EFFECT OF GROWTH RETARDANTS ON FLOWERING, FRUITING AND YIELD OF OKRA Cv.PBN-OK-1 [*Abelmoschus esculentus* (L)]

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2019

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DISSERTATION

Submitted to the
Vasantrao Naik Marathwada Krishi Vidyapeeth
in partial fulfillment of the requirements for the Degree of

MASTER OF SCIENCE
(Horticulture)

IN

VEGETABLE SCIENCE

DEPARTMENT OF HORTICULTURE,
COLLEGE OF AGRICULTURE, LATUR
VASANTRAO NAIK MARATHWADA KRISHI VIDYAPEETH,
PARBHANI - 431 402 (M.S.), INDIA.

2019

CANDIDATE'S DECLARATION

I hereby declare that the dissertation

or part there of has not been

previously submitted by

me for a degree of

any University.

Date: 30 / 07 /2019 **(Jadhav A.D.)**

Place: Latur **Reg. No: 2016H/09ML**

Dr .G. R. MUNDE
M.Sc. (Agri.), Ph.D. (Horti)
Officer In-charge
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CERTIFICATE-I

This is to certify that the dissertation entitled **"EFFECT OF GROWTH RETARDANTS ON FLOWERING, FRUITING AND YIELD OF OKRA Cv.PBN-OK-1 [*Abelmoschus esculentus* (L)]"** submitted by **Miss. JADHAV ASHWINI DHONDIRAM** to the Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (Horticulture) in** the subject of **VEGETABLE SCIENCE** is record of original and bonafide research work carried out by her under my guidance and supervision. It is of sufficiently high standard to warrant its presentation for the award of the said degree.

I also certify that the dissertation or part thereof has not been previously submitted by her for a degree of any university.

Place: Latur
Date: 30/ 07 /2019

Dr. G. R. MUNDE
Research Guide
&
Chairman Advisory committee

CERTIFICATE-II

This is to certify that the dissertation entitled "**EFFECT OF GROWTH RETARDANTS ON FLOWERING, FRUITING AND YIELD OF OKRA Cv. PBN-OK-1 [*Abelmoschus esculentus* (L)]**" Submitted by **Miss. JADHAV ASHWINI DHONDIRAM** to the Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (Horticulture)** in the subject of **VEGETABLE SCIENCE** has been approved by the student's advisory committee after viva-voce examination in collaboration with the external examiner.

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ACKNOWLEDGEMENT

*In the name of **Lord Budhha**, the most gracious & the most merciful. I forfeit my humbleness to his thought without the will of whom nothing would be realized.*

This dissertation would not been possible without the guidance and the help of several individuals who in one way or another contributed and extended their valuable assistance in the preparation & completion of this study.

*I have immense pleasure in expressing my whole hearted sense of gratitude and indebtedness towards my Research Guide **Dr .G.R. Munde,** Officer Incharge Custard Apple Research Station, Ambajogai, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani for his inspiring guidance, keen interest his activeness and sharpness. I take this opportunity to express my deep and sincere feeling of gratitude to him for suggesting research topic, valuable guidance, constant inspiration, constructive criticism, talented versatile advice and untiring efforts in preparation of the manuscript of this thesis.*

*I would also like to place on recorded my sincere thanks and deep sense of gratitude to advisory committee members, **Dr. V. S. Jagtap**, Associate Professor, College of Agriculture Latur, VNMKV Parbhani, **Dr. V. N. Toprope** , Associate Professor, Department of Botany, College of Agriculture Latur, for their suggestion and valuable guidance during the different stages in the completion of my thesis.*

*I wish to express my sincere thanks to **Dr. A. S. Dhawan** Hon. Vice-chancellor, V.N.M.K.V. Parbhani, **Dr. P. G. Ingole** Director of Instruction and Dean, Faculty of Agriculture, V.N.M.K.V, Parbhani, **Dr. D. N. Gokhale**, Associate Dean (P. G.) College of Agriculture, Parbhani, **Dr. D. P. Waskar**, Director of Research, VNMKV., Parbhani, **Dr. B. M. Thombre**, Associate Dean and Principal, College of Agriculture, Latur and Head of Department **Dr. A. S. Kadam**, Department of Horticulture, College of Agriculture, Latur, for providing necessary facilities for experimental work..*

*I would like to express my indebtedness to **Prof. N. H. Chavan** Senior Research Assistant, Department of Horticulture, **Dr. P. R. Dadgale** Agril Assistant Department of Horticulture, College of Agriculture Latur for providing me useful suggestions and guidance throughout my post graduation study.*

I heartily eulogize my dear friends ***Pooja, Shamal, Mohini, Rupali, Onkar, Tushar, Somanath, Abhijit, Roshan, Purushottam, Nivrutti,*** *my juniors* ***Ashwini, Shraddha, Mayuri, Shweta, Vaishali, Ankita, Tanaji, Sandesh, Ashvin, Shyam, Ishwar****, my roommates* ***Shital, Sonali, Minal.***

I allocate my highest respect and heartful regards from my inner core of heart to my ever loved parents, ***Sri. Jadhav Dhondiram Rupaji*** *and* ***Sau. Jadhav Vimal Dhondiram****; who have given me life and taught the concepts of life and their dedicated efforts to educate me to this level, with boundless affection, I owe an encompassing debt to my beloved brother* ***Swapnil*** *and sister* ***Sukeshani Khandare*** *and my brother-in-law* ***Milind Khandare*** *for constant encouragement throughout my career. I am also extremely indebted to my husband* ***Mr. Gaikwad Sidharth Gangaram*** *and my cute baby* ***Arth*** *for their love, care and moral support throughout my life.*

Finally, I express my grateful thanks to all those who directly or indirectly influenced my success

Place : Latur *(Jadhav A. D.)*

Date: 30 / 07/2019 *2016H/09ML*

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ABBREVIATIONS

@	_	At the rate of
%	_	Per cent / - Per
cm	_	Centimeter
cm^2	_	Centimeter square
Cv.	_	Cultivar
DAS	_	Days after sowing
dm^2	_	Decimeter square
et al.	_	Et alia, and other
etc.	_	Et-ce-te-ra (and other)
Fig.	_	Figure
g	_	Gram
ha	_	Hectare
kg	_	Kilogram(s)
i.e.	_	id est. (that is)
m	_	Meter(s)
No.	_	Number(s)
°C	_	Degree calicoes
q	_	Quintals
S. E. ±	_	Standard error of mean
CD	_	Critical difference
t	_	Tonnes
RBD	_	Randomized block design
Var.	_	Variety
N	_	Nitrogen
P	_	Phosphorus
K	_	Potassium
CCC	_	Cycocel
M H	_	Maleic hydrazide
BA	_	Benzylandinine
ppm	_	Parts per million
ml	_	Mililitre
mg	_	Milligram
NS	_	Non significant

Abstract

ABSTRACT

EFFECT OF GROWTH RETARDANTS ON FLOWERING,FRUITING AND YIELD OF OKRA Cv.PBN-OK-1 [*Abelmoschus esculentus* (L)]

By

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A Candidate for the Degree of

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ABSTRACT

A field experiment entitled "Effect of growth retardants on flowering, fruiting and yield of Okra Cv. PBN-OK-1[*Abelmoschus esculentus* (L.)]" was conducted at Horticulture Farm, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani during *kharif* 2018. With the object to evaluate the effectiveness of various growth retardant on flowering, fruiting and yield of okra. The experiment was laid out in Randomized Block Design with thirteen treatments and two replications. The experiment consist of growth retardants viz. CCC (300, 500, 700 ppm), MH (200, 250, 300 ppm), Ethrel (150, 250, 350 ppm), BA (100, 150, 200 ppm) and control treatments. Okra variety PBN-OK-1 was sown on 4th August 2018 by dibbling two seeds per hill at 60 cm x 45 cm spacing.

The result and discussion of present study showed that, various treatments' of growth retardant has got significant influence on vegetative growth, flowering and yield attribute's of okra. From the critical evaluation of results of the present investigation, the following conclusion can be drawn. Cycocel 500 ppm was found beneficial for decreasing the plant height (50.91 cm), maximum number of internodes per plant (15.16), minimum intermodal length (1.94 cm), maximum number of branches per plant (1.85) and maximum leaf area (242.95 cm^2). Cycocel 500 ppm was found effective for minimizing days to first flower to open (17.61), days to 50 percent flowering (20.06) and more number of flowers per plant (17.33). Cycocel 500 ppm was found effective for yield attributes like fruit length (11.38 cm), fruit diameter (2.04 cm), number of green fruit per plant (25.72), fresh weight of fruit (252.57g), fruit yield per plant (247.85g) and fruit yield (137.82 q/ha). The cycocel 500 ppm followed by cycocel 700 ppm, MH 300 ppm and BA 200 ppm was effective in relation to growth, flowering and yield character of okra.

Introduction

CHAPTER – I

INTRODUCTION

Okra (*Abelmoschus esculentus* L.) is an important vegetable belonging to the family Malvaceae. Okra is also knowns as “Queen of vegetable”. Okra leaves are used in inflammation and dysentery. The fruits also help in cases of renal colic, leucorrhoea and general weakness. In India, the crop has not adapted as leafy vegetable as in East countries.

India is the second largest producer of vegetables with 2.9 percent of total cropped area under vegetable crop. In India the area 511.09 (In' 000 h), production 6219 (In ' 000 MT) and productivity 12.2 (In MT/h) of okra in (2018-2019) (source Indiastat.com.). The production of okra in the world is 89, 00,434 (In Tonne). The harvested area of okra in world 21, 57,961(tones) in 2016. It is extensively grown in several states of India, in different seasons. In Maharashtra total area under okra is reported to be 14.43 (In ' 000 h) with total production 148.09 (In ' 000 MT) and productivity 10.26 (In MT/h) in year 2016-17(source Indiastat.com).

Okra can easily be grown thrice in a year under tropical climate, where winter are mild; twice in sub-tropical climate and once in a year in temperate climate during summer. Okra makes very delicious vegetable from its tender immature fruit. Fruits of okra contain good amount of vitamins A, B, C and protein. It is an excellent source of calcium and iodine, which is necessary for the resistance against throat diseases e.g. Goitore. Besides, the roots and stem of okra are used for cleaning the cane juice in the manufacture of jaggery and sugar (Chauhan, 1972). Mature fruits and stems containing crude fibre are used in the paper industry.

Immature fruits are cooked as vegetables. Due to substantially high yield, easy cultivation, steady market demand and export potential okra has become commercially important vegetable of the state. The export oriented fresh okra should be green, tender, fibreless, short (7-8cm), slender pods with

pointed tip and five ridges, free from YVMV and borer incidence. In recent year, okra has a vast potential as one of the foreign exchange earner crop. Among the green vegetables exported, okra accounts for about 60 per cent (Kohil, 2000). It is mainly exported to Middle East, Western Europe and U.S.A. Looking to the importance of okra as major vegetable and also as prospective foreign exchange earner in recent years. There is need to standardize various cultural practices in okra for enhancing its productivity.

Because of high acceptability in the market and fetching higher price. Cultivators are eager to know about its scientific management practices and special treatments for obtaining higher yield. It is well known that plant requires nutrients for their growth and development. They may grow and survive even if little amount of nutrients are available, but for their reproductive phase certainly an additional quantum of energy is essential which should either be met with the application of nutrients through soil or foliar or through the both ways. Further for augmentation of various physic-biochemical processes, growth regulators may prove beneficial.

During rainy season due to high temperature, high humidity and comparatively high soil temperature. Okra crop put forth more vegetative growth and late commencement of reproductive phase. The yield potential of okra can be improved with the adoption of scientific cultivation technology including use of growth retardants. Growth retardants help in efficient utilization of metabolites in certain physiological processes going in plant system. They play vital role in the regulation of plant system. formation of pods, seeds etc. in the plant. Among the various growth substances. 2-chloroethyl trimethyl ammonium chloride (CCC) and 6 Benzyladenine or aminopurine (BA) is very promising, and it is being used on large scale in a number of fruit vegetables and flowering crops in developed countries. However, its use in developing countries is also common.

The production of tender immature fruits in okra is favorably influenced by number of leaves, number of branches per plant, number of fruits

per plant and their size with respect to length, diameter and weight. Whereas seed yield of okra is favorably influenced by number of mature fruits per plant, number and weight of seeds per fruit. The number of fruits per plant is expected to be more when plant grows up to desired height and produces higher number of leaves and branches. Most of the above mentioned attributes can easily be hastened by application of Benzyladenine and Cycocel except vertical growth of plants. It is interesting to note that growth retardants like BA and CCC produced shorter stem length through inhibitions of cell division and elongation of sub apical meristems but did not completely suppress apical dominance. Growth and yield of okra depends upon many factors including seed quality, nutrition, climatic conditions and cultural practices (Kusvuran, 2012)

From a study (Patel and Singh 1989), there have been clear indications that application of CCC retarded plant growth, induced formation of branches produced more number of fruits per plant, more seeds per fruit and thereby resulted in ultimate higher yields. CCC application causes retardation in plant height by reducing internodal length which is favorable situation for accommodating more plant population per hectare. Higher plant density in Okra has already been proved beneficial for obtaining higher yield (Rathod and Singh 1989 a.b).

The role of cycocel has been found to retard the plant height by reducing internodal length and simultaneously induces the formation of lateral shoots, thereby; plants possess more number of fruit bearing shoots. Cycocel plant growth regulator provides excellent results in greenhouses and plant nurseries. It reduces stem elongation and promotes longer shelf life for poinsettias and other marketable plants. In addition, Cycocel contains an active wetting agent, saving you money on surfactants and adjuvant. It works on commercially grown plants in covered greenhouses and containerized ornamentals in uncovered areas. You can improve and induce flowering of bedding plants after one application.

Maleic hydrazide has been introduced into agriculture as a major commercial herbicide and a depressant of plant growth in numerous circumstances such as suppression of sprouting of vegetables and stored food crops, control of sucker growth on tobacco plants, retardation of flowering and prolongation of dormancy period. In early works the inhibitory effects of MH on plant growth were mainly considered to result from the suppression of plant metabolism (inhibition of enzymic activity) and interference of the compound with plant hormones and growth regulators. Maleic hydrazide is a synthetic compound which has a plant growth regulating action (Swietlińska and Zuk, 1978). Ethrel is synthetic ethylene releaser. It stimulates the flowering and acts as growth inhibitor as well as promoter.

Among several growth substances, CCC (Cycocel), Maleic hydrazide (MH), Ethrel and Benzylandinine (BA) are very promising and these are being used on large scale in fruit and vegetable crops.

The invention of plant growth regulators is an outstanding achievement, which has contributed a good deal in the process of Agriculture. With the discovery of phytohormones and other chemicals having the same properties, new vistas has been opened on the horizon of crop production They have provided human beings with powerful means, to stimulate growth and development of plant These synthetic growth regulating chemicals, when applied to plants can cause modifications in growth and development in a desired direction

Keeping in view the above points an experiment entitled "Effect of growth retardant on flowering, fruiting and yield of okra cv.PBN-OK-1 (*Abelmoschus esculentus* L.)" was undertaken with the object.

Objective:-

1) To evaluate the effectiveness of various growth retardant on flowering, fruiting and yield of okra.

Review of Literature

CHAPTER-II

REVIEW OF LITERATURE

Among the growth retarding chemicals CCC (Cycocel), MH (Maleic Hydrazide), Ethrel and BA (Benzyladenine) are most effective growth retardants. These are widely used in number of the vegetable crops for increasing fruit set for obtaining higher yield as they resulted more number of effective branches for flowering and fruiting. Therefore, a field experiment was carried out to find out the effect of growth retardants on growth, development and yield of okra. The relevant findings are reviewed here in chronological order. Hence, in this chapter the review of literature is presented pertaining to the assigned problem and relevant findings are reviewed in brief.

2.1.1. Effect CCC (Cycocel) on growth and yield attributes

a. Effect CCC (Cycocel) on growth attributes

Mehrotra *et al. (*1969) concluded that application of cycocel @ 500 ppm significantly increased number of leaves (10.2) and increased number of days to flowering (48.6) in okra.

Shukla and Tewari (1973) the plants treated twice with 1000 and 1500 ppm CCC, first at seedling stage when one fully expanded leaf was observed and second at week before anthesis, increased length and fresh weight of fruits in okra cv. ‘Pusa Sawani’.

EL- Beheidi (1980) in an experiment at Zagazig University, Zagazig, Egypt, with the okra cv. Balady. He recorded highest average field emergence (71.5%) from seed soaked for 24 hours in an aqueous solution containing 250 ppm cycocel plus100 ppm proline. The total yield was higher in plants from seeds treated with 250 ppm cycocel plus either proline 100 ppm or sucrose 100 ppm (3.37-5.5 Kg/12m² plot) as compared to control (2.4-4.15 Kg / 12m² plot).

Omran *et al.* (1980) reported that application of CCC (cycocel) @ 500 ppm at fruiting stage suppressed the plant height and increased number of branches as well as number of nodes and number of leaves per plant in okra cv. 'Gamny' and 'Kolony Gam'.

Gowda (1983) studied the effect of cycocel on various attributes of bhendi cv. Pusa Sawani on growth, yield and quality and reported that, Cycocel at 1000 or 1500 ppm applied at an early growth stage increase the number of leaves but reduced the plant height.

Zayed *et al.* (1985) when okra cv. 'Clemson spineless' plants sprayed with CCC at 500, 1000 and 1500 ppm 5 weeks after planting. The highest concentration of CCC (1500 ppm) reduced the number of days to flowering and increased the number of pods per plant, and it produced early and more yield over control.

Patel (1988) reported that the application of cycocel in okra plant reduced the plant height at all the stages of plant growth. However, it was minimum (78.45 cm) due to cycocel 4500 ppm. He also recorded that the cycocel 1000 ppm + urea retained the highest number of leaves on plant 6. Number of lateral shoots was significantly more due to cycocel 1000 and 1500 ppm.

Mangal *et al.* (1988) working with okra cv. 'Pusa Sawani' stated that seed treatment with CCC @ 100 ppm increased the germination by 66.7% of seeds when sown in soils having 6 mmhos/cm salinity level. While, maximum fruit yield (g) per plant was recorded with seed treatment with CCC 250 ppm when sown in soils having 6 mmhos/cm salinity level over control.

Bharad (1989) observed that CCC at higher concentration (1500 ppm) increased number of fruits per plant, weight of green fruits, yield and duration of reproductive phase. The treatment also reduced number of days to

first flower opening. However, its effect was non significant on length and diameter of fruits over control in okra cv. ‘Gujarat Bhinda-1’.

Arora *et al.* (1990) reported that okra seed (cv. HB-55) treated with cycocel @ 100 ppm followed by foliar spray (20 and 40 days after sowing) of cycocel @ 100 ppm reduced the plant height. However, same concentration increased the number of branches and leaves per plant as well as the decreased occurrence of YVMV (yellow vein mosaic virus) as compared to control.

Sadiq *et al.* (1990) experiment was carried out on cucumber cv. Marketer. Maximum stem length (118.8 cm), numbers of days to flowering (38.0) and maturity (49.3), maximum number of fruits per plant (14.0), number of branches per plant (5.5) and fruit yield (93722.2 kg/ha) were obtained with 500 ppm cycocel.

Chudasama (1991) reported that application of cycocel 1200 ppm recorded minimum plant height (65.78 cm), number of functional leaves at first flower formation (11.05), number of functional leaves after 45 days of first flower formation (35.35), number of branches per plant (3.20), stem diameter (2.70 cm) and duration of reproduction phase (42.00), number of fruit per plant (28.15) with the application of cycocel 1000 ppm in okra cv. Parbhani Kranti.

Patel and Singh (1991) reported dwarfing effect on okra cv. ‘Pusa Sawani’ noted with increase in concentration of cycocel from 500 to 1000 ppm applied either as seed treatment or as foliar spray (20 and 40 days after sowing) over control.

Rathod and Patel (1996) recorded that minimum plant height, while studying the effect of cycocel on growth and yield of summer okra cv. Parbhani Kranti.

Asghar *et al.* (1997) reported that plant height and internodal length are significantly reduced than control in bhendi with cycocel treatment.

Gasti *et al.* (1997) reported that growth retardant mepiquat chloride at 175 ppm gave highest yield over control as a result of retarded growth in okra.

Sajjan *et al.* (2002) noticed that pinching at 20 days after sowing in okra produce more number of fruits (9.01 per plant), processed seed yield (951.90 Kg per ha) and seed recovery (81.15%) compared to no – pinching (6.57, 718.80 Kg per ha and 73.12%, respectively).

Sajjan *et al.* (2003) revealed that application of cycocel @ 400 ppm as a seed treatmentand foliar spray at 30 days after sowing increased number of leaves per plant and number of branches (4.2/plant) in okra Cv. 'Pusa Sawani'.

Kokare *et al.* (2006) study conducted on the effect of plant growth regulators on growth, yield and quality of okra Cv. Parbhani Kranti. The growth retardant cycocel 400 ppm found to be increased total chlorophyll content in leaf (1.392 mg/g) and decreased days to 50 per cent flowering (42.50 days).

Prasad and Shrihari (2008) the results showed that the number of days to 50 percent germination of seed was advanced to 3.6 by soaking the seed with 300 ppm cycocel compared to 8.6 days in untreated seed. Seed soaking and spraying of cycocel @ 300 ppm twice at 20 and 40 days age of the seedlings significantly reduced the plant height (50 cm), minimum internodal length (1.83cm) and minimum leaf area (702.4 cm^2) but increased the number of branches (5.43), maximum number of nodes (42.66), and maximum number of leaves per plant (35.67), early germination (3.6 days) and late germination (8.6 days) was observed in control on okra cv. Pusa Sawani.

Pateliya *et al.* (2008) results indicated that foliar application of cycocel 300 ppm on okra cv. GO-2 at 25 and 50 days after sowing retarded duration of reproductive phase (67.20 days), reduced day to first flower opening (37.26).

Barche *et al.* (2010) concluded that the minimum plant height (91.86 cm), maximum number of leaves per plant (24.43), number of branches (3.65), duration of reproductive phase(37.15 days) was observed most in cycocel @ 1500 ppm seed + foliar treatment, highest germination percentage (91.99) was observed in cycocel 1000 + foliar application in okra Cv. Parbhani Kranti.

Rajput *et al.* (2011) reported that, influence of the three plant growth retardants, viz., Cycocel, Maleic hydrazide and Etherl in the different concentrations of foliar spray at two stages i.e. 25 and 50 DAS of okra. The results indicated that foliar application of cycoel 300 ppm at 25 and 50 days after sowing retarded the duration of reproductive phase reduced (68.20 days) to first flower opening (36.26).

Mandal *et al.* (2012) study conducted to evaluate the effect of plant growth regulators on quality and economics of hybrid okra Cv. Mahyco hybrid-10 at Bihar Agricultural College, Sabour during the *Kharif* season, 2006. Minimum plant height (108.70 cm), intermodal length (8.65 cm) was observed under cycocel 1000 ppm. Maximum number of branches per plant (6.67), number of days taken to 50 percent flowering (50.32) and number of days taken to fruits set (52.45) was observed under cycocel 600 ppm.

Kagwade (2012) reported that cycocel 500 ppm in okra cv. Parbhani Bhendi sighnificantly reduced plant height (87.46), internodal length (2.33 cm), increased number of branches (7.00) and number of internodes (37.80) and leaf area (887.67 cm^2).

Charalampos Thanopoulos *et al.* (2013) reported that application of cycocel (500 and 2000 ppm) on okra cv. 'Boyiatiou' reduced the plant height (140.3cm) due to reduction in internode length (2.5 cm); however, when applied at the time of transplantation (0 DAT) (both concentrations) or 26 DAT (2000 ppm) it also caused a reduction in number of nodes on the main stem (57.0). The number and weight of pods per plant (75.0 and 357.81) respectively, was reduced by 2000 ppm cycocel irrespective of the time of application.

Singh (2013) reported that the effect of cycocel (CCC) and benzylamine (BA) on growth and reproductive characters of okra Cv. Parbhani Kranti. Following seed, foliar and seed + foliar application of 1000 ppm cycocel enhanced flowering by 4.19 days, highest reproductive phase (37.15) and maximum pod length (11.69 cm).

Bhagure and Tambe (2013) study was conducted to find out the effect of seed soaking and foliar sprays of plant growth regulators on germination, growth and yield of okra (*Abelmoschus esculentus* L.) Cv. Parbhani Kranti. The treatment comprised of the two concentrations i.e. seed soaking of GA_3 (50 and 100 ppm) and cycocel (100 ppm and 150) and foliar spray of cycocel (250, 500, 750, 1000 ppm) at 30 and 45 days after sowing and control. Soaking of okra seeds with GA_3 @ 100ppm and foliar sprays cycocel @ 750 and 1000 ppm at 30 and 45 DAS, respectively was found to be beneficial in early germination (2.75 days), highest germination percentage (99.5), reduction in height of plant (86.65 cm), length of internodes (5.10 cm), and increase number of leaves (43), number of internodes (15.90), number of branches (3.15) and leaf area (1249.5 cm^2).

Bandaru *et al.* (2013) study was conducted to find out the Effect of cycocel on germination, growth and yield of okra [*Abelmoschus esculentus* (L) Moench.] cv. Kashi Pragati, observed that seed soaked with cycocel 450 ppm showed quick germination (3.67 days), minimum plant height (99.13 cm),

maximum number of nodes (30.13), intermodal length (3.74 cm), maximum number of branches (4.97), minimum days to first flowering (30 days) and minimum days to 50 percent flowering (34 days).

Pateliya *et al*. (2014) reported that the cycocel 300 ppm recorded maximum retardation in the okra plant. The girth of the main stem (2.77 cm) and number of internodes (11.65) was recorded highest at cycocel 300 ppm. The foliar application of cycocel 300 ppm significantly reducedinternodal length (4.64 cm) as compared to control (5.73 cm).

Bhagure and Tambe (2015) study was conducted on to find out the Effect of seed soaking and foliar sprays of plant growth regulators on germination, growth and yield of okra (*Abelmoschus esculentus* L.) cv. Parbhani Kranti. Reported that the soaking of okra seeds with GA_3 @ 100 ppm and foliar sprays of cycocel @ 750 and 1000 ppm at 30 and 45 DAS, respectively were found to be beneficial to increase the physiological attributes like leaf area (1134.6 cm^2), leaf area index (1.32 m^2), chlorophyll a (1.41 mg/g), chlorophyll b (0.48 mg/g), total chlorophyll (1.89 mg/g) and yield attributes like early flowering (34.00 days) and increase number of flowers (23.40).

Kumar *et.al.* (2018) reported that minimum plant height (84.17 cm), internodal length (4.44 cm), more number of leaves (27.72), leaf area (33.22 dm^2), and petiole length of leaves per plant (16.69 cm), minimum days to first flowering (45.26 DAS) and 50 per cent flowering (48.36 DAS) and nodal position of first flower (3.98) were recorded most in cycocel @ 600 ppm on okra (*Abelmoschus esculentus* L.) cv. Varsha Uphar.

Kumawat *et.al.* (2019) reported maximum numbers of branches (1.83) and maximum length of internodes (7.6 cm) were recorded in foliar spray of cycocel @1000 ppm in okra (*Abelmoschus esculentus* L.) cv. Parbhani Kranti.

b. Effect of CCC (Cycocel) on yield attributes

Mehrotra *et al. (*1969) concluded that application of cycocel @ 500 ppm significantly increased the length of fruit (12.03), number of fruits per plant (14.4), yield of fruits (213.4 g) in okra.

Chhonkar *et al.* (1977) reported that foliar application of cycocel @ 125 ppm at 38 days after sowing significantly produced more number of pod per plant as well as higher pod yield per hectare (118.13 q/ha) in okra cv. 'Pusa sawani' as compared to control.

Arora *et al.* (1990) reported that the Cycocel at 50 ppm as a foliar spray alone gave the earliest flowering in okra. The highest average fruit set and yield (176.9 q/ha, compared with 84.5 q/ha in the control) were obtained with Cycocel at 100 ppm as seed + foliar treatment.

Chudasama (1991) reported that application of cycocel 800 ppm on okra Cv. Parbhani Kranti found, maximum fruit weight per plant (292.15 g) and maximum yield of fruit per hectare (257.01 q/ha) with cycocel 1000 ppm.

Rathod (1994) recorded highest green fruit yield (99.81 q/ha) with cycocel at 750 ppm, followed by cycocel at 500 ppm applied as a foliar spray four week after sowing in okra cv.'Parbhani Kranti'.

Sajjan *et al.* (2003) reported that application of cycocel @ 200 ppm at 30 days as a foliar spray on okra cv. 'Pusa Sawani' significantly increased seed yield 12.5 per cent as compared to control.

Kokare *et al.* (2006) study conducted on the effect of plant growth regulators on growth, yield and quality of okra cv. Parbhani Kranti. It revealed that maximum plant height was observed in the plots sprayed with GA_3 200 ppm, while spraying the plants with NAA 200 ppm resulted in increase in number of leaves (20.00), leaf area (28.10 cm^2), plant dry weight

(18.55 g/plant), number of fruits (18.03), fruit girth (2.12 cm), fruit yield per plant (187.60 g) and fruit yield (138.89 q).

Pateliya *et al*. (2008) results indicated that foliar application of cycocel 300 ppm at 25 and 50 days after sowing the fruit length (12.86 cm), fruit diameter (1.93 cm), fresh weight of fruit (13.84 g), fruit yield per plant (250.24 g), numbers of fruits per plant (16.44) and fruit yield per hectare (15.17 t/ha) was noted highest in the treatment. Whereas fruit quality i.e. crude fibre (2.25%) content was found non-significant. While, highest net return (94584) with higher cost benefit ratio (1:3.53) was also produced under the treatment of cycocel 300 ppm in okra.

Prasad and Shrihari (2008) reported in okra that maximum number of pickings (14.7), minimum fruit length (9.9 cm), maximum fruit diameter (2.39 cm), maximum fruit weight (12.20 g), maximum number of fruit (15.32), maximum yield per plant (0.187 kg), and fruit yield per plant (0.166 kg), highest pod yield per plot (24.71 kg) and reduced incidence (31.0 %) of YVM virus was observed in seed soaking plus foliar spray of cycocel at 300 ppm, where as maximum incidence was (56.0%) observed in control.

Barche *et al.* (2010) concluded that minimum day taken to 50 percent flowering (40.28) was recorded under cycocel @ 1500 seed + foliar treatment and maximum number of tender immature fruits per plant (23.67), maximum length and diameter (12.48 and 1.84) respectively, maximum fresh weight of fruit per plant (322.0 g) and highest dry weight of tender immature fruit per plant (72.26 g) was recorded under cycocel @ 1000 ppm seed + foliar treatment in okra cv. Parbhani Kranti.

Rajput *et al.* (2011) reported that, influence of the three plant growth retardants, viz., Cycocel, Maleic hydrazide and Etherl in the different concentrations of foliar spray at two stages i.e. 25 and 50 DAS of okra. The fruit yield per plant (250.44 g), number of fruits per plant (17.44) and fruit yield per hectare (150.70 q/ha) noted highest in the cycocel 300 ppm. While,

highest net return (1, 39,305 Rs.) with higher cost benefit ratio (1:3.35) was also resulted in the same treatment as compared to other treatments.

Mandal *et al.* (2012) reported that the plant sprayed with cycocel 1000 ppm fetched minimum fruit length (14.70 cm) and fruit diameter (1.75) and number of fruits per plant (27.33), weight of fruits per plant (297.90 g), fruit yield per plot (8.937 kg) and fruit yield (109.63 q/ha) was observed with cycocel @ 800 ppm in hybrid okra cv. Mahyco hybrid-10.

Singh (2013) reported that treatment 75 ppm BA + 100 ppm cycocel gave fresh fruit weight (304.54 g), dry weight (60.81g), number of seed per fruit (56.02), seed weight per fruit (3.33 g) and good quality pods yield (154.22 q/ha) as compared to control (138.60 q/ha) in okra cv. Parbhani Kranti.

Bhagure and Tambe (2013) study was conducted on soaking of okra seeds with GA_3 @ 100 ppm and foliar sprays cycocel @ 750 and 1000 ppm at 30 and 45 DAS, induced early flowering (34 days) increase number of flowers (23.40), fruit set (87.54 %), number of fruits (20.46), and yield per plant (201.30 g/plant) in okra.

Bandaru *et al*. (2013) study was conducted to find out the effect of cycocel on germination, growth and yield of okra [*Abelmoschus esculentus* (L) Moench.] cv. Kashi Pragati, observed that seed soaked with cycocel 450 ppm showed maximum pod length (11.12 cm), maximum pod weight (14.2 g), pod diameter (2.09 cm), maximum number of pods per plant (31.05), maximum yield per plant (441.09 g) and yield of green pods per hectares (245.05 q).

Pateliya *et al*. (2014) reported that spraying of cycocel 300 ppm at 25 and 50 days after sowing of okra, significantly influenced on increase in fruit length (12.86 cm) and fruit diameter (1.93 cm). Significantly highest fruit yield per plant (250.24 g), number of fruits per plant (16.44) and fruit yield per

hectare (15.17 t/ha) was noted at cycocel 300 ppm. The minimum fruit yield was obtained in control (10.94 t/ha).

Sanganagoud *et al.* (2014) reported that cycocel 400 ppm treatment in okra significantly increased germination per cent (84.06). The highest number of dry fruits per plant at seed maturity (21.30), number of seeds per fruit (44.36), seed yield per plant ((43.70) g) as well as per plot (kg) and per hectare (23.28) q) were recorded with GA_3 50 ppm + CCC 400 ppm in combination with two pickings.

Bhagure and Tambe (2015) reported that the soaking of okra seeds with GA_3 @ 100 ppm and foliar sprays of cycocel @ 750 and 1000 ppm at 30 and 45 DAS, respectively were found to be beneficial to fruit set (87.54 %), diameter of fruit (2.26 cm), number of fruits per plant (20.46), yield (201.30 g/per plant) and reduce length of fruit (10.00 cm) in okra (*Abelmoschus esculentus* L.) cv. Parbhani Kranti.

Haldankar *et.al*. (2018) reported that cv.Varsha Uphar variety of okra (*Abelmoschus esculentus* L.) when treated with cycocel @ 600 ppm gave maximum number of fruits per plant (22.02), yield per plant (290.73 g) and per hectare (161.52 q), weight of a single fruit (13.21 g), fruit breadth (16.13 mm), Vitamin – 'A' (29.05 µg/100g) and crude fiber per cent (2.19%) with the application of cycocel @ 600 ppm.

Kumawat *et al.* (2019) reported that on okra (*Abelmoschus esculentus* L.) cv. Parbhani Kranti when treated with cycocel @ 1000 ppm gave maximum fruit length (13.2 cm), fruit width (4.2 cm), fruit weight (12.3 g), no. of fruit plant(11.8), fruit yield per plot (4.1 kg), yield (40.5 q/h), gross return (6075), and B:C ratio 3.18 with the application of cycocel @ 1000 ppm.

2.1.2 Effect of MH (Maleic Hydrazide) on growth and fruit yield

a. Effect of MH (Maleic Hydrazide) on growth attributes

Klein and Srivastava (1963) reported that MH might be attributed to breaking of the apical dominance and stimulation of branching, when okra is treated with 40 ppm MH at 20 and 40 days after sowing, over control.

Choudhary and Babel (1969) observed that to obtain earlier total yield of fruits in bottle gourd was obtained with 50 ppm MH and individual fruits was the highest with application of 100 ppm MH.

Choudhary and Singh (1970) observed that 100 ppm MH was the most effective in producing more number of fruits per vine and subsequently the yield of cucumber.

Das and Pattanaik (1971) conducted an experiment at Department of Horticulture, O.U.A.T., Bhubneshwar to evaluate effect of growth regulators on plant growth and yield of okra. The okra seeds were treated with GA3 and MH (Maleic Hydrazide) at 10, 20, 40 and 80 ppm before sowing. MH treatments reduced plant height and stimulate branching and delayed flowering, in okra cv. 'Pusa Sawani' over control.

Gujar and Srivastava (1972) working with okra cv. 'Pusa Sawani' observed that nipping at 27 days after sowing, reduced the plant height (36 cm) and increased the number of laterals (3.63) per plant. Whereas, MH at 800 ppm as a foliar sprays at 20 days induced first flower opening, increased average number of fruits (13.37) per plant and yield (300 g) per plant over control.

Tosh *et al*. (1978) reported that application of MH @ 500 ppm on okra cv. Pusa Sawani at flowering (48 – 50 days) and fruiting (58 – 60 days) stages increased the number of fruit per plant, average fruit size and total yield.

Pandya and Dixit (1997) reported that application of MH 150 ppm on growth, sex, and yield of bottle gourd cv. Pusa Summer Prolific Long,

reduce the length of main axis (5.90 m), increased the number of branches per vine (19.00), male: female sex ratio (2.58: 1), increase the fruit girth (22.75 cm), fruit weight (951.00 g), also increased the highest fruit yield per vine (14 kg) as well as yield per hectare (33.500 t/ha).

Birbal *et al.* (2003) showed that maleic hydrazide (MH) at 50 mg/L applied at 2 and 4 leaf stage, significantly increased number of branches per plant, number of fruits per plants while it decreased length of main vine and sex ratio as compared to unsprayed treatments in bottle gourd

Mahorkar *et. al.* (2008) observed that application of MH 80 ppm on okra cv. Parbhani Kranti maximize the number of branches and number of leaves per plant than other treatment.

Thappa *et al.* (2011) working with Cucumber (*Cucumis sativus* L.) observed that the maximum number of primary branches (5.75), days to first female flower (65.00 days), minimum number of days to 50 percent flowering (63.67 days) was recorded with 100 ppm maleic hydrazide and maximum reduction of length of primary branches per vine (97.81 cm) was recorded with 200 ppm maleic hydrazide + 100 ppm NAA.

Ullah *et al*. (2011) working with cucumber cv. 'Sialkot Selection' observed that the maximum number of pistil late flowers per plant (36.3), The lowest male to female flower ratio (12.4), maximum number of fruits (25.7) and maximum fruit yield per plant (3.80 kg) was recorded with MH at 450 µmol per liter.

Mahida *et al.* (2015) studied on sponge gourd revealed that application of MH 400 ppm at 2-true leaf stage and 4 leaf stages significantly reduced the length of main axis (356.25cm) and increased the fruit girth (15.25cm).

Parihar *et al*. (2016) reported that application of MH 100 ppm + GA_3 60 ppm gave maximum number of leaves (32.16), stem girth (4.75cm),

number of branches (3.96), leaf area (2708.74 cm^2) and minimum plant height (89.00 cm) in okra cv. Varsha Uphar.

Kaur *et al.* (2016) reported that maximum number of branches (13.77) were recorded with the application of malice hydrazide @ 200 ppm, maximum number of days for female flower appearance (49.97 days) and maximum number of days for male flower appearance (52.05 days) in cucumber.

Verma *et al*. (2019) reported that combination of gibberellic acid and maleic hydrazide, 100 ppm MH + 60 ppm GA_3 was found significantly superior as compared to other treatments. In respect of morphological characters viz., plant height (33.83 cm), number of leaves per plant (8.40), number of branches per plant (2.93), stem girth per plant (2.96) and leaf area index (0.23) in okra (*Abelmoschus esculentus* (L.) Moench) cv. Varsha Uphar.

Sarkar *et al*. (2019) reported that MH (150-350 ppm) significantly increase the side branch while the least number of branch (ranged from 3.75 to 4.50), maximum number of female flowers (31.56 %) and maximum number of female flowers (48.88 %) were observed in cucumber.

b. Effect on yield and yield attributes

Gujar and Srivastava (1972) working with okra cv. 'Pusa Sawani' observed that nipping at 27 days after sowing, reduced the plant height (36 cm) and increased the number of laterals (3.63) per plant. Whereas, MH at 800 ppm as a foliar sprays at 20 days induced first flower opening, increased average number of fruits (13.37) per plant and yield (300 g) per plant over control.

Tosh *et al.* (1978) reported that application of MH @ 500 ppm on okra cv. 'Pusa Sawani' at flowering (48-50 days) and fruiting (58-60 days) stage increased the number of fruit per plant, average fruit size and total yield.

Baruah and Das (1997) carried out an investigation on effect of plant growth regulators on growth, flowering and yield of bottle gourd at different sowing dates (cv. Kiyari Lao.) observed that, plants sprayed with NAA at 25 ppm or MH at 50 ppm produced the best yields (5.48 and 4.86 kg/plant, respectively).

Thappa *et al.* (2011) working with cucumber observed that maximum number of fruit (11.58), maximum fruit weight per vine (2.19 kg) and maximum yield (13.13 tonne/ha) was recorded with 100 ppm maleic hydrazide + 100 ppm ethephon.

Verma *et al.* (2019) conducted an experiment on okra (*Abelmoschus esculentus* (L.) Moench) cv. Varsha Uphar, observed that yield attributes viz., no of fruits per plant (21.30), fruit length (13.3 cm), fruit girth (17.01 cm), fruit weight (10.85 g) were recorded by application of MH 100 ppm + GA_3 60 ppm and maximum fruit yield of (125.29 q/ha), maximum net return of Rs. 88698 /ha and cost benefit ratio of 1:3.52 was observed in MH 100 ppm + GA_3 40 ppm.

2.1.3 Effect of Ethrel on growth and yield attribute

a. Effect of Ethrel on growth attributes

Singh and Mishra (1977) reported that okra treated with Ethrel at 200 ppm significantly produced sizeable pod per plant and increased yield per hectare over control in okra cv. 'Pusa Sawani'.

Sreekumar *et al.* (1979) reported that application of Ethrel @ 800 ppm as a foliar spray at 30 days after sowing reduced shoot elongation and significantly increased fruit yield over control in okra cv. 'Kilichundan'.

Verma and Chaudhary (1980) observed that, when cucumber Cv. Poonam Khira was sprayed at 2-4 leaf stage with MH 100 ppm, GA_3 10 ppm and ethrel (50, 100, 150 or 200 ppm), the ethrel treatment were most effective

in increasing the number of fruits (2.0 - 3.2 per plant), more fruit weight (209 - 394 g/plant) compared with (1.75 – 2.0 fruits/plant) and (201 – 207 g/plant) fruit weight in the control.

Singh and Kumar (1988) revealed that application of Ethrel at 50-100 mg/l after 30 days of sowing as a foliar spray gave the higher fruit weight and yield over control in okra cv. 'Pusa Sawani'.

Marsh and Jones (1990) reported that okra Cv. Clemson Spineless treated with ethephon 200 µl/liter observed shorter shoot length at flowering (100 cm), maximum number of leaves (21.3) same with ethephon 400 and 600 µl/liter and maximum number of branches (4.5) was observed with ethephon 200, 400 and 600 µl/liter.

Thappa *et al.* (2011) revealed that ethephon 100 ppm increased the number of nodes (30.18) in cucumber.

Mehdi *et al*. (2012) revealed that application of ethrel 300 ppm recorded minimum days to first fruit set (50.06), days to first fruit ripening (104.24) and duration of ripening (51.33), fruit length (29.97 cm) with the application of ethrel 600 ppm in cucumber.

Vyas *et al.* (2015) reported that the treatment of Ethrel 200 ppm increase the fruit setting (21.64), total number of fruits per plant (20.09), length of marketable fruits (23.73 cm), weight of marketable fruits (331.67 g), thereby fruit yield per plot (20.18 kg) and per hectare (134.50 q), increasing more number of female flowers (6.13, 30.92 and 18.22 at 45, 60 and 75 DAS, respectively), decrease the number of male flowers (112.82 and 118.46 at 60 and 75 DAS, respectively) and thereby reducing the male female ratio (3.61, 3.43 and 2.94 at 60, 90 and 120 DAS, respectively) in ridge gourd (*luffa acutangula roxb* L.) cv. Pusa Nasdar.

Mahida *et al.* (2015) studied on sponge gourd cv. Pusa Chikni revealed that treatment of ethrel 250 ppm increased the number of branches per

vine (13.75) and number of female flowers per vine (44.75) while, reduced the days to first female flower appearance (58.25) and lowered the male: female sex ratio (7.00:1) and increased the number of fruits per vine (25.75), fruit yield per vine (3.97 kg) as well as fruit yield per hectare (17.68 t).

Kaur *et al.* (2016) reported maximum number of branches (13.77), maximum number of days for female flower appearance (49.97 days), maximum number of days for male flower appearance (52.05 days) was observed with ethephon @ 200 ppm in cucumber.

Kadi *et al.* (2018) reported that diameter of fruits (3.4 cm), minimum total soluble solids (2.16) with the application of ethrel @ 300 and 200 ppm respectively in cucumber.

b. Effect on yield and yield attributes

Chhonkar *et al.* (1977) studied the effect of ethrel and cycocel on growth and yield of okra. They found that ethrel 200 ppm produced 129.87 quintals of immature pods per hectare as compared to control (86.60 q/ha) with application of CCC.

Deore *et al*. (1987) revealed that application of Ethrel @ 1000 ppm as a foliar spray at 25 days after sowing increased yield (96.84 q/ha) over control in okra.

Chudasama (1991) reported that in okra Cv. Parbhani Kranti application ethrel 200 ppm observed maximum length of fruit (12.05 cm) and maximum diameter of fruit (1.69 cm).

Mehdi *et al*. (2012) observed that application of ethrel 300 ppm in cucumber resulted in maximum fruit diameter (5.11cm), average fruit weight (0.44 g), number of fruit per plant (20.35) and fruit yield per plant (8.41 kg).

2.1.4 Effect of BA (Benzyladenine) on growth and fruit yield

Ismaeil (2005) revealed that application of benzyladenine at 100 ppm on okra plant cv. Balady gave maximum seeds germination (91.18), maximum root length (24.67cm), maximum root diameter (0.83 cm), maximum number of leaves per plant (8.00), leaf area per plant (156.00 cm^2), fresh weight (4.22 g/plant), number of early fruits per plant (10.67), early yield weight (69.33 g) and total yield per plant (210.30 g).

Singh (2013) studied the effect of cycocel (CCC) and benzyladenine (BA) on growth and reproductive characters of okra cv. Parbhani Kranti. 75 ppm BA + 100 ppm CCC and reported quality yield of pods (154.22 q/ha) as compared to control (138.60 q/ha).

Material and Methods

CHAPTER-III

MATERIAL AND METHODS

The experiment entitled “Effect of growth retardant on flowering, fruiting and yield of okra cv.PBN-OK-1 (*Abelmoschus esculentus* L.)” was be conducted at college of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, during *Kharif*, 2018. The details of materials used and methods adopted during the course of present investigation are summarized in this chapter.

3.1 Experimental site

A field experiment was laid out in *kharif s*eason of 2018 at the farm of college of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani.

3.2 Climate and weather condition

Parbhani comes under sub-tropical region and is situated at 408.50 m above the sea level. Geographically it is situated between 19°16' N latitude and 76°47' longitude.

The annual precipitation of Parbhani, which comes under assured rainfall zone, is 800-900 mm. The rainfall is mostly received during June to September. The maximum temperature 41.3°c in June and minimum 8.5°c in December. Summer is hot and dry, while winter is cool. The mean relative humidity ranges from 20 to 88 per cent and thus the climate is sub-tropical. The data on rainfall, temperature and relative humidity during entire crop season was obtained from the Meteorological Observatory of Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani.

3.3 Soil

Soil type of experimental plot was fairly uniform, medium black with uniform texture and well drained.

The soil in experimental plot was clay in texture, medium in nitrogen, medium in available phosphorus and organic carbon, high in available potassium and basic in reaction.

3.4 Experimental materials

The experiment was laid out in Randomized Block Design with thirteen (13) treatments and two (2) replications. The details of treatments along with various concentrations are given below**.**

Sr.No	Treatment	Chemical's with concentration
1	T_1	CCC @300 ppm
2	T_2	CCC @ 500 ppm
3	T_3	CCC @ 700 ppm
4	T_4	MH @ 200 ppm
5	T_5	MH @ 250 ppm
6	T_6	MH @ 300 ppm
7	T_7	Ethrel @ 150 ppm
8	T_8	Ethrel @ 250 ppm
9	T_9	Ethrel @ 350 ppm
10	T_{10}	BA @ 100 ppm
11	T_{11}	BA @ 150 ppm
12	T_{12}	BA @ 200 ppm
13	T_{13}	Control (water spray)

Application of spray: 1st spray - 25 days after sowing

2nd spray - 50 days after sowing

3.5 Other details

1. Name of crop	:	Okra (*Abelmoschus esculentus* L.)
2. Family	:	Malvaceae
3. Number of Treatments	:	13
4. Number of Replications	:	2
5. Experimental Design	:	Randomized Block Design
6. Spacing	:	60 x45cm
7. Plot size	:	3.0 x 2.70 m
8. No of plants per treatment	:	30

3.5.2 Schedule of cultural practices

Sr.No	Particulars	Frequency	Data
1.	Ploughing	1	28/06/2018
2.	Harrowing	2	29/06/2018
3.	Stubble picking	1	29/06/2018
4.	FYM application	1	30/06/2018
6.	Application of fertilizers	1	03/08/2018
7.	Sowing	1	04/08/2018
8.	Gap filling	1	10/08/2018
9.	Weeding	2	18/08/2018 and7/09/2018
10	Application of first spray	1	29/08/2018
11.	Top dressing	1	6/09/2018
12.	Spraying of plant protection	2	8/09/2018 and 14/10/2018
13.	Application of second spray	1	23/09/2018
13.	Irrigation	6	3,14,22,29/10/2018 and 13/11/2018,
14.	Harvesting	09	25/11/2018

3.6 Preparatory tillage

The area of experiential plot was ploughed deeply one month before sowing. The weed grown and stubble of previous crop were picked up. The land was harrowed twice and soil was brought to fine tilth. Before final harrowing FYM was applied @ 20 tons per hectare.

3.7 Plot preparation

The field was divided into plots as per required dimensions the size of plot was 3.0 x 2.70 m and spacing was 60 x 45 cm by using the measuring tape, rope and pegs. Flat beds were prepared by keeping 50 cm distances between two treatments and 1m distances between two replications with manual labour.

3.8 Fertilizer application

Recommended dose Nitrogen, phosphorus and potash were applied through urea, single superphosphate and muriate of potash respectively 100:50:50 kg/ha. Nitrogen in the form of urea was applied in two split doses i.e. half dose of nitrogen and full dose of Phosphorus and potash was applied before sowing and remaining dose of nitrogen was applied one month after sowing as top dressing. Quantity of fertilizers applied per plot was common and uniform. Fertilizers were applied at the depth of 5 cm and were properly mixed with soil. Plots were irrigated immediately after application of fertilizers.

3.9 Seeds and sowing

3.9.1 Source of seed

The seed of okra cv. Parbhani Okra-1 was obtained from Vegetable Research Scheme, V.N.M.K.V, Parbhani.

3.9.2 Method of sowing

Sowing was done in field by dibbling method. Two seeds per hill were dibbled when sufficient moisture was available in soil.

3.9.3 Gap filling and thinning

Gap filling was done on the 5th day after sowing, so as to maintain optimum plant population per plot. Thinning was done to keep only one healthy plant at each hill.

3.10 Preparation and application of growth retardants.

The solutions of the Cycocel (CCC), Maleic Hydrazide (MH), Ethrel and Benzylandinine (BA) plant growth retardant were prepared in parts per million (ppm) concentration.

3.10.1 Cycocel (CCC)

It is growth retardant. The trade name of CCC is Lihocin 50 AS. Which contain 50 per cent Chlorine Choline Chloride. Lihocin 2ml was pipette out by using micropipette and poured into volumetric flask and the volume was made to 1 liter by using distilled water to obtain 1000 ppm concentration. From this stock solution the working solution of 300, 500, 700 ppm were prepared by diluting the desired quantities of stock solution in distilled water.

3.10.2 Maleic hydrazide (MH)

The stock solution of 1000 ppm was made by dissolving required quantity of MH in small quantity of methanol. The final volume of dissolved MH was made 1 liter by adding distilled water. From this stock solution the working solution of 200, 250 and 300 ppm were prepared by diluting the desired quantities of stock solution in distilled water.

3.10.3 Ethrel

Stock solution of 1000 ppm Ethrel of 1000 ml was prepared by dissolving 1.0 ml of Ethrel in 95 % alcohol and finally added in 1000 ml distilled water. Then prepare 1000 ml working solution of 150, 250 and 350 ppm. For that, Ethrel 150, 250 and 350 ml stock solution was taken and diluted in 700, 600 and 500 ml distilled water, respectively. For second spraying same method was used for preparing stock solution. (1 ppm = 1 mg chemical dissolved in distilled water and prepared one liter volume).

3.10.4 Benzylandinine (BA)

The stock solution of 1000 ppm was made by dissolving required quantity of BA. The final volume of solution dissolved was made 1 liter by adding distilled water. From this stock solution the working solution of 100, 150 and 200 ppm were prepared by diluting the desired quantities of stock solution in distilled water.

3.10.5 Application of growth retardant

The growth retardants Cycocel (300, 500 and 700 ppm), Maleic Hydrazide (200, 250 and 300 ppm), Ethrel (150, 250 and 350 ppm) and Benzylandinine (100, 150and 200 ppm) was applied two times i.e. at 25 DAS and 50 DAS.

3.11 Observations on vegetative growth

Five plants were selected from each net plot as observational plants and were labeled. The observations in respect of growth characters were recorded at 30 DAS, 60 DAS and 90 DAS.

3.12 AFTER CARE OPERATION

3.12.1 Thining

Thining of the crop was done after 15 days of sowing to maintain the plant Population.

3.12.2 Irrigation

The crop was irrigated as and when needed to maintain the optimum moisture level.

3.12.3 Weeding

To keep the plot free from weed, weeding and inter culturing was done as per the requirement.

3.12.4 Plant protection

At the time of active crop growth period, the crop was attacked by jassids, white fly and shoot borer. These pests were controlled by alternative spraying of Endosulfan35 EC 1.0 ml per liter, Monocrotophos 36 EC 1.0 ml per liter and Dimethoate 30 EC @1.5 ml per liter.

3.13 HARVESTING

The okra fruits from randomly selected plants were harvested separately for recording observation. The fruits from the net plot were picked separately and weighed. The okra fruits were picked continuously at alternate days after the first picking. From each treatment five plants were selected and labeled for regular observations. The mean values of the observations were subjected to the statistical analysis.

3.14 STATISTICAL ANALYSIS

The data obtained in respect of various observations were subjected to the statistical analysis as per procedure given by Panse and Sukhatme (1995).

3.15 OBSERVATION RECORDED

All the observations with respect to growth, floral and fruit characters and fruit yield were recorded from randomly selected five plants

from each net plot. The mean values of the observations were subjected to the statistical analysis for following attributes.

3.15.1 Plant height (cm)

Plant height was recorded by measuring from the base of plant stem at ground level to main growing tip of the plant. This was recorded at 30, 60 and 90 DAS with the help of meter scale and height of each stem was measured in centimeters and average was worked out.

3.15.2 Number of internodes per plant

The number of internode was separately counted for the selected five plants in each treatment from all replications at 30, 60 and 90 DAS and average number of internode per plant was worked out.

3.15.3 Internodal length (cm)

Internodal length of fifth internodes on main stem of plant was recorded by taking actual count from the observation plants in each treatment by centimeter scale and average internodal length was worked out.

3.15.4 Number of branches per plant

The number of branches produced by the each plant under different treatments was recorded separately for the selected five plants and average was worked out.

3.15.5 Leaf area (cm^2)

All the leaves of a plant were clipped and graded into three grades viz., big, medium and small. Leaf area was measured by using graph paper. The leaf area was calculated for each category and sum of the total leaf area from three categories was recorded as total leaf area per plant and expressed in cm^2.

3.15.6 Days to first flower to open

Observation on days taken for first flower opening was recorded for all selected five plants in each treatment and average number of days was worked out.

3.15.7 Days to 50 per cent flowering

The observation was recorded by counting the days from the date of sowing to 50 per cent flowering for each treatment and average number of days was worked out.

3.15.8 Number of flowers

Total number of flowers produced on each plant was recorded by taking actual count from the observational plants in each treatment.

3.15.9 Fruit Length (cm)

The length of fruits was measured in centimeter from the base of the calyx to tip of the fruit and mean value was recorded.

3.15.10 Fruit diameter (cm)

The diameter of ten randomly selected fruits at edible maturity stage at mid fruit length from five observational plants were recorded with vernier calliper and mean value has worked.

3.15.11 Number of green fruits per plant

Total number of edible green fruits on each of the five selected plants was counted at edible fruit maturity stage and average was worked out.

3.15.12 Fresh weight of fruit (g)

Fresh fruit weight was recorded at each picking by weighing randomly selected ten fruits harvested from each of the treatments and mean fruit weight was computed and expressed in grams.

3.15.13 Fruit yield per plant (g)

The green fruits from the selected five plants in net plot in each treatment were harvested and weighed in gram at each picking.

3.15.14 Fruit yield (q/ha)

The final fruit yield was obtained by summing up of the yield of all the pickings. On the basis of net plot area, the yield was worked out on hectare basis for each treatment and it was expressed in quintal per hectare.

Results and Discussion

CHAPTER-IV

RESULTS AND DISCUSSION

The results of the present investigation entitled "Effect of growth retardant on flowering, fruiting and yield of Okra cv.PBN-OK-1 (*Abelmoschus esculentus* L.)" was conducted at college of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, during *Kharif*, 2018. The results pertaining to various growth and yield characters influenced by different plant growth retardant application are presented in tables and also illustrated graphically wherever found necessary in this chapter.

4.1 Growth characters

4.1.1. Plant height (cm)

At 30 DAS, the data presented in Table 4.1 revealed that the minimum plant height was recorded in treatment T_2 (14.45), which was followed by treatment T_3 (16.24), T_6 (16.35) and T_{12} (16.38) respectively. Maximum plant height was recorded in treatment T_{13} (22.73) which was followed by treatment T_8 (21.63), T_9 (20.52) and T_7 (19.40) respectively, however treatment T_{13} was at par with treatment T_8.

At 60 DAS, the data presented in Table 4.1 revealed that the minimum plant height was recorded in treatment T_2 (34.18), which was followed by treatment T_3 (37.21), T_6 (37.53) and T_{12} (37.93) respectively. The maximum plant height was recorded in treatment T_{13} (49.89), which was followed by treatment T_8 (44.90), T_9 (43.98) and T_7 (42.93) respectively.

At 90 DAS, the data presented in Table 4.1 revealed that the minimum plant height was recorded in treatment T_2 (50.91), which was followed by treatment T_3 (56.78), T_6 (57.55) and T_{12} (63.01) respectively. The maximum plant height was recorded in treatment T_{13} (69.68), which was followed by treatment T_8 (67.04), T_9 (64.89) and T_7 (64.76) respectively,

however treatment T_{13} was at par with treatment T_8. Rests of the treatments were intermediate.

The minimum plant height was recorded under T_2 (14.45), (34.18), (50.91) i.e. CCC @ 500 ppm at 30, 60 and 90 DAS respectively. The reduction in plant height due to application of growth retardants may be attributed due to inhibition of cell division and elongation of sub apical meristems as described by Patel and Singh (1991).The reduction in height was more with increase cycocel concentration. These results are in accordance with the results of Mehrotra *et al*.(1970), Chhonkar *et al.* (1977), Suryanarayana and Subbarao (1981), Abdul *et al.*(1985), Sajjan *et al*. (2003), Prasad and Shrihari (2008), Pateliya *et al*. (2008) and Munikrishnappa and Tirakannanavar (2009).

Table 4.1: Effect of plant growth retardant on plant height (cm) in okra cv.PBN-OK-1

Treatments	Plant height (cm)		
	30 Days	60 Days	90 Days
T_1 CCC @ 300ppm	17.38	38.82	62.23
T_2 CCC @ 500ppm	14.45	34.18	50.91
T_3 CCC @ 700 ppm	16.24	37.21	56.78
T_4 MH @ 200 ppm	18.59	38.34	63.66
T_5 MH @ 250 ppm	18.11	38.33	63.83
T_6 MH @ 300 ppm	16.35	37.53	57.55
T_7 Ethrel @ 150 ppm	19.40	42.93	64.76
T_8 Ethrel @ 250 ppm	21.61	44.90	67.04
T_9 Ethrel @ 350 ppm	20.52	43.98	64.89
T_{10} BA @ 100 ppm	18.92	38.21	63.68
T_{11} BA @ 150 ppm	16.74	39.82	64.27
T_{12} BA @ 200 ppm	16.38	37.93	63.01
T_{13} Water spray	22.73	49.89	69.68
SE(m)±	0.54	0.65	1.15
C.D.	1.68	2.04	3.61
C.V.	8.21	9.30	7.62

4.1.2 Number of internodes per plant

At 30 DAS, the data presented in Table 4.2 revealed that the maximum number of internodes was recorded in treatment T_2 (5.88), which was followed by treatment T_3 (5.47), T_6 (5.03) and T_{12} (4.57) respectively, however treatment T_2 was at par with T_3. The minimum number of internodes was recorded in treatment T_{13} (3.18), which was followed by T_8 (3.34), T_9 (3.49) and T_7 (3.53) respectively, however treatment T_{13} was at par with treatment T_8, T_9 and T_7 respectively.

At 60 DAS, the data presented in Table 4.2 revealed that the maximum number of internodes was recorded in treatment T_2 (9.62), which was followed by treatment T_3 (9.07), T_6 (8.26) and T_{12} (8.05) respectively, however treatment T_2 was at par with T_3. The minimum number of internodes was recorded in treatment T_{13} (3.29), which was followed by treatment T_8 (3.58), T_9 (3.99) and T_7 (4.17) respectively, however treatment T_{13} was at par with treatment T_8.

At 90 DAS, the data presented in Table 4.2 revealed that the maximum number of internodes was recorded in treatment T_2 (15.16), which was followed by treatment T_3 (14.56), T_6 (14.46) and T_{12} (13.82) respectively, however treatment T_2 was at par with treatment T_3 and T_6 respectively. The minimum number of internodes was recorded in treatment T_{13} (12.50), which was followed by treatment T_8 (12.97), T_9 (12.98) and T_7 (13.02) respectively, however treatment T_{13} was at par with treatment T_8, T_9 and T_7 respectively. Rests of the treatments were intermediate.

The maximum number of internodes per plants was recorded under T_2 (5.88), (9.62), (15.16) i.e. CCC @ 500 ppm at 30, 60 and 90 days respectively, which was significantly superior over control. The maximum number of internodes per plant might be due to induction of axillary shoots as compared to untreated plants and restricted cell division and elongation in the apical meristem, which reduced the internodal length. These results are in

accordance with the results obtained by Tosh *et al*. (1978), Rathod (1994), Sajjan *et al*. (2003), Prasad and shrihari (2008) and Kumar *et al.* (2018).

Table 4.2: Effect of plant growth retardant on number of internodes per plant in okra cv.PBN-OK-1

Treatments	No of internodes per plant		
	30 Days	60 Days	90 Days
T_1 CCC @ 300ppm	4.13	7.36	13.27
T_2 CCC @ 500ppm	5.88	9.62	15.16
T_3 CCC @ 700 ppm	5.47	9.07	14.56
T_4 MH @ 200 ppm	3.89	7.09	13.27
T_5 MH @ 250 ppm	3.65	4.19	13.76
T_6 MH @ 300 ppm	5.03	8.26	14.46
T_7 Ethrel @ 150 ppm	3.53	4.17	13.02
T_8 Ethrel @ 250 ppm	3.34	3.58	12.97
T_9 Ethrel @ 350 ppm	3.49	3.99	12.98
T_{10} BA @ 100 ppm	3.52	6.53	13.63
T_{11} BA @ 150 ppm	4.57	7.08	13.17
T_{12} BA @ 200 ppm	4.57	8.05	13.82
T_{13} Water spray	3.18	3.29	12.50
SE(m)±	0.24	0.22	0.25
C.D.	0.75	0.68	0.78
C.V.	8.24	7.92	8.62

4.1.3 Internodal length (cm)

At 30 DAS, the data presented in Table 4.3 revealed that the minimum internodal length was recorded in treatment T_2 (1.28), which was followed by T_3 (1.35), T_6 (1.49) and T_{12} (1.58) respectively, however treatment T_2 was at par with treatment T_3. The maximum internodal length was recorded

in treatment T_{13} (2.51), which was followed by treatment T_8 (2.46), T_9 (2.23) and T_7 (2.22) respectively, however treatment T_{13} was at par with T_8.

At 60 DAS, the data presented in Table 4.3 revealed that the minimum internodal length was recorded in treatment T_2 (1.77) which was followed by T_3 (1.82), T_6 (1.95) and T_{12} (1.98) respectively, however treatment T_2 was at par with treatment T_3, T_6 and T_{12} respectively. The maximum internodal length was recorded in treatment T_{13} (3.18), which was followed by treatment T_8 (3.09), T_9 (2.56), T_{10} (2.51) and T_7 (2.51) respectively, however treatment T_{13} was at par with T_8.

At 90 DAS, the data presented in Table 4.3 revealed that the minimum internodal length was recorded in treatment T_2 (1.94) which was followed by T_3 (1.98), T_6 (2.00) and T_{12} (2.10) respectively, however treatment T_2 was at par with treatment T_3, T_6 and T_{12} respectively. The maximum intermodal length was recorded in treatment T_{13} (3.40), which was followed by treatment T_8 (3.00), T_9 (2.84), T_{10} (2.73) and T_7 (2.73) respectively. Rests of the treatments were intermediate.

The data on internodal length showed that the growth retardants were effective in decreasing internodal length significantly than control treatment. Minimum internodal length was recorded in treatment T_2 (1.28), (1.77) and (1.94) i.e CCC @ 500 ppm at 30, 60 and 90 DAS respectively. The length of internodes was decreased with increased in concentration of cycocel, the growth of internodes was short mainly due to cycocel which restricted cell division and elongation in the apical meristem, hence length of internodes was decreased. These results are in agreement with those of Patil *et al.* (2008), Nawalkar *et al. (*2007), Mandal *et al.* (2012) Similar results reported by Parmar *et al.* (2008), Prasad and Srihari (2008) and Bhagure and Tambe (2013) in okra.

Table 4.3: Effect of plant growth retardant on number of internodal length (cm) in okra cv.PBN-OK-1

Treatments	Internodal length (cm)		
	30 Days	60 Days	90 Days
T_1 CCC @ 300ppm	1.63	2.18	2.11
T_2 CCC @ 500ppm	1.28	1.77	1.94
T_3 CCC @ 700 ppm	1.49	1.95	2.00
T_4 MH @ 200 ppm	1.88	2.26	2.28
T_5 MH @ 250 ppm	1.88	2.12	2.47
T_6 MH @ 300 ppm	1.35	1.82	1.98
T_7 Ethrel @ 150 ppm	2.22	2.51	2.73
T_8 Ethrel @ 250 ppm	2.46	3.09	3.00
T_9 Ethrel @ 350 ppm	2.23	2.56	2.84
T_{10} BA @ 100 ppm	2.05	2.51	2.73
T_{11} BA @ 150 ppm	1.63	2.11	2.12
T_{12} BA @ 200 ppm	1.58	1.98	2.10
T_{13} Water spray	2.51	3.18	3.40
SE(m)±	0.06	0.13	0.12
C.D.	0.18	0.42	0.38
C.V.	8.42	8.29	7.19

4.1.4 Number of branches per plant

The data presented in Table 4.4 revealed that the maximum number of branches per plant were recorded in treatment T_2 (1.85), which was followed by treatment T_3 (1.78), T_6 (1.63) and T_{12} (1.59) respectively, however treatment T_2 were at par with T_3, T_6 and T_{12} respectively. The minimum number of branches per plant was recorded in treatment T_{13} (1.01) which was followed by treatment T_8 (1.06), T_9 (1.09) and T_7 (1.15) respectively, however

treatment T_{13} was at par with treatment T_8, T_9 and T_7 respectively. Rests of the treatments were intermediate.

The data presented in Table 4.4 showed that the maximum number of branches per plant were recorded with T_2 (1.85) i.e. CCC @ 500 ppm at last picking stage. The increase in number of branches might be due to effect of suppressing apical dominance by the cycocel treatment there by promoting growth of the axillary bud for new shoots development. Due to this reason numbers of branches were observed higher under cycocel treated plants. These results are in agreement with those of Mehrotra *et al*. (1970), chhonkar *et al*. (1977), Tosh *et al.* (1978), Arora *et al.* (1990), Sajjan *et al.* (2003), Patel *et al*. (2005), Bhagure and Tambe (2013) and Kumawat *et al*. (2019) in okra.

4.1.5 Leaf area (cm^2)

The data presented in Table 4.4 revealed that the maximum leaf area was recorded in treatment T_2 (242.95), which was followed by treatment T_3 (242.37), T_6 (242.08) and T_{12} (239.47) respectively, however treatment T_2 was at par with T_3, T_6 and T_{12} respectively. The minimum leaf area was recorded in treatment T_{13} (224.43) which was followed by treatment T_8 (232.52), T_9 (232.91) and T_7 (234.06) respectively. Rests of the treatments were intermediate.

The maximum leaf area (242.95) was recorded in treatment T_2 i.e CCC @ 500 ppm. The reduction in plant height so the number of leaves also minimize, leaves are seat of photosynthesis ultimately, it maximize the leaf area. And leaf area influences the photosynthetic capacity of plant. (Srivastava and Goswami, 1988). Similar results were also reported by Prasad and Srihari (2008), Bhagure and Tambe (2013) and Kumawat *et al.* (2019) due to application of cycocel in okra.

Table 4.4: Effect of plant growth retardant on number of branches per plant and leaf area (cm^2) in okra cv. PBN-OK-1

Treatments	No. of branches per plant	Leaf area (cm^2)
T_1 CCC @ 300ppm	1.27	236.97
T_2 CCC @ 500ppm	1.85	242.95
T_3 CCC @ 700 ppm	1.78	242.37
T_4 MH @ 200 ppm	1.17	237.52
T_5 MH @ 250 ppm	1.26	238.10
T_6 MH @ 300 ppm	1.63	242.08
T_7 Ethrel @ 150 ppm	1.15	234.06
T_8 Ethrel @ 250 ppm	1.06	232.52
T_9 Ethrel @ 350 ppm	1.09	232.91
T_{10} BA @ 100 ppm	1.16	239.09
T_{11} BA @ 150 ppm	1.21	239.20
T_{12} BA @ 200 ppm	1.59	239.47
T_{13} Water spray	1.01	224.43
SE(m)±	0.14	1.89
C.D.	0.44	5.90
C.V.	11.23	8.13

4.1.6 Days to first flower to open

T_2 recorded minimum days to open first flower (17.61), which was followed by treatment T_3 (18.21), T_6 (18.38) and T_{12} (19.37) respectively, however treatment T_2 was at par with T_3, T_6 and T_{12} respectively. The maximum days to first flower to open was recorded in treatment T_{13} (22.62), which was followed by treatment T_7 (22.62), T_8 (22.39) and T_{10} (22.33) respectively, however treatment T_{13} was at par with treatment T_7, T_8 and T_{10} respectively. Rests of the treatments were intermediate.

The days required for first flower to open (17.61 days) were minimum in treatment (T_2) which was receiving cycocel 500 ppm. Maximum days to first flowering (22.62 days) were observed in control treatment (T_{13}).The earlier flowering recorded with growth retardant treatments as compared to control treatment might be due to suppression of vegetative growth which leads to less demand for food materials synthesized by treated plant. Thus, excessive carbohydrate reserve might have induced early flowering and accelerated reproductive phase of the plant. Parmar *et al*. (2008) in okra cv. G0-2 recorded earlier flowering due to cycocel application. Belhekar *et al*. (2006) recorded same results due to application of MH on bottle gourd.

4.1.7 Days to 50 percent flowering

T_2 recorded minimum days to 50 percent flowering (20.06), which was followed by treatment T_3 (20.23), T_6 (20.93) and T_{12} (21.51) respectively, T_2 was at par with T_3 and T_6 respectively. The maximum days to 50 percent flowering open was recorded in treatment T_{13} (26.14), which was followed by treatment T_8 (24.96), T_9 (24.05) and T_7 (23.76) respectively, however treatment T_{13} was at par with T_8. Rests of the treatments were intermediate.

The days required for fifty per cent flowering (20.06 days) were minimum in treatment (T_2) which was receiving cycocel 500 ppm. This might be due to suppression of vegetative growth and induction of early reproductive phase. These results reported by Arora and Dhankar (1992), Singh (2000) and Desai *et al*. (2005), Kokare *et al.* (2006) reported that CCC 400 ppm application decreased days to 50 percent flowering in okra.

4.1.8 Number of flowers per plant

The data presented in Table 4.5 revealed that the maximum number of flowers per plant were recorded in treatment (17.33), which were followed by treatment T_3 (16.75), T_6 (16.18) and T_{12} (16.00) respectively, however treatment T_2 was at par with T_3. The minimum number of flowers was recorded in treatment T_{13} (12.50), which was followed by treatment T_8 (13.05), T_9 (13.08), T_7 and T_1 (13.17) respectively, however treatment T_{13} was at par with T_8 and T_9 respectively. Rests of the treatments were intermediate.

Treatment CCC 500 ppm produced significantly more number of flowers per plant (17.33). More number of flowers per plant due to application of CCC 500 ppm, foliar spray of cycocel at higher concentration increased the number of flowers as compared to other treatment. These effects were perhaps, due to the facts that the treated plants were able to build up carbohydrate reserve favorable for more number of flowers. These results were reported by Arora and Dhankar (1990), Rajput *et al*. (2011) and Bhagure and Tambe (2015). All these reported that application of plant growth substances to seed and foliage of vegetable crops retards vegetative growth, which in turn expressed in more number of flowers in okra.

Table 4.5: Effect of plant growth retardant on flowering characters in okra cv. PBN-OK -1

Treatments	Days to 1st flower to open	Days to 50 percent flowering	No. of flowers per plant
T_1 CCC @ 300ppm	19.65	21.90	13.17
T_2 CCC @ 500ppm	17.61	20.06	17.33
T_3 CCC @ 700 ppm	18.21	20.23	16.75
T_4 MH @ 200 ppm	20.95	21.87	14.13
T_5 MH @ 250 ppm	20.33	22.06	14.03
T_6 MH @ 300 ppm	18.38	20.93	16.18
T_7 Ethrel @ 150 ppm	22.62	23.76	13.17
T_8 Ethrel @ 250 ppm	22.39	24.96	13.05
T_9 Ethrel @ 350 ppm	21.91	24.05	13.08
T_{10} BA @ 100 ppm	22.33	21.78	14.10
T_{11} BA @ 150 ppm	21.47	21.94	14.24
T_{12} BA @ 200 ppm	19.37	21.51	16.00
T_{13} Water spray	22.62	26.14	12.50
SE(m)±	0.82	0.43	0.19
C.D.	2.58	1.36	0.59
C.V.	6.79	8.76	7.87

4.1.9 Fruit Length (cm)

The data presented in Table 4.6 revealed that the maximum fruit length was recorded in treatment T_2 (11.38), which was followed by treatment T_3 (11.31), T_6 (11.20) and T_{12} (11.13) respectively, however treatment T_2 was at par with T_3, T_6 and T_{12} respectively. The minimum fruit length was recorded in treatment T_{13} (9.55), which was followed by treatment T_8 (9.61), T_9 (10.26) and T_7 (10.27) respectively, however treatment T_{13} was at par with T_8. Rests of the treatments were intermediate.

The maximum fruit length was noted with T_2 (11.38 cm) CCC @ 500 ppm as compared to control (9.55 cm). This might be due to cycocel triggers off the mobilization of metabolites, produced in other parts of the plants in to the fruit. Thus, fruit length can be promoted and stem growth inhibited. These findings are in accordance Pateliya *et al*. (2008), Sanganagoud *et al.* (2014) and Rajput *et al.* (2011) in okra.

4.1.10 Fruit diameter (cm)

The data presented in Table 4.6 revealed that the maximum fruit diameter was recorded in treatment T_2 (2.04), which was followed by treatment T_3 (1.89), T_6 (1.80) and T_{12} (1.75) respectively, however treatment T_2 was at par with T_3 respectively. The minimum fruit diameter was recorded in treatment T_{13} (1.27), which was followed by treatment T_8 (1.35), T_9 (1.37) and T_7 (1.42) respectively, however treatment T_{13} was at par with T_7, T_8 and T_9 respectively. Rests of the treatments were intermediate.

Maximum diameter of fruit (2.04) was recorded in treatment which received T_2 i.e CCC 500 ppm. The reason for increased in fruit diameter was due to increased rate of respiration and photosynthesis of growth retardant treated plants than the plants in control treatment as explained by (Audus, 1960). Kakade *et al.* (2010).This increase in fruit diameter due to CCC was reported by Tosh *et al.* (1978), Gowda *et al*. (1992) and Rajput *et al.* (2011).

4.1.11 Number of green fruits per plant

The data presented in Table 4.6 revealed that the maximum fruit number of green fruits per plant was recorded in treatment T_2 (25.72), which was followed by treatment T_3 (25.35), T_6 (25.36) and T_{12} (25.08) respectively, however treatment T_2 was at par with T_3, T_6 and T_{12} respectively. The minimum number of green fruits per plant was recorded in treatment T_{13} (21.90), which was followed by treatment T_8 (21.82), T_9 (21.15) and T_7 (22.93) respectively, however treatment T_{13} was at par with T_7. Rests of the treatments were intermediate.

The maximum number of green fruits (25.72) per plant was recorded with T_2 CCC @ 500 ppm which was significantly superior over control (21.90). This might be due to cycocel produced healthier and a stockier plant which leads to plant for being more physiologically active to produce maximum number of fruits per plant. The similar results were reported by Patel and Singh (1991), Arora and Dhankar (1992), Singh (2000), Patil and Patil (2010) and Mandal *et al*. (2012).

4.6 Effect of growth retardants on fruit characters in okra cv. PBN–OK-1.

Treatments	Fruit Length (cm)	Fruit diameter (cm)	Number of green fruits per plant
T_1 CCC @ 300ppm	10.99	1.48	25.03
T_2 CCC @ 500ppm	11.38	2.04	25.72
T_3 CCC @ 700 ppm	11.31	1.89	25.35
T_4 MH @ 200 ppm	10.67	1.43	23.66
T_5 MH @ 250 ppm	11.00	1.54	24.39
T_6 MH @ 300 ppm	11.20	1.80	25.36
T_7 Ethrel @ 150 ppm	10.27	1.42	22.93
T_8 Ethrel @ 250 ppm	9.61	1.35	21.82
T_9 Ethrel @ 350 ppm	10.26	1.37	21.15
T_{10} BA @ 100 ppm	10.52	1.45	23.39
T_{11} BA @ 150 ppm	10.60	1.71	23.64
T_{12} BA @ 200 ppm	11.13	1.75	25.08
T_{13} Water spray	9.55	1.27	21.90
SE(m)±	0.17	0.07	0.53
C.D.	0.54	0.23	1.68
C.V.	6.34	6.68	7.19

4.1.12 Fresh weight of fruit (g)

The data presented in Table 4.7 revealed that the maximum fresh weight of fruit was recorded in treatment T_2 (252.38), which was followed by treatment T_3 (243.57), T_6 (239.56) and T_{12} (222.98) respectively. The minimum fresh weight of fruit was recorded in treatment T_{13} (141.90), which was

followed by treatment T_8 (146.12), T_9 (149.12) and T_7 (157.80) respectively, however treatment T_{13} was at par with T_8. Rests of the treatments were intermediate.

The maximum fresh weight of fruit (252.38 g) was recorded under T_2 CCC @ 500 ppm, as compared to control (141.90 g). This might be due to enhancement effect of cycocel for food materials translocation towards the site of new pod formation and pod development. Ultimately increased the fruit weight. The results are in agreement with Tosh *et al.* (1978), Patel *et al.* (2005) and Sanganagoud *et al.* (2014) in okra.

Table 4.7: Effect of plant growth retardant on Fresh weight of fruit (g) in okra cv. PBN-OK-1.

Treatments	Fresh weight of fruit (g)
T_1 CCC @ 300ppm	219.56
T_2 CCC @ 500ppm	252.38
T_3 CCC @ 700 ppm	243.57
T_4 MH @ 200 ppm	211.72
T_5 MH @ 250 ppm	166.25
T_6 MH @ 300 ppm	239.56
T_7 Ethrel @ 150 ppm	157.80
T_8 Ethrel @ 250 ppm	146.73
T_9 Ethrel @ 350 ppm	149.12
T_{10} BA @ 100 ppm	183.55
T_{11} BA @ 150 ppm	165.82
T_{12} BA @ 200 ppm	222.98
T_{13} Water spray	141.90
SE(m)±	1.77
C.D.	5.51
C.V.	6.30

4.1.13 Fruit yield per plant (g)

The data presented in Table 4.8 revealed that the maximum fruit yield per plant was recorded in treatment T_2 (247.85), which was followed by treatment T_3 (236.65), T_6 (233.05), and T_{12} (231.91) respectively. The minimum fruit yield per plant was recorded in treatment T_{13} (118.26), which was followed by treatment T_8 (144.99), T_9 (146.13) and T_7 (148.15) respectively. Rest of the treatments was intermediate.

The maximum fruit yield per plant (247.85 g) was recorded with T_2 CCC @ 500 ppm, the increasing fruit yield in the treatment cycocel might be due to decreased in the plant height and increased the number of branches as a resulting in diversion of flow of food materials for increasing in flowering and fruiting in okra trends was observed by Tosh *et al.* (1978), Chudasma (1991), Sajjan *et al.* (2003), Prasad and Shrihari (2008), Pateliya *et al.* (2008) and Rajput *et al.* (2011) in okra.

4.1.14 Fruit yield (q/ha)

The data presented in Table 4.8 revealed that the maximum fruit yield (q/ha) was recorded in treatment T_2 (137.82), which was followed by treatment T_3 (130.75), T_6 (128.55) and T_{12} (124.52) respectively. The minimum fruit yield (q/ha) was recorded in treatment T_{13} (63.15), which was followed by treatment T_8 (82.49), T_9 (88.20) and T_7 (88.92) respectively. Rests of the treatments were intermediate.

The maximum fruit yield (q/ha) was recorded in T_2 CCC @ 500 ppm (137.75). The highest fruit yield, might be due to triggering effects of physiological processes ultimately increased in individual fruit weight, fruit size and total number of fruits, so yield per plant was increased. Application of cycocel also reduced plant height and increases number of branches resulting indiversion off low of food materials for improvement of flowering and fruit yield. This results are in accordance with results obtained by Tosh *et al*. (1978), Gowda (1983), Abdul *et al*. (1985), Arora and Dhankar (1992), Rathod (1994),

Singh (2000), Sajjan *et al*. (2003), Desai *et al.* (2005), Patel *et al*. (2005) Prasad and Shrihari (2008), Pateliya *et al.* (2008) and Rajput *et al.* (2011).

Table 4.8: Effect of plant growth retardant on Fruit yield per plant (g) and (q/ha) in okra cv. PBN-OK-1.

Treatments	Fruit yield per plant(g)	Fruit yield in (q/ha)
T_1 CCC @ 300ppm	220.59	123.51
T_2 CCC @ 500ppm	247.85	137.82
T_3 CCC @ 700 ppm	236.65	130.75
T_4 MH @ 200 ppm	231.91	118.03
T_5 MH @ 250 ppm	158.11	113.21
T_6 MH @ 300 ppm	233.05	128.55
T_7 Ethrel @ 150 ppm	148.15	88.92
T_8 Ethrel @ 250 ppm	144.99	82.49
T_9 Ethrel @ 350 ppm	146.13	88.20
T_{10} BA @ 100 ppm	158.97	93.24
T_{11} BA @ 150 ppm	156.29	120.20
T_{12} BA @ 200 ppm	231.91	124.52
T_{13} Water spray	118.26	63.15
SE(m)±	1.89	1.69
C.D.	5.90	5.26
C.V.	6.44	7.20

Fig1. Effect of growth retardants on plant height (cm)

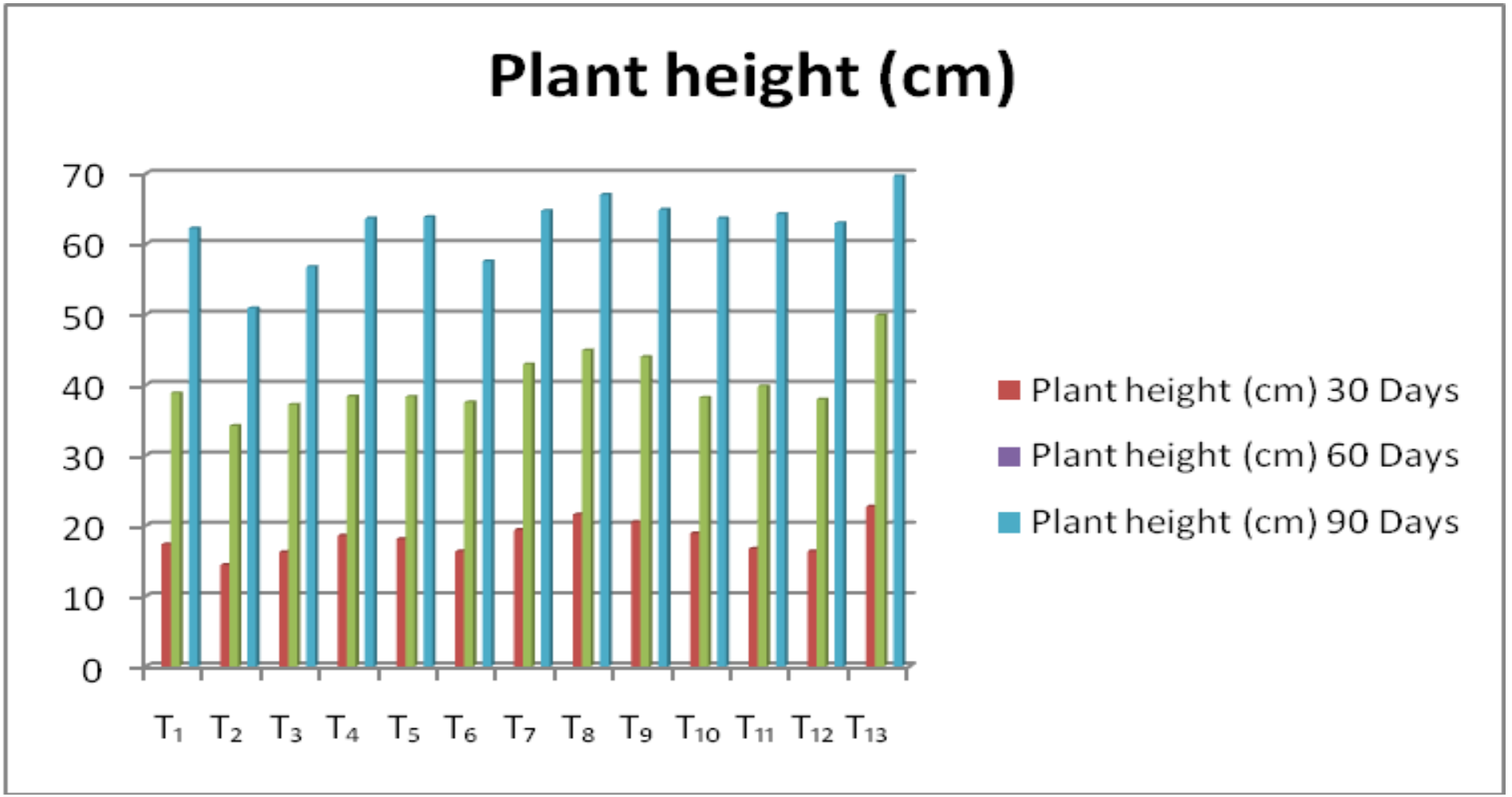


Fig.2. Effect of growth retardants on number of internodes per plant

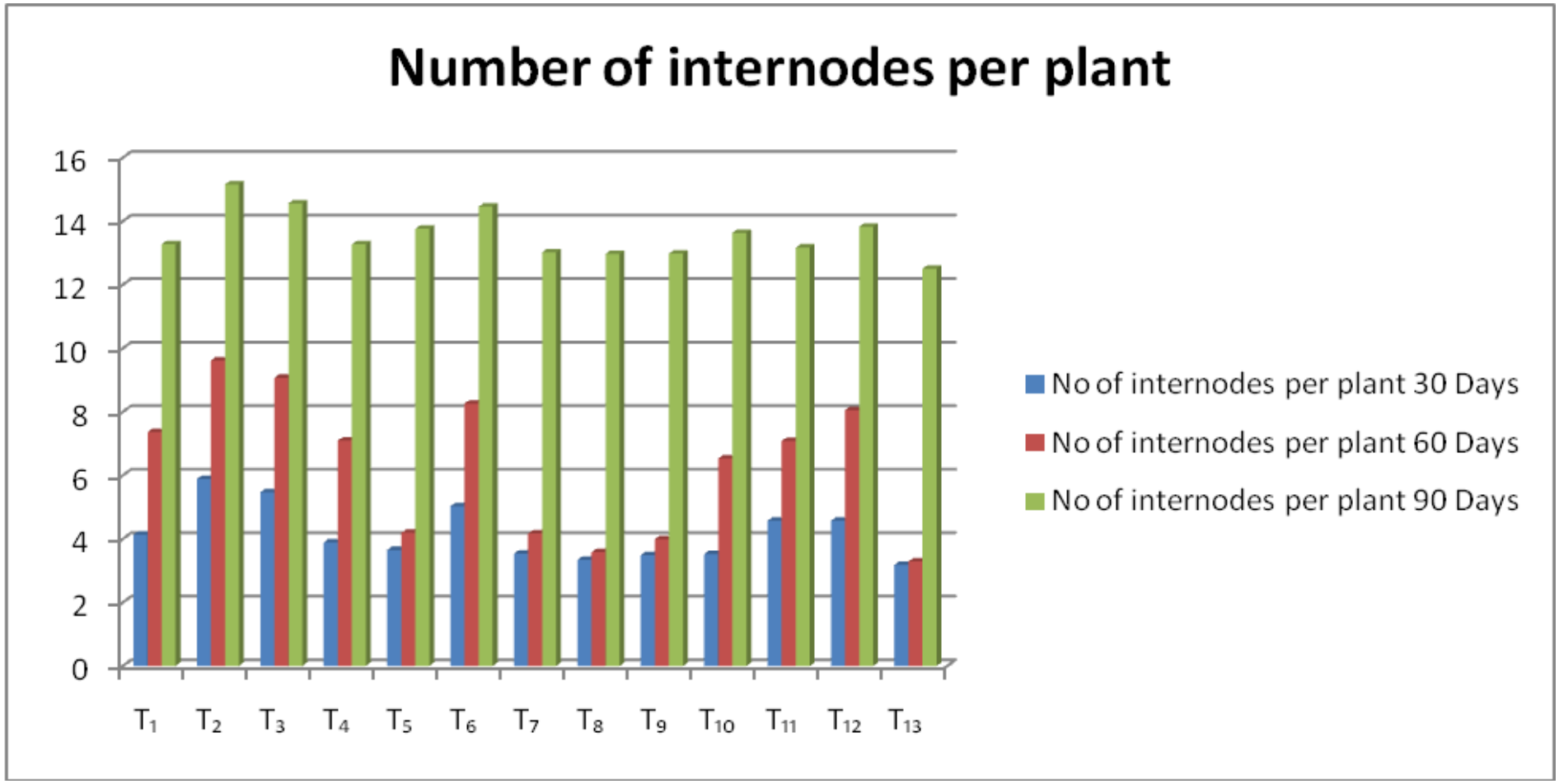


Fig.3. Effect of growth retardants on internodal length (cm)

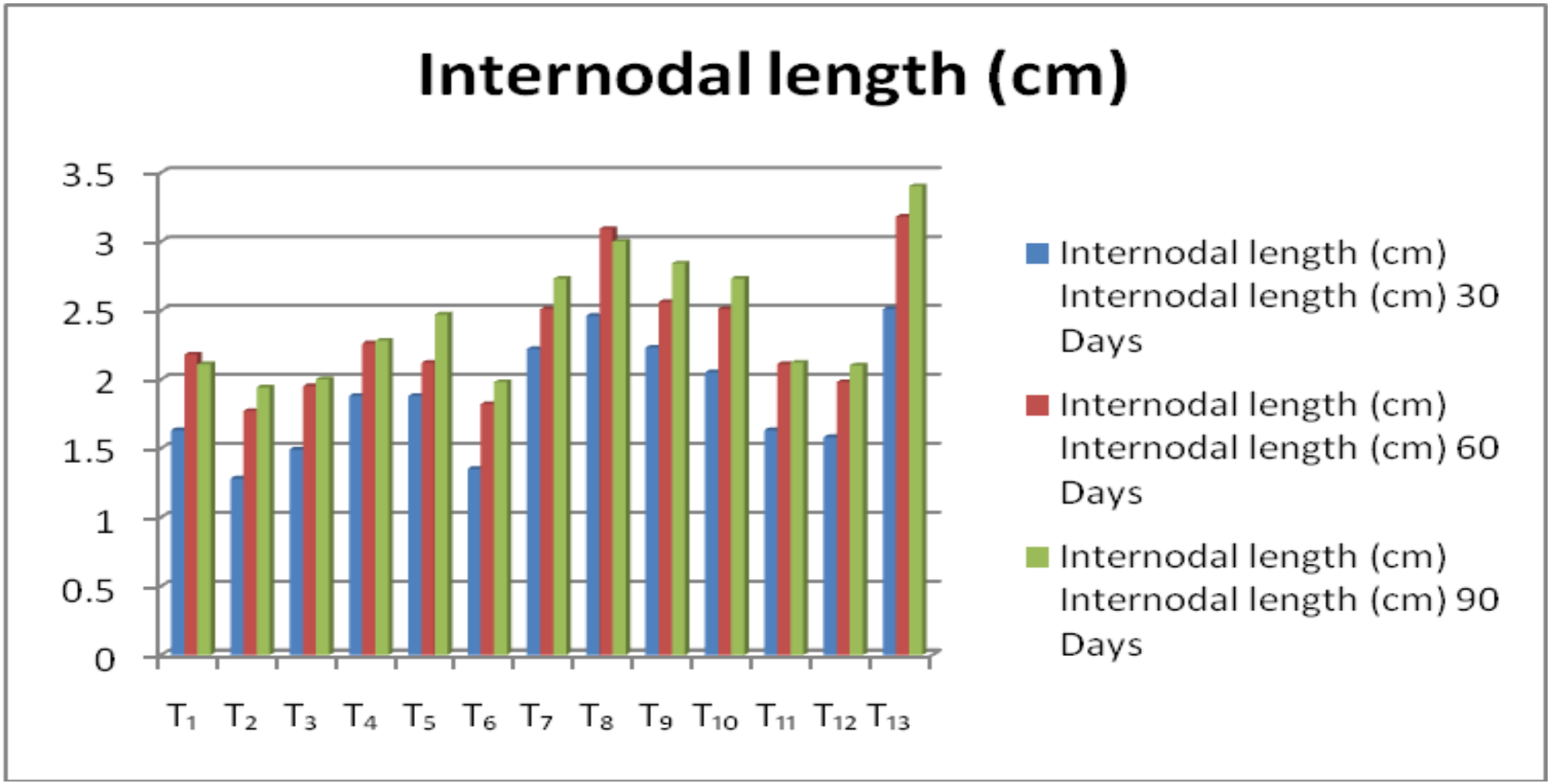


Fig.4. Effect of growth retardants on number of branches per plant

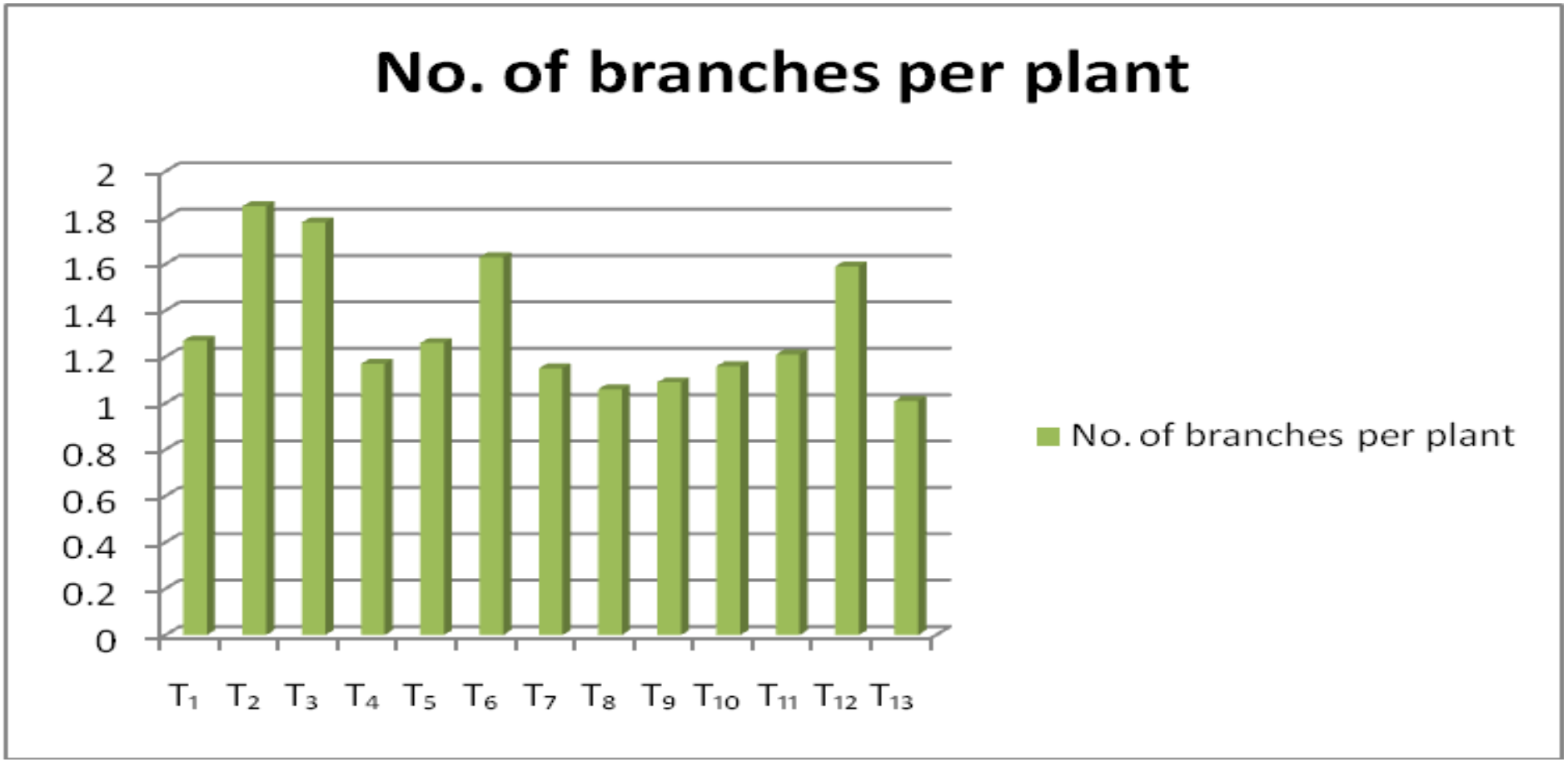


Fig.5. Effect of growth retardants on leaf area (cm^2)

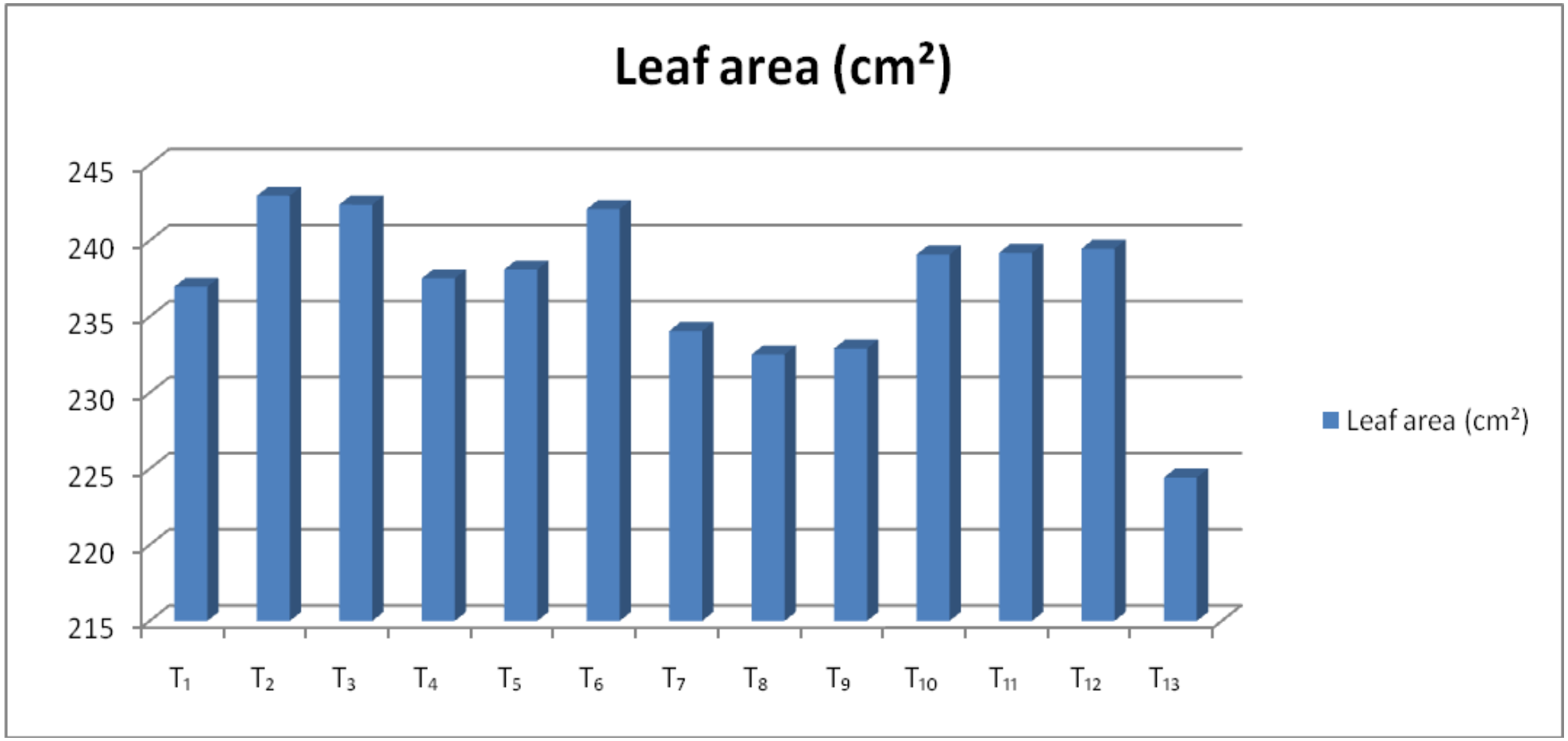


Fig.6. Effect of growth retardants on Days to 1st flower to open

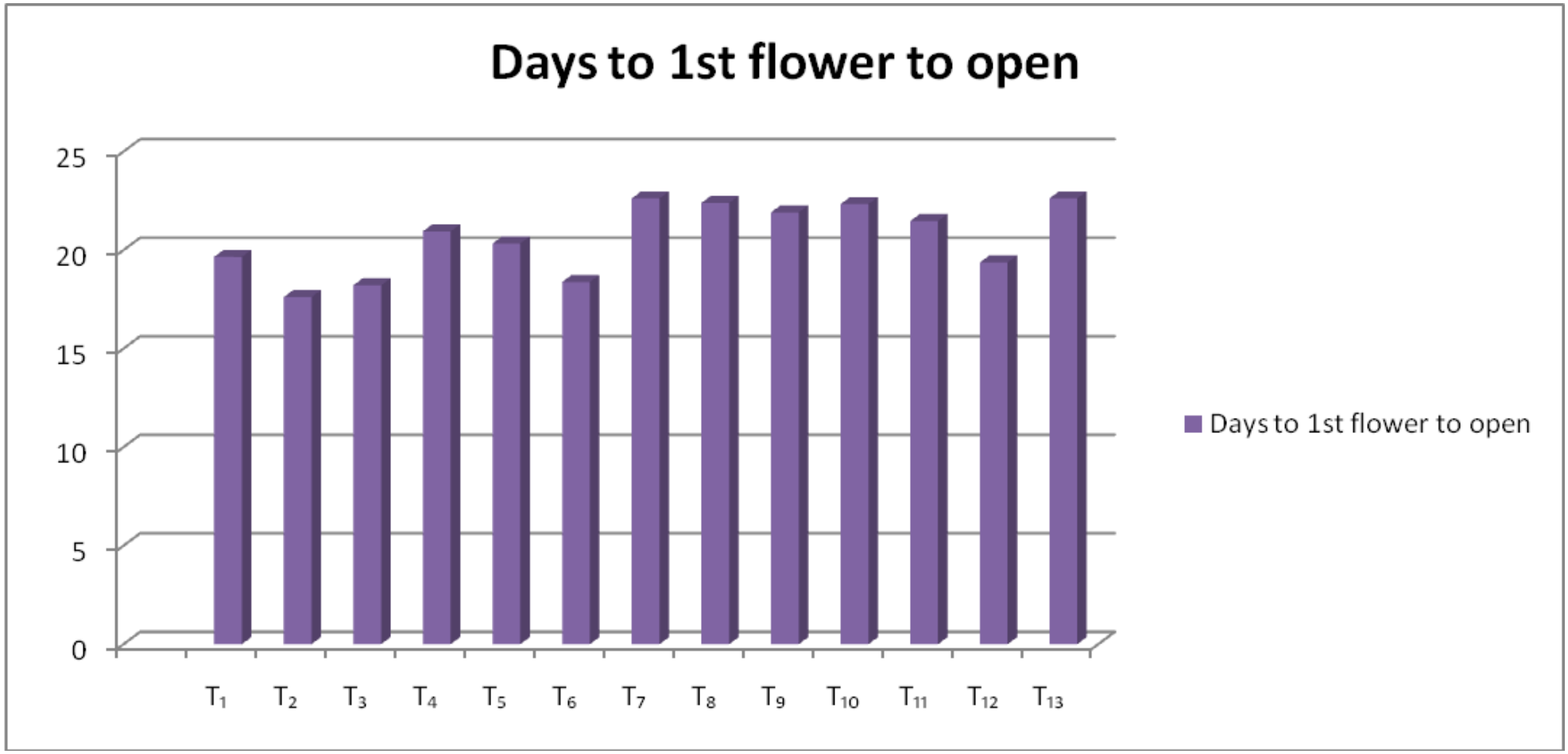


Fig.7. Effect of growth retardants on Days to 50 percent flowering

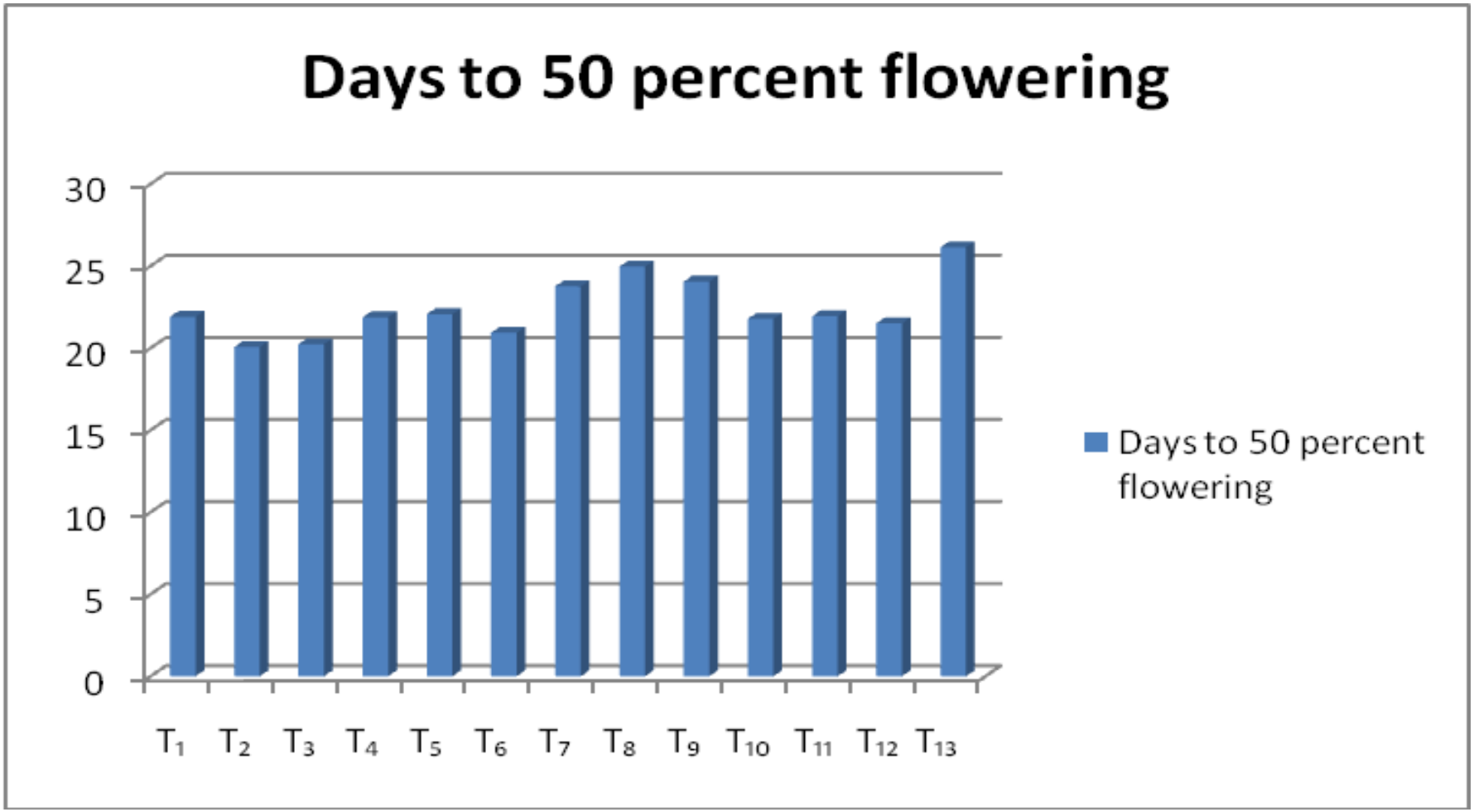


Fig.8. Effect of growth retardants on No. of flowers

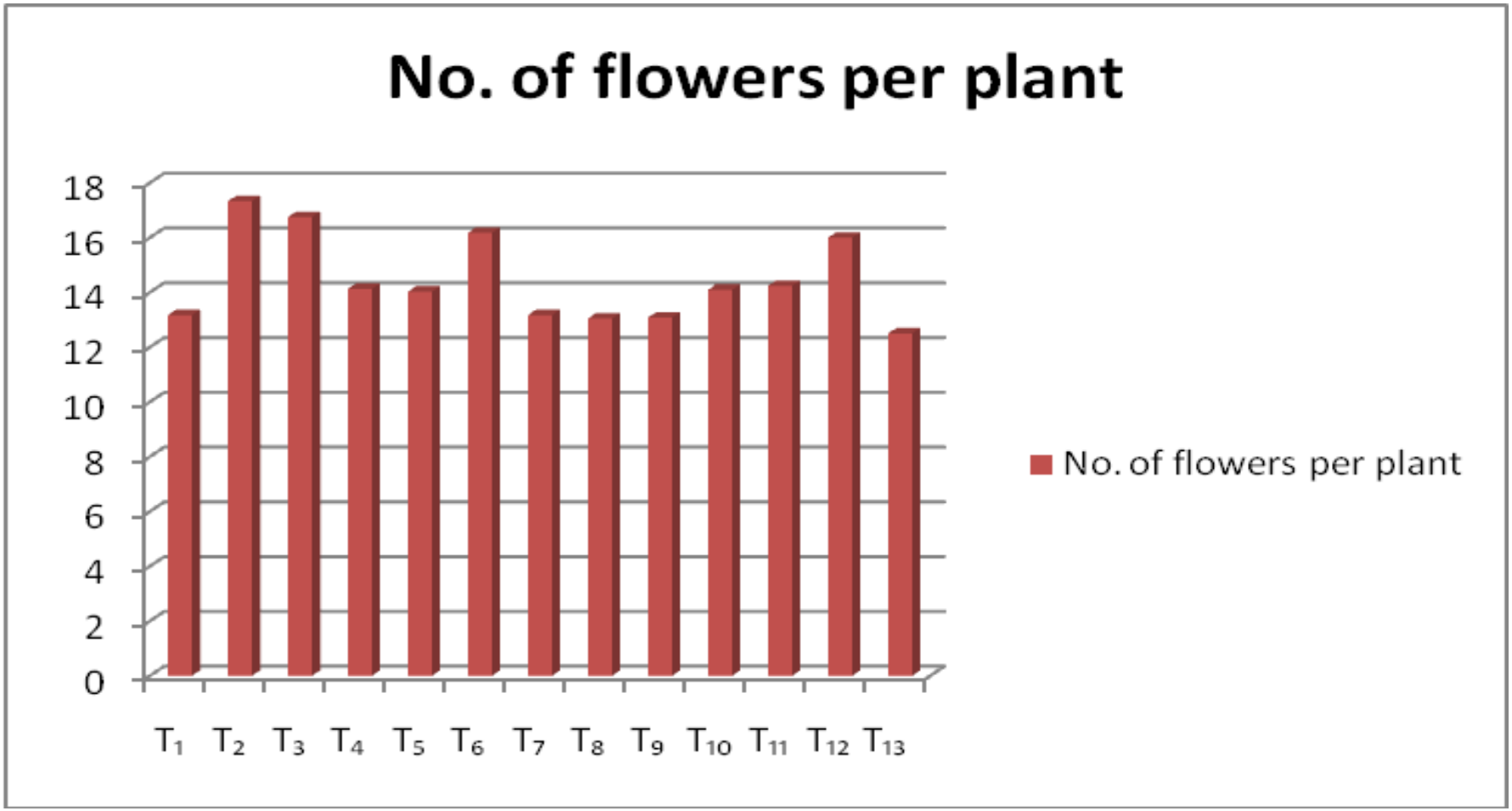


Fig.9. Effect of growth retardants on Fruit length (cm)

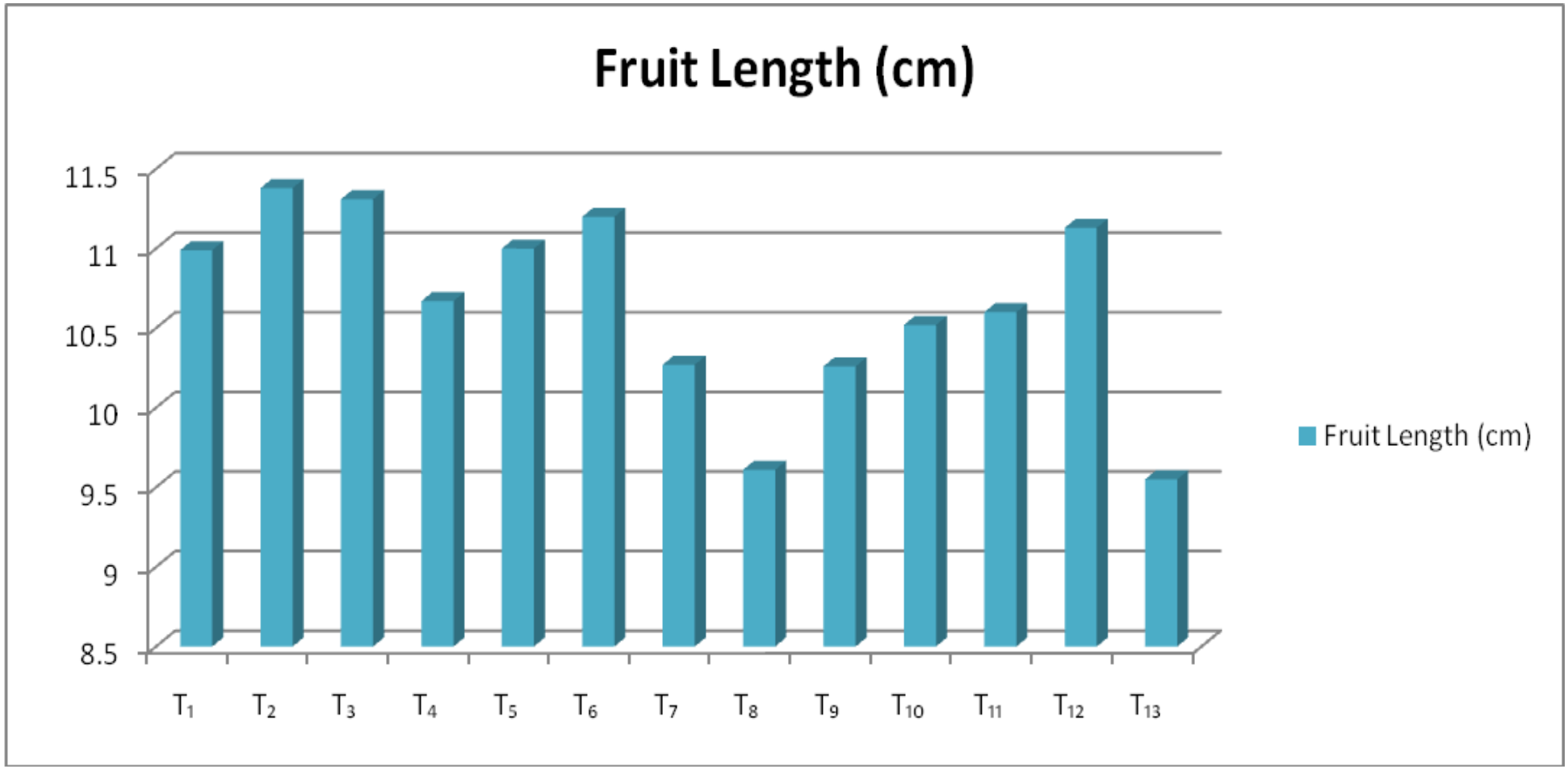


Fig.10. Effect of growth retardants on Fruit diameter (cm)

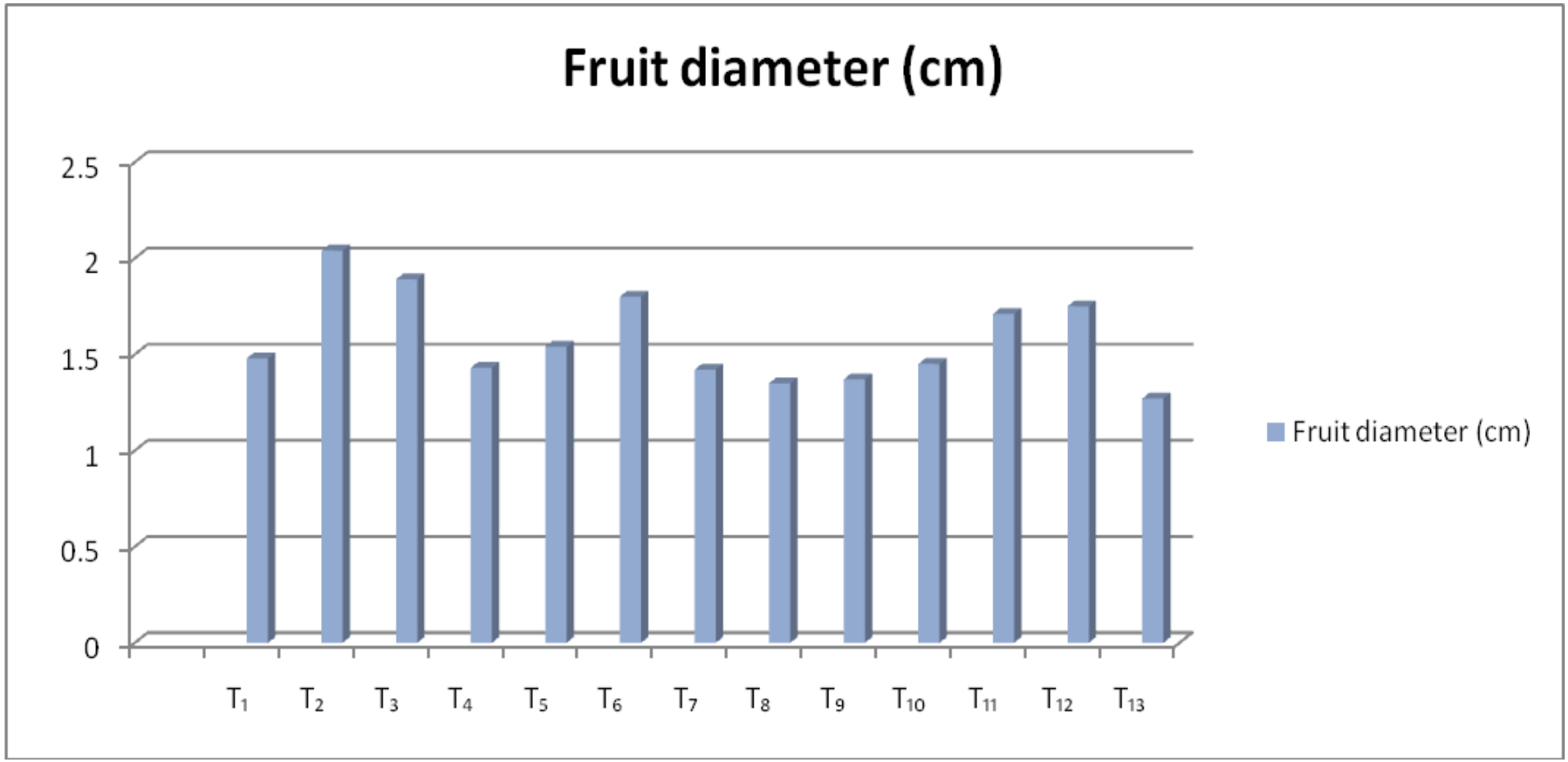


Fig.11. Effect of growth retardants on No. of green fruit per plant

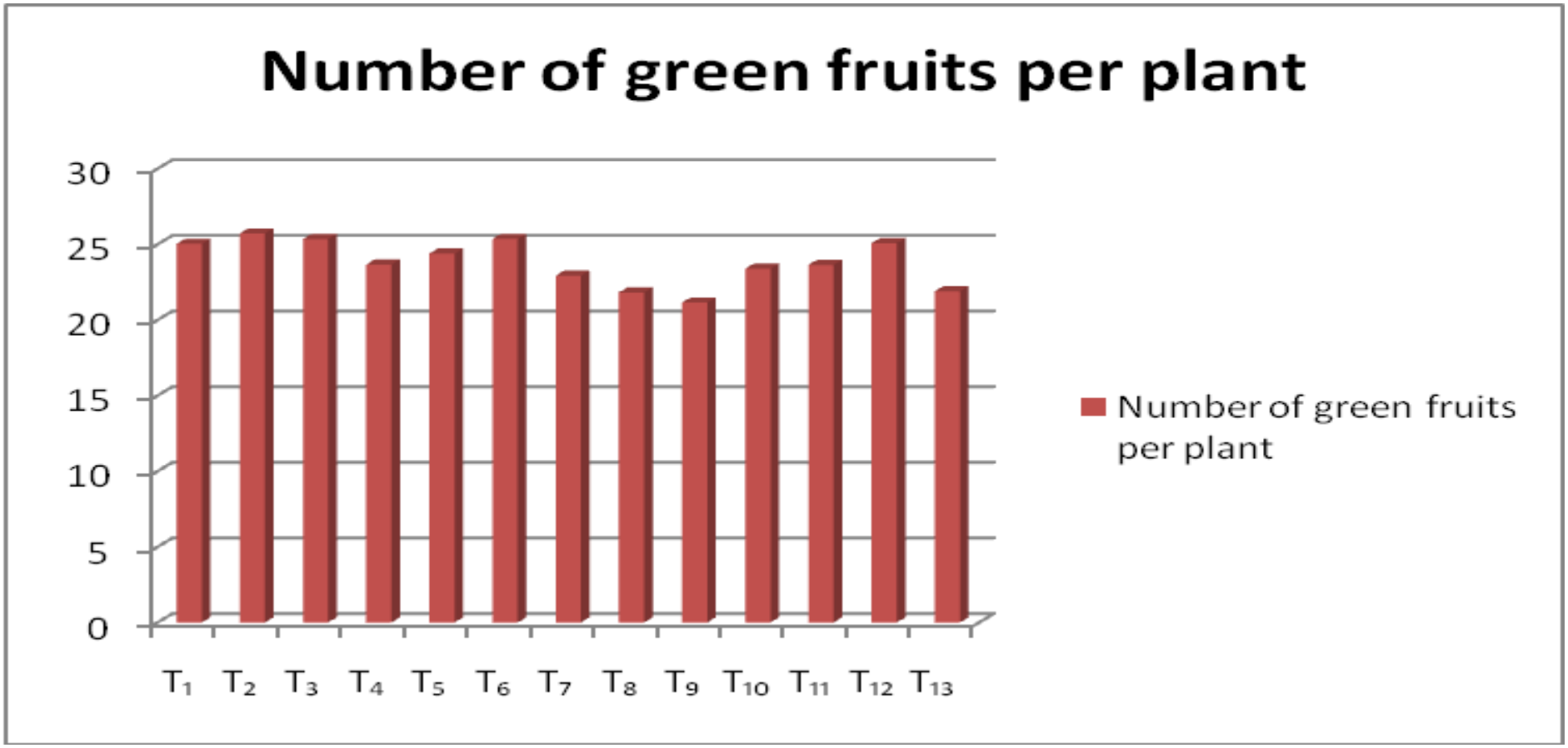


Fig.12. Effect of growth retardants on Fresh weight of fruit (g)

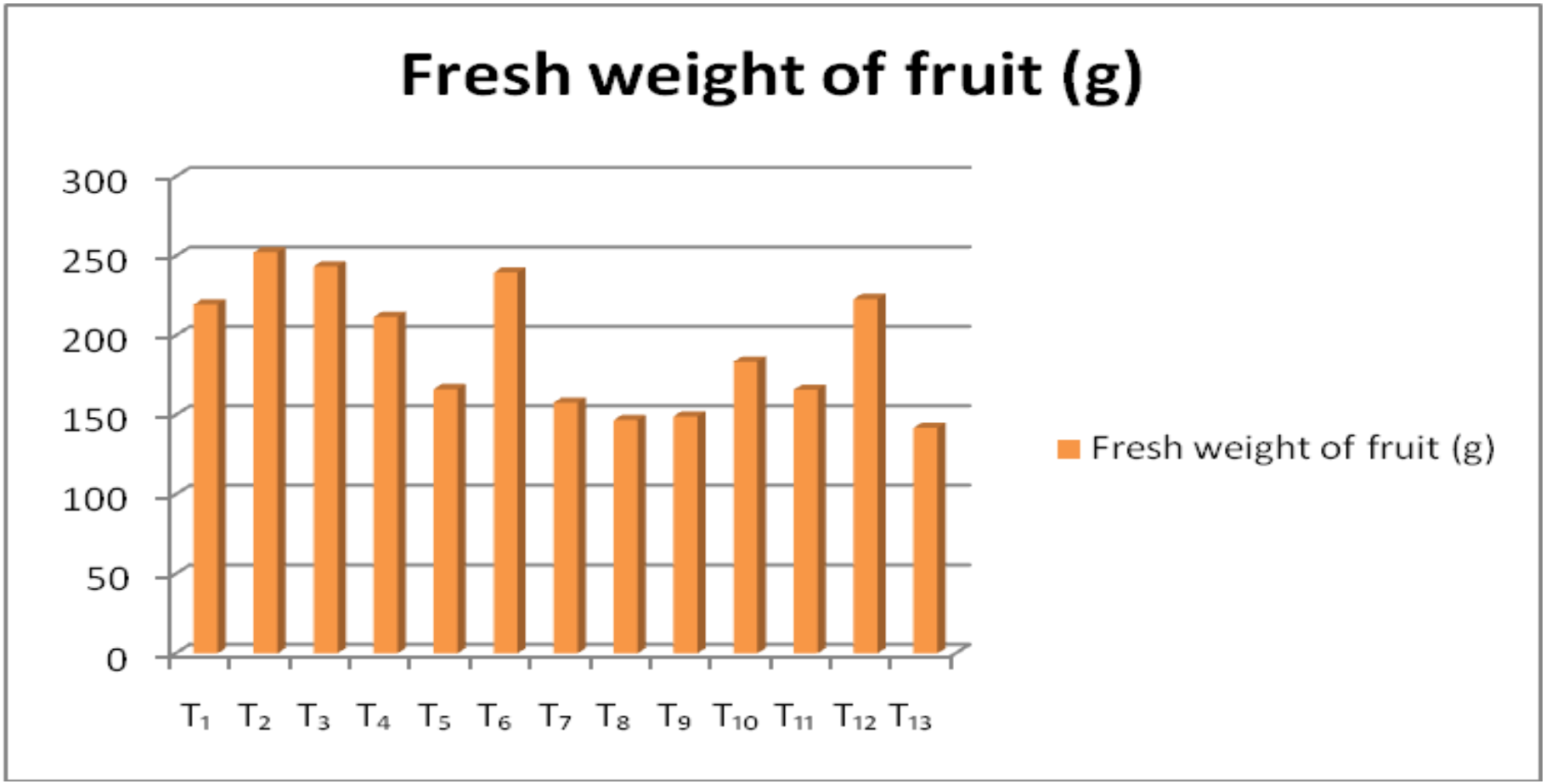


Fig.13. Effect of growth retardants on Fruit yield per plant (g)

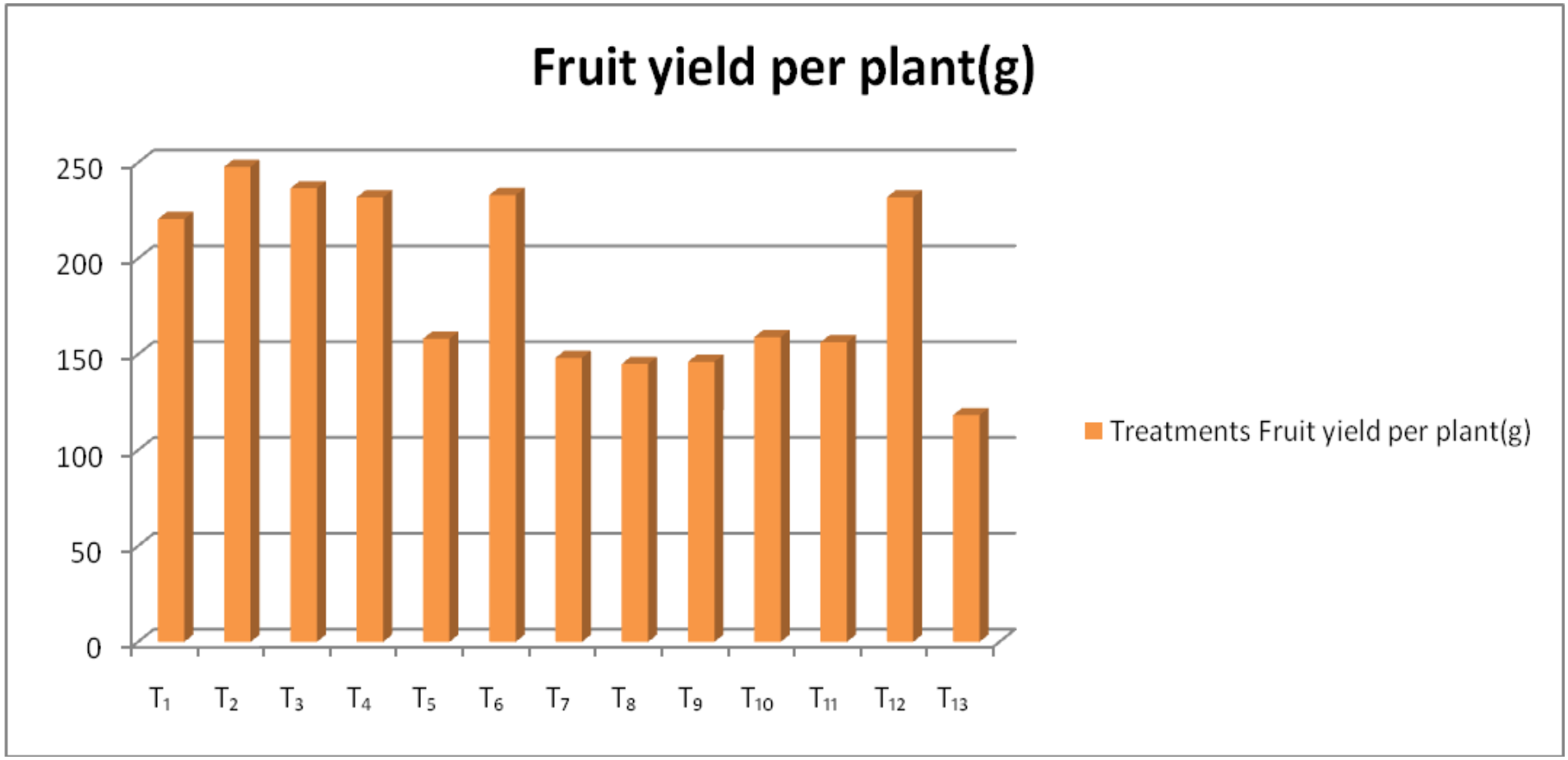


Fig.14. Effect of growth retardants on Fruit yield in (q/ha)

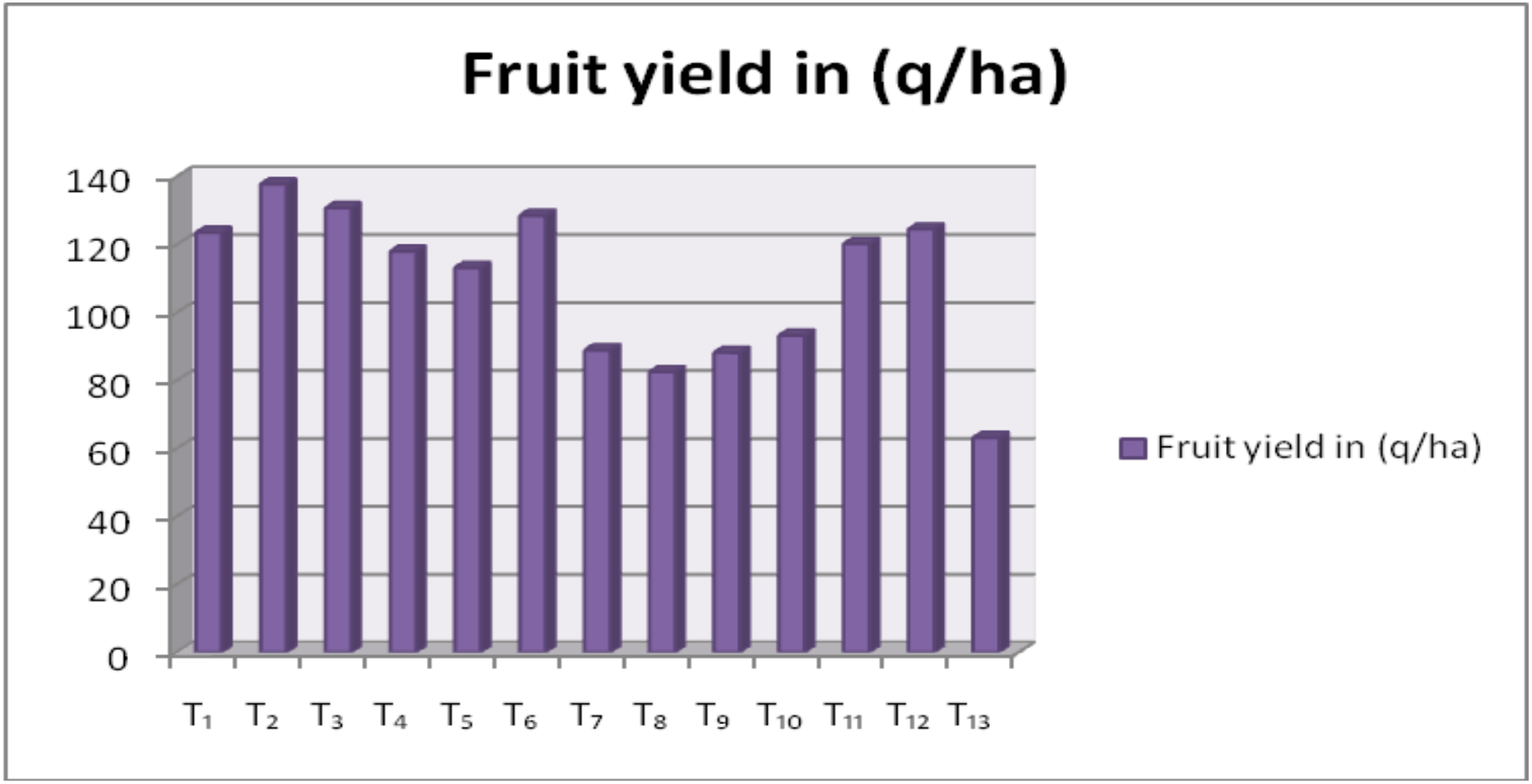


Plate 1. Plot view of okra after 20 days of seed sowing

Plate 2. Plot viewed after irrigation

Plate 3. Flowering of Okra

Plate 4. Field observed by Research Guide

Plate 5. view of okra field

Plate 6. Treatment of Cycocel on okra

Plate 7.Treatment of Maleic Hydrazide

Plate 8. Treatment of Ethrel on okra

Plate 9. Treatment of control

Plate 10.Taking of observation after 30 days

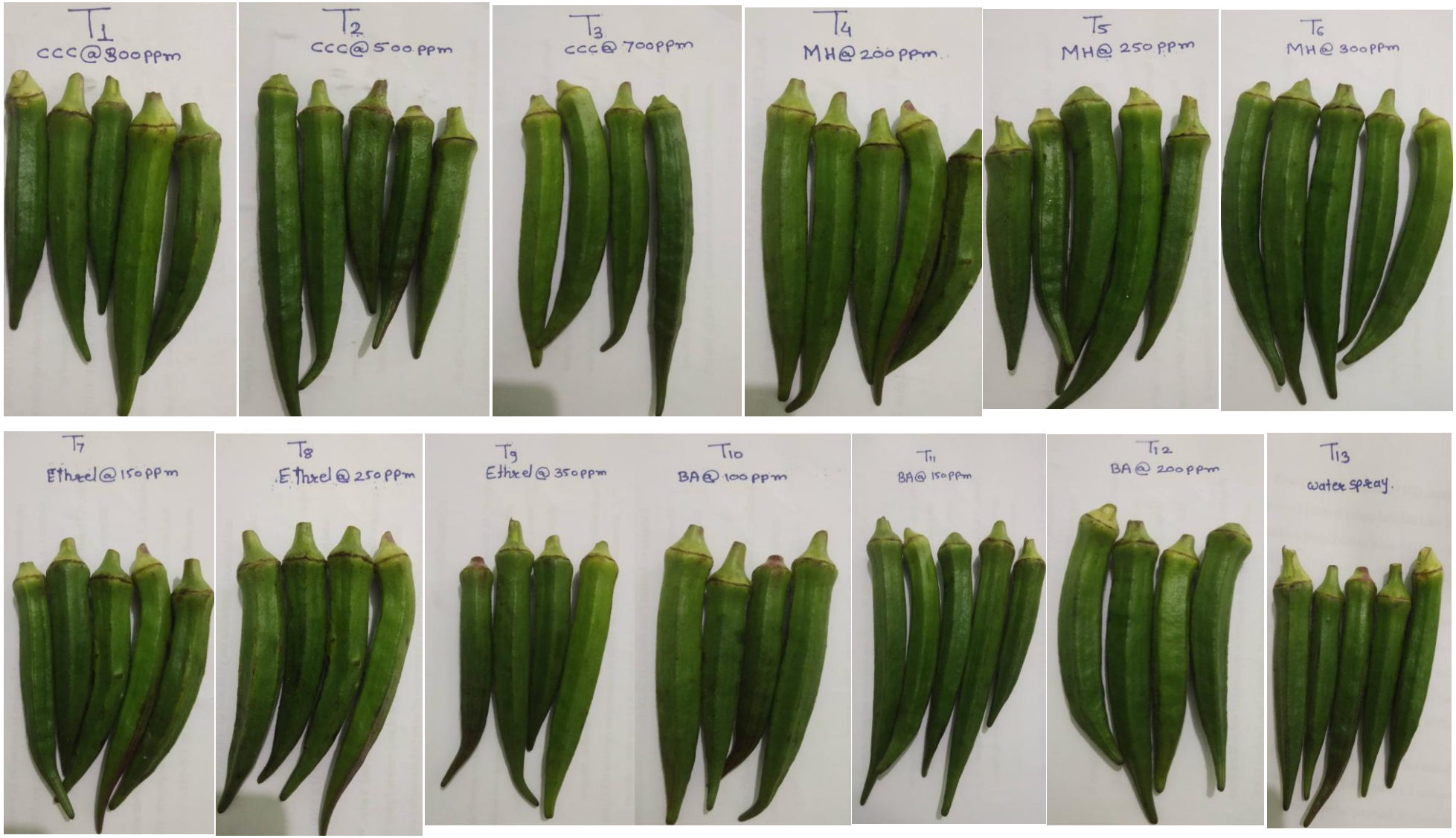
Plate 11.Taking observation after 60 days

Plate 12.Taking observation after 90 days

Plate 13. Picking of fruit for observation

Plate 14. Harvesting of okra fruit

Plate 15. Effect of different chemical's on okra cv. PBN-OK-1



Summary and Conclusion

CHAPTER-V

SUMMARY AND CONCLUSION

The present investigation entitled “Effect of growth retardant on flowering, fruiting and yield of okra cv. PBN-OK-1 (*Abelmoschus esculentus* L.)” was conducted at the main farm of Department of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during *kharif* season 2018, with the object to evaluate the effectiveness of various growth retardant on flowering, fruiting and yield of okra.

The present experiment was laid out in RBD with two replications and thirteen treatments on 3.0 x 2.70 m plot size. The treatments consist of Cycocel (T_1 300, T_2 500 and T_3 700 ppm), Maleic hydrazide (T_4 200, T_5 250 and T_6 300 ppm), Ethrel (T_7 150, T_8 250 and T_9 350 ppm) and Benzylandinine (T_{10} 100, T_{11} 150 and T_{12} 200 ppm) with T_{13} control treatment. The application of growth retardant as per treatment was applied as foliar spray at 25 and 50 days after sowing. The observations on growth characters like plant height (cm), number of internodes per plant, internodal length (cm), number of branches per plant and leaf area (cm^2) as well as flowering character like days to first flower to open, days to 50 percent flowering, number of flowers and yield attribute like fruit length (cm), fruit diameter (cm), number of green fruit per plant, fresh weight of fruit (g), fruit yield per plant (g), fruit yield (q/ha) were recorded. The results of present investigation are summarized as bellow.

The effect of growth retardant on growth characters like plant height, number of internodes per plant, internodal length, number of branches and leaf area of okra was found to be significant. The minimum plant height (14.45 cm), (34.18 cm) and (50.91 cm), maximum number of

internodes per plant (5.88), (9.62) and (15.16), minimum internodal length (1.28 cm), (1.77 cm) and (1.94 cm) respectively, was recorded at 30, 60 and 90 DAS, maximum number of branches per plant (1.85) and maximum leaf area (242.95 cm^2) was recorded with T_2 CCC @ 500 ppm.

The different treatments of growth retardant showed positive response on flowering character of okra viz. minimum days to first flower open (17.61), minimum days to 50 percent flowering (20.06) and maximum number of flowers (17.33) recorded with T_2 CCC @ 500 ppm while, maximum days to first flower open (22.62 days), maximum days to 50 percent flowering (26.14 days) and minimum number of flower (12.50) recorded with T_{13} Control.

The yield attribute were significantly superior with the growth retardant T_2 cycocel @ 500 ppm. The maximum fruit length (11.38 cm), maximum fruit diameter (2.04 cm), maximum number of green fruits per plant (25.72), maximum fresh weight of fruit (252.38 g), maximum fruit yield per plant ((247.85 g) and fruit yield (137.75 q/ha) was recorded under the treatment T_2 CCC @ 500 ppm. Whereas the minimum fruit length (9.55 cm), minimum fruit diameter (1.27 cm), minimum number of green fruits per plant (21.90), minimum fresh weight of fruit (141.90 g), minimum fruit yield per plant (118.26 g) and minimum fruit yield (63.15 q/ha) was recorded under the treatment T_{13} (control).

CONCLUSION

The result and discussion of present study showed that, various treatments' of growth retardant has got significant influence on vegetative growth, flowering and yield attribute's of okra. From the critical evaluation of results of the present investigation, the following conclusion can be drawn.

1. Cycocel 500 ppm was found beneficial for decreasing the plant height (50.91 cm), maximum number of internodes per plant (15.16), minimum intermodal length (1.94 cm), maximum number of branches per plant (1.85) and maximum leaf area (242.95 cm^2).
2. Cycocel 500 ppm was found effective for minimizing days to first flower to open (17.61), days to 50 percent flowering (20.06) and more number of flowers per plant (17.33).
3. Cycocel 500 ppm was found effective for yield attributes like fruit length (11.38 cm), fruit diameter (2.04 cm), number of green fruit per plant (25.72), fresh weight of fruit (252.57g), fruit yield per plant (247.85g) and fruit yield (137.82 q/ha).
4. The cycocel 500 ppm followed by cycocel 700 ppm, MH 300 ppm and BA 200 ppm was effective in relation to growth, flowering and yield character of okra.

Thus, it can be concluded that, growth retardant cycocel 500 ppm will be beneficial for retarding vegetative growth, enhancing flowering and increasing yield of okra under Marathwada condition. As the results of present investigation are based on one season data further detailed experimentations are necessary to confirm findings.

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Vitae

VITAE

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of

Master of Science (Horticulture)

In

Vegetable Science

2019

Title of Thesis : Effect of growth retardant on flowering, fruiting and yield of okra cv.PBN-OK-1 (*Abelmoschus esculentus* L.)

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