EFFECT OF MEPIQUAT CHLORIDE ON GROWTH, YIELD AND QUALITY OF OKRA (*Abelmoschus esculentus* L. Moench) HYBRID ARKA ANAMIKA

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In partial fulfilment of the requirements for

The award of the Degree of

MASTER OF SCIENCE (Agriculture)

in

HORTICULTURE

BANGALORE **AUGUST, 2019**

Affectionately Dedicated

To My Beloved Parents,

Father : M. Mallikarjuna

Mother : M. Nirmala

Sisters and Grand Parents

DIVISION OF HORTICULTURE
UNIVERSITY OF AGRICULTURAL SCIENCES
GKVK, BANGALORE 560 065

CERTIFICATE

This is to certify that the thesis entitled **"EFFECT OF MEPIQUAT CHLORIDE ON GROWTH, YIELD AND QUALITY OF OKRA (*Abelmoschus esculentus* L. Moench) HYBRID ARKA ANAMIKA"** submitted in partial fulfillment of the requirements for the award of the degree of **MASTER OF SCIENCE (Agriculture)** in **HORTICULTURE** to the University of Agricultural Sciences, Bangalore, is a record of bonafide research work carried out by **Miss POORNIMA MORIGERI., ID No. PALB 7273** under my guidance and supervision and that no part of this thesis has been submitted for the award of any degree, diploma, associateship, fellowship or other similar titles.

BENGALURU
AUGUST, 2019

Dr. R. VASANTHA KUMARI
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(Y.A. NANJA REDDY)

3. _____
(SARALA KUMARI)

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With regardful memories……

In everyone's life, the day arises when one has to shape the feelings in words. Sometimes, the words become unable to express the feelings of the mind, because, the feelings of heart are beyond the reach of the words. When, I come to complete this manuscript, so many memories have rushed through my mind which is full of gratitude to those who encouraged and helped me at various stages of this research. It gives me immense pleasure to record my feelings at this place.

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August, 2019 ***(Poornima Morigeri)***

EFFECT OF MEPIQUAT CHLORIDE ON GROWTH, YIELD AND QUALITY OF OKRA (*Abelmoschus esculentus* L. Moench) HYBRID ARKA ANAMIKA

POORNIMA MORIGERI

ABSTRACT

A field investigation on "Effect of mepiquat chloride on growth, yield and quality of Okra (*Abelmoschus esculentus* L. Moench) hybrid Arka Anamika" carried out under open field condition in the Department of Horticulture, GKVK, UAS, Bangalore. The experiment consisted eight treatments with different concentrations of mepiquat chloride (50, 62.5 and 125 g a.i. ha^{-1}) and stages (at initiation of flowering and fruiting) of application with three replications was laid out in Randomized Complete Block Design. The results revealed that treatment (T_3) containing 125 g a.i. ha^{-1} of mepiquat chloride sprayed at initiation of flowering showed significant decrease in plant height (60.20 cm), internodal length (4.63 cm) and leaf area (374.13 cm) at 60 DAS whereas maximum was recorded under control. Growth parameters *viz.* number of leaves (18.06), number of branches (3.93), stem girth (5.25 cm) and chlorophyll content (58.93) were recorded highest in the treatment (T_3) consists of 125 g a.i. ha^{-1} of mepiquat chloride at initiation of flowering. Similarly T_3 noted with better yield and quality parameters *viz.* pod length (15.13 cm), pod diameter (2.16 cm), number of pods per plant (14.2), pod yield/plant (572.1 g), total pod yield (14.26 t/ha), ascorbic acid (16.31 mg/100g) and TSS (2.03 ^{o}Brix) at 60 DAS. The higher cost: benefit ratio (1: 1.96) also obtained under T_3. Thus it can be concluded that 125 g. a.i. ha^{-1} mepiquat chloride sprayed at initiation of flowering results in better growth, yield and quality attributes of Okra.

August, 2019

Department of Horticulture
UAS, Bengaluru

(R. VASANTHA KUMARI)
Major Advisor

ಬೆಂಡಿ ಹೈಬ್ರಿಡ್ ಅರ್ಕಾ ಅನಾಮಿಕದ ಬೆಳವಣಿಗೆ, ಇಳುವರಿ ಮತ್ತು ಗುಣಮಟ್ಟದ ಮೇಲೆ ಮೆಪಿಕ್ವಾಟ್ ಕ್ಲೋರೈಡ್‌ನ ಪರಿಣಾಮ (*ಅಬೆಲ್ಮೋಸ್ಕಸ್ ಎಸ್ಕುಲೆಂಟಸ್* ಎಲ್. ಮೊಯೆಂಚ್)

ಪೂರ್ಣಿಮಾ ಮೋರಿಗೆರಿ

ಪ್ರಬಂಧದ ಸಾರಾಂಶ

ತೆರೆದ ಕ್ಷೇತ್ರದ ಸ್ಥಿತಿಯಲ್ಲಿ ಬೆಂಡಿ ಹಬ್ರಿಡ್ ಅರ್ಕಾ ಅನಾಮಿಕದ ಬೆಳವಣಿಗೆ, ಇಳುವರಿ ಮತ್ತು ಗುಣಮಟ್ಟದ ಮೇಲೆ ಮೆಪಿಕ್ವಾಟ್ ಕ್ಲೋರೈಡ್‌ನ ಪರಿಣಾಮದ ಕುರಿತು ೨೦೧೮–೧೯ರ ಅವಧಿಯಲ್ಲಿ ತೋಟಗಾರಿಕೆ ವಿಭಾಗ, ಗಾಂಧಿ ಕೃಷಿ ವಿಜ್ಞಾನ ಕೇಂದ್ರ, ಕೃಷಿ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ, ಬೆಂಗಳೂರಿನಲ್ಲಿ ತನಿಖೆ ನಡೆಸಲಾಯಿತು. ಈ ಪ್ರಯೋಗವು ಮೂರು ಪುನರಾವರ್ತನೆಗಳೊಂದಿಗೆ ಎಂಟು ಉಪಚಾರವನ್ನು ಒಳಗೊಂಡಿದೆ. ಅವು ೫೦, ೬೨.೫ ಮತ್ತು ೧೨೫ ಗ್ರಾಂ ಆ.ಇ/ಹೆಕ್ಟರ್ ಮೆಪಿಕ್ವಾಟ್ ಕ್ಲೋರೈಡ್ ಸಾಂದ್ರತೆಗಳನ್ನು ಹೂ ಬಿಡುವಿಕೆ ಮತ್ತು ಹಣ್ಣು ಬಿಡುವಿಕೆಯ ಪ್ರಾರಂಭದಲ್ಲಿ ಅನ್ವಯಿಸಲಾಗಿದೆ. ಹೂ ಬಿಡುವಿಕೆಯ ಸಮಯದಲ್ಲಿ ಸಿಂಪಡಿಸಲಾದ ೧೨೫ ಗ್ರಾಂ ಆ.ಇ/ಹೆಕ್ಟರ್ ಮೆಪಿಕ್ವಾಟ್ ಕ್ಲೋರೈಡ್ ಬಿತ್ತನೆ ಮಾಡಿದ ೬೦ ದಿನಗಳಲ್ಲಿ ಗಿಡದ ಎತ್ತರ (೬೦.೨೦ ಸೆಂ.ಮೀ), ಅಂತರಪರ್ವ ಉದ್ದ (೪.೬೩ ಸೆಂ.ಮೀ) ಮತ್ತು ಎಲೆಗಳ ವಿಸ್ತೀರ್ಣ (೩೭೪.೧೩ ಸೆಂ.ಮೀ^{೨}) ಗಮನಾರ್ಹ ಇಳಿಕೆ ತೋರಿಸಿದೆ, ಆದರೆ ಉಪಚಾರ (ನಿಯಂತ್ರಣ)ದಲ್ಲಿ ಗರಿಷ್ಠ ದಾಖಲಾಗಿದೆ. ಬೆಳವಣಿಗೆ ನಿಯತಾಂಕಗಳಾದ ಎಲೆಗಳ ಸಂಖ್ಯೆ (೧೪.೦೬), ಕೊಂಬೆಗಳ ಸಂಖ್ಯೆ (೩.೯೩), ಕಾಂಡದ ಸುತ್ತಳತೆ (೫.೨೫ ಸೆಂ.ಮೀ) ಮತ್ತು ಪತ್ರಹರಿತ್ತಿನ ಅಂಶ (೫೪.೯೩)ವು ಹೂ ಬಿಡುವಿಕೆಯ ಪ್ರಾರಂಭದಲ್ಲಿ ಸಿಂಪಡಿಸಲಾದ ೧೨೫ ಗ್ರಾಂ ಆ.ಇ/ಹೆಕ್ಟರ್ ಮೆಪಿಕ್ವಾಟ್ ಕ್ಲೋರಿಡ್ ಉಪಚಾರದಲ್ಲಿ ಅತಿ ಹೆಚ್ಚು ದಾಖಲಾಗಿದೆ. ಇದೇ ಉಪಚಾರದಲ್ಲಿ ಉತ್ತಮ ಇಳುವರಿ ಮತ್ತು ಗುಣಮಟ್ಟದ ನಿಯತಾಂಕಗಳೊಂದಿಗೆ ಗುರುತಿಸಲ್ಪಟ್ಟಿದೆ. ಕಾಯಿಯ ಉದ್ದ (೧೫.೧೩ ಸೆಂ.ಮೀ), ಕಾಯಿಯ ವ್ಯಾಸ (೨.೧೬ ಸೆಂ.ಮೀ), ಪ್ರತಿ ಗಿಡಕ್ಕೆ ಕಾಯಿಗಳ ಸಂಖ್ಯೆ (೧೪.೨), ಪ್ರತಿ ಗಿಡಕ್ಕೆ ಕಾಯಿಗಳ ಇಳುವರಿ (೫೭೨.೧ ಗ್ರಾಂ), ಪ್ರತಿ ಹೆಕ್ಟರಿಗೆ ಕಾಯಿಗಳ ಇಳುವರಿ (೧೪.೨೬ ಟನ್), ಟಿ.ಎಸ್.ಎಸ್ (೨.೦೩ ^{o}ಬ್ರಿಕ್ಸ್) ಮತ್ತು ಆಸ್ಕೋರ್ಬಿಕ್ ಆಮ್ಲ (೧೬.೩೧ ಮಿಗ್ರಾಂ/ ೧೦೦ಗ್ರಾಂ). ಉತ್ತಮ ವೆಚ್ಚ– ಲಾಭ ಅನುಪಾತ (೧:೧.೯೬) ಸಹ ಟಿ ೩ ಅಡಿಯಲ್ಲಿ ಪಡೆಯಲಾಗಿದೆ. ಆದ್ದರಿಂದ ಹೂ ಬಿಡುವಿಕೆಯ ಸಮಯದಲ್ಲಿ ಸಿಂಪಡಿಸಲಾದ ೧೨೫ ಗ್ರಾಂ ಆ.ಇ/ಹೆಕ್ಟರ್ ಮೆಪಿಕ್ವಾಟ್ ಕ್ಲೋರಿಡ್‌ನ ಪ್ರಮಾಣವು ಬೆಂಡಿಯ ಉತ್ತಮ ಬೆಳವಣಿಗೆ, ಇಳುವರಿ ಮತ್ತು ಗುಣಮಟ್ಟದ ನಿಯತಾಂಕಗಳಿಗೆ ಕಾರಣವಾಗುತ್ತದೆ ಎಂದು ತೀರ್ಮಾನಿಸಬಹುದು.

ಆಗಸ್ಟ್, 2019

ತೋಟಗಾರಿಕೆ ವಿಭಾಗ,
ಕೃಷಿ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ, ಬೆಂಗಳೂರು

ಆರ್. ವಸಂತ ಕುಮಾರಿ
ಮುಖ್ಯ ಸಲಹೆಗಾರರು

Effect of Mepiquat Chloride on Growth and Yield of Okra (*Abelmoschus esculentus* L. Moench) Hybrid Arka Anamika

POORNIMA MORIGERI PALB 7273 and R. VASANTHA KUMARI

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Introduction

- Okra (*Abelmoschus esculentus* L. Moench) is commonly known as lady's finger or bhendi belongs to the family Malvaceae. It is an important vegetable crop cultivated in various states of India. It has good demand throughout the year for its tender pods and considered as one of the major vegetable of the tropical and sub tropical regions of the world. Tender okra pods are consumed usually as vegetable and in culinary preparations as fried pieces. Seeds are source of oil, protein and are also used as a coffee substitute. It is rich source of iodine which is useful in the treatment of simple goiter.
- Arka Anamika cultivar is resistant to yellow vein mosaic virus. Pods are lush green, tender and long free from spines having 5-6 ridges with good keeping and cooking qualities.
- Mepiquat chloride (N, N-dimethyl piperidinium chloride), well known potential systemic plant growth regulator and it is an antigibberellin which checks vegetative growth and hastens the development of reproductive parts by reducing the plant height, there by decreasing the distance between the source and sink to effect better translocation of photosynthates into developing pods.

Objective

To study the effect of mepiquat chloride on growth and yield attributes of okra hybrid Arka Anamika.

Material and Methods

Crop : Okra

Variety : Arka Anamika

Location : Department Of Horticulture, UAS-B, GKVK

Number of Treatments : 08

Number of Replications: 03

Design: RCBD

Treatments details :

T1 - 50 g a.i. ha^{-1} mepiquat chloride at initiation of flowering

T2 - 62.5 g a.i. ha^{-1} mepiquat chloride at initiation of flowering

T3 - 125 g a.i. ha^{-1} mepiquat chloride at initiation of flowering

T4 - 50 g a.i. ha^{-1} mepiquat chloride at initiation of fruiting

T5 - 62.5 g a.i. ha^{-1} mepiquat chloride at initiation of fruiting

T6 - 125 g a.i. ha^{-1} mepiquat chloride at initiation of fruiting

T7 - 50 g a.i. ha^{-1} mepiquat chloride at initiation of flowering and at initiation of fruiting

T8 - Control

Experimental Results

Table : Effect of mepiquat chloride on growth and yield parameters of okra

Treatments	Internodal length (cm)		Pod length (cm)	Pod yield/plant (g)	Pod yield (t/ha)
	60 DAS	90 DAS			
T_1	5.53	5.73	12.07	485.4	11.99
T_2	5.16	5.32	13.07	516.33	12.75
T_3	4.63	4.77	15.13	572.1	14.26
T_4	5.77	5.97	11.40	471.83	11.65
T_5	5.37	5.55	12.57	504.33	12.45
T_6	4.84	5.03	14.27	540.87	13.35
T_7	5.03	5.20	13.93	528.33	13.07
T_8	7.71	9.16	10.23	433.7	10.71
F- test	*	*	*	*	*
SEm±	0.10	0.09	0.30	3.11	0.08
CD @ 5%	0.31	0.27	0.90	9.42	0.23

- Plant height was minimum in T_3 *i.e.,* 125 g a.i. ha^{-1} mepiquat chloride at initiation of flowering. It was 60.20 cm at 60 days and 93.90 cm at 90 days. Highest plant height was recorded in T_8 under control.
- Shorter internodal length (4.63 and 4.77 cm) at 60 and 90 DAS was recorded in T_3 followed by T_6 and maximum found in T_8 (control).
- Pod length (15.13 cm), pod yield per plant (572.1 g) and pod yield per hectare (14.26 tons) recorded highest in T_3 *i.e.,* 125 g a.i. ha^{-1} mepiquat chloride at initiation of flowering.

Discussion

- The reduction in plant height and internodal length is due to anti-gibberellin property of the growth retardant mepiquat chloride which reduces the cell elongation and also lowers the rate of cell division.
- Mepiquat chloride greatly influenced the length of pod and yield characters. The reason is due to fruit yield in plants depends on accumulation of photo assimilates and partitioning in different parts of the plant.
- Mepiquat chloride can restrict the vegetative growth by inducing the plant to direct more carbohydrates into reproductive organs. The growth retardants are capable of redistribution of dry matter in the plant thereby bringing improvements in yield characters.

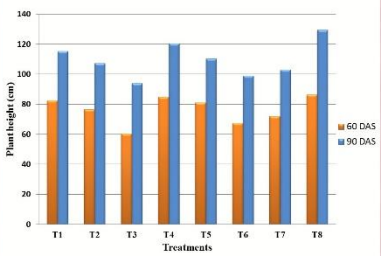

Fig 1.. Effect of mepiquat chloride on plant height

General view of experimental plot

Summary

- The present study showed that there was a good improvement in both growth and yield attributes as the concentration of mepiquat chloride increased. Although every treatments were superior over control. The prominent findings were obtained at higher dose, so it can be concluded that the treatment with 125 g a.i. ha^{-1} of mepiquat chloride sprayed at initiation of flowering is appropriate.

Advisory committee

Chairperson: R. Vasantha Kumari

Members: B. G. Hanumantharaya
Y. A. Nanja Reddy
Sarala Kumari

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LIST OF ABBREVIATIONS

%	:	Per cent
^{0}C	:	Degrees Celsius
@	:	At the rate of
a.i	:	Active ingredient
cm	:	Centimetre(s)
CCC	:	Cycocel
CD	:	Critical difference
DAS	:	Days after sowing
EC	:	Electrical conductivity
et al.	:	And other
etc	:	Et cetera
Fig.	:	Figure
FYM	:	Farm yard manure
g	:	gram
ha	:	hectare
IAA	:	Indole acetic acid
i.e.	:	that is
kg	:	kilogram
MC	:	Mepiquate chloride
MT	:	million tones
NAA	:	Naphthalene acetic acid
NS	:	Non-significant
ppm	:	Parts per million
RCBD	:	Randomized complete block design
Sl. No.	:	Serial number
TSS	:	Total soluble solid
viz.,	:	Namely

I INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench) is commonly known as lady's finger or bhendi belongs to the family Malvaceae. It is an important vegetable crop cultivated in various states of India. It has good demand throughout the year for its tender fruits and considered as one of the major vegetables of the tropical and subtropical regions of the world. Okra can be grown on a wide range of soils, but well-drained fertile soils with adequate organic matter result in high yield and a pH of 6.0-6.8 is ideally suited. Okra cultivation has gained popularity among the farmers of India because of easy cultivation and wider adaptability (Mandal *et al*., 2012).

The total area and production under okra are reported to be 1148.0 thousand hectare and 7896.3 thousand tons respectively in world. It is commercially cultivated in India, Nigeria, Sudan, Pakistan, Ghana, Egypt, Benin, Saudi Arabia, Mexico and Cameroon. It is also a popular vegetable in the home garden in many areas. India covers an area of 528.0 (in 000' ha) with an annual production of 6146 (in 000' MT). The highest productivity is reported from Egypt (12.5 tons ha^{-1}) followed by Saudi Arabia (13.3 tons ha^{-1}).

In India okra is largely cultivated in states like, Uttar Pradesh, West Bengal, Bihar, Madhya Pradesh, Gujarat, Maharastra, Andra Pradesh, Karnataka and Tamil Nadu. In Karnataka it is grown in Bagalkot, Mandya, Belgaum, Haveri, Bangalore and Bijapur districts.

Okra plant grows to two meters tall, the leaves are heart-shaped 10-20 cm long and broad, palmately lobed with 5-8 lobes. The flowers are with five white to yellow petals with red or purple spot at the base of each petal. The fruit is a capsule grows up to 18 cm long with pentagonal cross-section containing numerous seeds.

Bendi is heat and drought tolerant vegetable species and tolerate soils with heavy clay and intermittent moisture, but frost can damage the pods. Although Okra is primarily a rainfed crop, it thrives well under irrigated conditions during warm moist or hot summer season with fairly high organic matter content of soils are best suited for this

crop. Okra has a high nutritional value and grows very quickly with high temperatures, which lends its production more to tropical parts of the world.

Okra has several uses, tender okra fruits are consumed usually as vegetable and in culinary preparations as fried pieces. Fresh fruits are the popular ingredient of soups and stews where a highly viscous consistency is desired and seeds are a source of oil, protein and are also used as a coffee substitute. The roots and stems of the plant are used for clarification of sugarcane juice just before it is converted into jaggery and sugar. It has good nutritional value, green tender fruits are a good source of vitamin A, B, C and also rich in proteins, carbohydrates, fats, minerals and iron.

It is a rich source of iodine which is useful in the treatment of simple goiter and it has been used as an ingredient for many herbal formulations, which are used for the cure of various ailments particularly the regulation of blood pressure, fat, diabetes, chronic dysentery, inflammation, genito-urinary disorders and ulcer (Singh e*t al.*, 2014). The dry seed contains 13-22% good edible oil and 20-24% protein. The oil is used in soap, cosmetic industry and as vanaspati while protein is used for fortified feed preparations. Composition of 100 g edible portion of okra contains 35 kcal energy, 89.6 g moisture, 1.9 g of protein, 0.2 g fat, 6.4 g carbohydrate, 0.7 g minerals, 66 mg calcium, 56 mg phosphorous and 1.2 g fiber (Gopalan *et al.*, 2012).

Excessive vegetative growth in terms of plant height, internoal length and leaf area is known to reduce the partitioning of assimilates to fruits and thus reduces the yield. Growth retardants are synthetic compounds found to reduce the height of plants by lowering the rate of cell division without changing any developmental pattern or induce phytotoxic effects. Most of the growth retardants shown to enhance vegetable production by inhibiting the formation of gibberellins and thereby reduce the unwanted shoot elongation in the plants (Rademacher, 2000).

Mepiquat chloride (N, N-dimethyl piperidinium chloride), well known potential systemic plant growth retardant used globally to control plant geometry (Rosolem *et al.*, 2013). 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, thereby decreasing the distance between the source and sink to effect better translocation of photosynthates into developing pods (Naz, 2006).

The studies on the effect of plant growth retardant mepiquat chloride on okra are meagre. Hence there is a need to evaluate mepiquat chloride on growth components, yield and quality aspects in okra. Therefore, the present study entitled "Effect of mepiquat chloride on growth, yield, and quality of okra (*Abelmoschus esculentus* L. Moench) hybrid Arka Anamika" was carried out with the following objectives,

1. To study the effect of mepiquat chloride on growth of okra.
2. To study the effect of mepiquat chloride on yield and quality of okra.
3. To workout the cost economics of okra cultivation with mepiquate chloride application.

II REVIEW OF LITERATURE

The response of plant or plant parts to growth regulators varies due to fluctuations in endogenous hormonal levels of plant and the manner in which the natural growth regulators interacted with the applied growth regulators. In view of their spectrum effectiveness on every aspect of plant growth, even a modest increase of 10-15 per cent could bring about an increment in the gross annual productivity.

The use of growth retardants has become an important tool in Horticulture to increase production. The details of the review of literature relating to mepiquat chloride and their effect in okra are meager, so the available review of literature on different growth retardants like cycocel, mepiquat chloride, paclobutrazol, maleic hydrazide (MH) etc. on okra and other crops are reviewed and presented in this chapter.

2.1 Effect of mepiquat chloride on growth parameters

2.2 Effect of mepiquat chloride on yield attributes

2.3 Effect of mepiquat chloride on quality parameters

2.4 Economics

2.1 Effect of mepiquat chloride on growth

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.

Dippenaar *et al.* (1990) revealed that the application of low concentration of mepiquat chloride through the foliar spray at different intervals of to a cotton plant, reduced the plant height by 13-18% when sprayed with 6.3-12.5 g a.i. ha^{-1} at the intervals of 14 days as compared to control.

Patel and Singh (1991) observed that okra plants were grown at four planting densities (74070, 55550, 49380 or 37030 plants ha^{-1}) treated with cycocel at 500, 1000 and 1500 ppm applied as seed soaking treatment and as a foliar spray at 20 and 40 DAS. Planting density had a significant effect on pod yield but plant height or pod number had no significant effect. The height of the plant was reduced with increasing cycocel concentration.

Wallace *et al.* (1993) reported a reduction in internodal length with the use of mepiquat chloride in cotton over control. Gasti (1994) also noticed that the application of mepiquat chloride was more effective than cycocel in reducing the internodal length.

Gasti (1994) observed more number of leaves per plant in okra with cycocel and mepiquat chloride sprayed at 45 days after sowing. Madalgeri and Ganiger (1993) reported more number of leaves per plant with cycocel at 750 ppm and mepiquat chloride at 150 ppm in potato.

Jeyakumar and Thangaraj (1996) studied the application of mepiquat chloride on the growth characteristics of the groundnut. Mepiquat chloride was sprayed at the concentration of 100, 125 and 150 ppm at 25 DAS, 35 DAS and 45 DAS respectively. Among the different treatments, mepiquat chloride at 125 ppm on 35 DAS was found to be the best which reduced the shoot length.

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

Wasnik and Bagga (1996) studied the effect of mepiquat chloride on growth and yield of chickpea varieties Pusa 261 and BG 384 and observed that spraying of 50 ppm mepiquat chloride increased the chlorophyll content in both the varieties. In BG 384, the number of secondary and tertiary branches were also increased.

Srinivasappa (1997) experimented the application of mepiquat chloride on the growth of diploid and autotetraploid *Solanum viarum* Dunal. Autotetraploid responded

with an increase in the number of branches. Reduction in plant height was observed in autotetraploid, while in a diploid increase in plant height was recorded at 180 days.

Gasti *et al*. (1998) studied the application of mepiquat chloride and cycocel on growth and yield attributes of onion. There was increased production of dry matter and its higher translocation to economic parts resulted in increased diameter and bulb weight by retarding vegetative growth, while the unsprayed onions developed almost equal proportions (25%) of all size grades of the bulb.

Berova and zlatev (2000) experimented with the application of plant growth retardant paclobutrazol in tomato. Foliar applications of paclobutrazol at concentrations of 1.0 mg l^{-1} and 25.0 mg l^{-1} respectively resulted in reduced height and the increased thickness of the young plant stem, as well as the accelerated root formation, which is a significant advantage of the paclobutrazol treatment.

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

Pravin *et al.* (2000) noticed that foliar application of mepiquat chloride (500 and 1000 ppm) in the combination of other plant growth retardants at 45 days after planting increased the chlorophyll a, chlorophyll b, and total chlorophyll contents in case of TPS (true potato seeds) and tuber-propagated potato. When potatoes cv. HPS-7/67 was treated with 300 ppm mepiquat chloride in combination with other treatments, the total chlorophyll content was highest when sprayed at 45 DAT.

Prabhu (2000) noticed reduced plant height (24.8 cm) 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.

Valencia (2002) conducted an experiment with the application of the cycocel and daminozide during 25 or 45 days after sowing at 250, 500 and 1000 mg l^{-1} on tomato. Results revealed that the reduction of plant height was greater with cycocel application

than that of daminozide and the effect was greater at the highest concentration (1000 mg l^{-1}) with the earlier application.

Significant reduction in the plant height, number of branches and number of leaves observed in pea with the application of mepiquat chloride (Dhaka and Anamika, 2003). Decreased plant height and increased number of branches and leaves were observed with the application of mepiquate chloride at 120 ppm in blackgram (Prakash *et al*., 2003).

Sivappa (2003) evaluated the effect of cycocel and mepiquat chloride on growth, yield and quality of okra (*Abelmoschus esculentus* L. Moench) cv. Arka Anamika. The report says that the application of mepiquat chloride at 450 ppm reduced the plant height (19.53 cm) at 40 days after sowing and mepiquat chloride at 300 ppm produced the maximum number of branches (2.80), number of leaves (23.66), total chlorophyll content (0.46 mg) and maximum leaf area (335 cm^2) compared to control.

Tari (2003) showed that the inhibitory effect of paclobutrazol on the abaxial stomatal conductances became more pronounced with time during the light period but the adaxial surfaces displayed similar or slightly higher conductance than those of the control. The transpiration rate on a unit area basis did not change significantly or increased in the treated leaves thus the reduced water loss of paclobutrazol treated bean plants due to the reduced leaf area.

Kamlesh (2005) revealed that increasing concentration of chlormequat caused linear decrease in internodal length and thereby reduced the plant height. Chlormequat increased number of branches, leaf number, leaf area and dry weight of stem, leaf and root components of okra plants.

Tekalign and Hammes (2005) observed that paclobutrazol decreased leaf area index, crop growth rate, and total biomass production, and increased specific leaf weight, tuber growth rate, net assimilation rate and partitioning coefficient in potato.

Elkoca and Kantar (2006) observed that in pea, the application doses of mepiquat chloride at 25, 50, 75 and 100 g a.i. ha^{-1} 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) experimented in groundnut with the application of different levels of salicylic acid and mepiquat chloride. The treatments that were treated with mepiquat chloride (1 ml l^{-1}) recorded minimum plant height at all the stages compared to salicylic acid treatments. The number of branches found the maximum (6.23) when 500 ppm of salicylic acid sprayed along with 1ml l^{-1} mepiquat chloride.

Mahorkar *et al*. (2007) reported that cycocel when applied as a foliar spray at 30 days after sowing reduced the plant height and increased number of leaves, number of branches and number of nodes per plant in okra cv. Parbhani Kranti.

Prasad and Srihari (2008) found that seed soaking and spraying of cycocel at 300 ppm twice at 20 and 40 days age of the seedlings significantly reduced the plant height, internodal length and leaf area but increased the number of branches, nodes and leaves in okra.

Reddy *et al.* (2008) examined the effect of mepiquat chloride on the growth of cowpea. Treatments contained the application of mepiquat chloride at 500 ppm, 1000 ppm and CCC @ 500 ppm and nipping at one week after tendril formation. The results showed that there was significantly increased chlorophyll content and nitrate reductace activity at later stages which in turn increased the yield.

Setia et al. (2009) noted that the foliar spraying of field grown lentil plants with paclobutrazol (PBZ-5, 10 and 20 micro g ml^{-1}) significantly suppressed plant height but increased the number of primary and secondary branches.

Sridhar *et al.* (2009) conducted an experiment on the effect of foliar spray of naphthalene acetic acid (50, 100 and 150 ppm) and mepiquat chloride (500, 1000 and 1500) at 45 and 65 DAT in capsicum. They observed the increased chlorophyll content

by foliar spray of 1500 ppm mepiquat chloride at 45 DAT (3.91 mg g^{-1} fw) and 1500 ppm mepiquat chloride at 45 and 60 DAT (4.11 mg g^{-1} fw) as compared to other treatments.

Kumar *et al.* (2010) reported that the effect of growth retardants and methods of application on the growth of potato crop. Three growth retardants *viz.*, triiodobenzoic acid (TIBA) at 100 ppm, mepiquat chloride at 100 ppm and cycocel at 750 ppm along with a control were the treatments. Mepiquat chloride at 100 ppm foliar sprayed most effective followed by cycocel at 750 ppm which indicates that mepiquat chloride at 100 ppm foliar sprayed at 30 and 45 days after planting helped best in obtaining the higher growth parameters.

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

Devi *et al*. (2011) carried out an experiment to study the response of soybean variety JS 335 to salicylic acid (50 ppm), ethrel (200 ppm) and cycocel (500 ppm) applied as a foliar spray at different stages. The study revealed that the application of ethrel at 200 ppm at both flower-initiation and pod-initiation stage gave higher vegetative growth compared to salicylic acid at 50 ppm, cycocel at 500 ppm and control but the maximum chlorophyll content and carotenoids were obtained from plants treated with cycocel at 500 ppm.

Kumar *et al*. (2012) reported that the application of different rates of cycocel on growth, yield, and quality of tomato. The findings revealed that the application of cycocel at 300 ppm brought about the best results. cycocel as retardant exhibited the capacity for profuse branching and higher leaf count compared to control.

Rajkumar *et al*. (2013) reported in okra, the 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 as compare to control.

Zidan *et al*. (2014) confirmed that the application of growth retardant "Dextril" (0.02, 0.04 and 0.06%) on tomato showed the decreased stem height by 30, 32 and 35% respectively compared to the control. The application of the same treatment increased the stem diameter, fresh and dry weight of shoots compared to the control.

Pal *et al.* (2017) carried out an experiment to evaluate the effect of mepiquat chloride on growth and yield of onion. Results revealed that the plant height was minimum (64.35 cm) with 125 g a.i. ha^{-1} of mepiquat chloride at 35 DAT and plant height was recorded maximum under control. The same treatment also resulted in the highest total chlorophyll content (0.46 mg) and maximum number of leaves (9.57).

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 10 ppm resulted in reduced plant height (180.4 cm) as compared to other treatments of paclobutrazol and over control.

Singh *et al.* (2017) investigated in cotton and reported that the application of mepiquat chloride at 1750 ml ha^{-1} (500 ml ha^{-1} + 625 ml ha^{-1} + 625 ml ha^{-1} at 60, 75 and 90 DAS) recorded statistically decreased plant height of 139.1 and 93.4 cm in the year of 2014 and 2015 respectively.

Flores *et al*. (2018) studied that the application of paclobutrazol (PBZ) through the dose of 150 mg l^{-1}, on the growth of seedlings determined by the content of chlorophyll, height and leaf area of cucurbits. Treatments were the doses of 150 mg l^{-1} of PBZ and the control (distilled water). In the four species (cucumber, squash, melon and watermelon) 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%.

Kumar *et al.* (2018) conducted an experiment on okra in which different concentrations of cycocel (200, 400 & 600 ppm), paclobutrazol (150, 250 & 300 ppm) and ethrel (150, 250 & 300 ppm) were sprayed at 30 DAS, to ascertain their impact on plant growth. He revealed that the lowest plant height, reduced internodal length, highest number of nodes and number of leaves were recorded in cycocel at 600 ppm.

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 a higher number of internodes (10.5) at 75 DAS in a foliar spray of cycocel at 1000 ppm.

2.2 Effect of mepiquat chloride on yield

Gunasena and Clements (1970) observed the increased dry weight of french bean pods when plants were sprayed with cycocel (500 ppm). Mehrotra *et al*. (1970) reported that chlormequat at 500 ppm increased yield and fruit number per plant in okra.

Marisiddiah and Gowda (1978) were found increased fruit dry weight in tomato with cycocel sprayed at 1000-3000 ppm. Cycocel (chlormequat) at 1000 or 1500 ppm applied at early growth stage increased the number of pods per plant in bhendi (Gowda, 1983).

Gasti (1994) reported the maximum yield of 27.17 t ha^{-1} of potato tubers when treated with mepiquat chloride (175 ppm). Similarly, Madalageri (1996) reported a 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.

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, 35 and 45 DAS (days after sowing) respectively. Among the application of different treatments, mepiquat chloride at 125 ppm on 35 DAS was found to be the best in yield characteristics such as total dry matter production (TDMP), the number of flowers and pod yield.

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

Ghourab *et al*. (2000) sprayed mepiquat chloride (0, 100, 150, 200, and 250 cm^3/fed) once at the start of flowering to know the response of cotton plant cv. Giza 80. The results revealed that the application of mepiquat chloride increased seed cotton yield, seed index, and lint percentage.

Prabhu (2000) showed that the maximum grain yield (1478.40 kg ha^{-1}) was recorded when black gram was sprayed with mepiquat chloride at 1000 ppm compared to control (1196.6 kg ha^{-1}).

In cotton, application of 50 ppm chlormequat chloride increased the number of bolls per plant, average weight of individual boll and seed yield (Shriram and Prasad, 2001).

Ganiger et al. (2002*)* observed that the number of pods per plant at 75 DAS showed maximum (9.5) in TIBA followed by cycocel at 500 ppm, while least number of pods were observed in NAA 250 ppm (6.93) and control (7.20) in cowpea. Nichols *et al.* (2003) reported that mepiquat chloride treatments resulted in higher seed as well as cotton yields compared with untreated check.

Sajjan *et al*. (2003) revealed that the use of growth retardant cycocel at 200 ppm as seed treatment resulted in increased length (18.2 cm) of okra fruit. Sivappa (2003) observed that application of mepiquat chloride at 300 ppm recorded maximum pods per plant (20.33), the diameter of pods (2.55 cm), pod weight (25.46 g), pod length (18.60 cm) and total pod yield (16.73 t ha^{-1}) compared to control.

The field trial was laid out in split plot design and replicated thrice. Growth regulators *viz.*, mepiquat chloride @ 200 ppm, NAA @ 40 ppm, putrescine @ 50 ppm along with water spray (control) was taken in main plots. Results revealed that cob yield

in sweet corn was higher (8003 kg per hectare) under mepiquat chloride @ 200 ppm spray compared to other treatments (Muthukumar *et al.*, 2005).

Bora and Sarma (2006) observed that the cycocel at 100 and 250 µg ml^{-1} recorded maximum number of pods per plant and seed yield in cv. Azad-P-1 and cv. Aparna, respectively in soyabean. Study showed that judicious application of GA_3 and cycocel can increase yield and protein content in seeds of pea.

Elkoca and Kantar (2006) reported the dose (25, 50, 75 and 100 g a.i. ha^{-1}) and stage (late vegetative, early blooming and early pod filling) of mepiquat chloride (MC) application on seed yield and yield parameters of a pea. Application doses of 25, 50, 75 and 100 g a.i. ha^{-1} significantly increased the seed yield under different application doses of MC ranged between 13.7 % and 20.1 % over the untreated control. Mepiquat chloride significantly increased seed yield by 11.4 % and 10.2 % when compared with the late vegetative and the early pod filling stages respectively.

Kanthaswamy (2006) carried out an investigation to study the influence of seasons, chemicals and varieties on growth, yield and quality in *Moringa*. Spraying of different growth regulators was done on whole tree at 90 DAS. Among them, mepiquat chloride at 50 ppm spray produced more number of fruits per tree and yield per tree followed by NAA at 20 ppm.

Naz (2006) reported that number of pods per plant, pod yield per plant, pod yield per hectare, harvest index, test weight and shelling per cent recorded higher values with the treatment of salicylic acid (500 ppm) + mepiquat chloride (1 ml l^{-1}) 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 cycocel 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 tons) compared to control.

Cheema *et al.* (2009) found that mepiquat chloride treated plots increased in seed cotton yield over untreated plots under different N levels. Application of mepiquat chloride proved as a desirable management tool to control excessive vegetative growth in tall growing cotton cultivars for efficient harvest.

Munikrishnappa and Shantappa (2009) reported that okra cv. Arka Anamika when treated with cycocel at 1500 ppm as both seed soaking and foliar spray gave the maximum number of fruits per plant, higher fruit girth and higher fruit yield per hectare.

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

An investigation was carried out to find out the response of growth retardants on okra, the results showed that the number of tender immature fruits, fresh and dry weight, length and diameter of tender fruit and total yield were higher in cycocel at 1000 ppm seed and foliar treatment (Brache *et al.,* 2010).

Kim *et al.* (2010) showed experimented in chinese yam, the exogenously applied IAA (50,100,200 and 300 ppm) combined with mepiquat chloride (600 ppm) increased the fresh weight of aerial and underground tubers. Kumar *et al*. (2010) found that mepiquat chloride at 100 ppm as a foliar spray at 30 and 45 days after planting proved to be most effective to boost growth parameters followed by cycocel at 750 ppm in potato.

A field experiment was conducted to investigate the influence of three plant growth retardants, *viz*., cycocel, maleic hydrazide and ethrel at different concentrations of foliar spray at two stages i.e. 25 and 50 DAS of okra. The results indicated that foliar application of cycocel 300 ppm at 25 and 50 days after sowing increased the number of fruits per plant, fruit yield per plant and fruit yield per hectare (Rajput *et al*., 2011)

Hameda *et al*. (2012) observed that the foliar application of mepiquat chloride at 250 ppm significantly reduced plant height. However, increasing the applied mepiquat

chloride level from 0 to 500 ppm significantly increased bulbing ratio as well as total yield, bulb weight, diameter, and clove weight in garlic**.**

A field experiment was conducted to study the effect of plant growth regulators in onion. The results showed that the bulb yield was significantly increased with the application of chloromequat chloride at 1000 ppm (Roopa, 2012).

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 control.

Thanopoulos *et al.* (2013) experimented in okra by applying growth retardant with the aim of assisting crop management and optimizing yield. Results showed the highest mean number of pods per plant (91.00) and mean weight of pods per plant (490.51 g) with the application of 500 ppm cycocel at 40 DAT when compared to other treatments.

Velayutham and Parthiban (2013) recorded that the number of primary and secondary rhizomes per plant, length and girth of primary and secondary rhizomes, fresh and dry weight of rhizomes, yield per plot and yield per hectare were recorded highest in cycocel 500 ppm sprayed plants. For obtaining highest yield with good quality of ginger rhizomes, foliar application of cycocel at 500 ppm at three months after planting could be recommended to the growers.

Among the most important yield attributing traits in Pigeon pea, number of pods per plant, number of seeds per pod and number of filled pods per plant, pod length, pod width, pod weight, 100 seed weight, biological yield and seed yield were observed to be the major yield attributing characters as influenced by the foliar application of plant growth regulators especially treatment of paclobutrazol at 90 ml ha^{-1} as compared to control (Pushpendra, 2014)

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^{-1}) and fresh storage root weight per plant (3.55 kg) over control (no spray).

Singh *et al.* (2017) found that the highest seed cotton yield (2976 kg ha^{-1}) was recorded with the application of mepiquat chloride at 1500 ml ha^{-1} primarily due to improved boll weight (3.92 g) and bolls per plant (53.2).

Laddha *et al*. (2018) observed that the effect of mepiquat chloride on yield attributes of brinjal with foliar spray of 1350 ppm, 1700 ppm, and 3400 ppm concentration. Among the concentrations, significantly highest number of fruits per plant (16.88), length of fruits (17.61 cm), diameter of fruits (5.07 cm), weight of five fruits (477 g), 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 parameters:

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

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

Sivappa (2003) showed that mepiquat chloride at 450 ppm recorded the highest ascorbic acid content (17.13 mg) and maximum total soluble solids (3.00 %) in the okra pods in 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) and also observed increase in nitrate

reductase activity (526.2 µ mol NO_2/g fw/hr) with a spray of mepiquat chloride at 1500 ppm.

Ganie and Solanki (2010) observed the effect of cycocel (0, 1000, 1500, 2000 ppm), intra row spacings (10, 15 cm) and levels of nitrogen (0, 80, 160, 240 kg ha^{-1}) 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.

Laddha *et al.* (2018) reported that the application of mepiquat chloride improved the quality of brinjal with foliar spray of 1350 ppm, 1700 ppm, and 3400 ppm concentration. Among the different concentrations, significantly increase in total soluble solids (5.40 %) was obtained in 3400 ppm and the least was in control.

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 at 100, 250, 500, 750 and 1000 ppm with control (no spraying of any chemical) treatments were studied on quality and post-harvest losses of multiplier onion. Pre-harvest spraying of onion with growth retardant cycocel at 1000 ppm recorded lowest post-harvest losses of bulbs caused by sprouting, rotting and physiological loss in weight with less reduction in quality characters viz., moisture content, TSS, pyruvic acid, ascorbic acid soluble protein and sulphur content.

2.4 Economics

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

Naz (2006) reported the data on benefit: cost ratio as influenced by salicylic acid and mepiquat chloride in groundnut 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 the B: C ratio in all the treatments compared to control (1: 2.67).

Pateliya *et al.* (2008) observed that all studied concentrations of cycocel and maleic hydrazide (MH) during the experiment procured more beneficial features in terms of benefit-cost ratio and net return per hectare as compared to control. A maximum benefit-cost ratio with higher net return was obtained in the treatment of cycocel at 300 ppm in okra.

Brache *et al.* (2010) showed that the maximum net return for immature fruit production (Rs. 165430.21) was obtained under cycocel at 1000 ppm seed + foliar treatment, followed by cycocel at 1500 ppm seed + foliar treatment (Rs. 144922.21). The best cost-benefit ratio for immature fruit production (1.80) was obtained under cycocel at 1000 ppm seed + foliar treatment in okra. The poorest cost: benefit ratio was obtained under control.

Mandal *et al.* (2012) showed that plant spray with 800 ppm cycocel fetched the maximum net return of Rs. 54,951 per hectare followed by 75 ppm NAA and 1000 ppm cycocel gaining a net return of Rs. 52,697 and Rs. 51,530 per hectare, respectively in okra. The benefit-cost ratio was 1: 2.52 with the same treatment 800 ppm of cycocel.

Pal *et al.* (2017) obtained the highest net return and B:C ratio (Rs. 190292.96, 1.80:1 respectively) in treatment 125 g a.i.ha^{-1} of mepiquat chloride at 35 DAT in onion. It was closely followed by 125 g a.i.ha^{-1} of mepiquat chloride at 50 DAT (Rs. 182322.96, 1.72:1). This might be due to the higher yield obtained in this treatment compared to all other treatments. The lowest net return and B:C ratio (Rs. 151802.96, 1.47:1 respectively) was recorded under control due to lower yields of the bulb.

Singh *et al.* (2017) obtained the highest net returns of Rs.83405 ha^{-1} and B:C ratio (2.0) was recorded with the application of mepiquat chloride at 1500 ml ha^{-1} indicative of its monetary benefits. Therefore, for maximizing the monetary returns, farmers should opt for mepiquat chloride application @ 1500 ml ha^{-1} should be considered a useful production practice for enhancing cotton yield.

The higher B:C ratio (1: 3.18) obtained in okra with the application of 1000 ppm cycocel. From the point of economics, it is thus inferred that the use of PGR foliar spray at 20 and 40 days after sowing increased both unit productivity and also net returns (Kumawat *et al.,* 2019).

III MATERIAL AND METHODS

The experiment on "Effect of mepiquat chloride on growth, yield and quality of okra (*Abelmoschus esculentus* L. Moench) hybrid Arka Anamika" was conducted in the Department of Horticulture, University of Agricultural Sciences, Gandhi Krishi Vignana Kendra, Bengaluru during the year of 2018-19. The details of the materials used and techniques adopted during the course of the study are described below.

3.1 Geographical location and climate

The experiment was conducted in the Eastern Dry Zone Karnataka at the Department of Horticulture, University of Agricultural Sciences, Bengaluru. The experimental site is located at 12^{o} 58' north latitude and 77^{o} 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 a pH of 6.4 to 6.8. The amount of nutrients recorded was adequate and fertile. The minimum and maximum temperature in a year ranged between 14.0 °C and 33.8 °C respectively. The average rainfall (660 mm) received from south-west monsoon between June and January.

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

3.2 Experimental details

The experiment was conducted to know the "Effect of mepiquat chloride on growth, yield and quality of okra (*Abelmoschus esculentus* L. Moench) hybrid Arka Anamika". The details of which are presented here below:

Location	:	Department of Horticulture, University of Agricultural Sciences, Bengaluru.
Crop	:	Okra (*Abelmoschus esculentus*)
Hybrid	:	Arka Anamika
Number of treatments	:	Eight

Plate 1: General view of experimental plot during bed preparation

Plate 2: General view of experimental plot after mulching

Number of replications : Three

Experimental design : RCBD [Randomized Complete Block Design]

Total experimental area : 400 sq. meter

Recommended spacing : 90 cm × 45 cm

3.2.2 Characteristics of hybrid Arka Anamika

Arka Anamika is an interspecific hybrid between *Abelmoschus esculentus* (IIHR20-31) x *Abelmoschus manihot.* It is resistant to yellow vein mosaic virus. Plants are tall well branched, fruits are lush green, tender and long. Purple pigment present on both sides of the petal base. Green stem with purple shade, fruits are free from spines having 5-6 ridges, delicate aroma. Good keeping and cooking qualities. The duration of the crop is 130-135 days.

3.2.1 Treatment Details:

T_1 - 50 g a.i. ha^{-1} mepiquate chloride at initiation of flowering

T_2 - 62.5 g a.i. ha^{-1} mepiquate chloride at initiation of flowering

T_3 - 125 g a.i. ha^{-1} mepiquate chloride at initiation of flowering

T_4 - 50 g a.i. ha^{-1} mepiquate chloride at initiation of fruiting

T_5 - 62.5 g a.i. ha^{-1} mepiquate chloride at initiation of fruiting

T_6 - 125 g a.i. ha^{-1} mepiquate chloride at initiation of fruiting

T7 - 50 g a.i. ha^{-1} mepiquate chloride at initiation of flowering and at initiation of fruiting

T_8 – Control (no spray)

3.3 Experimental procedure

Okra was grown under open field conditions with different treatments, by adopting the University of Agricultural sciences, Bengaluru recommended package of practices.

3.3.1 Preparation of the main field

The entire experimental area was thoroughly ploughed to a depth of 30 cm, clods were broken and the soil was brought to a fine tilth. The weeds and stubbles were removed prior to planting. Farm Yard Manure (FYM) at the rate of 25 tons per hectare and a basal dose of 50 kg each of nitrogen, phosphorus and potash per hectare was added and mixed well in the soil.

3.3.2 Preparation of beds

Raised beds of 30 cm height, 24 m length and 60 cm width were prepared leaving a space of 45 cm between two beds as path to enable easy cultural operations like spraying, weeding and harvesting (plate 1).

3.3.3 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 is covered to bed and margins of the sheet secured by burying in the soil (plate 2).

3.3.4 Sowing of seeds

Seeds of okra hybrid Arka Anamika were procured from the Indian Institute of Horticulture Research (IIHR), Bengaluru. The seeds were sown in beds at a spacing of 90 cm x 45 cm on 13th August 2018 and gap filling was carried out 10 days after transplanting. The experiment was laid out in a Randomized Complete Block Design with three replications.

3.3.5 Irrigation

Irrigation was given through an already laid out drip irrigation system by providing one lateral pipeline per bed with emitters at every 45 cm apart. The emitters were placed away from the plants as a precaution against root rot. The beds were kept moderately moist throughout the period of crop growth.

3.3.6 Intercultivation and plant protection measures

Need-based plant protection measures were taken during the experimental period. The entire beds were kept weed free by adopting mulching practices and hand weeding at regular intervals as and when the weeds were noticed in the plot. The pests like whitefly and plant hoppers were noticed and controlled by spraying with suitable recommended pesticides.

3.3.7 Plan and layout of the experimental plot

R-I		R-II		R-III
T_1		T8		T5
T2		T7		T6
T3		T6		T7
T4		T5		T8
T5		T4		T1
T6		T3		T2
T7		T2		T3
T8		T1		T4

3.3.8 Application of Fertilizer

The fixed amounts of nitrogen (100 kg N ha^{-1}), phosphorus (50 kg P_2O_5 ha^{-1}) and potash (50 kg K_2O ha^{-1}) were applied through 19:19:19 as basal dose and remaining nitrogen was supplied through urea. Nitrogen was applied in two equal split doses, once as basal dose and the other about a month after sowing.

3.3.9 Harvesting

The tender pods were harvested periodically by manual picking. Sorting and grading operations were carried out and packed in polythene bags. Ten pickings were

Plate 3: General view of experimental plot at 15 DAS

Plate 4: Spraying of mepiquate chloride

GOLLAGI, S. G., 1999, Influence of growth regulators and nutrients on productivity potential and quality in chilli (*Capsicum annum* L.). M.Sc. (Agri.) Thesis. Univ. Agric. Sci., Dharwad, pp : 51 - 55.

GOPALAN, C., RAMASASTRI, B. V. AND BALASUBRAMANIAN, S. C., 2012, Nutritive value of Indian foods. pp : 47 - 58.

GOWDA, N. C., 1983, Effects of inter row spacing and cycocel on growth yield and quality attributes of bhendi (*Abelmoschus esculentus* (L.) Moench.) cv. Pusa Sawani. Thesis, Haryana Agric. Univ. **9** (4) : 345.

GUNASENA, H. M. P. AND CLEMENTS, R. H., 1970, A preliminary investigation into the effect of CCC growth and development of dwarf bean. *J. Nath. Agric. Soc. Ceylone.,* **7** : 14 - 24.

HAMEDA., AHMED, S., SAYED. AND MORSY, A. H. A., 2012, Response of productivity and storability of garlic (*Allium sativum* L.) to some potassium levels and foliar spray with mepiquat chloride (PIX). *Int. J. Agril. Sci. and Soil Sci.,* **2** (7) : 298 - 305.

HUNJE, R. V., KULKARNI, G. V., VYAKARNAHAL, B. S. AND SHASHIDHARA, S. D., 1995, Effect of growth regulators on growth and yield in cowpea. *Karnataka J. Agric. Sci.,* **88** (4) : 429 - 431.

JEYAKUMAR, P. AND THANGARAJ, M., 1996, Effect of mepiquat chloride on certain physiological and yield characteristics of groundnut (*Arachis hypogaea* L.). *J. Agri and Crop Sci.,* **176** (3) : 159 - 164.

KAMLESH, B. R., 2005, Effect of chlormequat on growth and yield of okra (*Abelmoschus esculentus* (L.) Moench). Thesis Ph.D, Saurashtra Univ. Rajkot. pp : 99-101.

KANTHASWAMY. V., 2006**,** Influence of chemicals and growth hormones on growth, yield and quality of moringa**.** *Int. J. Agric. Sci.* **2** (2) : 288 - 290.

done at an interval of about two to three days during the crop period of three and half months.

3.4 Collection of experimental data

The data was collected on various parameters *viz*., vegetative growth, pod yield and quality parameters from five randomly selected and labelled plants in each replication and treatment.

3.4.1 Growth parameters

The following observations were recorded on vegetative characters of five randomly selected and labeled plants.

3.4.1.1 Plant height

The height of five labelled plants was recorded twice (60 and 90 days after sowing). Plant height was measured from the ground level to the tip of the largest shoot by using meter scale and mean was calculated and expressed in centimetres.

3.4.1.2 Number of leaves per plant

Numbers of fully opened and photosynthetically active leaves were counted at 60 and 90 days after sowing in each labelled plant of each treatment and the mean number of leaves per plant was calculated.

3.4.1.3 Internodal length

Length of the internode was measured in centimetres at the centre of the plant leaving three to four basal internodes from each labelled plant at 60 and 90 days after sowing and the mean internodal length was worked out.

3.4.1.4 Number of nodes per plant

The number of nodes per plant was counted from all the labelled plants from each treatment at 60 and 90 days after sowing and the mean number of nodes was worked out.

Plate 5: General view of experimental plot at 30 DAS

Plate 6: General view of experimental plot at 60 DAS

3.4.1.5 Number of branches per plant

The numbers of branches from each of the labelled plants were recorded at 60 and 90 days after sowing and the mean number of branches in each treatment was worked out.

3.4.1.6 Stem girth

The girth of the stem from each labelled plant was measured at 60 and 90 days of sowing at the collar region of the stem, about five centimetres above the ground level and the mean stem girth was worked out.

3.4.1.7 Leaf area

The leaf area was measured at 60 days after sowing by using leaf area meter. Five matured leaves were collected from the selected plants of all the treatments and fed to leaf area meter and observations were recorded and averaged and expressed in cm^2.

3.4.1.8 Chlorophyll content (mg)

Leaf chlorophyll content was measured through SPAD meter, a device developed by M/S Minolta crop., Ramosey, New Jersey. It measures the light attenuation at 430 nm (the peak wave length for chlorophyll a and b absorption). The unit less values measured by the chlorophyll meter (SPAD- 502) termed as SCMR (SPAD chlorophyll meter reading), is a good estimate of chlorophyll content of leaf on the intact plant. The SPAD meter is simple hand-held equipment that operates with DC power and is portable. SCMR values were recorded from plants at 60 DAS from each treatment. Several measurements were made on each leaf at top and middle and averaged to make an appropriate estimation of leaf chlorophyll content.

3.4.2 Yield parameters

3.4.2.1 Number of days taken to first flowering

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

3.4.2.2 Number of days taken to first harvest

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

3.4.2.3 Pod 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.

3.4.2.4 Diameter of the pod (cm)

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

3.4.2.5 Fresh weight of pod (g)

The pods taken from each labeled plants from each treatment at 90 days after sowing and the weight of each pod were recorded separately as fresh weight and expressed in grams.

3.4.2.6 Dry weight of pod (g)

After taking the fresh weight of pods, the same pods were used for taking the dry weight. The pods were dried in fresh air later dried in an oven at 60-65 ^{0}C to a constant weight. The oven-dry weight of each of these pods was recorded separately and expressed in grams.

1.4.2.7 Number of seeds per pod

Okra pods were cut vertically with the help of knife and counted the number of seeds and average number of seeds per pod was taken.

1.4.2.8 Number of pods per plant

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

3.4.2.9 Pod yield per plant (g)

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

3.4.2.10 Pod yield per plot (kg)

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

3.4.2.11 Pod yield per hectare (t)

Total weight of pods harvested from each picking in the tagged plants in each replication was recorded till final harvest and the total yield of pods per hectare under different treatments was computed in tonnes per hectare.

3.4.3 Quality parameters

3.4.3.1 Total ascorbic acid

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

pink colour to come out. 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 equivalent per 100 ml of juice using a standard curve of α -ascorbic acid.

$$\text{Ascorbic acid (mg/100g)} = \frac{\text{Titratable value} \times \text{Dye factor} \times \text{Vol.made up}}{\text{Aliquot of extraction} \times \text{vol.of sample taken}} \times 100$$

3.4.3.2 Total soluble solids (TSS)

The total soluble solids (TSS) was recorded from five randomly selected tender fruits by using hand refractometer and were expressed in degree Brix after making necessary temperature correction at room temperature (28 ºC) and the mean was worked out.

3.4.4 Cost economics

The cost economics of each treatment was calculated based on inputs used and income obtained from each treatment. The gross income and expenditure for each treatment were estimated by taking into consideration of total expenditure and yield obtained from each treatment. The cost economics was worked out based on the selling price of okra pods.

The net returns per hectare were calculated by deducting the cost of cultivation from gross income per hectare. The benefit-cost ratio computed by dividing gross returns with total cost of cultivation.

$$\text{Benefit : cost ratio} = \frac{\text{Gross returns (Rs/ha)}}{\text{Total cost of cultivation (Rs/ha)}}$$

3.5 Statistical analysis

The experimental data collected on different parameters were statistically analysed and interpreted by Fishers method of analysis of variance. The level of significance used in ‘F’ and ‘t’ test was at P= 0.05 and critical difference (CD at 5%) was worked out where the ‘F' test was significant.

IV RESULTS AND DISCUSSION

The result of the field experiment entitled "Effect of mepiquat chloride on growth and yield of okra (*Abelmoschus esculentus* L. Moench) hybrid Arka Anamika" is discussed in this chapter. The experiment was conducted at the Department of Horticulture, University of Agricultural Sciences, Bengaluru during 2018-19.

The objectives of the experiment are

1. To study the effect of mepiquat chloride on growth of okra.
2. To study the effect of mepiquat chloride on yield and quality of okra.
3. To workout the cost economics of okra cultivation with mepiquate chloride application

4.1 Effect of mepiquate chloride on growth parameters

4.1.1 Plant height (cm)

The data on plant height (cm) as influenced by foliar spray of mepiquat chloride recorded at 60 and 90 days after sowing (DAS) are presented in Table 1 and Fig 1.

At 60 DAS the lowest (60.20 cm) plant height was noted with 125 g a.i. ha^{-1} MC at initiation of flowering (T_3) followed by T_6 (67.30 cm) with 125 g a.i. ha^{-1} MC at initiation of fruiting, T_7 (71.87 cm) 50 g a.i. ha^{-1} MC both at initiation of flowering and fruiting. The maximum (86.33 cm) height of plant was recorded in control (T_8).

The lowest plant height (93.90 cm) at 90 DAS, was recorded in treatment (T_3) received 125 g a.i. ha^{-1} MC at initiation of flowering followed by T_6 (98.83 cm) 125 g a.i. ha^{-1} MC at initiation of fruiting and it was on par with T_7 (102.90 cm) 50 g a.i. ha^{-1} MC both at initiation of flowering and fruiting. Whereas, the maximum (129.43 cm) plant height was recorded under control at 90 DAS of the crop.

From the observations, it was very clear that when the concentrations of mepiquat chloride increased, there was a significant reduction in the height of the plant. Significant reduction in plant height due to application of mepiquat chloride was obtained at any

given stage. Highest reduction in plant height (60.20 and 93.90 cm) was noticed at 125 g a.i. ha^{-1} at 60 and 90 DAS respectively (Table 1).

The reduction of plant height was more when mepiquat chloride was applied at initiation of flowering with no significant difference between flowering and fruiting. The mechanism of reduction in plant height with mepiquat chloride is due to inhibition of cell division and reduction in cell expansion due to anti-gibberellins property. Such a reduction was reported by Pal *et al.* (2017) at the concentration of 125 g a.i. ha^{-1} in onion when applied at 35 DAS. Sivappa (2003) also shown that higher concentration of mepiquat chloride decreased the plant height in okra.

4.1.2 Number of leaves per plant

The data on the number of leaves as influenced by foliar spray of mepiquat chloride recorded at 60 and 90 days after sowing (DAS) are presented in Table.1 and Fig.2.

At 60 DAS, the number of leaves of different treatments varied significantly. The plants received 125 g a.i. ha^{-1} MC at initiation of flowering (T_3) and fruiting (T_6) recorded significantly, the maximum number of leaves (18.06) and (17.63) respectively as compared to control (15.00).

At 90 DAS also similar pattern was observed. However combined application of mepiquat chloride at flower initiation and fruiting did not improve leaf number over the individual application.

This clearly shows that a higher concentration of growth retardant (MC) increased the number of leaves per plant. An increase in the number of leaves was due to the increase in number of branches by the suppression of apical dominance with the application of mepiquat chloride. These results are in accordance with the findings of Pal *et al.* (2017) with 125 g a.i. ha^{-1} of mepiquat chloride at 35 DAT which showed the highest number of leaves in onion. Zayed *et al*. (1985) and Gasti (1994) reported an increase in the number of leaves with the application of mepiquat chloride in okra. Prakash *et al*. (2003) also observed increased in number of leaves in blackgram.

Table 1. Effect of mepiquat chloride on plant height (cm) and number of leaves in okra hybrid Arka Anamika

Treatment details	Plant height (cm)		Number of leaves	
	60 DAS	90 DAS	60 DAS	90 DAS
T_1 - 50 g a.i. ha^{-1} MC at initiation of flowering	82.37	115.33	15.90	22.73
T_2 - 62.5 g a.i. ha^{-1} MC at initiation of flowering	76.43	107.20	16.00	24.37
T_3 - 125 g a.i. ha^{-1} MC at initiation of flowering	60.20	93.90	18.06	26.23
T_4 - 50 g a.i. ha^{-1} MC at initiation of fruiting	84.73	120.33	15.57	22.10
T_5 - 62.5 g a.i. ha^{-1} MC at initiation of fruiting	80.83	110.27	15.97	23.50
T_6 - 125 g a.i. ha^{-1} MC at initiation of fruiting	67.30	98.83	17.63	25.77
T_7 - 50 g a.i. ha^{-1} MC at initiation of flowering and at initiation of fruiting	71.87	102.90	16.30	25.20
T_8 – Control	86.33	129.43	15.00	18.83
F test	*	*	*	*
S Em±	0.89	0.64	0.27	0.57
CD @ 5%	2.70	1.94	0.84	1.74

*significant at 5%

4.1.6 Internodal length (cm)

The data on internodal length (cm) as influenced by application of mepiquat chloride on at 30, 60 and 90 days after sowing is presented in Table 2 and Fig. 3.

At 60 DAS, the internodal length decreased from control (7.71 cm) to a minimum in T_3 (4.63 cm) and T_6 (4.84 cm) with 125 g a.i. ha^{-1} MC sprayed at initiation of flowering and fruiting stage which is followed by T_7 (5.03 cm) 50 g a.i. ha^{-1} MC sprayed at two stages *i.e*. at initiation of flowering and fruiting stage.

Similarly, at 90 DAS, the lowest internodal length (4.77 cm) was recorded in the treatment received 125 g a.i mepiquat chloride at initiation of flowering (T_3) and followed by (T_6) 125 g a.i. mepiquat chloride at initiation of fruiting (5.03 cm) which is on par with T_7 (5.20 cm) 50 g a.i. MC at initiation of flowering and fruiting stage. The highest internodal length (9.16 cm) was noticed in control (T_8).

Lesser internodal length in plants received 125 g a.i. ha^{-1} of mepiquat chloride at initiation of flowering and fruiting is due to anti gibberellin property of growth retardant which restricts the cell elongation and cell division. A similar trend of decreased internodal length was also reported by Kumawat *et al*. (2019) in okra. The results were also in accordance with the findings of Sivappa (2003) noticed reduced internodal length with a higher concentration of mepiquat chloride in okra.

4.1.5 Number of nodes per plant

Different treatments of mepiquat chloride significantly influenced the number of nodes per plant (Table 2).

Number of nodes increased significantly when MC was sprayed at initiation of flowering over the control. The effect was relatively more when 125 g a.i. ha^{-1} MC was applied at initiation of flowering (17.1) and fruiting (16.23) at 60 DAS.

At 90 DAS, the number of nodes were maximum in (T_3) 125 g a.i. ha^{-1} MC at initiation of flowering (19.50) followed by T_6 (17.90) sprayed at initiation of fruiting and

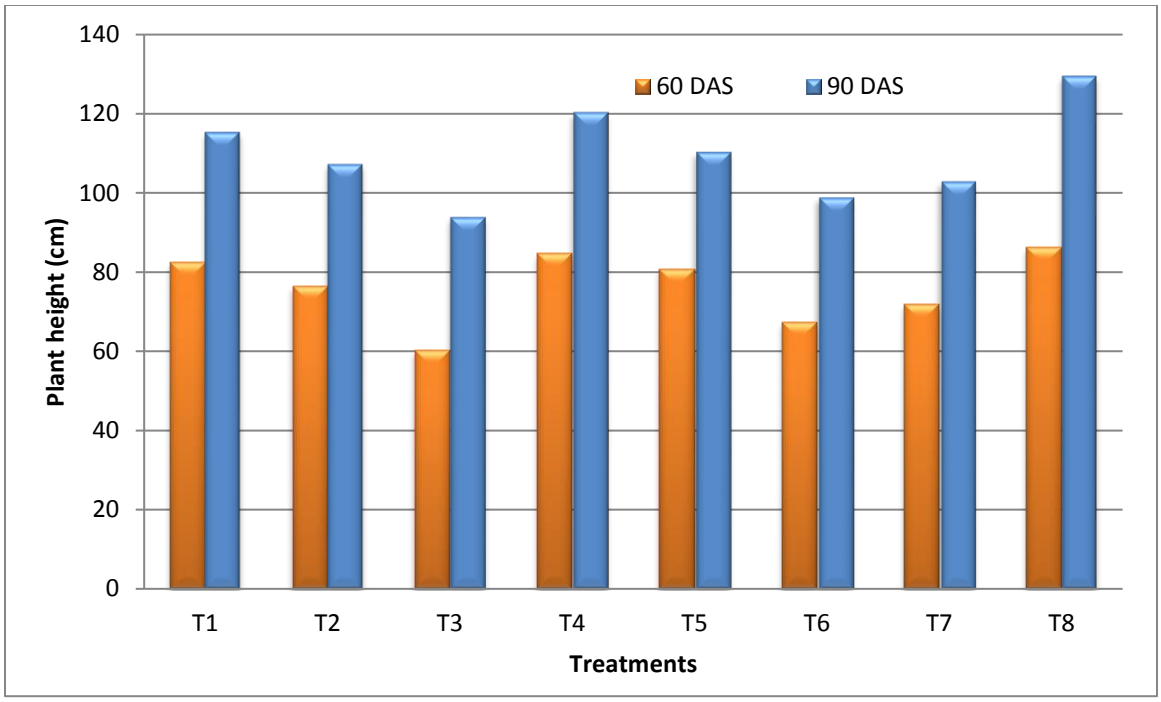

Fig. 1: Effect of mepiquate chloride on plant height (cm) of okra hybrid Arka Anamika

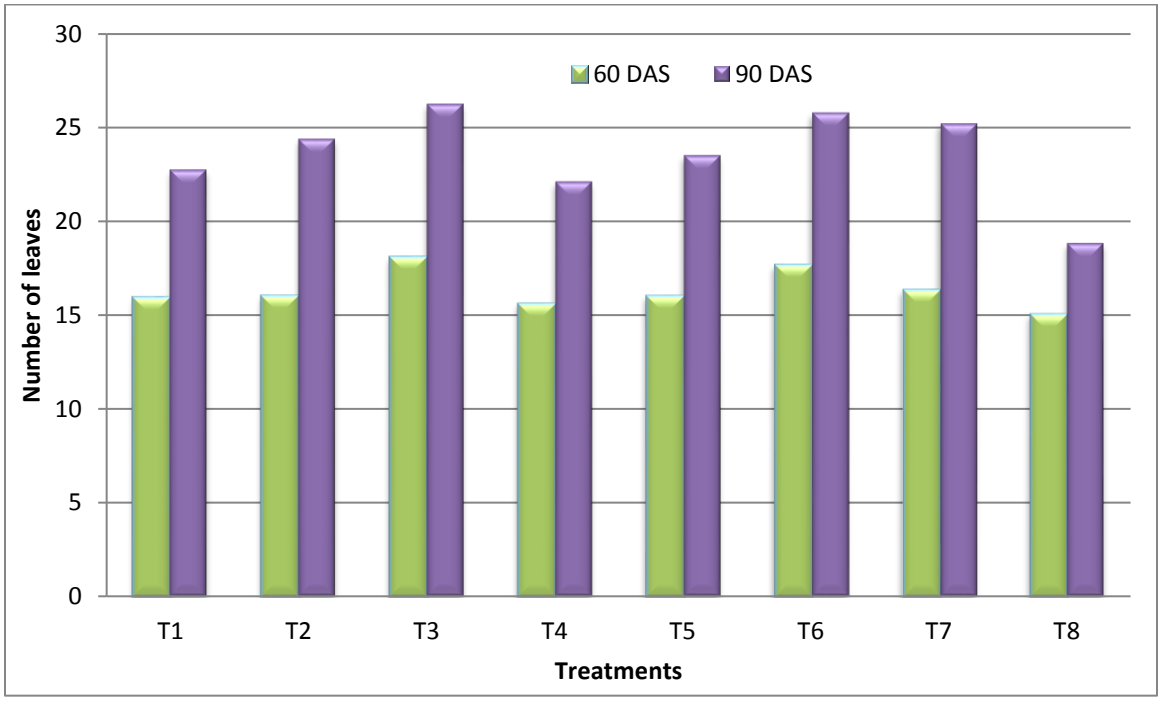

Fig. 2: Effect of mepiquate chloride on number of leaves in okra hybrid Arka Anamika

T_3 (125 g a.i. ha^{-1} MC at initiation of flowering)

T_8 (control)

Plate 7: Effect of mepiquate chloride on plant height of okra at 60 DAS

Table 2. Effect of mepiquat chloride on the number of nodes and internodal length (cm) in okra hybrid Arka Anamika

Treatment details	Number of nodes per plant		Internodal length (cm)	
	60 DAS	90 DAS	60 DAS	90 DAS
T_1 - 50 g a.i. ha^{-1} MC at initiation of flowering	14.64	15.57	5.53	5.73
T_2 - 62.5 g a.i. ha^{-1} MC at initiation of flowering	15.18	16.63	5.16	5.32
T_3 - 125 g a.i. ha^{-1} MC at initiation of flowering	17.10	19.50	4.63	4.77
T_4 - 50 g a.i. ha^{-1} MC at initiation of fruiting	14.61	15.07	5.77	5.97
T_5 - 62.5 g a.i. ha^{-1} MC at initiation of fruiting	15.03	16.00	5.37	5.55
T_6 - 125 g a.i. ha^{-1} MC at initiation of fruiting	16.23	17.90	4.84	5.03
T_7 - 50 g a.i. ha^{-1} MC at initiation of flowering and at initiation of fruiting	16.11	17.53	5.03	5.20
T_8 – Control	13.15	14.17	7.71	9.16
F test	*	*	*	*
S Em±	0.21	0.29	0.10	0.09
CD @ 5%	0.64	0.88	0.31	0.27

*significant at 5%

it was on par with T_7 (17.53) 50 g a.i. ha^{-1} MC sprayed at both initiation of flowering and fruiting. Minimum number of nodes was observed under control (14.17).

Data shows that application of mepiquat chloride at higher concentrations resulted in a significant increase in the number of nodes per plant. Similarly, data obtained in this study was found in accordance with Rajkumar *et al*. (2013) in okra. The findings are also in line with the results of Kumar *et al.* (2018) obtained the maximum number of nodes with the application of 600 ppm of cycocel in okra.

4.1.3 Number of branches per plant

There were significant differences in the number of branches with the application of mepiquat chloride (Table 3).

Among the different treatments, MC at 125 g a.i. ha^{-1} at initiation of flowering (T_3) recorded the maximum number of branches (3.93) and (4.47) followed by (T_6) 125 g a.i. ha^{-1} MC at initiation of fruiting (3.67) and (4.00) at 60 and 90 DAS respectively. The minimum number of branches was recorded under control.

The increase in the number of branches might be due to its effectiveness in suppressing the apical dominance, thereby promoting growth and axillary buds into new shoots (Narsegowda and Mundappagowda, 1980). These results are in accordance with findings of Prabhu (2000) noticed more number of branches when sprayed with 500-1000 ppm of mepiquat chloride. The findings are also in line with the results of Kumawat *et al*. (2019) in okra.

4.1.4 Stem girth (cm)

The data pertaining to stem girth was found significant difference (Table 3, Fig.4) among the different concentration of mepiquat chloride tried.

Among the different treatments, the plants received 125 g a.i. ha^{-1} MC at initiation of flowering (T_3) recorded significantly, the maximum stem girth (5.25 cm) followed by (T_6) 125 g a.i. ha^{-1} MC at initiation of fruiting (4.94 cm), T_7 (4.67 cm) and least stem girth (3.44 cm) under control when the observations recorded at 60 DAS.

Table 3. Effect of mepiquat chloride on the number of branches per plant and stem girth (cm) in okra hybrid Arka Anamika

Treatment details	Number of branches per plant		Stem girth (cm)	
	60 DAS	90 DAS	60 DAS	90 DAS
T_1 - 50 g a.i. ha^{-1} MC at initiation of flowering	2.93	3.13	3.90	4.04
T_2 - 62.5 g a.i. ha^{-1} MC at initiation of flowering	3.33	3.53	4.48	4.66
T_3 - 125 g a.i. ha^{-1} MC at initiation of flowering	3.93	4.47	5.25	5.80
T_4 - 50 g a.i. ha^{-1} MC at initiation of fruiting	2.73	2.93	3.72	3.82
T_5 - 62.5 g a.i. ha^{-1} MC at initiation of fruiting	3.27	3.40	4.02	4.32
T_6 - 125 g a.i. ha^{-1} MC at initiation of fruiting	3.67	4.00	4.94	5.18
T_7 - 50 g a.i. ha^{-1} MC at initiation of flowering and at initiation of fruiting	3.53	3.80	4.67	4.81
T_8 – Control	2.47	2.53	3.44	3.52
F test	*	*	*	*
S Em±	0.07	0.07	0.06	0.07
CD @ 5%	0.21	0.22	0.17	0.20

*significant at 5%

Similar trend was observed at 90 DAS where T_3 (5.80 cm) recorded maximum stem girth followed by T_6 (5.18 cm) and T_7 (4.81 cm) over the control.

These results are in accordance with findings of Elkoca and Kantar (2006) reported increased stem girth of pea plants received mepiquat chloride at an early blooming stage significantly. The findings are also in line with Zidan *et al*., 2014 and Berova and zlatev (2000) with regard to the stem diameter and thickness of stem in tomato.

4.1.7 Leaf area (cm^2)

The data on Leaf area at 60 days after sowing as influenced by foliar application of mepiquat chloride is presented in Table 4.

The highest leaf area (430.87 cm^2) was recorded in control (T_8) followed by T_4 (417.33 cm^2), T_1 (406.03 cm^2) where the plants received a lesser concentration (50 g a.i. ha^{-1}) of MC sprayed at initiation of fruiting and 50 g a.i. MC sprayed at initiation of flowering respectively. The leaf area was recorded minimum (374.13 cm^2) in T_3 with 125 g a.i. ha^{-1} MC at initiation of flowering.

The minimum leaf area in plants treated with a higher concentration of mepiquat chloride is due to the 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. The findings were also found corroborated to Reddy et al. (1990) in cotton and Tekalign and Hammes (2005) in potato.

4.1.8 Chlorophyll content

The data on chlorophyll content at 60 days after sowing as influenced by foliar application of mepiquat chloride are presented in Table 4.

The chlorophyll content (SPAD meter reading) increased from control (44.37) to T_3 (58.93) with 125 g a.i. ha^{-1} MC at initiation of flowering which is on par with T_6 (58.3) 125 g a.i. ha^{-1} MC at initiation of fruiting followed by T_7 (52.53) 50 g a.i. ha^1

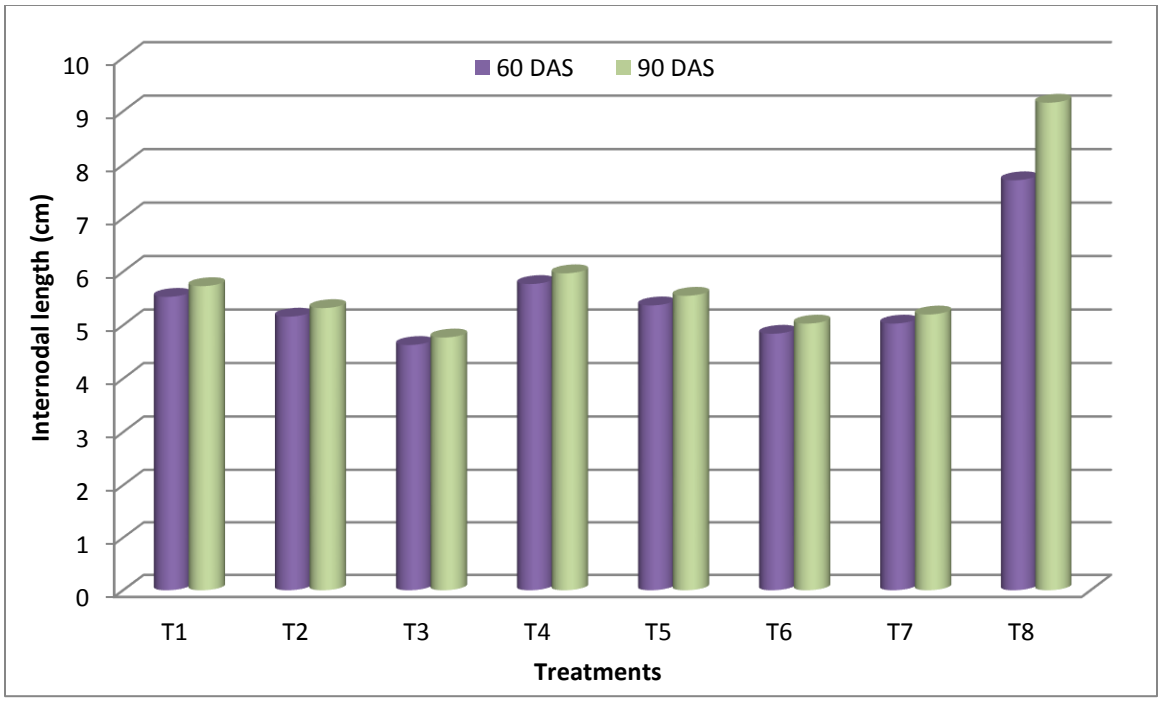

Fig. 3: Effect of mepiquate chloride on internodal length (cm) of okra hybrid Arka Anamika

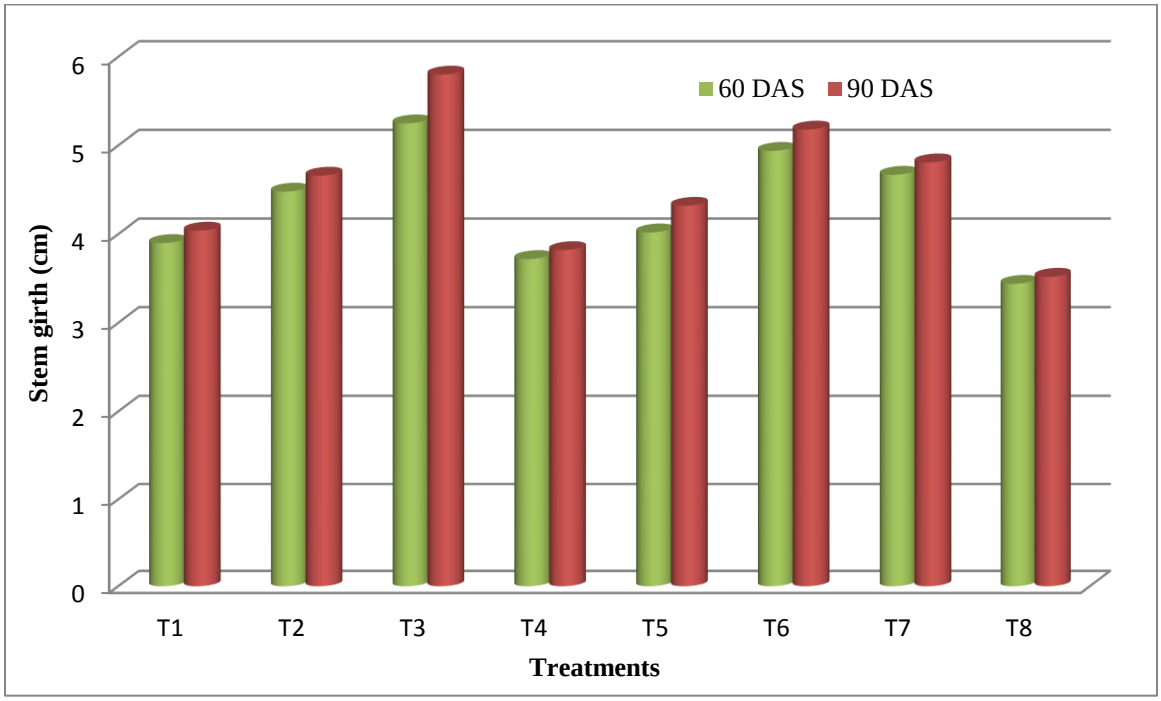

Fig. 4: Effect of mepiquate chloride on stem girth (cm) of okra hybrid Arka Anamika

Table 4. Effect of mepiquat chloride on leaf area (cm^2) and chlorophyll content in okra hybrid Arka Anamika

Treatment details	Leaf area (cm^2)	Chlorophyll content (SPAD meter reading)
T1 - 50 g a.i. ha^{-1} MC at initiation of flowering	406.03	49.23
T2 - 62.5 g a.i. ha^{-1} MC at initiation of flowering	389.50	54.30
T3 - 125 g a.i ha^{-1} MC at initiation of flowering	374.13	58.93
T4 - 50 g a.i. ha^{-1} MC at initiation of fruiting	417.33	48.60
T5 - 62.5 g a.i. ha^{-1} MC at initiation of fruiting	395.87	53.40
T6 - 125 g a.i. ha^{-1} MC at initiation of fruiting	383.37	58.30
T7 - 50 g a.i. ha^{-1} MC at initiation of flowering and at initiation of fruiting	385.03	52.53
T8 – Control	430.87	44.37
F test	*	*
SEm±	3.04	1.12
CD@5%	9.22	3.40

*significant at 5%

MC at initiation of flowering and fruiting and T_2 (54.3) 62.5 g a.i. ha^{-1} of MC sprayed at initiation of flowering. The chlorophyll content determines the photosynthetic activity of okra plants and influences the photosynthesis and yield of pods.

In the present study mepiquat chloride at 125 g a.i. recorded maximum chlorophyll content in leaves. This was in accordance with the results of Wasnik and Bagga (1996) in chickpea and Sridhar *et al.* (2009) found that foliar spray of 1500 ppm mepiquat chloride significantly increased chlorophyll content in bell pepper. The results are also in line with Reddy *et al.* (2008) in cowpea and Xu and Taylor (1992) in cotton.

4.2 Yield attributes

4.2.1 Number of days taken to flowering

Significant differences were not observed between the treatments in respect of the number of days taken for flowering (Table 5). This is due to the application of treatments started after initiation of flowering.

4.2.2 Number of days taken to first harvest

The data pertaining to the days taken for first harvest due to various concentrations of mepiquat chloride treatments did not differ significantly (Table.5). However, least number of days taken to first harvest observed in T_1 and T_6 (49.33) followed by T_7 (49.67). It was believed that early flowering results in an early harvest of bhendi.

4.2.3 Pod length (cm)

The data on length of pod with different concentrations of mepiquat chloride treatments in okra are presented in Table 6 and Fig 5.

Length of pod varied significantly with mepiquat chloride treatments. Maximum pod length was recorded in treatment (T_3) 125 g a.i. ha^{-1} MC at initiation of flowering (15.13 cm) which is on par with (T_6) 125 g a.i. ha^{-1} MC at initiation of fruiting (14.27 cm) followed by T_7 (13.93 cm) 50 g a.i. ha^{-1} MC at initiation of flowering and fruiting,

Table 5. Effect of mepiquat chloride on the number of days taken to first flowering and harvest in okra hybrid Arka Anamika

Treatment details	Days taken to first flowering	Days taken to first harvest
T1 - 50 g a.i. ha^{-1} MC at initiation of flowering	39.67	49.33
T2 - 62.5 g a.i. ha^{-1} MC at initiation of flowering	38.33	50.33
T3 - 125 g a.i ha^{-1} MC at initiation of flowering	39.33	50.33
T4 - 50 g a.i. ha^{-1} MC at initiation of fruiting	40.00	50.67
T5 - 62.5 g a.i. ha^{-1} MC at initiation of fruiting	38.67	50.33
T6 - 125 g a.i. ha^{-1} MC at initiation of fruiting	39.67	49.33
T7 - 50 g a.i. ha^{-1} MC at initiation of flowering and at initiation of fruiting	39.00	49.67
T8 – Control	40.33	50.33
F test	NS	NS
SEm±	0.51	0.46
CD@5%	-	-

NS – non-significant

T_2 (13.07 cm) 62.5 g a.i ha^{-1} at initiation of flowering and T_5 (12.57 cm) at initiation of fruiting. Pod length was minimum (10.23 cm) under control. Growth retardants are responsible for better partitioning and efficient translocation of photo-assimilates towards the economic sink (Pushpendra, 2014).

Laddha *et al*. (2018) observed the highest fruit length (17.61 cm) in brinjal with the application of 3400 ppm of mepiquat chloride. Similar results were also recorded by Gollagi (1999) in chilli and Sivappa (2003) in okra with the treatment of mepiquat chloride.

4.2.4 Diameter of the pod (cm)

The results of pod diameter are presented in Table.6 and Fig.5 and there were significant differences in pod diameter with different concentrations of mepiquat chloride at different harvests were observed.

Application of 125 g a.i. ha^{-1} MC at initiation of flowering (T_3) recorded maximum pod diameter (2.16 cm). The treatments of 125 g a.i. ha^{-1} MC after 15 days of initiation of flowering (2.10 cm) and 50 g a.i. ha^{-1} MC at vegetative stage and at initiation of flowering (2.09 cm) was statistically on par. The minimum diameter of the pod (1.64 cm) was observed in control plots.

An increase in pod diameter is due to the mobilization of photosynthates towards pod with mepiquat chloride action. The results are in accordance with the findings of Laddha *et al*. (2018) in brinjal, Sivappa (2003) and Kumar *et al.* (2018) in okra.

4.2.7 Fresh weight of pod (g)

The results on the fresh weight of the pod at 90 days after sowing are presented in Table.6 and Fig 6. There was a significant difference in fresh weight of pod with different concentration of mepiquat chloride treatments in okra.

The treatment with 125 g a.i. ha^{-1} of mepiquat chloride at initiation of flowering (T_3) recorded the maximum fresh weight of pod (22.51 g). The next best treatment was

(T_6) 125 g a.i. ha^{-1} MC sprayed at initiation of fruiting (21.65 g). While the minimum fresh weight of pod was recorded in control (16.84 g).

The increase in fresh weight of pod is due to the increased chlorophyll content of leaves that produced more photosynthates towards the economic parts. It may also due to the higher diameter and length of the pod. Pateliya *et al.,* 2008 reported similar results in okra. The findings were also in agreement with Gasti (1994) in okra with mepiquat chloride application.

4.2.8 Dry weight of the pod

The data on the dry weight of pod at 90 days after sowing as influenced by the various concentration of growth retardant mepiquat chloride was found significant (Table.6 and Fig.6).

The maximum dry weight of pod (7.95 g) was observed in the treatment of 125 g a.i. ha^{-1} MC at initiation of flowering (T_3) and it was on par with (T_6) 125 g a.i. ha^{-1} at initiation of fruiting (7.77 g). While the minimum dry weight of pod was noticed in control (6.14 g).

The increase in dry weight of pod mainly due to more fresh weight of pods in the same treatment. Gunasena and Clements (1970) observed that increased dry weight of french bean pods when plants were sprayed with growth retardant cycocel (500 ppm). Similar observations also recorded by Marisiddiah and Gowda (1978) in tomato.

4.2.6 Number of seeds per pod

The data on the number of pods per plant differed significantly with treatments of mepiquat chloride are presented in Table 6.

Plants treated with 125 g a.i. ha^{-1} MC at initiation of flowering (T_3) recorded the highest number of seeds per pod (51.67) followed by T_6 with 125 g a.i. ha^{-1} MC at initiation of fruiting (49.67), T_7 (48.33) 50 g a.i. ha^{-1} MC at initiation of flowering and fruiting, T_2 (47.33) 62.5 g a.i. ha^{-1} at initiation of flowering. The minimum number of seeds (44.00) produced per pod was in control.

Table 6. Effect of mepiquat chloride on pod length (cm), pod diameter (cm), fresh weight of pod (g), dry weight of pod (g) and number of seeds per pod in okra hybrid Arka Anamika

Treatment details	Pod length (cm)	Pod diameter (cm)	Fresh weight of pod (g)	Dry weight of pod (g)	Number of seeds per pod
T1 - 50 g a.i. ha^{-1} MC at initiation of flowering	12.07	1.75	18.89	6.96	46.33
T2 - 62.5 g a.i. ha^{-1} MC at initiation of flowering	13.07	1.93	19.71	7.32	47.33
T3 - 125 g a.i ha^{-1} MC at initiation of flowering	15.13	2.16	22.51	7.95	51.67
T4 - 50 g a.i. ha^{-1} MC at initiation of fruiting	11.40	1.70	19.50	6.85	46.67
T5 - 62.5 g a.i. ha^{-1} MC at initiation of fruiting	12.57	1.82	17.76	7.18	47.00
T6 - 125 g a.i. ha^{-1} MC at initiation of fruiting	14.27	2.10	21.65	7.77	49.67
T7 - 50 g a.i. ha^{-1} MC at initiation of flowering and at initiation of fruiting	13.93	2.09	20.38	7.56	48.33
T8 – Control	10.23	1.64	16.84	6.14	44.00
F test	*	*	*	*	*
SEm±	0.30	0.07	0.94	0.09	0.77
CD@5%	0.90	0.23	2.86	0.27	2.33

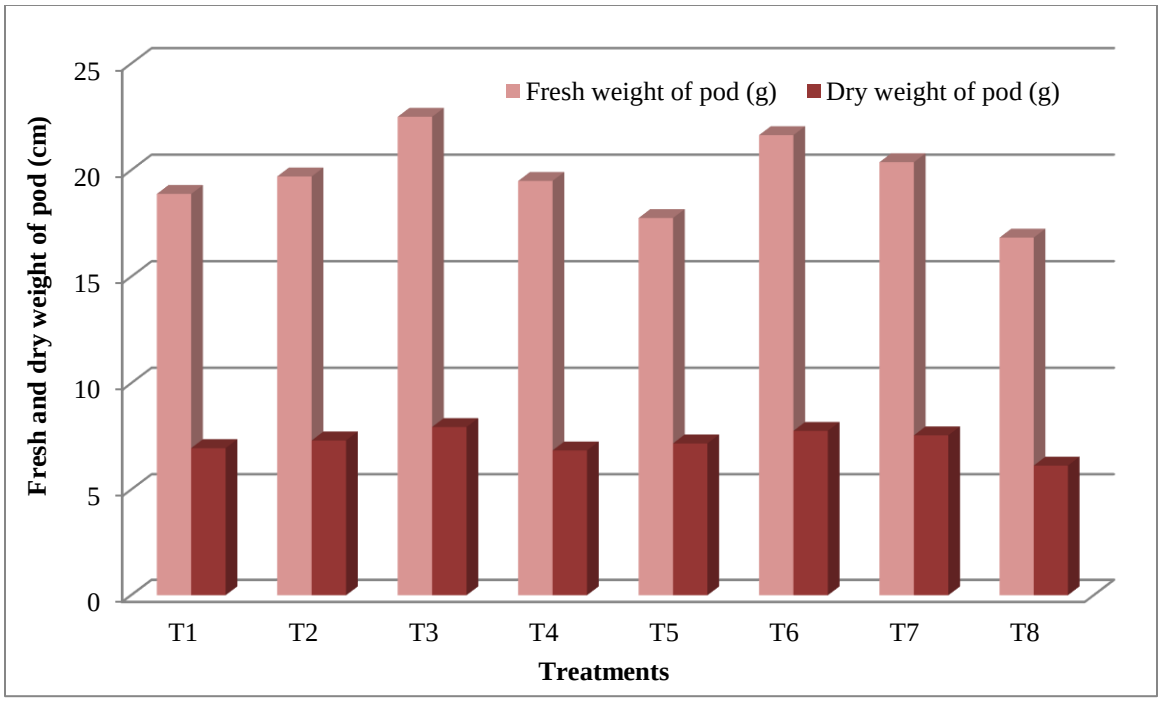

Fig. 6: Effect of mepiquate chloride on fresh and dry weight of pod (g) in okra hybrid Arka Anamika

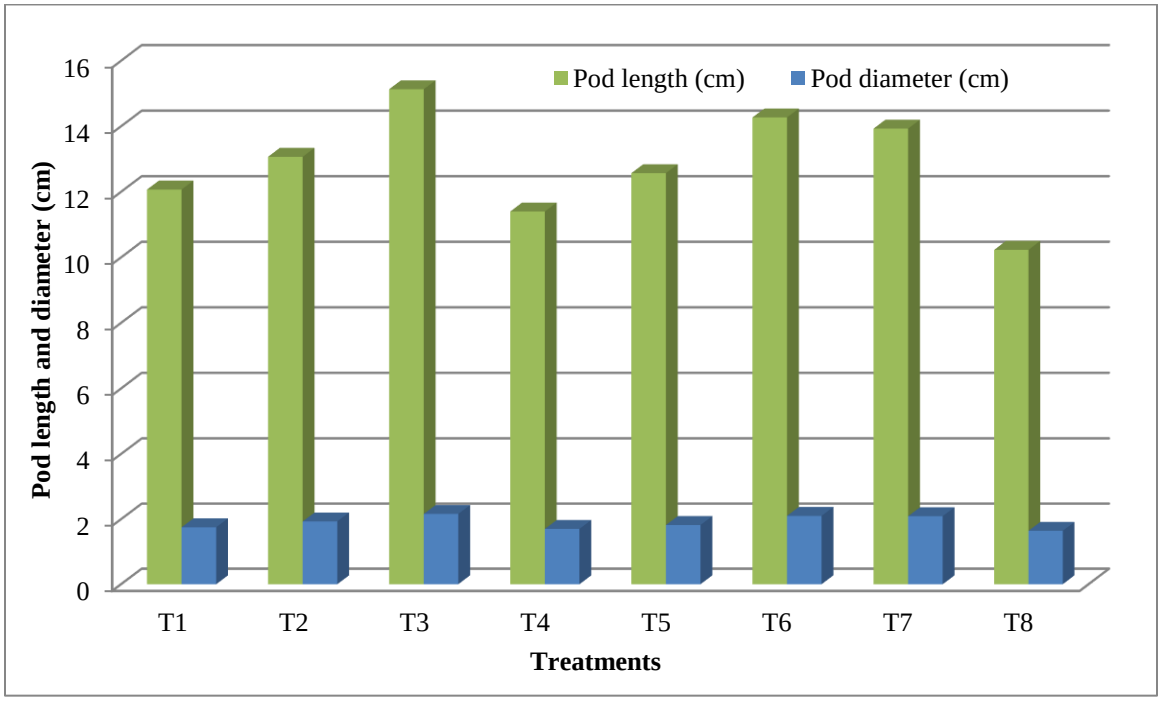

Fig. 5: Effect of mepiquate chloride on pod length and diameter (cm) of okra hybrid Arka Anamika

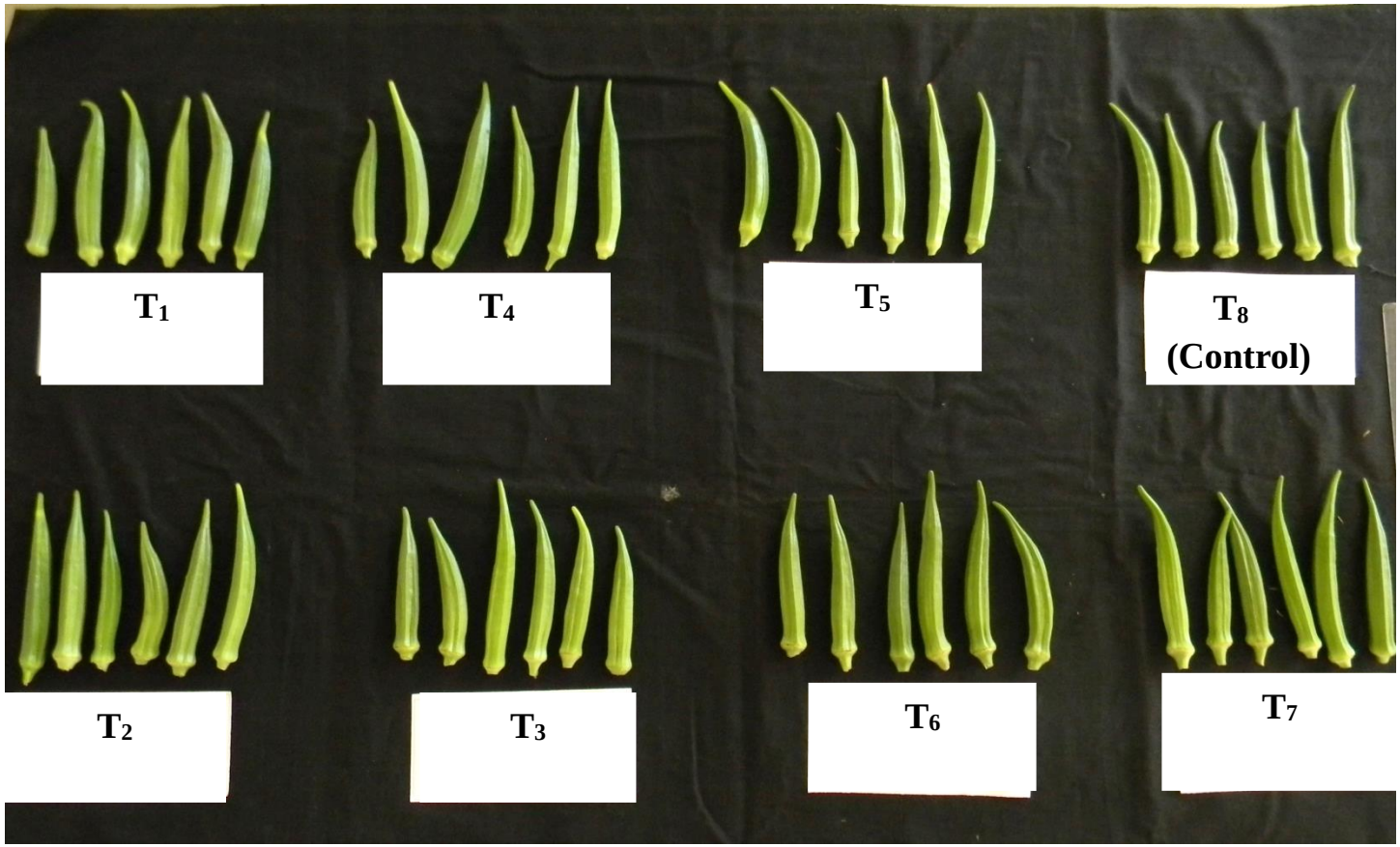

Plate 8: Harvested okra pods at 60 DAS

The maximum number of seeds per pod may be due to the increased length and diameter of pods. The similar findings were observed by Sridhar *et al.* (2009) with the highest number of seeds per fruit with the application of mepiquat chloride in chilli. Hunje *et al*. (1995) recorded more number of seeds per plant with the application of 100 ppm cycocel in cowpea.

4.2.5 Number of pods per plant

The results pertaining to the number of pods per plant in okra with mepiquat chloride application was found a significant difference (Table 7).

Plants treated with 125 g a.i. ha^{-1} of MC at initiation of flowering (T_3) recorded the highest number of pods per plant (14.20) which was significantly higher than other treatments and it was followed by T_6 with 125 g a.i. ha^{-1} MC at initiation of fruiting (13.17) which was on par with (T_7) 50 g a.i. ha^{-1} MC at initiation of flowering fruiting (13.00). The lowest number of pods (10.53) produced per plant was in control (T_8).

Increase in the number of pods per plant may be due to the presence of more number of nodes and branches in plants received 125 g a.i. ha^{-1} of mepiquat chloride. The results were found in accordance with the findings of Pateliya *et al*. (2008) and Sivappa (2003) in okra. Similar findings are also observed by Laddha *et al*. (2018) in brinjal.

4.2.9 Pod yield per plant (g)

The data on pod yield per plant was significantly influenced by the foliar spray of growth retardant mepiquat chloride (Table 7).

Application of 125 g a.i. ha^{-1} of mepiquat chloride at initiation of flowering (T_3) recorded significantly the maximum pod yield per plant (572.10 g) followed by (T_6) with 125 g a.i. ha^{-1} MC at initiation of fruiting (540.87 g), T_7 (528.33 g) 50 g a.i. ha^{-1} MC at initiation of flowering and fruiting, T_2 (516.33 g). However, the minimum pod yield per plant (433.70 g) was recorded in the treatment (T_8) control.

This significant improvement in yield may be due to reduced plant height and increased branching resulting in diversion of food material for the improvement of flowering and fruiting (Kuraishi and Muri, 1962). The results were in accordance with Wasnik and Bagga (1996) in chickpea and Laddha *et al*. (2018) in brinjal.

4.2.10 Pod yield per plot (kg)

Significant differences among the treatments were observed with regard to pod yield per plot (Table 7).

Application of 125 g a.i. ha^{-1} MC at initiation of flowering (T_3) produced significantly the maximum pod yield per plot (21.78 kg) followed by (T_6) 125 g a.i. ha^{-1} MC at initiation of fruiting (21.09 kg), T_7 (20.58 kg) and T_2 (19.60 kg). However, the minimum pod yield per plot (17.23 kg) was recorded in control (T_8).

Significant positive association with the number of branches, pod length, pod diameter, number of pods and chlorophyll content responsible for the higher pod yield per plot. Similar results were also reported by Pal *et al.* (2017) and Laddha *et al*. (2018) with mepiquat chloride treatment in onion and brinjal respectively. Prasad and Shrihari (2008) also found highest pod yield per plot in okra.

4.2.11 Pod yield/ha (t)

The data on total yield per hectare as influenced by the effect of different concentrations of mepiquat chloride are presented in Table.7 and Fig.7.

The treatment (T_3) with the application of 125 g a.i. ha^{-1} MC at initiation of flowering produced the highest yield per hectare (14.26 t), which was found to be significantly superior over the other treatments. The next best yield was obtained in T_6 (13.39 t ha^{-1}) application of 125 g a.i. ha^{-1} MC at initiation of fruiting, which is on par with T_7 (13.07 t ha^{-1}) application of 50 g a.i. ha^{-1} MC at initiation of flowering and fruiting. Lowest yield was noticed in control (10.71 t ha^{-1}).

Table 7. Effect of mepiquat chloride on the number of pods per plant, pod yield per plant (g), pod yield per plot (kg) and total pod yield (t/ha) in okra hybrid Arka Anamika

Treatment details	Number of pods/plant	Pod yield/plant (g)	Pod yield/plot (kg)	Total pod yield (t/ha)
T1 - 50 g a.i. ha^{-1} MC at initiation of flowering	11.73	485.40	18.96	11.99
T2 - 62.5 g a.i. ha^{-1} MC at initiation of flowering	12.80	516.33	19.60	12.75
T3 - 125 g a.i ha^{-1} MC at initiation of flowering	14.20	572.10	21.78	14.26
T4 - 50 g a.i. ha^{-1} MC at initiation of fruiting	11.53	471.83	18.43	11.65
T5 - 62.5 g a.i. ha^{-1} MC at initiation of fruiting	12.07	504.33	19.05	12.45
T6 - 125 g a.i. ha^{-1} MC at initiation of fruiting	13.17	540.87	21.09	13.35
T7 - 50 g a.i. ha^{-1} MC at initiation of flowering and at initiation of fruiting	13.00	528.33	20.58	13.07
T8 – Control	10.53	433.70	17.23	10.71
F test	*	*	*	*
SEm±	0.36	3.11	0.16	0.08
CD@5%	1.09	9.42	0.48	0.23

*significant at 5%

Increased yield with the application of growth retardant may be attributed to the fact that growth regulators remain physiologically more active to build up sufficient food reserves for developing pods which ultimately lead to increased total yields (Memane *et al.,* 2008). The results are in agreement with the earlier findings of Muthukumar *et al.* (2005) in sweet corn, Sivappa (2003) in okra and Sridhar *et al.* (2009) in capsicum. Singh *et al.* (2017) found the highest cotton yield with the application of mepiquat chloride at 1500 ml ha^{-1}.

4.3 Quality parameters

4.3.1 Ascorbic acid (%)

The data pertaining to the ascorbic acid was found a significant difference with the application of mepiquat chloride (Table.8 and Fig.8).

The maximum ascorbic acid content was recorded in T_3 with 125 g a.i. ha^{-1} of mepiquat chloride at initiation of flowering (16.31 mg 100^{-1} g) and it was on par with T_6 (16.15 mg 100^{-1} g) 125 g a.i. ha^{-1} MC at initiation of fruiting, T_7 (16.10 mg 100^{-1} g) and T_2 (15.30 mg 100^{-1} g). The lowest ascorbic acid content (14.02 mg 100^{-1} g) was recorded in control (T_8).

The pods produced from the plants received a higher concentration of mepiquat chloride showed the maximum ascorbic acid content. The results are in accordance with the findings of Vethamoni and Gomathi (2018) in onion. Sridhar *et al.* (2009) observed an increase in ascorbic acid content with mepiquat chloride treatment. Similar findings were also reported by Chutichudet *et al*. (2007).

4.3.2 Total soluble solids (^{o}brix)

The data on total soluble solids influenced by the effect of mepiquat chloride are presented in Table.8 and Fig.9.

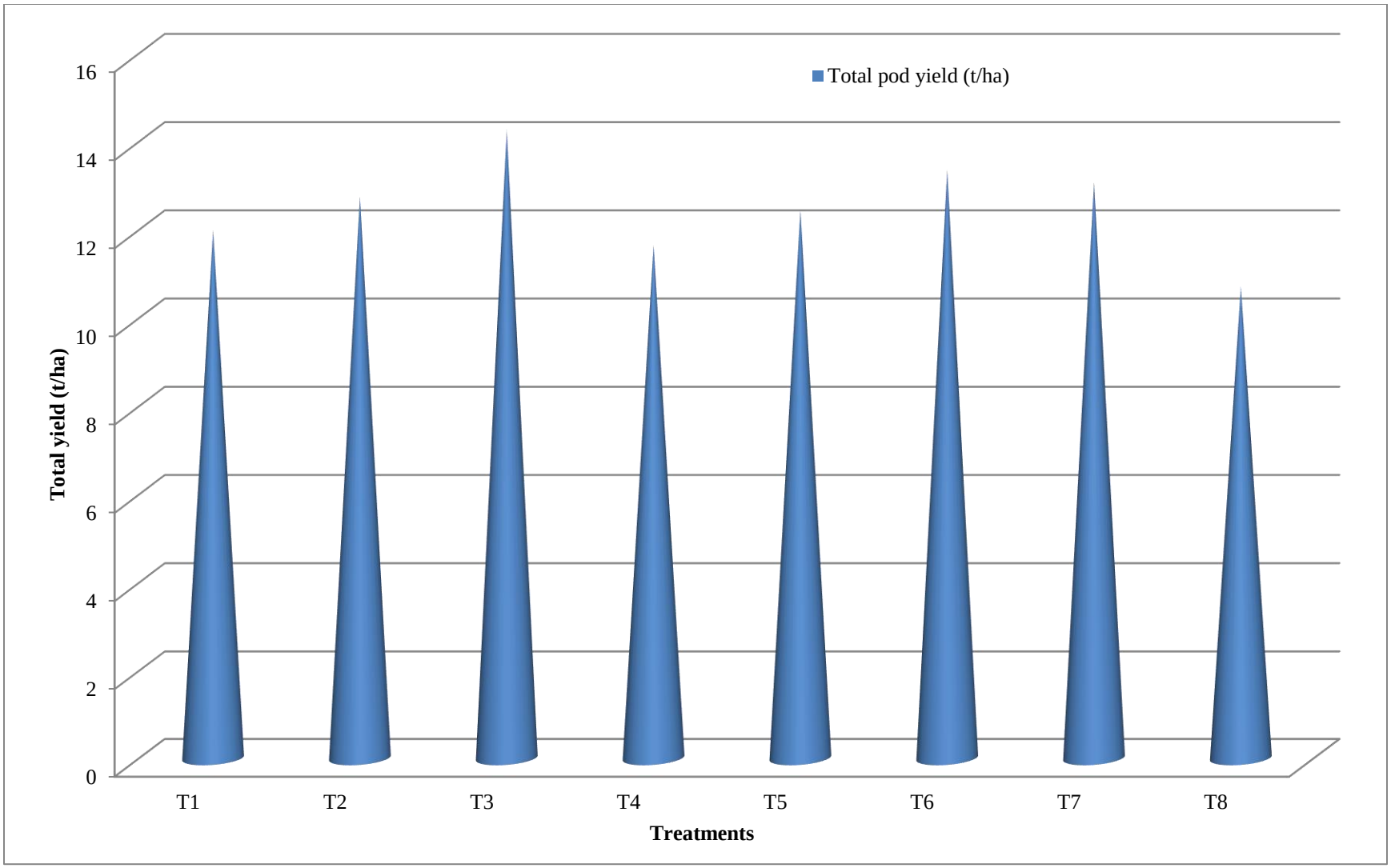

Fig. 7: Effect of mepiquate chloride on total yield (t/ha) of okra hybrid Arka Anamika

Table 8. Effect of mepiquat chloride on ascorbic acid (mg/100 g) and total soluble solids (°brix) in okra hybrid Arka Anamika

Treatment details	Ascorbic acid (mg/100g)	Total soluble solids (°brix)
T1 - 50 g a.i. ha^{-1} MC at initiation of flowering	15.08	1.49
T2 - 62.5 g a.i. ha^{-1} MC at initiation of flowering	15.30	1.66
T3 - 125 g a.i ha^{-1} MC at initiation of flowering	16.31	2.03
T4 - 50 g a.i. ha^{-1} MC at initiation of fruiting	14.99	1.42
T5 - 62.5 g a.i. ha^{-1} MC at initiation of fruiting	15.11	1.59
T6 - 125 g a.i. ha^{-1} MC at initiation of fruiting	16.15	1.93
T7 - 50 g a.i. ha^{-1} MC at initiation of flowering and at initiation of fruiting	16.10	1.86
T8 – Control	14.02	1.41
F test	*	*
SEm±	0.21	0.03
CD@5%	0.64	0.10

*significant at 5%

Application of 125 g a.i. ha^{-1} of mepiquat chloride at initiation of flowering produced the highest total soluble solids (2.03 °Brix), which is followed by T_6 (1.93 ^{o}Brix) 125 g a.i. ha^{-1} MC at initiation of fruiting and it was on par with T_7 (1.86 ^{o}Brix) and total soluble solids (TSS) found minimum (1.41 ^{o}Brix) in control (T_8).

The higher total soluble solids under the growth retardant might be due to its properties of promoting the accumulation of carbohydrates by suppressing the apical dominance. Similar findings were recorded by Vethamoni and Gomathi (2018) in onion, Laddha *et al.* (2018) in brinjal.

4.4 Cost Economics

The data on the effect of mepiquat chloride on cost economics of okra is presented in Table 9.

The benefit cost ratio is an important factor, which decides the optimum input levels to be used for hike of production and net returns in any crop. In the present investigation, cost-benefit ratio was worked out for the usage of mepiquat chloride at different concentrations. Profit does not depend only on the productivity of the crop but also the quality of the produce in association with the competitive price in the market. This can be achieved by increasing the yield and quality of the crop by the application of growth retardant mepiquat chloride.

The maximum cost - benefit ratio (1: 1.96) was obtained in the treatment with 125 g a.i. ha^{-1} MC at initiation of flowering (T_3) followed by (T_6) 125 g a.i. ha^{-1} MC at initiation of flowering (1: 1.83) and it was on par with (T_7) 50 g a.i. ha^{-1} MC at initiation of flowering and fruiting. The minimum cost benefit ratio (1:1.48) was recorded in control (T_8). The results are in confirmity with the findings of Pal *et al.* (2017) the highest cost-benefit ratio (1:1.72) was registered with application of mepiquat chloride at 125 g a.i. ha^{-1} at the initiation of flowering in onion.

Similar results obtained with the findings of Singh *et al.* (2017) in cotton and Kumawat *et al*. (2019) in okra who got highest net returns and B:C ratio with the application of mepiquat chloride.

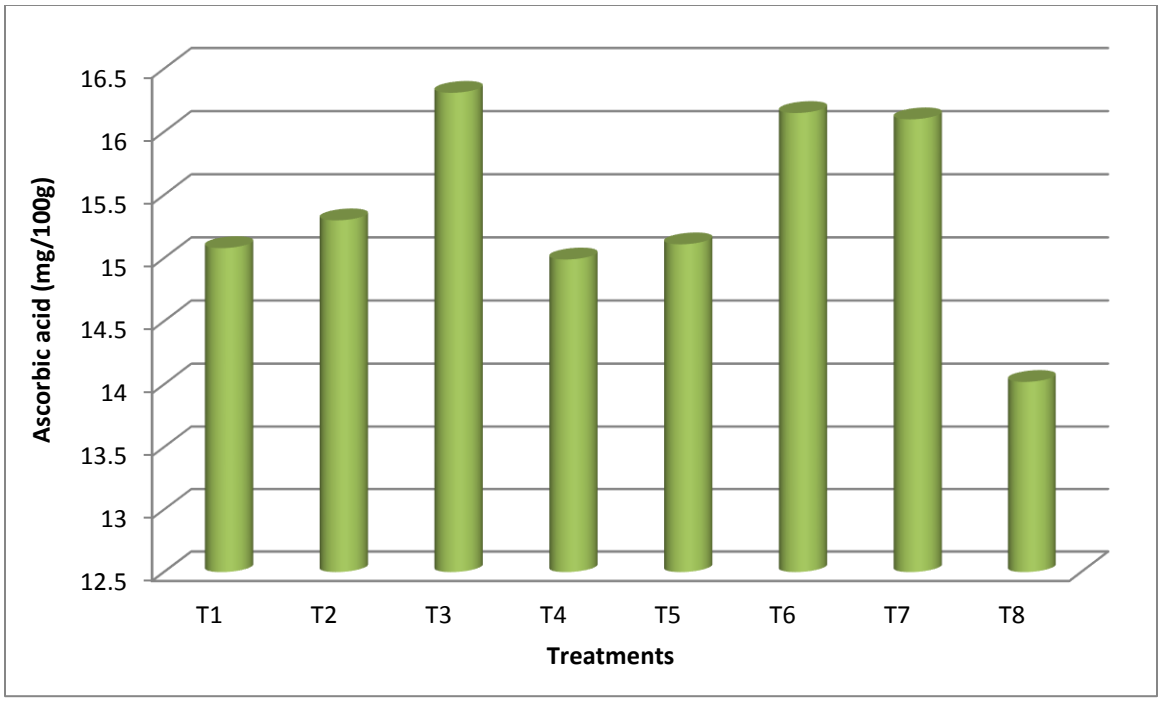

Fig. 8: Effect of mepiquat chloride on ascorbic acid (mg/100 g) in okra hybrid Arka Anamika

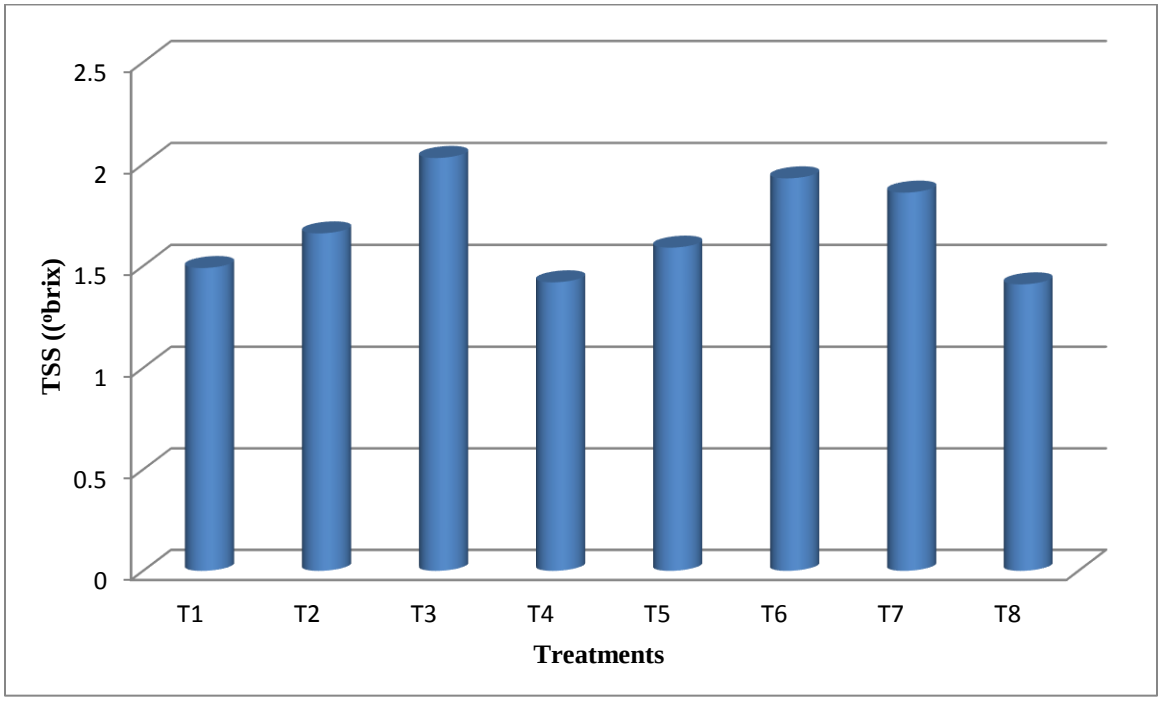

Fig. 9: Effect of mepiquat chloride on total soluble solids (ºbrix) in okra hybrid Arka Anamika

Table 9. Effect of mepiquat chloride on benefit cost ratio in okra hybrid Arka Anamika

Treatment details	Total cost of cultivation (Rs)	Total yield of pods/ha (t)	Gross returns (Rs)	Net returns (Rs)	Benefit cost ratio
T1 - 50 g a.i. ha^{-1} MC at initiation of flowering	217300	11.99	359700	142400	1:1.66
T2 - 62.5 g a.i. ha^{-1} MC at initiation of flowering	217490	12.75	382500	165010	1:1.76
T3 - 125 g a.i ha^{-1} MC at initiation of flowering	218450	14.26	427800	209350	1:1.96
T4 - 50 g a.i. ha^{-1} MC at initiation of fruiting	217300	11.65	349500	132200	1:1.61
T5 - 62.5 g a.i. ha^{-1} MC at initiation of fruiting	217490	12.45	373500	156010	1:1.72
T6 - 125 g a.i. ha^{-1} MC at initiation of fruiting	218450	13.35	400500	182050	1:1.83
T7 - 50 g a.i. ha^{-1} MC at initiation of flowering and at initiation of fruiting	218050	13.07	392100	174050	1:1.80
T8 – Control	216550	10.71	321300	104750	1:1.48

V SUMMARY

The field experiment entitled "Effect of mepiquat chloride on growth and yield of okra (*Abelmoschus esculentus* L. Moench) hybrid Arka Anamika" was studied in a randomized block design with eight treatments and three replications. The study was conducted in the year 2018-19 at the Department of Horticulture, University of Agricultural Sciences, Bengaluru. The prominent findings of the current investigation are summarized in this chapter.

Among the growth parameters, application of 125 g a.i ha^{-1} mepiquat chloride at initiation of flowering significantly reduced plant height (60.20 and 93.90 cm) in both the stages (60 and 90 DAS) by reducing internodal length (4.63 and 4.83 cm) at 60 and 90 days after sowing respectively.

Number of leaves (18.06 and 26.23), number of branches (3.93 and 4.47), number of nodes per plant (17.1 and 19.50), stem girth (5.25 and 5.80 cm) at 60 and 90 DAS respectively and chlorophyll content-SPAD meter reading (58.93) were significantly highest in (T_3) 125 g a.i. ha^{-1} mepiquat chloride sprayed at initiation of flowering. The leaf area was minimum (374.13 cm^2) in T_3 and highest leaf area (430.87 cm^2) was observed in control (T_8) compared to all other treatments.

There was no significant difference observed regarding the days taken to first flowering and harvest with the application of mepiquat chloride. The treatment (T_3) with 125 g a.i. ha^{-1} mepiquat chloride at initiation of flowering recorded maximum pod length (15.13 cm), pod diameter (2.16 cm), number of seeds per pod (51.67), number of pods per plant (14.2), fresh weight of pod (22.51 g), dry weight of pod (7.95 g), pod yield per plant (572.1 g), pod yield per plot (21.78 kg) and total pod yield (14.13 t ha^{-1}). T_8 (control) showed the lowest values with respect to all yield attributes.

Quality of okra pods was significantly improved due to the application of mepiquat chloride. Maximum TSS (2.03 ^oBrix) and ascorbic acid (16.31 mg 100^{-1} g) of pods were observed in the treatment 125 g a.i. ha^{-1} mepiquat chloride sprayed at the

initiation of flowering. While the minimum TSS and ascorbic acid content were found in control (T_8) *viz* 1.41 $^oBrix and 14.02 mg 100^{-1} g respectively.

The highest total cost of cultivation was incurred with a spray of 125 g a.i. ha^{-1} mepiquat chloride at the initiation of flowering and the highest returns were also obtained in the same treatment. It has produced more gross returns (Rs. 427800 ha^{-1}), net returns (Rs. 209350 ha^{-1}) and cost-benefit ratio (1: 1.96), while the lowest gross returns (Rs. 321300 ha^{-1}), net returns (Rs. 104750 ha^{-1}) and cost-benefit ratio (1: 1.48) were obtained in unsprayed control (T_8).

Conclusion

Okra hybrid Arka Anamika has the habit of producing long plants with more vegetative growth than reproductive growth. So optimization of vegetative growth and enhancement of yield and quality attributes of okra can be achieved through the application of growth retardant like mepiquat chloride.

In determining the impact of growth retardant mepiquat chloride on okra, the present study revealed that all the treatments were superior over control. Although it could be concluded that the optimum dose of mepiquat chloride *i.e.,* 125 g a.i. ha^{-1} sprayed at an appropriate time (at the initiation of flowering) results in better growth, yield and quality attributes of okra.

Future line of work

- Experiment could be tried during early stages of vegetative growth.
- Similar investigation could be tried on other commercial varieties of okra.
- More number of plant growth regulators may be included to the investigations for boosting the productivity of okra.
- Studies are needed to standardize the concentration and intervals of application of different growth regulators to achieve quality production.

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APPENDIX - I

Monthly meteorological data recorded during the crop period at GKVK, Bengaluru (2018 -19)

Month	Temperature (^{0} C)		Mean	Relative Humidity (%)	Bright sun shine (Hours)	Rainfall (mm)
	Max	Min				
August	27.7	18.9	23.3	90	4.7	129.7
September	28.1	18.9	23.5	89	5.7	196.0
October	27.9	18.3	23.1	88	6.1	164.7
November	26.7	16.6	21.65	87	6.4	56.2
December	26.3	14.6	20.45	87	7.3	13

APPENDIX - II

Detailed cost of cultivation of okra as influenced by mepiquat chloride on an area of 1 hectare:

Sl. No.	Treatment	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
1	Land Preparation	12000	12000	12000	12000	12000	12000	12000	12000
2	Drip irrigation	80000	80000	80000	80000	80000	80000	80000	80000
3	Mulching	30000	30000	30000	30000	30000	30000	30000	30000
4	Seedlings cost	3500	3500	3500	3500	3500	3500	3500	3500
5	Planting cost	1250	1250	1250	1250	1250	1250	1250	1250
6	Fertilization/FYM	30000	30000	30000	30000	30000	30000	30000	30000
7	Weeding	10000	10000	10000	10000	10000	10000	10000	10000
8	Maintenance of labour	2000	2000	2000	2000	2000	2000	2000	2000
9	Mepiquat chloride cost	750	940	1900	750	940	1900	1500	0
10	chemical spray labour	2500	2500	2500	2500	2500	2500	2500	2500
11	Harvesting	5000	5000	5000	5000	5000	5000	5000	5000
12	Transportation	7000	7000	7000	7000	7000	7000	7000	7000
13	Marketing	3000	3000	3000	3000	3000	3000	3000	3000
14	Packeging material	5000	5000	5000	5000	5000	5000	5000	5000
15	Plant protection	10000	10000	10000	10000	10000	10000	10000	10000
16	Harvesting	15000	15000	15000	15000	15000	15000	15000	15000
	Total	**217300**	**217490**	**218450**	**217300**	**217490**	**218450**	**218050**	**216550**