Effect of Gibberellic Acid and Cycocel on Vegetative Growth, Flowering, Yield and Quality Attributes of African Marigold (*Tagetes erecta* L.)

THESIS

Submitted to
Babasaheb Bhimrao Ambedkar University
(A Central University)
Lucknow

BABASAHEB
BHIMRAO
AMBEDKAR
UNIVERSITY
LUCKNOW
प्रज्ञा शील करुणा
ESTABLISHED 1996

For the Degree of

Doctor of Philosophy

In

HORTICULTURE

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2019

Enrolment No. 1038/15

Dedicate To……..

Beloved Parents

Who gave me a lot of moral support and encouragement which cannot be expressed in words

Ram Vilas.

DECLARATION

I, **Ram Vilas, Enrolment No-1038/15** hereby declare that, I am a candidate for the degree of **Doctor of Philosophy (Agriculture) in Horticulture** in the Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedkar University, (A Central University), Vidya-Vihar, Rae Bareli Road, Lucknow - 226 025 (U.P.), India and have carried out my research work entitled **"Effect of Gibberellic Acid and Cycocel on Vegetative Growth, Flowering, Yield and Quality Attributes of African Marigold (*Tagetes erecta* L.)"** This thesis is submitted for the award of degree of Doctor of Philosophy in Horticulture is my original research work.

This thesis submitted to Babasaheb Bhimrao Ambedker University, Lucknow satisfies all the requirements as stipulated in the Doctor of Philosophy (Ph.D.) regulations-1999 as amended in 2008/2010/2013 and it is fit for submission and evaluation for the award of the degree of Doctor of Philosophy of the University.

Date: 2/12/2019

Place: Lucknow

R. Vilas 2/12/2019
(Ram Vilas)

CERTIFICATE

This is to certify that the thesis entitled **"Effect of Gibberellic Acid and Cycocel on Vegetative Growth, Flowering, Yield and Quality Attributes of African Marigold (*Tagetes erecta* L.)"** submitted by **Mr. Ram Vilas**, Enrollment No.1038/15 is an original research work and has not been previously submitted in part or full for the award of any other degree or diploma to this or any other university.

This thesis submitted to Babasaheb Bhimrao Ambedkar University, Lucknow satisfies all the requirement as stipulated in the Doctor of Philosophy (Ph.D.) regulations-1999 as amended in 2008/2010/2013 and it is fit for submission and evaluation for the award of the degree of Doctor of Philosophy of the University.

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ACKNOWLEDGEMENT

It is the contribution of one or more persons towards the task, which makes it successful. It gives me immense pleasure in acknowledging all the help that I have received during the period of research.

In my opinion, it is the "Almighty" before whom I should please for providing me courage and zeal to complete this manuscript by showering the endless blessings, with a world full of cheer, calm and peace.

First and foremost I express my deep sense of gratitude to my supervisor ***Dr. Sanjay Kumar, Professor and Head,*** *Department of Applied Plant Science (Horticulture) under the school of Bio-Sciences and Biotechnology, Babasaheb Bhimrao Ambedkar University, Lucknow-226 025 (U.P.), who is not only a teacher and guide to me, but my mentor and well-wisher too. His persistent encouragement, perpetual motivation, everlasting patience, constructive criticism and valuable technical inputs in research have benefitted me to an extent which is beyond expression. He is not only trained me in science but in all aspects of life.*

I wish to acknowledge in a deep sense of gratitude for ***Dr. R.B. Ram, Prof. and Dean,*** *Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedkar University, Lucknow, for providing me invaluable help, advice, encouragement and necessary lab facilities during the course of my research programme.*

It is my deep sense to express my heartiest gratitude to ***Prof. Deepa Hansraj Dwivedi, Dr. M.L. Meena, Dr. Sutanu Maji, Dr. Ravi Shankar Verma and Dr. Rubee Lata*** *Department of Applied Plant Science (Horticulture), for her encouragement and help during the course of study. And also* ***Dr. Pushpendra Kumar Karhana, Principal*** *of R.B. (PG) College Agra.*

Uncountable words of cordial veneration and gratitude are dedicated from the deepest part of my heart to my affectionate and beloved father ***Shri Babu Ram Gautam*** *and mother* **Smt. Ram Rachi Gautam** *for their never ending blessings, inspiration, and constant encouragement moral support throughout my academic life.*

I would fail my efforts if do not express my respect to my venerable and beloved Tau ji Late ***Shri Lal Sahay Gautam, Shri Ram Sanehi Lal Gautam,*** *and Chacha ji* ***Shri Raja Ram Gautam, Chachi Smt. Sunita Gautam*** *for their moral support and constant inspiration during my studies.*

I express my foremost indebtness and gratitude to my affectionate and beloved elder Brothers and his wife Mr***. Makarand Singh and Mrs. Geeta, Mr. Mipal Singh and Mrs. Uma, Mr. Dalveer Singh and Mrs. Basanti, Mr. Neeraj Kumar, and Mrs. Manju**, **Mr. Rajendra Singh, Mrs. Santoshi, Vimlesh Kumar and Smt. Manketi*** *and also my wife and son* ***Mrs. Kavita Singh and Kunal Gautam*** *for their blessings and dedicated efforts. They always enlightened me to follow a righteous path in my life. They have been a constant source of inspiration and this work is especially dedicated to them.*

In my opinion, it is the almighty before which should please for providing me courage and zeal to complete this manuscript by showering the endless blessing, with a world full of cheer, calm and peace.

I would like to take this opportunity to extend my gratitude to my seniors ***Dr. Rakesh Kumar Meena, Dr. Devendra Kumar, Dr. Sandeep Kumar Rajvanshi, Dr. Shashank Verma, Dr. Pushkar Singh Patel, Dr. Dinesh Chandra Meena, Dr. Kamal ram Meena and Dr. Jitendra Kumar Meena,*** *for their timely advices, encouragement, guidance and good will which enabled me to start and successfully complete my work.*

I express my heartiest thanks to my batch mates ***Smirti Singh, Munni Gond, and Mr. Sachin kishor.***

I also express my deep sense to my juniors ***Mr. Pradeep kumar, Mr.Rajiv Kumar, Mr. Amit Bhargwa, Mr. Prem Kumar, Mr. Lalit Kumar, Mr. Viplaw, Kumar Mr. Mata Prasad, Mr. Harvendra Pal, Mr. Bhag Chandra, Mr. Rajmani Singh, Mr. Saturanjay, Mr. Mohit Kumar and Batti Lal*** *for supporting me at every stage of my research work. I am also greatful to IARI, New Delhi for providing Marigold seeds for my research.*

Who directly or indirectly, gave encouragement and humorous company at BBAU, Lucknow. I am also thankful to all departmental staff members, especially ***Mr. Vinay Kumar*** *Office Assistant, Department of Applied Plant Science (Horticulture), BBAU,* ***Mrs. Anita Tiwari, Mr.S.S. Verma*** *Laboratory Assistant,* ***Munni Devi (MTS), Mr. Anilesh Kumar Singh*** *and finally, I thank the Almighty for leading me all the ways towards successful completion of this work.*

I am also thankful to library section for the providing the facility of library during my research period and plagiarism.

Date: 2/12/2019

Place: Lucknow

R.Vilas 2/12/2019

(Ram Vilas)

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LIST OF ABBEREVITIONS

ANOVA	:	Analysis of variance
CD	:	Critical Difference
cm	:	Centimetre
CV	:	Coefficient of variation
per se	:	As such with mean
et al.	:	and others
Fig	:	Figure
g	:	Gram
kg	:	Kilogram
m	:	Metre
ha	:	Hectare
mg	:	Milligram
SE(d)	:	Standard error difference
S.Em	:	Standard error mean
df	:	Degrees of freedom
RBD	:	Randomized Block Design
viz.	:	Namely
vs.	:	Against
No	:	Number
i.e.	:	That is
@	:	at the rate of
SS	:	Sum of Squares
MSS	:	Mean Sum of Squares
RH	:	Relative humidity
%	:	per cent
@	:	at the rate of
&	:	And
^{0}C	:	degree Celsius

Chapter-I

Introduction

Floriculture is a part of cultivation and manages fancy plants and blossom item. Horticulture is a craftsmanship and information on developing decorative plant and blooms the motivation behind flawlessness items and financial utility. Gardening items for the most part comprise of cut blossoms, pot plants, cut foliage, deeds bulbs, tubers, rootd cutting and dried blooms or leaves. The significant horticulture crops in worldwide cut blossom exchange are rose, carnation, chrysanthemum, gargera gladiolus, gypsophila, liastris, nerine, orchids, archilea, anthuriu, tulip and lilies. Blossoms are considerd as a token of excellence, love and endownment of nature. Blossoms gives the sentiments of adoration, harmony, delight, agreement and decreases pressure. Blooms have extraordinary significance during celebration days exceptionally on commemorations, relationships, valentine's Day, birth days. Decorative blossoms held in emergency clinic rooms can diminish the strain of patients and show signs of improvement their improvement. It is produces a tranquil climate and increment the excellence of a home.

Marigolds (*Tagetes erecta* L.) are one of the yearly blooms. In India, marigold is one of the most generally developed blossoms and utilized widely on strict and social capacities in various structures. It was presented in India during the sixteenth century and from that point forward it has been naturalized in various agro-climatic locales of India so that it currently has all the earmarks of being local of this nation. Horticulture is a concentrated sort of farming and the salary per unit territory from gardening is a lot higher than some other part of agribusiness.

Marigold (*Tagetes erecta* L.) has a place with the family Asteraceae and it is source to South and Central America basically Mexico. It is otherwise called 'Gainda' in Hindi. The family Tagetes contain around 33 species announced by **(Rayberg, 1915).** Among these, *Tagetes erecta* and *Tagetes patula* are all the more generally developed for their elaborate measures while *Tagetes minuta* is developed for its high substance of fundamental oil. Out of these, chiefly two sorts are industrially created in India viz., African marigold (*Tagetes erecta* L., 2n = 24) and French marigold

(*Tagetes patula* L., 2n = 48). It is one of the most seasoned developed blossoming plants, goes under the elaborate being extremely mainstream in tropical and sub-tropical nations as a nursery plant for embellishment.

Tagetes erecta is generally known as African marigold. The plant of *Tagetes erecta* is intense yearly, tall in nature 90 to 95 cm tallness, straight and additionally stretching. Leaf is pinnate, isolated and pamphlets are lanceolate and worn out. It has huge estimated bloom. Blossom hues are yellow and orange in various shades for example light yellow, brilliant yellow, splendid yellow, profound orange, brilliant yellow and brilliant orange. The flowerets are quilled or two lipped.

Tagetes patula is commonly known as French marigold. French marigold is shorter in tallness, around 30-40 cm, these plant are shaggy and solid in nature. Dim green leafs, stem are ruddy in shading and leaves are isolated pinnately. Blossoms are exceptionally minor in size, single or two fold. Blossoms are natural on long peduncles. Bloom hues are yellow and orange in different shades for example dark red, darker red, bicolour like light yellow with maroon blotches, gold and red shading.

There is an incredible increment popular of floricultural items with expanding pay and globalization of economy. Netherlands, Italy, Germany and Japan have solid custom for developing and utilization of blooms. Anyway new generation focuses are creating in Latin America, Kenya, South Africa, Israel, India. Shrilanka, Thailand and so on to fulfill the inner need just as import. Utilization of bloom is rising both in created and creating nations. Worldwide gardening industry with a speculation of about US$ 60 billion is developing at 10-12% per annum. Significant bringing in nations are USA, Japan, West Europe, East Europe, South Korea, Thailand and Indonesia. As far as worth: Germany (30.3%), USA (16.8%), Uk (9.7%), France (9.7%), and the Netherlands (8.4%) are driving nations.Significant sending out nations are the U.S.A., Netherland, U.K., Germany and Arab Emts were significant bringing in nations of Indian horticulture during (2018-19).

In India, marigold is one of the most typically developed blossoms and utilized comprehensively on profound and social capacities in uncommon structures. It was presented in India during the sixteenth century and from that point forward it has been naturalized in various agro-climatic locales of India so that it currently has all the earmarks of being local of this nation. Marigold bloom likewise discovers exchange application various regions like readiness of characteristic color and fundamental oil. In India, marigold is one of the most every now and again created blossom yield and use generally on strict and social utility in various structure.

In India, significant bloom developing states are Maharashtra, Karnataka, Andhra Pradesh, Haryana, Tamil Nadu, Rajasthan and West Bangal have risen as significant gardening focuses. The most noteworthy free blossom developing states are Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Gujarat, Haryana, Himachal Pradesh Jammu and Kashmir and Jharkhand. In India about 324.00 thousand hectare zone under free blossoms with creation foreseen to 1962.03 thousand MT free bloom and 704.23 thousand MT of cut bloom. In India, most extreme territory of bloom encased by Jammu and Kashmir (49.58 thousands hectare), most elevated creation of free blossom is secured by Tamil Nadu state (482.52 thousands MT) and most noteworthy generation of cut bloom is roofed by West Bengal (203.42 thousands MT) **(Anonymous, 2018)**.The nation has sent out 19726.57 MT of horticulture items to the world for the value of Rs. 571.38 Crores/81.94 USD Millions of every 2018-19.

Other than its decorative qualities, it has therapeutic esteems moreover. The two leaves and bloom are similarly significant from therapeutic perspective. Leaf glue is utilized remotely against bubbles and carbuncles, leaf remove is great solution for ear hurt. Bloom separate is considered as blood purifier, a solution for draining heaps and is likewise a decent solution for eye illness and ulcers. The fundamental oil present in various types of *Tagetes* can discover an utilization in the fragrance business. **(Dhingra and Dhingra, 1956)** announced that all pieces of *Tagetes erecta* contain basic oil which can be extricated by steam refining. The oil has an articulated scent and go about as a replant to flies. African marigold speaks to disgusting personalities. In England, it was a typical conviction that if the blooms of African marigold don't open before 7 am, it will rain or roar that day. The marigold was from the start respected with doubt because of its solid upsetting smell and it was considered as a noxious plant. Along these lines, the vast majority of the individual decided to respect its magnificence from a separation and just a couple minded to deal with it. Marigold is otherwise called kinship blossom in the United States.

Marigold, not just developed as fancy cut bloom and scene plant yet in addition an asset of carotenoid shade for poultry feed to expand the yellow shade of egg yolks and oven skin. The prime shading in the bloom is xanthophylls generally lutein which represents more than 80-90 percent. It is available as esters of Palmitic and Myristic corrosive. There is enormous interest for common shades of marigold in the universal market. In India, the hauling out of carotenoids on the business scale is being done in Kerala and Andhra Pradesh states for the most part in Cochin and Hyderabad correspondingly and it is being traded to Mexico. as needs be huge zones in Tamil Nadu, Karnataka, Andhra Pradesh and Maharashtra are encased by contract development of marigold **(Raghava, 2000)**.

Hormone can be characterized as a substance delivered one piece of any life form however later on moved to another piece of a similar living being the place it influences a particular physiological activity. The term phytohormone is applied to those hormones which are solely created inside a living plant. The term 'development controller' is applied to natural mixes other than plant supplements, which when utilized in minute amounts can either restrain, invigorate or change development. In this gathering are incorporated auxins, gibberellins, cytokinins, abscisic corrosive and ethylene.

The utilization of development retardants make to lessen plant stature as well as bring trust in such individuals. Development retardants not just make accessible to the shopper plants of different sizes and shapes yet have additionally advanced new plants types which were lighter to impractical. For instance, there was no hereditary diminutive person plant in poinsettias however use of development retardants has delivered scaled down poinsettias. For instance, SADH is extremely successful in controlling stature of chrysanthemum and other sheet material plants, in spite of the fact that cycocel and alar are very powerful in chrysanthemum. Phosphon is exceptionally successful in controlling stature in lilies that Cycocel (CCC) was powerful in hindering development in numerous Malvaceous plants. (Bose and Hore, 1967) created predominate bougainvilleas in Calcutta by the dirt utilization of cleans of B-9, Cycocel and Phosphon. The perfect development retardant of things to come ought to be one which will be all around powerful, non-phytotoxic and will drag out the post-collect existence without leaving any unsafe leftover impact. Utilization of plant expansion controllers in blossom assumed a significant job in vegetative engendering, disallowance of abscission, prevention of bud lethargy, development control and consolation of blooming, impeding senescence, and so on. Development ad vertisers not with standing development retardants have been utilized in horticulture to move plant development in a favored manner **(Sharma et al., 2001)**. Hormones of plants are natural embodiment in modest quantities which control intracellular procedures and change physiological and biochemical responses in plants. In current conditions hormonal application has been a significant piece of bloom development. Inside the general gathering of plant hormones, some go about as development advertisers while others go about as development retardants. Gibberellic corrosive was discovered very effective in controlling development and blossoming in chrysanthemum **(Gautam et al., 2006)**. Gibberellic (GA_3) are a gathering of plant hormones made by the leaves of the cutting edge plant and building up the apex in the roots and stem **(Takahashi et al., 2012)**.

The most extreme impact of gibberellic is the change of smaller person plants to in tall ones by mounting in stem extension **(Phinney, 1956)**. Gibberellins instigated early blooming and delayed blossom life. Among the diverse development controllers GA_3 and cycocel this two are utilized broadly in the blossom creation. These two have enormous probability in controlling development, directing and drawing out cut blossom, time span of usability and its sprout quality. (Yabuta and Sumuki,1938) secluded Gibberellins An and B in the gem structure from the parasite yet not long after it was likewise segregated from the higher plants. The GA_3 guideline of development it self is associated with both cell division and impacts **(Sachs et al., 1958)** and cell broadening without cell division **(Haber and** Lopold,1960 and **Haber et al., 1969)**. Then again Cycocel (2-chloroethyl-trimethyl-ammonium chloride) is a powerful development retardant. Cycocel is a manufactured development retardant and Cycocel (CCC) impeded stem stretching by forestalling cell division in sub-apical meristem, for the most part without comparatively influencing the apical meristem. Cycocel was found to impact fundamentally the vegetative development of plants without influencing the bloom bud inception, rise of blossoming and length of blooming Cycocel increment the quantity of fanning, number of leaves, number of blooms and bloom yield per plant yet decrease the mean load of blossom.

In this way keeping in see these realities, the present examination expects to accomplish the accompanying target.

Keeping in mind above facts and considering the importance of the above mentioned data following investigation has been designed under the title **"Effect of Gibberellic Acid and Cycocel on Vegetative Growth, Flowering, Yield and Quality Attributes of African Marigold (*Tagetes erecta* L.)"**

Objectives:

1. To assess the effect of Gibberellic acid and Cycocel on vegetative growth of African marigold.
2. To find out the effect of Gibberellic acid and Cycocel on flowering of African marigold.
3. To estimate the flower yield of African marigold influenced by the spraying of Gibberellic acid and Cycocel.
4. To evaluate the effect of Gibberellic acid and Cycocel on quality attributes of African marigold.

Chapter-II

Review of Literature

A thorough review of literature on the effects of plant growth regulators on vegetative growth and flowering in African marigold (*Tagetes erecta* L.) was made. The effect of GA_3 and Cycocel are discussed on the basis of earlier works done on similar lines on this project. There is a growing interest in the plant growth regulators as these are very potential chemicals which can be used for getting higher yield, quality produce or controlling plant height and regulating flowering. Supporting evidences from other flower crops are also incorporated in the review for making the interpretation of results easier and to the point.

Role of plant growth regulators in vegetative growth of flowering plants:

Several works has been done to see the effect of plant growth regulators on the vegetative growth of flower plants. Investigation includes the effect of growth regulators on plant height, number of main branches and number of leaves per plant. 'Plant height control' this is an important area where good work has been done regarding the role of plant growth regulators. In modern days, city dwellers living in flats can hardly afford to grow tall plants because of lack of space. The use of growth retardants to reduce plant height brings hope for such people. The some available literature has been reviewed and is presented in brief as bellow:

2.1: Effect of Gibberellic acid on plant growth and flowering:

2.2: Effect of Cycocel on plant growth and flowering:

2.1 : Effect of Gibberellic acid on plant growth and flowering:

Mittal (1967) saw that GA_3 treated dahlia plants were taller in tallness comprisen untreated ones. **(Nanda *et al.,* 1973)** GA_3 expanded the expansion development (stature) of Impatiens balsa mina till 56 days under 8 and 24 hours photoperiods.

Smash *et a1*., (1970) found that splashing GA_3 on antirrhinum, in the fixation scope of 5-25 ppm aftermath in early blossoming. **(Mukhopadhyay et a1., 1975)** saw that foliar utilization of GA_3 (10 ppm) on carnation 140 days after germination improved the number and size of f1owers. Gibberellic corrosive has demonstrated powerful in managing the development and blooming of roses **(Koseva and Decheva, 1976; Ei-Shafle *et al.*, 1980). El-Shafle (1978)** announced that showering of GA_3 multiple times at month to month interims at 250 ppm on cv. Montezuma of Rose improved the quantity of blossoms and the longest, thickness and new weight of bloom stems contrasted with other consideration (50, 100, 150 and 200 ppm). The most elevated number of blossoms in a single year old plant (7.6 to 9.7) and the biggest 1owers were additionally acquired in Queen Elizabeth and Baccara rose cultivars by treatment with GA_3 at 250 ppm (El-Shafle et al., 1980). (Gowda, 1985) presumed that GA_3 shower on cv. Hotshot brought about increasingly number of blooms and longer stems which are the significant characters of a decent cut blossom.

(Slam *et al.*, 1970) made that splashing of GA_3 on antirrhinum, in the fixation differ of 5-25 ppm brought about early blossoming. At whatever time, (Mukhopadhyay et al., 1975) saw that foliar use of GA_3 (10 ppm) on carnation 140 days after germination upgraded the number and size of blossoms.

Verzilov and Runkova (1972) on Stock demonstrated that treatment with GA_3 at 0.02% propelled blossoming by 5-7 days, expanded the length of the bloom stems and improved blossom quality. A consolidated treatment of CCC and GA_3 restricted the inordinate extension without lessening the hour of blooming. CCC alone hampered development more especially in overshadow than in tall cultivars. Gibberellic was found to control blooming in orchids. In specific types of Cymbianum, use of GA_3 at 1000, 5000 or 10000 ppm at an interim of 2, 4, or a month and a half quickened blooming.

Shanmugan *et a1*., (1973) built up that Gibberellic corrosive at a convergence of 180 to 400 ppm expanded the plant tallness, intenodal length, however advanced prior blooming in Chrysanthemum. **(Sulladmath, 1983)** led field preliminaries on the impacts of development controllers treatment 25 days ater transplanting and twice or more at 15 days interims on the blooming qualities of China aster. He informationed that GA_3 treatment propelled blossoming in connection to control. Time of blooming was accounted for longest in the plants treated with GA_3 at 300 ppm.

Accati *et al.*, (1979) detailed that Caration cv. Pauline treated with ABA at 50 ppm or foliar splash once during resting of culttings caused later bud development outcome same bloom yield as hand squeezed plants. **(Mynctt, 1979)** applied ABA, GA_3 and NAA at 50 or 100 ppm under brief day condition and found that GA_3 hindered bud improvement more under brief days than under long days, NAA impeded advancement and caused bloom distortion while ABA had no impact on improvement**. (Dubey, 1972)** noticed that pot developed carnation cv. Improved Marguerite splashed with MH at 500 to 1000 ppm expanded the quantity of blossoms however blooming was deferred by 8-28 days relying upon the focus, searing of the leaf edges and twisting of leaves were brought about by fixation somewhere in the range of 1500 and 2000 ppm. At the point when pot developed carnation cv. Hanacy splashed with Cycocel at the focus running from 10 to 100 ppm improved botanical commencement and expanded the yield of bloom extensively **(El-Fouly *et al.*, 1977).**

Nijs and Boesman (1981) reminderd noteworthy increment in plant development by the utilization of GA_3 at 5-100 ppm. Also, **(Sarhan and Sayed, 1983)** recorded impressive increment in plant tallness and blossom stalk length with the utilization of GA_3 at 50-200 ppm. Treatment with ethephon at 1000 ppm condensed the tallness of antirrhinum plants, higher portions were poisonous and deferred blooming (Munshi et al., 1980).

Kumar and Nanda (1981) exploratory that the Impatiens balsamina seedlings of cultivar 'Rose' treated with GA_3 and held under inductive (8 hours) and non inductive (24 hours) photoperiod, bloomed in both photoperiodic conditions. Bloom bud commencement happened most punctual (inside 6 and 8 days in 8 hours and 24 hours photo periods, individually) and the quantity of blossom bud was highe (54.8 in 8 hours and 82.5 in 24 hours photoperiods) in GA_3.

Auge (1982) treated the gladiolus corms at 22°C for about a month and afterward absorbed GA_3 answer for 24 hours before planting, the GA_3 treated corms grew and bloomed before. In an examination on cv. Sylvia of Gladiolus, **(Dua *et al.*, 1984)** found improved blossom quality and better corm increase when the plants were splashed thrice with 100 ppm of GA_3. **(Halevy and Shillo, 1970)** detailed that dirt dousing with 0.8 percent CCC expanded stem length and number of blossoms per spike and marginally propelled the date of anthesis in Gladiolus.

Bhattacharjee (1983) announced that dousing Hippeastrum bulbs with GA_3 at 10 to 100 ppm, advanced vegetative development, impact early blossoming, expanded bloom estimate and stalk length, upgraded the quantity of bloom per stalk, broadened blossom life span, improved number, measure and weight of bulb. **(Bhattacharjee, 1983)** revealed that GA_3 (upto 1000 ppm) advanced early blooming in Lilium tigr'inum with soil douse of GA_3 flower generation was improved with GA_3 at 10 ppm. Bulb number and bulb weight expanded with GA_3 (upto 1000 ppm).

Mukhopadhyay and Banker (1983) splashed the plants of tuberose 40 days atter planting and twice at fortnight interim with GA_3 at 25-100 ppm or ethephon at 500-2000 ppm and saw that expanding fixations decreased the plant tallness. GA_3 expanded spike lengths and blossom number per spike. Ethephon at the most noteworthy fixation decreased spike length and blossom number. Length of blooming in the field was improved with GA_3 at 100 mg/liter. Both GA_3 and ethephon at all fixations repressed bulb generation.

Bhattacharjee (1984) watched upgraded vegetative development, cormel generation and improvement in blooming by utilizing GA_3 at 10 and 100 ppm, use of SADH, CCC at 1000, 2500 and 5000 ppm each as soil douse and ethrel at 500, 1000 and 2000 ppm expanded blossom size. **(Joneck, 1980)** detailed that dousing of Gladiolus corm in GA_3 and IAA arrangements hurried separation of flower primordia yet Kinetin hindered corm growing and shoot pinnacle separation. **Awad and Hamied (1985)**, working with GA_3 (10-500 ppm), Kinetin (1-50 ppm), ethephon (1-100 ppm) and gamma illumination (23-415 R), recorded separation of individual blossoms and longer bloom spikes by treatment with short fixations in Gladiolus.

Mukhopahdyay and Sadhu (1985) announced that GA_3 treatment (10 to 500 ppm) deferred growing of bulbs in tuberose and furthermore decreased the quantity of bulbs per plants at 50 ppm. While concentrating the impact of various development managing synthetic concoctions on the development and yield of bloom of Calendula**, (Pal *et a1.*, 1986)** revealed that treatment with GA_3 (25,50 and 100 ppm) caused checked increment in plant tallness. **(Hore and Sen, 1986)** directed an investigation on French marigold (*Tagetes patula*) to evaluate the impact of pre-transplanting splashing of roots in Ethrel, NAA, thiourea, or $NaH_2PO_4.2HO$,GA_3, each at 50, 100 and 200 ppm, on development and blossoming. GA_3 at 50 and 100 ppm, $NaH_2PO_4.2H_2O$ at100 ppm and thiourea at 200 ppm hurried blooming by nine days, while medicines with thiourea at 100 ppm, $NaH_2PO_4.2H_2O$ at 100 ppm, GA_3 at 100 ppm and Ethrel at 50 ppm caused stamped increments in plant stature over the untreated control. Most extreme plant spread was gotten with $NaH_2PO_4.2H_2O$ at 200 ppm.

Shedeed *et a1.*, (1986) revealed that period two progressive seasons, Zinnia elegans and *Tagetes erecta* were treated with GA_3 at 100-400 ppm or Alar (daminozide) at 250-2000 ppm, at about a month from planting out 0323 No IOHS/Z and again a month later, in the two species GA_3 for the most part expanded plant tallness though daminozide diminished it. Vidhu and Murty (1985) inspected. development substance interceded Chlorophyll changes in Tagetes erecta. Plant were splashed multiple times with IAA (50-500 ppm), TIBA (50-500 ppm), GA_3 (50-500 ppm) or Kinetin (10-100 ppm). High IAA focuses, low GA_3 and TIBA fixations and all Kinetin focuses animated Chlorophyll blend.

Hanks and Jones (1986) got negligible impact of auxin on stem length adjust showering two cultivars of Narcissus sp., Carlton and Fortune in the nursery, yet gibberellic corrosive caused some stretching and when GA4+7 was splashed thrice in seven days beginning from 27 March at the state when blossom buds were simply noticeable, instigated 10% expansion in stem length.

Lal and Mishra (1986) detailsed that the best number of blooms were created in Marigold treated with GA_3 at 200 ppm and the blossom size was most noteworthy at 150 ppm GA_3.While concentrating the impact of various development managing synthetic concoctions on the development and yield of blossom of calendula, **(Pal *et al.*, 1986)** announced that foliar shower of GA_3 (25,50 and 100 ppm) hurried blooming by 4-5 days. Note worthy increment in the quantity of more up to date per plant was recorded with GA_3 at each fixation. Moderate development decrease and the most elevated number of blooms first plant were acquired with CCC at 300 ppm or

TIBA at 750 ppm when seedlings of African marigold cv. Phenomenal were treated with TIBA or CCC.

Chaudhary (1987) saw that the treated tuberose plant with 50 ppm GA_3 brought about increasingly number of blooms per plant. **(Nagarjuna *et a1.*, 1988)** contemplated the impact of root plunge and splash medications of development controller GA_3 on Chrysanthemum. They announced splashing was more viable than plunging. Further, the opportunity to 50 % blooming was rushed by GA_3 (100 and 200 ppm) by 17 to 21 days. Blossom width was recorded most noteworthy with GA_3 at 200 ppm. MH (250-500 ppm) deferred the Howering by 17-23 days, contrasted and untreated controls. Treatment with B-9 at 5000 ppm gave the most noteworthy number of blossoms per plant (102.9). **Dutta (1992)** utilized GA_3 at three focuses as foliar showers in Chrysanthemum.The medications were given twice 30 and 45 days in the wake of planting. Blossom bud inception and initiation of blooming were progressed fundamentally by the medications of GA_3 while it was postponed by CCC.

Dahab *el al.*, (1987) announced that when the Chrysanthemum frutescens were treated with GA_3 at 250, 500, 1000 ppm; multiple times during the beginning times, the treatment particularly at 500 ppm and 1000 ppm expanded the plant stature, plant spread, breadth and the quantity of shoot per plant and the length of shoots. GA_3 hastend blooming however under higher fixations it diminished the quantity of inflorescence per plant.

Girwani *et al.*, (1987) saw that GA_3 at 100 ppm brought about the tallest plants and biggest bloom distance across and peduncle length in African marigold.

Syamal *et al.*, (1990) treated the African Marigold plants utilizing cultivar 'Sun Set Giant' with various convergences of GA_3 and saw that the most noteworthy number of blossoms per plant and seed generation were acquired with 200 ppm GA_3.

Drewes *et al.*, (1990) decided the impact of the utilization of Gibberellins to Tagetes minuta seeds at both 25°C, the ideal germination temperature at 35°C, at which temperature the seeds are thermoinhibited. Both GA_3 and GA4+7 quickened germination at 25°C. Seed germination at 25°C was restrained by paclobutrazol, however on resulting use of GA4+7, quick germination was incited. Following use of

GA_3 or 6 AM to thermoinhibited seeds, a fundamentally higher last germination rate was seen than in the refined water control.

Beura and Maharana (1990) revealed greatest shoot root proportion (2.12) and most reduced number of tubers per plant (6.25) and tuber yield with 200 ppm of GA_3 shower in Dahlia variabilis.

Singh *et a1.*, (1991) directed a trial on African Marigold, cultivar 'Hazara' with five degree of Gibberllic corrosive for example 100, 200, 300, 400 and 500 ppm and announced that the higher convergence of Gibberellic corrosive medicines at 22 days in the wake of transplanting expanded the development and blossom yield essentially and furthermore expanded the quantity of blooms per plant, bloom weight and the length of blossoming. Treatment with 400 ppm gibberellic corrosive multiplied the blossom creation contrasted with the untreated plants. Critical increment in blossom generation of dahlia by Ehtrel splash at 500 and 1000 ppm and a pattern of increment in bloom yield by CCC and MH was additionally recorded by **(Pappiah and Muthuswamy, 1974).** Expanded more current number was accounted for with the treatment of GA_3 in dahlia cv. Cr. Perfect work of art **(Bhattacharjee *et al.*, 1976).**

Davis (1991) revealed that seedling stature of Zinnia elegans cv. Califomia Giant and *Tagetes erecta* cultivars Golden Climax and Orange Lady can be controlled during creation by applying 5-25 mg Uniconazole/liter without antagonistically influencing resulting development in the wake of blossoming. The unfriendly impact subsequent to transplanting brought about by applying 50 mg uniconazole per liter could be somewhat turned around in the two species by a solitary splash of 100 mg GA_3/liter. Buddy and Das (1990) examined the impact of foliar shower of development controllers on pruned lillies, GA_3 expanded plant stature and number of leaves.

Ravidas *et al.*, (1992) GA_3 at 100 ppm brought about most extreme plant stature (53.87 cm) and increasingly number of leaves per plant (6.33), greatest number of florets (16.0) per spike, weight of corm (35.61g) and weight of cormels (13.48g) contrasted with GA_3 at 100 ppm in gladiolus cv. Fellowship.

Das *et al.,* (1992) watched critical increment in plant tallness (69.30 cm) and number of leaves (26.00) contrasted with control (45 cm and 18, separately) with the shower of GA_3 at 200 ppm in Hemerocallis aurantiaca (Day lilly).

Dehale *et al* ., (1993). GA_3 improved blossom size, which expanded put away nourishment material in the tissue, which caused increment in container life of blooms in a roundabout way. The constructive outcome of GA_3 in expanding the jar life saw in the present study is in consonance with the discoveries of **(Dhekney *et al* ., 2000)**.

Bessler (1996) revealed that plant of Begonia cv. 'Constant Dunkelscharlack' raised from seed were treated with GA_3 at 0-1000 ppm, applied as shower or poured in the pot. GA_3 application diminished the level of female blossoms with expanding fixation and expanded extension. The level of twofold male blooms was not influenced by development controller application.

Singh and Bijimol (2001) sober minded an enlarge in plant tallness (35.15 cm), expanded number of florets (41.66) and progressively number of leaves (32.83) per plant, per spike and weight of florets (55.40g) per plant in tuberose with GA_3 at 200 ppm treatment contrasted with control.

Padmapriya and Chezhiyan (2002) to think about the blooming execution and female characters in 4 chrysanthemum cultivars (Baggi, Indira, Red Gold and Shyamal) in light of development substances medications; for example gibberellic corrosive (GA_3) at 100 and 150 ppm, salicylic corrosive (SA) at 50 and 100 ppm, triacontanol (TR) at 1, 2 and 3 ppm and brassinoste roids (BR) at 0.1, 0.2 and 0.3 ppm. The length of the hower stalk and shower was expanded radically by GA_3 treatment in all cultivars contrasted with the control. Indira recorded the longest shower with GA_3 treatment at 150 ppm, while the broadest blossom breadth was gotten in BR treated plants independent of the cultivar. The heaviness of the personage bloom was expanded in Shyamal treated with SA at 100 ppm.

Du Hong Mei *et a1.,* (2002) examined on GA_3 treatment on anthesis of spring Chrysanthemum and natural impacts. GA_3 at 25, 50 and 100 mg/liter, applied during the separation of bloom buds, propelled the hour of bud development of spring Chrysanthemum by l, 3, and 1 day, individually. Alabastrums increased and the hour of first blooming was progressed by 2,6 and 6 days separately, when GA_3 was applied at 25, 50 and 100 mg/liter during the growth of alabastrums. The hour of first blooming was progressed by 2 and 6 days when GA_3 was splashed during the separation of blossom buds and extension of alabantrums, individually and by 8 days when GA_3 was showered twice. Dry matter and dissolvable sugar content expanded in the apical buds because of the GA_3 medications.

Maurya and Nagda (2002) watched most elevated tallness (104.50 cm) in the plant treated with 100 ppm GA_3 when contrasted with control (95.10 cm) in gladiolus cv. Kinship. Splashing of GA_3 at 100 ppm expanded the quantity of corms per plant(1.87), weight of corms per plant (78.70g) and weight of corms per bed (1.60kg) when contrasted with control (1.20,53.30g and 0.95 kg/bed, correspondingly).

Singh *et al* ., (2002) revealed that GA_3 100 ppm broadly expanded crisp load of leaf and breadth of blossom, which was at standard with GA_3 200 ppm.

Sujatha *et al.*, (2002) uncovered that showering of GA_3 at 100 ppm found the most extreme plant spread (31.10 cm), increasingly number of leaves (15.19), progressively number of blossoms (18.63) per pot and distance across of bloom head (7.53 cm) toward to control in gerbera.

Khan and Tewari (2003) directed a trial on dahlia where they discovered GA_3 at 90 ppm widely enlarged the plant tallness (69.00 cm), made progressively number of branches (6.60) and blooms (15.80) per plant as in opposition to controlin dahlia.

Kumar *et al.*, (2003) directed a trial on China aster and notice that the most noteworthy stature (62.00 cm), number of branches (20.27) per plant, number of blossoms (67.33) per plant, bloom weight (2.86g) and blossom yield (192.59g) was found with GA_3 at 200 ppm in opposition to GA_3 100 ppm in China aster cv. Kamini.

Kulkarni (2003) in an examination on chrysanthemum found the expediting of early blossoming (88.60 days) with the utilization of GA_3 at 200 ppm in spite of control (97.10 days) in chrysanthemum.

Tripathi *et al.*, (2003) demonstrated that GA_3 at 400 ppm watched most extreme blossom yield per plant (127.71g) and number of blooms per plant (78.83) in French marigold.

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Pandey and Chandra (2008) completed a trial and found that GA_3 at 450 ppm broadly expanded plant stature, number of branches, distance across of fundamental stem, number of leaves, number of blooms and all out yield of blossoms in French marigold as in opposition to different medications.

Bihari and Narayan (2009) inspected that splashing of 100 ppm GA_3 at multi day safter transplanting demonstrated essentially proficient for a floriferous yield of African marigold cv. African Orange.

Dalal *et al.*, *(*2009) found the most elevated vegetative development, blossom yield and quality with treatment of GA_3 at 150 ppm in gerbera under polyhouse conditions. While, early blossoming was seen with 50 ppm GA_3 application.

Mayoli *et al.*, (2009) indicated early blossoming, most excellent bloom, greatest stem measurement, early bloom bud inception, the most elevated blossom head width and higher tuberous root crisp load in ranunculus cut blossom when tuberous roots were immersed in 100 mg/l GA_3 before planting.

Parmar *et al.*, (2009) directed a trial on creepy crawly lily and found that on that splashing of 200 ppm GA_3 twice for example 45 and 60 days subsequent to planting uncovered strength in all vegetative, botanical and yield characters viz., plant stature (79.92 cm), number of leaves per plant (60.33), leaf width (7.23 cm), leaf territory (377.92 cm), dry load of plant (0.97 kg), bloom measurement (4.26 cm), days taken for first spike development (53.38 days), days taken for first blossom rise (61.14 days), spike length (89.62 cm), number of blossoms per spike (17.32), new blossom weight (2.85g), dry bloom weight (0.38g) and yield (50812 rose bud groups for every hectare).

Ramdevputra *et al.*, (2009) saw that all the vegetative development characters of African marigold were exceptionally impacted by GA_3 at 300 ppm. Greatest number of blossoms per plant (86.43), weight of blooms (248.67g) per plant and blossom yield (79.56 q/ha) were gotten by splashing of GA_3 at 300 ppm.

Shinde *et al.*, (2010) demonstrated that fundamentally the most noteworthy number of branches, plant spread, number of suckers per plant, number of blossoms per plant and yield of blooms per plant equivalent to per hectare with the splashing of GA_3 at 200 ppm in (Chrysanthemum morifolium R.) cv. IIHR-6. In any case, least number of days for inception of blooming and that for top blossoming, greatest term of blooming, blossom width, crisp blossom weight and container life of blooms were acquired with 150 ppm GA_3.

Shivaprakash *et al.*, (2011) demonstrated that use of 200 ppm GA_3 bring about more plant stature, heighest stem circumference, progressively dry issue creation in stem, leaf and blossom in African marigold (*Tagetes erecta* L.) cv. Orange twofold, likewise saw essentially more width of bloom, number of blossoms per plant, yield per plot (6.45 kg) and yield per ha. (9.83t) than control.

Kumar *et al.*, (2012) in a study found that GA_3 application at 350 ppm was generally significant as it gave most elevated bloom yield per plant, greatest new weight per blossom and most elevated number of blossoms per plant, prior bloom bud commencement and blossoming, likewise greatest number of leaves as this like plant stature in African marigold.

Kumar *et al.*, (2012) indicated that use of GA_3 at higher centralization of 100 ppm as a pre-reap splash exerte a noteworthy convince on crop development and recorded most elevated mean qualities for plant tallness (76.18 cm), stalk length (60.98 cm), stem size (1.66 cm), absolute chlorophyll content (1.826 mg/g) and early blossoming (40days) in rose. While, GA_3 at 100 ppm radically increased the quality attributes viz., mean bloom breadth (6.89 cm), anthocyanin content (0.1970 OD worth) and shelf life (2.6 days).

Kumar *et al.*, (2012) indicated that GA_3 at 200 ppm enlisted widely the most elevated bloom yield per plant (639.18 gm) with longest length of blossoming (87.18 days) in spite of control in African marigold.

Kanwar *et al.*, (2013) indicated that solitary splash of GA_3 at 150 ppm saw broadly higher plant tallness (83.30 cm), leaf zone (1188.58 cm), number of blossoms per plant (78.49), normal load of bloom (4.85g) and yield of blossoms per plant (365.23g) as this like per hectare (132.27 q/ha) in African marigold.

Sanjay Kumar and Bikas Das (2015) saw that number GA_3 at 300 ppm was best in all regards and it expanded plant tallness, leaf number, number of blooms length of blossoming, mean load of bloom and diminished the days taken for bloom bud commencement and blooming. At whatever point, Cycocel at 2000 ppm was additionally discovered successful in controlling vegetative development without influencing the blossom quality, term of blooming, days required for blossom bud commencement and blossoming.

Sarkar *et al.*, (2018) in an assessment found that the use of GA_3 at 200 ppm recorded widely higher plant tallness (85.36cm), number of branches per plant (39.72), absolute leaf number (183.43), number of blooms (63.80) and blossom Y/Ha (10.19t).

2.2: Effect of Cycocel on plant growth and flowering:

Bomemann and Muhe (1967) detailed that, treatment with 3% CCC arrangement in soil of pruned rose plant caused dwarfmg and improved blooming.

Bhattacharjee and Bose (1979) announced that two splashing with 8-9 at 4000 ppm on pruned rose plants caused stamped decline in shoot development.

Mukherjee (1971) revealed that medicines with CCC at 8000 ppm make the Amaranthus tricolor plants thick and increasingly alluring. He like wise detailed (1971) a similar outcome in Antirrhinum majus with no unfavorable impact on blossom creation. **Mukherjee (1971)** announced that treatment with CCC in Hollyhock impeded the plant stature to a degree of 33.4 percent which has likewise actuated more blossoms. B-nine is additionally a viable development retardant in Dahlia as revealed by **(Bhattacharjee *et a1*., 1971).**

Bhattacharjee *et a1*., (1971) likewise acquired enormous size blossoms with SADH shower. In another trial on dahlia, SADH (1000-5000 ppm), TIBA (500-2000 ppm) and Ethrel (2000 ppm) postponed bloom bud appearance by 6-15 days, where as MH (500-1000 ppm), GA_3 (10-100 ppm) and NAA (10-100 ppm) propelled it by 4-5 days **(Bhattacharjee, 1984).**

Hore and Bose (1972) revealed that utilization of SADH hindered shoot development in Jasminum sambac. In Jasminum grandiflorum, GA_3 at 25-75 ppm fundamentally expanded the length of essential and optional shoots though MH at 1000-3000 ppm, TIBA at 100-300 ppm CCC at 500-1500 ppm, Ethrel at 100-500 ppm diminished shoot length. The most noteworthy number of horizontal shoots was on plants treated with CCC, trailed by TIBA and MH. GA_3 treatment brought about minimal number of horizontal shoots, MH expanded the quantity of intemodes and GA_3 expanded their length **(Pappiah and Muthuswami, 1977).**

Pappiah and Muthuswamy (1974) announced that concealment of plant tallness in tuberose can be accomplished by applying MH and Ethrel and when CCC and Ethrel were applied then these animated progressively number of branches. Treatment with IAA and GA_3 at 100 and 1000 ppm indicated checked advancement in short length of Dahlia variabilis cv. Marter Piece (Bhattacharjee et al., 1976). Also, TIBA at 2000 ppm or MH at 5000 ppm extraordinarily diminished plant tallness in tuberose contrasted and the control **(Bhattacharjee *et al*., 1984).**

Shanmugan and Muthuswamy (1974) contemplated the impact of Cycocel on Chrysanthemum, cycocel was splashed at 5000, 1000 and 15000 ppm treatment expanded anyway size in the cultivar "White" yet decreased it in "Yellow" cultivar. All medications hurried fiowering in "White' and deferred in "Yellow'. **(Kanwar and Nanda, 1985)** announced that the blossom bud inception in amber plants was progressed impressively and the quantity of bloom buds was higher in GA_3 than in Tonic corrosive treated plants.

Nanjan and Muthuswamy (1975) announced that TIBA at higher focus caused shorter shoots and intemodes yet expanded the quantity of branches and blossoms in Rosa borbom'ana. Utilization of GA_3 expanded the length of shoots both by broadening the intemode length and expanding the quantity of hubs **(Koseva and Decheva, 1976; El-Shafle *at al.,* 1980).**

El-Shafie and Hassan (1978) explored the impact of GA_3 and CCC on development and blossoming of (Gerbera jamesonii). Treatment with low grouping of GA_3 (50 ppm) caused early 1owering though CCC postponed it. The quantity of blooms was expanded by GA_3 at 100 ppm during the primary season and at 100, 150 and 200 ppm in the subsequent one. CCC at 500 ppm advanced blooming in the two seasons. Less yet heavier blooms were delivered with 750 CCC. Both GA_3 and CCC marginally expanded the bloom width. Development of blossom peduncle was advanced by GA_3 and hindered by CCC.

Wilson and Holcomb (1979) watched decrease in plant stature of African marigold, and dim green shade of foliage in cv. Moon Shoot, Yellow Gallore, First Lady when the plants were splashed with SADH at 2500.

Buddy *et al.,* (1980) revealed that treatment with ethrel advanced the stature of plants while CCC hindered development in Jasminum auriculatum. The impact of mulching materials, GA_3 medications and shade on development of Lilium were examined by (Lee Jung IL, 1997) during the hot season in Korea Republic. Under 75 percent conceal, stem breadth expanded with expanding use of GA_3. The longest intemode was watched following two use of GA_3 at 75 percent conceal. Tallest plants were seen in the husk mulch +75 percent conceal +3 use of GA_3 treatment.

Bose *et al.,* (1980) Soaking on Hippeastrum bulbs in 3 focus every one of IAA, GA_3, CCC and Ethrel demonstrated different reactions to development and blossoming. IAA expanded the weight and number of bul blets while GA_3 improved the bloom breadth and bulb weight. CCC (1000 ppm) expanded the quantity of blooms per plant. Utilization of IAA at 100 ppm and GA_3 at 10, 100 or 1000 ppm twice as foliar shower at all interim of 15 days advanced the quantity of bul blets on the treated plants while high convergence of CCC and Ehtrel (1000 ppm) expanded the heaviness of bul blets. All groupings of IAA, GA_3 and 1000 ppm CCC expanded the number and size of blossoms.

Biswas (1981) revealed that conservative rugged plants with increasingly number of Hower was acquired because of treatment with 4000 ppm of CCC when applied thrice as foliar showers on *Tagetes erecta.* Biswas (1981) additionally created diminutive person rugged plants with increasingly number of blossoms in Helichrysum bracteatus with CCC at 2000 ppm. To get stocky plants with no unfriendly impact on bloom generation Biswas (1981) got great outcome by applying 4000 ppm CCC twice at an interim of about fourteen days in Delphinum ajacis. In a pot culture investigate "Bliss" cultivar of rose, **(Hallikeri, 1985)** utilized CCC as soil douse and recorded decrease in plant tallness with CCC at 2500 ppm quickened blossom bud appearance and improved bloom yield.

Maharana and Pani (1982) utilized Cycocel (2500-10000 ppm) on HT rose cultivar "Festivity". It was seen that CCC impeded plant stature and propelled blooming at 5000 or 10000 ppm. Biswas (1981) announced that triple splash of CCC at 2000 ppm decreased the plant tallness of antirrhinum apparently with no unfriendly impact on blossom creation.

Sarhan and Sayed (1983) recorded the biggest number of blossoms per spike when antirrhinum plants were splashed with 50-1200 ppm CCC. Use of SADH (250 - 2000 ppm) a month subsequent to planting and again a month later decreased the plant stature and deferred f10wering in antirrhinum. Be that as it may, there was an expansion in the quantity of inflorescence and florets per inforescence **(Shedeed *et al.*, 1986).** In a preliminary with GA_3, MH and NAA each at different fixations upto 1000 ppm, Reddy (1978) saw that the quantity of blooms per plant and the span of blossoming in China-aster (Callistephus chinensis) was improved by GA_3 at 200 or 300 ppm, MH postponed blossoming while NAA had little impact on development and blooming.

Bhattacharjee (1983) showed that when Jasminum grandiflorum was splashed with IAA, GA_3 NAA, MH or TIBA at 10, 100 or 1000 ppm. CCC, SADH at 100, 1000 or 5000 ppm, and ethrel at 500, 1000 or 2000 ppm then the most elevated number of blossoms per plant every year was acquired with IAA at 10 ppm (5993.6), SADH at 5000 ppm, GA_3 at 10 ppm and CCC at 100 ppm developed the bloom number by 31.8-4930 over the control plants delivering on a normal 4019.7 blooms for each plant.

Novoselova *et al.*, (1985) saw that splashing or watering *Tagetes patula*, developed as a pot plant in winter and spring, with CCC toward the beginning of bud arrangement markedly affected development and blossoming, best outcomes were acquired when 2-5% arrangements were utilized as soil soak on 2 dates. The treated plants were increasingly uniform in development, predominate and thick with more branches and created bigger number of blossoms in correlation with the control plants. Different paces of a crymidol as granular, granular communicate, soil douse or foliar splash medications were additionally tried by **(Murray *et al.*, 1986).**

Shedeed *et al.*, (1986) The plant stature of *Tagestes erecta* was controlled most viably by 311 to 622 mg acrymidol/m as a douse or granular consolidated. During two progressive seasons, *Tagetes erecta* was treated with GA_3 at 100-400 ppm or SADH at 250-2000 ppm at about a month from planting out and again a month later. GA_3 by and large expanded plant tallness while SADH diminished it. Blooming time was not influenced by GA_3 where as SADH postponed it.

Dhua *et a1.*, (1987) announced that treatment with GA_3 at 200 mg/l caused most punctual blossoming and gave the greatest yield of spikes and blooms in Tuberose. In tuberose **Biswas *et a1,*. (1983)** found that leaf development was speediest (11 days) in bulbs treated with IAA at 10 mg/l, the principal bloom spike rose most punctual (87 days) in bulbs absorbed CCC at 2.0 ml/l. The most noteworthy number of blossom spikes (6/bunches) was acquired after foliar use of GA_3 at 1000 mg/l, CCC at 0.2 ml. also, the most noteworthy number of blooms per spike (46) was on plants showered with GA3 at 100 mg/l. **(Jana and Biswas**,**1982)** announced that in tuberose most limited time to blossom opening (97) happened in plants treated with 10 ppm GA_3, and the best number of blooms per spike (35.5) was on plants treated with 1000 ppm.

Pobudkiewicz and Goldsberry (1989), examined the impact of Cycocel on the tallness of diminutive person Carnation 'Snowmass'. Root cuttings of cv. Snowmass were planted in 4 inch measurement pots on eleventh Oct. further more, squeezed on seventeenth Oct. to leave 3-4 sets of leaves. They were splashed on lst Jan. (at the point when plants were 3-4 inches tall) and again on 25th Jan. with Cycocel at 0, 1500, 2000, 2500, 3000 or 3500 ppm. Treatment didn't influence blooming time or blossom width. Every single treated plant were essentially shorter than the controls, yet there were no noteworthy contrasts in stature between 1500, 2000 and 2500 ppm medications. Introductory development was hindered generally (26%) by 3500 ppm, yet optional shoots by passed the principal flush of blossoms. Overshadowing was not kept up for long time, the subsequent application and negligible leaf staining from the primary splash was increased. Cycocel treatment is in this way not prescribed at present for use on predominate carnations.

Gowda and Jayanti (1991) found that the decrease in plant stature and expanded number of branches showered with 2000 ppm Cycocel on African marigold cv. Bangalore Local at third and fifth weeks in the wake of transplanting of seedlings. They additionally Studied that the impact of Cycocel at (1000, 1500 and 2000 ppm) fixations in marigold plant and uncovered that the expanded number of blooms per plant with expanded focuses.

Latimer (1991) directed and investigate zinnia with different showers of parclobutrazol 20 ppm, 5000 ppm diminozide and 200 ppm ancimidol. It was reasoned that green house plants showered paclobutrazol 20 ppm diminished the plant tallness.

Aswath *et a1.*, (1993) detailed that among the four development retardants viz. CCC, Alar, MH and TIBA application on China aster cv. 'Powder Puff Mixed' treatment with MH at 1500 ppm was seen as the best in decreasing plant stature.

Khimani and Pati (1993) to examine the occasional varieties in the impacts of CCC at 500, 1000 and 1500 ppm on yield ascribing characters and yield in Kharif and Rabi seasons. Noteworthy increment in Hower yield was noted because of treatment with CCC at 1000 ppm despite the fact that the plant stature was diminished in both the seasons because of the activity of development impeding synthetic substances.

Ryu *et al.*, (1993) revealed that CCC alone or in blend with GA_3, ABA, MH delivered acceptable outcomes, both as far as blossoming and plant size control. Established cuttings Chrysanthemum cv. 'Tumruli' were splashed with GA_3 (10, 20, 40 ppm) and CCC (5000, 10000 and 15000 ppm) 35 days subsequent to planting in pots.

Aswath *et al.*, (1994) recorded lower plant tallness (38.52 cm) and most extreme number of branches (24.43 per plant) with cycocel was splashed at 1500 ppm contrasted with control (47.56 cm and 15.52 cm, individually) in china aster.

Talukdar *et al.*, (1994) announced that GA_3 at 20 ppm delivered the tallest plants (31.3 cm contrasted and 19.8 cm for controls). Treatment with 10 ppm GA_3 brought about noteworthy more blossom per plant than in charge, without a critical increment in plant stature. CCC at 5000 ppm came about in the most limited (16.8 cm) contrasted and 19.8 cm for controls. In a pot try different things with shower chryranthemum cv. 'Prof. Harris', established cuttings were splashed with GA_3 (10, 20, 40 ppm) and CCC (5000, 10000, 15000 ppm). GA_3 medicines essentially expanded the plant tallness with 40 ppm being best (54.6 cm contrasted and 41.5 cm for untreated controls). Number of leaves and branches were most elevated with 5000 ppm CCC **(Talukdar and Paswan, 1996).** Splashing African marigolds with Cycocel (750 ppm) diminished the quantity of branches (17/plant). Use of maleic hydratide diminished plant stature **(Yadav, 1997). (Dawh *et al.*, 1998)** led an examination on *Tagetes erecta* and announced that as the chloride saltiness level in water system water expanded to 3000 ppm the crisp and dry load of leaves per plant diminished. Three showers of Cycocel or Alar at 250 or 500 ppm or paclobutrazol at 12.5 ppm diminished the unsafe impact of saltiness on leaf weight. Both basic oil rate and oil yield per plant were altogether diminished as saltiness expanded. Development controller treatment diminished the unsafe impacts of saltiness on oil rate and yield. The level of terpinene hydrocarbons was expanded by the most noteworthy saltiness of 3000 ppm and the development controllers created an extra increment in hydrocarbons. P-cymene was the significant hydrocarbon pursued by Limoncne then alpha-tespinene. Oxygenated mixes diminished with expanded saltiness, yet this impact was enhanced by applying development controllers to influenced plants.

Talukdar and Paswan (1996) led an analysis in chrysanthemum cv. "Prof. Harris" with GA_3 (10, 20 and 40 ppm) and CCC (5000, 10000 and 15000 ppm). The biggest blossoms were acquired) with 40 ppm GA_3 (9.9 cm contrasted and 7.1 cm in controls) and CCC at 500 ppm gave most elevated number of beam florets. All medicines of GA_3 and CCC signiticantly expanded individual blossom fragile living creature and dry weight (g).

Yadav (1997) revealed that splashing African marigold with Cycocel (750 ppm) brought about the most elevated blossom weight (10.8g/bloom), width (8.2 0cm) and diminished the quantity of days to blooming (43.68). Utilization of maleic hydrazide decreased plant stature.

Dabas *et al.*, (2001) examined the reaction of Tagetes erecta cv. Yellow Treasure to gibberellic corrosive (100,150,200 and 250 ppm), maleic hydrazide (200, 400, 600 and 800 ppm), and NAA (20, 40, 60 and 80 ppm) application at 10, 25, 40 days in the wake of transplanting. Among the development controllers, just gibberellic corrosive essentially expanded the quantity of essential branches per plant. The most elevated number of essential branches per plant (17.1) was acquired with 100 ppm. The impact of Gibberellic corrosive (splashed at 50, 100 and 200 mg/liter) on development and blossoming of Chryranthemum morifolium cv. Jayanti was researched by (Gupta and Dutta, 2001). GA_3 was successful at all focuses in expanding the plant stature and cut bloom yield. The ideal increment in these parameters was seen at 100 mg GA_3/Liter. The impacts of CCC (1000, 2000 and 3000 ppm) and maleic hydrazide (500, 750 and 1000 ppm), just as of squeezing (20 or 30 days in the wake of planting) on the development and yield of African marigold were resolved in a field explore during the blustery season. Plant tallness and length of intemode diminished where as stem width and number of branches per plant expanded with expanding paces of CCC and maleic hydrazide. The qualities for the parameters estimated were higher with right on time than late squeezing aside from intemode length **(Kandelwal *et al.*, 2003).**

Khandelwal *et al.*, (2003) decided the impact of (1009, 2000, 5000 ppm) and maleic hydrazide (500, 750 and 1000 ppm), just as squeezing (20 or 30 days in the wake of transplanting) on the development and yield of African marigold during blustery season. The quantity of days to first nowering and length of blossoming were lower where as bloom weight, unblemished Hour life span, number of blooms and yield were higher with right on time than late squeezing. As a rule, the estimations of the yield and yield qualities expanded with expanding paces of chlormequat and maleic hydrazide.

Prashanth (2003) recorded that base shoot length and least bury nodal length with CCC at 3000 ppm in floribunda rose cv. Icy mass.

Balachandra *et al.*, (2004) revealed that decrease in plant stature (57.30 cm) with splash of CCC (1000 ppm) yet delivered most extreme number of branches (16.40 per plant) contrasted with control (61.60 cm and 14.00, separately) in ageratum.

Himabindu (2010) saw that CCC at 1250 ppm recorded least plant tallness (91.81cm) and least number of days to half blossoming (68.28) in African marigold cv. Pusa Narangi Gainda and CCC at all fixations diminished the quantity of days to half blossoming over control (73.97).

Pushkar and Singh (2012) detailed that early squeezing (20 DAT) with higher convergence of Cycocel (1000 ppm) was proposing for most extreme number of buds and blossoms per plant, weight of blooms and yield of blooms per hectare in African marigold.

Naidu *et al.*, (2014) discover the compelling development retardant for vegetative development and blossom yield of African marigold cv. Pusa Narangi Gainda. Plants were showered with CCC, at 750, 1000 and 1250 ppm separately. All the convergence of CCC smothered plant stature upgraded the plant spread and number of laterals over control. Anyway CCC at 750 ppm recorded most extreme blossom yield per plant and per hectare.

Buddy *et al.*, (2014) detailed that the impact of CCC on development and bloom yield of African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda. CCC (200 and 400 ppm) were splashed on plant at 25 days subsequent to transplanting while refined water showered uniquely as Control. Among the treatment CCC (400 ppm) diminished the stature of plant and yet it altogether expanded the quantity of bloom, width of blossoms and all out yield of blooms when contrasted with different medications. utilizing CCC and MH in African Marigold and Gladiolus.

Khobragade *et al.*, (2014) included four degrees of Cycocel as a foliar applications viz. C1-Control, C2-Cycocel 1000 ppm, C3-Cycocel 1500, C4-Cycocel 2000. Among the treatment Cycocel 2000 ppm, was discovered essentially greatest number of blossoms per plant and yield of blooms per plot and per hectare when contrasted with other treatment. In any case, the foliar utilization of Cycocel at 2000 ppm recorded postponed blooming.

Sasikumar *et al.*, (2015) Stated that the uses of CCC at 2000 ppm on African marigold (Tagetes erecta L.) cv. Pusa Narangi Gainda was recorded least plant stature (46.0 cm), most extreme plant spread (29.66 cm) and greatest number of branches (19.0), greatest blooming span (25.33 days), number of blossoms per plant (40), single blossom weight (119.46g), blossom yield per plant (408.10g), blossom yield per unit region (17.83 t/h). They additionally found that the most extreme bloom distance across (7.93) cm and greatest time span of usability of blossoms with CCC 2000 ppm.

Chapter-III

Materials and Methods

The present inspection titled "**Effect of Gibberellic Acid and Cycocel on Vegetative Growth, Flowering, Yield and Quality Attributes of African Marigold (*Tagetes erecta* L.)"**was carried out at Horticulture Research Farm, Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedkar University,Vidya-Vihar, Rae Bareli Road, Lucknow 226 025 (U.P.) during the summer season of 2016-17 and 2017-18. The information of methodology adopted in this experiment have been presented below:

Location and site of experiment:

The present investigation was carried out at Horticulture Research Farm, Department of Horticulture, Babasaheb Bhimrao Ambedkar University (A Central University), Vidya-Vihar, Rae Bareli Road, Lucknow 226 025 (U.P.), India during the 2017-18.The Horticulture Research Farm, Department of Applied Plant Science Horticulture, Babasaheb Bhimrao Ambedkar University, Vidya- Vihar, Rae Bareli Road, Lucknow is situated at elevation of 111 meter above mean sea level in the subtropical tracts of Central U.P. at 26^0-56^0 North latitude.

Topography, climate and weather conditions:

The climate of Lucknow is characterized by sub-tropical with hot, dry summer and cool winters. This region receives an averages annual rainfall of 650-750 mm, which is distributed over a period of more than 100 days with peak period during July-August. It also recieve scattered showers during winter months. The coldest month is January, while the maximum temperature observed during May-June. The Horticulture Research Farm is located approximately 10 km away from the Lucknow Railway station towards South-East Lucknow, Rae Bareli Road near South city.

Temperature:

The temperature governs the evaporation from the crop and soil of the experimental field. During the experiment maximum temperature ranged from 37.2°C to 48.°C and minimum temperature 20.2°C to 27.3°C.

Relative Humidity:

During the experiment the utmost relative humidity was highest in the month of July (93%) although the lowest relative humidity was recorded in the month of April (26%).

Meteorological data for the year 2017 and 2018.

Table No. 3.1: Average meteorological data for the year-2017.

Period		Mean Temp.(^{0}C)		Relative humidity (%)		Wind Velocity (km/hr)	Total Rainfall (mm)
Month	Date	Maximum	Minimum	Maximum	Minimum		
Jan.-2017	01-07	19.60	9.40	97.00	75.00	1.10	0.00
	08-14	20.20	5.50	92.00	42.00	1.80	0.00
	15-21	22.40	5.70	95.00	41.00	1.70	0.00
	22-28	25.90	9.80	95.00	43.00	2.00	0.00
Jan.-Feb. 2017	29-04	23.10	8.60	96.00	54.00	1.70	0.00
	05-11	25.60	9.90	93.00	39.00	3.40	0.00
	12-18	26.10	10.00	96.00	42.00	1.60	0.00
	19-25	28.90	12.50	82.00	30.00	4.20	0.00
Feb.-Mar. 2017	26-04	30.00	12.70	82.00	24.00	4.00	0.00
	05-11	28.90	13.40	79.00	33.00	4.10	0.00
	12-18	28.40	11.10	82.00	23.00	4.70	0.60
	19-25	33.40	17.00	74.00	24.00	4.10	0.70
Mar.-Apr 2017	26-01	38.20	19.30	67.00	20.00	5.30	0.00
	02-08	38.70	21.80	65.00	24.00	4.10	0.00
	09-15	38.10	20.20	54.00	17.00	5.30	0.00
	16-22	38.70	24.40	72.00	37.00	2.20	0.00
	23-29	38.70	23.90	52.00	23.00	4.90	0.00
Apr.-May 2017	30-06	40.00	23.60	51.00	16.00	4.30	0.00
	07-13	39.10	25.00	71.00	38.00	2.80	0.00
	14-20	40.30	25.40	70.00	31.00	3.20	0.00
	21-27	41.00	26.10	66.00	31.00	4.10	0.00
May-June 2017	28-03	37.20	25.40	73.00	39.00	3.30	0.40
	04-10	39.70	27.10	71.00	42.00	3.40	0.50
	11-17	40.30	26.50	72.00	34.00	3.00	0.80
	18-24	36.60	25.00	79.00	48.00	3.10	100
	25-30	37.80	28.50	82.00	58.00	2.50	0.80

Table No. 3.2: Average meteorological data for the year-2018.

Period		Mean Temp.(^{0}C)		Relative humidity (%)		Wind Velocity (km/hr)	Total Rainfall (mm)
Month	Date	Maximum	Minimum	Maximum	Minimum		
Jan.- 2018	01-07	16.60	6.00	96.00	65.00	1.00	0.00
	08-14	18.00	4.70	99.00	60.00	1.20	0.00
	15-21	23.50	4.90	96.00	40.00	2.30	0.00
	22-28	22.10	5.70	97.00	50.00	2.00	0.00
Jan.-Feb. 2018	29-04	26.10	8.20	88.00	34.00	3.60	0.00
	05-11	24.80	8.20	86.00	38.00	3.60	0.00
	12-18	24.40	10.40	89.00	46.00	3.70	0.00
	19-25	30.00	11.70	92.00	36.00	2.00	0.00
Feb.-Mar. 2018	26-04	31.30	14.70	84.00	33.00	4.20	0.00
	05-11	31.50	13.90	74.00	27.00	5.00	0.60
	12-18	33.50	15.50	75.00	24.00	4.00	0.80
	19-25	34.40	16.50	72.00	22.00	3.90	0.00
Mar.-Apr. 2018	26-01	35.80	17.00	68.00	23.00	4.20	0.00
	02-08	35.70	19.80	70.00	33.00	2.50	0.00
	09-15	35.20	19.60	71.00	26.00	3.30	0.00
	16-22	39.50	21.80	47.00	17.00	4.80	0.00
	23-29	37.70	18.20	54.00	25.00	3.80	0.00
Apr.-May 2018	30-06	35.04	23.00	71.00	43.00	2.50	0.00
	07-13	39.60	24.40	56.00	26.00	4.10	0.00
	14-20	37.40	24.70	73.00	44.00	2.30	0.00
	21-27	42.10	25.70	69.00	28.00	2.90	0.00
May-June 2018	28-03	37.40	26.10	73.00	52.00	2.80	0.40
	04-10	38.20	28.00	70.00	52.00	2.30	0.60
	11-17	39.70	27.50	65.00	38.00	5.30	0.90
	18-24	40.90	27.50	66.00	35.00	3.40	0.95
	25-30	38.20	26.70	74.00	57.00	3.60	0.90

[Source: ICAR – Indian Institute of Sugarcane Research (IISR) Lucknow]

3.3: Soil characteristics of the experimental field:

The soil of research trial field was alluvial loam, well drained with good water asset capacity. The soil samples (up to a depth of 20 cm) were assembleed randomly from five different places of the experimental site ahead of layout of experiment. The samples were assorted thoroughly and a consistent sample was analyzed for evaluating the physico-chemical properties of the soil as per the method specified below in Table-3.3.

Table No-3.3: Methods used for determination of different physical and chemical properties of soil.

Particular	References	Methods	Value (%)
Mechanical composition			
Course sand	Bouyaucos, 1962	Bouyaucos Hydrometer	3.37
Fine sand			45.38
Silt			28.30
Clay			18.40
Chemical composition			
Total nitrogen	Jackson, 1973	personalized Kjeldal's methods	0.082
Total phosphorus	Jackson, 1973	Bicarbonate extractable P and development of blue colour	0.075
Total potassium	Jackson, 1973	Nonaligned normal ammonium acetate	0.028
Ph		Neutral common ammonium by Blackman	7.20

3.4: Experimental material:

The experimental material for the experiment was seeds of African marigold cv.- Pusa Narangi Gainda.

3.5: Experimental details:

S. No.	Particulars		Details
1.	Crop	:	African marigold (*Tagetes erecta* L.)
2.	Variety	:	Pusa Narangi Gainda
3.	Experimental design	:	Randomized Block Design (RBD)
4.	Number of treatments	:	11
5.	Replication	:	3
6.	Number of plots	:	33
7.	Plot size	:	1.80 x 1.20 m
8.	Row to Row distance	:	45 cm
9.	Plant to Plant distance	:	30 cm
10.	Number of plants per row	:	04
11.	Number of row per plot	:	04
12.	Number of plants per plot	:	16
13	Number of total plants	:	528

3.6: Treatment details:

There were thirty three treatment combinations of two plant growth regulators *viz*., GA_3 (50, 100, 200, 300 and 400 ppm) and CCC (500, 1000, 1500, 2000 and 2500 ppm). The details of treatments are given below.

3.6.1: Details of treatment combinations:

S. No.	Symbols	Treatment Combination
1.	T_0	Control
2.	T_1	GA_3 @ 50 ppm
3.	T_2	GA_3 @ 100 ppm
4.	T_3	GA_3 @ 200 ppm
5.	T_4	GA_3 @ 300 ppm
6.	T_5	GA_3 @ 400 ppm
7.	T_6	Cycocel @ 500 ppm
8.	T_7	Cycocel @ 1000 ppm
9.	T_8	Cycocel @ 1500 ppm
10.	T_9	Cycocel @ 2000 ppm
11.	T_{10}	Cycocel @ 2500 ppm

3.6.2: Lay out of experiment:

An area of 15.2 m x 9.4 m size was separated into 33 plots having the size of 1.8 m x 1.2 m and arranged in the three replications of 11 plots. The experiment was laid out in R.B.D under 11 treatments as depicted in Fig.No-2.

Length = 15.2 m.

Main Irrigation Channel = 1 m.

Sub irrigation Channel = 1.0 m.

Bed 11X1.2 = 13.2

Width= 9.4 meter.

Main Irrigation Channel = 1 m.

Sub Irrigation Channel= 1.0 + 1.0 +1.0 = 3.0 m.

Bed Width= 3 x 1.8 m =5.4 m.

Layout of field

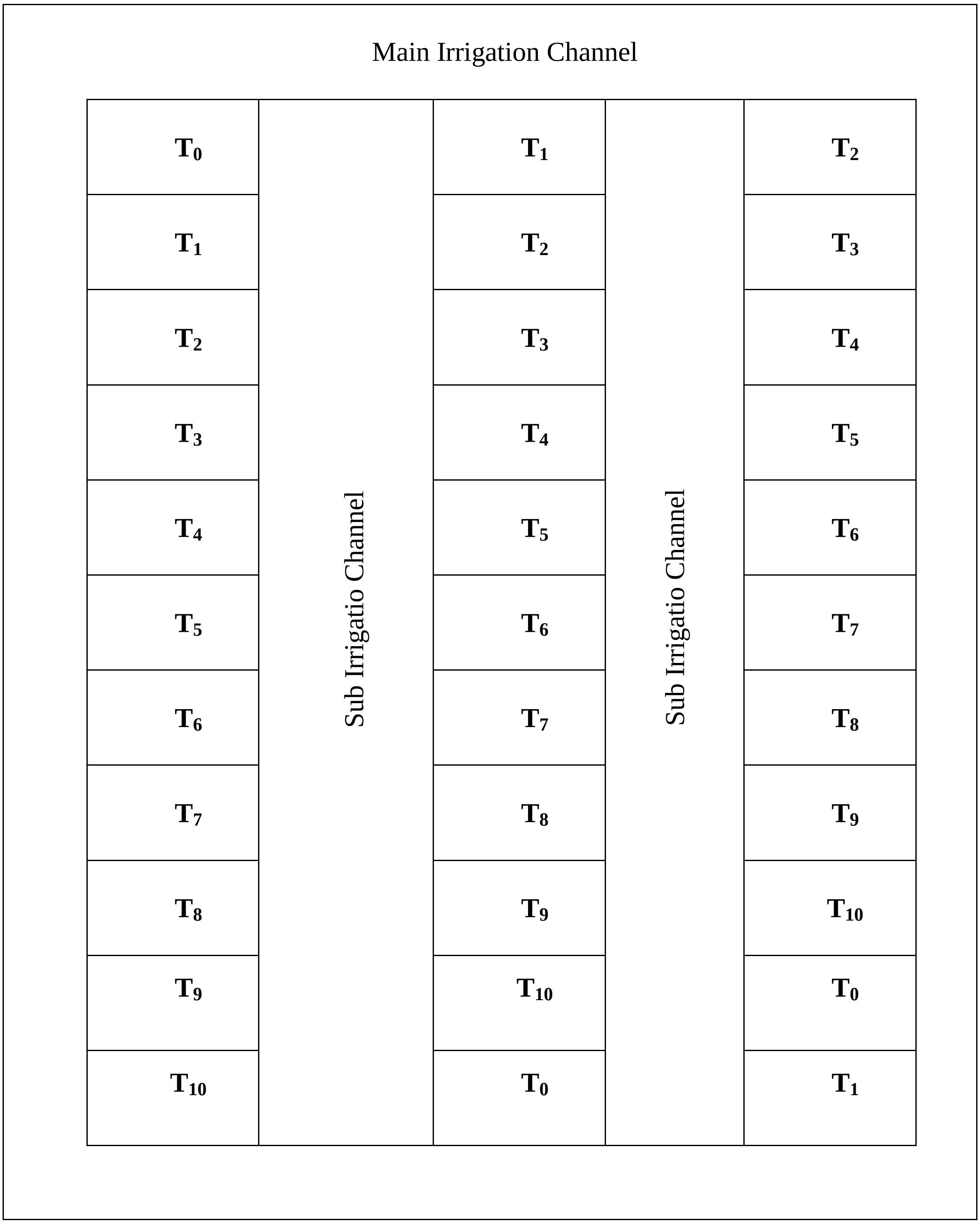

Fig.No-3.6.2: Lay-out Plan of Experiment Field for the years 2017 and 2018.

3.7: Cultural operations:

3.7.1: Field preparation:

Field preparation was done by mould board plough once, followed by leveling and weeding manually. Harrowing was done to smash the clods followed by criss-cross plugging by cultivator, then the field was crushed by rotavator. During harrowing, well decayed FYM was included in the soil. The experiment was laid out with the help of measuring tape, rope and bamboo pegs. The small-sized beds were ready.

3.7.2: Raising of seedlings:

In this experiment, marigold seeds were sown on raised beds, measuring 120×60×10cm. The soil of bed was prepared to fine filth with combination of well decomposed FYM (15kg) and (250g) DAP/bed. The line sowing of seeds was done at 4-5cm spacing. The seed beds were enclosed with a mixture of garden soil and coarse sand. The nursery beds were sheltered by the paddy straw after sowing. firstly, watering was done with watering can at alternate days. The seeds were germinated within 4-5 days of sowing and there after mulch cover was detached. The seedlings were toughened by withdrawing the watering 2-3 days before lifting the seedlings. But, watering was done in forenoon to facilitate smooth lifting of seedlings.

3.7.3: Transplanting of seedlings:

Marigold seedlings were transplanted after 30 days of sowing. Well of seedlings with consistent growth having 3-5 leaves were chosen for transplanting. The seedlings were transplanted in experimental field on 10 Feburary. and instantly after transplanting, light irrigation was done. Transplanting was done in the evening hours to avoid revelation to sunlight and to allow better establishment in cool hours of night. Seedlings were transplanted with spacing of 45 cm from row to row and 30 cm from plant to plant

3.7.4: Manure and fertilizer application:

Phosphorous (as Single Super Phosphate) and potash (as Murat of Potash) were applied at of 75 kg per hectare for the period of the land preparation. Nitrogen fertilizer (as Urea) at the rate of 100 kg per hectare was applied in two split doses, (20 and 40 days after transplanting) as top dressing.

Plate No-1: Nursery raising of African marigold (Tagetes erecta L.) at Horticulture research Farm.

Plate No-2: A general view of seedling taken for transplanting.

Plate No-3: A general view of lay-out plan of experimental site.

Plate No-4: A general view of transplanting of Marigold seedling in the field.

3.7.5: Gap filling of seedling:

Marigold seedlings are usually soft, tender and vulnerable to damping off. Hence, gap filling was done after two weeks of transplanting.

3.7.6: Weeding and irrigation:

Hand weeding was done time to time to remain the field free from the weeds. Manual weeding was done during the whole cropping period at an period of 15-20 days. Earthing up was done as and when required. Soil was reserved moist and frequent irrigation was provided to check moisture stress.

3.7.7: Staking:

Staking is very importent for providing support to the plants, therefore, after 35-40 days of transplanting every plant was supported by 60-75 cm long *sarkanda* sticks to keep the plants straight.

3.7.8: Plant tagging:

Representative plants were selected randomly in every plot and tagged for recording of data on different characters.

3.7.9: Pinching:

Elimination of the terminal portion or new growth of the plants or untimely flower buds is called pinching. This practice stimulates the development of side shoots and makes the plant more floriferous. Pinching was done either once (20 DAT) or twice (20 DAT and 40 DAT) depending upon the treatment.

3.7.10: Rouging:

The plants which did not validate to the varietal characters in African marigold were removed by hand before flowering to keep the chastity of the crop.

3.7.11: Plant protection:

Leaf speck and leaf blight were noticed during the plant growth. T_0 control leaf spot and leaf blight, Dithane M-45 at 2.5 g/l water was applied double at 15 days period for the duration of the vegetative growth.

3.7.12: Harvesting:

Fully-opened flowers were plucked in the morning by hand. Before selection was irrigated to maintain turgidity of flowers and better post-harvest life. After harvesting, flowers were reserved in shade with suitable ventilation capability. Then, they were graded on the basis of size. The bruised and distorted flowers were redundant. The packing of flowers were done in polythene bags. A total of five plucking were done during the whole flowering duration.

3.8: Preparation of growth regulator solutions:

3.8.1: Gibberellic acid (GA_3):

Desired quantities of the GA_3 were first dissolved in few drops of Ethyl alcohol (C_2H_5OH) and then volume was made up to 500 ml of distilled water to make the accurate concentrations of GA_3.

3.8.2: Cycocel (CCC):

Desired quantities of the Cycocel were first dissolved in few drops of water and then volume was made up to 500 ml of distilled water to make the proper concentrations of CCC**.**

3.8.3: Application of growth regulators:

With the help of a sprayer, the growth regulators were sprayed till the surplus stage for the period of the afternoon on the plants. First spraying was undertaken at 20 DAT subsequently by 40 DAT.

3.9: Observations were recorded:

For growth, flowering and yield benchmarks, five plants were randomly selected from each plot of all the replications. The practice for recording the data is mentioned with apposite headings.

Plate No-5: A general view of inspection marigold crop by supervisor.

Plate No-6: A general view of spraying Gibberellic acid and Cycocel on marigold crop.

3.9.1: Vegetative parameters:

3.9.1.1: Plant height: (cm):

Plant height was recorded with the help of a meter rod from base of plant up to tip of apical shoot at full flourish stage for each tagged plants in each plot and expressed by centimeters**.**

3.9.1.2: Number of branches per plant:

Total numbers of branched per plant were counted from each tagged plant.

3.9.1.3: Number of leaves per branch:

Total numbers of leaves per branch were counted from all tagged plant for examination.

3.9.1.4 Number of leaves per plants:

Total numbers of leaves per plant were counted from every tagged plant.

3.9.2: Flowering Characters:

3.9.2.1: Days taken to first bud appearance (days):

Number of days taken to first bud emergence from the date of transplanting was counted and then average was calculated.

3.9.2.2: Days taken to first flowering (days):

Number of days taken to first flowering from the date of transplanting were counted and then average was recorded.

3.9.2.3: Days taken to 50 % flowering (days):

Days taken for 50% flowering from the date of transplanting was counted and average was recorded.

3.9.2.4: Days taken to first flower picking (days):

Days taken for first flower picking from the date of transplanting were counted and then average was taken.

3.9.2.5: Diameter of flower (cm):

Four flowers from each tagged plants were selected and their diameter was measured with the help of vernier calliper and their mean was calculated.

3.9.2.6: Duration of flowering (days):

The duration of flowering was calculated on the basis of days to first anthesis up to the last picking stage and number of days was counted and then average was calculated.

3.9.2.7: Number of flowers per plant:

Total number of flowers per plant was recorded from every tagged plant at every harvest. After the final harvest, the number of flowers of every picking was counted and then average was worked out counting all the fully opened flowers.

3.9.3: Yield Characters:

3.9.3.1: Mean weight of flowers (g):

A regular watching was done on the experimental field. The period of bloom was calculated on the basis of days to first anthesis up to the last picking. This was done with all the five chosen plants in all the treatments and their mean values were calculated.

3.9.3.2 : Flower yield per plant (g):

It was calculated by multiplying total number of plants and flower yield per plant for each plot and then recorded per unit area.

3.9.3.3: Flower yield per plot (kg):

Flower yield per plot was calculated in kg from the flower weight per plant for all the treatments in all replications and then averaged.

3.9.3.4: Flower yield per hectare (t):

Flower yield per hectare was considered in quintal from the flower weight per plot for all the treatments in all replications and then common.

3.9.4: Quality Characters:

3.9.4.1: Moisture content in flower (%):

The moisture substance of the marigold flower was concluded by oven drying method as per AOAC system Method. Mean value of 3 replication were conveyed as kg of water per kg of dry solids.

$$\text{Moisture \%} = \frac{\text{Loss in weight}}{\text{Weight of Sampal}} \text{ x } 100$$

3.9.4.2: Shelf life of flower (days):

Five flowers from each tagged plant in each treatment were plucked at fully open stage and they were kept at room temperature in disposal plates to observe their shelf life. When the flowers started wilting, number of days were recorded. The exact numbers of days were calculated by referring back to the date of picking.

Statistical Analysis:

The data recorded for various vegetative, flowering, fruiting, yield and quality characters during the year 2016-17 and 2017-18 of experiment were statistically analyzed as per method described. The significance of difference tested through variance ratio and the significance of difference between any two means was judged with the critical difference (C. D.) at 5% level of significance which was worked out according to following formula:

The standard error (S.E.M±) for the difference of treatment mean was computed as follow:

$$\text{S. E. M} \pm = \sqrt{\frac{\text{MSEr}}{\text{r}}}$$

Where,

MSE = Mean sum of squares due to error.

r = replication

Critical difference:

C.D. (0.05) = S.E. (d) x t (5% at error d. f.)

Where,

C.D. (0.05) = Critical difference at 5 per cent level of significance.

Chapter-IV

Experimental Finding

In this chapter, the experimental findings obtained during the investigation entitled "**Effect of Gibberellic Acid and Cycocel on Vegetative Growth, Flowering, Yield and Quality Attributes of African Marigold (*Tagetes erecta* L.)".** The study was carried out during two seasons of the years 2016-17 and 2017-18 at Horticulture Research Farm, Department of Applied Plant Science, Babasaheb Bhimrao Ambedkar University (A central University), Vidya-Vihar, Rae Bareli Road, Lucknow (U.P.), India. The field experiment was designed with 11 treatments with 3 replication and laid out in a Randomized Block Design. The experiment was conducted as per methods elaborated in the preceding chapters.

4.1: Vegetative growth characters:

4.2: Flowering Characters:

4.3: yield characters:

4.4: Quality characters:

4.1: Vegetative growth characters:

4.1.1: Plant height (cm):

The results pertaining to the effect of plant growth regulators on growth, flowering and yield of African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda at 30, 45, 60, 75 and 90 days after transplanting during two years a part with pooled mean data are presented in the Table No-4.1.1 and Fig.No-4.1.1.

During first year and second year as well as pooled mean data at 30 DAT, the result showed non significant differences.

At 30 DAT, during the first year of treatment application, data clearly showed that among the growth regulators spray, maximum plant height (27.37 cm) was reported under the treatment T_5 (GA_3 at 400 ppm), leaded by GA_3 at 300 ppm (25.51 cm) T_4 without showing significant variation with each other. While, minimum plant height (20.68 cm) was noticed with the treatment T_{10} (Cycocel at 2500 ppm). It is vivid from the data during the second year of treatment application at 30 DAT, data clearly showed that among the growth regulators spray, maximum plant height (27.75 cm) was recorded under the treatment T_5 (GA_3 at 400 ppm) followed by GA_3 at 300 ppm (26.13 cm) treatment T_4. without showing significant variation with each other. While, minimum plant height (21.33 cm) was noticed with the treatment T_{10} (Cycocel at 2500 ppm). Similarly on the basis of pooled mean data maximum plant height (27.56 cm) at 30 DAT was recorded in (GA_3 at 400 ppm) spray, followed by (GA_3 at 300 ppm) (25.82 cm) treatment T_4. while, lowest plant height (21.66 cm) was noticed under the treatment T_{10} (Cycocel at 2500 ppm).

At 45 DAT, during the first year of treatment application data clearly suppressed that among the growth regulators spray, maximum plant height (57.43 cm) were recorded under the treatment T_5 (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (54.92 cm) treatment T_4 without showing significant variation with each other. While, minimum plant height (41.28 cm) was noticed with the treatment T_{10} (Cycocel at 2500 ppm). It is vivid from the data during the second year of treatment application at 45 DAT, data clearly showed that among the growth regulators spray, maximum plant height (57.91 cm) was recorded under the treatment T_5 (GA_3 at 400 ppm) followed by GA_3 at 300 ppm (55.35 cm) treatment T_4 without showing significant variation with each other. While, minimum plant height (42.12 cm) was noticed with the treatment T_{10} (Cycocel at 2500 ppm) Similarly on the basis of pooled mean data maximum plant height (57.67 cm) at 45 DAT was recorded in GA_3 at 400 ppm spray, followed by GA_3 at 300 ppm (55.14 cm) treatment T_4 while, lowest plant height (41.07 cm) was noticed under the treatment T_{10} (Cycocel at 2500 ppm).

At 60 DAT, during the first year of treatment application data clearly showed that among the growth regulators spray, maximum plant height (70.67 cm) was recorded under the treatment T_5 (GA_3 at 400 ppm) followed by GA_3 at 300 ppm (69.93cm) T_4 without showing significant variation with each other. While, minimum plant height (63.38 cm) was noticed with the treatment T_{10} (Cycocel at 2500 ppm). It is vivid from the data during the second year of treatment application at 60 DAT, data clearly showed that among the growth regulators spray, maximum plant height (71.02 cm) was recorded under the treatment T_5 (GA_3 at 400 ppm) followed by GA_3 at 300 ppm (70.37cm) treatment T_4 without showing significant variation with each other. While, minimum plant height (63.69 cm) was noticed with the treatment T_{10} (Cycocel 2500 at ppm) Similarly on the basis of pooled mean data maximum plant height (70.84 cm) at 60 DAT was recorded in the treatment T_5 (GA_3 at 400 ppm) followed by GA_3 at 300 ppm (70.15 cm) treatment T_4 while, lowest plant height (63.53 cm) was noticed under the treatment T_{10} (Cycocel at 2500 ppm).

Plate No-7: A general view of marigold crop at the time observation taking.

At 75 DAT, during the first year of treatment application data clearly showed that among the growth regulators spray, maximum plant height (78.48 cm) was recorded under the treatment T_5 (GA_3 at 400 ppm) followed by GA_3 at 300 ppm (76.25 cm) treatment T_4 without showing significant variation with each other. While, minimum plant height (62.57 cm) was noticed with the treatment T_{10} (Cycocel at 2500 ppm). It is vivid from the data during the second year of treatment application at 75 DAT, data clearly showed that among the growth regulators spray, maximum plant height (79.01 cm) was recorded under the treatment T_5 (GA_3 at 400 ppm) followed by GA_3 at 300 ppm (76.55 cm) treatment T_4 without showing significant variation with each other. While, minimum plant height (62.86 cm) was noticed with the treatment T_{10} (Cycocel at 2500 ppm) Similarly on the basis of pooled mean data maximum plant height (78.74 cm) at 75 DAT was recorded intreatment T_5 (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (76.40 cm) treatment $T_{4.}$ while, lowest plant height (62.71 cm) was noticed under the treatment T_{10} (Cycocel at 2500 ppm).

At 90 DAT, during the first year of treatment application data clearly showed that among the growth regulators spray, maximum plant height (95.45cm) was recorded under the treatment T_5 (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (93.26 cm) the treatment $T_{4.}$ Without showing significant variation with each other. While, minimum plant height (84.62 cm) was noticed with the treatment T_{10} (Cycocel at 2500 ppm). It is vivid from the data during the second year of treatment application at 90 DAT data clearly showed that among the growth regulators spray, maximum plant height (95.71 cm) was recorded under the treatment T_5 (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (93.26 cm) treatment $T_{4.}$ Without showing significant variation with each other. While, minimum plant height (84.26 cm) was noticed with the treatment T_{10} (Cycocel at 2500 ppm) Similarly on the basis of pooled mean data, maximum plant height (95.58 cm) at 90 DAT was recorded in treatment (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (93.26 cm) treatment $T_{4.}$ While, lowest plant height (84.44 cm) was noticed under the treatment T_{10} (Cycocel at 2500 ppm).

Table No-4.1.1: Effect of Gibberellic acid and Cycocel on plant height (cm) of African marigold:

S. N.	Treatments	Plant height (cm)														
		Plant height 30 (days)			Plant height 45 (days)			Plant height 60 (days)			Plant height 75 (days)			Plant height 90 (days)		
		2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
T_0	Control	22.85	23.84	23.34	47.19	47.96	47.58	65.48	64.22	64.85	69.08	69.34	69.21	88.12	87.95	88.03
T_1	GA_3 @ 50 ppm	23.29	23.73	23.51	49.49	48.85	49.17	66.19	66.23	66.22	70.32	70.85	70.58	90.55	90.00	90.27
T_2	GA_3 @ 100 ppm	24.09	25.03	24.56	50.86	51.93	51.40	66.25	66.50	66.37	72.34	72.84	72.59	92.59	92.37	92.48
T_3	GA_3 @ 200 ppm	24.89	25.32	25.10	53.22	54.18	53.70	67.70	67.73	67.71	75.30	75.68	75.49	93.09	92.64	92.83
T_4	GA_3 @ 300 ppm	25.51	26.13	25.82	54.92	55.35	55.14	69.93	70.37	70.15	76.25	76.55	76.40	93.26	93.26	93.26
T_5	GA_3 @ 400 ppm	27.37	27.75	27.56	57.43	57.91	57.67	70.67	71.02	70.84	78.48	79.01	78.74	95.45	95.71	95.58
T_6	Cycocel @ 500 ppm	22.99	24.58	23.78	46.57	46.80	46.69	65.37	65.73	65.55	66.48	66.23	66.35	87.59	87.43	87.51
T_7	Cycocel @ 1000 ppm	22.85	23.81	23.35	45.39	45.83	45.61	65.15	65.26	65.20	64.64	64.66	64.65	86.95	86.96	86.95
T_8	Cycocel @ 1500 ppm	21.99	22.70	21.69	45.23	44.56	44.90	65.04	65.26	65.15	63.89	64.01	63.95	86.19	86.15	86.17
T_9	Cycocel @ 2000 ppm	21.62	21.75	21.68	43.62	43.53	43.58	64.15	64.81	64.48	63.15	63.38	63.26	85.69	85.90	85.79
T_{10}	Cycocel @ 2500 ppm	20.68	21.33	21.66	41.28	42.12	41.70	63.38	63.69	63.53	62.57	62.86	62.71	84.62	84.26	84.44
	SE (m) ±	1.04	1.00	1.02	1.85	1.83	1.84	1.25	1.26	1.25	1.21	1.19	1.20	1.12	1.19	1.15
	CD at 5%	3.09	2.97	3.03	5.51	5.45	5.48	3.72	3.76	3.74	3.62	3.53	3.57	3.34	3.55	3.44

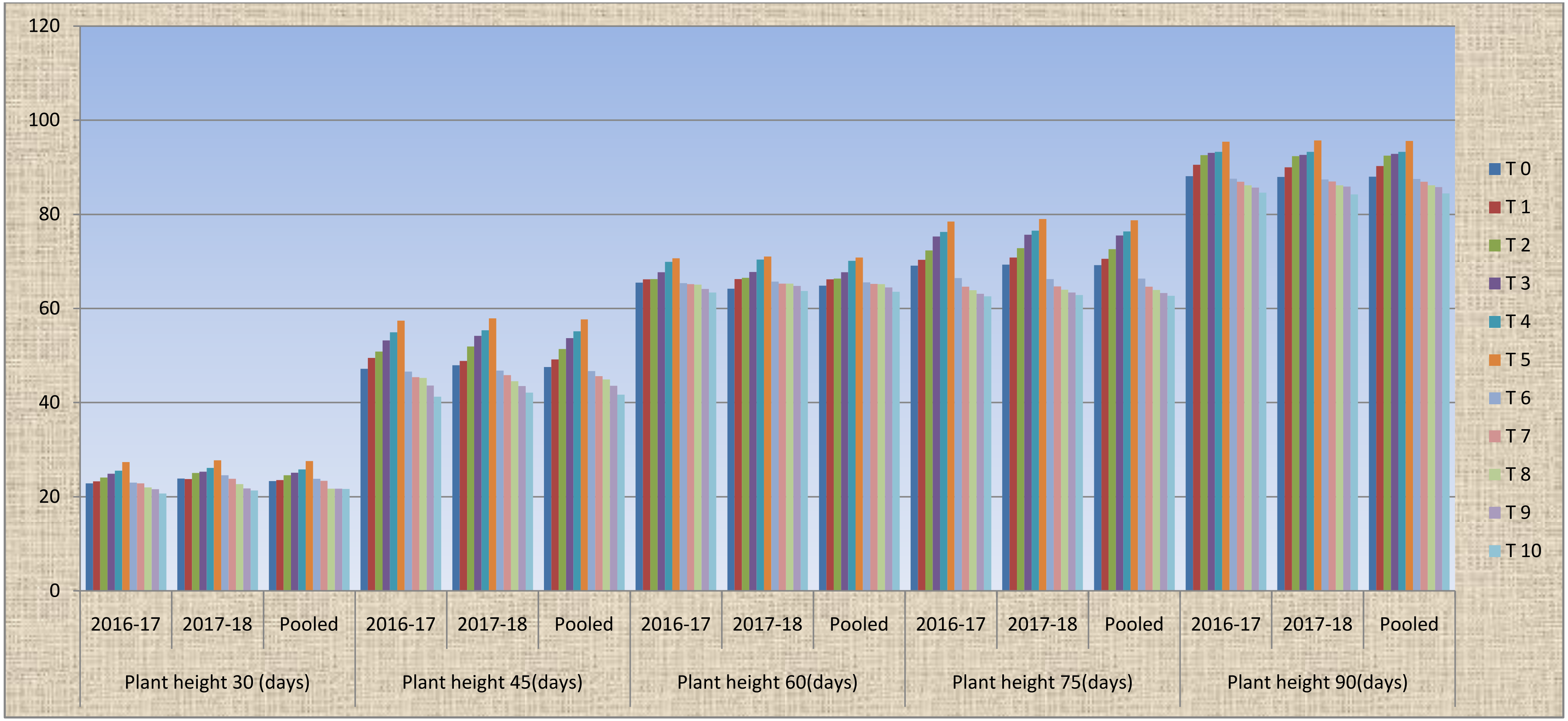

Fig.No-4.1.1: Effect of Gibberellic acid and Cycocel on plant height (cm) of African marigold:

4.1.2: Number of branch per plant:

The results pertaining to the effect of plant growth regulators on growth, flowering and yield of African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda at 30, 45, 60, 75 and 90 days after transplanting during two years apart with pooled mean data are presented in the Table No-4.1.2 and Fig.No-4.1.2.

For the period of first year and second year as well as jointed mean data at 30 DAT, the result suppressd non significant differences.

At 30 DAT, during the first year of treatment application data obviously showed that among the growth regulators spray the highest number of branches per plant (2.87 cm) was reported under the treatment T_5 (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (2.79 cm) treatment $T_{4.}$ Without showing noteworthy variation with each other. While, minimum number of branch per plant (2.08 cm) was observed with the treatment T_0 (Control). It is vivid from the data during the second year of treatment application at 30 DAT, data clearly showed that among the growth regulators, maximum number of branches per plant (2.91cm) was recorded under the treatment T_5 (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (2.82 cm) treatment T_4 without showing significant variation with each other. While, minimum number of branches per plant (2.19 cm) was noticed with the treatment T_0 (Control). Equally on the basis of pooled mean data maximum plant height (2.89 cm) at 30 DAT was recorded in (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (2.81 cm) treatment T_4 while, lowest number of branches per plant (2.14 cm) was notice under the treatment T_0 (Control).

At 45 DAT, during the first year of treatment application, data evidently showed that among the growth regulators spray, maximum number of branches per plant (7.77 cm) was reported under the treatment T_5 (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (7.66 cm) treatment T_4 without showing significant variation with every other. While, minimum branch per plant (5.52 cm) was noticed with the treatment T_0 (Control). It is vivid from the data during the second year of treatment application at 45 DAT, data obviously showed that among the growth regulators, maximum number of branches per plant (8.08 cm) was recorded under the treatment T_5 (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (7.46 cm) treatment T_4 without showing significant dissimilarity with each other. While, minimum number of branches per plant (5.03 cm) was noticed with the treatment T_0 (control). Equally because of pooled mean data, maximum branch per plant (7.90 cm) at 45 DAT was reported in (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (7.56 cm) T_4 while, minimum number of branches per plant (5.27 cm) was notice underthe treatment T_0 (control).

At 60 DAT, during the first year of treatment application, data evidently showed that among the growth regulators spray, maximum number of branches per plant (9.15 cm) was recorded under the treatment T_5 (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (9.13 cm) T_4 without showing significant variation with each other. Whereas, minimum branch per plant (7.70 cm) was noticed with the treatment T_0 (control). It is vivid from the data during the second year of treatment application at 60 DAT, data clearly noticed that among the growth regulators maximum number of branches per plant (9.41 cm) was recorded under the treatment T_5 (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (9.26 cm) T_4 without showing significant variation with each other. While, minimum number of branches per plant (7.34 cm) was noticed with the treatment T_0 (control). Similarly on the basis of pooled mean data, maximum number of branches per plant (9.28 cm) at 60 DAT was reported in the treatment (GA_3 at 400 ppm) followed by GA_3 at 300 ppm (9.20 cm) T_4 while, lowest number of branches per plant (7.52 cm) was notice under T_0 (control).

At 75 DAT, during the first year of treatment application, data obviously noticed that among the growth regulators spray, maximum number of branches per plant (13.13 cm) was recorded under the treatment T_5 (GA_3 at 400 ppm) followed by GA_3 at 300 ppm (12.36 cm) T_4 without showing significant variation with each other. While, minimum number of branches per plant (9.23 cm) was noticed with the treatment T_0 (control). It is vivid from the data during the second year of treatment application at 75 DAT, data evidently noticed that among the growth regulators spray, maximum number of branches per plant (13.10 cm) was reported under the treatment T_5 (GA_3 at 400 ppm) followed by GA_3 at 300 ppm (11.81 cm) T_4 without showing significant dissimilarity with each other. While, minimum number of branches per plant (9.19 cm) was noticed with the treatment T_0 (control). Similarly on the basis of pooled mean data, maximum number of branches per plant (13.12 cm) at 75 DAT was recorded in treatment T_5 (GA_3 at 400 ppm) followed by GA_3 at 300 ppm (12.09 cm) T_4. while, lowest number of branches per plant (9.21 cm) was notice under the treatment T_0 (control).

At 90 DAT, during the first year of treatment application, data clearly showed that among the growth regulators spray, maximum number of branches per plant (13.17 cm) was recorded under the treatment T_5 (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (12.36 cm) T_4 without showing significant variation with each other. While, minimum number of branches per plant (9.26 cm) was noticed with the treatment T_0 (control). It is vivid from the data during the second year of treatment application at 90 DAT, data clearly showed that among the growth regulators maximum number of branches per plant (13.47 cm) was recorded under the treatment T_5 (GA3 at 400 ppm) followed by GA_3 at 300 ppm (12.10 cm) T_4 without showing significant variation with each other. While, minimum number of branches per plant (9.19 cm) was noticed with the treatment T_0 (control) Similarly on the basis of pooled mean data, maximum number of branches per plant (13.32 cm) at 90 DAT was recorded in the treatment (GA_3 at 400 ppm) followed by GA_3 at 300 ppm (12.23 cm) T_4 while, lowest number of branches per plant (9.23 cm) was notice under the treatment T_0 (control).

Table No-4.1.2: Effect of Gibberellic acid and Cycocel on Number of branches per plant of African marigold.

S. N.	Treatments	Number of branches per plant														
		Number of branch per plant 30 (days)			Number of branch per plant 45 (days)			Number of branch per plant 60 (days)			Number of branch per plant 75 (days)			Number of branch per plant 90 (days)		
		2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
T_0	Control	2.08	2.19	2.14	5.52	5.03	5.27	7.70	7.34	7.52	9.23	9.19	9.21	9.26	9.19	9.23
T_1	GA_3 @ 50 ppm	2.63	2.63	2.63	7.27	7.14	7.20	8.95	8.78	8.87	10.40	10.25	10.33	10.42	10.25	10.34
T_2	GA_3 @ 100 ppm	2.67	2.73	2.70	7.32	7.20	7.26	9.08	8.91	9.00	11.51	10.45	10.98	11.54	11.26	11.40
T_3	GA_3 @ 200 ppm	2.76	2.73	2.75	7.35	7.37	7.36	9.09	8.98	9.04	12.27	11.28	11.78	12.28	11.62	11.95
T_4	GA_3 @ 300 ppm	2.79	2.82	2.81	7.66	7.46	7.56	9.13	9.26	9.20	12.36	11.81	12.09	12.36	12.10	12.23
T_5	GA_3 @ 400 ppm	2.87	2.91	2.89	7.77	8.04	7.90	9.15	9.41	9.28	13.13	13.10	13.12	13.17	13.47	13.32
T_6	Cycocel @ 500 ppm	2.26	2.21	2.24	5.64	5.50	5.57	8.22	8.01	8.12	9.29	9.22	9.26	9.30	9.18	9.24
T_7	Cycocel @ 1000 ppm	2.27	2.28	2.28	5.66	5.63	5.64	8.39	8.26	8.33	9.33	9.24	9.29	9.35	9.31	9.33
T_8	Cycocel @ 1500 ppm	2.31	2.30	2.31	5.69	5.65	5.67	8.29	8.28	8.29	9.38	9.28	9.33	9.40	9.33	9.37
T_9	Cycocel @ 2000 ppm	2.33	2.53	2.43	5.71	5.67	5.69	8.51	8.28	8.40	9.40	9.31	9.36	9.42	9.35	9.39
T_{10}	Cycocel @ 2500 ppm	2.59	2.62	2.61	5.73	5.68	5.70	8.68	8.46	8.57	9.43	9.31	9.37	9.45	9.38	9.42
	SE (m) ±	0.14	0.13	0.13	0.15	0.17	0.16	0.21	0.18	0.19	0.18	0.17	0.17	0.18	0.17	0.17
	CD at 5%	0.43	0.40	0.42	0.46	0.53	0.50	0.63	0.55	0.59	0.56	0.51	0.54	0.54	0.52	0.53

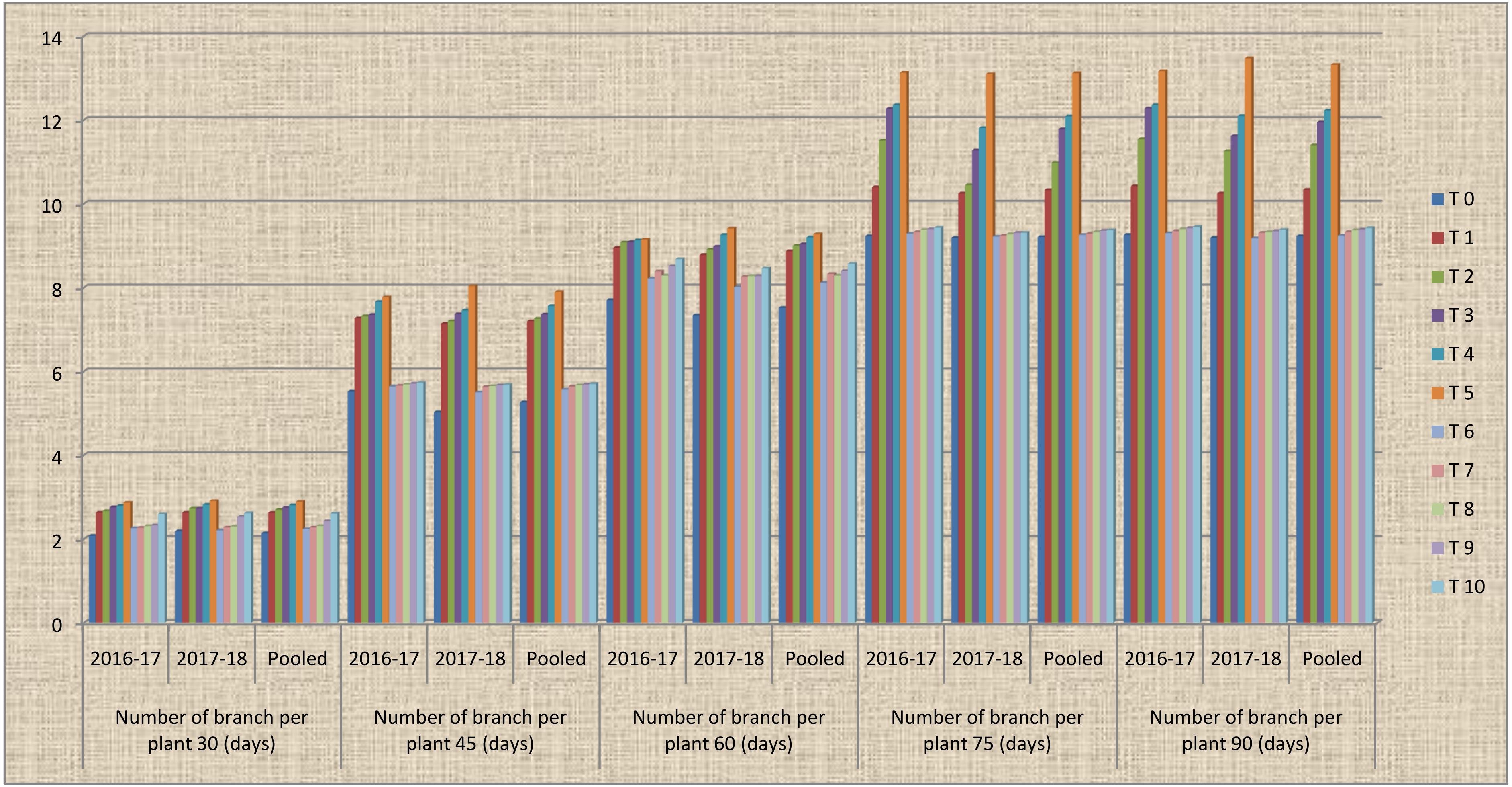

Fig.No-4.1.2: Effect of Gibberellic acid and Cycocel on Number of branches per plant of African marigold.

4.1.3: Number of leaves per branch:

Growth regulator treatments showed significant effect on number of leaves per branches at different stages of observation i.e., 30, 45, 60, 75 and 90 days after transplanting during both the years as well as in pooled mean data are presented in the Table No-4.1.3 and Fig.No-4.1.3.

For the period of first year and second year as well as jointed mean data at 30 DAT, the result suppressd non significant differences.

At 30 DAT, during the first year of treatment application data clearly showed that among the growth regulators maximum number of leaves per branches (8.31 cm) was recorded under the treatment T_5 (GA_3 at 400 ppm), followed by GA_3 at 300 ppm (8.06 cm) treatment T_4 without showing significant variation with each other. While, minimum number of leaves per branches (6.81 cm) was noticed with the treatment T_0 (control). It is vivid from the data during the second year of treatment application at 30 DAT, data clearly showed that among the growth regulators spray, maximum number of leaves per branches (9.15 cm) was recorded under the treatment T_5 (GA_3 at 400 ppm) followed by GA_3 at 300 ppm (8.86 cm) treatment T_4 without showing significant variation with each other. While, minimum number of leaves per branches (6.59 cm) was noticed with the treatment T_0 (control). Similarly on the basis of pooled mean data, maximum number of leaves per branches (8.73 cm) at 30 DAT was observeded in (GA_3 at 400 ppm) followed by GA_3 at 300 ppm (8.46 cm) T_4 while, lowest number of leaves per branches (6.70 cm) was notice under the treatment T_0 (control).

At 45 DAT, during the first year of treatment application data obviously showed that among the growth regulators maximum number of leaves per branches (14.00 cm) was recorded under the treatment T_5 (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (13.95 cm) T_4 without showing significant variation with each other. While, minimum number of leaves per branches (10.42 cm) was noticed with the treatment T_0 (control). It is vivid from the data during the second year of treatment application at 45 DAT, data clearly showed that among the growth regulators maximum number of leaves per branches (14.18 cm) was recorded under the treatment T_5 (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (13.90 cm) T_4 without showing significant variation with each other. While, minimum number of leaves per branches (10.56 cm) was noticed with the treatment T_0 (control). Similarly on the basis of pooled mean data maximum number of leaves per branches (14.09 cm) at 45 DAT was recorded in treatment T_5 (GA_3 at 400 ppm) followed by GA_3 at 300 ppm (13.93 cm) T_4 while, lowest number of leaves per branches (10.49 cm) was showed under the treatment T_0 (control).

At 60 DAT, during the first year of treatment application data evidently showed that among the growth regulators spray, maximum number of leaves per branches (13.39 cm) was recorded under the treatment T_5 (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (13.28 cm) T_4 without showing significant variation with each other. While, minimum number of leaves per branches (11.96 cm) was noticed with the treatment T_0 (control). It is vivid from the data during the second year of treatment application at 60 DAT, data clearly showed that among the growth regulators spray, maximum number of leaves per branches (14.80 cm) was recorded under the treatment T_5 (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (14.47 cm) T_4 without showing significant variation with each other. While, minimum number of leaves per branches (11.35 cm) was noticed with the treatment T_0 (control). Similarly on the basis of pooled mean data, maximum number of leaves per branches (14.10 cm) at 60 DAT was reported in treatment (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (13.88 cm) T_4 while, lowest number of leaves per branches (11.66 cm) was notice under the treatment T_0 (control).

At 75 DAT, during the first year of treatment application data obviously noticed that among the growth regulators spray, maximum number of leaves per branches (14.92 cm) was observed under the treatment T_5 (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (14.83 cm) T_4 without showing significant variation with each other. While, minimum number of leaves per branches (10.77 cm) was showeded with the treatment T_0 (control). It is vivid from the data during the second year of treatment application at 75 DAT, data obviously noticeded that among the growth regulators maximum number of leaves per branches (15.28 cm) was observed under the treatment T_5 (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (15.12 cm) T_4 without showing significant variation with each other. While, minimum number of leaves per branches (12.10 cm) was showed with the treatment T_0 (control). Similarly on the basis of pooled mean data maximum number of leaves per branches (15.10 cm) at 75 DAT was recorded in the treatment GA_3 at 400 ppm followed by GA_3 at 300 ppm (14.98 cm) T_4 while, lowest number of leaves per branches (11.44 cm) was showed under T_0 (control).

At 90 DAT, during the first year of treatment application data evidently showed that among the growth regulators spray, maximum number of leaves per branches (14.94 cm) was observed under the treatment T_5 (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (14.92 cm) T_4 without showing significant variation with each other. While, minimum number of leaves per branches (10.85 cm) was showed with the treatment T_0 (control). It is vivid from the data during the second year of treatment application at 90 DAT, data clearly showed that among the growth regulators maximum number of leaves per branches (14.98 cm) was observed under the treatment T_5 (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (14.86 cm) T_4 without showing significant dissimilarity with each other. While, minimum number of leaves per branches (12.52 cm) was showed with the treatment T_0 (control). Similarly on the basis of pooled mean data maximum number of leaves per branches (14.96 cm) at 90 DAT was observed in the treatment (GA_3 at 400 ppm) followed by GA_3 at 300 ppm (14.89 cm) T_4 While, lowest number of leaves per branches (11.69 cm) was notice under the treatment T_0 (control).

Table No-4.1.3: Effect of Gibberellic acid and Cycocel on Number of leaves per branch of African marigold.

S. N.	Treatments	Number of leaves per branch														
		Number of leaves per branch 30 (days)			Number of leaves per branch 45 (days)			Number of leaves per branch 60 (days)			Number of leaves per branch 75 (days)			Number of leaves per branch 90 (days)		
		2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
T_0	Control	6.81	6.59	6.70	10.42	10.56	10.49	11.96	11.35	11.66	10.77	12.10	11.44	10.85	12.52	11.69
T_1	GA_3 @ 50 ppm	7.20	7.69	7.45	13.88	13.44	13.66	12.99	14.03	13.51	14.61	14.32	14.47	14.72	14.02	14.37
T_2	GA_3 @ 100 ppm	7.82	7.80	7.81	13.88	13.51	13.70	13.05	14.03	13.54	14.71	14.44	14.58	14.73	14.26	14.50
T_3	GA_3 @ 200 ppm	7.97	7.86	7.92	13.89	13.60	13.75	13.20	14.04	13.62	14.80	14.70	14.75	14.77	14.85	14.81
T_4	GA_3 @ 300 ppm	8.06	8.86	8.46	13.95	13.90	13.93	13.28	14.47	13.88	14.83	15.12	14.98	14.92	14.86	14.89
T_5	GA_3 @ 400 ppm	8.31	9.15	8.73	14.00	14.18	14.09	13.39	14.80	14.10	14.92	15.28	15.10	14.94	14.98	14.96
T_6	Cycocel @ 500 ppm	6.82	6.82	6.82	10.52	10.63	10.58	12.12	12.39	12.26	11.38	13.02	12.20	11.21	13.00	12.11
T_7	Cycocel @ 1000 ppm	6.97	6.90	6.94	10.81	10.66	10.74	12.63	13.40	13.02	11.50	13.08	12.29	11.36	13.01	12.19
T_8	Cycocel @ 1500 ppm	7.01	6.99	7.00	10.87	11.66	11.27	12.67	13.55	13.11	12.18	13.43	12.81	12.14	13.26	12.70
T_9	Cycocel @ 2000 ppm	7.06	7.44	7.25	10.95	12.71	11.83	12.72	13.65	13.19	13.43	13.70	13.57	13.50	13.65	13.58
T_{10}	Cycocel @ 2500 ppm	7.09	7.62	7.36	12.81	13.28	13.05	12.83	13.92	13.38	13.74	13.96	13.85	13.83	13.84	13.84
	SE (m) ±	0.33	0.35	0.34	0.27	0.39	0.33	0.26	0.45	0.35	0.28	0.43	0.35	0.26	0.39	0.32
	CD at 5%	1.00	1.06	1.03	0.82	1.16	0.99	0.79	1.35	1.07	0.84	1.29	1.07	0.77	1.18	0.98

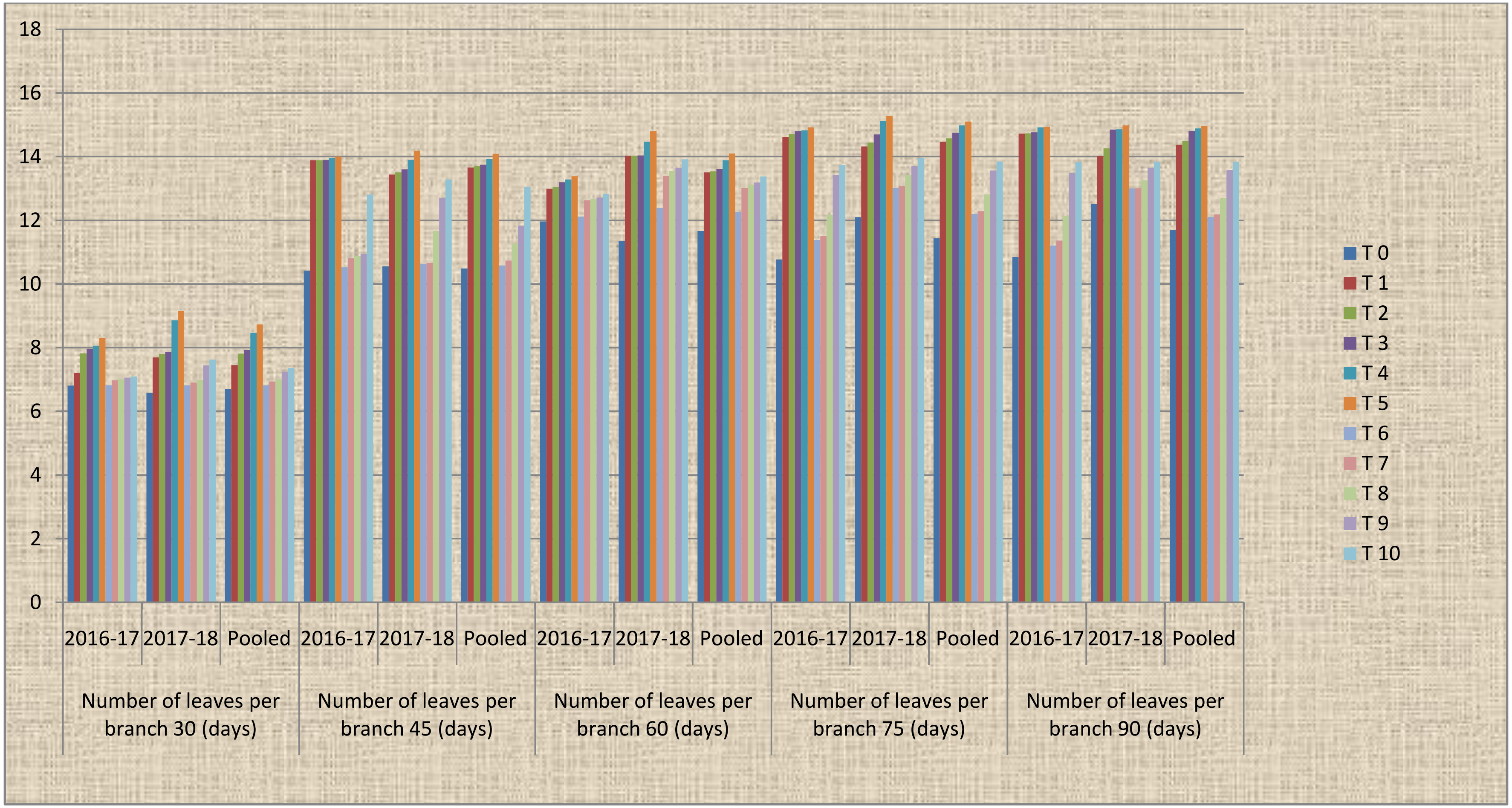

Fig.No-4.1.3: Effect of Gibberellic acid and Cycocel on Number of leaves per branch of African marigold.

4.1.4: Number of leaves per plant:

Growth regulator treatments showed significant effect on number of leaves per plant at different stages of observation i.e., 30, 45, 60, 75 and 90 days after transplanting during both the years as well as in pooled mean data.

During first year of examination at 30 DAT, the results showed non-significant differences.

30 DAT, during the first year of treatment application, data obviously noticed that among the growth regulators maximum number of leaves per plant (19.70 cm) was observeded under the treatment T_5 (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (19.47 cm) T_4 without showing significant variation with each other. While, minimum number of leaves per plant (16.33 cm) was noticed with the treatment T_0 (contro). It is vivid from the data during the second year of treatment application at 30 DAT, data clearly showed that among the growth regulators maximum number of leaves per plant (20.47 cm) was recorded under the treatment T_5 (GA_3 at 400 ppm) followed by GA_3 at 300 ppm (19.46 cm) T_4 without showing significant variation with each other. While, minimum number of leaves per plant (17.25 cm) was noticed with the treatment T_0 (Control). Similarly on the basis of pooled mean data, maximum number of leaves per plant (20.08 cm) at 30 DAT was observed in the treatment (GA_3 at 400 ppm) followed by GA_3 at 300 ppm (19.46 cm) T_4 while, lowest number of leaves per plant (16.79 cm) was notice under the treatment T_0 (Control).

At 45 DAT, during the first year of treatment application data obviously noticed that among the growth regulators spray, maximum number of leaves per plant (81.83 cm) was observed under the treatment T_5 (GA_3 at 400 ppm) followed by GA_3 at 300 ppm (80.02 cm) T_4 without showing significant dissimilarity with each other. While, minimum number of leaves per plant (70.77 cm) was showed with the treatment T_0 (Control). It is vivid from the data during the second year of treatment application at 45 DAT, data clearly showed that among the growth regulators maximum number of leaves per plant (85.77 cm) was recorded under the treatment T_5 (GA_3 at 400 ppm) followed by GA_3 at 300 ppm (85.16cm) T_4 without showing significant variation with each other. While, minimum number of leaves per plant (75.68 cm) was noticed with the treatment T_0 (Control). Similarly on the basis of pooled mean data, maximum number of leaves per plant (83.80 cm) at 45 DAT was observed in the treatment (GA_3 at 400 ppm) followed by GA_3 at 300 ppm (82.59 cm) T_4 while, lowest number of leaves per plant (73.22 cm) was notice under the treatment T_0 (Control).

At 60 DAT, during the first year of treatment application data obviously showed that among the growth regulators spray, maximum number of leaves per plant (120.80 cm) was observed under the treatment T_5 (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (119.52 cm) T_4 without showing significant variation with each other. While, minimum number of leaves per plant (111.64 cm) was showed with the treatment T_0 (Control). It is vivid from the data during the second year of treatment application at 60 DAT, data evidently showed that among the growth regulators maximum number of leaves per plant (123.00 cm) was recorded under the treatment T_5 (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (121.36 cm) T_4 without showing significant variation with each other. While, minimum number of leaves per plant (109.56 cm) was noticed with the treatment T_0 (control). Similarly on the basis of pooled mean data maximum number of leaves per plant (121.90 cm) at 60 DAT was recorded in the treatment (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (120.44 cm) T_4 while, lowest number of leaves per plant (110.60 cm) was notice under the treatment T_0 (control).

At 75 DAT, during the first year of treatment application, data obviously showed that among the growth regulators spray, maximum number of leaves per plant (141.49 cm) was recorded under the treatment T_5 (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (141.08 cm) T_4 without showing significant variation with each other. While, minimum number of leaves per plant (127.03 cm) was noticed with the treatment T_0 (control). It is vivid from the data during the second year of treatment application at 75 DAT, data clearly showed that among the growth regulators spray, maximum number of leaves per plant (144.01 cm) was observed under the treatment T_5 (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (143.93 cm) T_4 without showing significant dissimilarity with every other. While, minimum number of leaves per plant (127.73 cm) was noticed with the treatment T_0 (Control). Similarly on the basis of pooled mean data, maximum number of leaves per plant (142.75 cm) at 75 DAT was recorded in the treatment (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm)

(142.51cm) treatment T_4 while, lowest number of leaves per plant (127.38 cm) was notice under the treatment T_0 (Control).

At 90 DAT, during the first year of treatment application, data clearly showed that among the growth regulators spray, maximum number of leaves per plant (142.92 cm) was recorded under the treatment T_5 (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (141.10 cm) T_4 without showing significant variation with each other. While, minimum number of leaves per plant (128.06 cm) was noticed with the treatment T_0 (Control). It is vivid from the data during the second year of treatment application at 90 DAT, data clearly showed that among the growth regulators maximum number of leaves per plant (143.73 cm) was observed under the treatment T_5 (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (141.94 cm) T_4 without showing significant variation with each other. While, minimum number of leaves per plant (127.75 cm) was noticed with the treatment T_0 (Control). Similarly on the basis of pooled mean data, maximum number of leaves per plant (143.33 cm) at 90 DAT was observed in the treatment (GA_3 at 400 ppm) followed by (GA_3 at 300 ppm) (141.52 cm) T_4 while, lowest number of leaves per plant (127.91 cm) was notice under the treatment T_0 (Control).

Table No-4.1.4: Effect of Gibberellic acid and Cycocel on Number of leaves per plant of African marigold.

S. N.	Treatments	Number of leaves per plant														
		Number of leaves per plant 30 (days)			Number of leaves per plant 45 (days)			Number of leaves per plant 60 (days)			Number of leaves per plant 75 (days)			Number of leaves per plant 90 (days)		
		2016- 17	2017-18	Pooled	2016- 17	2017-18	Pooled	2016- 17	2017-18	Pooled	2016- 17	2017-18	Pooled	2016-17	2017-18	Pooled
T_0	Control	16.33	17.25	16.79	70.77	75.68	73.22	111.64	109.56	110.60	127.03	127.73	127.38	128.06	127.75	127.91
T_1	GA_3 @ 50 ppm	18.36	19.08	18.72	79.54	80.74	80.14	116.59	118.93	117.76	140.37	140.63	140.50	139.66	140.78	140.22
T_2	GA_3 @ 100 ppm	18.90	19.26	19.08	79.59	81.54	80.56	116.90	119.16	118.03	140.71	142.36	141.54	139.66	141.38	140.52
T_3	GA_3 @ 200 ppm	19.05	19.30	19.17	79.88	83.72	81.80	118.13	120.40	119.27	140.83	143.36	142.10	140.66	141.54	141.10
T_4	GA_3 @ 300 ppm	19.47	19.46	19.46	80.02	85.16	82.59	119.52	121.36	120.44	141.08	143.93	142.51	141.10	141.94	141.52
T_5	GA_3 @ 400 ppm	19.70	20.47	20.08	81.83	85.77	83.80	120.80	123.00	121.90	141.49	144.01	142.75	142.92	143.73	143.33
T_6	Cycocel @ 500 ppm	16.46	17.69	17.07	78.40	77.47	77.93	112.59	111.45	112.02	135.96	136.37	136.17	137.06	138.60	137.83
T_7	Cycocel @ 1000ppm	16.74	18.05	17.39	78.91	78.54	78.72	113.67	113.85	113.76	137.44	137.55	137.50	138.24	139.06	138.65
T_8	Cycocel @ 1500 ppm	16.76	18.26	17.51	78.97	78.87	78.92	114.19	114.99	114.59	138.84	138.56	138.70	138.56	139.33	138.95
T_9	Cycocel @ 2000 ppm	17.35	18.90	18.12	79.31	80.74	80.02	115.47	117.53	116.50	139.45	140.11	139.78	139.15	139.40	139.28
T_{10}	Cycocel @ 2500 ppm	17.99	18.97	18.48	79.37	80.94	80.15	116.11	118.83	117.47	139.55	140.44	140.00	139.64	139.96	139.80
	SE (m) ±	0.40	0.46	0.43	0.87	0.52	0.69	1.70	0.48	1.09	1.32	0.59	0.95	1.53	0.60	1.06
	CD at 5%	1.20	1.38	1.29	2.59	1.56	2.075	5.07	1.45	3.26	3.93	1.77	2.85	4.55	1.80	3.18

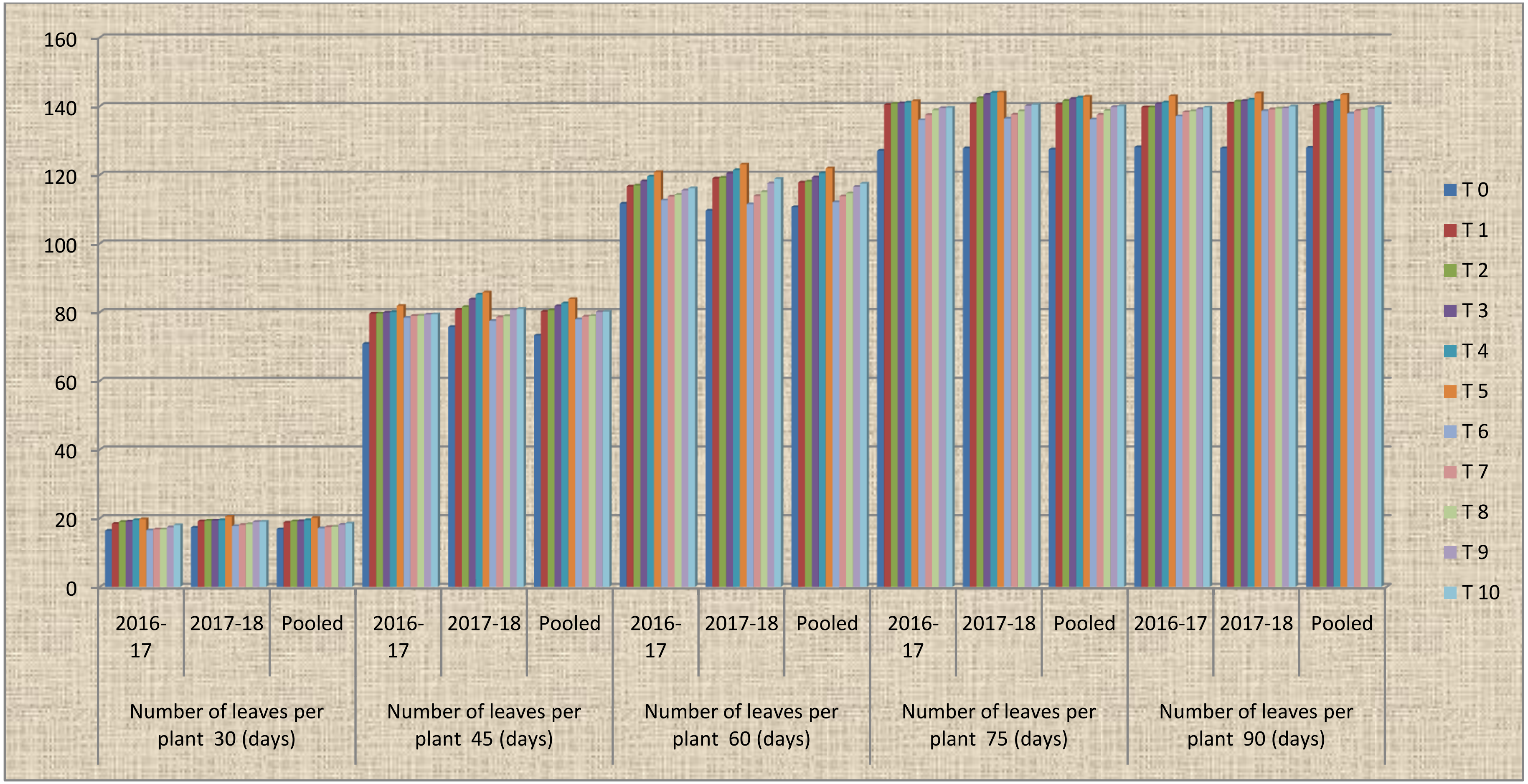

Fig.No-4.1.4: Effect of Gibberellic acid and Cycocel on Number of leaves per plant of African marigold.

4.2: Flowering characters:

4.2.1: Days taken to first bud appearance (days):

During the data recorded 2017 and 2018 year as well as pooled mean data on days taken to first bud appearance are presented in Table No-4.2.1 and illustrated in Fig.No-4.2.1.

Influence of growth regulators the days taken to first bud appearance were affected significantly by growth regulators. During the first year of the investigation, treatment T_{10} (Cycocel at 2500 ppm) is recorded early beginning of flower bud which took of flower bud which took (40.24 days) followed by the treatment T_9 (Cycocel at 2000 ppm) which took for bud initiation (41.47 days) for the same. However, late initiation (51.89 days) was recorded in treatment T_0 (control condition).

During the second year of investigation that treatment T_{10} (Cycocel at 2500 ppm) recorded early bud initiation (41.82 days) followed by the treatments T_9 (Cycocel at 2000 ppm) having respective days for bud initiation (42.57 days). Maximum days taken to bud appearance (52.35 days) was recorded in treatment T_0 (control condition).

Findings based on pooled data revealed that treatment T_{10} (Cycocel at 2500 ppm) is the minimum days to first bud appearance (41.03 days) followed by treatment T_9 (Cycocel at 2000 ppm) having days taken to first bud appearance (42.02 days). Maximum first bud appearance (52.12 days) was observed in treatment T_0 (control condition).

Table No-4.2.1: Effect of Gibberellic acid and Cycocel on days taken to first bud appearance (days) of African marigold.

Days taken to first bud appearance (days)				
S.N.	Treatment Combinations	2016 - 17	2017-18	Pooled
T_0	Control	51.89	52.35	52.12
T_1	GA_3 @ 50 ppm	49.36	50.27	49.82
T_2	GA_3 @ 100 ppm	48.64	49.91	49.28
T_3	GA_3 @ 200 ppm	46.73	47.69	47.21
T_4	GA_3 @ 300 ppm	46.65	47.57	47.11
T_5	GA_3 @ 400 ppm	45.47	47.16	46.32
T_6	Cycocel @ 500 ppm	44.18	45.45	44.82
T_7	Cycocel @ 1000 ppm	43.55	44.02	43.79
T_8	Cycocel @ 1500 ppm	42.39	43.39	42.89
T_9	Cycocel @ 2000 ppm	41.47	42.57	42.02
T_{10}	Cycocel @ 2500 ppm	40.24	41.82	41.03
	SE (m) ±	0.69	0.46	0.57
	CD at 5%	2.07	1.39	1.73

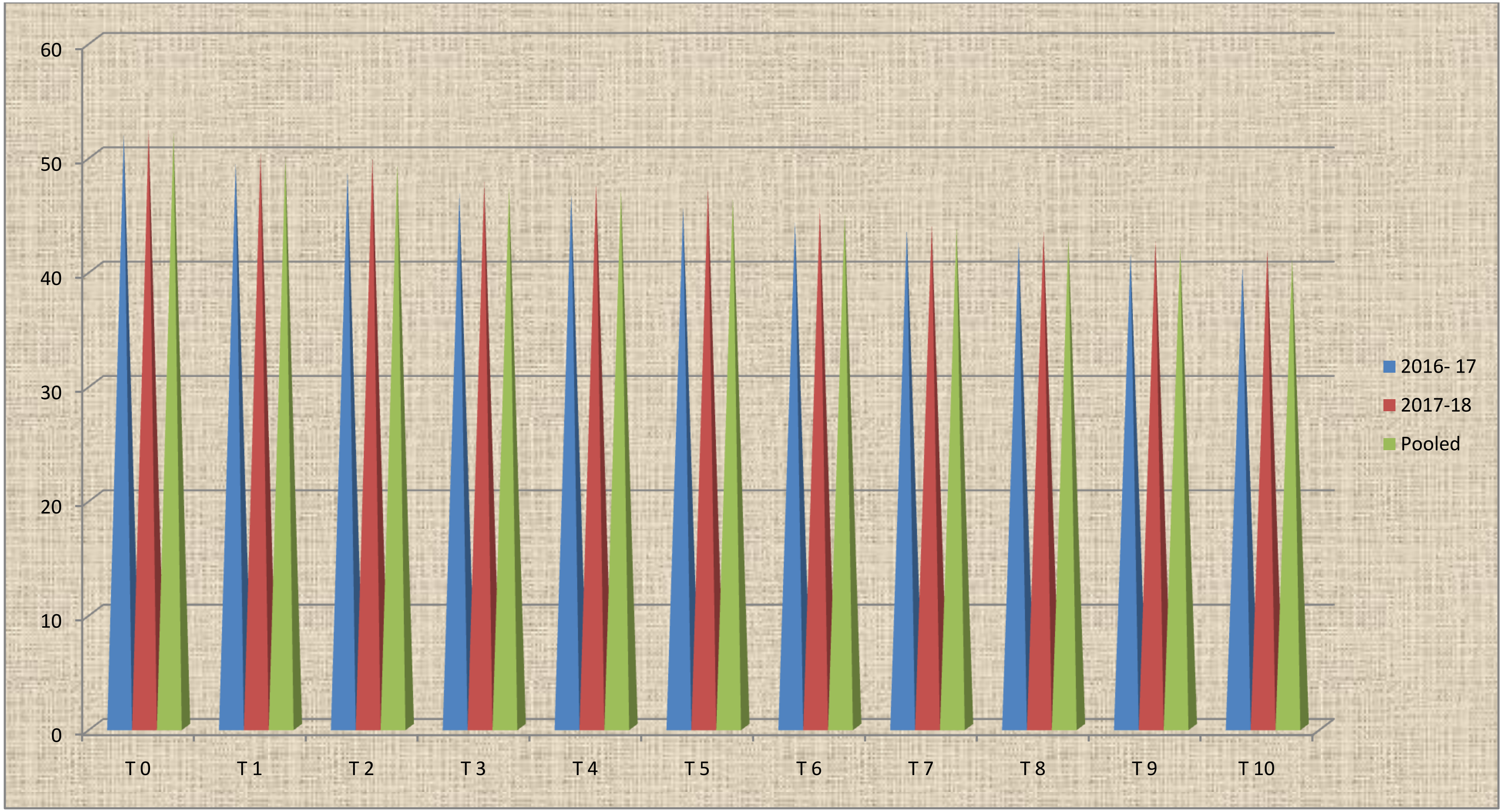

Fig.No-4.2.1: Effect of Gibberellic acid and Cycocel on days taken to first bud appearance (days) of African marigold.

4.2.2: Day taken to first flowering (days):

The data observed during 2016-17 and 2017-18 as well as with pooled mean on days to first flowering are presented in Table No-4.2.2 and depicted through Fig.No-4.2.2.

Effect of growth regulators the days to first flowering were affected significantly by growth regulators. During the first year of the investigation, treatment T_{10} (Cycocel at 2500 ppm) is recorded early first flowering which (54.77days) followed by the treatment T_9 (Cycocel at 2000 ppm) which took for flowering (55.29 days) for the same. However, late initiation (65.81days) were observed with treatment T_0 (control condition).

During the second year of investigation, treatment T_{10} (Cycocel at 2500 ppm) recorded early first flowering (53.77days) followed by the treatments T_9 (Cycocel at 2000 ppm) having respective days for flowering (57.69days).The treatment T_0 (control) showed late flowering clearly (66.05 days).

Similarly on the basis of pooled mean data revealed that treatment T_{10} (Cycocel at 2500 ppm) is the maximum recorded early flowering (54.27 days) followed by T_9 (Cycocel at 2000 ppm) (56.49 days). Whereas, the treatment T_0 (control) registered late flowering (65.93 days).

Table No-4.2.2: Effect of Gibberellic acid and Cycocel on days taken to first flowering (days) of African marigold.

Days taken to first flowering (Days)				
S.N.	**Treatment Combination**	**2016 - 17**	**2017-18**	**Pooled**
T_0	Control	65.81	66.05	65.93
T_1	GA_3 @ 50 ppm	64.62	65.36	64.99
T_2	GA_3 @ 100 ppm	64.18	65.09	64.64
T_3	GA_3 @ 200 ppm	64.11	63.77	63.94
T_4	GA_3 @ 300 ppm	63.82	63.10	63.46
T_5	GA_3 @ 400 ppm	63.73	61.76	62.75
T_6	Cycocel @ 500 ppm	62.35	61.31	61.83
T_7	Cycocel @ 1000 ppm	58.08	59.49	58.79
T_8	Cycocel @ 1500 ppm	57.51	58.12	57.82
T_9	Cycocel @ 2000 ppm	55.29	57.69	56.49
T_{10}	Cycocel @ 2500 ppm	54.77	53.77	54.27
	SE (m) ±	0.83	0.69	0.76
	CD at 5%	2.48	2.06	2.27

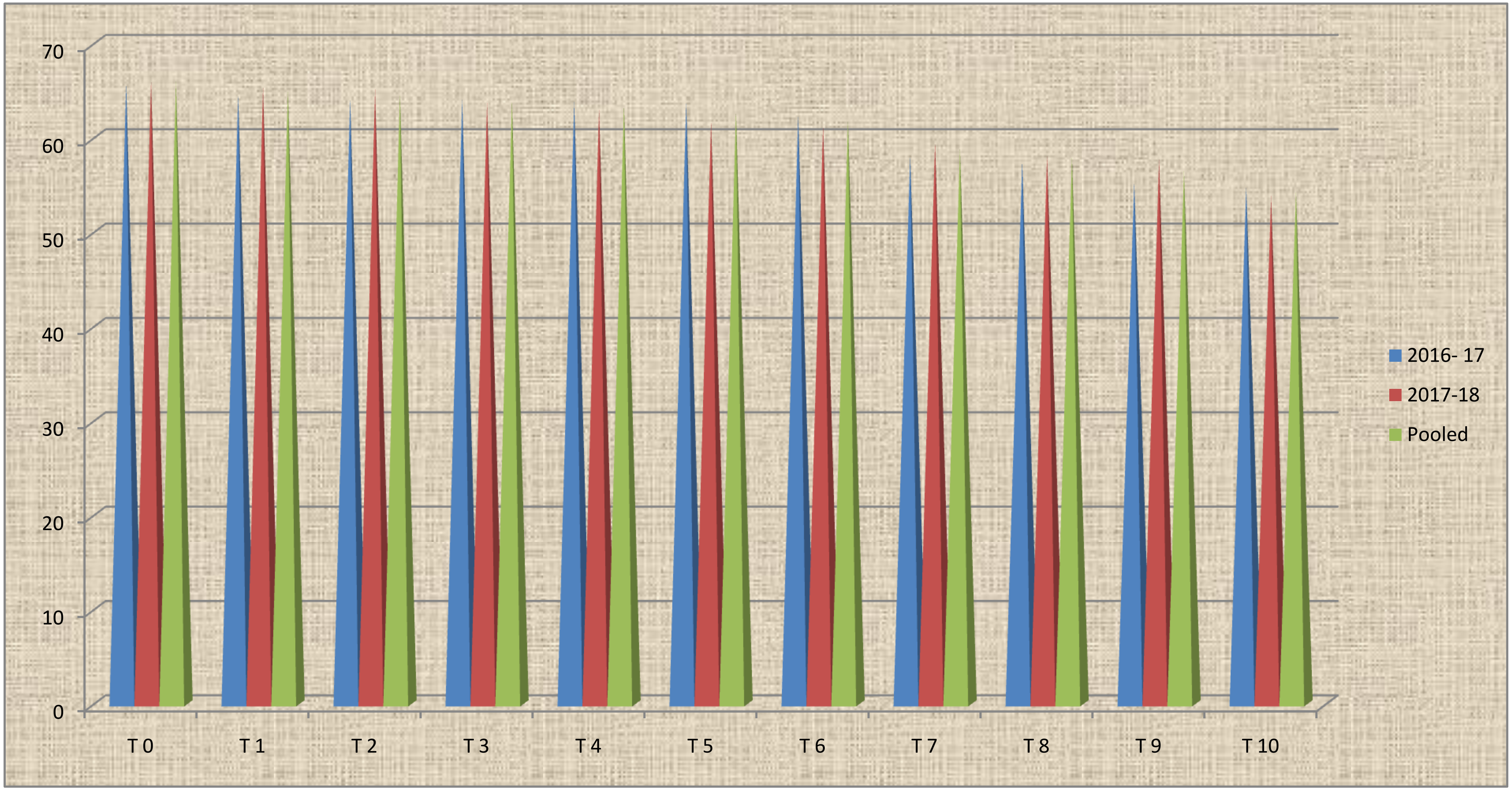

Fig.No-4.2.2: Effect of Gibberellic acid and Cycocel on days taken to first flowering (days) of African marigold.

4.2.3: Days to 50 percent flowering:

The data observeded during 2017 and 2018 as well as with pooled mean on days to 50 percent flowering are presented in Table No-4.2.3 and depicted through Fig.No-4.2.3.

Effect of growth regulators the days to 50% flowering were affected significantly by growth regulators. During the first year of the investigation, treatment T_{10} (Cycocel at 2500 ppm) recorded early flowering which (71.58 days) followed by the treatment T_9 (Cycocel at 2000 ppm) which took for 50% flowering (73.03 days) for the same. However, late flowering (79.38 days) was observed with treatment T_0 (control condition).

During the second year of investigation, treatment T_{10} (Cycocel at 2500 ppm) recorded 50% flowering (72.50 days) followed by the treatments T_9 (Cycocel at 2000 ppm) having respective days for 50% flowering (72.53 days).The treatment T_0 (control) showed late flowering clearly (78.95 days).

Equally on the basis of pooled mean data treatment 50 percent flowering treatment T_{10} (Cycocel at 2500 ppm) is recorded early flowering (72.04 days) followed by the treatment T_9 (Cycocel at 2000 ppm) (72.78 days). Whereas, the treatment T_0 (control) registered late flowering (79.17 days).

Table No-4.2.3: Effect of Gibberellic acid and Cycocel on days taken to 50% flowering (days) of African marigold.

Days taken to 50% flowering (Days)				
S.N.	**Treatment combination**	**2016- 17**	**2017-18**	**Pooled**
T_0	Control	79.38	78.95	79.17
T_1	GA_3 @ 50 ppm	78.69	78.76	78.73
T_2	GA_3 @ 100 ppm	77.29	77.90	77.60
T_3	GA_3 @ 200 ppm	77.20	77.58	77.39
T_4	GA_3 @ 300 ppm	77.00	77.40	77.20
T_5	GA_3 @ 400 ppm	76.88	76.87	76.88
T_6	Cycocel @ 500 ppm	76.64	75.65	76.15
T_7	Cycocel @ 1000ppm	75.18	75.44	75.31
T_8	Cycocel @ 1500 ppm	73.88	74.82	74.35
T_9	Cycocel @ 2000 ppm	73.03	72.53	72.78
T_{10}	Cycocel @ 2500 ppm	71.58	72.50	72.04
	SE (m) ±	0.74	0.53	0.63
	CD at 5%	2.22	1.59	1.91

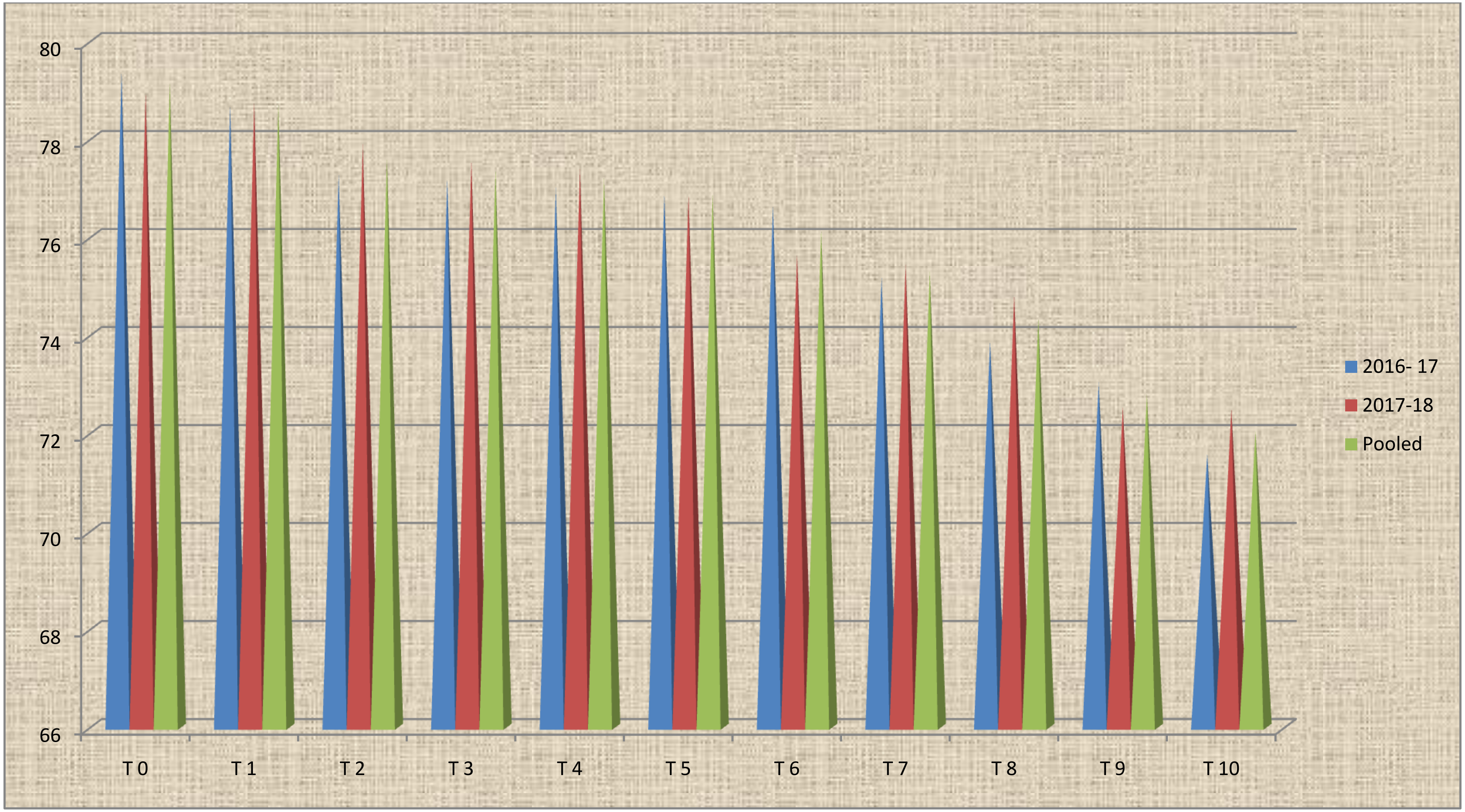

Fig.No-4.2.3: Effect of Gibberellic acid and Cycocel on days taken to 50% flowering (days) of African marigold.

4.2.4: Days Taken to First Flower Picking:

During the data recorded 2017and 2018 year as well as pooled mean data on days taken to first picking are presented in table No-4.2.4 and showed in Fig.No-4.2.4.

Influence of growth regulators the days to first picking were affected significantly by growth regulators. During the first year of the investigation, treatment T_{10} (Cycocel at 2500 ppm) recorded first picking of flower at the (76.89 days) followed by the treatment T_9 (Cycocel at 2000 ppm) which took for picking of flower (77.52 days) for the same However, late picking of the flower (82.19 days) were observed in treatment T_0 (control condition).

During the second year of the investigation, treatment T_{10} (Cycocel at 2500 ppm) recorded first picking of flower at the (76.37 days) followed by the treatment T_9 (Cycocel at 2000 ppm) which took for picking of flower (76.57 days) for the same. However, late picking of the flower (82.36 days) was observed in treatment T_0 (control).

Similarly on the basis of pooled mean data treatment T_{10} (Cycocel at 2500 ppm) recorded days to first picking (76.63 days) followed by the treatment T_9 (Cycocel at 2000 ppm) (77.04 days). Whereas, the treatment T_0 (control) registered late picking of flower (82.27 days).

Plate No.8: A general view of marigold crop at the time of harvesting.

Table No-4.2.4: Effect of Gibberellic acid and Cycocel on days taken to first flower picking (days) of African marigold.

Days taken to first flower picking (Days)				
S.N.	**Treatment combination**	**2016- 17**	**2017-18**	**Pooled**
T_0	Control	82.19	82.36	82.27
T_1	GA_3 @ 50 ppm	81.52	82.31	81.91
T_2	GA_3 @ 100 ppm	80.46	81.87	81.16
T_3	GA_3 @ 200 ppm	80.28	81.23	80.75
T_4	GA_3 @ 300 ppm	79.52	80.76	80.14
T_5	GA_3 @ 400 ppm	79.26	79.73	79.49
T_6	Cycocel @ 500 ppm	78.52	79.10	78.81
T_7	Cycocel @ 1000ppm	78.48	78.91	78.69
T_8	Cycocel @ 1500 ppm	77.85	77.04	77.44
T_9	Cycocel @ 2000 ppm	77.52	76.57	77.04
T_{10}	Cycocel @ 2500 ppm	76.89	76.37	76.63
	SE (m) ±	0.94	0.61	0.77
	CD at 5%	2.79	1.81	2.3

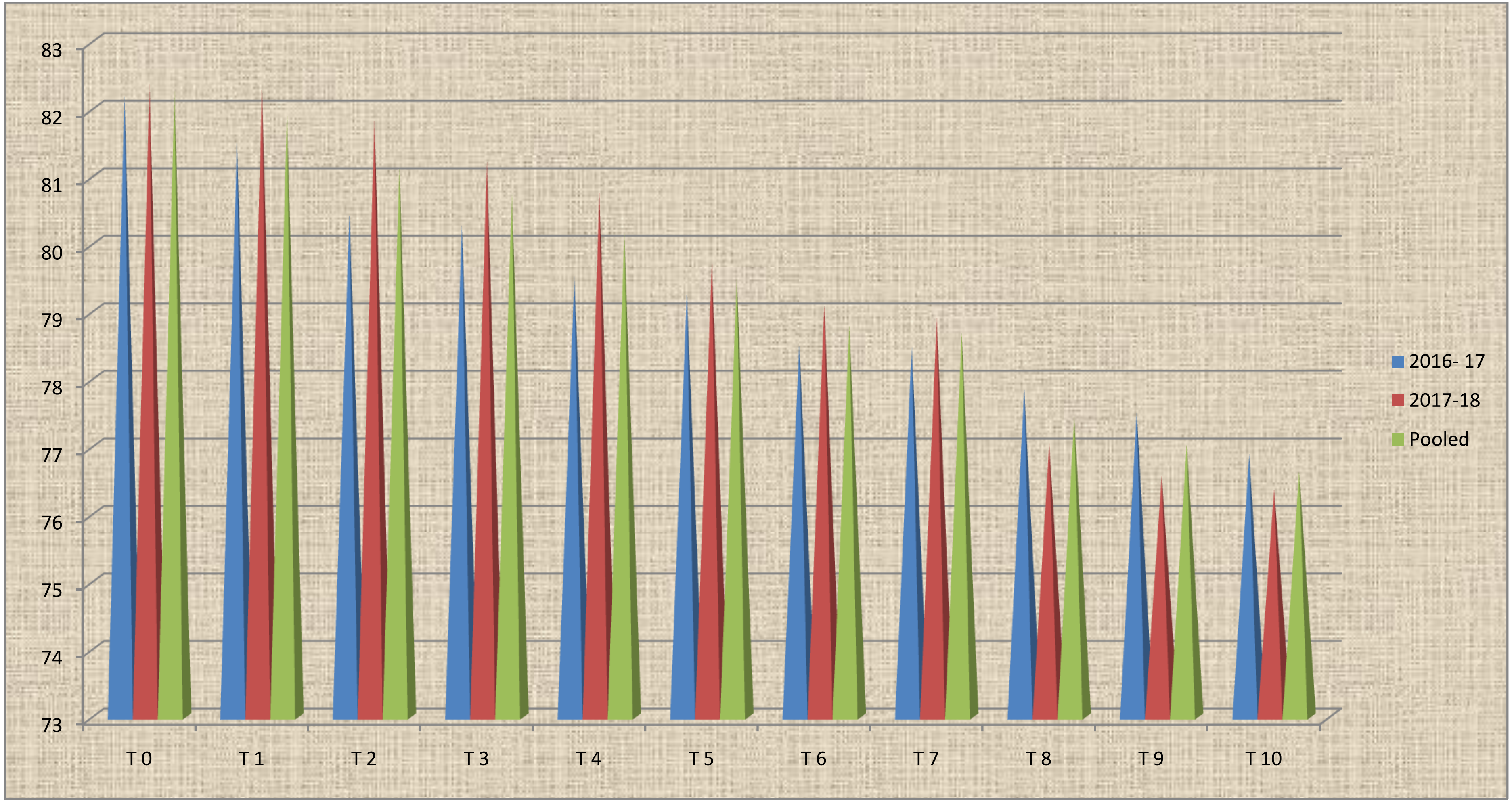

Fig.No-4.2.4: Effect of Gibberellic acid and Cycocel on days taken to first flower picking (days) of African marigold.

4.2.5: Flower Diameter (cm):

The data to effect of different growth regulators on flower diameter recorded periodically are presented in Table No-4.2.5 and illustrated in Fig.No-4.2.5.

Marked differences were showed among application of growth regulators on flower diameter. The perusal of data obviously indicated that during the first year of investigation, maximum flower diameter (5.44 cm) was registered by the treatment T_5 (GA_3 at 400 ppm) followed by the treatment T_4 (GA_3 at 300 ppm) having flower diameter of (5.33 cm). The smallest flower diameter (4.05 cm) was observed with T_0 (control).

It is present from data observed during second year of investigation that treatment T_5 (GA_3 at 400 ppm) is recorded maximum flower diameter (5.41cm) followed by the treatment T_4 (GA_3 at 300 ppm) having flower diameter (5.35 cm). whereas smallest flower diameter (3.94 cm) was observed in treatment T_0 (control).

The two years pooled data indicate that the maximum flower diameter (5.43 cm) was observed under the treatment T_5 (GA_3 at 400 ppm) followed by the treatment T_4 (GA_3 at 300 ppm) flower diameter (5.34 cm). Whereas smallest flower diameter (4.00 cm) was observed under the treatment T_0 (control condition).

Table No-4.2.5: Effect of Gibberellic acid and Cycocel on diameter of flower (cm) of African marigold.

Diameter of flower (cm)				
S.N.	**Treatment combination**	**2016- 17**	**2017-18**	**Pooled**
T_0	Control	4.05	3.94	4.00
T_1	GA_3 @ 50 ppm	5.07	5.03	5.05
T_2	GA_3 @ 100 ppm	5.14	5.06	5.10
T_3	GA_3 @ 200 ppm	5.16	5.09	5.13
T_4	GA_3 @ 300 ppm	5.33	5.35	5.34
T_5	GA_3 @ 400 ppm	5.44	5.41	5.43
T_6	Cycocel @ 500 ppm	4.16	4.36	4.26
T_7	Cycocel @ 1000ppm	4.35	4.48	4.42
T_8	Cycocel @ 1500 ppm	4.42	4.53	4.48
T_9	Cycocel @ 2000 ppm	4.98	5.01	5.00
T_{10}	Cycocel @ 2500 ppm	5.06	5.03	5.04
	SE (m) ±	0.21	0.22	0.21
	CD at 5%	0.71	0.67	0.69

Fig.No-4.2.5: Effect of Gibberellic acid and Cycocel on diameter of flower (cm) of African marigold.

4.2.6: Duration of flowering (days)

The data pertaining to effect of various growth regulators period of flowering are presented in Table No-4.2.6 and depicted through Fig.No-4.2.6.

Data showed that the duration of flowering was significantly influenced by plant growth regulators. During the first year of investigation, maximum duration of flowering (60.55 days) was recorded under the treatment T_{10} (Cycocel at 2500 ppm) followed by the treatment T_9 (Cycocel at 2000 ppm) having duration of flowering (59.66 days) While, minimum duration of flowering (50.48 days) was observed under treatment T_0 (control condition).

During the second year of investigation, maximum duration of flowering (61.19 days) was recorded under treatment T_{10} (Cycocel at 2500 ppm) followed by treatment T_9 (Cycocel at 2000 ppm) 59.23 days. The minimum duration of flowering (49.40 days) was observed under T_0 (control condition)

Findings based on the pooled mean data the results pertaining to period of flowering observed maximum (60.87 days) under the treatments T_{10} (Cycocel at 2500 ppm) followed by the treatment T_9 (Cycocel at 2000 ppm) having duration of flowering (59.45 days). The minimum duration of flowering (49.94 days) was observed under the treatment T_0 (control condition).

Table-4.2.6: Effect of Gibberellic acid and Cycocel on duration of flowering (days) of African marigold.

Duration of flowering (Days)				
S.N.	**Treatment combination**	**2016- 17**	**2017-18**	**Pooled**
T_0	Control	50.48	49.40	49.94
T_1	GA_3 @ 50 ppm	51.66	50.84	51.25
T_2	GA_3 @ 100 ppm	52.51	51.27	51.89
T_3	GA_3 @ 200 ppm	53.17	53.12	53.15
T_4	GA_3 @ 300 ppm	54.59	54.23	54.41
T_5	GA_3 @ 400 ppm	55.24	55.17	55.21
T_6	Cycocel @ 500 ppm	56.27	56.22	56.25
T_7	Cycocel @ 1000ppm	57.26	57.43	57.35
T_8	Cycocel @ 1500 ppm	58.47	58.36	58.42
T_9	Cycocel @ 2000 ppm	59.66	59.23	59.45
T_{10}	Cycocel @ 2500 ppm	60.55	61.19	60.87
	SE (m) ±	2.11	1.69	1.90
	CD at 5%	6.28	5.04	5.66

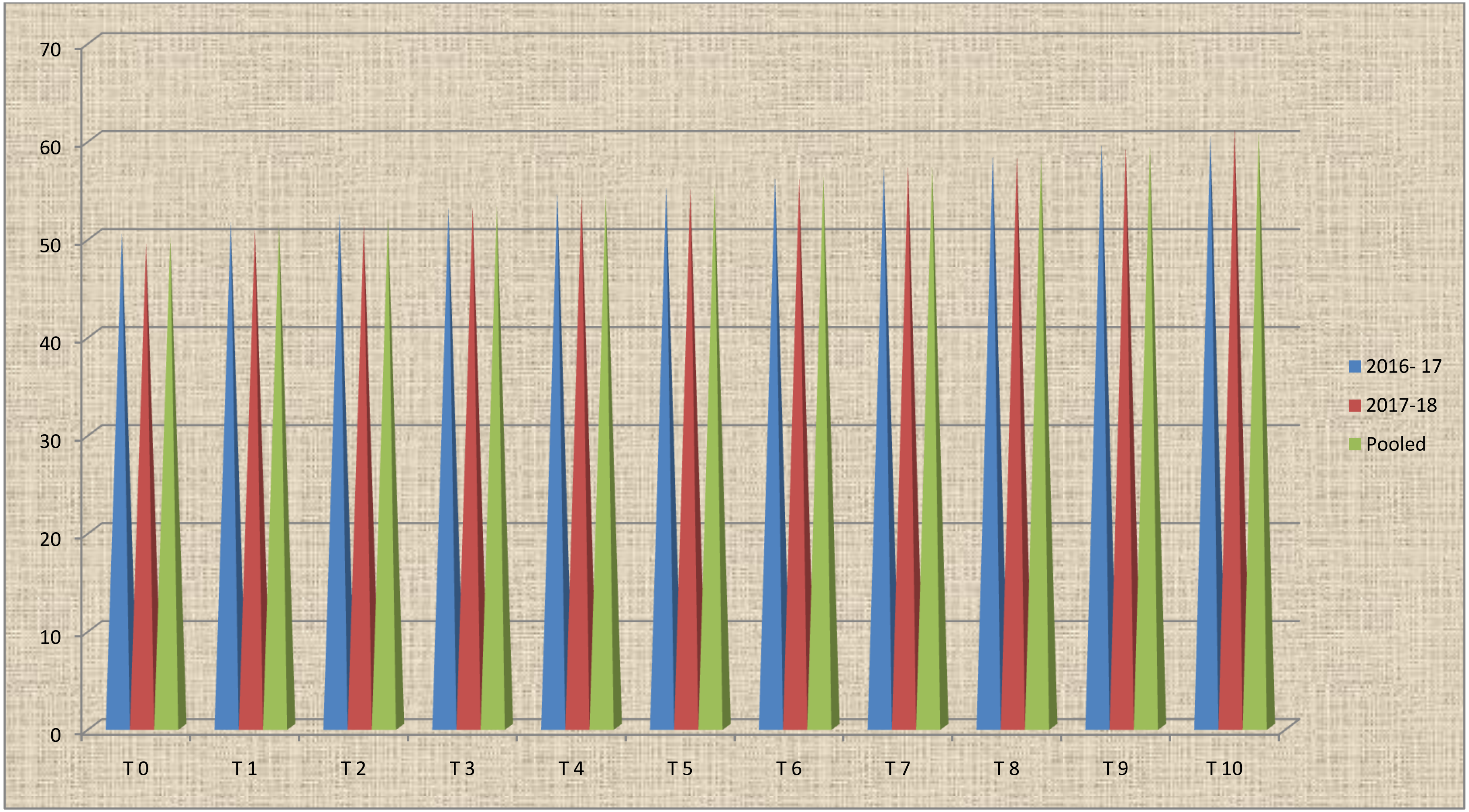

Fig.No-4.2.6: Effect of Gibberellic acid and Cycocel on duration of flowering (days) of African marigold.

4.2.7: Number of flowers per plant:

The data obseved number of flowers per plant are presented in Table No-4.2.7 and illustrated in Fig. No-4.2.7.

It is clear from the data during the first year of investigation that T_5 (GA_3 at 400 ppm) is recorded maximum number of flowers per plant (27.45) followed by treatment T_4 (GA_3 at 300 ppm) having number of flowers per plant (27.23). Minimum number of flowers per plant (16.55) was found under the treatment T_0 (control condition).

It is vivid from the data recorded number of flowers per plant during second year that maximum number of flowers per plant (30.48) was observed under the treatment T_5 (GA_3 at 400 ppm) followed by the treatment T_4 (GA_3 at 300 ppm) number of flowers per plant (28.68). Minimum number of flowers per plant (16.40) was noticed under the treatment T_0 (control condition).

Findings based on pooled mean data revealed followed the similar treatments.The maximum number of flowers per plant 28.97 T_5 (GA_3 at 400 ppm) followed by the treatment T_4 (GA_3 at 300 ppm) 27.96. The lowest number of flowers 16.48 was found under the treatment T_0 (control condtion).

Table No-4.2.7: Effect of Gibberellic acid and Cycocel on number of flowers per plant of African marigold.

Number of flowers per plant				
S.N.	**Treatment combination**	**2016- 17**	**2017-18**	**Pooled**
T_0	Control	16.55	16.40	16.48
T_1	GA_3 @ 50 ppm	24.18	25.72	24.95
T_2	GA_3 @ 100 ppm	24.53	26.63	25.58
T_3	GA_3 @ 200 ppm	24.65	27.89	26.27
T_4	GA_3 @ 300 ppm	27.23	28.68	27.96
T_5	GA_3 @ 400 ppm	27.45	30.48	28.97
T_6	Cycocel @ 500 ppm	18.47	20.46	19.47
T_7	Cycocel @ 1000ppm	18.74	21.25	20.00
T_8	Cycocel @ 1500 ppm	21.55	22.38	21.97
T_9	Cycocel @ 2000 ppm	23.17	24.36	23.77
T_{10}	Cycocel @ 2500 ppm	23.18	25.07	24.13
	SE (m) ±	0.76	0.53	0.64
	CD at 5%	2.27	1.59	1.93

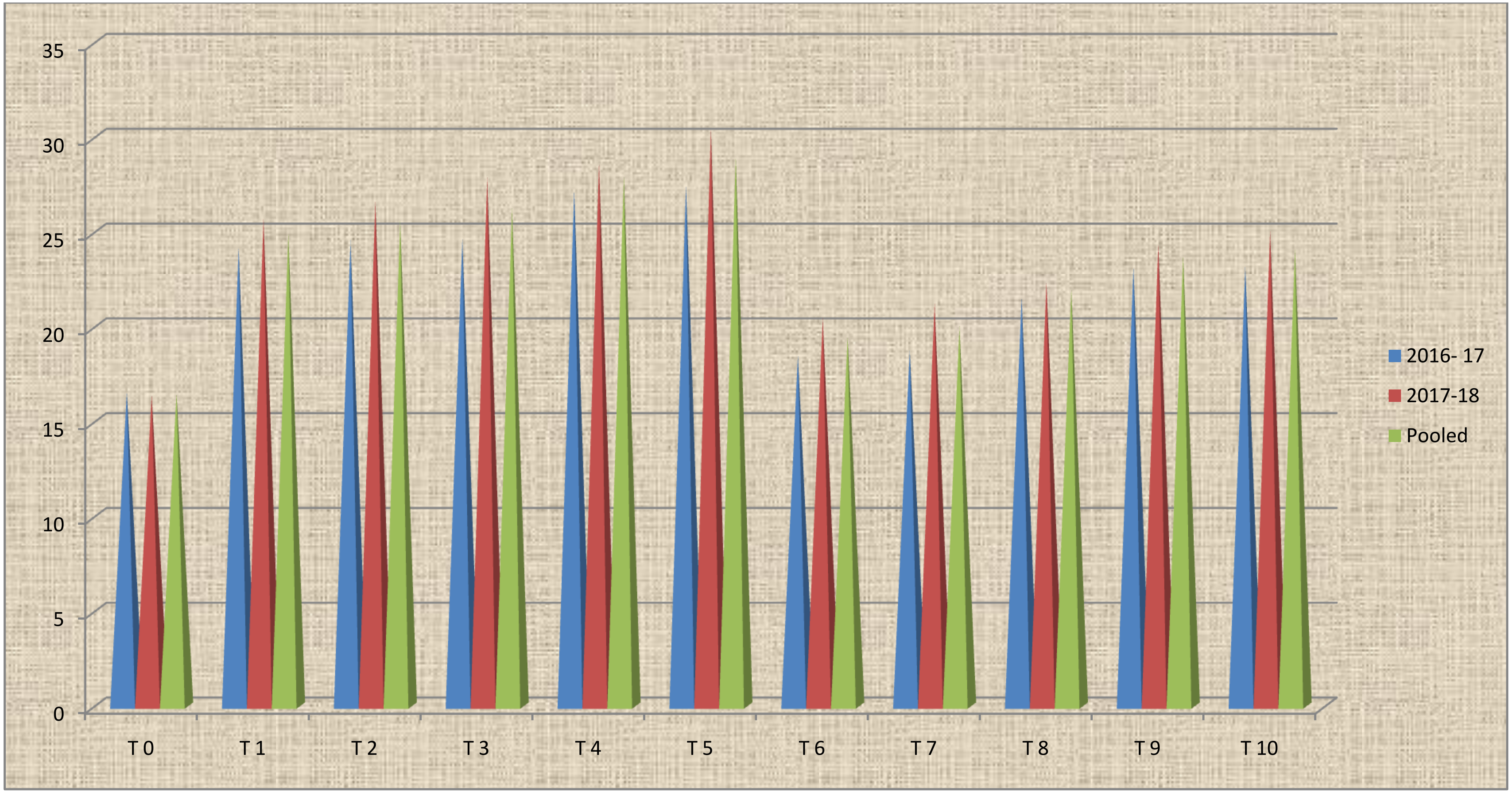

Fig.No-4.2.7: Effect of Gibberellic acid and Cycocel on number of flowers per plant of African marigold.

4.3: Yield Characters:

4.3.1: Mean weight of flowers (g):

The data observed mean weight of flowers are presented in Table No-4.3.1 and illustrated in Fig.No-4.3.1.

It is clear from the data during the first year of investigation that treatment T_5 (GA_3 at 400 ppm) is recorded maximum mean weight of flower (7.60g) followed by treatment T_4 (GA_3 at 300 ppm) having mean weight of flower (6.69g). Minimum mean weight of flower (4.47g) was recorded in treatment T_0 control condition.

It is apparent from data observed during second year of investigation that treatment T_5 (GA_3 at 400 ppm) is maximum mean weight of flower (6.99g) followed by treatment T_4 (GA_3 at 300 ppm) having mean weight of flower (6.66g). Minimum mean weight of flower (4.32g) was recorded in treatment T_0 (control condition).

Findings based on pooled mean data revealed that treatment T_5 (GA_3 at 2500 ppm) is the maximum mean weight of flower (7.30g) followed by treatment T_4 (GA_3 at 2000 ppm) having mean weight of flower (6.68g). Minimum mean weight of flower (4.40g) was observed in treatment T_0 (control condition).

Table No-4.3.1: Effect of Gibberellic acid and Cycocel on mean weight of flowers (g) of African marigold.

Mean weight of flowers (g)				
S.N.	**Treatment combination**	**2016- 17**	**2017-18**	**Pooled**
T_0	Control	4.47	4.32	4.40
T_1	GA_3 @ 50 ppm	5.94	6.34	6.14
T_2	GA_3 @ 100 ppm	6.39	6.39	6.39
T_3	GA_3 @ 200 ppm	6.56	6.62	6.59
T_4	GA_3 @ 300 ppm	6.69	6.66	6.68
T_5	GA_3 @ 400 ppm	7.60	6.99	7.30
T_6	Cycocel @ 500 ppm	4.76	5.13	4.95
T_7	Cycocel @ 1000ppm	4.92	5.26	5.09
T_8	Cycocel @ 1500 ppm	5.49	5.35	5.42
T_9	Cycocel @ 2000 ppm	5.52	5.47	5.50
T_{10}	Cycocel @ 2500 ppm	5.88	5.66	5.77
	SE (m) ±	0.53	0.34	0.43
	CD at 5%	1.58	1.02	1.30

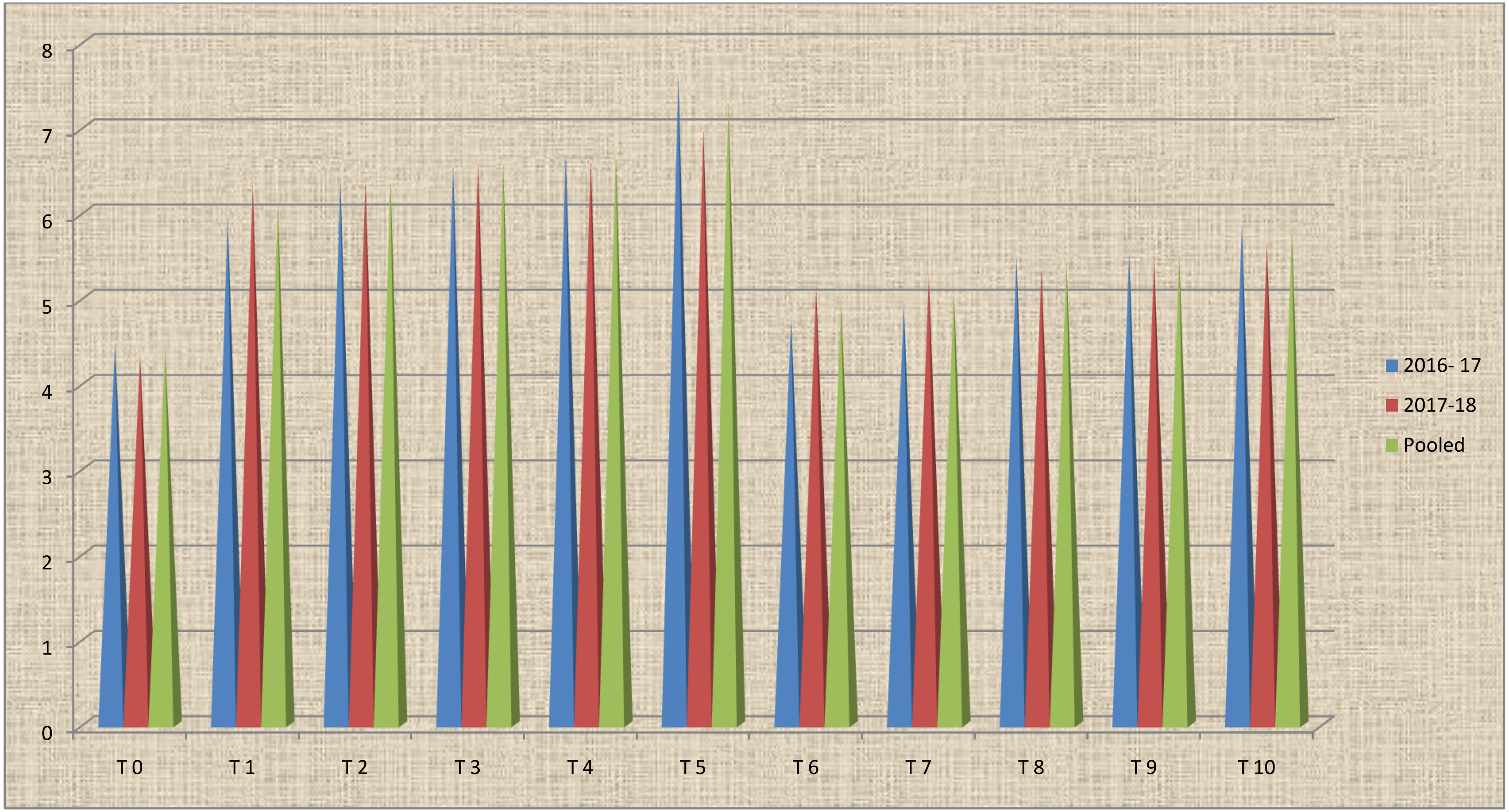

Fig.No-4.3.1: Effect of Gibberellic acid and Cycocel on mean weight of flowers (g) of African marigold.

4.3.2: Flowers yield per plant (g):

The data observed flower yield per plant are presented in Table No-4.3.2 and illustrated in Fig.No-4.3.2.

It is clear from the data during the first year of investigation that treatment T_5 (GA_3 at 400 ppm) is recorded maximum flower yield per plant (206.91g) followed by treatment T_4 (GA_3 at 300 ppm) having flowers yield per plant (183.57g). Minimum fresh weight of flower per plant (73.77g) was observed in treatment T_0 (control condition).

It is obvious from data observed during second year of investigation that treatment T_5 (GA_3 at 400 ppm) is Maximum flower yield per plant (201.91g) followed by treatment T_4 (GA_3 at 300 ppm) having flowers yield per plant (185.97g). Minimum flower yield per plant (71.09g) was observed in treatment T_0 (control condition).

Findings based on pooled mean data revealed that treatment T_5 (GA_3 at 400 ppm). The maximum flower weight per plant (204.41g) followed by treatment T_4 (GA_3 at 300 ppm) having flowers yield per plant (184.77g). Minimum flower yield per plant (72.43g) was observed in treatment T_0 (control condition).

Table No-4.3.2: Effect of Gibberellic acid and Cycocel on flower yield per plant (g) of African marigold.

Flower yield per plant (g)				
S.N.	**Treatment combination**	**2016- 17**	**2017-18**	**Pooled**
T_0	Control	73.77	71.09	72.43
T_1	GA_3 @ 50 ppm	136.97	142.69	139.83
T_2	GA_3 @ 100 ppm	156.11	179.42	167.77
T_3	GA_3 @ 200 ppm	161.51	183.47	172.49
T_4	GA_3 @ 300 ppm	183.57	185.97	184.77
T_5	GA_3 @ 400 ppm	206.91	201.91	204.41
T_6	Cycocel @ 500 ppm	89.12	107.98	98.55
T_7	Cycocel @ 1000ppm	101.93	115.11	108.52
T_8	Cycocel @ 1500 ppm	113.26	137.08	125.17
T_9	Cycocel @ 2000 ppm	128.67	137.10	132.89
T_{10}	Cycocel @ 2500 ppm	131.49	137.83	134.66
	SE (m) ±	12.89	9.36	11.12
	CD at 5%	38.29	27.83	33.06

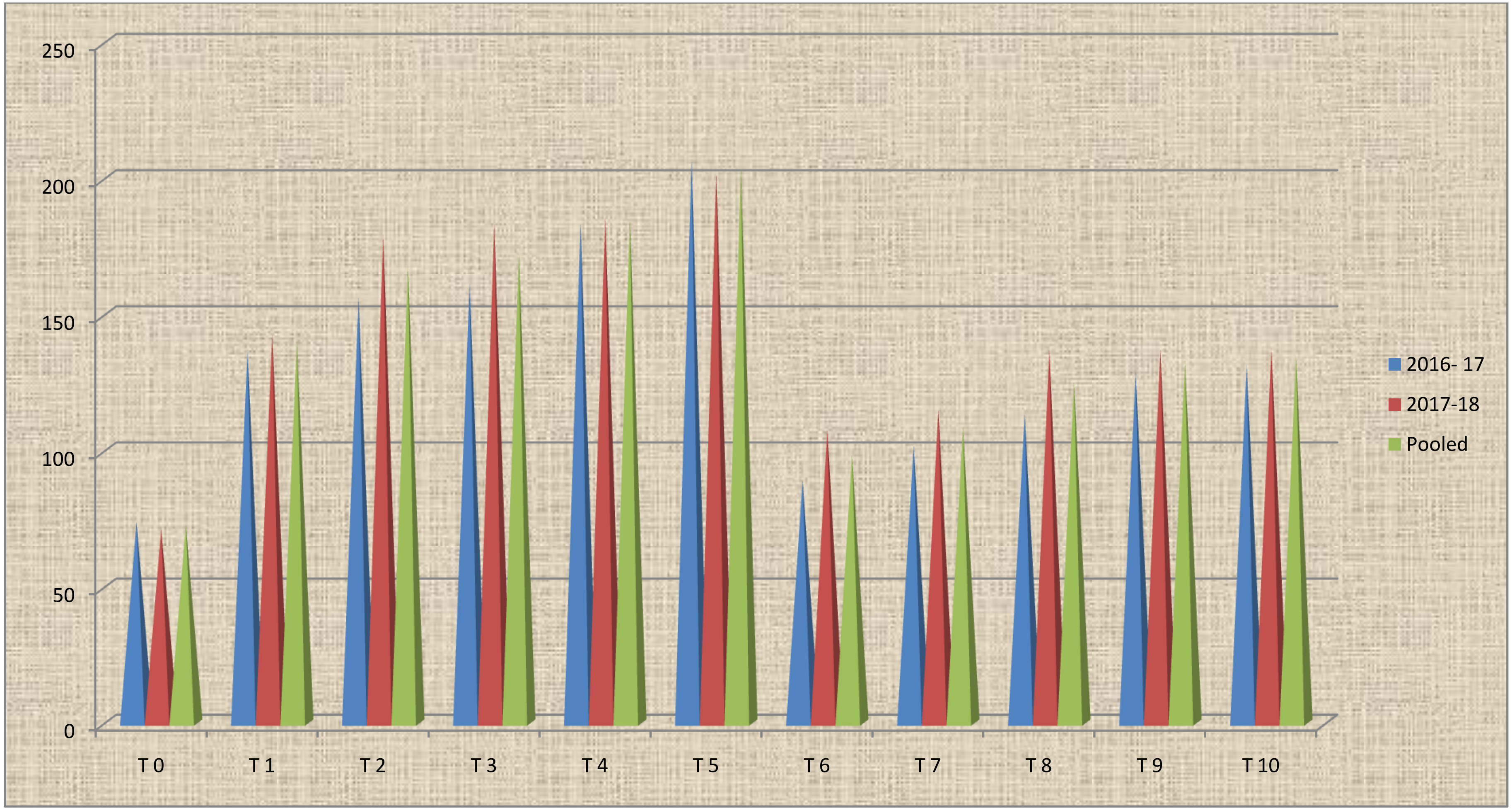

Fig.No.-4.3.2: Effect of Gibberellic acid and Cycocel on flower yield per plant (g) of African marigold.

4.3.3: Flower yield per Plot (kg):

The data observed flower yield per plot are presented in Table No-4.3.3 and illustrated in Fig.No-4.3.3.

It is clear from the data during the first year of investigation that treatment T_5 (GA_3 at 400 ppm) is recorded maximum flower yield per plot (3.30kg) followed by treatment T_4 (GA_3 at 300 ppm) having flowers yield per plot (2.93kg). Minimum flower yield per plot (1.17kg) was recorded in treatment T_0 (control condition).

It is apparent from data recorded during second year of investigation that treatment T_5 (GA_3 at 400 ppm) is maximum flower yield per plot (3.22kg) followed by treatment T_4 (GA_3 at 300 ppm) having fresh yield of flowers per plot (2.97kg). Minimum fresh flower yield per plot (1.13kg) was recorded in treatment T_0 (control condition).

Findings based on pooled mean data revealed that treatment T_5 (GA_3 at 400 ppm) is the maximum flower yield per plot (3.26kg) followed by treatment having fresh flowers yield per plot (2.95kg). Minimum fresh flower yield per plot (1.23kg) was recorded in treatment T_0 (control condition).

Table No-4.3.3: Effect of Gibberellic acid and Cycocel on flower yield per plot (kg) of African marigold.

Flower yield per plot (kg)				
S.N.	**Treatment combination**	**2016- 17**	**2017-18**	**Pooled**
T_0	Control	1.17	1.13	1.23
T_1	GA_3 @ 50 ppm	2.18	2.28	2.23
T_2	GA_3 @ 100 ppm	2.49	2.86	2.67
T_3	GA_3 @ 200 ppm	2.58	2.93	2.75
T_4	GA_3 @ 300 ppm	2.93	2.97	2.95
T_5	GA_3 @ 400 ppm	3.30	3.22	3.26
T_6	Cycocel @ 500 ppm	1.51	1.72	1.61
T_7	Cycocel @ 1000ppm	1.62	1.84	1.73
T_8	Cycocel @ 1500 ppm	1.80	2.15	1.97
T_9	Cycocel @ 2000 ppm	2.05	2.19	2.12
T_{10}	Cycocel @ 2500 ppm	2.09	2.20	2.14
	SE (m) ±	0.20	0.15	0.17
	CD at 5%	0.62	0.44	0.53

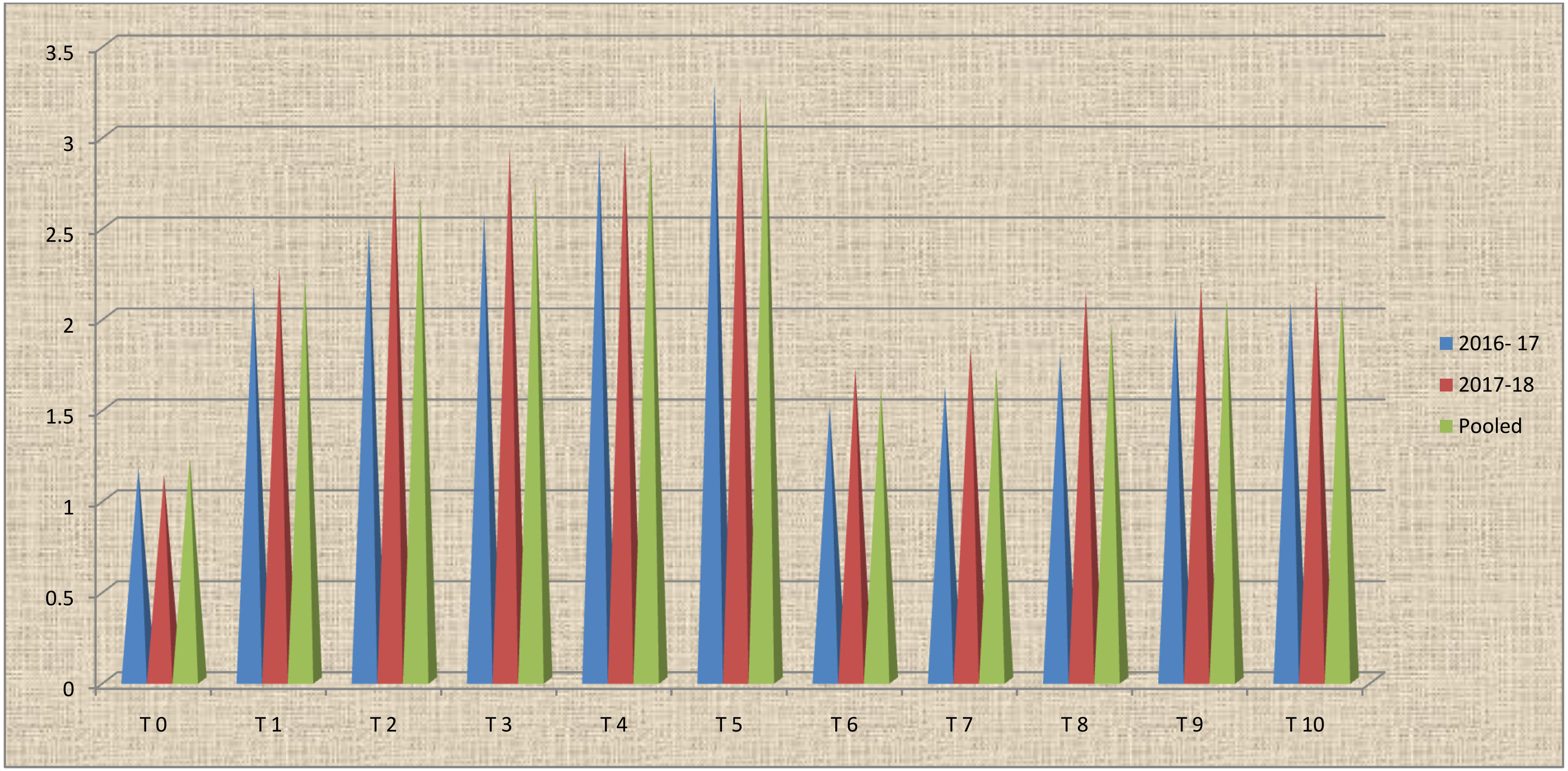

Fig.No-4.3.3: Effect of Gibberellic acid and Cycocel on flower yield per plot (kg) of African marigold.

4.3.4: Flower yield per hectare (t):

The data observed flower yield per hectare are presented in Table No-4.3.4 and illustrated in Fig.No-4.3.4.

It is clear from the data during the first year of investigation that treatment T_5 (GA_3 at 400 ppm) is recorded maximum fresh flower yield per hectare (11.04t) followed by treatment T_4 (GA_3 at 300 ppm) having fresh flowers yield per hectare (10.87t). Minimum flower yield per hectare (5.45t) was observed in treatment T_0 (control condition).

It is apparent from data observed during second year of investigation that treatment T_5 (GA_3 at 400 ppm) maximum flower yield per hectare (14.95t) followed by treatment T_4 (GA_3 at 300 ppm) having fresh yield of flowers per hectare (13.77t). Minimum fresh flower yield per hectare (5.26t) was recorded in treatment T_0 (control condition).

Findings based on pooled mean data revealed that treatment T_5 (GA_3 at 400 ppm) is the maximum flower yield per hectare (13.00t) followed by treatment T_4 (GA_3 at 300 ppm) having fresh flowers yield per hectare (12.32t). Minimum fresh flower yield per hectare (5.36t) was observed in treatment T_0 (control condition).

Table No-4.3.4: Effect of Gibberellic acid and Cycocel on flower yield per hectare (t) African marigold.

Flower yield per hectare (t)				
S.N.	**Treatment combination**	**2016- 17**	**2017-18**	**Pooled**
T_0	Control	5.45	5.26	5.36
T_1	GA_3 @ 50 ppm	8.53	10.56	9.55
T_2	GA_3 @ 100 ppm	9.72	13.29	11.51
T_3	GA_3 @ 200 ppm	10.30	13.58	11.94
T_4	GA_3 @ 300 ppm	10.87	13.77	12.32
T_5	GA_3 @ 400 ppm	11.04	14.95	13.00
T_6	Cycocel @ 500 ppm	6.59	7.99	7.29
T_7	Cycocel @ 1000ppm	7.09	8.52	7.81
T_8	Cycocel @ 1500 ppm	7.53	10.15	8.84
T_9	Cycocel @ 2000 ppm	7.59	10.15	8.87
T_{10}	Cycocel @ 2500 ppm	7.87	10.20	9.04
	SE (m) ±	0.41	0.98	0.69
	CD at 5%	1.23	2.06	1.64

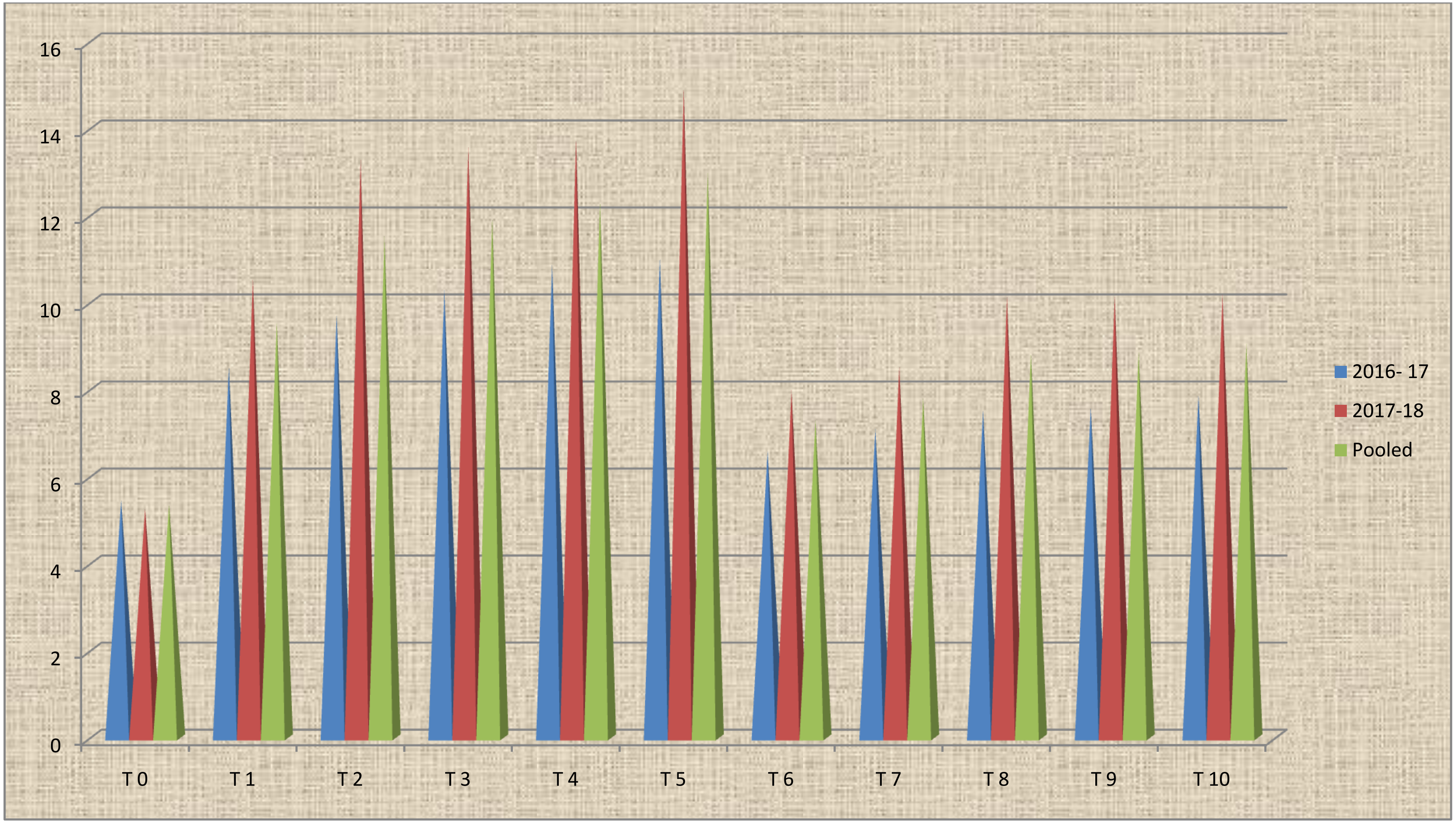

Fig.No-4.3.4: Effect of Gibberellic acid and Cycocel on flower yield per hectare (t) of African marigold.

4.4: Quality characters:

4.4.1: Shelf life of flower (days):

The data observed Shelf life of flower are presented in Table No-4.4.1 and illustrated in Fig.No-4.4.1.

It is clear from the data during the first year of investigation that treatment T_5 (GA_3 at 400 ppm) is recorded maximum shelf life of flower (7.26 days) followed by treatment T_4 (GA_3 at 300 ppm) having shelf life of flower (6.98 days). Minimum shelf life of flower (2.49 days) was observed in treatment T_0 (control condition).

It is apparent from data recorded during second year of investigation that treatment T_5 (GA_3 at 400 ppm) is maximum shelf life of flower (4.68 days) followed by treatment T_4 (GA_3 at 300 ppm) having shelf life of flower (4.60 days). Minimum shelf life of flower (2.12 days) was recorded in treatment T_0 (control condition).

Findings based on pooled mean data showed that treatment T_5 (GA_3 at 400 ppm) is the maximum shelf life of flower (5.97days) followed by treatment T_4 (GA3 at 300 ppm) having shelf life of flower (5.79 days). Minimum shelf life of flower (2.31 days) was observed in treatment T_0 (control condition).

Plate No-9: A general view of marigold flowers shelf life in lab condition.

Table No-4.4.1: Effect of Gibberellic acid and Cycocel on shelf life of flower (days) of African marigold.

Shelf life of flower (days):				
S.N.	**Treatment combination**	**2016- 17**	**2017-18**	**Pooled**
T_0	Control	2.49	2.12	2.31
T_1	GA_3 @ 50 ppm	5.74	3.83	4.79
T_2	GA_3 @ 100 ppm	5.97	4.25	5.11
T_3	GA_3 @ 200 ppm	6.81	4.59	5.70
T_4	GA_3 @ 300 ppm	6.98	4.60	5.79
T_5	GA_3 @ 400 ppm	7.26	4.68	5.97
T_6	Cycocel @ 500 ppm	4.59	2.64	3.62
T_7	Cycocel @ 1000ppm	4.70	2.67	3.69
T_8	Cycocel @ 1500 ppm	4.86	3.20	4.03
T_9	Cycocel @ 2000 ppm	5.00	3.23	4.12
T_{10}	Cycocel @ 2500 ppm	5.25	3.39	4.32
	SE (m) ±	0.40	0.27	0.33
	CD at 5%	1.19	0.80	1.00

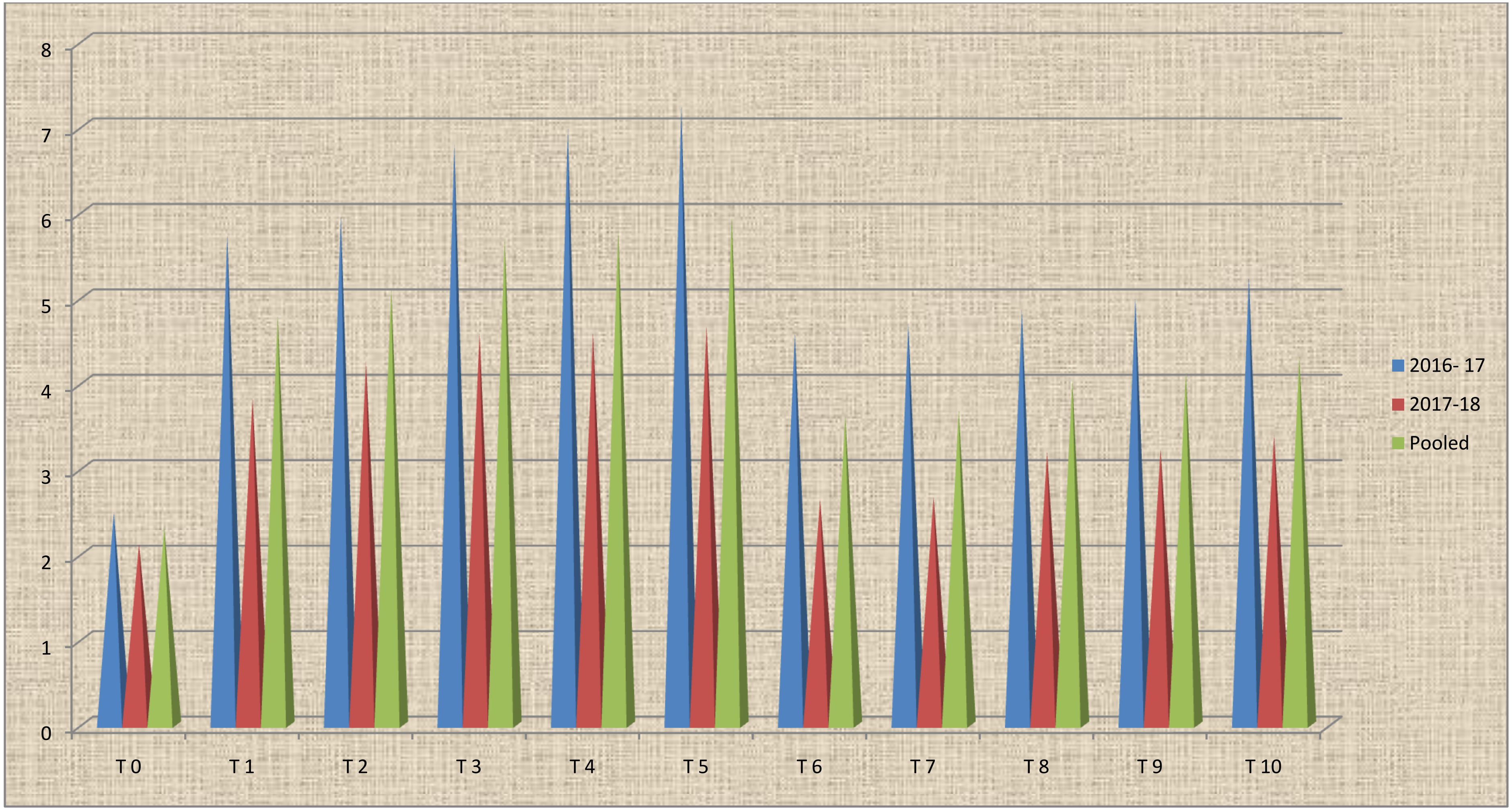

Fig.No-4.4.1: Effect of Gibberellic acid and Cycocel on shelf life of flower (days) of African marigold.

4.4.2: Moisture content in flower (%):

The data observed Moisture content in flower are presented in Table No-4.4.2. and illustrated in Fig.No-4.4.2.

It is clear from the data during the first year of investigation that treatment T_5 (GA_3 at 400 ppm) is recorded maximum moisture content in flower (85.67%) followed by treatment T_4 (GA_3 at 300 ppm) having moisture content in flower (85.56%). Minimum moisture content in flower (80.05%) was observed in treatment T_0 (control condition).

It is apparent from data observed during second year of investigation that treatment T_5 (GA_3 at 400 ppm). Maximum moisture content in flower (85.81%) followed by treatment T_4 (GA_3 at 300 ppm) having moisture content in flower (85.78 %). Minimum moisture content in flower (80.40%) was recorded in treatment T_0 (control condition).

Findings based on pooled mean data revealed that treatment T_5 (GA_3 at 400 ppm) is the maximum moisture content in flower (85.74%) followed by treatment T_4 (GA_3 at 300 ppm) having moisture content in flower (85.67%). Minimum moisture content in flower (80.23%) was recorded in treatment T_0 (control condition).

Plate No-10: An over view of marigold flower treatment Combinatios.

Plate No-11: A general view of moisture percent estimation in marigold flower under laboratory condition.

Table No-4.4.2: Effect of Gibberellic acid and Cycocel on moisture content in flower (%) of African marigold.

Moisture content in flower (%)				
S.N.	**Treatment combination**	**2016- 17**	**2017-18**	**Pooled**
T_0	Control	80.05	80.40	80.23
T_1	GA_3 @ 50 ppm	83.21	83.37	83.29
T_2	GA_3 @ 100 ppm	84.29	84.41	84.35
T_3	GA_3 @ 200 ppm	84.76	85.53	85.15
T_4	GA_3 @ 300 ppm	85.56	85.78	85.67
T_5	GA_3 @ 400 ppm	85.67	85.81	85.74
T_6	Cycocel @ 500 ppm	80.27	80.57	80.42
T_7	Cycocel @ 1000ppm	80.97	81.30	81.14
T_8	Cycocel @ 1500 ppm	82.10	82.17	82.14
T_9	Cycocel @ 2000 ppm	82.62	82.41	82.52
T_{10}	Cycocel @ 2500 ppm	82.67	83.08	82.88
	SE (m) ±	0.99	0.75	0.87
	CD at 5%	2.95	2.24	2.60

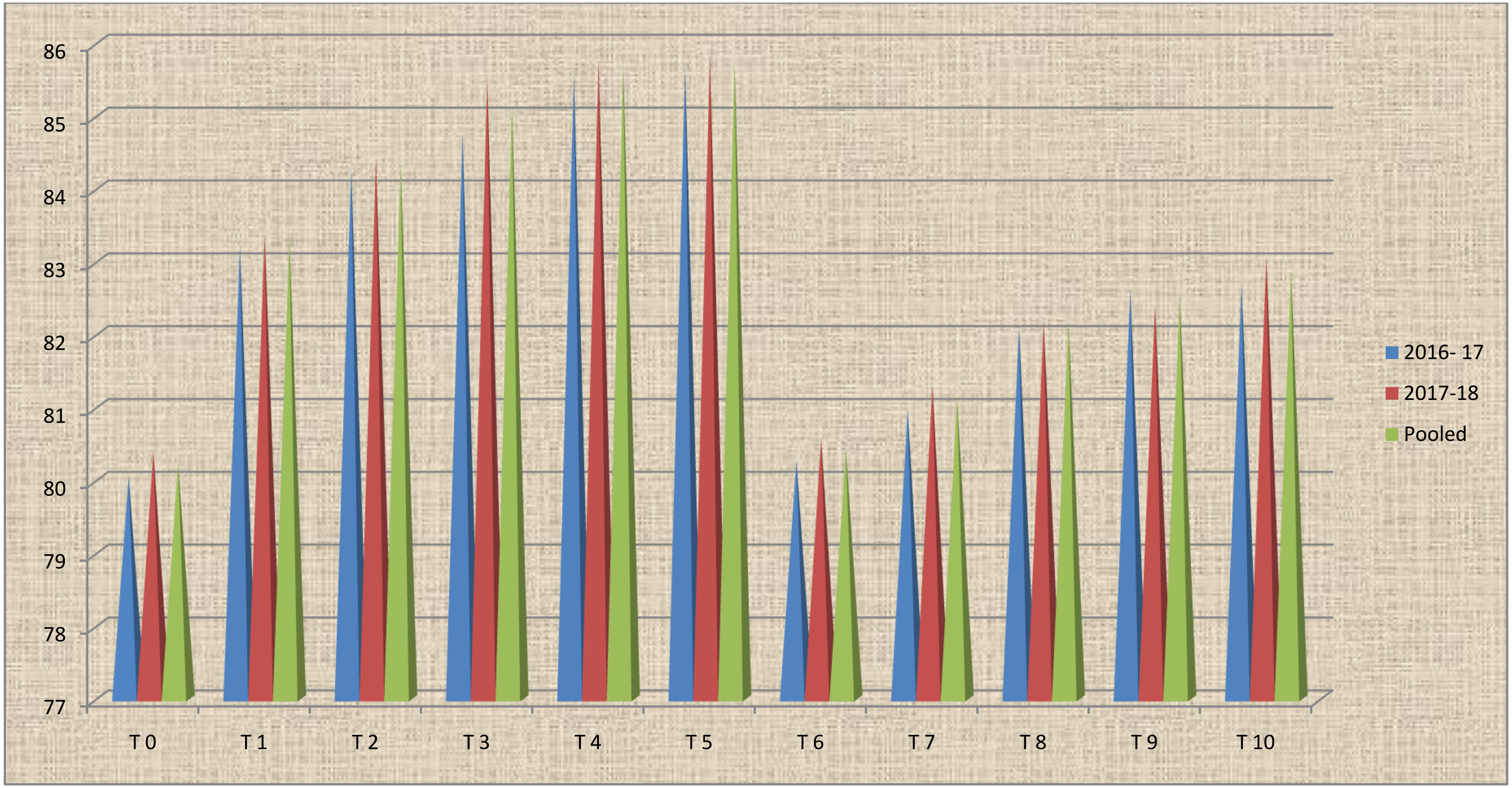

Fig.No-4.4.2: Effect of Gibberellic acid and Cycocel on moisture content in flower (%) of African marigold.

Chapter-V

Discussion

African marigold (*Tagetes erecta* L.) is one of the most essential profitable loose flower crops grown all over the world and in India as well. It bears flowers round the year in rainy, winter and summer seasons. Marigold produces beautiful flowers with longer blooming period and excellent keeping quality.

Flower yield and quality benchmarkes are directly or indirectly controlled by environment under which crops are grown. In addition, genotype, soil, cultural practices and their connections also have deep manipulate on productivity of crop plants. However, it is not possible to influence the environment for better crop growth, but one can maneuver the micro climate of the field to certain extent by adopting suitable cultural practices. Hence, an attempt has been made to increase the yield and quality of flower by manipulating cultivation practices like application of growth regulators and to study their effect on growth, flowering and yield of African marigold.The present studies entitled **"Effect of Gibberellic Acid and Cycocel on Vegetative Growth, Flowering, Yield and Quality Attributes of African Marigold (*Tagetes erecta* L.)"** was conducted to judge the influence of different growth regulators on growth, flowering and yield-attributes of African marigold. The experimental findings computed on the basis of the observations recorded and statistical analysis are presented and discussed precisely in this chapter under the following heads:

5.1: Vegetative growth Characters:

5.1.1: Plant height (cm).

5.1 2: Number of branches per plant.

5.1.3: Number of leaves per branch.

5.1.4: Number of leaves per plants.

5.2: Flowering Characters:

5.2.1: Days taken to first bud appearance (days).

5.2.2: Days taken to first flowering (days).

5.2.3: Days taken to 50% flowering (days).

5.2.4: Days taken to first flower picking (days).

5.2.5: Diameter of flower (cm).

5.2.6: Duration of flowering (days).

5.2.7: Number of flowers per plant.

5.3: Yield Characters:

5.3.1: Mean weight of flowers (g).

5.3.2: Flower yield per plant (g).

5.3.3: Flower yield per plot (kg).

5.3.4: Flower yield per hectare (t).

5.4: Quality Characters:

5.4.1: Moisture content in flower (%).

5.4.2: Shelf life of flower (days).

5.1: Vegetative growth Characters:

5.1.1: Plant height (cm):

The growth parameters of marigold such as plant height influenced significantly due to different growth regulators treatments under study. The perusal of data presented in TableNo-4.1.1 and Fig.No-4.1.1 revealed that higher plant height was recorded with the application (T_5) GA_3 at 400 ppm followed by treatments (T_4) GA_3 at 300 ppm. The minimum plant height was noticed under the treatment (T_{10}) Cycocel at 2500 ppm. This significant increase in the plant height may be attributed to the action of Gibberellic acid which promotes vegetative growth by way of cell division and cell elongation and this may have resulted in the increase of plant height and Cycocel hindered the growth of plants. Though, the plant height is a genetically controlled character, it is evident from results that, GA_3 has played a significant role in mounting the plant height. Another probable reason of significant increase in plant height might be due to the effect of gibberellins on photosynthetic activity in efficiently utilizing photosynthetic products by plants. Yet another possible reason of increase in the plant height might be due to increased osmotic uptake of water and nutrients, by maintaining constant swelling force against the softening of cell walls, resulting in an increased uptake. These results are in close conformity with the findings of **Pandey and Chandra (2008), Ramdevputra *et al*., (2009), Shivaprakash *et al., (*2011), Kanwar and Khandelwal (2013) and Sarkar *et al.*, (2018)** in Afriacan marigold.

5.1.2: Number of branches per plants:

As mentioned earlier in the result that different growth regulators have significantly affected the number of branches per plant (Table No-4.1.2 and Fig.No-4.1.2). The maximum number of branches was recorded with T_5 GA_3 at 400 ppm followed by treatments T_4 GA_3 at 300 ppm. The minimum number of branches was recorded treatment (T_0) control condition. The results are in accordance with the report of **Pandey and Chandra, (2008)** in French marigold, **Ramdevputra *et al*., (2009)** in African marigold and **Sarkar *et al.,* (2018).**

5.1.3: Number of leaves per branch:

As mentioned earlier in the result that different growth regulators have significantly affected the number of leaves per branch (Table No-4.1.3 and Fig.No-4.1.3). The maximum number of leaves per branch was observed with (T_5) GA_3 at 400 ppm followed by treatments (T_4) GA_3 at 300 ppm. The minimum number of leaves was observed under the treatment (T_0) control condition. The results are in accordance with the report of **Pandey and Chandra (2008),** in French marigold, **Kumar *et al.*, (2012)** in African marigold and **Sarkar *et al.,* (2018).**

5.1.4: Number of leaves per plant:

As mentioned earlier in the result that different growth regulators have significantly affected the number of leaves per plant (Table No-4.1.4 and Fig.No-4.1.4).The highest number of leaves was observeded with (T_5) GA_3 at 400 ppm followed by treatments (T_4) GA_3 at 300 ppm. The minimum number of leaves was observed treatment (T_0) control condition. The results are in accordance with the report of **Ravidas *et al.*, (1992)** in gladiolus cv. Friendship, **Singh and Bijimol, (2001)** in tuberose, **Pandey and Chandra, (2008),** in French marigold, **Kumar *et al.*, (2012)** in African marigold and **Sarkar *et al.*, (2018).**

5.2: Flowering Characters:

5.2.1: Days taken to first bud appearance (days):

As reported in the preceding chapter, different concentrations of growth regulators used had significantly affected the number of days taken for first bud formation (Table No-4.2.1 and Fig.No-4.2.1).The minimum number of days were taken for first flower bud formation under T_{10} Cycocel at 2500 ppm followed by T_9 Cycocel at 2000 ppm, while late initiation of bud was observed was treatment (T_0) control. The augmentation in first flower bud formation in Cycocel treatments may be because of retardant of plant growth due to early initiation of flower bud. similar results have also been reported by **Bhattacharjee *et al.*, (1971), Dutta (1992), Aswath *et al.*, (1993), Yadav (1997), Ramdevputra *et al.*, (2009)** in marigold, **Parmar *et al.*, (2009)** and **Himabindu *et al.*, (2010).**

5.2.2: Days taken to first flowering (days):

Gibberellic and Cycocel treatments have significantly affected the number of days required for flowering (anthesis). Anthesis was advanced by Cycocel at both levels i.e., 2000 ppm and 2500 ppm. It is evident from the Table No-4.2.2 and Fig.No 4.2.2 that treatment T_{10} (CCC at 2500 ppm) recorded earliest flowering which was closely followed by T_9 (CCC at 2000 ppm).While, comparatively more period for first flowering was noted under T_0 (control). This advancement in anthesis with Cycocel treated plants might be attributed to the boost in endogenous levels of Cycocel which by virtue of its characteristics of quickening the flowering might have advanced the date of anthesis. Similar results have also been reported by **Pal *et al.*, (1986), Rya *et al.*, (1993), Yadav (1997), Puskar and Singh (2012),** and **Naidu *et al.*, (2014).**

5.2.3: Days taken to 50 % flowering (days):

Days to fifty percent flowering was significantly manipulated by various growth regulators treatments It is apparent from the Table No-4.2.3 and Fig.No-4.2.3) that treatment (T_{10}) CCC at 2500 ppm recorded earliest 50 percent flowering which was closely followed by (T_9) CCC at 2000 ppm. While late flowering treatment (T_0) control. Similar findings were reported by **Chaudhary (1987), Himabindu (2010), Buddy *et al.*, (2014) and Khobragade *et al.*, (2014).**

5.2.4: Days taken to first flower picking (days):

Days taken to first flowering was significantly influenced by various growth regulators treatments. It is evident from the Table No-4.2.4 and Fig.No-4.2.4 that treatment (T_{10}) CCC at 2500 ppm recorded earliest taken of first flowering. Which was intimately followed by (T_9) CCC at 2000 ppm. While late flowering treatment (T_0) control. Similar findings were reported by **Sasikumar *et al.*, (2015) and Dutta (1992).**

5.2.5: Diameter of flower (cm):

Marked differences were showed among growth regulators applications on flower diameter (Table No-4.2.5 and Fig.No-4.2.5). The perusal of data evidently point out that maximum flower size was registered by the treatment (T_5) GA_3 and 400 ppm followed by treatments (T_4) GA_3 and 300 ppm. The smallest flower diameter was recorded was treatment (T_0) control. The role of GA_3 in improving the bud size may be ascribed to the translocation of metabolites at the site of bud development. Increase in flower diameter might be due to cell elongation in the flower. Gibberellins are also known to enhance the sink strength of actively growing parts. The similar findings were also noted by **Bose *et al.*, (1980), Talukdar and Paswan (1996), Shivaprakash *et al.*, (2011**) in marigold and **Shinde *et al.*, (2010)** in chrysanthemum.

5.2.6: Duration of flowering (days):

Average duration of flowering significantly influenced by different growth regulators treatments (Table No-4.2.6 and Fig.No-4.2.6). Treatment (T_{10}) CCC at 2500 ppm observed maximum duration of flowering which was intimately followed by (T_9) CCC at 2000 ppm.while minimum duration of flowering treatment (T_0) control. This significant increase in the duration of flowering with cycocel might be due to early initiation of anthesis; hence more time was available for flower formation. Another probable reason for this increased flowering duration may be the availability of optimum quantity of Cycocel under these treatments as a result duration of flowering of flowering might have significantly improved. Similar results have been observed by **Ramdevputra *et al*., (2009)** in marigold, **Dutta *et al*., (1993) and Sarkar *et al*.,(2018).**

5.2.7: Number of flowers per plant:

Gibberellic and Cycocel treatments have significantly affected the number of flowers per plant (Table No-4.2.7 and Fig.No-4.2.7). The maximum number of flowers per plant was recorded under treatment T_5 (GA_3 and 400 ppm) followed by treatments T_4 (GA_3 at 300 ppm).Whereas, minimum number of flowers per plant was recorded treatment (T_0) control condition. This increase in the number of flowers may be attributed to an improved plant height and number of branches per plant as influenced by the GA_3 treatments.These results are in conformity with the findings of **Chaudhary (1987), Sujatha *et al.*, (2002), Kumar *et al.*, (2003), Pandey and Chandra (2008), Ramdevputra *et al.*, (2009), and Sarkar *et al.*, (2018).**

5.3: Yield Characters:

5.3.1: Mean weight of flowers (g):

Mean weight of flowers per plant was significantly influenced by different growth regulators treatments (Table No-4.3.1 and Fig.No-4.3.1). The maximum mean weight of flower was recorded under the treatment (T_5) GA_3 at 400 ppm followed by treatments T_4 (GA_3 at 300 ppm).Whereas minimum mean weight of flowers per plant was observed treatment (T_0) control condition. The increase in mean weight of flowers per plant with GA_3 might be due the production of more number of flowers and bigger sized flowers.These results are in close agreement with the findings of **Singh (1991), Singh and Bijimol (2001), Maurya and Nagda (2002) and Ramdevputra *et al.*, (2009).**

5.3.2: Flower yield per plant (kg):

Flower yield per plant depends on yield-contributing factors. It is characterized by the increase in number of flowers and also owing to enhance in weight of individual flowers. In the present investigation, significantly higher flower yield per plant was observed under both the concentrations of GA_3 (Table No-4.3.2 and Fig.No-4.3.2). The maximum flower yield per plant was registered under (T_5) GA_3 at 400 ppm followed by treatments T_4 (GA_3 at 300 ppm). Minimum flower yield per plant was showed under T_0 (control).These findings were in accordance with the result of **Tripathi *et al.*, (2003)** in French marigold, **Pandey and Chandra, (2008), Ramdevputra *et al.*, (2009)** in African marigold and **Kumar *et al.*, (2003)** in china aster.

5.3.3: Flower yield per plot (kg):

Flower yield depends on yield-contributing factors. It is characterized by the increase in number of flowers and also owing to enhance in weight of individual flowers. In the present investigation, significantly higher flower yield per plot was observed under both the concentrations of GA_3 (Table No-4.3.3 and Fig.No-4.3.3).The maximum flower yield was registered under treatment T_5 (GA_3 at 400 ppm) followed by treatments T_4 (GA_3 at 300 ppm). Minimum flower yield per plot was noticed under T_0 (control). These findings were in accordance with the result of **Tripathi *et al.*, (2003), Sunitha *et al.*, (2007), Shivaprakash *et al.*, *(*2011), Sasikumar *et al.*, (2015), Kumar *et al.*, (2012) and Puskur and singh (2012)** all in African marigold.

5.3.4: Flower yield per hectare (t):

Flower yield per hectare is a complex character, which depends on yield-contributing factors. It is characterized by the increase in number of flowers and also because of enhance in weight of individual flowers. In the present investigation, significantly higher flower yield per hectare was observed under both the concentrations of GA_3 (Table No-4.3.4 and Fig.No- 4.3.4). The maximum flower yield per hectare was registered under treatment T_5 (GA_3 at 400 ppm) followed by treatments T_4 (GA_3 at 300 ppm). Minimum flower yield was noticed under T_0 (control condition). This increase in yield per hectare under GA_3 over the other treatments may be attributed to the fact that GA_3 treated plants remained physiologically more active to build up sufficient food stocks, which in turn, promoted better plant growth and ultimately more number of flowers, leading to higher yields. Another, probable reason for this increase in yield might be due to direct growth regulating action of GA_3. The presence of GA_3 might have enhanced the growth promoting enzymes thereby synthesizing more nucleic acid etc. in the plants. Since RNA and DNA synthesis are mostly extra nuclear and centralized in chloroplasts which might have accelerated the rate of food assimilation and ultimately might have enhanced the number of flowers as well as the yield per plant. These findings were in accordance with the result of **Singh *et al.*, (1991)** in African marigold, **Pandey and Chandra (2008)** in French marigold, **Ramdevputra *et al.*, (2009),** in African marigold, **Shivaprakash *et al.*, (2011)** in African marigold, **Kanwar *et al.*, (2013)** and **Sarkar *et al.*, (2018).**

5.4: Quality Characters:

5.4.1: Shelf life of flower (days):

Average shelf life of flowers was significantly affected by different growth regulators treatments plant was recorded under both the concentrations of GA_3 (Table No-4.4.1 and Fig.No-4.4.1).The maximum shelf life of flower under treatment T_5 (GA_3 at 400 ppm) followed by treatments T_4 (GA_3 at 300 ppm). Minimum shelf life of flower was showed under T_0 (control condition). The higher effectiveness of GA_3 might be attributed to higher auxin activity which has been reported to delay senescence and increase the translocation of metabolites.The like result of enhanced shelf life with GA_3 was also reported by **Dehale *et al.*, (1993), Dhekney *et al.*, (2000) and Ramdevputra *et al.*, (2009)** in African marigold.

5.4.2: Moisture content in flower (%):

The maximum moisture content in flower was significantly affected by different growth regulators treatments plant was observed under both the concentrations of GA_3 (Table No-4.4.1 and Fig.No-4.4.1).The maximum moisture under treatment T_5 (GA_3 at 400 ppm) followed by treatments T_4 (GA_3 at 300 ppm). Minimum shelf life of flower was showed under T_0 (control condition). The similar result of enhanced shelf life with GA_3 was also reported by **Du-Hong Mei *et al.*, (2002), Dawh *et al.*, (1998), Shivaprakash *et al.*, (2011)** and **Parmar *et al.*, (2009)** in spider lily.

Chapter-VI

Summary and Conclusion

The present investigation entitled **"Effect of Gibberellic Acid and Cycocel on Vegetative Growth, Flowering, Yield and Quality Attributes of African Marigold (*Tagetes erecta* L.)"** was carried out at Horticulture Research Farm, Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedkar University, Vidya-Vihar, Rae Bareli Road, Lucknow 226 025 (U.P.) during the summer season of 2016-17 and 2017-18.Year. The present investigation are summarized below:

- To assess the effect of Gibberellic acid and Cycocel on vegetative growth of African marigold.
- To find out the effect of Gibberellic acid and Cycocel on flowering of African marigold.
- To estimate the flower yield of African marigold influenced by the spraying of Gibberellic acid and Cycocel.
- To evaluate the effect of Gibberellic acid and Cycocel on quality attributes of African marigold.

6.1: Vegetative growth characters:

6.1.1: Plant height (cm):

In the present investigation, the plant height was significantly influenced by different growth regulators. Among the growth regulator under treatments T_5 (GA_3 at 400 ppm) recorded maximum plant height followed by treatments T_4 (GA_3 at 300 ppm).The minimum plant height was showed under the treatment T_{10} (Cycocel at 2500 ppm).

6.1.2: Number of branches per plant:

The number of branches per plant was significantly affected due to different growth regulators.The maximum number of branches per plant was observed under treatment T_5 (GA_3 at 400 ppm) followed by treatments T_4 (GA_3 at 300 ppm). While, the minimum number of branches was registered under treatment T_0 (control).

6.1.3: Number of leaves per branch:

The number of leaves per branch was significantly affected due to different growth regulators.The maximum number of leaves per branch was observed under treatment T_5 (GA_3 at 400 ppm) followed by treatments T_4 (GA_3 at 300 ppm). Whereas, the minimum number of leaves was observed under treatment T_0 (control).

6.1.4: Number of leaves per plant:

The number of leaves per plant was significantly affected because of different growth regulators.The maximum number of leaves per plant was observed under treatment T_5 (GA_3 at 400 ppm) followed by treatments T_4 (GA_3 at 300 ppm). Whereas, the minimum number of leaves was observed under treatment T_0 (control).

6.2: Flowering characters:

6.2.1: Days taken to first bud appearance (days):

The effect of different growth regulators treatments on days taken to first bud appearance was found to be significant. The minimum days taken to first bud appearance was registered under the treatment T_{10} (Cycocel at 2500 ppm) followed by treatments T_9 (Cycocel at 2000 ppm). While, the treatment (T_0) showed late bud appearance.

6.2.2: Days taken to first flowering (days):

In this investigation, days to first flowering was significantly influenced by various plant growth regulators.The earliest flowering was registered under the treatment T_{10} (Cycocel at 2500 ppm) followed by treatments T_9 (Cycocel at 2000 ppm). While, the treatment (T_0) recorded maximum time for first flowering.

6.2.3: Days taken to 50% flowering (days):

Days required for 50 per cent flowering was significantly influenced by different growth regulators.The treatment T_{10} (Cycocel at 2500 ppm) followed by treatments T_9 (Cycocel at 2000 ppm). Observed least days for 50 per cent flowering. Whereas, the treatment (T_0) recorded maximum days for 50 per cent flowering.

6.2.4: Days taken to first picking (days):

In this investigation, days to first picking was significantly manipilated by various plant growth regulators. The earliest picking was registered under the treatment T_{10} (Cycocel at 2500 ppm) followed by treatments T_9 (Cycocel at 2000 ppm). While, the recorded late picking treatment T_0 (normal condition).

6.2.5: Diameter of flower (cm):

Application of different growth regulators treatments significantly influenced the average flower diameter under the investigation. Maximum flower diameter was observed under the treatment T_5 (GA_3 at 400 ppm) followed by treatments T_4 (GA_3 at 300 ppm). Minimum flower diameter was observed treatment T_0 (normal condition).

6.2.6: Duretion of flowering (days):

Application of different growth regulators significantly influenced maximum duration of flowering the treatment T_{10} (Cycocel at 2500 ppm) followed by treatment T_9 (Cycocel at 2000 ppm). While, minimum flowering period was observed under the treatment T_0 (normal condition).

6.2.7: Number of flowers per plant:

Number of flowers was significantly influenced by different growth regulators.The maximum number of flowers per plant was recorded under the treatment T_5 (GA_3 at 400 ppm) followed by treatments T_4 (GA_3 at 300 ppm). whereas, minimum number flowers per plant was registered under treatment T_0 (normal condition).

6.3: Yield Characters:

6.3.1: Mean weight of flower (g):

Average fresh weight of flowers per plant was influenced by the application of different growth regulators.The maximum fresh flower weight was recorded under the treatment T_5 (GA_3 at 400 ppm) followed by treatments T_4(GA_3 at 300 ppm). However, minimum fresh flower weight was observed treatment T_0 (control).

6.3.2: Flower yield per plant (g):

Maximum weight of flowers per plant was showed under the treatment T_5 (GA_3 at 400 ppm) followed by treatments T_4(GA_3 at 300 ppm). Minimum flower yield per plant was observed treatment T_0 (normal condition).

6.3.3: Flower yield per plot (kg):

Maximum flowers yield per plot was showed under the treatment T_5 (GA_3 at 400 ppm) followed by treatments T_4 (GA_3 at 300 ppm). Minimum flowers yield per plot was observed treatment T_0 (normal condition).

6.3.4: Flower yield per hectare (t):

Maximum flowers yield per hectare was showed under the treatment T_5 (GA_3 at 400 ppm) followed by treatments T_4 (GA_3 at 300 ppm). Minimum flowers yield per hectare was observed treatment T_0 (normal condition).

6.4: Quality characters:

6.4.1: Shelf life of flower (days):

The maximum shelf life of flowers was observed under the treatment T_5 (GA_3 at 400 ppm) followed by treatments T_4 (GA_3 at 300 ppm). The lowest shelf life of flowers was observed treatment T_0 (normal condition).

6.4.2: Moisture content in flower (%):

The maximum moisture content in flowers was observed under the treatment T_5 (GA_3 at 400 ppm) followed by treatments T_4 (GA_3 at 300 ppm). Minimum moisture content in flowers was observed in treatment T_0 (normal condition).

Conclusion:

On the basis of above result obtained in present investigation, it was concluded that the maximum plant height at 30, 45, 60, 75, and 90 days after planting number of branches per plant, number of leaves per p branch, number of leaves per plant, diameter of flower (cm), number of flower per plant, mean weight of flower (g), weight of flower per plant (g), flower yield per plot (kg), yield per hectare (t), shelf life of flower (days) and moisture content in flower (%) observed from T_5 treatment application of (GA_3 at 400 ppm) followed by T_4 treatment application of (GA_3 at 300 ppm) btained better response of marigold over the Treatment T_0 (control condition). Treatment T_{10} (Cycocel at 2500 ppm) significantly for days taken to first bud appearance, days taken to first flowering, days taken to 50 per cent flowering and days taken to first flower picking followed by treatment T_9 (Cycocel at 2000 ppm) than significantly increase over the treatment T_0 (control). Application of different growth regulatiors significantly influenced maximum duration of flowering the treatment T_{10} (Cycocel at 2500 ppm) followed by treatment T_9 (Cycocel at 2000 ppm). While, minimum flowering period was observed under the treatment (T_0) normal condition.

Accati, E. G., Basoccu, L. and Sullis, S. (1979). Acta Hort., No. **91**, pp. 11.5-9.

Amer, Orchid Soc., Bull, 39:1005-6. Bessler, B. (1996). Changes in habit and sex expression in tuberous begonia hybrids by use of GA_3 and benzylaminopurine. Gartenbauwissenschaft, Germany, **61**(5): 205-210.

Amit Kumar., Jitendra Kumar., Mohan Br Singh., J. P. and Rajbeer, R. N. (2012). Studies on the effect of plant growth regulators on growth, flowering and yield of African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda. *Ann. Hort.* 5: 52.

Anonymous (2017). Indian Horticulture Database, National Horticulture Board, pp 14-24.

Aswath, S., Narayana Gowda, J.V. and Ananda Murthy, G.M. (1994). Effect of growth retardants on growth, flowering and nutrient contents in China aster (C*allistephus chinensis* L.) cv. Powder puff mixed. J. Ornam.Hort., **2**(1-2): 9-13.

Auge, R. (1982). Revue Horticole, No. **230**, pp. 43-48.

Awad, A. R. E. and Hamied, A. A. (1985). Acta Hort., No.**167**, pp. 17785.

Awasth. C., Narayan Gowda, J. V. and Ananda Murthy G.M. (1993). Effect of growth retardants on growth and flowering in China aster (*Callistephus chinesis* L.) cv. Powderpuff Mix. Proc. Golden Jubilee Symp. *Hort. Soc. of India*, Bangalore, May **24-28,** pp. 225.

Azzaz, N. A., Hassan, E. A. and El-Emarey, F.A. (2007). Physiological, anatomical and Physiochemical studies on pot marigold (*Calendula officinalis* L.) plants. *African Crop Science Conference Proceedings* Vol. **8.** pp. 1727-1738.

Badge, S., Panchbhai, D.M. and Dod, V.N. (2014). Response of pinching and foliar application of gibberellic acid on growth and flower yield in summer African marigold. *Research on Crops*, **15**(2): 394-397.

Badge, S., Panchbhai, D.M. and Patil, S. (2015). Regulation of flowering by pinching and foliar application of gibberellic acid in African marigold (*Tagetes erecta* L.). *Indian Horticulture Journal*, **5**(1/2): 41-46.

Balachandra, R.A., Deshpande, V. K. and Shekhargouda, M. (2004). Effect of growth regulators on seed yield and quality of ageratum.Karnataka J. Agri. Sci., **17**(1): 110- 111.

Beura, S. and Maharana, T. (1990). Effect of growth regulators on tuber production of dahlia (*Dahlia variabilis* D.) cv. Black Out. *Orissa Journal of Horticulture*, **18**(1-2): 48-51.

Bhat,Z.A. and Shephered,H. (2007). Effect of pinching on growth, flowering, seed yield and quality traits in African marigold (*Tagets erecta* L.). *Journal of Ornamental Horticulture,***10**(3), 197-198.

Bhattacharjee, S. K. (1983). Singapore J. Prim. Indus., **11**: 34-39.

Bhattacharjee, S. K. (1983). Response of Lilium tigrinum Ker-Gawl (tigerlily) to soil drench application of growth regulating chemicals. Progressive Horticulture, **15**: 204-209.

Bhattacharjee, S. K. (1984). Gartenbauwiss, 49: 103-106.

Bhattacharjee, S.K. (1984). Effect of growth regulating chemicals on growth, flowering and tuberous-root formation of Dahlia variabilis Desf. Punjab Horticultural Journal, **24**(1-4): 138-144.

Bhattacharjee, S.K., Gupta, D. K. and Bose, T.K. (1971). B-nine, an effective growth retardant on Dahlia, ineffectiveness of CCC. Phyton. Angentina, **28**(1):61-65.

Bhattacharjee, S.K., Mukhopadhyay, T.P. and Bose, T.K. (1976). Interaction of auxin and gibberellic with growth retardants on growth and flowering of Dahlia variabilis and Malviscus conzatii. Ind. Agri**., 20**(3): 193-199.

Bihari, M. and Narayan, S. (2009). Effect of foliar application of GA_3 and micro elements on vigour and flowering behaviour of African marigold cv. African Orange. *Journal of Interacademicia*, **13**(4): 400-403.

Biswas, S. (1981). Studies on the comparative effect of cycocel and ethrel on. Proc. Nati Acad. Sci. USA Vol. 78, No. **2**, pp. 1176-1180.

Bivins, J.L. (1968). Amer. Orchid Soc. Bull, **37**: 385-387. Bivins, J .L. (1970).

Bomemann, E. and Muhe, R. (1967). Dtsche Gartenb, **14**: 328-9.

Bose, T. K. and B. I-Iore (1967). Effect of Growth Retardants on Some Varieties of Bougainvillea. *Sci. Cult*. **33**(18): 379-80.

Bose, T. K. and Yadav, L. P. (1993). Nutrient management in flower crops. *Commercial Flowers*, pp. **713.**

Bose, T. K., Jana, B. K. and Mukhopadhyay, T. P. (1980). Eroth regulators on growth and flowering of Hippeastrum hybridam SHS cierztzc: Horticulture, **12**:195-200.

Bradley, M. V., and Crane, J. C. (1957). Gibberellin stimulated cambial activity in stems of apricot spur shoots. *Science*, **126**(3280): 972-973.

Brian, P. W. and Grove, J. F. (1957). Gibberellic acid. *Endeavour*, **16**:161.

Brian, P. W. (1958). Role of gibberellin like hormones in regulation of plant growth and flowering. *Nature*, **181**(4616): 1122.

Cathey, HM. (1964). Physiology of growth retarding chemicals. *Ann. Rev. Plant Physiol*., **15:** 271-302.

Chandrappa, Gowda., J. V. N., Gowda, M. C. and Gowda, A. P. M. (2006). Influence of growth, regulators and their combinations on growth and flower production in anthurium cv. Royal Red. *Research on Crops*, **7**(1): 279- 281.

Chaudhary, M. L. (1987). Effect of Growth regulants on growth and flowering of tuberose (*Polianthes tuberosa* L.). *Annals of Agricultural Sciences*, **32**(2): 1451-1457.

Chauhan, S., Rao, V.K., Kumar, A. and Ghosh, S. (2016). Response of pinching on African marigold cv. Pusa Basanti Gainda under hill condition of Uttarakhand. *Jouranal of Hill Agriculture,***7**(1): 46-51.

Chauhan, S., Singh, C.N. and Singh, A.K. (2005). Effect of vermicompost and pinching on growth and flowering in marigold cv. Pusa Narangi Gainda. *Progressive Horticulture,* **37**(2): 419-422.

Cooper, J. P. (1958). The effect of gibberellic acid on a genetic dwarf in loliumperenne. *New Phytologist,* **57**(2): 235-238.

Dabas, H.K., Mitra, L., Dabas, S. (2001). Effect of different concent rations of GA_3, MH and NAA on primary branches of marigold (*Tagetes erecta* L.). *Indian-Agriculturist***. 45** (3/4): 265-267.

Dahab, A. M. A., Eldabh, K. S. and Salem, M. A. (1987). Effect of gibberellic acid on growth, flowering and constituents of *Chrysanthemum frutescens*. *Acta Horticulturae*, **205**: 129-135.

Dahiya, DS., Rana G. S. (2001). Regulation of flowering in chrysanthemum as influenced by GA_3 and shade house of different intensities. *South Indian Horticulture,* **49**:313-314.

Dalal, S. R., Somavanshi, A.V. and Karale, G.D. (2009). Effect of gibberellic acid on growth, flowering, yield and quality of gerbera under polyhouse conditions. *International Journal Agriculture Science,* **5**(2): 355-356.

Das, S. N., Jana, B. K. and Das, B. C. (1992). Effect of growth regulators on growth and flowering of *Hemerocallis aurantiaca*. *South Indian Hortculture*, **40**(1): 336-339.

Davis, TD.(1991). Post-production performance of uniconazole-treated zinnia and marigold plugs. *Hort T echnology*, **121**, 4952, 15.

Dawh, A. K., Omer, E.A., Rarhed, E. M. (1998). Yield of leaves and oil of *Tagetes erecta* as affected by salinity and growth regulators, *Egptian Journal of Horticulture*. **25**(2): 145-165.

Dehale, M.H., Deshmukh, P.P. and Moharkar, V.K. (1993). Influence of foliar application of GA3 on quality chrysanthemum. *J. Soils & Crops*, **3**(2): 135-137.

Dhekney, S. A., Ashok, A. D. and Rengasamy, P. (2000). Action of various growth regulators and flora preservatives on vase life of cut rose cv. First Red grown under controlled conditions *South Indian Hort.*, **48** (1-6): 69-71.

Dhingra, S. N. and Dhingra, D. R. (1956). Perfum. Essent. Oil. Rec., **47**: 391-4.

Dhua, R.S., Ghose, S. K., Mitra, S. K., Yadav, L. SP. and Bose, T.K. (1987). Effect of bulb size, temperature treatment of bulbs and chemicals on growth and flower production in tuberose (*Polianthes tuberose* L.). *Acta Horticulture*, **205**:121-128.

Drewes, F .E., Staden, J. Van., Van, Staden., J. (1990). Germination of *Tagetes minuta* L. Role of gibberellins. Plant Growth Regulation. **9**(4): 285-291.

Du, Hong Mei., Zhang, Xiaoping., Du, H.M., Zhang, X.P. (2002). Study on GA_3 treatment on anthesis of spring Chrysanthemum and biological effects. *Journal of Shanghai Jiaotong University* Agricultural Science, **20**(4): 307-311.

Dure, L. S., and Jensen, W. A. (1957). The influence of gibberellic acid and indoleacetic acid on cotton embryos cultured *in vitro*. *Botanical Gazette*, **118** (4): 254-261.

Dutta, J. P. (1992). Regulation of flowering by supplementary illumination and application of growth substances in Chrysanthemum cv. Co.1. Ph.D. Thesis, T.N.A.U., Coimbatore.

Dutta, J.P., Ramdas, S. and Abdul Khader, M. D. (1993). Regulation of flowering by growth regulators in chrysanthemum (*Chrysanthemum indicum* Linn.) cv. 'CO.1'. *South Indian J. Hort*., **41**(5): 293-299.

El-Shafle, S. A., El-Kholy, SA. and Aflfy, M. M. (1980). Monufeia *J. Agric. Res*., **3**: 291-310.

Gautam, S. K., Sen, N. L., Jain, M. C. and Dashora, L. K. (2006). Effect of plant growth regulators on growth, flower ingand yield of chrysanthemum cv. Nilima. *Orissa Journal of Horticulture,* **34(**1): 36-40.

Genders, R. (1971). Pelham's New Gardening Annual. Pe1ham Book Ltd., London, pp. **53-55.**

Girwani, A., Babu, R. S. and Chandrasekhar, R. (1987). Response of marigold (*Tagetes erecta L.*) to growth regulators and zinc. *Indian Journal Agricultur. Science*, **60**(3): 220-222.

Gnyandev, B., Kurdikeri, M.B.,Patil, A.A. and Channappagoudar, B.B. (2014). Influence of pinching, nitrogen level and growth retardants spray on seed yield and quality of China aster cv. Phule Ganesh. *International Journal of Tropical Agriculture*, **32**(3-4): 377-380.

Goh, C. J. (1979). Proc. 10th International Conference on Plant Growth Substances, Madison, Wisconsin, USA, Abstract No. **29**.

Gowda, N. J. V. and Jayanthi, R. (1991). Effect of cycocel and maleic hydrazide on growth and flowering of African marigold *(Tagetes erecta* L.). *Prog. Hort*., **23**(1-4): 114-118.

Gowda, J .V. N. and J ayanthi, R. (1985). The Indian Rose Annual, 4: 1857. Goh, C.J. (1976). Ann Bot., **40**: 645-6.

Greulach, V. A., and Haesloop, J. G. 1958. The influence of gibberellic acid on cell acid on cell division and cell elongation in *Phaseolus vulgaris*. *American Journal of Botany*, 566-570.

Greulach, V.A., and Haesloop, J.G. (1958). The influence of gibberellic acid on cell acid on cell division and cell elongation in *Phaseolus vulgaris*. *American Journal of Botany*, 566-570.

Gupta, V. N., Dutta, S. K. (2001). Influence of gibberellic acid (GA_3) on growth and Howering in Chrysanthemum (Chrysanthemum morifolium, Ramat) cv. Jayanthi. New De1hi, India '. *Indian Journal of Plant Physiology*, **6**(4): 420-422.

Haber, A. H. and Leopold, (1960). Effects of gibberellin and gama irradiated wheat. Amer. J. Bot., **47**: 140-144.

Haber, A. H., Thompsan, P. J., Welle, P. L. and Triflett, L. L. (1969). Non-Photosynthetic retardation of chloroplast scene by light. *Amer. J. Pl. Physio.*, **44**: 1619-1528.

Hetman J, Laskowska H, Saniewski M, Beijersvergen JCM (1992). The effect of CCC on the yield of tulip cv. Polka. *Acta Hortic*. **325**:387-392.

Himabindu. (2010). Effect of plant growth regulators and spacing on growth, flower yield, carotenoid content in African marigold (*Tagetus erecta L*.) cv. Pusa Narangi Gainda. M.Sc.Thesis, submitted to Andhra Pradesh Horticultural University, *Venkataramannagudem. Hort.*, **7**(2): 193-195.

Iltis, H. (1945). *J. Hered.*, **36**: 291-5.

Jonecki, J. (1980). Acta Hort., No. **109,** pp. 347-55.

Kanwar, J. and Khandelwal, S. K. (2013). Effect of plant growth regulators on growth and yield of African marigold (*Tagetes erecta* L.). *Madras Agriculture Journal*, **100**(1/3): 45-47.

Kato, J. (1958). Studies on the physiological effect of gibberellins II. *Physiologia Plantarum*, **11**(1): 10-15.

Kazemi, S.S., Hashemabadi, D., Torkashvand, A.M. and Kaviani, B. 2014. Effect of Cycocel and Daminozide on Vegetative Growth, Flowering and the Content of Essence of Pot Marigold (Calendula officinalis).*J. Ornamental Plants,* **4**(2).

Khan, F. U. and Tewari, G. N. (2003). Effect of growth regulators on growth and flowering of Dahlia (*Dahlia variabilis* L.). *Indian Journal of Horticulture,* **60**(2): 192-194.

Khandelwal, S. K., Jain, N. K. and Singh, P. (2003). Effect of growth retardants and pinching on growth and yield of African marigold (*Tagetes erecta* L.). *Journal of Ornamental Horticulture*, **6**(3), 271-273.

Khimani, R. A. and Patil, A. A. (1993). Seasonal variation in respect of gaillardia to different grth retardants.1bid. pp. **227.**

Khobragade, Y. R., Jadhao, B. J., Dod, V. N., Panchbhai, D. M., Wankhde, S. G., and Walke, R. D. (2014). Response of African marigold varieties to foliar application of cycocel in rainy Kharif season. Ph. D. Thesis, University of Agricultural Science, Akola.

Kulkarni, B. S. (2003). Evaluation of varieties and effects of planting date and growth regulators on the performance of chrysanthemum (*Dendranthem aindicum*). *Ph.D. (Horticulture) Thesis*, University of Agricultural Science, Dharwad.

Kumar, A., Kumar J., Braj, M., Singh, J. P., Rajbeer and Nathi, R. (2012). Studies on the effect of plant growth regulators on growth, flowering and yield of African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda. *Annals of Horticulture,* **5**(1): 47-52.

Kumar, S. and Das, B. (2015). Effect of Gibberellic and Cycocel on vegetative growth, flowering and yield of African marigold (*Tagetes erecta* L.). *Ad. Plant Sci.* ***28****(I):135-137.*

Kumar, M.S., Ponnuswami, V., Jawaharlal, M. and Kumar, R. (2012). Effect of plant growth regulators on growth, yield and exportable quality of cut roses. *Journal of Life Sci*ence, **7**(4): 733-738.

Kumar, R. and Singh, K. (2003). Effect of growth regulator and shoot tip pinching on carnation. *Journal of Ornamental Horticulture*, **6**(2): 134-136.

Kumar, R., Ram M. and Gaur, G. S. (2012). Effect of GA_3 and ethrel on growth and flowering of African marigold cv. Pusa Narangi Gainda. *Indian Journal Horticulture*, **67**:362- 366.

Kumar, S. and Nanda, K. K. (1981). Gibberellic acid and salicyclic acid caused formation of new proteins associated with extension growth and flowering of Impatiens balsamin. Biol. Plant, **23**: 321327.

Lal, H. and Mishra, S. P. (1986). Effect of gibberellic acid and maleic hydrazide on growth and flowering of marigold and china aster. *Prog. Hort*.,**18**(1-2): 151-154.

Lal, H. and Mishra, S.P. (1986). Effect of gibberellic acid and maleic hydrazide of growth and flowering of marigold and aster. *Progressive Horticulture*, **18**(1-2): 151-152.

Latimer, J. G. (1991). Selecting and using Plant Growth Regulators on Floricultural crops. Virginia Cooperative Extension, Virgiana, USA.

Maharana, T. and Pani, A. (1982). Effect of post punning and spray of different growth regulators on the growth and flowering of a hybrid rose. Bangladesh Hort., **10**: 1-4.

Maurya, R. P. and Nagda, C. L. (2002). Effect of growth substances on corm and cormel yield in gladiolus (*Gladiolus grandiflorus* L.) cv. Friendship. *Haryana Journal of Horticulture Science,* **31**(1 and 2): 60-61.

Mayoli, R. N., Isutsa, D. K. and Tunya, G. O. (2009). Effects of GA_3 and shade on growth of ranunculus cut flower under tropical high altitude conditions. *African Journal of Horticulture Science*, **2**:13-28.

Mittal, SP. (1967). Effects of gibberellin on growth and flowering of Dahlia. *Madras Agric. J.*, **54**: 103-107.

Mohamed BR, Fawzi AFA (1980). Tulip production as affected by chlormequat chloride (CCC) treatment. *Ann. Agric. Sci. Moshtohar* **12**:243-249.

Mohariya, A. D., Patil, B.N., Wankhede, S.G., Band, P.E., Kartikeyan, R. (2003). Effect of GA_3 and TIBA on growth, flowering and yield of different varieties of chrysanthemum. *Advance in Plant Science*; **16**(1):93-96.

Mukherjee, D. (1971). Standardisation on the use of growth retardants on some ornamental plants. Ph.D. Thesis, Calcutta Univ. Calcutta.

Mukhopadhyay, A. and Sadhu, M. K. (1985). Studies on the effects of treatments of bulbs of Polianthes tuberosa L.with gibberellic acid. *Progrressive H0rt*., **l7:** 125-128.

Mukhopadhyay, A. and Bankar, G. J. (1983). Regulation of growth and flowering in Polianthes tuberosa with gibberellic acid. Scientia Hort, **19**: 149-152.

Mukhopadhyay, A., Das, P., Bose, T. K. (1975). Effect of spacing, pinching, disbudding and treatment with GA_3 on growth an flowering in Carnation. *Plant. Science Symp.,* Volume **132.**

Murray, G. E.; Sanderson, KC. and Williams, J. C. (1986). Hort. Science, **21**: 1202.

Nagarjuna, B., Reddy, V.P., Rao, M. K. and Reddy, E. N. (1988). Effect of growth regulators and potassium nitrate on growth, flowering and yield of chrysanthemum. *South Indian Horticulture*, **36**(3): 136-140.

Naidu, J.H., Ashok, P., Chandrashekhar, R., and Sasikala, K. (2014). Effect of plant growth retardants and spacings on vegetative growth and flower yield of African marigold *(Tagetes erecta* L) cv. Pusa Narangi Gainda. *International Journal of Farm Sciences.*, **4**(2): 92-99.

Nanda, K. K., Kuamr, M., Sawhney, S. and Sawhney, N. (1973). Effect of Cyclohexamide on GA_3 response on photoperiodic reactions of Impatiens balsamina L. Annals, Bot., **37**: 107-111.

Neetu, Singh, A.K. and Kumar, R. (2013)a. Effect of different concentrations of GA_3 and varieties on growth and flowering of gladiolus. *Progressive Research* **8**(2): 263-265.

Neetu, Singh, A.K., Sisodia, A. and Kumar, R.(2013)b. Effect of GA_3 on growth and flowering attributes in gladiolus cultivars. *Ann. Agric. Res.*, **34**(4): 315-319.

Nijs, L.P.D. and Boseman, G. (1981). Medelimgin Vans de Facultiel Land Berewetan Schappan Ri Rijkanverdite Genet., **46**: 236-40.

Novoselova, A. N, Serova, OK. and Pyatitiskaya, L. P. (1985). Byulleten Glavnogo Botanicheskogo Sada, No. **135**, pp. 41-44.

Padmapriya, S.; Chezhiyan, N. (2002). Influence of gibberellic acid and certain other chemicals on flowering characters of Chrysanthemum (Dendranthema grandiflora Tzeled) Cultivars-I. South Indian Horitculture, **50**: 4-6, 437-443.

Pal, P., Maity, R. G. and Bose, T. K. (1980). Nat. Seminar Prodn. Tech. Comm. Flower Crops, Tamilnadu Agricultural University, Coimbatore, pp. **27-29.**

Pal, R. K., Pandey, A. K. and Pal, A. K. (2014). Effect of bio growth regulators on growth and flower yield of African marigold (*tagetes erecta* L.) cv. Pusa Narangi. Prog. Hort., **46** (2): 319-321.

Pandey, A. K. and Chandra, H. (2008). Studies on the effect of GA_3 and NAA on growth and flowering of French marigold (*Tagetes patula* L.). *Progressive Horticulture*, **40(**1): 96-99.

Pappiah, C. M. and Muthuswamy, S. (1974). South Indian Hart, **22**: 7780.

Parmar, A. B., Patel, H. C., Chavda J. C. and Parmar, J. R. (2009). Effect of plant growth regulators on growth and flowering of spider lily (*Hymenocallisspeciosa*L.). *Asian Journal of Horticulture*, **4**(1): 170-172.

Parups, E. V. and Helson, V. A. (1970). Greenhouse, Garden, Grass, **9**: 1-3.

Phinney, B.O. (1956). Growth response of single-gene dwarf mutants in maize to gibberellic acid. *Proceedings of the National Academy of Sciences*, **42**(4): 185-189.

Pobdukiewicz, A., Goldsberry, KL. (1989). Effect of Cycocel on the height of dwarf carnation 'Snowmass'. *Research Bulletin, Colaradao Greenhouse Growers Association***, 473**: 4-5.

Prashanth, P. (200). Studies on effect of certain plant growth regulators on Rose Floribunda CV. Ice Berg. M.Sc (Horti.) Thesis, submitted to Achraya N G Ranga Agricultural University, Hyderabad.

Pushkar, N.C. and Singh, A.K. (2012). Effect of Pinching and Growth Retardants on Flowering and Yield of African marigold (*Tagetes erecta* L.) var. Pusa Narangi Gainda, International J. Hort., **2**(1): 1-5.

Raghava, S.P.S. (2000). Marigold versatile crop with golden harvest. *Floriculture Today*, **4**(11): 40-41.

Rajyalaksmi, R. and Rajshekhar, M. (2014). Effect of different growth regulators and pinching on growth and flowering of African marigold cv.

PusaNarangiGainda in different planting dates. *The Journal Research Angrau*,**42**(1): 52-54.

Rakesh, R.S., Singhrot, R.P., and Singh, Sharma J.R. (2005). Flowering and yield response of chrysanthemum to GA_3 and pinching treatment. *Haryana Journal of Horticultural Sciences*; **34**(1 / 2):93-94.

Ram, K., Abban, S.L. and Sachan, B.P. (1970). Influence of gibberellic acid on growth and flowering of antirrhinum *(Antirrhinum majus*) *Lal-Baugh Journal,* **15**(4): 9-12.

Ramaswamy, N., Paulraj, C. and Chockalingam, P. (1979). Studies on the influence of growth regulators on the flowering and yield of tuberose (Polianthes tuberosa L.). AUARA, Annamalai Univ. of Agni Res. Annual, **7/8**, 29-33.

Ramdevputra, M.V., Deshmukh, H.N., Butani, A.M., Savaliya, J.J., Pansuriya, A.G. and Kanzaria, D.R. (2009). Effect of different gibberllic acid (GA_3) concentrations on growth, flowering and yield of African marigold. *Asian Journal of Horticulture*, **4**(1): 82-85.

Rana, P., Kumar, J. and Kumar, M. (2005). Response of GA_3, plant spacing and planting depth on growth, flowering and corm production in gladiolus. *Journal of Ornamental Horticulture*, **8**(1): 41-44.

Ravidas, L., Rajeevan, P. K. and Valasalakumari, P. K. (1992). Effect of foliar application of growth regulators on the growth, flowering and corn yield of gladiolus cv. Friendship. *South Indian Hortculture*, **40**: 329-335.

Sachs, R.M., Baratz, C. and Long, L. (1958). Cell division and gibberellic acid. *Exp. Cell Res.,* **18**:230-244.

Sachs, R.M., Bretz, C.F., and Lang, A. (1959). Shoot histogenesis the early effects of gibberellin upon stem elongation in two rosette plants. *American Journal of Botany*, 376-384.

Sarhan, A.Z. and El-Sayed, A.A. (1983). Annals Agric, Sci. Moshtohor, **19**: 419-26.

Sarkar, D., Saud, B. K., Mahanta, P., Kalita, P., Neog, B., and Talukdar, M. C. (2018). Response of Pinching and Gibberellic Acid on Growth and Physiological Characteristics of African Marigold. *Int. J. Curr. Microbiol. App. Sci*, ***7***(3), 1666-1672.

Sasikumar, K., Baskaran, V., and Abirami, K. (2015). Effect of Pinching and growth retardents on growth and flowering in African marigold cv. Pusa Narangi.Gainda. *Journal of Horticulture science,***10**(1)**:** 109-111.

Shah, S.C., Gupta L.K. and Farish Singh (1994). Effect of growth regulators on growth, yield and pyrethrin content in pyrethrum. *Recent Horticulture,* **1**(1):84-87.

Shanmugan, A. and Muthuswamy, S. (1974). Effect of CCC and TIBA on Chrysanthemum (Chrysamthemum indicum). *Ind. 1 Hart,* **31**: 370-374.

Shanmugan, A.; Muthuswamy, S. and Rao, V.N.M. (1973). A study of the effect of growth substances on Chrysanthemum (Chrysanthemum indicum Linn.). *Mad. Agri. J.,* **60**: 1-5.

Sharma, C.P., Maurya, A.N., Srivastava, O.P., and Mishra, K. (2001). Role of GA_3, Malic hydrazide and Ethrel in modifying vegetative and floral characters of *Chrysanthemum morifolium* Ram.The Orissa Journal of Horticulture., **29**(2): 35-38.

Sharma, M.L. and Others (1961). Perfixm. Essent. Oil Rec., 52: 561-2. Steiner, G.(1941*). Proc. Biol. Soc. Warh.,* **54**: 31-34.

Shedeed, R.M., EL-Gamassy, K.M., Hashim, M.E., Almulla, A.M.N. (1986). Ann. Agric Sci. Ain Shams, Univ., **31**: 677-689.

Shinde, K.H., Parekh, N.S., Upadhyay, N.V. and Patel, H.C. (2010). Investigation of different levels of gibberellic acid (GA_3) and pinching treatments on growth, flowering and yield of chrysanthemum (*Chrysanthemum morifolium* R.) cv. 'IIHR-6' under middle Gujarat conditions. *Asian Journal Horticulture*, **5**(2): 416-419.

Shivaprakash, B.N., Hugar, A.H., Kurubar, A.R., Vasudevan, S.N. and Husain, S.A. (2011). Studies on impact of bio-fertilizers and GA_3 on growth and flower yield of marigold (*Tagetes erecta* L.) cv. Orange Double. *Asian Journal of Horticulture*, **6**(2): 406-411.

Singh, A.K. (2002). Effect of growth regulators on growth and flowering in calendula, *Indian Perfumer*, **46**(3): 275-278.

Singh, A.K. (2004). Influence of plant bio-regulators on growth and seed yield in French marigold (*Tagetes patula* Linn.). *Journal of Ornamental Horticulture*, **7**(2): 192-195.

Singh, A.K. and Bijimol, G. (2001). Influence of growth regulating chemicals ongrowth, flowering and bulb production in tuberose (*Polianthus tuberose* L.). *Indian Perfumer*, **45**(1): 31-34.

Singh, A.K. and Sharma, Gaurav. (2004). Effect of growth regulating chemicals on growth and seed attributes in *Calendula officinalis*. *Progressive Hort*., **36**(2): 266-268.

Singh, A.K., Kumar, P., Sisodia, A., Pal, A.K., Singh, H.V. and Padhi, Minakshi. (2017). Effect of pinching, urea and GA_3 on growth, flowering and seed attributes in African marigold (*Tagetes erecta* L.). *J. Ornamental Horticulture*, **20**(1and2): 34-39.

Singh, M. P., Singh, R. P. and Singh, G.N. (1991). Effect of GA_3 and ethrel on the growth and flowering of African marigold (*Tegetes erecta* L.). *Haryana J. Hort. Sci*., **20**: 81-84.

Singh, M.P., Singh, R.P. and Singh, G.N. (1991). Effect of GA_3 and ethrel on the growth and flowering of African marigold (*Tagetes erecta* L.). *Haryana Journal* of *Horticulture Science*, **20**: 81-84.

Soost, R.K. (1959). Effects of gibberellic acid on genetic characters in two tomato lines. *Botanical Gazette*, **121**(2): 114-118.

Steiner, G. (1941). *Proc. Boil. Soc. Warh.*, **54**: 31-34.

Sujatha, A., Nair, V.S. and Sharma, T.V.R.S. (2002). Effect of plant growth regulators on yield and quality of gerbera under Bay island conditions. *Indian Journal of Horticulture*, **59**(1):100-105.

Sunitha, H.M., Hunje, R., Vyakaranahal, B.S. and Bablad, H.B. (2007). Effect of pinching and growth regulators on plant growth, flowering and seed yield in African marigold (*Tagetes erecta* L.). *Journal of Ornamental Horticulture,* **10**(2): 91-95.

Syamal, M.M., Rajput, C.B.S. and Singh, J.N. (1990). Effect of GA_3 and MH on growth, flowering and seed yield on Marigold and China aster. *Ind. J. Hort,* **47**: 439-441.

Takahashi, N., Phinney, B.O. and Mac Millan, J. (2012). *Gibberellins,* Springer Science and Business Media.

Talukdar, M.C., Paswan, L. (1996). Growth and flowering of diflora) cv. "Prof. Harris" as mfluenced by growth regulators. *Hort. J.,* **9**(2): 155-158

Talukdar, M.C., Paswan, L. (1994). Effect of GA_3 and CCC on growth and flowering of Chrysanthemum (Dendranthema grandiflora) cv. 'Tumruli'. *Hort. I*, **7**(2): 140-144.

Tripathi, A.N., Tripathi, S.N., Shukla, R.K. and Pandey, G. (2003). Effect of GA_3, NAA and CCC on growth and flowering of French marigold (*Tagetes patula L.*). *Journal Applied Horticulture*, **5**(2): 112-113.

Tyler, J. (1938). Plant Dis. Reptr, Suppl., 109:133-51.

Varma, L.R. and Arha. (2004). Regulation of flowering in African marigold (*Tageteserecta*L.) by the application of GA_3 Ethrel and MH. *Journal of Ornamental Horticulture*, **7**(3&4):168- 170.

Verma, V.K. (2003). Response of foliar application of nitrogen and gibberelilc acid on the growth and flowering of carnation (Dianthus caryophyllus L.). *Himanchal Journal of Agricultural Research*, **29**:1-2, 59-64.

Verma, V.K. and Parmar, Y.S. (2003). Response of foliar application of nitrogen and gibberellic acid on growth and flowering of carnation (*Dianthus caryophyllus* L.) *Himachal Journal of Agricultural Research*, **29**(1&2): 59-64.

Verzilov, V.P. and Ruhkova, L.V. (1972). Isvestz'ya Akademmzi Nauk. USSR *Biologisches Kaya*, **5**: 761-6.

Wilson, M. and Holcomb, S.J. (1979). Bull-Pennyslvanza Flower Grs., No.**311**, pp. 12.

Yadav, K.S., Sisodia, A. and Singh, A.K. (2014). Effect of GA_3 and kinetin on growth and flowering parameters of African marigold (*Tagetes erecta L.*). *Indian Perfumer*, **(1):** 21-25.

Yadav, P.K. (1997). Note on the effect of Cycocel and Maleic hydrazide on growth and flowering of African marigold. Current Agriculture, **21**: 1-2, 113-114.

Appendix-1

Analysis of variance of plant height (cm) at 30 days after planting 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	2.527			
Treatment	10	109.429	10.943	3.366	0.01003
Error	20	65.014	3.251		
Total	32	176.970			

Appendix-2

Analysis of variance of plant height (cm) at 30 days after planting 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	4.928			
Treatment	10	106.275	10.627	3.523	0.00796
Error	20	60.337	3.017		
Total	32	171.541			

Appendix-3

Analysis of variance of plant height (cm) at 45 days after planting 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	8.415			
Treatment	10	750.954	75.095	7.262	0.00009
Error	20	206.829	10.341		
Total	32	966.197			

Appendix-4

Analysis of variance of plant height (cm) at 45 days after planting 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	6.080			
Treatment	10	749.331	74.933	7.407	0.00008
Error	20	202.334	10.117		
Total	32	957.746			

Appendix-5

Analysis of variance of plant height (cm) at 60 days after planting 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	4.560			
Treatment	10	151.122	15.112	3.202	0.01285
Error	20	94.403	4.720		
Total	32	250.084			

Appendix-6

Analysis of variance of plant height (cm) at 60 days after planting 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	1.977			
Treatment	10	169.712	16.971	3.520	0.00799
Error	20	96.420	4.821		
Total	32	268.109			

Appendix-7

Analysis of variance of plant height (cm) at 75 days after planting 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.745			
Treatment	10	963.508	96.351	21.610	0.00000
Error	20	89.173	4.459		
Total	32	1,053.425			

Appendix-8

Analysis of variance of plant height (cm) at 75 days after planting 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.507			
Treatment	10	1,011.685	101.169	23.795	0.00000
Error	20	85.032	4.252		
Total	32	1,097.224			

Appendix-9

Analysis of variance of plant height (cm) at 90 days after planting 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	25.085			
Treatment	10	403.227	40.323	10.628	0.00001
Error	20	75.878	3.794		
Total	32	504.190			

Appendix-10

Analysis of variance of plant (cm) at 90 days after planting 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	22.462			
Treatment	10	406.470	40.647	9.471	0.00001
Error	20	85.837	4.292		
Total	32	514.768			

Appendix-11

Analysis of variance of number of branch per plant at 30 days after planting 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.030			
Treatment	10	2.084	0.208	3.201	0.01285
Error	20	1.302	0.065		
Total	32	3.417			

Appendix-12

Analysis of variance of number of branch per plant at 30 days after planting 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.014			
Treatment	10	1.967	0.197	3.476	0.00853
Error	20	1.132	0.057		
Total	32	3.113			

Appendix-13

Analysis of variance of number of branch per plant at 45 days after planting 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.096			
Treatment	10	27.731	2.773	38.427	0.00000
Error	20	1.443	0.072		
Total	32	29.271			

Appendix-14

Analysis of variance of number of branch per plant at 45 days after planting 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.097			
Treatment	10	32.596	3.260	33.963	0.00000
Error	20	1.919	0.096		
Total	32	34.612			

Appendix-15

Analysis of variance of number of branch per plant at 60 days after planting 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.031			
Treatment	10	6.592	0.659	4.803	0.00140
Error	20	2.745	0.137		
Total	32	9.367			

Appendix-16

Analysis of variance of number of branch per plant at 60 days after planting 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.072			
Treatment	10	10.821	1.082	10.491	0.00001
Error	20	2.063	0.103		
Total	32	12.956			

Appendix-17

Analysis of variance of number of branch per plant at 75 days after planting 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.046			
Treatment	10	67.746	6.775	63.100	0.00000
Error	20	2.147	0.107		
Total	32	69.939			

Appendix-18

Analysis of variance of number of branch per plant at 75 days after planting 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.108			
Treatment	10	52.678	5.268	59.683	0.00000
Error	20	1.765	0.088		
Total	32	54.552			

Appendix-19

Analysis of variance of number of branch per plant at 90 days after planting 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.348			
Treatment	10	81.283	8.128	39.596	0.00000
Error	20	4.106	0.205		
Total	32	85.737			

Appendix-20

Analysis of variance of number of branch per plant at 90 days after planting 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.288			
Treatment	10	65.835	6.584	70.674	0.00000
Error	20	1.863	0.093		
Total	32	67.986			

Appendix-21

Analysis of variance of number of leaves per branch at 30 days after planting 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.212			
Treatment	10	9.137	0.914	2.662	0.02989
Error	20	6.864	0.343		
Total	32	16.213			

Appendix-22

Analysis of variance of number of leaves per branch at 30 days after planting 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	1.240			
Treatment	10	19.774	1.977	5.164	0.00090
Error	20	7.659	0.383		
Total	32	28.673			

Appendix-23

Analysis of variance of number of leaves per branch at 45 days after planting 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.284			
Treatment	10	78.589	7.859	34.32	0.00000
Error	20	4.579	0.229		
Total	32	83.452			

Appendix-24

Analysis of variance of number of leaves per branch at 45 days after planting 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.909			
Treatment	10	59.694	5.969	12.962	0.00000
Error	20	9.211	0.461		
Total	32	69.814			

Appendix-25

Analysis of variance of number of leaves per branch at 60 days after planting 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.587			
Treatment	10	6.212	0.621	2.872	0.02140
Error	20	4.326	0.216		
Total	32	11.125			

Appendix-26

Analysis of variance of number of leaves per branch at 60 days after planting 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	3.732			
Treatment	10	28.326	2.833	4.546	0.00195
Error	20	12.462	0.623		
Total	32	44.521			

Appendix-27

Analysis of variance of number of leaves per branch at 75 days after planting 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.150			
Treatment	10	77.105	7.710	31.588	0.00000
Error	20	4.882	0.244		
Total	32	82.136			

Appendix-28

Analysis of variance of number of leaves per branch at 75 days after planting 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	2.953			
Treatment	10	28.365	2.837	5.013	0.00108
Error	20	11.317	0.566		
Total	32	42.635			

Appendix-29

Analysis of variance of number of leaves per branch at 90 days after planting 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.348			
Treatment	10	81.283	8.128	39.596	0.00000
Error	20	4.106	0.205		
Total	32	85.737			

Appendix-30

Analysis of variance of number of leaves per branch at 90 days after planting 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.058			
Treatment	10	21.274	2.127	4.483	0.00211
Error	20	9.492	0.475		
Total	32	30.823			

Appendix-31

Analysis of variance of number of leaves per plant at 30 days after planting 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	1.290			
Treatment	10	47.116	4.712	9.587	0.00001
Error	20	9.830	0.491		
Total	32	58.236			

Appendix-32

Analysis of variance of number of leaves per plant at 30 days after planting 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.290			
Treatment	10	24.945	2.495	3.856	0.00494
Error	20	12.940	0.647		
Total	32	38.175			

Appendix-33

Analysis of variance of number of leaves per plant at 45 days after planting 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	11.890			
Treatment	10	234.594	23.459	10.231	0.00001
Error	20	45.858	2.293		
Total	32	292.343			

Appendix-34

Analysis of variance of number of leaves per plant at 45 days after planting 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	4.247			
Treatment	10	620.463	62.046	74.415	0.00000
Error	20	16.676	0.834		
Total	32	641.385			

Appendix-35

Analysis of variance of number of leaves per plant at 60 days after planting 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	31.265			
Treatment	10	242.358	24.236	2.773	0.02502
Error	20	174.784	8.739		
Total	32	448.407			

Appendix-36

Analysis of variance of number of leaves per plant at 60 days after planting 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	1.497			
Treatment	10	535.153	53.515	74.783	0.00000
Error	20	14.312	0.716		
Total	32	550.962			

Appendix-37

Analysis of variance of number of leaves per plant at 75 days after planting 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	11.350			
Treatment	10	508.496	50.850	9.669	0.00001
Error	20	105.177	5.259		
Total	32	625.023			

Appendix-38

Analysis of variance of number of leaves per plant at 75 days after planting 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.452			
Treatment	10	655.683	65.568	61.014	0.00000
Error	20	21.493	1.075		
Total	32	677.628			

Appendix-39

Analysis of variance of number of leaves per plant at 90 days after planting 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	5.220			
Treatment	10	439.265	43.927	6.240	0.00026
Error	20	140.800	7.040		
Total	32	585.285			

Appendix-40

Analysis of variance of number of leaves per plant at 90 days after planting 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	4.857			
Treatment	10	517.226	51.723	46.690	0.00000
Error	20	22.156	1.108		
Total	32	544.238			

Appendix-41

Analysis of variance of days taken to first bud appearance after planting 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	14.760			
Treatment	10	382.968	38.297	26.250	0.00000
Error	20	29.179	1.459		
Total	32	38.297			

Appendix-42

Analysis of variance of days taken to first bud appearance after planting 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	4.395			
Treatment	10	352.136	35.214	53.523	0.00000
Error	20	13.158	0.658		
Total	32	369.689			

Appendix-43

Analysis of variance of days taken to first flowering after planting 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.279			
Treatment	10	493.371	49.337	23.512	0.00000
Error	20	41.967	2.098		
Total	32	535.617			

Appendix-44

Analysis of variance of days taken to first flowering after planting 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	2.889			
Treatment	10	438.394	43.839	30.227	0.00000
Error	20	29.007	1.450		
Total	32	470.289			

Appendix-45

Analysis of variance of days taken to 50% flowering after planting 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	2.308			
Treatment	10	172.339	17.234	10.248	0.00001
Error	20	33.635	1.682		
Total	32	208.282			

Appendix-46

Analysis of variance of days taken to 50% flowering after planting 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	1.789			
Treatment	10	152.026	15.203	17.625	0.00000
Error	20	17.251	0.863		
Total	32	171.066			

Appendix-47

Analysis of variance of days taken to first flower picking after planting 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	1.019			
Treatment	10	84.065	8.406	3.168	0.01351
Error	20	53.065	2.653		
Total	32	138.149			

Appendix-48

Analysis of variance of days taken to first flower picking after planting 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.013			
Treatment	10	152.721	15.272	13.579	0.00000
Error	20	22.494	1.125		
Total	32	175.229			

Appendix-49

Analysis of variance of diameter of flower (cm) 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.448			
Treatment	10	7.215	0.722	5.046	0.00104
Error	20	2.860	0.143		
Total	32	10.524			

Appendix-50

Analysis of variance of diameter of flower (cm) 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.027			
Treatment	10	6.158	0.616	4.007	0.00400
Error	20	3.073	0.154		
Total	32	9.259			

Appendix-51

Analysis of variance of duration of flowering (days) 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	1.077			
Treatment	10	552.465	55.246	17.992	0.0000
Error	20	61.412	3.071		
Total	32	614.95			

Appendix-52

Analysis of variance of duration of flowering (days) 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.361			
Treatment	10	445.924	44.592	29.681	0.00000
Error	20	30.048	1.502		
Total	32	476.333			

Appendix-53

Analysis of variance of number of flower per plant 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	14.034			
Treatment	10	377.038	37.704	21.353	0.0000
Error	20	35.315	1.766		
Total	32	426.38			

Appendix-54

Analysis of variance of number of flower per plant 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.356			
Treatment	10	504.406	50.441	58.278	0.00000
Error	20	17.310	0.866		
Total	32	522.072			

Appendix-55

Analysis of variance of mean weight of flower (g) 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.666			
Treatment	10	26.335	2.634	3.102	0.01496
Error	20	16.980	0.849		
Total	32	43.981			

Appendix-56

Analysis of variance of mean weight of flower (g) 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.162			
Treatment	10	20.174	2.017	5.681	0.00049
Error	20	7.102	0.355		
Total	32	27.438			

Appendix-57

Analysis of variance of weight of flower per plant (g) 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	548.511			
Treatment	10	48,464.529	4,846.453	9.723	0.00001
Error	20	9,969.31	498.466		
Total	32	58,982.351			

Appendix-58

Analysis of variance of weight of flower per plant (g) 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	103.600			
Treatment	10	46,466.498	4,646.650	17.649	0.00000
Error	20	5,265.595	263.280		
Total	32	51,835.693			

Appendix-59

Analysis of variance of flower yield per plot (kg) 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.158			
Treatment	10	12.031	1.203	9.197	0.00002
Error	20	2.616	0.131		
Total	32	14.805			

Appendix-60

Analysis of variance of flower yield per plot (kg) 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.027			
Treatment	10	11.973	1.197	17.472	0.00000
Error	20	1.371	0.069		
Total	32	13.371			

Appendix-61

Analysis of variance of flower yield per hectare (t) 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	1.315			
Treatment	10	101.546	10.155	19.465	0.00000
Error	20	10.433	0.522		
Total	32	113.295			

Appendix-62

Analysis of variance of flower yield per hectare (t) 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.570			
Treatment	10	255.036	25.504	17.586	0.00000
Error	20	29.005	1.450		
Total	32	284.610			

Appendix-63

Analysis of variance of shelf life of flower (days) 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	1.177			
Treatment	10	54.809	5.481	11.371	0.00000
Error	20	9.641	0.482		
Total	32	65.627			

Appendix-64

Analysis of variance of shelf life of flower (days) 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.673			
Treatment	10	23.682	2.368	10.835	0.00000
Error	20	4.371	0.219		
Total	32	28.726			

Appendix-65

Analysis of variance of moisture content in flower (%) 2016-17

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	0.197			
Treatment	10	147.560	14.756	2.769	0.02518
Error	20	106.574	5.329		
Total	32	254.331			

Appendix-66

Analysis of variance of moisture content in flower (%) 2017-18

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Signficance
Replication	2	1.051			
Treatment	10	190.467	19.047	4.061	0.00371
Error	20	93.806	4.690		
Total	32	285.325			