraploid *Solanum viarum* Dunal. Autotetraploid responded with increase in number of branches (150 days), in diploid there was reduction in number of branches. Reduction in plant height was observed in autotetraploid, while in the diploid increase in plant height was recorded at 180 days.

Berova and Zlatev (2000) reported that application of plant growth retardant paclobutrazol (PBZ) on tomato. Seedlings were treated at the time of pricking out with soil and foliar applications of PBZ at concentrations of 1.0 and 25.0 mg/l respectively. This resulted in reduced height and the increased thickness of the young plant stem, as well as the accelerated root formation are a significant advantage of the PBZ treatment.

Ghourab *et al.*, 2000 reported that to study the response of cotton plant cv. Giza 80 to the application of mepiquat chloride (0, 100, 150, 200, and 250 cm<sup>3</sup>/fed), sprayed once at the start of flowering. The results revealed that the application of mepiquat chloride reduced plant height and length of internodes, tended to increase number of open bolls per plant significantly.

Lohot (2000) found that spraying of mepiquat chloride at 1000 ppm increased chlorophyll a, chlorophyll b and total chlorophyll content in cotton leaves.

Prabhu (2000) noticed reduced plant height (24.8cm) in black gram at 75 days after sowing with the application of mepiquat chloride (500 ppm) as compared to control (30.3 cm) and also observed more number of branches (7.20) when sprayed with 500-1000 ppm of mepiquat chloride.

Pravin *et al.* (2000) noticed that foliar application of mepiquat chloride (500 and 1000 ppm) in combination with other plant growth retardants at 45 days after transplanting increased chlorophyll content in tuber propagated potato.

Lopezvalencia *et al.* (2002) conducted an experiment using a single application of the growth retardant Cycocel (chlormequat) and B-9 (daminozide) during 25 or 45 days after sowing at 250, 500 and 1000 mg/l on tomato cv. Floradade. Observations were recorded on plant height, stem diameter, number of flowers per cluster and yield. The reduction in height of the plant was greater with cycocel than that of B-9. The effect was greater at the highest concentration (1000 mg/litre) with earlier application.

Sivappa (2003) studied the effect of cycocel and mepiquat chloride on growth of okra (*Abelmoschus esculentus* L. Moench) Cv. Arka Anamika. He reported that application of mepiquat chloride at 300 ppm produced maximum number of leaves (23.66), number of branches (2.80), maximum leaf area (335 cm<sup>2</sup>) and total chlorophyll content (0.4550 mg) compared to control.

Elkoca and Kantar (2006) observed that the dose (untreated, 25, 50, 75 and 100 g a.i./ha) and stage (late vegetative, early blooming and early pod filling) of mepiquat chloride (MC) application on the growth parameters of pea. Application of 25, 50, 75 and 100 g a.i./ha significantly reduced stem height by 5.3 %, 7.2 %, 7.5 % and 6.4 % and increased stem width by 7.5 %, 12.7 %, 12.3 % and 15.7 % respectively, when compared with the untreated control.

Naz (2006) took up an investigation in groundnut with different levels of salicylic acid and mepiquat chloride. The treatments which were treated with mepiquat chloride (1ml/l) were recorded minimum plant height at all the stages compared to salicylic acid treatments. Number of branches found maximum (6.23) when 500 ppm of salicylic acid sprayed along with 1ml/l mepiquat chloride.

Reddy *et al.*, 2009 studied the effect of mepiquat chloride on growth of cowpea. MC @ 500 ppm, MC @ 1000 ppm, lihocin @ 500 ppm and nipping at 1 week after tendrils formation significantly increased chlorophyll content and nitrate reductase activity at later stages which in turn increased the yield.

Sridhar *et al.*, 2009 conducted an experiment on effect of foliar spray of naphthalene acetic acid (50, 100 and 150 ppm) and mepiquat chloride (500, 1000 and 1500 ppm) on bell pepper at 45 and 65 DAT. They observed the increased chlorophyll content by foliar spray of 1500 ppm mepiquat chloride at 45 DAT (3.91 mg/g fw) and 1500 ppm mepiquat chloride at 45 and 60 DAT (4.11 mg/g fw) as compared to other treatments.

Kumar *et al.*, 2010 reported that the effect of growth retardants and methods of application on growth of potato. Three growth retardants *viz.*, TIBA @ 100 ppm, mepiquat chloride @ 100 ppm and cycocel @ 750 ppm along with a control mepiquat chloride @ 100 ppm foliar sprayed was most effective followed by CCC @ 750 ppm. This suggested that mepiquat chloride @ 100 ppm foliar sprayed at 30 and 45 days after planting helped best in obtaining the higher growth parameters.

Shinde (2010) observed the influence of different plant growth regulators *viz.*, proginb (20, 40 and 60 ppm), CCC (500 and 1000 ppm) and TIBA (100 and 200 ppm) on growth in soybean and opined that cycocel and TIBA decreased the plant height whereas, proginb increased it significantly. The number of branches increased significantly with different PGRs.

Devi *et al.*, 2011 studied the response of soybean variety JS 335 to salicylic acid @ 50 ppm, Ethrel @ 200 ppm, Cycocel @ 500 ppm and control (water spray) applied as

foliar spray at different stages *viz.* flower-initiation (40 DAS), pod-initiation (60 DAS) and flower-initiation + pod-initiation. The study revealed that application of Ethrel @ 200 ppm at both flower-initiation (40 DAS) + pod-initiation (60 DAS) gave higher vegetative growth compare to salicylic acid @ 50 ppm, Cycocel @ 500 ppm and control. However, maximum chlorophyll content and carotenoids were obtained from cycocel @ 500 ppm treated plants.

Kumar *et al.*, 2012 reported that the application different rates of cycocel on growth of tomato. The result revealed that the application of cycocel at 3000 ppm exhibited the capacity for profuse branching and higher leaf count compared to control.

Roopa (2012) evaluated the effect of mepiquat chloride and cycocel on growth of onion. The results of the experiment revealed that, higher concentration of growth retardants like mepiquat chloride and cycocel significantly reduced the plant height and the application of mepiquat chloride at 1500 ppm reduced the plant height and increased the number of leaves. It was also observed that growth retardants had profound influence on chlorophyll content in leaf.

Rajkumar *et al.*, 2013 reported application of cycocel at 450 ppm as seed soaking treatment and foliar sprays at 20 and 40 days after sowing influenced the plant height, number of nodes per plant, internodal length and number of branches per plant in okra as compare to unsoaked (control).

Zidan *et al.*, 2014 reported that the application of growth retardant "Dextril" on tomato. The results showed that, "Dextril" treatment of (0.02 0.04 – and 0.06%) levels decreased stem height by 30, 32 and 35% respectively compared to the control. Treatment with "Dextril" increased stem diameter, fresh and dry weight of shoots but it did not affect leaf number compared to the control.

Pal *et al.*, 2017 evaluated the effect of mepiquat chloride on growth of onion. Results revealed that the minimum plant height (64.35 cm) was recorded with 125 g a.i./ha of mepiquat chloride at 35 DAT whereas maximum plant height was recorded

under control. Treatment 125 g a.i./ha of mepiquat chloride at 35 DAT also resulted in maximum number of leaves (9.57) and total chlorophyll content (2.37 mg/g).

Panyapruek *et al.*, 2017 conducted an experiment to determine the effects of paclobutrazol and mepiquate chloride on growth, yield and starch content of cassava. Sole application of mepiquat chloride at the rate of 10ppm resulted in reduced plant height (180.4 cm) as compared to other treatments of paclobutrazol over control.

Singh *et al.*, 2017 investigated in cotton and reported that application of mepiquat chloride @1750 ml/ha (@500 ml/ha + 625ml/ha+ 625ml/ha at 60, 75 and 90 DAS) recorded statistically least plant height of 139.1 and 93.4 cm, in 2014 and 2015, respectively.

Flores *et al.*, 2018 studied that the application of paclobutrazol (PBZ) with the dose of 150 mg.l-1, on the growth of seedlings determined by the chlorophyll content, height and leaf area of cucurbits. Treatments were the doses of 150 mg of PBZ.l-1 water and the control (distilled water). PBZ increased the chlorophyll content in 26.0%, 14.9%, 19.4% and 26.5%, respectively, compared to the control; height decreased in 24.0%, 34.7%, 16.3% and 23.4%; leaf area decreased in 40.1, 0.5, 30.4 and 16.2%.

Kumawat *et al.*, 2019 conducted an experiment in Okra, on the effect of plant growth regulators and micronutrients. They observed higher numbers of branches (2.2) and higher number of internodes (10.5) was recorded at 75 DAS in foliar spray of cycocel at 1000ppm.

## **2.2 Effect of mepiquat chloride on yield**

Sadiq *et al.*, 1990 observed that effect of CCC on cucumber. Plants at the four leaf stage were sprayed with CCC [chlormequat] at 0, 100, 200, 300, 400 or 500 ppm. Lowest stem length (118.8 cm), numbers of days to flowering (38.0) and maturity (49.3), and highest number of fruits/plant (14.0), number of branches/plant (5.5) and fruit yield (93.7 tons/ha) were obtained with 500 ppm CCC.

Gasti (1994) reported the maximum yield of 27.17 tons/ha of potato tubers when treated with mepiquat chloride (175 ppm). Similarly, Madalageri *et al.* (1993) reported 25.8 per cent higher yield in potato when sprayed with mepiquat chloride @ 600 ppm at 30 DAT in TPS genotype HPS-1/13 as compared to unsprayed check.

Deka and Shadeque (1996) reported that increased number of fruits, fruit set and yield per plant when plants are treated with cycocel at 1500 ppm as foliar spray in capsicum cv. California Wonder.

Jeyakumar and Thangaraj (1996) studied the application of mepiquat chloride on yield characteristics of groundnut. Mepiquat chloride was sprayed at the concentration of 100, 125 and 150 ppm on 25 DAS (days after sowing), 35 DAS and 45 DAS respectively. Among the treatments application of mepiquat chloride at 125 ppm on 35 DAS was found to be the best in yield characteristics such as Total Dry Matter Production (TDMP), number of flowers, and pod yield.

Wasnik and Bagga (1996) carried out field a study on spray of mepiquat chloride at pre- flowering stage on two chickpea varieties i.e. Pusa 261 and BG 384. Variety BG 384 showed increase in number of pods per plant, pod weight and seed weight per plant and yield per m<sup>2</sup> with mepiquat chloride sprayed at 50 ppm.

Devendra *et al.* (1999) studied the influence of mepiquat chloride on tuber yield of potato. The results revealed that the application of mepiquat chloride increased the tuber yield of 24 to 41% compared to unsprayed control. Thus, mepiquat chloride as Chamatkar 5% AS at 1.0 to 1.5 lit/ha can safely be used to increase the marketable tuber yield.

Gollagi (1999) reported that application of mepiquat chloride significantly increased the fruit length in chilli from 9.29 cm (control) to 14.22 cm (1000 ppm) and also increased fruit weight.

Ghourab *et al.*, 2000 reported that to study the response of cotton plant cv. Giza 80 to the application of mepiquat chloride (0, 100, 150, 200, and 250 cm<sup>3</sup>/fed), sprayed

once at the start of flowering. The results revealed, that the application of mepiquat chloride increased seed cotton yield, seed index and lint percentage.

Prabhu (2000) showed that maximum grain yield (1.47 q/ha) was recorded when black gram was sprayed with mepiquat chloride at 1000 ppm compared to control (1196.6 kg/ha).

Rao *et al.* (2000) conducted an experiment on effect of mepiquat chloride on biomass, photosynthesis and yield in water stressed and irrigated tomato. Yield reduction in sprayed and stressed plants was 7.5%, 19% and 16.5% and in plants where no spray was given it was 39.0%, 41.2% and 47.4% when stress was imposed at vegetative, flowering and fruiting stages, respectively, compared to the control plants. The reduction in yield was attributed to reduction in fruit number and size.

Sivappa (2003) reported that application of mepiquat chloride at 300 ppm in okra recorded maximum pods per plant (20.33), diameter of pods (2.55 cm), pod weight (25.46 g), pod length (18.60 cm) and total pod yield (16.73 t/ha) compared to control.

Elkoca and Kantar (2006) reported that the dose (untreated, 25, 50, 75 and 100 g a.i./ha) and stage (late vegetative, early blooming and early pod filling) of mepiquat chloride (MC) application on seed yield and yield parameters of pea. Application doses of 25, 50, 75 and 100 g a.i./ha significantly increases of the seed yield under different application doses of MC ranged between 13.7 % and 20.1 % over the untreated control. MC significantly increased seed yield by 11.4 % and 10.2 % when compared with the late vegetative and the early pod filling stages respectively.

Naz (2006) reported that number of pods per plant, pod yield (q/ ha), harvest index (%), test weight (g) and shelling per cent (%) recorded higher values with the treatment of salicylic acid (500 ppm) + mepiquat chloride (1 ml/l) over all other treatments in groundnut.

Pateliya *et al.*, 2008 investigated the effect of different growth retardants on okra. The experimental results indicated that foliar application of CCC 300 ppm at 25 and 50

days after sowing increased fruit yield per plant (250.24 g), number of fruits per plant (16.44) and fruit yield per hectare (15.17 t/ha) than compared to control.

Sharma and Lashkari (2009) reported that maximum weight of pods per plant and highest yield of pods with cycocel treatment over control in cluster bean cv. Pusa Navbahar.

Sridhar *et al.*, 2009 experimented in chilli, the number of seeds/fruit (242) and fruit yield was significantly high (159.89 g/plant) with double spray of mepiquat chloride at 1500 ppm at 45 DAT and at 65 DAT followed by mepiquat chloride at 1500 ppm at 45 DAT (156.49 g/plant) compared to control.

Kim *et al.*, 2010 showed in Chinese yam, the exogenously applied IAA (50, 100, 200 and 300 ppm) combined with mepiquat chloride (600 ppm) increased fresh weight of aerial and underground tubers.

Kumar *et al.*, 2012 reported that the effect of different rates of Cycocel on yield of tomato. The results revealed that the application of cycocel at 3000 ppm recorded highest number of fruits per plant (13.50) and yield per hectare (128.42 q/ha) compared to control.

Rajkumar *et al.*, 2013 observed in okra, the application of cycocel at 450 ppm applied as seed soaking treatment and foliar sprays at 20 and 40 days after sowing influenced the number of pods per plant and pod yield per plant as compare to unsoaked (control).

Parmar *et al.*, 2016 found that effect of cycocel on yield of tomato. The results showed that cycocel @ 250 ppm increases fruit weight (65.75 g), total number of fruits per plant (45.24) and fruit yield per plant (2.88 kg).

Pal *et al.*, 2017 carried out an investigation to evaluate the effect of mepiquat chloride on yield of onion. Results revealed that the maximum neck diameter (2.15 cm),

root length (8.03 cm), bulb diameter (5.80 cm), bulb yield (53.27 kg/plot) and yield per ha (295.93 ton) was recorded with 125 g a.i. ha<sup>-1</sup> of mepiquat chloride at 35 DAT.

Panyapruek *et al.*, 2017 found that in cassava the combined application of paclobutrazol and mepiquat chloride each at the rate of 10 ppm produced higher storage root yield (23.12 t/ha) and fresh storage root weight/plant (3.55 kg) over control.

Singh *et al.*, 2017 found that highest seed cotton yield (2.97 q/ha) was recorded with application of mepiquat chloride at 1500 ml/ha primarily due to improved boll weight (3.92g) and bolls/plant (53.2).

Kumar *et al.*, 2018 revealed that effect of cycocel on quality aspects of summer okra. The experiment consisted of treatments cycocel (200, 400 & 600 ppm), was sprayed at 30 DAS. The results recorded that highest total number of harvesting (17.65), number of fruits per plant (22.02), yield per plant (290.73 g) and per hectare (161.5 q) were recorded in CCC @ 600 ppm.

Laddha *et al.*, 2018 observed that the effect of mepiquat chloride on yield attributes of brinjal were foliar sprayed with 1350 ppm, 1700 ppm and 3400 ppm concentration. Among the concentrations, significantly highest number of fruits per plant (16.88), length of fruits (17.61cm), diameter of fruits (5.07 cm), weight of five fruits (477g), weight of fruits per plant (1.25 kg) and weight of seeds per plant (60.60 g) were obtained in 3400 ppm concentration as against control.

### **2.3 Effect of mepiquat chloride on quality**

Gollagi *et al.*, 1999 found that application of mepiquat chloride at 500-1000 ppm to chilli increased the ascorbic acid content (121.3 mg g<sup>-1</sup> fruit weight) compared to control (91.0 mg g<sup>-1</sup> fruit weight).

Ghourab *et al.*, 2000 reported that to study the response of cotton plant cv. Giza 80 to the application of mepiquat chloride (0, 100, 150, 200, and 250 cm<sup>3</sup>/fed), sprayed once at the start of flowering. The results revealed that the application of mepiquat chloride showed significant increase in phenol contents in leaves and oil content in seeds.

Sivappa (2003) observed, application of mepiquat chloride at 450 ppm recorded highest ascorbic acid content (17.13 mg) and maximum total soluble solids (3.00%) in the okra plants treated with mepiquat chloride at 300 ppm followed by cycocel 1000 ppm (2.60%). Minimum total soluble solids recorded in control (1.50%).

Sridhar *et al.*, 2009 reported in chilli that double spray of mepiquat chloride at 1000 ppm at 45 DAT and at 65 DAT significantly increased ascorbic acid content (551.9 mg/100g fw) than control (247.2 mg/100g fw). Also observed increase in nitrate reductase activity (526.2  $\mu$  molNO<sub>2</sub>/g fw/hr) with spray of mepiquat chloride at 1500 ppm.

Ganie and Solanki (2010) observed the effect of cycocel (0, 1000, 1500, 2000 ppm), intra row spacing (10, 15cm) and levels of nitrogen (0, 80, 160, 240 kg ha<sup>-1</sup>) on the quality characters *viz.*, TSS, Sulphur and Protein content (%) in bulbs of *kharif* onion. The results showed that 1500 ppm cycocel produced noticeably superior results in terms of all the above said characters in comparison to other treatments.

Kumar *et al.*, 2012 reported that the effect of different rates of cycocel on quality of tomato. The findings carried out on tomato, revealed that the application of cycocel at 3000 ppm recorded maximum total soluble solid (6%) compared to control.

Parmar *et al.*, 2016 observed the effect of cycocel on quality of tomato. The results showed that cycocel @ 250 ppm significantly increase the total soluble solids and ascorbic acid content.

Kumar *et al.*, 2018 revealed that effect of cycocel on quality aspects of summer okra. The experiment consisted of three treatments *viz.*, cycocel (200, 400 & 600 ppm), PBZ (150, 250 & 300 ppm) and ethrel (150, 250 & 300 ppm) was sprayed once at 30 DAS. The results showed that highest Vitamin – ‘A’ (29.05  $\mu$ g/100g) and crude fiber (2.19 %) were recorded in CCC @ 600 ppm while maximum ascorbic acid (14.06 mg/100g) were noticed in ethrel @ 300 ppm.

Laddha *et al.*, 2018 reported that the application of mepiquat chloride on quality of brinjal were foliar sprayed with 1350 ppm, 1700 ppm and 3400 ppm concentration. Among the concentrations, significantly increase in total soluble solids (5.40 %) was obtained in 3400 ppm concentration under T<sub>3</sub> as against control (T<sub>8</sub>).

Vethamoni and Gomathi (2018) observed that the pre harvest spraying of growth retardants *viz.*, 250, 500, 1000 and 2000 ppm of cycocel and mepiquat chloride 100, 250, 5000, 750 and 1000 ppm with no spraying control treatments were studied on quality of onion. Pre harvest spraying of onion with growth retardant cycocel at 1000 ppm recorded highest moisture content, TSS, pyruvic acid, ascorbic acid soluble protein and sulphur content.

#### **2.4 Cost of economics**

Sivappa (2003) revealed that highest net returns were obtained from mepiquat chloride at 300 ppm (Rs. 57,156/ha) followed by CCC 1000 ppm (Rs. 56,735/ha) in okra. Highest benefit cost ratio was obtained in the treatment mepiquat chloride at 300 ppm (1: 3.28) and least was noticed in control (1: 2.43).

Naz (2006) reported in groundnut the data on B:C ratio as influenced by salicylic acid and mepiquat chloride indicated that it was maximum with foliar application of salicylic acid (500 ppm) + mepiquat chloride (1000 ppm) has been found to be most economical. Although there was an increase in B: C ratio in all the treatments compared to control (1: 2.67).

Barche *et al.*, 2010 showed that maximum net returns for immature fruit production (Rs. 165430.21) was obtained under CCC @ 1000 ppm seed + foliar treatment, followed by CCC @ 1500 ppm seed + foliar treatment (Rs. 1,44,922.21). The best cost benefit ration for immature fruit production 1:80 was obtained under CCC @ 1000 ppm seed + foliar treatment. The poorest cost: benefit ratio (1:5:93) was obtained under control.

Pal *et al.*, 2017 reported that the effect of mepiquat chloride on cost of economics of onion. Highest net return and benefit cost ratio (Rs 1,90,292.96 and 1.80:1) was observed in the treatment 125 g a.i. ha<sup>-1</sup> of mepiquat chloride at 35 DAT and least (Rs 1,51,802.96 and 1.47:1) was noticed in control.

Singh *et al.*, 2017 obtained highest net returns of Rs. 83,405/ha and B:C ratio (2.0) was recorded with the application of mepiquat chloride at 1500 ml/ha indicative of its monetary benefits. Therefore, for maximizing the monetary returns, farmers should opt for mepiquat chloride application @1500 ml/ha should be considered a useful production practice for enhancing cotton yield.

### III MATERIAL AND METHODS

Studies on “Effect of Mepiquat Chloride on growth, yield and quality of Tomato (*Solanum lycopersicum* L.) was carried out at the Department of Horticulture, Gandhi Krishi Vignana Kendra, University of Agricultural Sciences, Bangalore during 2018-19. The material used and the methodology adopted during the course of investigation are presented below.

#### 3.1 Geographical location and climate

The experimental site is located at 12<sup>0</sup> 58" north latitude and 77<sup>0</sup> 35" east longitude with an altitude of 830 m above mean sea level (MSL). The soil of the experimental area is red sandy loam with uniform fertility having pH of 6.4 to 6.8. The experiment were carried out with the main objective of knowing the effect of mepiquat chloride on growth, yield and quality in tomato (*Solanum lycopersicum* L.) with var Alankar was conducted for one season under open condition.

The details of the metrological data on weather conditions that prevailed during the experiment period are presented in Appendix -1.

#### 3.2 Experimental details

Effect of Mepiquat Chloride on growth, yield and quality of Tomato (*Solanum lycopersicum* L.) was conducted for one season under open condition.

The study was conducted as detailed below:

1. Crop : Tomato
2. Variety : Alankar
3. Season : Kharif
4. Date of transplanting : 11/08/2018
5. Treatments : 08
6. Replications : 03
7. Experimental design : Randomized Complete Block Design

8. Spacing : 90×45 cm  
 9. Gross plot : 400 Sq m  
 10. Net plot : 8×2 m

**Treatment details:**

| Treatment No.  | Treatments                | Dose (g a.i./ha) | Time of Application   |
|----------------|---------------------------|------------------|---|
| T <sub>1</sub> | Mepiquat Chloride (5% AS) | 50.0             | At initiation of flowering  |
| T <sub>2</sub> | Mepiquat Chloride (5% AS) | 62.5             | At initiation of flowering  |
| T <sub>3</sub> | Mepiquat Chloride (5% AS) | 125.0            | At initiation of flowering  |
| T <sub>4</sub> | Mepiquat Chloride (5% AS) | 50.0             | At initiation of fruiting   |
| T <sub>5</sub> | Mepiquat Chloride (5% AS) | 62.5             | At initiation of fruiting   |
| T <sub>6</sub> | Mepiquat Chloride (5% AS) | 125.0            | At initiation of fruiting   |
| T <sub>7</sub> | Mepiquat Chloride (5% AS) | 50.0             | Two spray:<br>At initiation of flowering and<br>2 <sup>nd</sup> spray at initiation of fruiting |
| T <sub>8</sub> | Untreated Control         | -                | -   |

AS: Aqueous solution

**3.2.1 Characters of tomato hybrid (Alankar)**

Plants are determinate, vivid red in colour, fruits are square round in shape. Fruits are of medium to large size (60-65 g) with good keeping quality (15-20 days) and long transportability. Suitable for summer, rabi and kharif seasons.

**3.3 Experimental procedure**

**3.3.1 Raising of seedlings**

Seedlings of tomato were raised by sowing one seed per plug in plastic portrays filled with sterilized and nutrient enriched cocopeat. Trays were watered lightly twice a day during early morning and late evening hours. Necessary cultural operations and plant protection measures were carried out from time to time to obtain healthy seedlings for transplanting in the main field.



**Plate 1: General view of initial land preparation**



**Plate 2: Installation of mulch on bed**

### **3.3.2 Preparation of land**

Land should be prepared well to make the soil suitable for transplanting of tomato. The field was ploughed, harrowed and rotavated 2 or 3 times to a depth of about 25-30 cm and the soil was brought to a fine tilth after removing the stubbles and weeds a fortnight prior to planting. 25 tons Farm yard manure was applied and mixed well with the soil.

### **3.3.3 Preparation of beds**

Raised beds of 30 cm height, 18m length and 1.0 m width were prepared leaving a space of 90cm between two beds as path to enable easy cultural operations like spraying, weeding and harvesting.

### **3.3.4 Irrigation System**

Drip irrigation system was installed for providing irrigation. One inline lateral pipe of 16 mm diameter with a discharge capacity of 4 liters per hour at 45 cm apart was provided.

### **3.3.5 Mulching**

Polyethylene mulch of 30-micron thickness bicoloured (silver and black) surface is used for controlling the weeds, conserve moisture and reduce the incidence of pest and diseases. This mulch was covered on bed and securing the margins of the sheet by burying in the soil.

## **3.4 Cultivation practices**

### **3.4.1 Transplanting**

In the raised bed method of planting, 25 day old hardened and stocky seedling were planted in the center of the bed at spacing of 45 cm from plant to plant and 90 cm from row to row. The individual seedling was watered immediately after transplanting with small amount of water to protect the seedling from wilting. Hardening of seedling

by reducing frequency of watering and higher exposure to sunlight was carried out nearly for one week before transplanting.

### **3.4.2 Irrigation**

Irrigation during the first week was provided daily with a hose can for better establishment of the seedlings. Subsequently the plants were irrigated for 1 to 2 hours a day with drip irrigation system supplied with fertilizers, from bore holes. Further irrigation is provided depending on the soil and weather conditions.

### **3.4.3 Gap-filling**

In order to maintain uniform stand of the crop in each plot the diseased seedlings were located every alternate day and replaced by the healthy plants till 8-10 days after transplanting.

### **3.4.4 Application of Fertilizer**

The fixed amounts of nitrogen (180 kg N/ha), phosphorus (120 kg P<sub>2</sub>O<sub>5</sub>/ha) and potash (150 kg K<sub>2</sub>O/ha) were applied through 19:19:19 complex fertilizer and remaining was supplied through urea and muriate of potash. Fertilizers were applied at six split doses as basal dose during transplanting, 15 DAT, 30 DAT, 45 DAT, 75 DAT and 100 DAT.

### **3.4.5 Weeding**

Operation was carried out at 30 days of transplanting (DAT). Hand weeding was done as and when necessary to keep the plots weed free. However, very fewer weeds were noticed.

### **3.4.6 Plant protection**

Diseases mainly observed were late blight and fusarium wilt. Which were controlled by spray of COC 5% EC and carbendizim (Drenching) @ 2g/l respectively.

Thrips and fruit borer were the main insect pests noticed in the field which were controlled by spraying Imidacloprid 0.3 ml/l and Monocrotophos 0.5ml/l respectively.

### **3.4.7 Pruning**

Plants were pruned to maintain only two stems at 45 days after transplanting and removal of basal leaves up to a height of one foot from the ground level were done to avoid contact with the soil and viral diseases.

### **3.4.8 Training**

Plants were trained to a single stem by twisting trellis twine around the main stem and fixing it to a stray wire, 2 m above medium surface to support the plant. Side branches were removed weekly to maintain a single stem. When plants had reached the horizontal wire at 2 m, the growing point was removed to restrict further vertical growth.

### **3.4.9 Harvesting**

Harvesting was done by hand picking of ripened tomatoes every four days in the morning. Fully mature fruits at colour breaking stage were harvested for distant market while fully matured ripe fruits with uniform colour fruits were harvested for local market.

## **3.5 Collection of experimental data**

Five plants were selected at random in each treatment from all the replications and were tagged to study the growth, yield and quality parameters of tomato and mean of the observation of these five plants was computed and recorded.

### **3.5.1 Growth parameters**

#### **3.5.1.1 Plant height (cm)**

The height of five randomly selected plants from each plot was measured at 30, 60, 90 and 120 DAT. The plant height was measured from the ground level to the tip of the growing point. The average was worked out and expressed as plant height in centimeter.

### **3.5.1.2 Internodal length (cm)**

Average of distance between 2<sup>nd</sup> and 3<sup>rd</sup> node from the base of the plant was taken for measuring the internodal length at four stages viz, 30, 60, 90 and 120 DAT and expressed in centimeters.

### **3.5.1.3 Number of leaves per plant**

Numbers of leaves per plant at fortnightly intervals after spray to harvest were counted in each labeled plant of each treatment and the mean was calculated.

### **3.5.1.4 Number of branches per plant**

The numbers of shoots emerging directly from the main stem from each of the labeled plants were recorded at 70 days after sowing (at harvest) and the mean number of branches in each treatment was worked out.

### **3.5.1.5 Stem girth (cm)**

Girth of the stem from each labeled plants were measured in centimeters at the center of the plant at fortnightly intervals after spray to harvest were recorded and the mean stem girth was worked out.

### **3.5.1.6 Leaf area (cm<sup>2</sup>)**

Leaf area was measured at 60 days after sowing by using leaf area meter. Five mature leaves were collected from the selected plants of all the treatments and observations recorded and expressed in cm<sup>2</sup>.

### **3.5.1.7 Chlorophyll content**

Five mature leaves from each treatment of tagged plants at 60 days were selected for measuring the total chlorophyll content and the observations were recorded by using SPAD meter. The SPAD meter is simple hand held equipment which operates with DC power and is manageable. Several measurements were made on each leaf at top and middle and averaged to make a proper estimation of leaf chlorophyll content.



**Plate 3: General view of tomato crop after transplanting**



**Plate 4: Twenty days after transplanting**

### **3.5.2 Reproductive parameters**

#### **3.5.2.1 Days taken to first flowering**

Days taken for first flowering from the date of transplanting to first flower opening was recorded in each treatment periodically as and when the first flower opened on the tagged plants.

#### **3.5.2.2 Number of flowers per plant**

The total number of fully opened flowers per plant as and when they produced from the emergence of first flower was recorded from each tagged plant in all the treatments at regular intervals.

#### **3.5.2.3 Percentage of fruit set (%)**

Number of fruits developing in different clusters was recorded from time to time. Later the per cent fruit set was calculated on the basis of total number of flowers appeared on that plant.

#### **3.5.2.4 Days taken to first harvest**

Number of days taken from the date of sowing to the date of first harvest of green tender fruits from the tagged plants in each treatment was recorded.

### **3.5.3 Yield parameters**

#### **3.5.3.1 Fruit weight (g)**

Ripe tomato fruits were harvested from all the tagged five plants of each treatment were weighed and recorded in grams.

#### **3.5.3.2 Fruit length (cm)**

The length of the fruit was measured using a measuring scale of harvested fruits and the mean of five selected fruits from tagged plants of each treatment was calculated and expressed in centimeters.

### **3.5.3.3 Fruit diameter (cm)**

Fruit diameter was measured by using scale. Five fruits from tagged plants of each treatment were selected and observations were recorded in centimeters.

### **3.5.3.4 Number of fruits/plant**

The number of mature fruits harvested from each tagged plants were recorded at each picking till the final harvest. The average number of fruits per plant was calculated treatment wise.

### **3.5.3.5 Fruit yield/plant (kg/plant)**

The total weight of fruits harvested per plant from each harvest, in the five tagged plants of each treatment and replication wise was recorded and average yield per plant was worked out and expressed in kilograms.

### **3.5.3.6 Fruit yield (t/ha)**

The fruit yield per hectare was calculated by using the following formula and expressed in tons per hectare.

$$\text{Fruit yield ha}^{-1} \text{ (tons)} = \frac{\text{Fruit weight (Kg plant}^{-1}) \times \text{No. of plants ha}^{-1}}{1000}$$

## **3.5.4 Quality parameters**

### **3.5.4.1 Total soluble solids (%)**

For determining the TSS, a drop of sample (juice) was placed on the prism of hand refractometer and the percentage was read directly.

### **3.5.4.2 Total ascorbic acid (mg/100g)**

Ascorbic acid content was determined by 2, 6- Dichlorophenol-indophenol method. One ml of juice sample was mixed thoroughly with 4% oxalic acid solution and volume was made up to 25ml. Ascorbic acid content was estimated by titrating with 25ml quantity of the extract against 2, 6-dichlorophenol-indophenol dye. The titration was

carried out up to a light pink colour. The dye was prepared by using 50 mg of sodium salt of 2, 6- Dichlorophenol-indophenol dye in about 200 ml of double distilled water containing 4.2 mg of sodium bicarbonate. Ascorbic acid content was calculated as mg of ascorbic acid equivalents per 100ml of juice using a standard curve of  $\alpha$  -Ascorbic acid.

$$\text{Ascorbic acid } \left( \frac{\text{mg}}{100\text{g}} \right) = \frac{\text{Titrateablevalue} \times \text{Dyefactor} \times \text{Vol. madeup}}{\text{Aliquatofextraction} \times \text{vol. ofsampletaken}} \times 100$$

#### **3.5.4.3 Fruit Firmness (kg/cm<sup>2</sup>)**

Fruit firmness was determined by using fruit penetrometer. Five ripened fruits were punctured at one place in radial axis with the penetrometer and the pressure required to penetrate the fruit was recorded and expressed in kg/cm<sup>2</sup>.

#### **3.5.4.4 Number of locules per fruit**

Tomato fruits were cut horizontally with the help of knife to count the locules after that average number of locules per fruit was recorded.

### **3.6 Economics**

The cost of production incurred in each treatment was worked out by considering the prevailing market price of input used and the fruits obtained. Different values were determined for each treatment as per details given below:

Gross return = Cost of fruit yield

Net return = Gross return - Total cost of cultivation

Benefit: cost ratio = Gross return/Total cost of cultivation

### **3.7 Statistical analysis**

The data pertaining to growth, reproductive, yield and quality character were statistically analyzed and interpreted by Fishers method of analysis of variance. The test of significance and critical differences were made at 0.05 probability. Suitable graphical illustrations of the data have also been given at appropriate places in the text.

## IV RESULTS AND DISCUSSION

The results of the investigation entitled “Effect of Mepiquat Chloride on growth, yield and quality of Tomato (*Solanum lycopersicum* L.)” was carried out during 2018-19 at the Department of Horticulture, Gandhi Krishi Vignana Kendra, University of Agricultural Sciences, Bengaluru are presented in this chapter.

### 4.1 Growth parameters of tomato plants

#### 4.1.1 Plant height (cm)

There was marked variations in the plant height at different stages of growth due to different treatments. A perusal of the data presented in Table 1 and depicted in Fig.1 clearly indicates that all the treatments significantly reduced the height of plant as compared to control.

At 30 DAT the maximum (70.97 cm) plant height was observed with T<sub>5</sub> followed by T<sub>1</sub> (70.13 cm), T<sub>4</sub> (69.73), T<sub>2</sub> (69.53), T<sub>8</sub> (69.17 cm). The minimum (68.93 cm) plant height was observed in T<sub>7</sub>.

At 60 DAT the lowest (82.20 cm) height was noted with 125 g a.i/ha of mepiquat chloride at initiation of flowering( T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (82.27 cm). Nevertheless, T<sub>1</sub> (85.07 cm) and T<sub>4</sub> (85.33 cm) were at par with each other. The highest (88.50cm) plant height was noted in control.

At 90 DAT the minimum (84.27 cm) plant height was recorded under 125 g a.i/ha of mepiquat chloride at initiation of flowering( T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (85.20 cm). Nevertheless, T<sub>1</sub> (87.23 cm) and T<sub>4</sub> (87.80 cm) were at par with each other. The maximum (89.67 cm) plant height was recorded under T<sub>8</sub>(control).

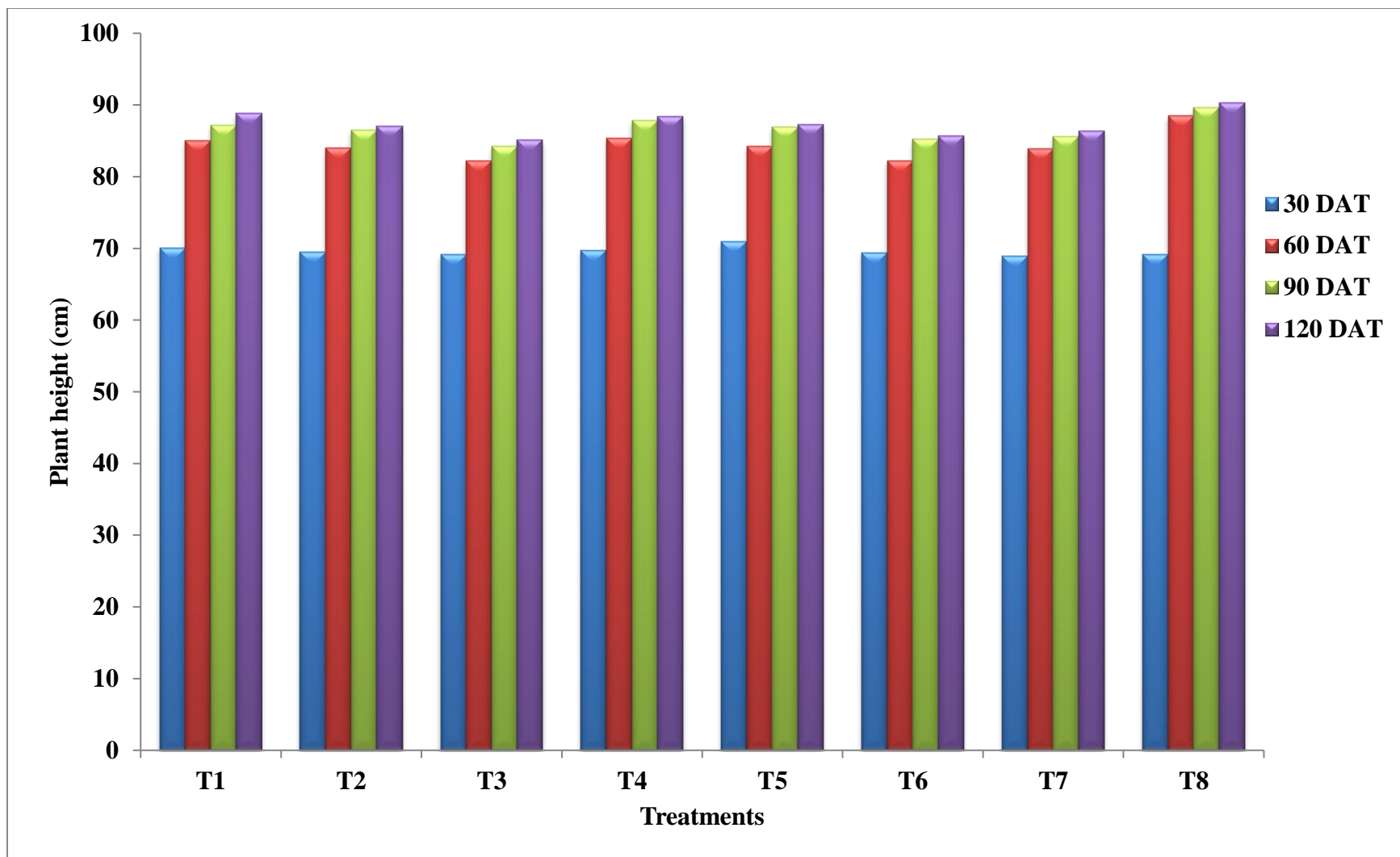
However data showed in Table 1 in 120 DAT showed that minimum (85.13 cm) plant height was observed in 125 g a.i/ha of mepiquat chloride at initiation of flowering (T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (85.68 cm).

**Table 1: Effect of mepiquat chloride on plant height (cm) in tomato**

| Treatments   | Plant height (cm) |             |             |             |
|--|-------------------|-------------|-------------|-------------|
|  | 30<br>DAT         | 60<br>DAT   | 90<br>DAT   | 120<br>DAT  |
| T <sub>1</sub> : MC @ 50 g a.i./ha at initiation of flowering                    | 70.13             | 85.07       | 87.23       | 88.83       |
| T <sub>2</sub> : MC @ 62.5 g a.i./ha at initiation of flowering                  | 69.53             | 83.97       | 86.47       | 87.03       |
| T <sub>3</sub> : MC @ 125 g a.i./ha at initiation of flowering                   | 69.10             | 82.20       | 84.27       | 85.13       |
| T <sub>4</sub> : MC @ 50 g a.i./ha at initiation of fruiting                     | 69.73             | 85.33       | 87.80       | 88.40       |
| T <sub>5</sub> : MC @ 62.5 g a.i./ha at initiation of fruiting                   | 70.97             | 84.27       | 86.93       | 87.27       |
| T <sub>6</sub> : MC @ 125 g a.i./ha at fruiting stage                            | 69.43             | 82.27       | 85.20       | 85.68       |
| T <sub>7</sub> : MC @ 50 g a.i./ha at initiation of flowering and fruiting stage | 68.93             | 83.87       | 85.63       | 86.37       |
| T <sub>8</sub> : Control   | 69.17             | 88.50       | 89.67       | 90.27       |
| <b>F test</b>  | <b>NS</b>         | <b>*</b>    | <b>*</b>    | <b>*</b>    |
| <b>S. Em±</b>  | <b>0.74</b>       | <b>0.40</b> | <b>0.41</b> | <b>0.47</b> |
| <b>CD at 5%</b>  | <b>2.25</b>       | <b>1.21</b> | <b>1.25</b> | <b>1.43</b> |

MC: Mepiquat Chloride

a.i: Active ingredient



**Fig. 1:** Effect of mepiquat chloride on plant height (cm) in tomato

Nevertheless, T<sub>4</sub> (88.40 cm) and T<sub>1</sub> (88.43 cm) at par with each other, whereas the maximum (90.27 cm) plant height was recorded under control.

From the recorded data it was clear that by increasing the concentrations of mepiquat chloride, there was a significant reduction in the plant height. This may be attributed to the mepiquat chloride might be owing to slowing down of cell division and reduction in cell expansion as these chemical possess anti-gibberellin quality. The results are in conformity with the findings of Dippenaar (1990) in cotton. Similar results were obtained by Pal *et al.* (2017) in onion and Kumar *et al.* (2012) in tomato by the treatment of cycocel at 3000 ppm.

#### **4.1.2 Internodal length (cm)**

There were marked variations in the internodal length (cm) at different stages of growth due to different treatments. A perusal of the data presented in Table 2 clearly indicates that all the treatments significantly reduced the internodal length (cm) as compared to control.

At 30 DAT the maximum (5.41 cm) internodal length was observed with T<sub>4</sub> followed by T<sub>8</sub> (5.39 cm), T<sub>2</sub> (5.01 cm), T<sub>5</sub> (4.83 cm) and T<sub>6</sub> (4.53 cm) while minimum (4.26 cm) internodal length was observed in T<sub>3</sub>. At 60 DAT the lowest (5.11 cm) internodal length was noted with 125 g a.i/ha of mepiquat chloride at initiation of flowering( T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (5.19 cm). Nevertheless, T<sub>2</sub> (5.32 cm) and T<sub>5</sub>(5.34 cm) were at par with each other. The highest (6.95cm) internodal length was noted in control.

At 90 DAT the minimum (5.49 cm) internodal length was recorded under 125 g a.i/ha of mepiquat chloride at initiation of flowering( T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (5.51 cm). T<sub>2</sub> (5.69 cm) and T<sub>5</sub> (5.71 cm) remained at par with each other. The maximum (7.51 cm) internodal length was recorded under T<sub>8</sub> (control).

At 120 DAT minimum (5.50 cm) internodal length was observed in 125 g a.i/ha of mepiquat chloride at initiation of flowering( T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat

chloride at initiation of fruiting T<sub>6</sub> (5.53 cm). Nevertheless, T<sub>2</sub> (5.70 cm) and T<sub>5</sub> (5.72 cm) at par with each other, whereas the maximum (7.84 cm) internodal length was recorded under control.

From the recorded data it was clear that by increasing the concentrations of mepiquat chloride, there was a significant reduction in the internodal length. This might be due to suppression in sub apical meristematic growth. Similar findings were reported by Wallace *et al.* (1993) and Ghourab *et al.* (2000) in cotton by the application of mepiquat chloride.

#### **4.1.3 Number of branches**

The variation in the number of branches per plant in response to different treatments was well marked at different stages of growth. Table 3 and Fig.2 indicates that all the treatments receiving mepiquat chloride proved to be superior to control.

At 30 DAT, the maximum (4.91) number of branches per plant was noted with T<sub>6</sub>, while it was the minimum (4.56) under T<sub>5</sub>. However, at 60 DAT, the maximum (8.73) number of branches per plant was recorded under 125 g a.i/ha of mepiquat chloride at initiation of flowering (T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (8.47) while it was minimum (6.23) number of branches per plant was recorded in control.

At 90 DAT the maximum (12.47) number of branches per plant was observed in 125 g a.i/ha of mepiquat chloride at initiation of flowering( T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (12.00), whereas the minimum (7.40) number of branches per plant was observed in T<sub>8</sub> (control).

At 120 DAT show that maximum (13.93) number of branches per plant was recorded with 50 g a.i/ha of mepiquat chloride at initiation of flowering( T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (12.53). Nevertheless, T<sub>5</sub> (10.30) and T<sub>1</sub> (10.07) were at par with each other, whereas the minimum (8.30) number of branches was recorded under control.

**Table 2: Effect of mepiquat chloride on internodal length (cm) in tomato**

| Treatments  | Internodal length (cm) |             |             |             |
|---|------------------------|-------------|-------------|-------------|
|   | 30<br>DAT              | 60<br>DAT   | 90<br>DAT   | 120<br>DAT  |
| <b>T<sub>1</sub></b> :MC @ 50 g a.i./ha at initiation of flowering                            | 4.34                   | 5.38        | 5.76        | 5.95        |
| <b>T<sub>2</sub></b> :MC @ 62.5 g a.i./ha at initiation of flowering                          | 5.01                   | 5.32        | 5.69        | 5.70        |
| <b>T<sub>3</sub></b> :MC @ 125 g a.i./ha at initiation of flowering                           | 4.26                   | 5.11        | 5.49        | 5.50        |
| <b>T<sub>4</sub></b> :MC @ 50 g a.i./ha at initiation of fruiting                             | 5.41                   | 5.43        | 5.90        | 6.11        |
| <b>T<sub>5</sub></b> :MC @ 62.5 g a.i./ha at initiation of fruiting                           | 4.83                   | 5.34        | 5.71        | 5.72        |
| <b>T<sub>6</sub></b> :MC @ 125 g a.i./ha at initiation of fruiting                            | 4.53                   | 5.19        | 5.51        | 5.53        |
| <b>T<sub>7</sub></b> :MC @ 50 g a.i./ha at initiation of flowering and initiation of fruiting | 4.42                   | 5.25        | 5.53        | 5.58        |
| <b>T<sub>8</sub></b> : Control  | 5.39                   | 6.95        | 7.51        | 7.84        |
| <b>F test</b>   | <b>NS</b>              | <b>*</b>    | <b>*</b>    | <b>*</b>    |
| <b>S. Em±</b>   | <b>0.08</b>            | <b>0.02</b> | <b>0.03</b> | <b>0.02</b> |
| <b>CD at 5%</b>   | <b>0.24</b>            | <b>0.07</b> | <b>0.09</b> | <b>0.07</b> |

**MC:** Mepiquat Chloride

**a.i:** Active ingredient

The number of branches per plant differed significantly due to different treatments. It increased with the application of growth retardants. This may be attributed to the suppression of apical dominance, thereby diverting the polar transport of auxins towards the basal nodes. Similar results were obtained by increased number of branches by the spraying of mepiquat chloride at 175 ppm (Gasti, 1994) in okra. Kumar *et al.* (2012) reported that effect of cycocel at 3000 ppm increases number of branches than control. Thus, it seems that the reduction in terminal growth of the plant paved way to a better lateral growth.

#### **4.1.4 Number of leaves per plant**

The variation in the number of leaves per plant in response to different treatments was well marked at different stages of growth. Table 4 indicates that all the treatments receiving mepiquat chloride proved to be superior to control.

At 30 DAT, the maximum (88.73) number of leaves per plant was observed in T<sub>6</sub>, while it was the minimum (84.60) under T<sub>4</sub>. However, at 60 DAT, the maximum (122.07) number of leaves per plant was recorded under 125 g a.i/ha of mepiquat chloride at initiation of flowering (T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (120.73) while it was minimum (109.33) number of leaves per plant was recorded in control.

At 90 DAT the maximum (214.53) number of leaves per plant was recorded under 125 g a.i/ha of mepiquat chloride at initiation of flowering ( T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (213.80), whereas the minimum (199.47) number of leaves per plant was recorded under T<sub>8</sub> (control).

At 120 DAT the highest (208.40) number of leaves per plant was noted in 125 g a.i/ha of mepiquat chloride at initiation of flowering (T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (204.17) while it was lowest (182.90) number of leaves per plant was noted in control.

**Table 3: Effect of mepiquat chloride on number of branches per plant in tomato**

| Treatments   | Number of branches |             |             |             |
|--|--------------------|-------------|-------------|-------------|
|  | 30<br>DAT          | 60<br>DAT   | 90<br>DAT   | 120<br>DAT  |
| T <sub>1</sub> :MC @ 50 g a.i./ha at initiation of flowering                               | 4.61               | 7.33        | 9.33        | 10.07       |
| T <sub>2</sub> :MC @ 62.5 g a.i./ha at initiation of flowering                             | 4.78               | 7.43        | 10.13       | 11.27       |
| T <sub>3</sub> :MC @ 125 g a.i./ha at initiation of flowering                              | 4.68               | 8.73        | 12.47       | 13.93       |
| T <sub>4</sub> :MC @ 50 g a.i./ha at initiation of fruiting                                | 4.61               | 7.13        | 9.00        | 9.57        |
| T <sub>5</sub> :MC @ 62.5 g a.i./ha at initiation of fruiting                              | 4.56               | 7.37        | 9.87        | 10.30       |
| T <sub>6</sub> :MC @ 125 g a.i./ha at initiation of fruiting                               | 4.91               | 8.47        | 12.00       | 12.53       |
| T <sub>7</sub> :MC @ 50 g a.i./ha at initiation of flowering<br>and initiation of fruiting | 4.80               | 7.67        | 10.20       | 11.43       |
| T <sub>8</sub> : Control   | 4.64               | 6.23        | 7.40        | 8.30        |
| <b>F test</b>  | <b>NS</b>          | <b>*</b>    | <b>*</b>    | <b>*</b>    |
| <b>S. Em±</b>  | <b>0.14</b>        | <b>0.15</b> | <b>0.12</b> | <b>0.21</b> |
| <b>CD at 5%</b>  | <b>0.42</b>        | <b>0.44</b> | <b>0.36</b> | <b>0.65</b> |

**MC:** Mepiquat Chloride

**a.i:** Active ingredient

The number of leaves per plant differed significantly due to different treatments. It increased with the application of mepiquat chloride. This may be attributed to the ability of growth retardants to delay senescence of leaf by arresting the chlorophyll degradation and protease activity and promoting. This finding is in agreement with Gasti (1994) in okra. Similar results were obtained by Memane *et al.* (2008) for the effect of cycocel (1000 ppm) on garlic and Prakash *et al.* (2003) reported an increase in number of leaves by growth regulators in black gram.

#### **4.1.5 Stem girth (cm)**

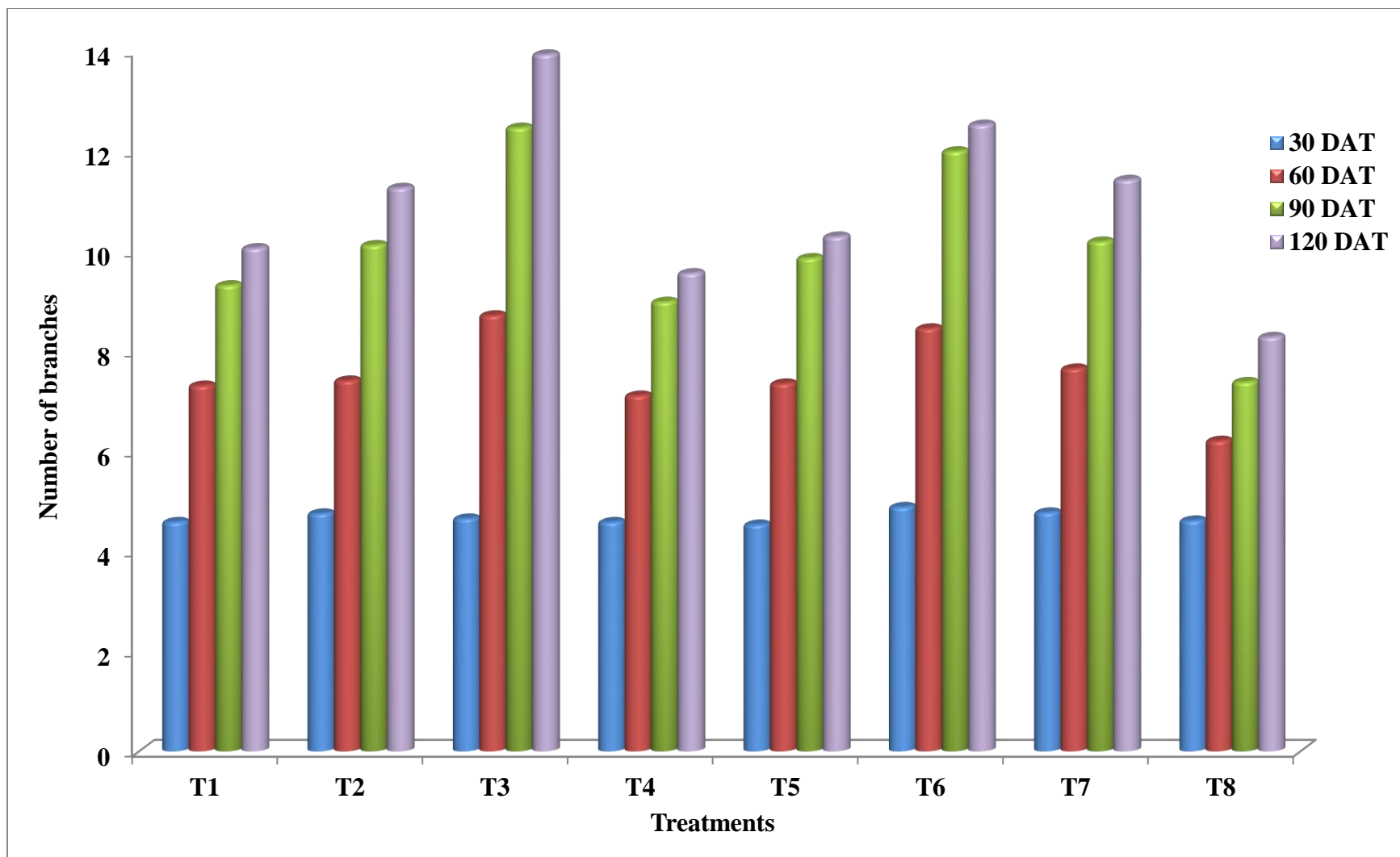
There were marked variations in stem girth due to different treatments. A perusal of data presented in Table 5 clearly indicates these variations.

At 30 DAT, the maximum (5.10 cm) stem girth was observed in T<sub>7</sub>, while it was the minimum (4.78) under T<sub>4</sub>. However, at 60 DAT, the maximum (5.23 cm) stem girth was noted with 125 g a.i/ha of mepiquat chloride at initiation of flowering ( T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (5.21 cm). Nevertheless, T<sub>5</sub> (5.06 cm) and T<sub>1</sub> (5.03 cm) were at par with each other. The minimum (4.88 cm) stem girth was observed in control.

At 90 DAT the highest (5.30 cm) stem girth was recorded under 125 g a.i/ha of mepiquat chloride at initiation of flowering (T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (5.29 cm). T<sub>1</sub> (5.13cm) and T<sub>4</sub> (5.13 cm) were at par with each other while it was lowest (4.98 cm) stem girth was noted under T<sub>8</sub> (control).

At 120 DAT the maximum (5.34 cm) stem girth was noted in 125 g a.i/ha of mepiquat chloride at initiation of flowering( T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (5.31 cm) while it was minimum (4.99 cm) stem girth was noted in control.

The stem girth differed significantly due to different treatments. It increased with the application of growth retardants. This may be attributed to the inhibition of longitudinal cell growth and the stimulation (Zidan *et al*, 2014). Similar results were



**Fig. 2: Effect of mepiquat chloride on number of branches in tomato**

**Table 4: Effect of mepiquat chloride on number of leaves per plant in tomato**

| Treatments  | Number of leaves per plant |             |             |             |
|---|----------------------------|-------------|-------------|-------------|
|   | 30<br>DAT                  | 60<br>DAT   | 90<br>DAT   | 120<br>DAT  |
| <b>T<sub>1</sub></b> : MC @ 50 g a.i./ha at initiation of flowering                               | 87.93                      | 115.73      | 208.67      | 191.47      |
| <b>T<sub>2</sub></b> : MC @ 62.5 g a.i./ha at initiation of flowering                             | 86.67                      | 117.00      | 209.67      | 198.27      |
| <b>T<sub>3</sub></b> : MC @ 125 g a.i./ha at initiation of flowering                              | 85.00                      | 122.07      | 214.53      | 208.40      |
| <b>T<sub>4</sub></b> : MC @ 50 g a.i./ha at initiation of fruiting                                | 84.60                      | 115.13      | 206.60      | 191.20      |
| <b>T<sub>5</sub></b> : MC @ 62.5 g a.i./ha at initiation of fruiting                              | 87.80                      | 116.47      | 207.47      | 194.40      |
| <b>T<sub>6</sub></b> : MC @ 125 g a.i./ha at initiation of fruiting                               | 88.73                      | 120.73      | 213.80      | 204.17      |
| <b>T<sub>7</sub></b> : MC @ 50 g a.i./ha at initiation of flowering<br>and initiation of fruiting | 87.00                      | 117.47      | 210.33      | 199.60      |
| <b>T<sub>8</sub></b> : Control  | 87.53                      | 109.33      | 199.47      | 182.90      |
| <b>F test</b>   | <b>NS</b>                  | <b>*</b>    | <b>*</b>    | <b>*</b>    |
| <b>S. Em±</b>   | <b>1.16</b>                | <b>0.61</b> | <b>1.00</b> | <b>1.20</b> |
| <b>CD at 5%</b>   | <b>3.52</b>                | <b>1.84</b> | <b>3.04</b> | <b>3.65</b> |

**MC:** Mepiquat Chloride

**a.i:** Active ingredient

obtained by Elkoca and Kantar (2006) for the application of mepiquat chloride both significantly shortened stem height and increased stem girth in pea.

#### **4.1.6 Leaf area (cm<sup>2</sup>)**

Table 6 indicates that increasing concentration of mepiquat chloride significantly enhanced the leaf area as compared to control. Significantly larger (73.74 cm<sup>2</sup>) leaves were produced under control, followed by 50 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>4</sub> (72.91 cm<sup>2</sup>) while it was lesser (68.74 cm<sup>2</sup>) under 125 g a.i/ha of mepiquat chloride at initiation of flowering (T<sub>3</sub>).

From the recorded data it was clear that by increasing the concentrations of mepiquat chloride, there was a significant reduction in the leaf area. This might be due to reduced size of cells in cortical region. Jeyakumar and Thangaraj (1996) revealed that leaf area was reduced with the application of mepiquat chloride at 125 ppm sprayed at 35 DAS in groundnut. Similar findings were reported by Reddy *et al.* (1990) in cotton and Flores *et al.* (2018) in cucurbits.

#### **4.1.7 Chlorophyll content**

In the present study, chlorophyll content was estimated and growth retardants had profound influence on chlorophyll content in leaf. A perusal of data presented in Table 6 clearly indicates that there was significant difference during the entire period of recording the observation.

The data clearly indicated that, the increased (24.43) total chlorophyll was observed with 125 g a.i/ha of mepiquat chloride at initiation of flowering (T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (24.34). T<sub>1</sub> (22.93) and T<sub>4</sub> (22.86) were at par with each other while it was decreased (20.65) in control.

The chlorophyll content differed significantly due to different treatments. It increased with the application of growth retardants. This could be attributed to the chlorophyll synthesis is enhanced due to some sort of mild stress created by growth inhibitors and retardants and also the chlorophyllase enzyme, responsible for chlorophyll



**Plate 5: General view of tomato crop during staking time**



**Plate 6: Spraying of mepiquat chloride at fruit initiation stage**

**Table 5: Effect of mepiquat chloride on stem girth (cm) in tomato**

| Treatments   | Stem girth (cm) |             |             |             |
|--|-----------------|-------------|-------------|-------------|
|  | 30<br>DAT       | 60<br>DAT   | 90<br>DAT   | 120<br>DAT  |
| <b>T<sub>1</sub></b> : MC @ 50 g a.i./ha at initiation of flowering                    | 4.98            | 5.03        | 5.13        | 5.17        |
| <b>T<sub>2</sub></b> : MC @ 62.5 g a.i./ha at initiation of flowering                  | 4.99            | 5.11        | 5.19        | 5.21        |
| <b>T<sub>3</sub></b> : MC @ 125 g a.i./ha at initiation of flowering                   | 5.09            | 5.23        | 5.30        | 5.34        |
| <b>T<sub>4</sub></b> : MC @ 50 g a.i./ha at initiation of fruiting                     | 4.78            | 4.99        | 5.13        | 5.16        |
| <b>T<sub>5</sub></b> : MC @ 62.5 g a.i./ha at initiation of fruiting                   | 5.01            | 5.06        | 5.17        | 5.19        |
| <b>T<sub>6</sub></b> : MC @ 125 g a.i./ha at initiation of fruiting                    | 4.95            | 5.21        | 5.29        | 5.31        |
| <b>T<sub>7</sub></b> : MC @ 50 g a.i./ha at initiation of flowering and fruiting stage | 5.10            | 5.15        | 5.21        | 5.26        |
| <b>T<sub>8</sub></b> : Control   | 4.87            | 4.88        | 4.98        | 4.99        |
| <b>F test</b>  | <b>NS</b>       | <b>*</b>    | <b>*</b>    | <b>*</b>    |
| <b>S. Em±</b>  | <b>0.04</b>     | <b>0.03</b> | <b>0.03</b> | <b>0.02</b> |
| <b>CD at 5%</b>  | <b>0.12</b>     | <b>0.10</b> | <b>0.08</b> | <b>0.05</b> |

**MC:** Mepiquat Chloride

**a.i:** Active ingredient

degradation, the activity might have been suppressed leading to a higher accumulation of chlorophylls. This finding is in agreement with Bangarswamay *et al.* (2001) in pigeon pea. Similar results were recorded by Cheema *et al.* (2009) in cotton and Xu and Taylor (1992) in cotton by the treatment of mepiquat chloride.

## **4.2 Reproductive parameters**

### **4.2.1 Days taken for first flowering**

The data presented on days taken for first flowering of tomato as influenced by different dosage of mepiquat chloride on crop growth (Table 6) indicates that there was a non-significant difference during the observation.

Among them number of days taken for first flowering was lower (24.40 days) under T<sub>5</sub> followed by T<sub>2</sub> (24.60 days), T<sub>7</sub> (25.27 days) and T<sub>3</sub> (25.63 days) while it was higher (26.00 days) in T<sub>6</sub>.

The days taken for first flowering differed non significantly due to different treatments. This could be attributed to the fact that mepiquat chloride was sprayed at 35 DAT in which time the flowering already started in all the treatments, so days taken for first flowering did not differ significantly.

### **4.2.2 Number of flowers/plant**

The data on number of flowers per plant of tomato plants as influenced by different concentration of mepiquat chloride on crop growth (Table 7) indicates that there was a significant difference during the entire period of growth.

The number of flowers per plant was significantly highest (74.17) under 125 g a.i/ha of mepiquat chloride at initiation of flowering (T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (72.07) and 50 g a.i/ha of mepiquat chloride at initiation of flowering and spray at initiation of fruiting T<sub>7</sub> (71.93) while it was lowest (64.67) number of flowers per plant was observed under T<sub>8</sub> (control).

**Table 6: Effect of mepiquat chloride on leaf area (cm<sup>2</sup>), chlorophyll content and days taken for first flowering**

| <b>Treatments</b>  | <b>Leaf area (cm<sup>2</sup>)</b> | <b>Chlorophyll content</b> | <b>Days taken for first flowering</b> |
|--|-----------------------------------|----------------------------|---------------------------------------|
| <b>T<sub>1</sub></b> : MC @ 50 g a.i./ha at initiation of flowering                            | 71.64                             | 22.93                      | 25.27                                 |
| <b>T<sub>2</sub></b> : MC @ 62.5 g a.i./ha at initiation of flowering                          | 70.76                             | 23.57                      | 24.60                                 |
| <b>T<sub>3</sub></b> : MC @ 125 g a.i./ha at initiation of flowering                           | 68.74                             | 24.43                      | 25.63                                 |
| <b>T<sub>4</sub></b> : MC @ 50 g a.i./ha at initiation of fruiting                             | 72.91                             | 22.86                      | 25.40                                 |
| <b>T<sub>5</sub></b> : MC @ 62.5 g a.i./ha at initiation of fruiting                           | 70.82                             | 23.12                      | 24.40                                 |
| <b>T<sub>6</sub></b> : MC @ 125 g a.i./ha at initiation of fruiting                            | 70.43                             | 24.34                      | 26.00                                 |
| <b>T<sub>7</sub></b> : MC @ 50 g a.i./ha at initiation of flowering and initiation of fruiting | 70.58                             | 23.85                      | 25.27                                 |
| <b>T<sub>8</sub></b> : Control   | 73.74                             | 20.65                      | 25.93                                 |
| <b>F test</b>  | *                                 | *                          | <b>NS</b>                             |
| <b>S. Em±</b>  | <b>0.27</b>                       | <b>0.44</b>                | <b>0.27</b>                           |
| <b>CD at 5%</b>  | <b>0.82</b>                       | <b>1.34</b>                | <b>0.83</b>                           |

**MC**: Mepiquat Chloride

**a.i**: Active ingredient

The number of flowers per plant differed significantly due to different treatments. It increased with the application of growth retardants. This might be due to an inhibition of vegetative growth and thus making availability of food reserves for developing flowers which was evident from significantly increased number of flowers per plant. The results are in conformity with the findings of Kumar *et al.* (2012) in tomato.

#### **4.2.3 Per cent fruit set (%)**

The data on per cent fruit set of tomato as influenced by different concentration of mepiquat chloride (Table 7) indicates that there was a significant difference during the entire period of growth.

The per cent fruit set was significantly highest (67.19 %) under 125 g a.i/ha of mepiquat chloride at initiation of flowering (T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (66.57 %) and 50 g a.i/ha of mepiquat chloride at initiation of flowering and spray at initiation of fruiting T<sub>7</sub> (65.95 %) while it was lowest (60.41 %) percent fruit set was observed under T<sub>8</sub> (control).

The per cent fruit set of tomato differed significantly due to different treatments. It increased with the application of growth retardants. This might be due to increases in the number of flowers and growth rate of fruit. Results obtained by Megbo (2010) in tomato by the application of growth regulator.

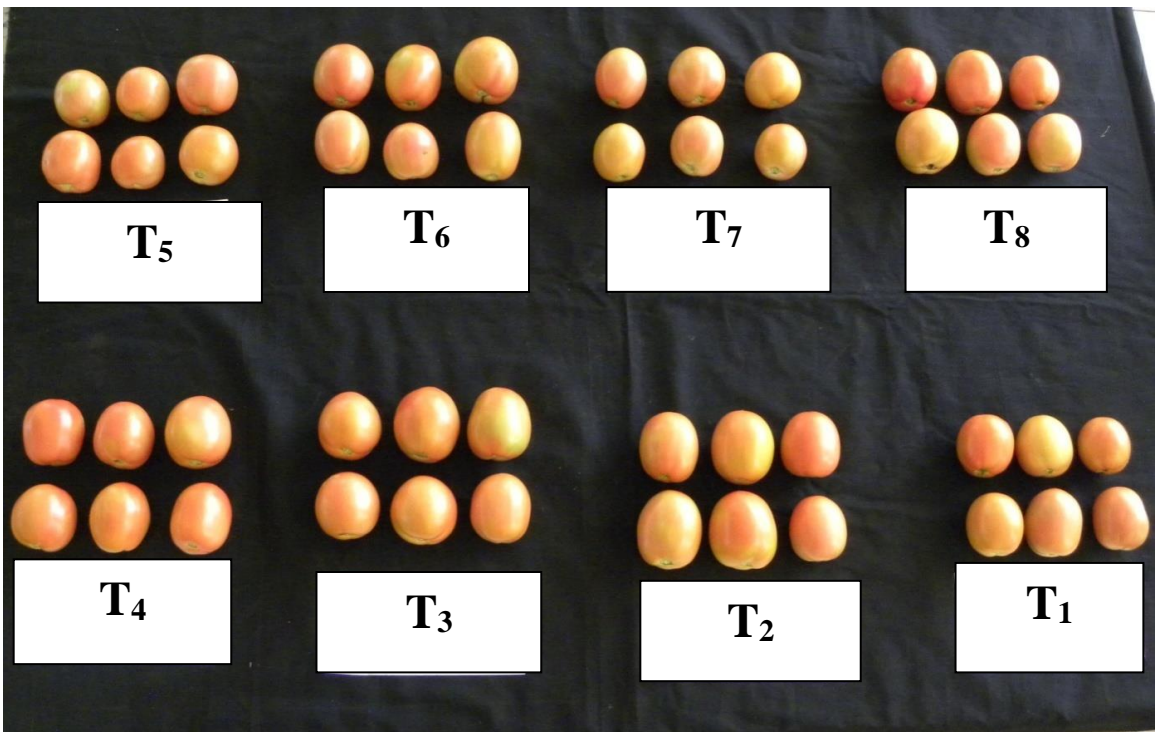
#### **4.2.4 Days taken for first harvest**

The data on days taken for first harvest of tomato plants as influenced by different concentration of mepiquat chloride on crop growth (Table 7) indicates that there was a non-significant difference during the entire period of growth.

Table 7 indicates that the days taken for first harvest did not differ significantly due to different treatments. Among them it was lesser (37.30 DAT) under control followed by 50 g a.i/ha of mepiquat chloride at initiation of flowering and initiation of fruiting T<sub>7</sub> (37.40 DAT) while it was higher (39.93 DAT) observed in 50 g a.i/ha of mepiquat chloride at initiation of fruiting (T<sub>4</sub>).



**Plate 7: General view of tomato crop**



**Plate 8: Effect of mepiquat chloride treatments on tomato fruits**

**Table 7: Effect of mepiquat chloride on number of flowers per plant, per cent fruit set (%) and days taken for first harvest**

| <b>Treatments</b>  | <b>Number of flowers /plant</b> | <b>Per cent fruit set (%)</b> | <b>Days taken for first harvest (DAT)</b> |
|--|---------------------------------|-------------------------------|---|
| <b>T1:</b> MC @ 50 g a.i./ha at initiation of flowering                            | 67.97                           | 65.42                         | 39.30                                     |
| <b>T2:</b> MC @ 62.5 g a.i./ha at initiation of flowering                          | 71.40                           | 64.24                         | 38.93                                     |
| <b>T3:</b> MC @ 125 g a.i./ha at initiation of flowering                           | 74.17                           | 67.19                         | 38.27                                     |
| <b>T4:</b> MC @ 50 g a.i./ha at initiation of fruiting                             | 66.57                           | 64.70                         | 39.93                                     |
| <b>T5:</b> MC @ 62.5 g a.i./ha at initiation of fruiting                           | 70.96                           | 64.21                         | 39.63                                     |
| <b>T6:</b> MC @ 125 g a.i./ha at initiation of fruiting                            | 72.07                           | 66.57                         | 38.47                                     |
| <b>T7:</b> MC @ 50 g a.i./ha at initiation of flowering and initiation of fruiting | 71.93                           | 65.95                         | 37.40                                     |
| <b>T8:</b> Control   | 64.67                           | 60.41                         | 37.30                                     |
| <b>F test</b>  | *                               | *                             | NS  |
| <b>S. Em±</b>  | <b>0.49</b>                     | <b>0.77</b>                   | <b>0.51</b>                               |
| <b>CD at 5%</b>  | <b>1.48</b>                     | <b>2.35</b>                   | <b>1.56</b>                               |

**MC:** Mepiquat Chloride

**a.i:** Active ingredient

The days taken for first harvest differed non significantly due to different treatments. Because mepiquat chloride sprayed during flower initiation stage.

### **4.3 Yield parameters**

The data pertaining to the yield parameters such as fruit length (cm), fruit diameter (cm), fruit weight (g), number of fruits per plants, yield per plant (kg) and yield per hectare (t/ha) recorded during the harvest period are presented in Table 8 and Table 9.

#### **4.3.1 Fruit length (cm)**

There were marked variations in fruit length due to different treatments. The data on fruit length (cm) was presented in Table 8 and depicted in Fig.3 clearly indicates that there was significant difference during the entire period of recording the observation.

The fruit length was significantly highest (5.65 cm) in 125 g a.i/ha of mepiquat chloride at initiation of flowering (T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (5.63 cm) and 50 g a.i/ha of mepiquat chloride at initiation of flowering and initiation of fruiting T<sub>7</sub> (5.13 cm) while it was lowest (4.48 cm) fruit length was observed in control.

#### **4.3.2 Fruit diameter (cm)**

There were marked variations in fruit diameter due to different treatments. The data on fruit width (cm) was presented in Table 8 and depicted in Fig. 3 clearly indicates that there was significant difference during the entire period of recording the observation.

The fruit diameter was significantly higher (4.57cm) under in 125 g a.i/ha of mepiquat chloride at initiation of flowering (T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (4.56 cm) and 50 g a.i/ha of mepiquat chloride at initiation of flowering and initiation of fruiting T<sub>7</sub> (4.53 cm) while it was lower (3.89 cm) fruit width was noted in T<sub>8</sub> (control).

The fruit length and fruit diameter differed significantly due to different treatments. It increased with the application of growth retardants. This may be attributed

**Table 9: Effect of mepiquat chloride on fruit length (cm), diameter (cm) and weight (g) in tomato**

| <b>Treatments</b>  | <b>Fruit length (cm)</b> | <b>Fruit diameter (cm)</b> | <b>Fruit weight (g)</b> |
|--|--------------------------|----------------------------|-------------------------|
| <b>T<sub>1</sub></b> : MC @ 50 g a.i./ha at initiation of flowering                            | 4.82                     | 4.40                       | 67.01                   |
| <b>T<sub>2</sub></b> : MC @ 62.5 g a.i./ha at initiation of flowering                          | 5.22                     | 4.51                       | 68.99                   |
| <b>T<sub>3</sub></b> : MC @ 125 g a.i./ha at initiation of flowering                           | 5.64                     | 4.57                       | 71.75                   |
| <b>T<sub>4</sub></b> : MC @ 50 g a.i./ha at initiation of fruiting                             | 4.70                     | 4.35                       | 65.82                   |
| <b>T<sub>5</sub></b> : MC @ 62.5 g a.i./ha at initiation of fruiting                           | 4.90                     | 4.47                       | 68.31                   |
| <b>T<sub>6</sub></b> : MC @ 125 g a.i./ha at initiation of fruiting                            | 5.64                     | 4.56                       | 70.21                   |
| <b>T<sub>7</sub></b> : MC @ 50 g a.i./ha at initiation of flowering and initiation of fruiting | 5.13                     | 4.53                       | 69.07                   |
| <b>T<sub>8</sub></b> : Control   | 4.48                     | 3.89                       | 63.26                   |
| <b>F test</b>  | *                        | *                          | *                       |
| <b>S. Em±</b>  | <b>0.12</b>              | <b>0.04</b>                | <b>0.40</b>             |
| <b>CD at 5%</b>  | <b>0.36</b>              | <b>0.11</b>                | <b>1.23</b>             |

**MC**: Mepiquat Chloride

**a.i**: Active ingredient

to greater accumulation of carbohydrates owing to greater photosynthesis which increased the fruit length and fruit width. Similar results were obtained by Laddha *et al.* (2018) in brinjal and Sivappa (2003) in okra where applied with mepiquat chloride which increased the fruit length and fruit diameter.

#### **4.3.3 Fruit weight (g)**

There were marked variations in fruit weight due to different treatments. The data on fruit weight (g) presented in Table 8 clearly indicates that there was significant difference in treatments.

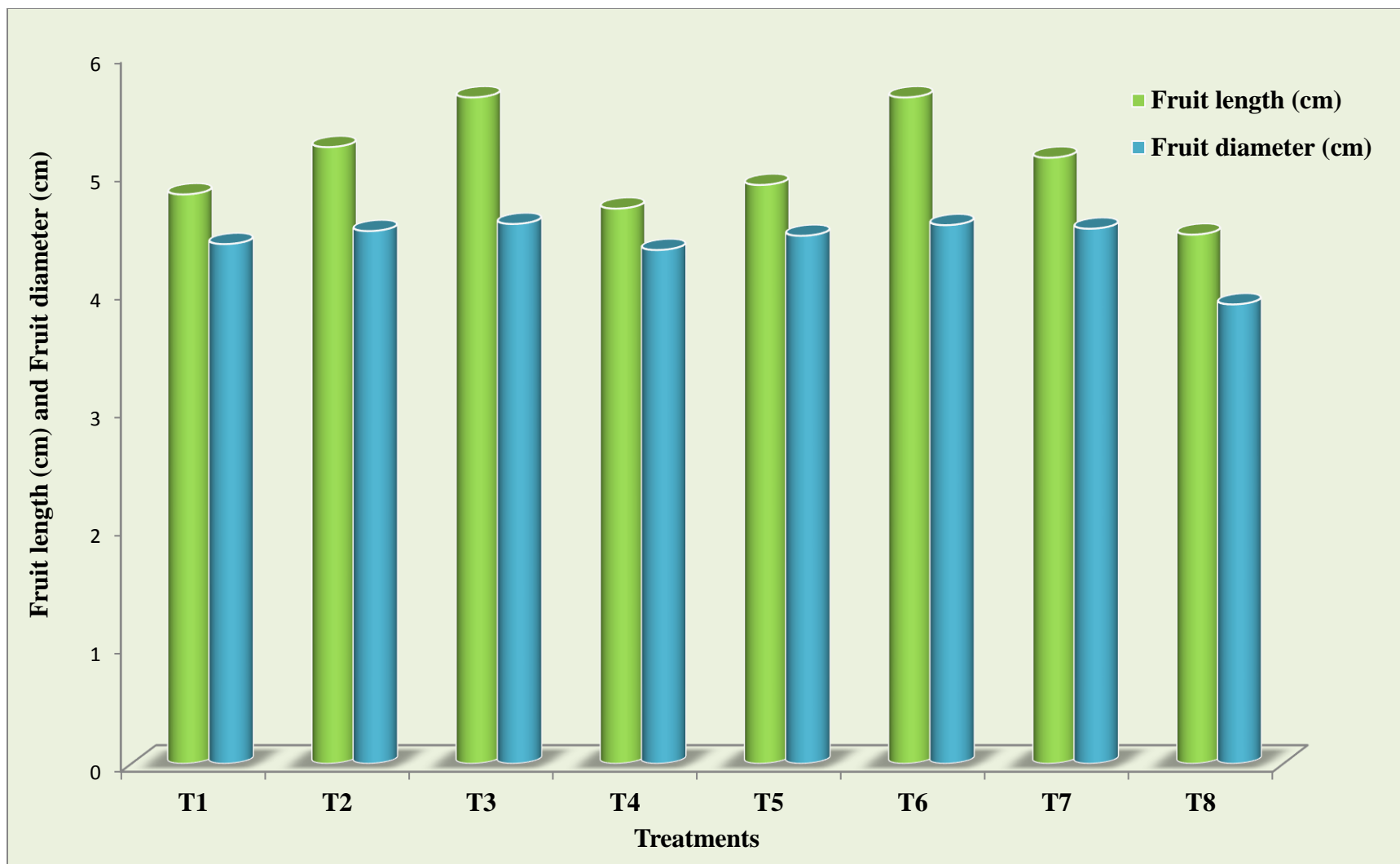
The fruit weight was significantly highest (71.75 g) in 125 g a.i/ha of mepiquat chloride at initiation of flowering (T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (70.21 g) and 50 g a.i/ha of mepiquat chloride at initiation of flowering and initiation of fruiting T<sub>7</sub> (69.07 g) while it was lowest (63.26 g) in T<sub>8</sub> (control).

The fruit weight (g) differed significantly due to different treatments. It increased with the application of growth retardants. Increase in fruit weight might be due to higher diameter of fruit and higher length of fruit in these treatments. These finding are in agreement with Sanganagoud *et al.* (2014) with CCC in okra, Mohsen (2013) in cucumber with Paclobutrazol. Similar results Laddha *et al.* (2018) found that effect of mepiquat chloride at 3400 ppm increases the fruit weight in brinjal.

#### **4.3.4 Number of fruits per plant**

The data on number of fruits per plant of tomato as influenced by different concentration of mepiquat chloride (Table 9) indicates that there was a significant difference during the entire period of harvesting.

The number of fruits per plant was significantly highest (49.83) under 125 g a.i/ha of mepiquat chloride at initiation of flowering (T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (47.96) and 50 g a.i/ha of mepiquat chloride at



**Fig. 3: Effect of mepiquat chloride on fruit length (cm) and fruit diameter (cm) in tomato**

initiation of flowering and spray at initiation of fruiting T<sub>7</sub> (47.43) while it was lowest (39.07) number of fruits per plant was observed under T<sub>8</sub> (control).

The number of fruits per plant differed significantly due to different treatments. It increased with the application of growth retardants. This might be due to an inhibition of vegetative growth and thus making availability of food reserves for developing fruits which was evident from significantly increased number of fruits per plant Ma and Smith (1992) or higher concentration treated plants had higher number of internodes i.e. short internodal length, which resulted to produce more number of fruit. Similar results were obtained by Laddha *et al.* (2018) in brinjal and Sridhar *et al.* (2009) in chilli.

#### **4.3.5 Yield per plant (kg)**

The data on yield per plant (kg) of tomato as influenced by different concentration of mepiquat chloride on crop growth (Table 9 and Fig.4) indicates that there was a significant difference during the entire period of harvest.

The yield per plant (kg) was significantly maximum (3.58 kg) under 125 g a.i/ha of mepiquat chloride at initiation of flowering (T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (3.37 kg) and 50 g a.i/ha of mepiquat chloride at initiation of flowering and initiation of fruiting T<sub>7</sub> (3.28 kg) while it was minimum (2.47 kg) yield per plant was observed under T<sub>8</sub> (control).

#### **4.3.6 Yield per plot (kg)**

The data on yield per plot (kg) of tomato as influenced by different concentration of mepiquat chloride (Table 9) indicates that there was a significant difference during the entire period of harvest.

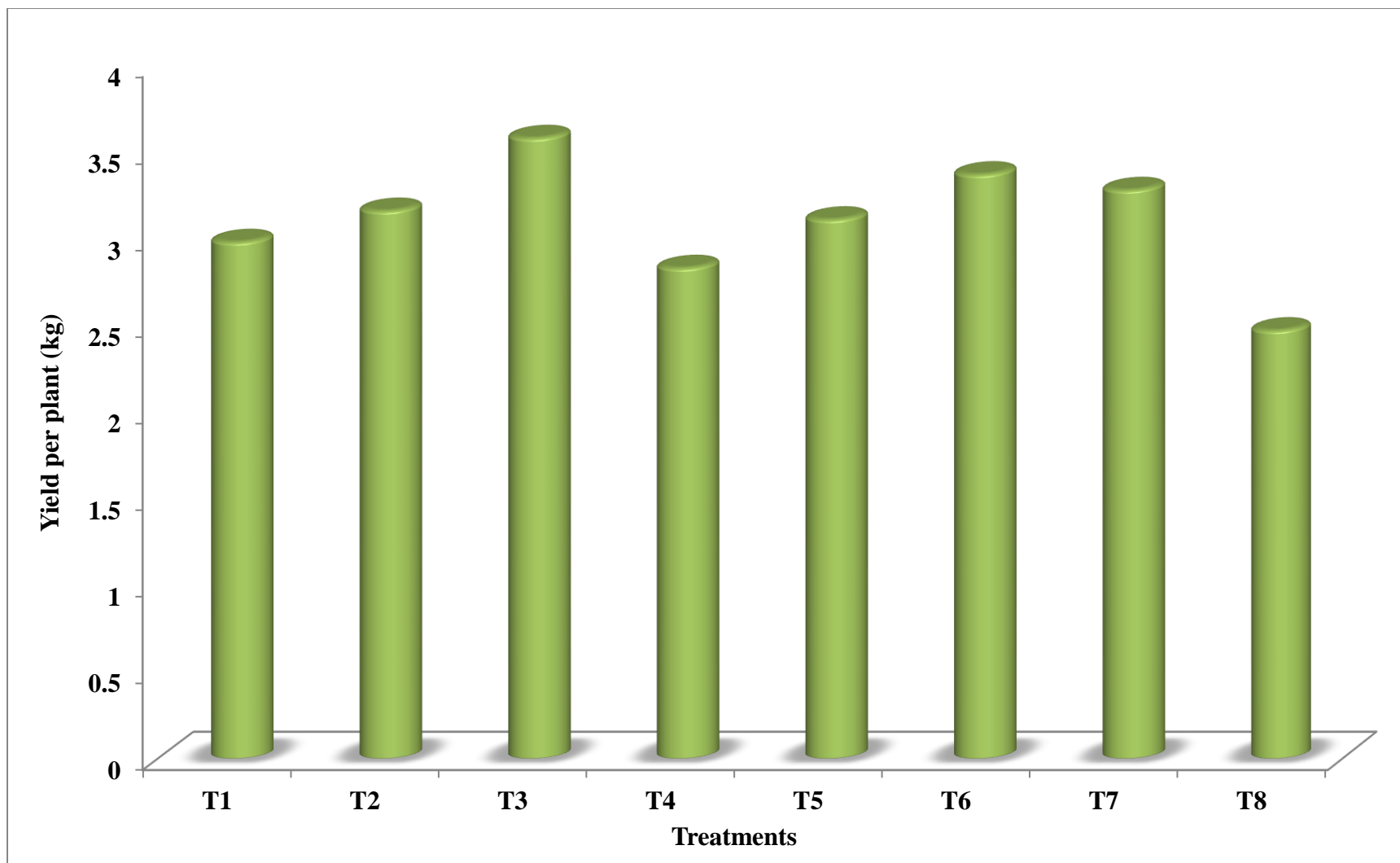
The yield per plot (kg) was significantly increased (143.01 kg) under 125 g a.i/ha of mepiquat chloride at initiation of flowering (T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (134.71 kg) and 50 g a.i/ha of mepiquat chloride at initiation of flowering and at initiation of fruiting T<sub>7</sub> (131.03 kg) while it was minimum (98.83 kg) yield per plot was observed under T<sub>8</sub> (control).

**Table 9: Effect of mepiquat chloride on number of fruits per plant, yield per plant (kg), per plot (kg) and per hectare (tons)**

| <b>Treatments</b>  | <b>Number of fruits/ plant</b> | <b>Yield per plant (kg)</b> | <b>Yield per plot (kg)</b> | <b>Yield per hectare (tons)</b> |
|--|--------------------------------|-----------------------------|----------------------------|---------------------------------|
| <b>T1:</b> MC @ 50 g a.i./ha at initiation of flowering                            | 44.47                          | 2.98                        | 119.18                     | 71.51                           |
| <b>T2:</b> MC @ 62.5 g a.i./ha at initiation of flowering                          | 45.87                          | 3.16                        | 126.58                     | 75.95                           |
| <b>T3:</b> MC @ 125 g a.i./ha at initiation of flowering                           | 49.83                          | 3.58                        | 143.01                     | 85.81                           |
| <b>T4:</b> MC @ 50 g a.i./ha at initiation of fruiting                             | 43.07                          | 2.83                        | 113.39                     | 68.03                           |
| <b>T5:</b> MC @ 62.5 g a.i./ha at initiation of fruiting                           | 45.58                          | 3.11                        | 124.52                     | 74.71                           |
| <b>T6:</b> MC @ 125 g a.i./ha at initiation of fruiting                            | 47.96                          | 3.37                        | 134.71                     | 80.83                           |
| <b>T7:</b> MC @ 50 g a.i./ha at initiation of flowering and initiation of fruiting | 47.43                          | 3.28                        | 131.03                     | 78.62                           |
| <b>T8:</b> Control   | 39.07                          | 2.47                        | 98.83                      | 60.43                           |
| <b>F test</b>  | *                              | *                           | *                          | *                               |
| <b>S. Em±</b>  | <b>0.54</b>                    | <b>0.03</b>                 | <b>1.39</b>                | <b>0.82</b>                     |
| <b>CD at 5%</b>  | <b>1.65</b>                    | <b>0.11</b>                 | <b>4.22</b>                | <b>2.47</b>                     |

**MC:** Mepiquat Chloride

**a.i:** Active ingredient



**Fig. 4: Effect of mepiquat chloride on yield per plant (kg) in tomato**

#### **4.3.6 Yield per hectare (tons)**

The data on yield per hectare (ton) of tomato as influenced by different concentration of mepiquat chloride (Table 9 and Fig 5) indicates that there was a significant difference during the entire period of growth.

The yield per hectare (ton) was significantly maximum (85.81t/ha) under 125 g a.i/ha of mepiquat chloride at initiation of flowering (T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (80.83 t/ha) and 50 g a.i/ha of mepiquat chloride at initiation of flowering and spray at initiation of fruiting T<sub>7</sub> (78.62 t/ha) while it was minimum (60.43 t/ha) yield per hectare was observed under T<sub>8</sub> (control).

The yield per plant, yield per plot and yield per hectare differed significantly due to different treatments. It increased with the application of growth retardants. It might be due to higher concentration treated plants had higher number of internodes i.e. short internodal length, which resulted to produce more number of fruits, yield per plant, yield per plot and yield per hectare. The yield increases may be attributed to the promoting effect of mepiquat chloride on numerous physiological processes, leading to improvement of all yield components (Elkoca and Kantar, 2006). The results are conformity with the findings of (Prasad and Shrihari, 2008) in okra.

#### **4.4 Quality parameters**

The data pertaining to the parameters such as Total soluble solids, fruit firmness, ascorbic acid and number of locules are presented in Table 10.

##### **4.4.1 Total soluble solids (<sup>0</sup>B)**

There were marked variations in TSS due to different treatments. The data on Total soluble solids (<sup>0</sup> B) was presented in Table 10 and depicted in Fig.6 clearly indicates that there was significant difference in treatments.

The Total soluble solids was significantly higher (4.69 <sup>0</sup>B) under 125 g a.i/ha of mepiquat chloride at initiation of flowering (T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at fruiting stage T<sub>6</sub> (4.64 <sup>0</sup>B) and 50 g a.i/ha of mepiquat chloride at initiation

flowering and at initiation of fruiting T<sub>7</sub> (4.52 °B) while it was with lower (3.88 °B) total soluble solids under T<sub>8</sub> (control).

The total soluble solids significantly increased with the application of growth retardants. This could be attributed to its property of promoting the accumulation of carbohydrate by suppressing the apical dominance. Accumulation of more carbohydrates might have resulted in more solids in fruits. This is in agreement with Ganie and Solanki (2010) in onion. Similar results obtained by Laddha *et al.* (2018) in brinjal (5.40%) and Kumar *et al.* (2012) in tomato (6%) increased total soluble solids.

#### **4.4.2 Ascorbic acid content (mg/100g)**

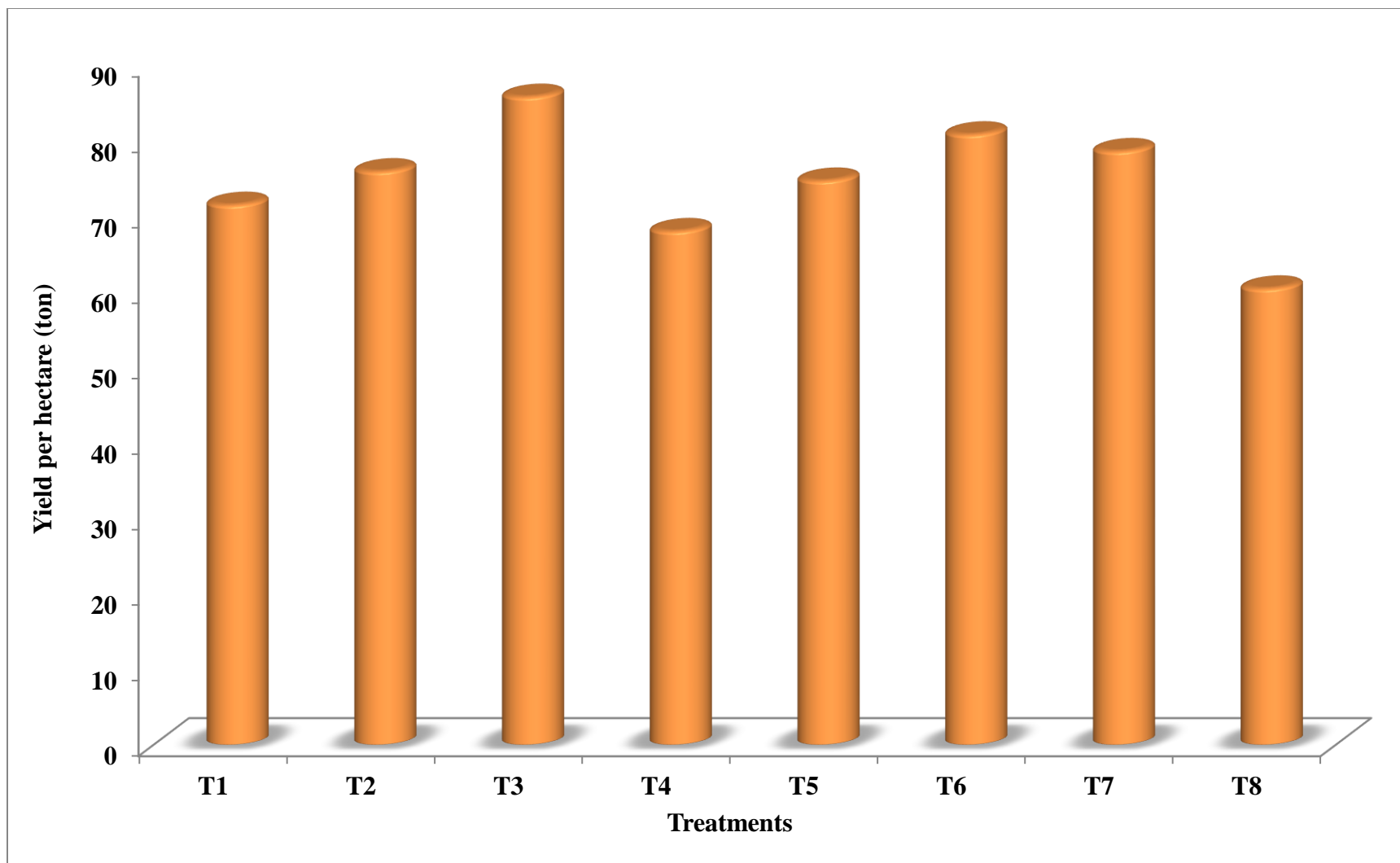
There were marked variations in ascorbic acid content due to different treatments. A perusal of data presented in Table 10 and depicted in Fig. 6 clearly indicates that there was significant difference during the entire period of crop harvest.

The ascorbic acid content (mg/100g) was significantly increased (17.05 mg/100g) under 125 g a.i/ha of mepiquat chloride at initiation of flowering (T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (16.92 mg/100g) and 50 g a.i/ha of mepiquat chloride at initiation of flowering and spray at initiation of fruiting T<sub>7</sub> (14.96 mg/100) while it was decreased (13.16 mg/100g) under T<sub>8</sub> (control).

The ascorbic acid (mg/100g) significantly increased with the application of growth retardants. Sridhar *et al.* (2009) found that spray of mepiquat chloride at 1000 ppm increased ascorbic acid content in chilli. Similar results were obtained by Kumar *et al.* (2012) with CCC in tomato and Chutichudet *et al.* (2007) with PBZ in okra.

#### **4.4.3 Fruit firmness (kg/cm<sup>2</sup>)**

The variation in the fruit firmness due to different treatments presented in Table 10 indicates that all the treatments receiving mepiquat chloride proved to be superior to control.



**Fig. 5: Effect of mepiquat chloride on yield per hectare (ton) in tomato**

The fruit firmness (kg/cm<sup>2</sup>) was significantly increased (4.17 kg/cm<sup>2</sup>) under 125 g a.i/ha of mepiquat chloride at initiation of flowering (T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (4.08 kg/cm<sup>2</sup>) and 50 g a.i/ha of mepiquat chloride at initiation of flowering and spray at initiation of fruiting T<sub>7</sub> (3.88 kg/cm<sup>2</sup>) while it was decreased (3.25 kg/cm<sup>2</sup>) fruit firmness was recorded under T<sub>8</sub> (control).

The fruit firmness (kg/cm<sup>2</sup>) significantly increased with the application of growth retardants. This may be attributed to mepiquat chloride influences the metabolism cell wall structure and promotes cell wall integrity as well as delay in cell wall degradation leads to increases the fruit firmness of tomato.

#### **4.4.4 Number of locules**

It is obvious from the data presented in Table 10 that different levels of mepiquat chloride had remarkable impact on number of locules on tomato fruit.

The number of locules was significantly higher (4.40) under 125 g a.i/ha of mepiquat chloride at initiation of flowering (T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (4.24) and 50 g a.i/ha of mepiquat chloride at initiation of flowering and initiation of fruiting T<sub>7</sub> (4.23) while it was lower (3.41) number of locules was observed under T<sub>8</sub> (control).

The number of locules is significantly increased to the treatment of mepiquat chloride at higher concentration. It is attributed to increased fruit diameter and enhanced fruit length. Similar results are obtained by Munos *et al.* (2011) in tomato.

#### **4.5 Cost economics**

Net income and benefit cost ratio of a crop are deciding factors for its adoption by farmers for the commercial production of any crop. It is therefore, important to calculate the income owing to tomato cultivation by application of different treatments.

**Table 10: Effect of mepiquat chloride on TSS (<sup>o</sup> B), ascorbic acid (mg/100g), firmness (kg/cm<sup>2</sup>) and number of locules**

| <b>Treatments</b>  | <b>TSS (<sup>o</sup>Brix)</b> | <b>Ascorbic acid (mg/100g)</b> | <b>Firmness (kg/cm<sup>2</sup>)</b> | <b>Number of locules</b> |
|--|-------------------------------|--------------------------------|-------------------------------------|--------------------------|
| <b>T<sub>1</sub></b> : MC @ 50 g a.i./ha at initiation of flowering                            | 4.14                          | 14.11                          | 3.55                                | 3.85                     |
| <b>T<sub>2</sub></b> : MC @ 62.5 g a.i./ha at initiation of flowering                          | 4.46                          | 14.57                          | 3.77                                | 4.02                     |
| <b>T<sub>3</sub></b> : MC @ 125 g a.i./ha at initiation of flowering                           | 4.69                          | 17.05                          | 4.17                                | 4.40                     |
| <b>T<sub>4</sub></b> : MC @ 50 g a.i./ha at initiation of fruiting                             | 3.97                          | 13.76                          | 3.49                                | 3.83                     |
| <b>T<sub>5</sub></b> : MC @ 62.5 g a.i./ha at initiation of fruiting                           | 4.31                          | 14.18                          | 3.63                                | 3.91                     |
| <b>T<sub>6</sub></b> : MC @ 125 g a.i./ha at initiation of fruiting                            | 4.64                          | 16.92                          | 4.08                                | 4.24                     |
| <b>T<sub>7</sub></b> : MC @ 50 g a.i./ha at initiation of flowering and initiation of fruiting | 4.52                          | 14.96                          | 3.88                                | 4.23                     |
| <b>T<sub>8</sub></b> : Control   | 3.88                          | 13.16                          | 3.25                                | 3.41                     |
| <b>F test</b>  | *                             | *                              | *                                   | *                        |
| <b>S. Em±</b>  | <b>0.04</b>                   | <b>0.13</b>                    | <b>0.05</b>                         | <b>0.08</b>              |
| <b>CD at 5%</b>  | <b>0.11</b>                   | <b>0.39</b>                    | <b>0.15</b>                         | <b>0.23</b>              |

**MC**: Mepiquat Chloride

**a.i**: Active ingredient

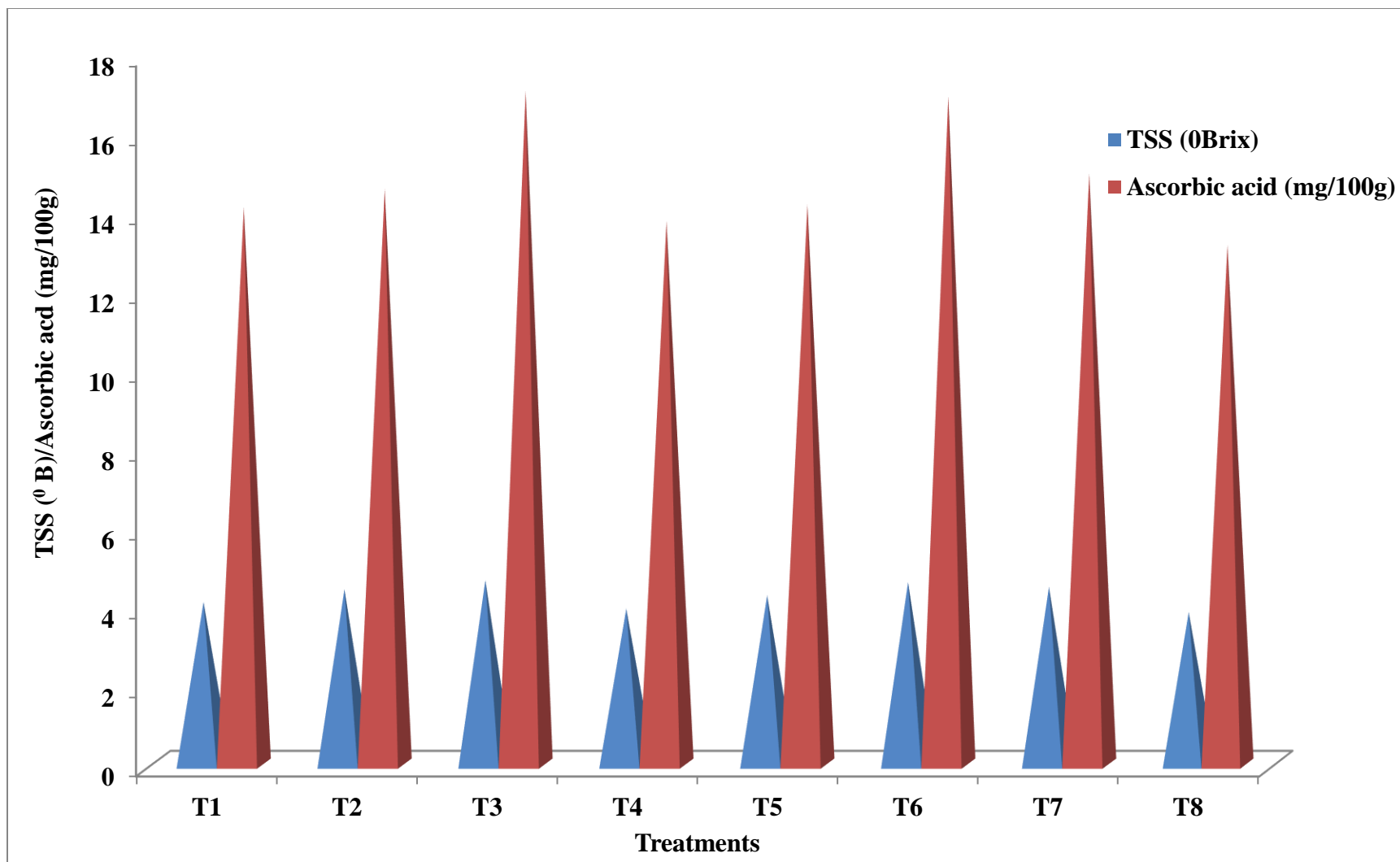


Fig. 6: Effect of mepiquat chloride on TSS (°B) and ascorbic acid (mg/100g) in tomato

The data pertaining to economics of treatments in tomato cultivation have been presented in Table 11. Among the treatments, the highest (Rs. 4,53,975, 1:2.12) net return and B:C ratio respectively was observed in 125 g a.i/ha of mepiquat chloride at initiation of flowering (T<sub>3</sub>) followed by 125 g a.i/ha of mepiquat chloride at initiation of fruiting T<sub>6</sub> (Rs.4,04,175, 1:2.00). The lowest (Rs. 2,02,050, 1:1.50) net return and B:C ratio was recorded under control.

It may be due to the reason that growth retardants induce dwarfism in plant, increase root growth capacity, photosynthesis efficiency and average weight of fruit which in turn increased the total yield. These results are in accordance with the findings of Sivappa (2003) who founded that highest net return and benefit cost ratio was obtained from mepiquat chloride at 300 ppm in okra. Similar results are obtained by Pal *et al.* (2017) in onion and Singh *et al.*, (2017) in cotton.

**Table 11: Effect of mepiquat chloride on economics of cultivation in tomato**

| <b>Treatment</b>  | <b>Total yield per ha (tons)</b> | <b>Total cost of cultivation (Rs.)</b> | <b>Gross return (Rs.)</b> | <b>Net return (Rs)</b> | <b>B:C ratio</b> |
|---|----------------------------------|--|---------------------------|------------------------|------------------|
| <b>T<sub>1</sub>: MC @ 50 g a.i./ha at initiation of flowering</b>                            | 71.51                            | 403000                                 | 715100                    | 312100                 | 1:1.77           |
| <b>T<sub>2</sub>: MC @ 62.5 g a.i./ha at initiation of flowering</b>                          | 75.95                            | 403187.5                               | 759500                    | 356312.5               | 1:1.88           |
| <b>T<sub>3</sub>: MC @ 125 g a.i./ha at initiation of flowering</b>                           | 85.81                            | 404125                                 | 858100                    | 453975                 | 1:2.12           |
| <b>T<sub>4</sub>: MC @ 50 g a.i./ha at initiation of fruiting</b>                             | 68.03                            | 403000                                 | 680300                    | 277300                 | 1:1.69           |
| <b>T<sub>5</sub>: MC @ 62.5 g a.i./ha at initiation of fruiting</b>                           | 74.71                            | 403187.5                               | 747100                    | 343912.5               | 1:1.85           |
| <b>T<sub>6</sub>: MC @ 125 g a.i./ha at initiation of fruiting</b>                            | 80.83                            | 404125                                 | 808300                    | 404175                 | 1:2.00           |
| <b>T<sub>7</sub>: MC @ 50 g a.i./ha at initiation of flowering and initiation of fruiting</b> | 78.62                            | 403750                                 | 786200                    | 382450                 | 1:1.95           |
| <b>T<sub>8</sub>: Control</b>   | 60.43                            | 402250                                 | 604300                    | 202050                 | 1:1.50           |

**MC:** Mepiquat Chloride

**Note:** Tomato fruits were sold at Rs. 10 per kg

## V SUMMARY

Investigation on the effect of mepiquat chloride on growth, yield and quality of tomato (*Solanum lycopersicum* L.) was carried out during 2018-19 at

Department of Horticulture, Gandhi Krishi Vignana Kendra, University of Agricultural Sciences, Bengaluru.

The recorded data were subjected to statistical analysis to judge the significance of treatments. It was found that all treatments were superior to control. The salient findings of the investigation are summarized here under.

1. Plant height was maximum (70.97 cm) at 30 DAT was recorded under T5 and (88.50 cm, 89.67cm and 90.27 cm) at 60, 90 and 120 DAT respectively, was recorded under control.
2. Internodal length (cm) was highest (5.41 cm) at 30 DAT was recorded under T4 and (6.95 cm, 7.51 cm and 7.84 cm) at 60, 90 and 120 DAT respectively, was recorded under control (T8).
3. Number of branches per plant was maximum (4.91) at 30 DAT was recorded under T6 and (8.73, 12.47 and 13.93) at 60, 90 and 120 DAT respectively, was recorded under 125 g a.i/ha of mepiquat chloride at initiation of flowering ( T3).
4. Number of leaves per plant was highest (88.73) at 30 DAT was recorded under T6 and (122.07, 214.53 and 208.40) at 60, 90 and 120 DAT respectively, was recorded under 125 g a.i/ha of mepiquat chloride at initiation of flowering ( T3).
5. Stem girth (cm) was maximum (5.10 cm) at 30 DAT was recorded under T7 and (5.23 cm, 5.30 cm and 5.34 cm) at 60, 90 and 120 DAT respectively, was recorded under 125 g a.i/ha of mepiquat chloride at initiation of flowering ( T3).
6. Leaf area (cm<sup>2</sup>) was increased (73.74 cm<sup>2</sup>) observed in control, whereas it decreased (68.74 cm<sup>2</sup>) in 125 g a.i/ha of mepiquat chloride at initiation of flowering (T3). Chlorophyll content was maximum (24.43) at 60 DAT recorded in 125 g a.i/ha of

mepiquat chloride at initiation of flowering (T3), whereas it minimum (20.65) in control.

7. Days taken for first flowering was minimum (24.40 days) observed in T5 while it was maximum (25.93 days) in control (T8).
8. Number of flowers per plant and percent fruit set were highest (74.17 and 67.19) recorded in 125 g a.i/ha of mepiquat chloride at initiation of flowering (T3). Days taken for first harvest was maximum (41.20 days) observed in control.
9. Fruit length, fruit width and fruit weight were highest (5.64 cm, 4.57 cm and 71.75 g respectively) obtained under 125 g a.i/ha of mepiquat chloride at initiation of flowering (T3).
10. Number of fruits per plant, yield per plant, yield per plot and yield per hectare were maximum (49.83, 3.58 kg, 143.01 kg and 85.81 t/ha respectively) under 125 g a.i/ha of mepiquat chloride at initiation of flowering (T3).
11. Total soluble solid, ascorbic acid, firmness and number of locules were maximum (4.69 °B, 17.05 mg/100g, 4.17 kg/cm<sup>2</sup> and 4.40) under 125 g a.i/ha of mepiquat chloride at initiation of flowering (T3).
12. The economics of cultivation of tomato were benefit cost ratio was highest (1:2.12) under 125 g a.i/ha of mepiquat chloride at initiation of flowering (T3) than other treatments.

### **Conclusion:**

In determining the impact of mepiquat chloride on tomato, the present investigation showed that all the treatments were superior to control. On the basis of the results obtained in the experiments, it could be concluded that the dose of 125 g a.i/ha at initiation of flowering (T3) was better compared to all the treatments. So the mepiquat chloride greatly influenced the vegetative, reproductive, yield, yield attributes and quality parameters of the crop.

**Future line of work:**

1. There is a need to standardize the optimum concentration of mepiquat chloride to get higher yield under different growing conditions.
2. The present study has to be taken up with respect to different location and in different commercial varieties of tomato.
3. Mepiquat chloride effect on plant and soil residues to be analysed.

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## APPENDIX – I

Meteorological data of the experiment during August-2018 to December-2018 at ZARS, UAS, GKVK, Bengaluru

| Month          | Temperature (° C) |      | Mean  | Relative Humidity (%) | Bright sun shine (Hours) | Rainfall (mm) |
|----------------|-------------------|------|-------|-----------------------|--------------------------|---------------|
|                | Max               | Min  |       |                       |                          |               |
| August-2018    | 27.7              | 18.9 | 23.3  | 90                    | 4.7                      | 129.7         |
| September-2018 | 28.1              | 18.9 | 23.5  | 89                    | 5.7                      | 196.0         |
| October-2018   | 27.9              | 18.3 | 23.1  | 88                    | 6.1                      | 164.7         |
| November-2018  | 26.7              | 16.6 | 21.65 | 87                    | 6.4                      | 56.2          |
| December-2018  | 26.3              | 14.6 | 20.45 | 87                    | 7.3                      | 13            |

**APPENDIX - II****Detailed cost of cultivation of tomato as influenced by mepiquat chloride for one season on an area of 1 hectare:**

| <b>Sl. No.</b> | <b>Treatment</b>                     | <b>T<sub>1</sub></b> | <b>T<sub>2</sub></b> | <b>T<sub>3</sub></b> | <b>T<sub>4</sub></b> | <b>T<sub>5</sub></b> | <b>T<sub>6</sub></b> | <b>T<sub>7</sub></b> | <b>T<sub>8</sub></b> |
|----------------|--------------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| <b>1</b>       | Land preparation                     | 12000                | 12000                | 12000                | 12000                | 12000                | 12000                | 12000                | 12000                |
| <b>2</b>       | Drip irrigation materials            | 80000                | 80000                | 80000                | 80000                | 80000                | 80000                | 80000                | 80000                |
| <b>3</b>       | Mulching                             | 35000                | 35000                | 35000                | 35000                | 35000                | 35000                | 35000                | 35000                |
| <b>4</b>       | Seedling cost                        | 5500                 | 5500                 | 5500                 | 5500                 | 5500                 | 5500                 | 5500                 | 5500                 |
| <b>5</b>       | Planting cost                        | 2500                 | 2500                 | 2500                 | 2500                 | 2500                 | 2500                 | 2500                 | 2500                 |
| <b>6</b>       | FYM (25 tons per ha)                 | 37500                | 37500                | 37500                | 37500                | 37500                | 37500                | 37500                | 37500                |
| <b>7</b>       | Chemical fertilizers                 | 19000                | 19000                | 19000                | 19000                | 19000                | 19000                | 19000                | 19000                |
| <b>8</b>       | Mepiquat chloride chemical cost      | 750                  | 937.5                | 1875                 | 750                  | 937.5                | 1875                 | 1500                 | 0                    |
| <b>9</b>       | Weeding                              | 7500                 | 7500                 | 7500                 | 7500                 | 7500                 | 7500                 | 7500                 | 7500                 |
| <b>10</b>      | Labour cost                          | 50000                | 50000                | 50000                | 50000                | 50000                | 50000                | 50000                | 50000                |
| <b>11</b>      | Staking and labour charge            | 45000                | 45000                | 45000                | 45000                | 45000                | 45000                | 45000                | 45000                |
| <b>12</b>      | Plant protection                     | 18000                | 18000                | 18000                | 18000                | 18000                | 18000                | 18000                | 18000                |
| <b>13</b>      | Plant Protection spray labour charge | 3250                 | 3250                 | 3250                 | 3250                 | 3250                 | 3250                 | 3250                 | 3250                 |
| <b>14</b>      | Harvesting                           | 15000                | 15000                | 15000                | 15000                | 15000                | 15000                | 15000                | 15000                |
| <b>15</b>      | Grading cost                         | 15000                | 15000                | 15000                | 15000                | 15000                | 15000                | 15000                | 15000                |
| <b>16</b>      | Packaging material                   | 7000                 | 7000                 | 7000                 | 7000                 | 7000                 | 7000                 | 7000                 | 7000                 |
| <b>17</b>      | Transportation                       | 10000                | 10000                | 10000                | 10000                | 10000                | 10000                | 10000                | 10000                |
| <b>18</b>      | Marketing                            | 40000                | 40000                | 40000                | 40000                | 40000                | 40000                | 40000                | 40000                |
|                | <b>Total</b>                         | <b>4,03,000</b>      | <b>4,03,187.5</b>    | <b>4,04,125</b>      | <b>4,03,000</b>      | <b>4,03,187.5</b>    | <b>4,04,125</b>      | <b>4,03,750</b>      | <b>4,02,250</b>      |