

**"GROWTH AND FLOWERING RESPONSE OF CHINA ASTER
(*Callistephus chinensis* L. Nees) CV. 'PHULE GANESH
PURPLE' TO PLANT GROWTH RETARDANTS"**

A

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BY

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ABSTRACT

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ASTER (*Callistephus chinensis* L. Nees) CV. ‘PHULE GANESH
PURPLE’ TO PLANT GROWTH RETARDANTS”**

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ABSTRACT

The present investigation on “Growth and flowering response of China aster (*Callistephus chinensis* L. Nees) cv. ‘Phule Ganesh Purple’ to plant growth retardants” was conducted at Floriculture Research Scheme, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari during the year 2009-10.

The foliar application of Maleic hydrazide (400 mg/l, 600 mg/l, 800 mg/l, 1000 mg/l), Chlorocholine chloride (1.0 ml/l, 1.5 ml/l, 2.0 ml/l, 2.5ml/l) PP₃₃₃ (0.5 ml/l, 1.0ml/l, 1.5 ml/l, 2.0 ml/l) after 15, 30 and 45 days after transplanting and hand pinching (30 DAT) was done. The experiment was laid out in randomized block design (RBD) with fourteen treatments including control and three replications.

The result revealed that an application of PP₃₃₃ 2.0 ml/l was recorded maximum reduction in plant height (25.2 cm), while maximum number of leaves (37.7) and leaf area (44.6 cm²) noted under

treatment T₇ (Chlorocholine chloride 2.0 ml/l). The early emergence of flower (46.1) was noted under treatment T₁₂ (PP₃₃₃ 2.0 ml/l) which was at par with treatment T₇ (Chlorocholine chloride 2.0 ml/l). The China aster plants had highest flower diameter (5.5 cm), maximum weight of ten flowers (27.3 g), longest stalk length (13.6 cm), maximum shelf life (19.7 days) and vase life (10.7 days) under treatment T₇ (Chlorocholine chloride 2.0 ml/l). On other hand this treatment produce highest number of flowers per plant (49.7) and ultimately yield of flowers per hectare (10.7 tonne).

Application of Chlorocholine chloride 2.0 ml/l was found most remunerative as it gave the highest net return with maximum benefit cost ratio.

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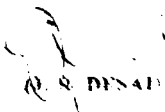
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C E R T I F I C A T E

This is to certify that the thesis entitled "Growth and flowering response of China aster (*Callistephus chinensis* L. Desv. cv. 'Phule Ganesh Purple' to plant growth regulators" submitted by PATEL SANKALPKUMAR GHANSHYAMBEK in partial fulfillment of the requirements for the award of the degree of MASTER OF SCIENCE (HORTICULTURE or FLORICULTURE AND LANDSCAPING) of the Navsari Agricultural University and record of bona fide research work carried out by him under the guidance and the thesis has not previously formed the basis for the award of any degree, diploma or other similar title.

Place: Navsari

Date: 25/05/2010


Dr. J.R. DENAI
Statel Advisor

DECLARATION

This is to declare that the whole of the research work submitted in this thesis for the partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (HORTICULTURE)** in the subject of **FLORICULTURE AND LANDSCAPING** is the result of investigation done by the undersigned under the direct guidance and supervision of **Dr. J. R. Desai**, Associate Professor, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari and that no part of the work has been submitted for any other degree so far.

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S. G. Patel

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LIST OF ABBREVIATION AND SYMBOLS

Sr. No.	Abbreviation	Meaning
1	%	Per cent
2	°C	Degree Celsius
3	C.D	Critical difference
4	C.V	Co- efficient of cviance
5	S. Em.	Standard error of mean
6	cm	Centimeter
7	hr	Hour
8	g	Gram
9	mg	Milligram
10	PP ₁₀₀	Paclobutrazol, PBZ
11	CCC	Chlorocholine chloride, Cycocel
12	MH	Maleic hydrazide
13	ppm	Parts per million
14	cv.	Cultivar
15	l	Liter
16	ha	Hectare
17	M	Meter
18	MT	Metric tonne
19	WP	Wettable powder
20	<i>et al.</i> ,	Et aliii (and other.)
21	i.e.	That is
22	Mm	Millimeter
23	DAT	Days after transplanting



INTRODUCTION

I. INTRODUCTION

China aster (*Callistephus chinensis* L. Nees) is one of the important commercial cut flower belonging to the family Asteraceae. China aster is native of China from it spread to Europe and other tropical countries during 1731 A.D. Among the flowers China aster occupies an important position because of its prettiness, elegance, diverse forms and varied attractive color ranges.

It is half hardy and free blooming annual with beautiful crown, dwarf, medium or tall and erect having hispid branches bearing alternative broadly ovate or triangular ovate, deeply and irregularly toothed leaves. The plant height ranges from 15cm to about 1m with pompon flowers. head having single, double, anemone florets, incurved, shaggy or quelled types. Flowers are solitary with vary wide range of colors. The plant is a self pollinated crop with a permanently 10% natural crossing.

China aster can be easily grown in open field as well as in cloth house for production of cut flowers. It from pure white to many shades of pink, primrose, pale blue, purple, dark blue and scarlet. China aster is cool season shallow rooted crop but it can be seen growing during rainy season around Pune, Bangalore and Mysore. It is a winter season annual, but frost is dangerous for its cultivation during this season. It needs open sunny situation. It can grow best in rich, porous and well drained soils. The summer crop is commonly produced in the cloth house. China aster can also be grown year round in areas where night temperatures are around 10°C. Seeds are sown during August to October and the plants bloom in about 3 1/2 to 4th months from date of sowing.

Both marginal and small farmers in various parts of our country are largely cultivating it as traditional crop in India. It is widely grown in Karnataka, west Bengal, and Maharashtra. Among the annual flowers it ranks next to chrysanthemum and marigold in area and production. Small and marginal farmers in and around cities mainly grown it. In Karnataka its area, production and productivity were reports to be 1000 ha, 11250 tonnes and 11.5 tonnes per hectare, respectively during 1997-98 and in Bangalore rural and urban district, it occupied about 500 ha area.

The crop was found to be suitable for intercropping in coconut gardens. Mixing of leafy vegetables like amaranthus and coriander fetches more returns. China asters are of diverse forms and colors used in making bouquets, button holes, garlands and for vase arrangements. It is used as cut flowers, Cut flowers of China aster plays a major role in decorations, worships, wedding, and in social and cultural function, bedding plant, for growing in pots, window boxes and other garden places where enhancement of colour in garden is required. Large compact flowers with straight stalks are considered ideal for cut flower and thickness of flower with more number of petals are suitable for garland making.

There is great scope for increasing area under floriculture and South Gujarat region as demand for cut flowers is increasing day by day in nearby city markets like Surat, Vadodara, Mumbai, Ahmedabad etc. The area and production of cut flowers in South Gujarat is not enough to fulfill the increasing demand for cut flowers, though the cultivation of flower crop is a profitable venture, as soil and climatic conditions of South Gujarat region are very well suited for their cultivation.

With the advent of floriculture in South Gujarat region, different floricultural crops are being exploited for their commercial cultivation. Aster is one of them. South Gujarat region of Gujarat is warm and humid. The winter season is mild and the situations are mostly frost free. It provides great scope for cultivation of floriculture crop like aster. Demands for cut flowers are increasing in the region day by day. Due to better transport facilities, the region is now well connected to big cities like Surat, Vadodara, Mumbai, and Ahmadabad etc. So the agro-climatic conditions are well suited for its cultivation during winter season.

Increase the flower production, quality of flowers and perfection in the form of plants are the important objectives of the commercial flower production. There is vast scope of build up flourishing cut flower trade in India. The exogenous application of growth regulator plays a major role on growth and flowering characters. The enhancement or delay in flowering will give better profit due to off season and prolonged flowering duration. Quality with maximum yield and extending post harvest life are of the prime importance in China aster cultivation. This can be achieved with optimum use of growth regulator. The effect of growth regulator vary with plant species, variety, concentration of retardants used, method of application, frequency of application and various other factors which influence the uptake and translocation of chemicals.

Plants treated with growth retardants are generally compact and sturdy and have typically shortened internodes, dark green leaves and shortened petioles. Treated plants usually remain dwarf under optimal growing condition.

Marked apical dominance in China aster has been one of the limiting factors for the production of flowers. The use of growth

retardants has received limited attention and Systematic investigation to assess the effect of growth retardants on growth, flowering and quality flower production in China aster is of prime importance under field condition.

Considering the importance of this crop and need for quality flowers the present study was taken up with the following objectives.

1. To study the effect of foliar application of Cycocel, MH and Paclobutrazol on growth, flowering, yield and quality in China aster.
2. To study the effect of plant growth retardants on post harvest life and quality of flowers.



*REVIEW
OF
LITERATURE*

II. REVIEW OF LITERATURE

There has been substantial emphasis on the use of plant growth retardants in recent years. For better understanding of the mode of action, the plant growth retardants are used for various purposes in agriculture including horticulture *viz.*, rooting of cuttings, influencing vegetative and reproductive growth, better quality of products, breaking seed dormancy, better fruit and flower setting and fruit maturity.

The effect of plant growth retardants on China aster and other seasonal flowering plants have been reported and claims are made for better growth, flower yield and flower quality which has led to much interest amongst the scientists and growers.

Research work regarding the suitability of plant growth retardants and their optimum concentrations on growth, flowering, flower yield and quality of China aster.

The investigation was therefore, undertaken to study the effect of Chlorocholine chloride (Cycocel), Maleic hydrazide (MH) and PP₃₃₃ (paclobutrazol) on China aster. The relevant literature available on different aspects has been reviewed under the following headings.

- 2.1 Response of Chlorocholine chloride (Cycocel):
- 2.2 Response of Maleic hydrazide (MH):
- 2.3 Response of PP₃₃₃ (Paclobutrazol):
- 2.4 Response of hand pinching:

2.1 RESPONSE OF CHLOROCHOLINE CHLORIDE (CYCOCEL):

Retardation of growth by chemical means has been made possible for many years. Cycocel plays a vital role in suppressing the apical dominance of the stem. Cycocel is known to retard the vegetative growth and so it is known as growth retardant. Research done by several workers on the effect of CCC on height of China aster and other flowers is reviewed as below.

China aster

Narayana Gowda (1990) reported in China aster that the reduction in plant height, increased number of laterals and flowers per plant due to pinching and cycocel spray. Also studied that cycocel sprayed delayed the flowering.

Aswath *et al.* (1994) while working with China aster cv. 'Power Puff Mixed' reported that application of cycocel 500, 1000, and 1500 ppm significantly delayed the flower bud appearance as compared to control. And they also observed higher number of leaves and branches were obtained with 1500 ppm cycocel. They observed alar and cycocel each at 1500 ppm resulted in increased number of flowers. CCC 1500 ppm caused significant reduction in plant height when applied 95 and 125 days after sowing.

Katkar *et al.* (2005) reported that CCC 750 ppm produced large sized of flower. Maximum weight of 10 flowers, higher vase life of flowers and maximum yield of flowers per plot were recorded with CCC 750 ppm over control in China aster cv. 'California Giant Mix'.

Joshi and Reddy (2006) conducted an experiment on China aster (*Callistephus chinensis* L. Nees) using local variety. They

revealed that the application of CCC 2500 ppm at 30, 45 and 60 days after transplanting reduced plant height, gave maximum laterals per plant and decreased the days to first flower initiation. Maximum number of flowers per plant and longevity of flowers were recorded due to application of CCC at 2000 ppm.

Marigold

Parmar and Singh (1983) conducted an experiment on African marigold var. 'Fantastic'. They reported that the average plant height was maximum when plant treated with the CCC (500ppm) followed by 750 and 1000 ppm. The minimum plant spread was observed in 750 ppm CCC and the more number of branches per plant tended to increased in 500 ppm CCC treatment followed by 750 and 1000 ppm. They also noticed that the number of days taken for full bloom was at par with control when CCC was sprayed at 500,750, 1000 ppm at 10 days after transplanting. The maximum number of flowers per plant was observed in 500 ppm and 750ppm of CCC. They revealed that the higher yield of flowers per plant was observed in 750 ppm CCC.

The plant height was reduced when plant treated with 500 and 1000 ppm CCC in marigold cv. 'African Giant'. CCC 500 ppm and 1000 ppm treated plants reduced the number of days to first flowering and flower diameter and also observed maximum number of flowers per plant in CCC 500 ppm and 1000 ppm treatments (Girwani *et al.*,1990).

Patel (1990) conducted an experiment on marigold cv. 'Lemon'. He found that the plant height significantly reduced when plants were treated with CCC 500 and 750 ppm. He observed that the spraying of CCC with 250, 500, and 750 ppm produced significantly more number of primary branches per plant as compared to control. He

also noted that the foliar application of CCC 750 ppm significantly delayed flowering and give minimum flower diameter too. He reported that the all level of CCC decreased flower weight.

Gowda and Jayanthi (1991) conducted an experiment on African marigold cv. 'Bangalore Local'. They reported that cycocel at 2000 ppm significantly reduced the plant height as compared to control. They also observed increased in flower diameter with CCC treatment (1000, 1500 and 2000 ppm) as compared to control in both seasons (June-July and August-September).

Singh and Rathore (1992) conducted an experiment on African marigold. They reported that the all the concentrations of CCC (2000, 4000 and 8000 ppm) decreased the plant height, an increase in primary and secondary branches and significantly produced more number of flowers per plant.

Yadav (1997) conducted an experiment on African marigold var. 'Fantastic'. He was concluded that the plant height was significantly reduced when plants treated with CCC 750 ppm and the number of branches, size of flower and number of flowers per plant was enhanced significantly by the spray of CCC (750 ppm) over control. He also reported that the number of days to flowering was reduced by spraying of CCC at 1000 ppm.

Khandelval *et al.* (2003) conducted an experiment on African marigold cv. "Pusa Naragi Gainda" and they reported that the application of CCC at 3000 ppm was recorded the minimum plant height and number of branches per plant. They also found that the application of CCC at 3000 ppm was taken more days for first flowering. They also concluded that the maximum flower diameter and weight of flower obtained when plant treated with the CCC at 1000

ppm. The maximum number of flowers per plant and yield of flowers was registered when marigold plants sprayed with CCC at 3000 ppm. They also revealed that all level of CCC (1000, 2000 and 3000 ppm) gave maximum longevity of flowers as compared to control.

Mishra and Pandey (2006) conducted an experiment on African marigold cv. 'Pusa Narangi Gaiinda'. The treatment CCC 1000 ppm + no pinch reduced plant height and increased number of branches. The treatment 250 ppm + no pinch decreased in days to full bloom, increased fresh weight of flower and gave maximum flower size. The maximum number of flowers and yield was observed in treatment CCC 1000 ppm + no pinch.

Sunitha *et al.* (2007) conducted an experiment on African marigold cv. "Double Orange". They reported that the application of CCC 1000 ppm was gave minimum plant height, number of branches per plant and flower yield.

Pushkar and Singh (2010) found that pinching at 20 days after transplanting + foliar application of cycocel @ 1000 ppm in African marigold cv. 'Pusa Narangi Gaiind' significantly decreased the plant height and increased the number of flowers and yield of flowers per hectare.

Chrysanthemum

Sen and Maharana (1971) conducted an experiment on chrysanthemum cv. 'Early Yellow'. They reported that the reduced in plant height, number of branches and flower diameter with increase in the concentrations of cycocel (0.25%, 0.05% and 1.0%). They also noted more number of flowers with 1.0 percent cycocel.

Nagarjuna *et al.* (1988) conducted an experiment on *Chrysanthemum indicum* L. They noted that the plant height, days to 50 percent flowering and yield of flower by weight per plant was reduced when plant was treated with CCC 10,000 ppm at 70 days after transplanting.

Dutta *et al.* (1993) conducted an experiment on chrysanthemum cv. 'CO-1'. They observed delay in commencement of flowering and an increased weight of flowers per plant with foliar application of CCC at all the levels (2000, 3000 and 4000 ppm). They also reported that an increase in vase life and the number of flowers per plant with consequent increase in concentrations of CCC treatment (2000, 3000 and 4000 ppm) in two seasons.

Talukdar and Paswan (1997) reported that the all levels of CCC treatments (5000, 10000, 15000 ppm) on *Dendranthema grandiflora* Tzveley cv. 'Maharaja' reduced the plant height, an increased number of branches per plant and vase life as compared to control. They also found that number of flowers per plant was increased with the treatments of 5000 and 10000 ppm of CCC. Further they concluded that the 10000 ppm of CCC caused delay in flowering.

Singh (2001) noted that CCC 450 ppm took maximum days for flowering and full bloom in local white cultivar of *c. coronarium*. Application of all the levels of CCC (2500, 3500 and 4500 ppm) caused significant reduction in flower size with stalk length. While significantly improved shelf life of flowers at all the levels of CCC. But the longest shelf life was recorded with CCC 4500 ppm. He also found maximum number of flowers per plant with CCC 4500 ppm and significantly increased the flower yield per plant and per hectare in terms of weight with all the levels of CCC.

Moond and Rakesh (2006) reported that the when they sprayed twice at 4 and 6 weeks after transplanting with CCC at 2000 ,4000, 6000, 8000, 10000 ppm on the chrysanthemum cv. 'Local' duration of flowering increased significantly with all levels of CCC. All the treatments significantly increased in number of flowers, flowers yield per plant over the control, and also significantly increase vase life of cut flower.

Gaillardia

Khimani *et al.* (1994) noted maximum reduction in plant height with CCC at 1500 ppm and also reported maximum number flowers per plant of *G. pulchella* cv. 'Picta Fouger' when sprayed with CCC 500, 1000, 1500 ppm at 30 and 60 days after transplanting.

Makwana (1999) conducted an experiment on *Gaillardia pulchella* cv. 'Lorenziana'. He reported that the application of CCC at 1000, 2000, and 3000 ppm decreased the plant height and increased in plant spread as compared to control. He also observed that the decreased the number of primary and secondary branches, increased the number of days taken for 50 percent flowering after transplanting, increased flower diameter and increased individual flower weight with foliar spray of CCC (1000, 2000 and 3000 ppm) as compared to control. Further he found that CCC at 3000 ppm produced significantly more number of flowers as compared to control. He also noted that vase life of flowers increased significantly with increase in the concentrations (1000, 2000 and 3000) of CCC.

Dahale *et al.* (2010) conducted an experiment on gaillardia. They revealed that cycocel @ 200 ppm was found most effective for increasing number of flowers per plant, weight of flowers per plant and flower quality as compare to other treatments.

Golden rod

Patil *et al.* (2004) registered maximum Number of flower stalks per plant when the plants treated with 1000 ppm CCC in golden rod. While the minimum plant height obtained with the application of CCC 2000 ppm. He also reported higher number of leaves per plant with an application of CCC 500 ppm.

Gladiolus

Kirad *et al.* (2001) reported on gladiolus var. 'White Prosperity' that the decreased in plant height with foliar spray of CCC 6000 ppm. They also recorded that the days to blooming was reduced with foliar application of CCC 2000 ppm.

Dahlia

In dahlia cv. 'Kelvin Rose', the reduced in plant height and decreased number of days to taken for first flower bud appearance with application of CCC 5000 ppm. Significantly increased in number of flowers during decreased in concentration of CCC 5000, 2500 and 1000 ppm (Bhattacharjee., 1984).

Khan and Tewari (2003) studied chlormequat (2000, 4000, 6000 ppm) when tried with dahlia and revealed that 6000 ppm chlormequat resulted in maximum reduction in plant height and leaf area. Similarly chlormequat 4000 ppm increased diameter of stem, number of leaves, flower diameter, shelf life and number of flowers.

Rose

Singh (2004) studied the application of 2000 ppm CCC on rose cv. 'Eiffel Tower' significantly increased number of leaves and reduced plant height. Maximum number of flowers/plant during

different flushes as well as number of flowers/plant/year was significantly enhanced with 2000 ppm CCC.

Crossandra

Sreekala *et al.* (2000) noted when plant treated with CCC 500 ppm gave significant increased in the number of branches and number of spikes produced/month. Likewise maximum leaf area was also noted with an application of CCC 5000 ppm + 1 % urea.

2.2 RESPONSE OF MALEIC HYDRAZIDE (MH):

China aster

Jaulhari and Amarjit (1960) reported that an application of maleic hydrazide at 500 ppm increased the average number of lateral shoots and flowers per plant, while plant height was reduced and delayed flowering. Higher concentration of 1000 to 2000 ppm markedly reduced height, number of laterals and delayed blooming in China aster. The flowering in case of China aster was delayed by 14 days with an application 1000 ppm maleic hydrazide as compare to control (Narayana reddy, 1978).

Reddy and Sulladmath (1983) observed the significant reduction in plant height with an application of MH 500 – 1000 ppm sprayed at 15 days after transplanting of China aster. Further they also reported that foliar application of MH (500-1000 ppm) at 15 days after transplanting extended 50 per cent flowering.

Narayana Gowda (1990) reported that maleic hydrazide spray delayed the flowering time in China aster cv. "Power puff Mixed". The maximum number of days taken for lower bud appearance (120.43 days) was with 1500 ppm MH as against control of 108.33 days.

Syamal *et al.* (1990) stated that the minimum number of branches per plant in China aster was obtained with MH at 400 ppm sprayed at 15 days after transplanting. They also revealed that all levels of MH (200-400 ppm) sprayed at 15 days after transplanting decreased flowers.

Aswath *et al.* (1994) observed maximum reduction in plant height in China aster with an application of MH 500 ppm sprayed at 25, 40 and 55 days after sowing. They also recorded that the application of MH at 1500 ppm decreased the number of branches and extended the number of days for flower bud appearance over control. Lower concentration of MH application (500 and 1000 ppm) modified more number of flowers whereas, higher concentration (1500 ppm) reduced number of flowers.

Marigold

Parmar and Singh (1983) revealed that the maximum reduction in plant height found with higher level of MH (1000 ppm) followed by 750 and 500 ppm at 10 days after transplanting of marigold var. 'Fantastic'. They also reported that MH 1000 ppm took maximum number of days for top bud initiation and gave minimum yield.

Syamal *et al.* (1990) stated that the minimum number of branches per plant in African marigold with MH at 400 ppm sprayed at 15 days after transplanting. They also revealed that all levels of MH (200-400 ppm) sprayed at 15 days after transplanting decreased flowers per plant in African marigold.

Gowda and Jayanthi (1991) found MH at 1500 ppm reduced plant height and increased number of branches per plant in African

marigold cv. 'Bangalore Local'. Greater number of flowers per plant and the minimum diameter of flower was observed with the foliar application of MH (500, 1000 and 1500 ppm) at 3rd and 5th week after transplanting. They also reported that the yield was increased with increased in concentration of MH.

Singh and Rathore (1992) reported that the reduced in plant height and number of flowers with increased in concentration of MH 50, 100 and 200 ppm in African marigold. The number of laterals per plant was significantly increased by application of MH 50 and 200 ppm.

Yadav (1997) concluded that an application of MH 750 ppm was significantly reduced the plant height and the number of branches per plant and also reduced the number of days for top bud initiation in African marigold var. 'Fantastic'. The foliar application of MH (500-1000 ppm) reduced days for full bloom. He also reported that the reduction in width of flower when plant treated with 1000 ppm MH. The fresh weight of flower decreased with foliar application of MH (500 -1000 ppm) at 10 and 20 days after transplanting.

Patel (2001) noted that when plant treated with MH 400 ppm at 15 days after transplanting reduced the plant height, number of days for first flowering and 50% flowering and increased the number of branches per plant, in African marigold cv. 'Pusa Basanti Gaiinda'. He also recorded maximum flower diameter, highest fresh weight of single flower and highest flower yield was observed when plant sprayed with 400 ppm MH.

Khandelval *et al.* (2003) registered reduced the plant height, number of branches per plant, number of days for first flowering, number of flowers per plant and yield in African marigold

cv. "Pusa Naragi Gaiinda" when plant treated with 1000 ppm MH at 20 days after transplanting..

Mishra and Pandey (2006) conducted an experiment on African marigold cv. 'Pusa Narangi Gaiinda'. They revealed that plant height was reduced and number of branches was increased when plant was treated with MH 1000 ppm + no pinch. Foliar application of MH 250 ppm + no pinch decreased in days to full bloom, increased number of flowers, increased fresh weight of flower, gave maximum flower size and maximum yield at full bloom stage.

Chrysanthemum

Sharma *et al.* (1995) reported that increasing the concentrations of MH (250-1000ppm) decreased the plant height and significantly prolonged the duration of bud emergence in Chrysanthemum cv. 'Move-in-Carvin' over control.

Dutta and Ramadas (1998) conducted an experiment on Chrysanthemum. They revealed that foliar application of MH (250-1000 ppm) sprayed at 30 and 45 days after transplanting suppressed the plant height, increased the number of lateral branches, extended first flower initiation and reduced flower size. They observed that the application of MH (250-1000 ppm) significantly increased the flower yield per plant in chrysanthemum over control.

Kumar and Ughreja (1998) conducted an experiment on chrysanthemum cv. 'IHR-6'. They observed that the application of MH 750 ppm sprayed at 30 and 45 days after transplanting reduced the plant height and took minimum days for flower formation. They reported that the foliar application of MH (250, 500 and 750 ppm) increased the number of lateral branches and delayed 50 per cent

flowering. Application of MH (250 ppm) at 30 and 45 days after planting produced more number of flowers per plant. They revealed that lower (250 ppm) and medium (500 ppm) concentration of MH recorded significantly gave maximum flower yield (97.35 g and 89.72 g, respectively) per plant, whereas higher concentration (1000 ppm) reduced the flower yield (75.0 g) over control (87.20 g).

Moond and Rakesh (2006) studied that minimum plant height was recorded with MH at 1250 ppm. Also stated maximum number of primary branches, leaves per plant and number of flowers per plant recorded with MH 1250 ppm in chrysanthemum cv. 'Local'.

Carnation

Jana and Kabir (1987) observed reduced in plant height in carnation cv. 'Improved Margurite' with an application of MH at all levels (10, 50 and 100 ppm). And they found that the foliar application of MH at 10 and 50 ppm significantly increased the weight of carnation flower over control.

Nerium

Anburani and Vijay Ananth (2008) registered maximum number of flowers per plant, flower diameter and single flower weight in nerium cv. 'Red Single' when plant treated with MH 1500 ppm.

2.3 RESPONSE OF PACLOBUTRAZOL:

China aster

Qrunfleh and Suwaan (1988) reported that when paclobutrazol sprayed at 4 weeks after transplanting at different concentrations from 200 to 2000 ppm, significantly delayed flowering and had no influence on flower diameter in China aster and Calendula.

while in *Portulaca*, paclobutrazol at 500 ppm reduced the flower diameter.

Mishra and Mishra (2006) studied that effect of levels and methods of application of paclobutrazol on growth and flower yield of China aster cv. 'White Stafour'. They recorded that foliar spray of paclobutrazol 20 ppm gave minimum plant height and significantly increased the number of flowers and gave maximum flower yield.

Marigold

Keever and Cox (1989) noted that good retardation in height was obtained in *Tagetes erecta* cv. 'First Lady' and *Tagetes patula* cv. 'Honey Comb' by the application of paclobutrazol at 200-2000 ppm given at 30 days after seed sown.

Latimer (1991) reported that an application of paclobutrazol at 40 ppm reduced the plant height in marigold cv. 'Papaya Crush'.

Maan (2003) found that plant treated with 40 mg/l paclobutrazol applied as soil drenching minimized leaf area, days to flower bud initiation, stalk length and diameter of flower in African marigold. He also noted maximum weight of single flower and flower yield per hectare with soil drenching of paclobutrazol.

Patel (2001) observed reduction in plant height and in time to flower bud initiation by applying the paclobutrazol as foliar spray with less concentration in marigold. Also noted that paclobutrazol sprayed (10, 20 and 30 mg/ lit) at 15 and 30 days after transplanting had been reduced the stalk length in marigold cv. 'Pusa Basanti Gaiinda'.

Chrysanthemum

Sanderson *et al.* (1988) found that foliar application of paclobutrazol at 16 days and one month after propagation reduced the number of flowers per plant in *Chrysanthemum morifolium* cv. 'Charm'.

Barett and Nell (1989) stated that the application of paclobutrazol as soil drench and foliar spray applied at 19 days after planting was effective for controlling the plant height in chrysanthemum.

Rounkova (1989) observed maximum reduction in plant height and leaf area by 50 ppm spray of paclobutrazol in chrysanthemum. He reported that foliar application of paclobutrazol at 50 ppm had no influence on flowering in chrysanthemum cv. 'Jantar'.

Song *et al.* (1992) noted reduction in flowers per plant with application of paclobutrazol in *Chrysanthemum indicum*. They also reported that significant reduction in plant height by the application of 30 and 60 mg paclobutrazol /litre (2 ml / 1.5 litre pot) when sprayed at 0, 2 and 4 weeks after pinching.

The reduction in the diameter of flower with foliar spray of 30 and 60 ppm paclobutrazol at 0, 2 and 4 weeks after pinching in chrysanthemum cv. 'Bright Golden Anne' were observed by Gilbertz (1992).

Yewale *et al.* (1997) observed that increasing concentration of paclobutrazol (0-100 ppm) when sprayed at one month after planting significantly extended the number of days for initiation of flower bud and complete opening of flower in all four variety (Raja Beauty, Miss R. Thompson and Shetali) in chrysanthemum.

Yewale *et al.* (1998) also reported that foliar spray of paclobutrazol 75 and 100 ppm at one month after planting found most effective in reducing plant height.

Working on White Stafour and Bronze Mandial cultivars of chrysanthemum, Singh *et al.* (1999) noted significant reduction in plant height with increased the concentration of paclobutrazol (10, 20, 40 and 60 ppm). The root dip method was most effective in plant height reduction followed by soil drench application. He also stated that flowering was delayed by increasing the concentration of paclobutrazol.

Singh (2001) found that the soil drench of paclobutrazol in chrysanthemum cv. 'Local White' gave higher number of branches over the control and maximum yield. Also noted reduce in time to flower bud initiation, flower diameter and flower stalk length with reducing concentration of paclobutrazol (100, 75, 50 mg/l) as compared to control. He found that drenching at 100 ppm gave the maximum number of flowers.

Rose

Singh (2002) conducted an experiment on rose cv. 'Black Nigrett'. He reported that the plant height was reduced and days were decreased for flowering when plant treated with 150 ppm paclobutrazol after 25 days of pruning. He also noted that foliar application of 100 ppm paclobutrazol after 25 days of pruning gave more number of flowers, maximum flower diameter and weight of flowers per plant.

Singh and Bist (2003) conducted an experiment on rose cv. 'Gruss-an-Teplitz'. They reported that paclobutrazol 20 mg /plant

conspicuously reduced plant height and increased number of flowers per plant.

Jasmine

Swaminathan *et al.* (1999) found that maximum number of flowers and flower yield per plant was obtained with spray of paclobutrazol of 20 and 10 ppm after 25 days of pruning in *Jasminum sambac*.

Golden Rod

Patil *et al.* (2004) observed that application of growth substances had a significant effect on all the vegetative parameters such as plant height, number of leaves.. The minimum plant height obtained with the application of paclobutrazol 2000 ppm and number of leaves of per plant was higher with the paclobutrazol 500 ppm.

Crossandra

Sreekala *et al.* (2000) observed most effective in reducing plant height and spike length of crossandra when paclobutrazol 250 ppm and 500 ppm was applied as foliar spray.

Poinsettia

Mc Daniel (1986) revealed that the higher concentration of paclobutrazol 50 mg/l spray at 15 days after pinching delayed flowering and reduced the flower diameter in poinsettia.

Cosmos

Mohd Ahmad *et al.* (1988) observed decreased the plant height and produced more number of branches per plant as compared to control, also decrease flower diameter, significantly increased the number of flowers per plant with an application of paclobutrazol (15-

150 ppm) at 10 days after transplanting in cosmos. They observed that paclobutrazol at higher concentration (60-150 ppm) sprayed at 10 days after transplanting significantly increased flower yield per plant.

2.4 HAND PINCHING:

Marigold

Schrwat *et al.* (2003) reported minimum plant height, maximum number of flowers and flower yield by pinching after 30 days of transplanting in marigold. They also stated number of branches, number of days to first flower bud initiation, 50 per cent flowering and duration of flowering were increased significantly by pinching treatments in marigold cv. 'African Giant Double orange'.

Chauhan *et al.* (2005) observed when pinching carried out 30 days after transplanting significantly enhanced number of branches, flowers/plant, individual flower weight and flower yield/ sq.m in marigold cv. 'Pusa Narangi Gaiinda'.

Bhat and Shepherd (2007) observed increased plant height, plant spread, number of flowers and size of flowers by double pinching in marigold.

Chrysanthemum

Rakesh *et al.* (2005) noted maximum number of flower buds per plant and yield of flowers per plant in chrysanthemum cvs. Flirt and Gauri with pinched 35 days after transplanting, however maximum duration of flowering was recorded with pinched 45 days after transplanting.

Beniwal *et al.* (2005) observed the maximum number of flower when plants were pinched 25 days after transplanting in chrysanthemum.



*MATERIALS
AND
METHODS*

III. MATERIALS AND METHODS

The details of materials used, experimental method followed and the techniques adopted during the course of this investigation are given below:

3.1 Experimental site

The present investigation to study the "Growth and Flowering response of China aster (*Callistephus chinensis* L. Nees) cv. 'Phule Chinese Purple' to plant growth retardants" was carried out at the Floriculture Research Scheme, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari during the year 2009-2010.

3.2 Soil characteristics

As per seventh approximation, the soil of Navsari has been placed under the great group of vertic ustocherpts, Sub order cherpts and order inceptisols with Jalalpore series, which include deep, moderately drained clayey soil, which was classified earlier as "deep black soil". The soil was considered quite suitable for China aster crop under South Gujarat condition.

The physical and chemical properties of soils are presented in Table -3.1 and 3.2.

Table 3.1: Physical properties of the soil

Sr. No.	Particulars	Value in percent (0-30 cm depth)	Texture
1.	Coarse sand	0.69	-
2.	Fine sand	9.17	-
3.	Silt	24.94	Clay
4.	Clay	65.20	-

Table 3.2: Chemical properties of the soil

Sr. No.	Particulars	Values (0-30cm depth)	Methods employed
1.	pH(1:2.5 soil water ratio)	7.7	Backman's pH meter (Jackson, 1967)
2.	Total N (%)	0.052	Modified Kjeldahl's method (Jackson, 1967)
3.	Available N (kg / ha)	160.00	Alkaline permanganate method (Jackson, 1967)
4.	Available phosphorus (kg / ha)	40.02	Olsen's method (Olsen's <i>et al.</i> 1954)
5.	Available potash (kg / ha)	384.50	Flame Photometer (Jackson, 1967)

3.3 Location

Navsari Agricultural University, where this investigation was carried out is located at 20° 57' North latitude and 72°54' East longitude and has an altitude of about 10 meters above the mean sea level. This location is about 13 km away from seashore.

3.4 Climate and weather

The climate of this region is typically tropical characterized by fairly hot summer, moderately cold winter and humid and warm monsoon. In general, the monsoon sets during the second fortnight of June and ends by the second fortnight of September. Pre monsoon rains in the last week of May and or first week of June are most uncommon. Winter commences from October onwards and ends by the middle of February. The temperature falls down from the

beginning of November. December and January are the coldest months of the year.

The summer season commences from the middle of February and ends by the first week of June. April and May are the hottest months of the year. The mean weekly meteorological data on maximum and minimum temperatures, rainfall, relative humidity and sunshine hours during the course of investigation recorded at the meteorological observatory of the N. M. College of Agriculture, Navsari Agricultural University, Navsari are presented in Table - 3.3. Data indicated that the weather parameters were favourable for the China aster cultivation.

3.5 Plant material

The China aster cv. 'Phule Ganesh Purple' used in the present experiment.

3.6 Characteristics of cultivar

A semi-erect variety with sturdy stem, long flower stalks and bright purple flower suitable for artistic flora management and pasting works.

3.7 Experimental details

Experimental design : R.B.D. (Randomized block design)

Total area of plot : 22.6 m × 20.7 m

Gross plot size : 2.8 × 2.1 m

Net plot size : 2.0 × 1.5 m

Spacing : 30 x 40 cm

Number of treatments : 14

Number of replications: 3

Number of plots : 42

plant population	: 49 plants /plot
planting season	: <i>Kharif</i> – 2009

3.8 Treatment details

T ₁ : Maleic hydrazide	400	mg/l
T ₂ : Maleic hydrazide	600	mg/l
T ₃ : Maleic hydrazide	800	mg/l
T ₄ : Maleic hydrazide	1000	mg/l
T ₅ : Chlorocholine chloride	1.0	ml/l
T ₆ : Chlorocholine chloride	1.5	ml/l
T ₇ : Chlorocholine chloride	2.0	ml/l
T ₈ : Chlorocholine chloride	2.5	ml/l
T ₉ : PP ₃₃₃	0.5	ml/l
T ₁₀ : PP ₃₃₃	1.0	ml/l
T ₁₁ : PP ₃₃₃	1.5	ml/l
T ₁₂ : PP ₃₃₃	2.0	ml/l
T ₁₃ : Hand pinching (30 DAT)		
T ₁₄ : Absolute control.		

3.9 Cultivation practices

3.9.1 Land preparation

The experimental area was ploughed once with tractor drawn plough. Finally the land was worked with a cultivator to bring fine tilth to the soil.

3.9.2 Manures and fertilizers

Chemical fertilizers were applied in the form of urea, single super phosphate and murate of potash. Full dose of P, K (50 kg/ha) and half dose of N (50kg/ha) was given at the time of transplanting. The remaining half dose of N (50kg/ha) was given 30 days after transplanting. Fertilizer dose of 100:50:50 kg NPK/ha was applied to respective treatment in each of the plots in the experiment as basal dose.

3.9.3 Source of seed

Seeds of China aster cv. 'Phule Ganesh Purple' were obtained from Pune and seeds were sown on the raised nursery beds on last week of September, 2009.

3.9.4 Transplanting of seedlings

Uniform well developed and 25 days old seedlings of China aster cv. 'Phule Ganesh Purple' were selected and transplanted. Immediately after transplanting a light irrigation was given for better establishment of seedlings in the field.

3.9.5 Aftercares

Gap filling

Gap filling was done on 16th Oct 2009, i.e. 9th day after transplanting and plant population of each treatment plot was maintained.

Plant protection

No serious pest and diseases were observed on this crop during the crop period. Bavistin drenching of 0.1 per cent alternately at 15 days interval regularly taken for controlling fusarium wilt.

Irrigation

Depending upon the soil moisture condition and crop need the irrigation was given at 8 to 10 days interval.

Weeding

To keep the plot free from weed, weeding was done when required.

Harvesting

Fully opened flowers were harvested with stalk during morning hours and the observations were recorded immediately.

3.10 Application of plant growth retardants

At 15, 30 and 45 days of transplanting, the foliar application of different concentrations of Chlorocholine chloride, Maleic hydrazide and PP₃₃₃ were applied given to the experimental crop of China aster cv. 'Phule Ganesh Purple'.

3.10.1 Preparation of the solution

For all the treatments, the required quantity of material for making 1000 mg l⁻¹ solution was weighed separately. Maleic hydrazide was dissolved in a little quantity of 0.1N NaOH, whereas Chlorocholine chloride and PP₃₃₃ were directly dissolved in distilled water. Then the volumes were made up one liter each with distilled water. The required concentration of working solution made up one liter each with distilled water. The required concentration of working solution for field application of Chlorocholine chloride, Maleic hydrazide and PP₃₃₃ were made up by adding distilled water in 1000 ppm stock solution.

3.11 Collection of experimental data and sampling technique

Five plants in each plot were selected at randomly from the net plot of each treatment and tagged for recording the observations.

3.11.1 Observations recorded

Five plants from each treatment of replication were selected at randomly from the net plot and tagged for recording the observations.

(a) Growth parameters

Plant height (cm)

The plant height was recorded from the base of plant at ground level to the growing tip of the plant. This was recorded during the flowering with the help of meter scale and the average height of each plant was worked out in centimeters for statistical analysis.

No. of leaves per plant

The numbers of fully derived leaves of five selected plants from each treatment were counted during the flowering. The average numbers of leaves per plant was worked out.

Leaf area (cm²)

For estimation of leaf area, 10 fully grown leaves from tagged plants were taken and leaf area was measured with the help of digital leaf area meter, then average worked out.

(b) Flowering parameters

Days to first flower

This observation recorded by counting the day from the date of transplanting to first flower opening for each treatment.

No. of flowers per plant

Total number of flowers per plant (tagged plants) was recorded from the net plot and then average numbers of flowers per plant were calculated.

Stalk length (cm)

The length of the flower stalk was recorded when the flower was harvested. It was measured in cm from the base to the top of the flower stalk with the help of feet scale and the mean was worked out.

Diameter of flower (cm)

For measuring diameter, fully open flowers were taken from five selected plants. Flowers from each treatment were measured in centimeter by using vernier calipers and average value was calculated.

Weight of ten flowers (g)

The flowers, which were used for recording the diameter, were used to record the fresh weight. It was measured in gram by using precision balance and average weight of ten flowers was worked out.

(c) Yield components

Yield of flowers per plant (g):

From previously selected five plants, the fresh weight of the flowers per plant was recorded at each picking and later the average yield of flowers per plant was calculated in grams.

Yield of flowers per plot (kg) and per hectare (tonne):

The yield of flowers per net plot was calculated on the basis of fresh weight of harvested cut flowers from each plant of net plot and the average was calculated in kilograms. The yield of flowers per hectare (estimated) were calculated on the basis of total fresh weight of harvested cut flowers obtained from net plot.

(d) Quality parameters

Shelf life of flower (days)

The observation on shelf life of flower was recorded by counting the days from the date of flower opening till the flower

become no longer fit for utilization and average days were calculated.

Vase life of flower (days)

Five fully opened and well developed flowers were selected and then cut with sharp knife and were immediately put in 250 ml volumetric flasks containing distilled water after weighting. The days were calculated from the date of putting the flowers in the flask to the flowers totally withered.

3.12 Economics

In order to calculate the effectiveness of different treatments and to ascertain the most remunerative treatments, the expenses incurred on all cultural operations right from preparation of land to harvesting of the crop including cost of inputs, viz., seedlings, fertilizers, irrigation, labours, field preparation and growth retardants applied to each treatments were computed and added.

The gross realization was worked out on the basis of mean flower yield per hectare of each treatment and the prevailing market price. The Benefit Cost Ratio was calculated on the basis of the formula given below:

$$\text{BCR (Rs.)} = \frac{\text{Net Realization (Rs./ha)}}{\text{Total cost of cultivation (Rs./ha)}}$$

3.13 Statistical analysis

The data collected on different parameters were subjected to statistical analysis by using randomized block design. The method of analysis of variance for experiment, randomized block design was used. The treatment differences were tested by 'F' test of significance on the basis of null hypothesis. The standard error of mean (S.E.M.) was calculated in each case. The critical differences (C.D.) at 5% level of probability were worked out to compare the treatment effects were significant.



Plate-I : General view of experimental field



*EXPERIMENTAL
RESULTS*

IV. EXPERIMENTAL RESULTS

This chapter embodies the results of the present investigation on "Growth and flowering response of China aster (*Callistephus chinensis* L.Nees) cv. 'Phule Ganesh Purple' to plant growth retardants." was conducted at Floriculture Research Scheme, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari during the year 2009-10. The data collected during the investigation on various aspects were subjected to statistical analysis using Randomized Block Design. The result along with statistical inference is presented here.

4.1 Effect of growth retardants on vegetative growth parameters.

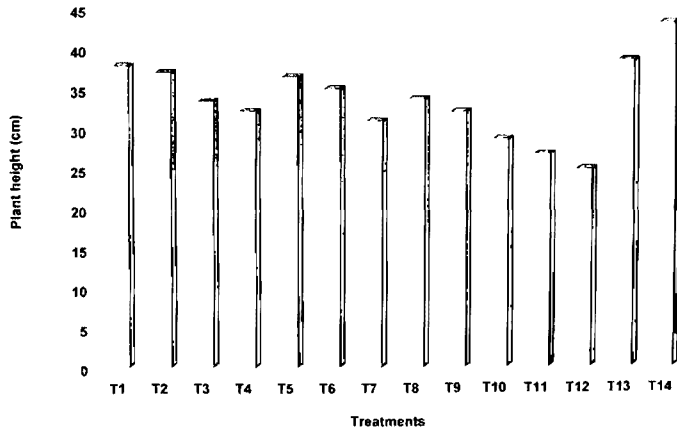
4.1.1 Plant height (cm):

The effect of growth retardants on plant height have been presented in Table-4.1 and graphically depicted in Figure-1 which is shown in Plate- II. From the data, it was found that there was significant difference in different treatments with respect to plant height. Significantly minimum plant height (25.2 cm) was recorded under treatment T_{12} (PP₃₃₃ 2.0 ml/l), which was at par with T_{11} (PP₃₃₃ 1.5 ml/l) being 27.1 cm, T_{10} (PP₃₃₃ 1.0 ml/l) being 28.9 cm and T_7 (Chlorocholine chloride 2.0 ml/l) being 31.1 cm. Whereas, a higher plant height (43.6 cm) was observed under treatment T_{14} (control), which was at par with treatment T_{13} (Hand pinching) being 38.9 cm and treatment T_1 (Maleic hydrazide 400 mg/l) being 37.9 cm.

Table- 4.1: Effect of growth retardants on plant height (cm) in China aster cv. 'Phule Ganesh Purple'.

Sr. No.	Treatment details	Plant height (cm)
1.	T ₁ - Maleic hydrazide 400 mg/l	37.9
2.	T ₂ - Maleic hydrazide 600 mg/l	37.1
3.	T ₃ - Maleic hydrazide 800 mg/l	33.5
4.	T ₄ - Maleic hydrazide 1000 mg/l	32.3
5.	T ₅ - Chlorocholine chloride 1.0 ml/l	36.6
6.	T ₆ - Chlorocholine chloride 1.5 ml/l	35.1
7.	T ₇ - Chlorocholine chloride 2.0 ml/l	31.1
8.	T ₈ - Chlorocholine chloride 2.5 ml/l	33.9
9.	T ₉ - PP ₃₃₃ 0.5 ml/l	32.3
10.	T ₁₀ -PP ₃₃₃ 1.0 ml/l	28.9
11.	T ₁₁ -PP ₃₃₃ 1.5 ml/l	27.1
12.	T ₁₂ -PP ₃₃₃ 2.0 ml/l	25.2
13.	T ₁₃ -Hand pinching (30 DAT)	38.9
14.	T ₁₄ -Control	43.6
	S.E.m. $\pm$	2.1
	C.D. at 5%	6.0
	C.V %	10.5

**Fig.-1 : Effect of growth retardants on plant height (cm) in China aster
Cv. 'Phule Ganesh Purple'**



T₁₀



T₁₃



T₁₂



Plate-II : Effect of growth retardants on plant height in China aster cv. 'Phule Ganesh Purple'.

4.1.2 Number of leaves per plant:

The data pertaining to the number of leaves per plant recorded and being presented in Table-4.2 and graphically shown in Figure-2.

The number of leaves per plant was significantly influenced with an application of plant growth retardants. Among all treatments, significantly maximum number of leaves per plant (37.3) was noted under treatment T_7 (Chlorocholine chloride 2.0 ml/l), which was at par with treatment T_3 (Chlorocholine chloride 2.5 ml/l) being 34.7. During the investigation, the minimum number of leaves per plant (20.8) was observed under treatment T_{12} (PP₃₃₃ 2.0 ml/l).

4.1.3 Leaf area (cm^2):

A reference to the data (Table-4.3 and figure-3) revealed that all treatments significantly increased or decreased leaf area as compare to control. Maximum leaf area (44.6 cm^2) was obtained in treatment T_7 (Chlorocholine chloride 2.0 ml/l) as compare to all other treatments and control (30.5 cm^2). While minimum leaf area (21.9 cm^2) was recorded in treatment T_{12} (PP₃₃₃ 2.0 ml/l).

4.2 Effect of growth retardants on flowering parameters

4.2.1 Days to first flower:

The data registered regarding the number of days required for emergence of first flower as influenced by different treatments was recorded and presented in Table-4.4 and also graphically shown in figure-4. The data revealed that there was significantly difference among all treatments in respect of number of days required for first flower emergence.

The early emergence of flower (46.1 days) was noted under treatment T_{12} (PP₃₃₃ 2.0 ml/l), which was at par with treatment T_7

Table- 4.2: Effect of growth retardants on number of leaves per plant in China aster cv. 'Phule Ganesh Purple'.

Sr. No.	Treatment details	No. of leaves per plant
1.	T ₁ - Maleic hydrazide 400 mg/l	23.6
2.	T ₂ - Maleic hydrazide 600 mg/l	25.8
3.	T ₃ - Maleic hydrazide 800 mg/l	28.9
4.	T ₄ - Maleic hydrazide 1000 mg/l	29.7
5.	T ₅ - Chlorocholine chloride 1.0 ml/l	26.9
6.	T ₆ - Chlorocholine chloride 1.5 ml/l	27.9
7.	T ₇ - Chlorocholine chloride 2.0 ml/l	37.3
8.	T ₈ - Chlorocholine chloride 2.5 ml/l	34.7
9.	T ₉ - PP ₃₃₃ 0.5 ml/l	25.5
10.	T ₁₀ -PP ₃₃₃ 1.0 ml/l	24.5
11.	T ₁₁ -PP ₃₃₃ 1.5 ml/l	21.7
12.	T ₁₂ - PP ₃₃₃ 2.0 ml/l	20.8
13.	T ₁₃ - Hand pinching (30 DAT)	25.4
14.	T ₁₄ - Control	21.9
	S.E.m. $\pm$	2.0
	C.D. at 5%	5.7
	C.V %	10.5

**Fig.-2 : Effect of growth retardants on number of leaves per plant in China aster
Cv. 'Phule Ganesh Purple'**

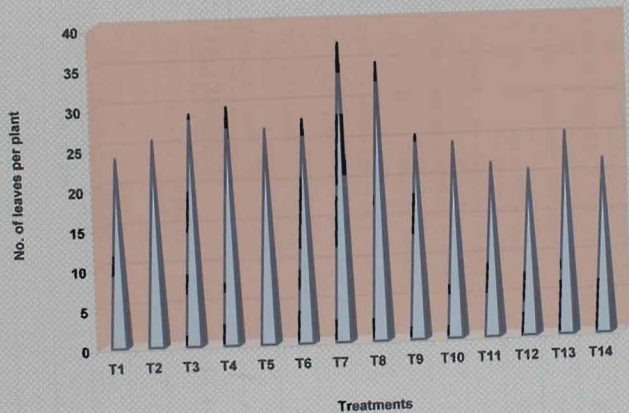


Table 4.3: Effect of growth retardants on leaf area in *China aster* cv. 'Phule Ganesh Purple'.

Sr. No.	Treatment details	Leaf area (cm ²)
1.	T ₁ - Maleic hydrazide 400 mg/l	25.5
2.	T ₂ - Maleic hydrazide 600 mg/l	39.7
3.	T ₃ - Maleic hydrazide 800 mg/l	35.2
4.	T ₄ - Maleic hydrazide 1000 mg/l	33.5
5.	T ₅ - Chlorocholine chloride 1.0 ml/l	31.0
6.	T ₆ - Chlorocholine chloride 1.5 ml/l	31.7
7.	T ₇ - Chlorocholine chloride 2.0 ml/l	44.0
8.	T ₈ - Chlorocholine chloride 2.5 ml/l	36.5
9.	T ₉ - PP ₃₃₃ 0.5 ml/l	33.2
10.	T ₁₀ -PP ₃₃₃ 1.0 ml/l	22.2
11.	T ₁₁ -PP ₃₃₃ 1.5 ml/l	24.7
12.	T ₁₂ - PP ₃₃₃ 2.0 ml/l	21.9
13.	T ₁₃ - Hand pinching (30 DAT)	32.9
14.	T ₁₄ - Control	36.5
	S.E.D. =	2
	C.V. at 5%	5.2
	C.V. at 1%	1

Fig. 3 : Effect of growth retardants on leaf area in *Calceolaria* cv. *Philo* against Purple

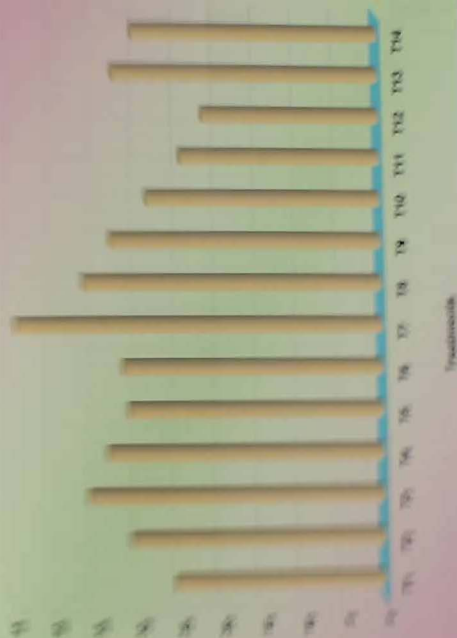
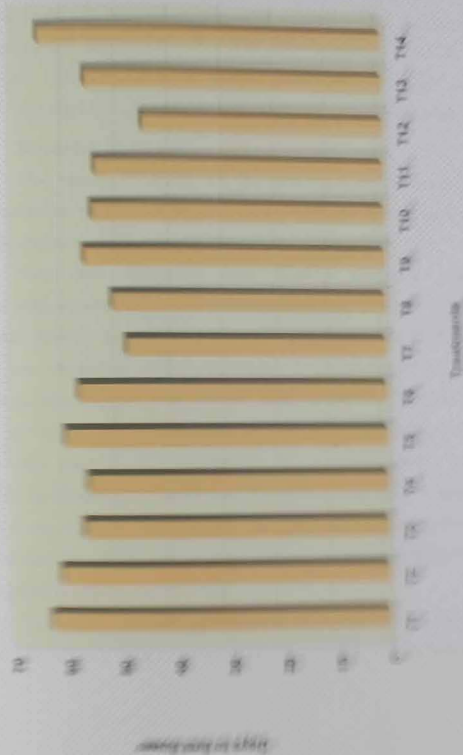


Table- 4.4: Effect of growth retardants on days to first flower in China aster cv. 'Phule Ganesh Purple'.

Sr. No.	Treatment details	Days to first flower
1.	T ₁ - Maleic hydrazide 400 mg/l	62.7
2.	T ₂ - Maleic hydrazide 600 mg/l	61.0
3.	T ₃ - Maleic hydrazide 800 mg/l	56.8
4.	T ₄ - Maleic hydrazide 1000 mg/l	56.1
5.	T ₅ - Chlorocholine chloride 1.0 ml/l	60.3
6.	T ₆ - Chlorocholine chloride 1.5 ml/l	57.9
7.	T ₇ - Chlorocholine chloride 2.0 ml/l	49.1
8.	T ₈ - Chlorocholine chloride 2.5 ml/l	51.7
9.	T ₉ - PP ₃₃₃ 0.5 ml/l	56.9
10.	T ₁₀ -PP ₃₃₃ 1.0 ml/l	55.5
11.	T ₁₁ -PP ₃₃₃ 1.5 ml/l	54.9
12.	T ₁₂ - PP ₃₃₃ 2.0 ml/l	46.1
13.	T ₁₃ - Hand pinching (30 DAT)	56.8
14	T ₁₄ - Control	65.6
	S.Em. $\pm$	3.2
	C.D. at 5%	9.3
	C.V %	9.8

Fig. 4 : Effect of growth retardants on days to first flower in China aster Cv. 'Phule Ganesh Purple'



(Chlorocholine chloride 2.0 ml/l) being 49.1. The maximum days required for emergence of flower (65.6 days) was observed under control. Treatment T_{13} , T_6 , T_8 , T_5 , T_2 , and T_1 were at par with each other. The observation indicate that PP333 2.0 ml/l caused early flowering, while hand pinching (30 DAT), PP333 0.5 ml/l, Chlorocholine chloride 1.5 ml/l, Chlorocholine chloride 1.0 ml/l, Maleic hydrazide 600 mg/l and Maleic hydrazide 400 mg/l delayed flowering in China aster along with control.

4.2.2 Diameter of flower:

The result obtained on the response of different levels of growth retardants on flowering size have been presented in Table A-5, graphically depicted in figure-5 which is shown in plate- IV.

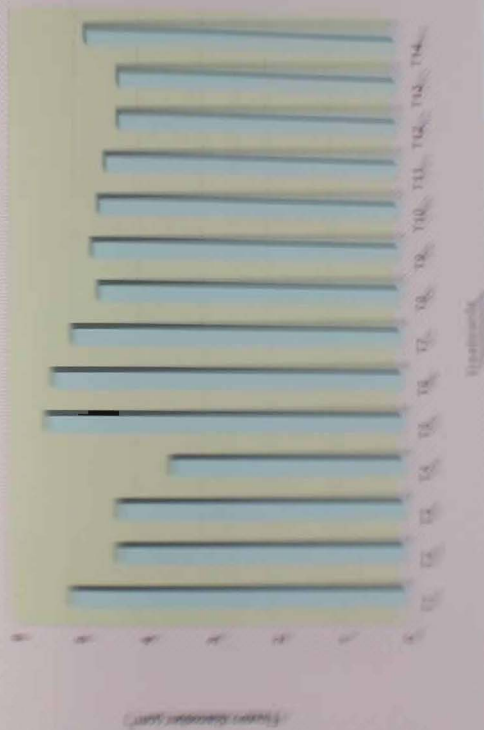
The data indicated that flower diameter significantly influenced with an application of different concentration of Chlorocholine chloride and Maleic hydrazide 400 mg/l. The maximum flower diameter 5.5 cm was recorded under treatment T_2 (Chlorocholine chloride 0.5 ml/l), which was statistically at par with treatment T_3 (Chlorocholine chloride 1.5 ml/l), T_7 (Chlorocholine chloride 2.0 ml/l), T_4 (Maleic hydrazide 400 Mg/L), T_{12} (Control), T_5 (PP333 0.5 ml/l), T_8 (Chlorocholine chloride 2.5 ml/l), and T_{10} (PP333 1.0 ml/l) being 5.4 cm, 5.0 cm, 5.0 cm, 4.5 cm, 4.8 cm, 4.7 cm, and 4.7 cm respectively, while minimum diameter of flower was observed under treatment T_1 (Maleic hydrazide 1000 mg/l) being 3.1 cm.

The above observation from the observation on the treatment of Maleic hydrazide a higher concentration reduced the flower size.

Table- 4.5: Effect of growth retardants on flower diameter in China aster cv. 'Phule Ganesh Purple'.

Sr. No.	Treatment details	Flower diameter (cm ²)
1.	T ₁ - Maleic hydrazide 400 mg/l	5.1
2.	T ₂ - Maleic hydrazide 600 mg/l	4.4
3.	T ₃ - Maleic hydrazide 800 mg/l	4.4
4.	T ₄ - Maleic hydrazide 1000 mg/l	3.6
5.	T ₅ - Chlorocholine chloride 1.0 ml/l	5.5
6.	T ₆ - Chlorocholine chloride 1.5 ml/l	5.4
7.	T ₇ - Chlorocholine chloride 2.0 ml/l	5.1
8.	T ₈ - Chlorocholine chloride 2.5 ml/l	4.7
9.	T ₉ - PP ₃₃₃ 0.5 ml/l	4.8
10.	T ₁₀ -PP ₃₃₃ 1.0 ml/l	4.7
11.	T ₁₁ -PP ₃₃₃ 1.5 ml/l	4.6
12.	T ₁₂ - PP ₃₃₃ 2.0 ml/l	4.4
13.	T ₁₃ - Hand pinching (30 DAT)	4.4
14.	T ₁₄ - Control	4.9
	S.E.m. $\pm$	0.3
	C.D. at 5%	0.8
	C.V %	9.5

Fig. 8 | Effect of growth retardants on flower diameter in China aster Cv. 'Phule Ganesh Purple'



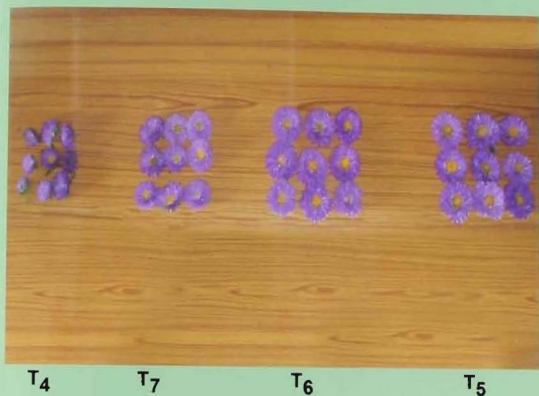


Plate-IV : Effect of growth retardants on flower diameter in China aster cv. 'Phule Ganesh Purple'.

4.2.3 Flower stalk length (cm):

The perusal of data presented in Table- 4.6, figure- 6 and plate-V showed that after the application of growth retardants, the difference among the various treatments in respect to length of flower stalk was observed.

Looking to the data among all the treatments, longest flower stalk (13.6) was obtained in treatment T_7 (Chlorocholine chloride 2.0 ml/l), which was at par with treatment T_6 (Chlorocholine chloride 1.5 ml/l) being 13.0 cm, whereas lowest stalk length 8.0 cm was recorded in treatment T_4 (Maleic hydrazide 1000 mg/l).

Therefore, it is clear from the observations that treatment T_1 to T_5 , T_8 to T_{13} reduced the flower stalk length.

4.2.4 Number of flowers/plant:

The data presented in Table-4.7 and graphically depicted in Figure-7 revealed that number of flowers per plant was significantly affected with the application of different growth retardants (Plate-III).

The data revealed that significantly higher number of flowers per plant (49.7) was recorded in treatment T_7 (Chlorocholine chloride 2.0 ml/l), which was statistically at par with treatment T_8 (Chlorocholine chloride 2.5 ml/l) being 45.7, whereas minimum numbers of flowers per plant was recorded in treatment T_{12} (PP₃₃₃ 2.0 ml/l) being 23.7.

4.3 Effect of growth regulators on yield parameters

4.3.1 Weight of ten flowers (g):

The data pertaining to weight of ten flowers in China aster as influenced by different treatments were recorded and are presented in Table-4.8 and also graphically illustrated in Figure-8.

Fig.-6 : Effect of growth retardants on flower stalk length in China aster Cv. 'Phule Ganesh Purple'

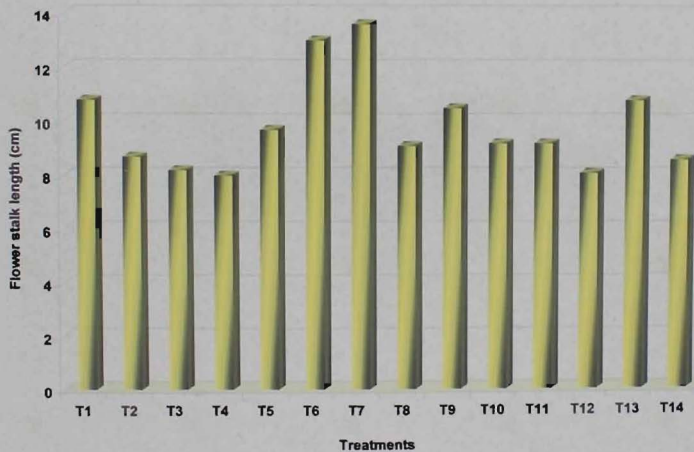


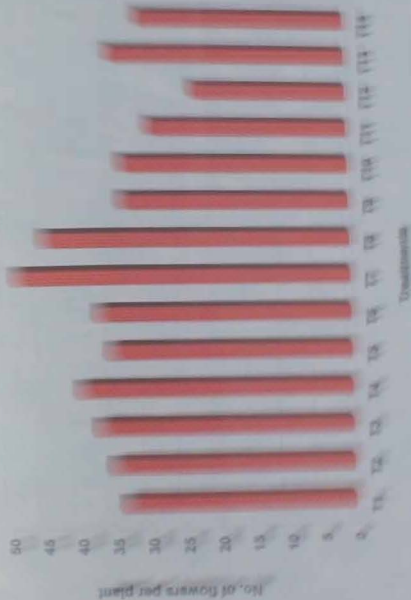


**Plate-V : Effect of growth retardants on flower stalk length in China aster
cv. 'Phule Ganesh Purple'.**

Table- 4.7: Effect of growth retardants on number of flowers per plant in China aster cv. 'Phule Ganesh Purple'.

Sr. No.	Treatment details	No. of flowers per plant
1.	T ₁ - Maleic hydrazide 400 mg/l	34.0
2.	T ₂ - Maleic hydrazide 600 mg/l	35.7
3.	T ₃ - Maleic hydrazide 800 mg/l	37.7
4.	T ₄ - Maleic hydrazide 1000 mg/l	40.3
5.	T ₅ - Chlorocholine chloride 1.0 ml/l	36.0
6.	T ₆ - Chlorocholine chloride 1.5 ml/l	37.7
7.	T ₇ - Chlorocholine chloride 2.0 ml/l	49.7
8.	T ₈ - Chlorocholine chloride 2.5 ml/l	45.7
9.	T ₉ - PP ₃₃₃ 0.5 ml/l	34.3
10.	T ₁₀ -PP ₃₃₃ 1.0 ml/l	34.3
11.	T ₁₁ -PP ₃₃₃ 1.5 ml/l	30.3
12.	T ₁₂ - PP ₃₃₃ 2.0 ml/l	23.7
13.	T ₁₃ - Hand pinching (30 DAT)	36.0
14.	T ₁₄ - Control	31.7
	S.Em. $\pm$	2.7
	C.D. at 5%	7.8
	C.V %	12.8

Fig.-7 : Effect of growth retardants on number of flowers per plant in *Gemsh Purple*



T₇



T₈



T₁₂

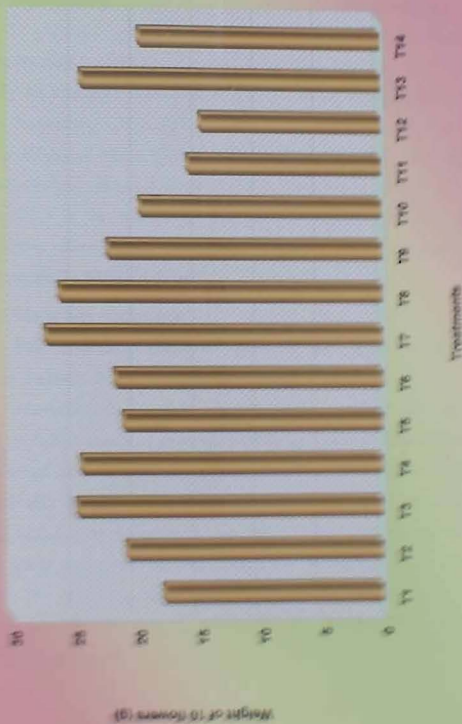


Plate-III : Effect of growth retardants on flowering in China aster cv. 'Phule Ganesh Purple'.

Table- 4.8: Effect of growth retardants on weight of ten flowers in China aster cv. 'Phule Ganesh Purple'.

Sr. No.	Treatment details	Weight of ten flowers(g)
1.	T ₁ - Maleic hydrazide 400 mg/l	17.7
2.	T ₂ - Maleic hydrazide 600 mg/l	20.7
3.	T ₃ - Maleic hydrazide 800 mg/l	24.7
4.	T ₄ - Maleic hydrazide 1000 mg/l	24.4
5.	T ₅ - Chlorocholine chloride 1.0 ml/l	21.0
6.	T ₆ - Chlorocholine chloride 1.5 ml/l	21.7
7.	T ₇ - Chlorocholine chloride 2.0 ml/l	27.3
8.	T ₈ - Chlorocholine chloride 2.5 ml/l	26.2
9.	T ₉ - PP ₃₃₃ 0.5 ml/l	22.3
10.	T ₁₀ -PP ₃₃₃ 1.0 ml/l	19.7
11.	T ₁₁ -PP ₃₃₃ 1.5 ml/l	15.8
12.	T ₁₂ - PP ₃₃₃ 2.0 ml/l	14.8
13.	T ₁₃ - Hand pinching (30 DAT)	24.5
14.	T ₁₄ - Control	19.8
	S.Em. $\pm$	1.3
	C.D. at 5%	3.8
	C.V %	10.53

Fig. 8 : Effect of growth retardants on weight of ten flowers in China aster Cv. 'Phule Ganesh Purple'



The data revealed that various treatments significantly influence the weight of ten flowers. Among various treatments, maximum flower weight (27.3 g) was noted in T₇ (Chlorocholine chloride 2.0 ml/l), which was statistically at par with treatment T₈ (Chlorocholine chloride 2.5 ml/l), T₃ (Maleic hydrazide 800 mg/l), T₁₃ (Hand pinching) and T₄ (Maleic hydrazide 1000 mg/l) being 26.2 g, 24.7 g, 24.5 g, 24.4 g respectively as compare to control. While flower weight was reduced in T₁ (Maleic hydrazide 400 mg/l) being (17.7), T₁₀ (PP₃₃₃ 1.0 ml/l) being 19.7 g, T₁₁ (PP₃₃₃ 1.5 ml/l) being 15.8 g and in T₁₂ (PP₃₃₃ 2.0 ml/l) being 14.8 g than control. In rest of treatments, the flower weight varied from 20.7 g to 22.3 g in treatments T₂ (Maleic hydrazide 800 mg/l), T₅ (Chlorocholine chloride 1.0 ml/l), T₆ (Chlorocholine chloride 1.5 ml/l) and in treatment T₉ (PP₃₃₃ 1.0 ml/l).

4.3.2 Yield per plant (g):

The recorded yield of flowers per plant of China aster presented in Table-4.9 and depicted graphically in Figure-9.

Flowers yield was significantly influenced by various treatments of foliar spray of growth retardants. Higher flower yield (132.1 g) was obtained in treatment T₇ (Chlorocholine chloride 2.0 ml/l), which was statistically at par with treatment T₈ (Chlorocholine chloride 2.5 ml/l) being 122.6 g as compare to control (53.0 g). In rest of treatments, the flower yield per plant ranged from 54.0 g in T₁₂ (PP₃₃₃ 2.0 ml/l) to 104.2 g in T₃ (Maleic hydrazide 800 mg/l). Indications from the observations are that T₇ and T₈ treatment are better for influencing the flower yield per plant of China aster.

Table- 4.9: Effect of growth retardants on flower yield per plant (g) in China aster cv. 'Phule Ganesh Purple'.

Sr. No.	Treatment details	Yield per plant (g)
1.	T ₁ - Maleic hydrazide 400 mg/l	57.7
2.	T ₂ - Maleic hydrazide 600 mg/l	69.8
3.	T ₃ - Maleic hydrazide 800 mg/l	104.2
4.	T ₄ - Maleic hydrazide 1000 mg/l	88.5
5.	T ₅ - Chlorocholine chloride 1.0 ml/l	70.2
6.	T ₆ - Chlorocholine chloride 1.5 ml/l	76.3
7.	T ₇ - Chlorocholine chloride 2.0 ml/l	132.1 ✓
8.	T ₈ - Chlorocholine chloride 2.5 ml/l	122.6
9.	T ₉ - PP ₃₃₃ 0.5 ml/l	79.6
10.	T ₁₀ -PP ₃₃₃ 1.0 ml/l	59.8
11.	T ₁₁ -PP ₃₃₃ 1.5 ml/l	54.2
12.	T ₁₂ - PP ₃₃₃ 2.0 ml/l	53.0
13.	T ₁₃ - Hand pinching (30 DAT)	81.4
14.	T ₁₄ - Control	54.0
	S.E.m. $\pm$	4.2
	C.D. at 5%	12.2
	C.V %	9.3

Fig.-9 : Effect of growth retardants on flower yield per plant (g) in China aster Cv. 'Phule Ganesh Purple'

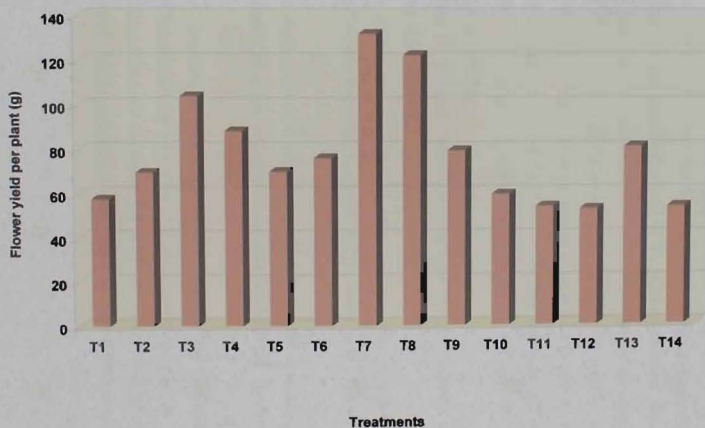


Fig.-10 : Effect of growth retardants on yield of flower per plot and per hectare in China aster Cv. 'Phule Ganesh Purple'

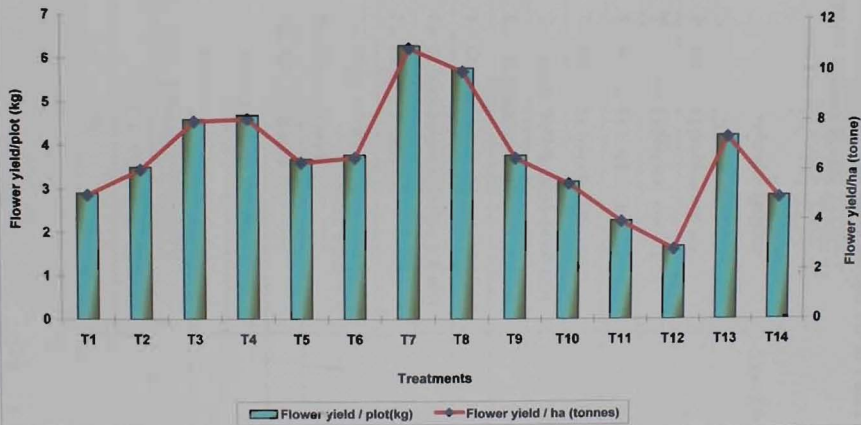


Table- 4.11: Effect of growth retardants on vase life of China aster cv. 'Phule Ganesh Purple'.

Sr. No.	Treatment details	Vase life (Days)
1.	T ₁ - Maleic hydrazide 400 mg/l	7
2.	T ₂ - Maleic hydrazide 600 mg/l	7.3
3.	T ₃ - Maleic hydrazide 800 mg/l	9.0
4.	T ₄ - Maleic hydrazide 1000 mg/l	8.7
5.	T ₅ - Chlorocholine chloride 1.0 ml/l	7.0
6.	T ₆ - Chlorocholine chloride 1.5 ml/l	7.7
7.	T ₇ - Chlorocholine chloride 2.0 ml/l	10.7 ✓
8.	T ₈ - Chlorocholine chloride 2.5 ml/l	9.3
9.	T ₉ - PP ₃₃₃ 0.5 ml/l	6.7
10.	T ₁₀ -PP ₃₃₃ 1.0 ml/l	7.3
11.	T ₁₁ -PP ₃₃₃ 1.5 ml/l	7.7
12.	T ₁₂ - PP ₃₃₃ 2.0 ml/l	8.3
13.	T ₁₃ - Hand pinching (30 DAT)	6
14.	T ₁₄ - Control	10.3
	S.Em. $\pm$	0.5
	C.D. at 5%	1.4
	C.V %	10.2

Fig.-11 : Effect of growth retardants on vase life of China aster Cv. 'Phule Ganesh Purple'

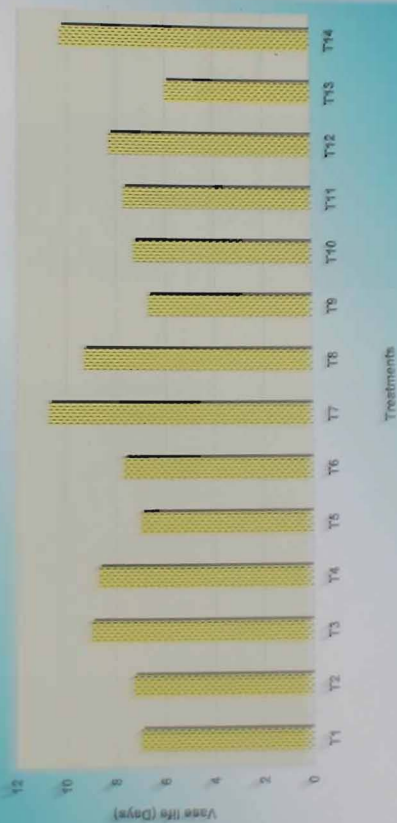


Plate-VII : Effect of growth retardants on vase life of China aster cv. 'Phule Ganesh Purple'.



T₁₃

T₁₄

T₇



Plate-VII : Effect of growth retardants on vase life of China aster cv. 'Phule Ganesh Purple'.

4.4.2 Shelf life of flower (days):

The data pertaining to shelf life of flower on plant itself are presented in Table - 4.12 and graphically depicted in Fig-12.

It is apparent from the data (Table - 4.13) the shelf life of the flower was significantly influenced by different growth retardants. The maximum (19.7 days) shelf life of the flower was observed in treatment T₇ (Chlorocholine chloride 2.0 ml/l) which was at par with treatment T₈ (Chlorocholine chloride 1.5 ml/l), T₁₃ (Hand pinching), T₂ (Maleic hydrazide 600 mg/l), T₄ (Maleic hydrazide 1000 mg/l), T₃ (Maleic hydrazide 800 mg/l), T₁₂ (PP₃₃₃ 1.5 ml/l), T₆ (Chlorocholine chloride 1.5 ml/l) and T₁₁ (PP₃₃₃ 1.5 ml/l) being 18.7, 18.7, 18.3, 18.0, 17.7, 17.7, 17.3, 17.3 days respectively. While the minimum shelf life of flower (14.0 days) was observed with control.

4.4 Economics

After the determining the effects of different on the flower yield of China aster, it was thought worthy to work their worthy to work out their economics in terms of net return and benefit cost ratio (BCR). These calculations have been presented in Table- 4.13 and graphically depicted in Fig-13. For these average gross realizations from average yield of flowers per hectare for each treatment was calculated considering the prevailing market price.

The data indicated that treatment T₇ gave a highest net return with highest benefit cost ratio followed by treatment T₈. Thus, investment of every rupee spent resulted in addition benefit Rs. 1,77,701 under treatment T₇.

Table- 4.12: Effect of growth retardants on shelf life (Days) of flowers in China aster cv. 'Phule Ganesh Purple'.

Sr. No.	Treatment details	Shelf life (days)
1.	T ₁ - Maleic hydrazide 400 mg/l	15.7
2.	T ₂ - Maleic hydrazide 600 mg/l	17.3
3.	T ₃ - Maleic hydrazide 800 mg/l	18.0
4.	T ₄ - Maleic hydrazide 1000 mg/l	18.3
5.	T ₅ - Chlorocholine chloride 1.0 ml/l	15.7
6.	T ₆ - Chlorocholine chloride 1.5 ml/l	17.7
7.	T ₇ - Chlorocholine chloride 2.0 ml/l	19.7
8.	T ₈ - Chlorocholine chloride 2.5 ml/l	18.7
9.	T ₉ - PP ₃₃₃ 0.5 ml/l	15.0
10.	T ₁₀ -PP ₃₃₃ 1.0 ml/l	15.7
11.	T ₁₁ -PP ₃₃₃ 1.5 ml/l	17.3
12.	T ₁₂ - PP ₃₃₃ 2.0 ml/l	17.7
13.	T ₁₃ - Hand pinching (30 DAT)	18.7
14.	T ₁₄ - Control	14.0
	S.Em. $\pm$	0.8
	C.D. at 5%	2.4
	C.V %	8.2

Fig.-12 : Effect of growth retardants on shelf life (Days) of flowers in China aster Cv. 'Phule Ganesh Purple'

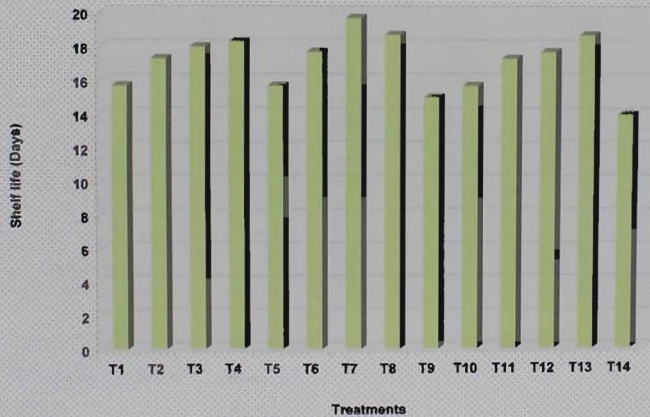




Plate-VI: General View of flowering plot



DISCUSSION

V. DISCUSSION

The present study on "Growth and flowering response of China aster (*Callistephus chinensis* L. Nees) cv. 'Phule Ganesh Purple' to plant growth retardants." was carried out during kharif in the year 2009-2010. The effect of plant growth retardants was recorded and the results obtained are discussed in this chapter. The attempt in this chapter is to assign the reasons for the changes affected in this chapter in growth attributes, flowering, quality parameters and yield due to imposition of different treatments and to substantiate these with the findings of earlier workers from the literature in order to understand the effect of cause relationship.

5.1 Effect on growth parameters

5.1.1 Plant height

A steady decrease in plant height was recorded due to increased concentration of growth retardants. The different growth retardants have successfully reduced the plant height significantly when compare to control. Among all the growth retardants the highest reduction in plant height at various concentration of PP₃₃₃. Significantly highest reduction in plant height with PP₃₃₃ 2.0 ml/l. Reduction in plant height due to inhibitory roll of growth retardants on cell division and cell elongation of apical meristematic cells and also gibberellins biosynthesis and reduction in gibberellins level. Due to antiauxin activity disturbed carbohydrate metabolism and inhibition of cell division and elongation of apical meristem might contribute to growth reduction in plants treated with Chlorocholine chloride. Reduced plant height due to Chlorocholine chloride treatment was reported earlier by Gowda and Jayanthi (1991), Singh and Rathore (1992), Yadav (1997), Khandelval et al. (2003), and Sunitha et al.

(2007) in African marigold; Khimani *et al.* (1994) and Makwana (1999) in gaillardia.

5.1.2 Number of leaves

It is apparent from the data in Table – 4.2 that all the growth retardants application influenced the number of leaves per plant. Maximum number of leaves per plant (37.3) was recorded under spraying of Chlorocholine chloride at 2.0 ml/l and minimum in PP333 2.0ml/l (20.8).

Production of more number of leaves due to Chlorocholine chloride concentration might be due to increased in vegetative growth, more transportation and utilization of the photosynthetic production. Thus, the number of leaves per plant since to have been increased. Similar findings were reported by Aswath *et al.* (1994) in China aster and Patil *et al.* (2004) in golden rod, Singh (2004) in rose.

5.1.3 Leaf area (cm²)

The leaf area is an important attribute as it has direct relevance with interception of light and photosynthesis and ultimately with overall growth and development. In current investigation the leaf area was significantly influenced by foliar application of growth retardants.

The data on effect of different plant growth retardants on leaf area are given in Table-4.3 in present investigation, Chlorocholine chloride 2.0 ml/l was found significantly increasing maximum leaf area (44.6 cm²). It might be due to emergence and exploitation of leaves pivotal of overall growth and development in plant and also due to inhibition of gibberellins synthesis, which stimulates minimum leaf expansion. Similar result also reported by Sreekala *et al.* (2000) in *Crossandra*. Khan and Tewari (2003) in *Dahlia*.

5.2 Flowering parameters

5.2.1 Days to first flower

Days required for first flower initiation recorded significantly minimum in Chlorocholine chloride 2.0 ml/l treatment (T_7) treated plants. This might be due to the fact that the reserve food material can be utilized for reproductive purpose with restriction on vegetative growth due to gibberellins action of Chlorocholine chloride (Joshi and Reddy, 2006) in China aster.

5.2.2 Flower diameter:

Maximum diameter of flower observed Caused by drawing photosynthates to the flower as a consequence of intensification of the sink and active cell elongation in flower. The application of Chlorocholine chloride 1.0 ml/l (T_5) was recorded maximum flower diameter. The increased in flower diameter by Chlorocholine chloride application might be due to the reduction in stem length, increased in number of branches and increased in plant spread which might have resulted in increased photosynthetic activity of treated plants (Yadav, 1997). These results are in agreement with results obtained by Gowda and Jayanthi (1991), Khandelval *et al.* (2003) and Mishra and Pandey (2006) in African marigold; Makwana (1999) in gaillardia; Katkar *et al* (2005).

5.2.3 No. of flowers per plant:

The results of the present investigation indicated that number of flowers per plant was recorded maximum under treatment T_7 (Chlorocholine chloride 2.0 ml/l). It might be due to accumulated more carbohydrates through photosynthesis and were directly used for increasing number of branches and hence production more number of flowers. These results are in agreement with results obtained by

Khimani *et al.* (1994) in *gaillardia* and Joshi and Reddy (2006) in *China aster*. It might be also due to increasing the length of floret and pedicles accompanied by increasing number of petals.

The data clearly showed that the Chlorocholine chloride 2.0 ml/l (T_7) significantly increased the number of flowers per plant. Increased in number of flowers with Chlorocholine chloride might be due to increased in mobilization of biomass to flowers from source (Joshi and Reddy, 2006). The similar results obtained by Parmar and Singh (1983), Singh and Rathore (1992), Yadav (1997), Khandelval *et al.* (2003) and Mishra and Pandey (2006) in *African marigold*; Sen and Maharana (1971), Dutta *et al.* (1993) and Talukdar and Paswan (1997) in *chrysanthemum*; Khimani *et al.* (1994) and Makwana (1999) in *gaillardia*; Bhattacharjee (1984) in *dahlia*.

5.3 Yield parameters

5.3.1 Weight of ten flowers (g):

The application of Chlorocholine chloride 2.0 ml/l (T_7) significantly increased weight of ten flowers due to the food material produced by the plants, used for nourishment of larger flower resulted increased in weight of ten flower.

5.3.2 Flowers per plant (g):

Increased in flower weight might be due to bigger sized flower. The application of Chlorocholine chloride 2.0 ml/l (T_7) was recorded maximum flower weight of *China aster* cv. 'Phule Ganesh Purple'. The increased in weight of flower by Chlorocholine chloride application might be due to the reduction in stem length and increased in number of branches and increased in plant spread which might have resulted in increased photosynthetic activity of treated plants. These results are in agreement with results obtained by Khandelval *et al.*

(2003) and Mishra and Pandey (2006) in African marigold; Makwana (1999) in *gailardia*.

5.3.3 Yield per plot (kg) and yield per hectare (Tonne):

It is apparent from the results that foliar spray of Chlorocholine chloride 2.0 ml/l (T_7) significantly increased flower yield per net plot and per hectare. The increased flower yield might be due to growth suppressing effect on plant height thereby ceasing the terminal growth and utilizing the available auxin for the formation of flowers (Yadav, 1997). The increased in flower yield might be attributed to the development of large number auxiliary shoots as a results of cessation of terminal growth (Gowda and Jayanthi, 1991). Also the more number of branches and maximum plant spread in this treatment had accumulated more carbohydrates through photosynthesis and were directly used for increasing flower weight, number of flowers and flower diameter which ultimately increased the flower yield. These results are also corroborative with the findings of Parmar and Singh (1983), Khandelval *et al.* (2003), Mishra and Pandey (2006) and Sunitha *et al.* (2007) in African marigold.

5.4 Quality parameters

5.4.1 Vase life:

Application of Chlorocholine chloride 2.0 ml/l (T_7) increased vase life might be due to reduced physiological weight loss and more water uptake by flowers. Restricted respiration due to inhibitory action of retardant might have increased the vase life. Similar findings were also obtained by Makwana (1999) in *gaillardia*, Dutta *et al.* (1993) and Talukdar and Paswan (1997) in *chrysanthemum*.

5.4.2 Shelf life of flower:

The plant treated with foliar application of Chlorocholine chloride 2.0 ml/l (T₇) significantly increased the shelf life of flower. Increased in longevity of flower might be due to maintaining the leaves of chlorophyll, protein and RNA content leaves at a higher level for a longer duration suppress the senescence (Kar *et al.* 1989). These findings were in accordance with the results obtained by Joshi and Reddy (2006) in China aster and Khandelval *et al.* (2003) in African marigold.

5.5 Economics:

Economics indicated that the plant sprayed at 15 days after transplanting with Chlorocholine chloride 2.0 ml/l (T₇) was found most remunerative as it gave the highest net return (Rs.1,77,701) with maximum benefit cost ratio (2.98).



*SUMMARY
AND
CONCLUSION*

VI. SUMMARY AND CONCLUSION

The present investigation on "Growth and flowering response of China aster (*Callistephus chinensis* L.Nees) cv. 'Phule Ganesh Purple' to plant growth retardants." was conducted at Floriculture Research Scheme, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari during the year 2009-10.

The foliar application of Maleic hydrazide (400 mg/l, 600 mg/l, 800 mg/l, 1000 mg/l), Chlorocholine chloride (1.0 ml/l, 1.5 ml/l, 2.0 ml/l, 2.5ml/l) PP₃₃₃ (0.5 ml/l, 1.0ml/l, 1.5 ml/l, 2.0 ml/l) after 15, 30 and 45 days after transplanting and hand pinching (30 DAT) was done. The experiment was laid out in randomized block design (RBD) with fourteen treatments including control.

The salient features of the results obtained are being summarized below:

- The foliar spray of PP₃₃₃ 2.0 ml/l significantly reduced height (25.2cm) which was at par with Chlorocholine chloride 2.0 ml/l (31.1), whereas highest plant height (43.6 cm) obtained in control.
- Among various treatments, significantly the maximum number of leaves per plant (37.3) was obtained with an application of Chlorocholine chloride 2.0 ml/l, while minimum (21.9) was obtained with PP₃₃₃ 2.0 ml/l.
- An application of Chlorocholine chloride 2.0 ml/l improved leaf area (44.6 cm²) as compare to other treatments and control (30.5).

- The foliar spray of PP₃₃₃ at 2.0 ml/l took significantly minimum days for emergence of first flower (46.1 days) as compare to other treatments and control (65.6 days).
- Minimum flower diameter (3.6 cm) was obtained with foliar spray of Maleic hydrazide 1000 mg/l, while maximum flower diameter (5.5 cm) was registered with an application of Chlorocholine chloridel.0 ml/l as well as in control (4.9 cm).
- Longest flower stalk (13.6 cm) was noted with an application of Chlorocholine chloride 2.0 ml/l, while minimum flower stalk length was recorded with Maleic hydrazide 1000 mg/l (8.0 cm).
- The maximum number of flowers per plant (49.7) was recorded with an application of Chlorocholine chloride 2.0 ml/l (14.8 g), whereas minimum number of flowers per plant (23.7) was obtained with PP₃₃₃ 2.0 ml/l.
- The maximum fresh weight of ten flowers (27.3 g) was recorded by the application of Chlorocholine chloride 2.0 ml/l over control (19.8 g), while minimum fresh weight of ten flowers was noted with PP₃₃₃ 2.0 ml/l (14.8 g).
- Significantly higher flower yield per plant (132.1 g), per plot (6.3 kg) and per hectare (10.7 tonne) was recorded with an application of Chlorocholine chloride 2.0 ml/l, whereas minimum flower yield was obtained with an application of PP₃₃₃ 2.0 ml/l per plant (53.0 g), per plot (1.7 kg) and per hectare (2.8 tonne) respectively.
- The Longest vase life was recorded with application of Chlorocholine chloride 2.0 ml/l (10.7days), while minimum was recorded with hand pinching (6.0 days).

- The shelf life of flowers was significantly increased with foliar application of Chlorocholine chloride 2.0 ml/l as compare to control (14 days).

CONCLUSION

On the basis of present investigation, it can be concluded that foliar application of Chlorocholine chloride 2.0 ml/l on China aster plant has been proved to be the best for obtaining dwarf plants and also best for vegetative growth. Likewise floral and yield parameters also found superior with this treatment. The shelf life as well as vase life of China aster flower also influence by this treatment. From economic point of view foliar application of Chlorocholine chloride 2.0 ml/l gave maximum B. C. R.(2.98).



REFERENCES

REFERENCES

- Anburani, A. and Vijay Ananth, A. (2008). Effect of growth retardants on growth and yield in nerium (*Nerium odorum*). cv. 'Red Single'. *J. Ornam. Hort.*, **11**(4): 298-301.
- Aswath, S.; Narayana Gowda, J. V. and Anand Murthy, G. M. (1994). Effect of growth retardants on growth, flowering and flower quality of China aster (*Callistephus chinensis* L. Ness) cv. 'Powder puff mixed'. *J. Ornam. Hort.*, **2**(1-2): 9-13.
- Barett, J. E. and Nell, T. A. (1989). Comparison of paclobutrazol and unicondazole on floriculture crops. *Acta Hort.*, **251**: 275-280.
- Beniwal, B. S.; Ahlawat, V. P.; Rakesh, and Dahiya, S. S. (2005). Effect of spacing and pinching on flower production of chrysanthemum cv. Flirt. *Haryana J. Horti. Sci.*, **34** (1-2): 97-98.
- Bhat, Z. A. and Shepherd, H. (2007). Effect of pinching on growth, flowering, seed yield and quality traits in African marigold (*Tagets erecta* Linn.). *J. Ornam. Hort.*, **10** (3):197-198.
- Bhattacharjee, S .K. (1984). Effect of growth regulating chemicals on growth, flowering and tuberous root formation of (*Dahlia variabilis* Desf.) cv. 'Kelvin Rose'. *Punjab Hort. J.*, **24**(1/4):138-144.
- Chauhan, S., Singh, C. N. and Singh, A. K. (2005). Effect of vermicompost and pinching on growth and flowering in marigold cv. Pusa Narangi Gaiinda. *Prog. Hort.*, **37** (2): 419-422.

- Dahale, M.; Deshmukh, M.; Dod, V. N.; Dharmik, Y. B. and Rathod, N. G. (2010). Effect of growth regulators on growth and flower yield of gaillardia. National Symposium on Lifestyle Floriculture: Challenges and Opportunities held during 19-21 March, 2010 at Solan pp 76-77.
- Dutta, J. P. and Ramdas, S. (1998). Growth and flowering response of chrysanthemum (*Dendranthema grandiflora* Tzelve) to growth regulator treatments. *Orissa J. Horti.*, **26(1)**: 70-75.
- Dutta, J. P.; Ramdas, S. and Khader, M. A. (1993). Regulation of flowering by growth regulators in chrysanthemum (*Chrysanthemum indicum* L.) cv. 'CO-1'. *S. Indian Horti.*, **41(5)**: 293-299.
- Gilbertz, D. A. (1992). Chrysanthemum response to timing of paclobutrazol and uniconazole sprays cv. 'Bright Golden Anne'. *Hort. Sci.*, **27(4)**: 322-323.
- Girwani, A.; Babu, R. S. and Chandrashekhar, R. (1990). Response of marigold (*Tagetes erecta*) to growth regulators and zinc. *Indian J. Agric. Sci.*, **60(3)**: 220-222.
- Gowda, J. V. N. and Jayanthi, R. (1991). Effect of cycocel and maleic hydrazide on growth and flowering of African marigold (*Tagetes erecta* L.). *Prog. Horti.*, **23(1-4)**: 114-118.
- Jackson, M. L. (1967). "Soil Chemical Analysis". Prentice Hall of India pvt. Ltd., New Delhi, pp 183 - 192.
- Jauhari, O. S. and Amarjit, S. 1960. A note on the effect of maleic hydrazide on growth and flowering of China aster (*Callistephus chinensis* L. Nees). *Sci. and Cul.*, **25**:697-698.

- Jana, B. K. and Kabir, J. (1987). Response of growth regulators on growth and flowering of carnation cv. 'Improved Margurite'. *Prog. Hort.*, **19**(2): 125-127.
- Lober, A. and Reddy, S. A. (2006). Effect of cycocel and alar on growth and flowering parameters in China aster (*Callistephus chinensis* L. Nees). *J. Ornam. Hort.*, **9** (1): 71-72.
- Kar, S. B., Barua, S. J. and Gupta, K. (1989). Response of the safflower plant (*Carthamus tinctorius* L.) cv. JLA 900 towards plant growth retardants dikegulac sodium, CCC and SADP. *Indian J. Plant Physiology*, **32** (2): 144- 147.
- Katkar, P. B., Nark, D. M., Bodamwad, S. G. and Gharat, S. N. (2005). Influence of plant growth regulator on flowering, quality and yield of flowers in China Aster (*Callistephus chinensis* (L.) Nees) cv. California Giant Mill. *South Indian Hort.*, **53** (1-6): 378-381.
- Neetver, G. J. and Cox, D. A. (1989). Growth inhibition in marigold following drench and foliar applied paclobutrazol. *Hort. Sci.*, **24**(2): 390.
- Wang, F. C. and Tewari, G. N. (2001). Effect of growth regulator on growth and flowering of dande (*Datura metel* L.). *Indian J. Hort.*, **60**(2): 302-304.
- Baradwaj, S. K., Jain N. K. and Singh, P. (2005). Effect of growth retardants and pinching on growth and yield of flower marigold (*Tagetes erecta* L.). *Ann. Karnataka Univ. Hort.*, **61**(3): 277-279.
- Prasad, R. V., Panigrahy, S. and Singh, S. (2006). Effect of growth retardants on growth and flowering of China Aster (*Callistephus chinensis* L. Nees). *Indian J. Hort.*, **63**(2): 167-170.

gaillardia (*Gaillardia pulchella*) var. 'Pieta Fonger'. *Floriculture Technology, Trades and Trends*, Oxford and IHL Publishing Co. Pvt. Ltd., New Delhi, pp. 119-121.

Kind, K. S., Bhatia, R. N. S., Barche, S., Billore, M. and Dalal, M. (2001) Effect of growth on gladiolus. *Ann. Agric. Res.*, 22 (2) 278-281.

Kumar, K. and Ughreja, P. P. (1998). Effect of foliar application of GAA, NAA, MH and etheerl on growth, flowering and flower yield of chrysanthemum (*Chrysanthemum morifolium* Ram.) cv. 'HHR 6'. *J. Applied Hort.*, 4(1&2), 20-26.

Latimer, J. G. (1991). Growth retardants affect landscape performance of Zinnia, Impatiens and Marigold. *Hort. Sci.*, 26 (5):557-560

Maan, V. (2003) Influence of paclobutrazol on growth and flowering of African marigold (*Tagetes erecta* L.) cv. 'Pusa Basanti Gaiinda'. M.sc thesis submitted to GAU, S. K Nagar.

Makwana, M. K. (1999). The effect of plant growth regulators on growth, yield and quality of gaillardia (*Gaillardia pulchella*) Cv. 'Lorenziana'. M.Sc. (Agri.) thesis submitted to Gujarat Agricultural University, Sardar Krushinagar.

Mc Daniel, G. L. (1986). Comparison of paclobutrazol, flurprimidol and tetcyclasis for controlling poinsettia height, *Hort. Sci.*, 21(5): 1161-1163.

Mishra, Ashutosh and Pandey, R. K. (2006). Effect of pinching and plant bioregulators on growth and flowering of African marigold (*Tagetes erecta*). *Prog. Hort.*, 38 (2): 205-207

- Mishra, D. K. and Mishra, H. R. (2006). Growth and flowering response of China aster (*Callistephus chinensis* L. Ness) to paclobutrazol. *J. Ornament. Hort.*, **9**(1): 63-65.
- Mohd. Ahmad.; Gauri Shankar and Muthoo, A. K. (1988). Effect of paclobutrazol on growth and flowering of cosmos (*Cosmos bipinatus* Cav.). *Punjab Hort. J.*, **28**(3): 105-108.
- Moond, S. K. and Rakesh (2006). effect of GA₃, CCC and MH on vegetative growth and yield of chrysanthemum. *Haryana J. Hortic. Sci.*, **35**(3&4): 258-259.
- Nagarjuna, D.; Reddy, V. P.; Rao, M. R. and Reddy, E. N. (1988). Effect of growth regulators and potassium nitrate on growth, flowering and yield of chrysanthemum (*Chrysanthemum indicum* L.). *S. Indian Hort.*, **36**(3): 136-140.
- Narayana Gowda, J. V. 1990. Influence of pinching and cycocel on growth and flowering of China aster (*Callistephus chinensis* L. Nees). *Mysore J. agric. Sci.*, **24**:238-245.
- Narayana Reddy, Y. T. 1978. Effects of growth substances on growth and flowering of China aster (*Callistephus chinensis* L. Nees). *Mysore J. agric. Sci.*, **12**(3):526.
- Olsen, S. R.; Cole, S. V.; Watanabe, B. S. and Dean, L. A. (1954). *Estimation of available phosphorous in soil extraction with Sodium bicarbonate*. U. S. D. A. cir 939.
- Parmar, A. S. and Singh, S. N. (1983). Effect of plant growth regulators on growth and flowering of marigold (*Tagetes erecta*). *S. Indian Hort.*, **31**(1): 53.

- Patel, K. R. (1990). Effect of plant growth regulators on growth, flowering and flower yield of marigold (*Tagetes erecta* L.) cv. 'Lemon'. M.Sc. (Agri.) thesis submitted to Gujarat Agricultural University, Sardar Krushinagar.
- Patel, N. V. (2001). Effect of plant growth retardants on growth, yield and flowering of African marigold (*Tagetes erecta* L.) cv. 'Pusa Basanti Gaiinda'. M. Sc. (Agri.) thesis submitted to Gujarat Agricultural University, Navsari.
- Patil, S. S.; Reddy, S.; Prashant, J. M and Kulkarni, B. S (2004). Effect of growth and yield of golden rod (*Solidago Canedensis* L.) *J. Ornam. Hort.*, 7(3-4): 159-163.
- Pushkar, N. C and Singh, A. K. (2010). Influence of pinching and growth retardants on vegetative growth and yield of African marigold (*Tagetes erecta* L.). National Symposium on Lifestyle Floriculture: Challenges and Opportunities held during 19-21 March, 2010 at Solan pp 92.
- Qrunfleh, M. M. and Suwaan, M. A. (1988). Response of three summer annuals to paclobutrazol application. *Adv. Hort. Sci.*, 2(1). 15-18.
- Rakesh.; Singhrot R. S.; Singh R. and Sharma J. (2005). Flowering and yield response of chrysanthemum to GA₃ and pinching treatments. *Haryana J. Horti. Sci.*, 34 (1-2): 93-94.
- Reddy, Y. T. N. and Sulladmath, U. V. (1983). Effect of growth regulators on growth and flowering of China aster. *S. Indian Hort.*, 31(2/3): 95-98.

- Romkova, I. V. (1989). Effect of ethylene producing substances and Cullin on some ornamental plants. *Acta Hort.*, 251: 281-288.
- Sanderson, K. C. Jr., Martin, W. C. and Mc Guire, J. (1988). Comparison of paclobutrazol tablets, Drench, gels, capsules and spray on chrysanthemum growth. *Hort. Sci.*, 23(6): 1008-1009.
- Schrawat, S. K., Dahiya, D. S., Singh, S. and Rana S. G. (2003). Effect of nitrogen and pinching on growth, flowering and yield of marigold (*tagetes erecta* L.) cv. African Giant Double Orange. *Haryana J. Hort. Sci.*, 32 (1&2): 59-61.
- Sen, S. K. and Maharana, J. (1971). Growth and flowering response of chrysanthemum to growth retardants cv. 'Early Yellow'. *Punjab Hort. J.*, 11(3/4): 274-277.
- Sharma, H. G.; Verma Vijay Jain, L. S. and Tiwari, B. L. (1995). Effect of foliar application of some plant growth regulators on growth and flowering of chrysanthemum var. 'Move-in-carvin'. *Orissa J. Horti.*, 23(1&2): 61-64.
- Singh, A. K. and Bist, L. D. (2003). Effect of paclobutrazol on growth and flowering in rose cv. Gruss-an-tepliz. *Indian J. Hort.*, 60(2): 188-191.
- Singh, A. K. (2002). Growth and flowering in rose influenced by the application of paclobutrazol. *S. Indian Hort.*, 50 (1):124-127.
- Singh, A. K. (2004). Plant growth and flower production in rose as influenced by CCC, TIBA and SADH spraying. *Prog. Hort.*, 36(1): 40-43.

- Singh, D. B.; Sunjoy Mehra and Bensam, N. C. (1999). Effect of paclobutrazol on flowering of chrysanthemum. *J. Ornam. Hort.*, 2(2): 92-96.
- Singh, J. (2001). Effect of plant growth substances on growth and flowering of chrysanthemum (*chrysanthemum coronarium* L.) cv. 'Local White'. M.sc (Agri.) thesis submitted to GAU, S. K. Nagar.
- Singh, R. and Rathore, S. V. S. (1992). Effect of different growth regulators on growth and flowering of African marigold (*Tagetes erecta* L.). *Prog. Hort.*, 24(1-2): 92-95.
- Song, T. S.; Lee, M. S. and Hans, I. S. (1992). Studies on the regulation of growth and flowering in bedding plants indigenous to Korea. 2. The effect of substances on growth and flowering of native Korean plants. *Research Reports of the Rural Development Administration, Horticulture*, 33(1): 48-54.
- Sreekala, C.; Lila Mathew, K.; Sarah George T. and Rajeevan P. K. (2000). Growth and flowering of crossandra [*Crossandra infundibuliformis*(L.)] as influenced by paclobutrazol and cycocel (CCC). *The Hort. J.*, 2000, 13(2):65-70
- Sunitha, H. M.; Hunje Ravi, 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* Linn.) cv. 'Double Orange'. *J. Ornam. Hort.*, 10(2): 91-95.

- Swaminathan, V.; Ramaswamy, N and Pillai, A. A. (1999). Studies on the growth regulators on off season flower production in *Jasminum sambac*. *South Indian hort.*, **47**(1-6):319-321.
- Syamal, M. M.; Rajput, C. B. S.; Upadhyay, R. K. and Singh, J. N. (1990). Effect of GA₃ and MH on growth, flowering and seed yield of marigold and China aster. *Indian J. Hort.*, **47**(4): 439-441.
- Talukdar, M. C. and Paswan, L. (1997). Growth and flowering in chrysanthemum (*Dendranthema grandiflorum* Tzveley) cv. 'Maharaja' as influenced by GA₃ and Cycocel. *Haryana J. Hort. Sci.*, **26**(1-2): 55-57.
- Yadav, P. K. (1997). Note on the effect of CCC and MH on growth and flowering of African marigold. *Curr. Agric.*, **22**(1/2): 113-114.
- Yewale, A. K.; Belorkar, P. V.; Bhattacharya, J.; Chanekar, M. A. and Chimurkar, B. S. (1998). Effect of growth retardant paclobutrazol on growth parameters of chrysanthemum. *J. Soils and Crops.*, **8**(1): 82-84.
- Yewale, A. K.; Belorkar, P. V.; Chanekar, M. A.; Padgilwar, T. R. and Chimurkar, B. S. (1997). Effect of growth retardant paclobutrazol on flowering of chrysanthemum. *J. Soils and Crops.*, **7**(2): 175-177.

APPENDIX – 1: Meteorological data during the year 2009 - 2010

Month	Temperature °C		Rainfall (mm)	Rainy days	Relative humidity (%)	
	Max.	Min.			AM	PM
September 2009	32.4	25.3	240.0	6	89.0	66.4
October 2009	33.9	21.5	84.0	3	85.1	47.0
November 2009	32.2	19.5	21.2	4	76.4	42.9
December 2009	31.2	16.3	0.0	0	80.0	36.4
January 2010	30.7	15.7	0.0	0	70.4	37.3

Source: Agricultural Meteorological Observatory, N.M. College of Agriculture,
Navsari Agricultural University

**Appendix – II Cost of cultivation of China aster cv. 'Phule Ganesh Purple' on
hectare basis**

Treatment details	Fixed cost (Planting material, land preparation and planting, Manures and Fertilizers, Plant Protection, Hoeing and Weeding, Irrigation, Harvesting and other labour charges)	Treatment cost (Rs./ha)	Total cost (Rs./ha)
T ₁ - Maleic hydrazide 400 mg	79085	5035	84120
T ₂ - Maleic hydrazide 600 mg	79085	7553	86638
T ₃ - Maleic hydrazide 800 mg	79085	10071	89156
T ₄ - Maleic hydrazide 1000 mg	79085	12589	91674
T ₅ - Chlorocholine chloride 1.0 ml	79085	5357	84442
T ₆ - Chlorocholine chloride 1.5 ml	79085	8035	87120
T ₇ - Chlorocholine chloride 2.0 ml	79085	10714	89799
T ₈ - Chlorocholine chloride 2.5 ml	79085	13392	92477
T ₉ - PP ₃₃₃ 0.5 ml	79085	3616	82701
T ₁₀ - PP ₃₃₃ 1.0 ml	79085	7232	86317
T ₁₁ - PP ₃₃₃ 1.5 ml	79085	10848	89933
T ₁₂ - PP ₃₃₃ 2.0 ml	79085	14464	93549
T ₁₃ - Hand pinching	79085	2000	81085
T ₁₄ - Control	79085	0	79085

CERTIFICATE

This is to certify that I have no objection to supply one copy of any part of this thesis at a time to any scientist through reprographic process, if necessary for rendering reference service in a library or documentation centre.

Place : Navsari

Date : 27/05/2010

S. G. Patel
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