Effect of Pinching and Growth Retardants on Growth, Flowering and Yield of African Marigold (*Tagetes erecta* L.) cv. "Pusa Narangi Gainda"

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Thesis
Submitted to the
Maharana Pratap University of Agriculture and Technology, Udaipur
in partial fulfillment of the requirement for the degree of
Master of Science in Agriculture
(Horticulture)
(Floriculture and Landscape Gardening)

By

DINESH KUMAR

2007

MAHARANA PRATAP UNIVERSITY OF AGRICULTURE AND TECHNOLOGY, UDAIPUR

RAJASTHAN COLLEGE OF AGRICULTURE, UDAIPUR

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Dated : / /2007

This is to certify that **Mr. Dinesh Kumar** has successfully completed the Comprehensive Examination held on 2 June, 2007 as required under the regulation for Post-Graduate studies.

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CERTIFICATE-II

Dated : / /2007

This is to certify that the thesis entitled **"Effect of pinching and growth retardants on growth, flowering and yield of African marigold (*Tagetes erecta* L.) cv. "Pusa Narangi Gainda"** submitted for the degree of Master of Science in Agriculture in the subject of Horticulture (Floriculture and Landscape Gardening), embodies bonafide research work carried out by **Mr. Dinesh Kumar** under my guidance and supervision and that no part of this thesis has been submitted for any other degree. The assistance and help received during the course of investigation have been fully acknowledged. The draft of this thesis was also approved by the advisory committee on -----------------.

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CERTIFICATE-III

Dated : / /2007

This is to certify that the thesis entitled **"Effect of pinching and growth retardants on growth, flowering and yield of African marigold (*Tagetes erecta* L.) cv. "Pusa Narangi Gainda"** submitted by **Mr. Dinesh Kumar** to the Maharana Pratap University of Agriculture and Technology, Udaipur in partial fulfillment of the requirements for the degree of **Master of Science in Agriculture** in the subject of Horticulture (Floriculture and Landscape Gardening),after recommendation by the external examiner was defended by the candidate before the following members of the examination committee. The performance of the candidate in the oral examination on his thesis has been found satisfactory, we therefore, recommend that the thesis be approved.

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This is to certify that **Mr. Dinesh Kumar** student of M.Sc. (Ag.), **Department of Horticulture**, Rajasthan College of Agriculture, Udaipur has made all corrections / modifications in the thesis entitled **"Effect of pinching and growth retardants on growth, flowering and yield of African marigold (*Tagetes erecta* L.) cv. "Pusa Narangi Gainda"** which were suggested by the external examiner and the advisory committee in the oral examination held on ---------------. The final copies of the thesis duly bound and corrected were submitted on ----------------.

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Date :

Place : Udaipur **(Dinesh Kumar)**

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ACRONYMS

%	:	Per cent
/	:	Per
@	:	At the rate of
B:C	:	Benefit Cost ratio
CD	:	Critical Difference
ºC	:	Degree Celsius
cm	:	centimeter
cv.	:	cultivar
d.f.	:	Degree of freedom
ds	:	desi siemens
ºE	:	Degree East
et al.	:	(*et albiti*) and elsewhere
etc.	:	etcetera
Fig.	:	Figure
g	:	gramme
ha	:	hectare
hrs.	:	hours
i.e.	:	(*id est*) that is
kg	:	Kilogram
m.eq.	:	milli equivalent
Max.	:	Maximum
Mg	:	Milligram
Min.	:	Minimum
mm	:	millimeter
MSS	:	Mean sum of square
No.	:	Number
NS	:	Non-significant
ºN	:	Degree North
ppm	:	Parts per million
t	:	Tonnes

Rs.	:	Rupees
R.H.	:	Relative humidity
S.Em.	:	Standard Error of Mean
viz.	:	(*Videlicet*) Namelv.

1. INTRODUCTION

The marigold is one of the easiest annual flowers to cultivate and have wide adoptability to different soils and climatic conditions. The plants with their attractive flower colours bloom for a considerably long period and the flowers can be kept remarkably well after cut. All these favorable points make marigold one of the most popular annual flowers in India for garden display as well as for commercial cultivation.

Marigold is broadly divided into two groups namely, African marigold and French Marigold. The former generally grows taller while latter is a dwarf type, belonging to family Asteraceae. The African marigold (*Tagetes erecta* L.) is a native of Mexico and the French marigold (*Tagetes patula*) is from Mexico and South America.

Marigold is ideal for cut flowers and for making garlands due to their variable height and wide spectrum of colour, shape and size of flowers. In popularity as cut flower, marigolds probably rank next to jasmine in India. Sometimes, the whole plant is cut and used for decoration. They can be planted in beds for mass display in mixed orders and can also be grown in pots. These are very suitable for hanging baskets, window boxes, rockeries and for edgings. When grown in newly planted shrubbery, they help to fill the gaps and add colours. Besides this, essential oils extracted from marigold has got immense importance for the inhibition of microorganisms.

African marigold (*Tagetes erecta* L.) is vigorous tall-growing (upto 90 cm) plants having large globular flowers of different shades like lemon yellow, bright yellow, golden yellow, orange and nearest colours, while, leaves are pinnately divided and leaflets are lanceolate and serrated. Florets are either two lipped or quilled.

Total area under marigold cultivation in India is nearly 25,000 hectares with an average yield of 8 tons per hectare (Anonymous, 1997). While in Rajasthan, it is grown in about 53 hectares with a total production of 100 tons (Vital Statistic, 2004).

Floriculture is remunerative avocation for the rural people. The income from a hectare of flowers is much more than the income from either a cereal or pulse crop. A survey showed that about 10,500 tons of the cut flowers worth Rs. 9.26 crores are being sold annually in the towns of metropolitan cities like Mumbai, Kolkata, Chennai and Delhi (Tosar, 1989).

Marigold besides having ornamental, medicinal, industrial use has additional use in controlling the soil nematodes. All varieties of marigold are resistant to *Meloidogyne incognita* and could be use to control of *Meloidogyne* incognita in highly infected area (Warden and Windrich, 1974). Some species of marigold produce thiophenes, naturally occurring biocides which are active against nematodes (Maleeva and Ivanova, 2000).

In addition to this the ability of crop to grow through out the year makes it further important as a commercial flower crop. Earlier it was grown in a limited areas around cites, but now a days its cultivation has spread over large areas due to value addition as natural colouring agent, poultry feed and essential oils.

Singh and Arora (1980) reported that in tall cultivar of *Tagetes erecta* the development of axillary branches and flower production was influenced by the presence of apical dominance. Further, it has been observed that such cultivars first grow upward to their final height and later on produce terminal flower buds. After the formation of terminal flower bud, axillary branches develop which also bear flowers. However, if the apical portion of shoot is removed early, large number of axillary shoot arises resulting in well shaped bushy plants bearing more number of uniform flower. Experiment on pinching revealed that removal of shoot apicals 40 days after transplanting enhanced the flower yield, while late pinching on 50 or 60 days after transplanting proved less effective in this respect.

The hormonal use in the plant system and their importance is the standing discovery and achievement of plant sciences. These substances have proved to be of various uses in the commercial culture of plants, and now man can change the pattern and development of plants by stimulating or retarding the growth.

Plant growth regulators can be used at any stage of plant life. A number of techniques for application of growth substances have been used on various flowering crops. The methods adopted successfully as seed soaking, seedling dip method and foliar spray etc.

The influence of numerous growth retardants has been commercially exploited both in green house as well as in open field condition. CCC, Ethrel and Maleic Hydrazide are commercially used to accelerate growth, induce dormancy, suppress apical dominance, induce lateral buds and produce more number of flowers in various crops for easy cultivation and higher flower yield (Mahalle *et al*., 2001; Khandelwal *et al*., 2003 and Mathew *et al*., 2004). Keeping in consideration the above facts, an investigation entitled “Effect of pinching and growth retardants on growth, flowering and yield of African marigold (*Tagetes erecta* L.) cv. “Pusa Narangi Gainda” was conducted at Horticulture Farm of the Department of Horticulture, Rajasthan College of Agriculture, Udaipur, during October 2006 to March 2007 with the following objectives.

(i) To find out the effect of pinching on growth, flowering and yield of African marigold.

(ii) To find out the effect of growth retardants on growth, flowering and yield of African marigold.

(iii) To determine the relative economics of the treatments.

2. REVIEW OF LITERATURE

Under the modern floriculture production technology, application of growth retarding chemicals and pinching has become beneficial under different agro climatic conditions. Their application have been found to be useful for better plant stature as well as for higher yield. A number of reports are available to support these facts. The relevant literature collected on the above aspect is reviewed as under :

2.1 EFFECT OF PINCHING :

2.1.1 On vegetative characters :

Kumpe and Langhands (1970) pinched carnation cutting at five different times and found that earlier the pinching, the more was the amount of fresh weight. It was also suggested that carnation should pinched as earlier as possible after planting, but not before or during propagation.

Sain and Naik (1977) reported that pinching the apical part at 30 and 60 days after transplanting reduced plant height, node number, number of branches, leaves number and flower number but leaf and flower size were increased in chrysanthemum cv. "Early White".

Sekhan (1981) reported that pinching the plants of marigold cv. "African Giant Double Orange" after 30 days of transplanting resulted in greatest reduction in plant height, fresh weight and more number of branches per plant as compared to pinching after 20 or 40 days of planting.

Handricks and Lemper (1983) tried pinching after 0,7, 14 and 21 days of planting and observed that late pinching (14 and 21 days) produced better quality plants with shorter stem and more number of branches as compared to early pinching (7 days) in chrysanthemum.

Chezhiyan *et al.* (1986) reported that pinching the chrysanthemum plants once (4 weeks after transplanting), twice (4 and 7 weeks after transplanting) and thrice (4, 6 and 8 weeks after transplanting) resulted significant reduction in plant height (40.76 and 38.17 cm) during two years with no pinching treatments and pinching the plants thrice have greatest reduction in plant height, while pinching the plants once produced larger number of branches per plant and induced early flowering than pinching twice or thrice.

Randhwa and Mukhopadhyay (1986) reported that the pinching in chrysanthemum is done when the plants are 8-10 cm tall by removing the tip of the main stem measuring 3-5 cm this would encourage the lateral shoots developed from the leaf axils.

Bhati and Chitkara (1987) carried out a field experiment on African marigold cv. “African Giant Orange”, “African Giant Yellow” and “French Dwarf Red” to study the effect of spacing (i.e. 40 x 40, 40 x 50 or 50 x 50 cm) and pinching (at 15 and 30 days after transplanting) and observed markedly reduced plant height and increased plant spread by pinching at 30 days after transplanting.

Wainwright and Irwin (1987) studied with growth and flowering of pot grown *Antirrhinum majus* and found that when seedlings were pinched at 3, 5 or 7 pairs of leaf stage and treated with paclobutrazol (1.25 or 1.75 mg/9 cm pot) as soil drench, pinching caused a significant reduction in plant height.

Imamura and Higaki (1988) found that topping increased the number of lateral shoots in anthurium and renum plants.

Noto and Romano (1989) studied with 6 cultivars of *Antirrhinum majus* L. and found that pinching reduced the stem length and increased the stem number.

Song *et al*. (1990) reported during an experiment that delaying the pinching date from May to July/August reduced the height of plant of *Gentiana axillariflora* cv. “Coreana”, *Inula britannia* cv. “Chinese”, *Aster yomena, A. koriaensis, Platycodon grandiflorus and Chrysanthemum.*

Jangra (1993) found that earliest pinching in marigold 30 days after transplanting promoted bushyness by reducing the plant height and increasing the number of branches per plant.

Joshi *et al*. (2002) carried out a field trial on African marigold cv. “Crackerjack” and applied 3 level of pinching viz., no pinching, early pinching at 20 days after transplanting (DAT) and late pinching at 30 DAT, and found significant effect of pinching on fresh and dry weight of the plant in comparison of no pinching.

Srivastava *et al*. (2002) conducted a research experiment on African marigold (*Tagetes erecta*) cv. "Pusa Narangi Gainda" and tried 4 levels of pinching viz., no pinching, pinching at 20, 30 and 40 days after transplanting. A significant effect of pinching was observed on plant height, number of branches. The maximum plant height was recorded under 30 DAT treatment while, the highest number of branches per plant was observed with 40 DAT treatment.

Joshi and Barad (2002) conducted a field experiment with African marigold cv. "Crackerjack" and tested 24 treatment combination comprised of 4 level of N_2 (50, 100, 150 and 200 kg ha^{-1}), two levels of P_2O_5 (50 and 100 kg ha^{-1}) and three levels of pinching i.e. no pinching, early pinching at 20 days after transplanting (DAT) and late pinching at 30 DAT), and found that pinching treatment significantly increased fresh and dry weight of the plant as compare to no pinching.

Beniwal *et al*. (2003) observed in an experiment that the pinching at 25 day after transplanting under the spacing of 20 x 30 cm produced maximum plant spread and fresh weight of plant in chrysanthemum.

Khandelwal *et al*. (2003) carried out a field experiment to study the effect of pinching (at 20 and 30 days after transplanting) on growth of African Marigold and found that the values for plant height, stem diameter were observed higher with early pinching as compare to late pinching while, the valves for internodes length were found lower with early pinching than late pinching.

Sehrawat *et al*. (2003) during an investigation trial tested five level of N_2 (0, 10, 20, 30 and 50 g/m^2 through urea) and three level of pinching (at 30, 40, 50 days after transplanting) on *Tagetes erecta* cv. "African Giant Double Orange" and observed that pinching significantly reduced plant height especially when conducted at 30 DAT.

Srivastava *et al*. (2005) conducted an experiment to assess the effect of spacing (i.e. 40 x 40, 40 x 50 and 40 x 60 cm) and pinching (no pinching, pinching at 20, 30 or 40 days after transplanting) on the growth of African marigold cv. "Pusa Basanti Gainda" and observed that delayed pinching (40 DAT) with wider spacing (40 x 60 cm) increased the number of secondary branches.

2.1.2 On floral characters :

Sain and Naik (1977) studied with pot grown rooted cuttings of chrysanthemum cv. "Early White" either pinched when 60 days old or not pinched and found that pinching the apical bud resulted in increased flower diameter and the reduction in flower number.

Barrett and Hertogh (1978) studied with pinching of forced tuberous rooted cv. "Park princes" dahlia and found that pinched plant flowered later and produced smaller flower than unpinched ones.

Bunt (1979) reported that apical dominance in carnation inhibited the growth of axillary shoots in comparison with the shoots on stopped plants and flowering was delayed on stopped plants.

Farina and Paterniani (1982) reported that carnation cuttings pinched after 15 days of transplanting and flowering stems thinned after 20 days later gave good results.

Raskauskas and Knyviene (1983) reported that pinching the plants 15 days after transplanting induced early flowering, less number of branches while, pinching 30 days after transplanting delayed flowering and increased the number of branches per plant in sim carnation.

Arora and Khanna (1986) observed the effect of N_2 (at 0, 20, 40 or 60 g/m^2) and pinching (at 0, 20, 30 and 40 days after transplanting) on the growth and flower production of African marigold cv. "African Giant Double Orange" and found that pinching had no significant effect on the production but delayed flowering by 10-20 days.

Reiss and Lewis (1986) reported that pinching delayed flowering and improved flower production in chrysanthemum.

Barman *et al*. (1993) conducted trials for two years on chrysanthemum cv. "Chandrama" and they observed that the pinching caused the buds to appear earlier but delayed bud breaks.

Jangra (1993) found that pinching in marigold 30 days after transplanting resulted delayed flowering, reduction in flower size and increased flower production.

Ramesh Kumar *et al.* (2002) carried out a field experiment on carnation to find out the effect of planting time, photoperiod, GA_3 and pinching and observed that pinching (once at 4 weeks after transplanting and twice at 4 and 8 weeks after transplanting) resulted into delayed in bud initiation, flower opening and peak flowering in comparison of no pinching treatment.

Srivastava *et al*. (2002) conducted a research experiment on African marigold (*Tagetes erecta*) cv. "Pusa Narangi Gainda" and tried 4 levels of pinching viz., no pinching, pinching at 20, 30 and 40 days after transplanting. A significant effect of pinching was observed on number of days to flowering and duration of flowering. The maximum number of days required for initiation of flowering and duration of flowering was observed with pinching at 40 DAT.

In an experiment, Beniwal *et al*. (2005) observed that in chrysanthemum the plant pinched at 25 days after transplanting exhibited earliest bud initiation, flowering as compared to other pinching treatments (no pinching, pinching at 35 and 45 DAT).

Srivastava *et al*. (2005) conducted an experiment to assess the effect of spacing (i.e. 40 x 40, 40 x 50 and 40 x 60 cm) and pinching (no pinching, pinching at 20, 30 or 40 days after transplanting) on flowering of marigold cv. “Pusa Basanti Gainda” and observed that delayed pinching (40 DAT) with wider spacing (40 x 60 cm) increased flower per plant and improved the quality of flower. Further, delay in flowering and its duration were also recorded under late pinching at (40 DAT) treatment.

2.1.3 On yield characters :

Barrett and Hertogh (1978) reported that pinching of dahlia plants resulted in delayed flowering, greater number of flowers, and smaller size flowers than un-pinched plant.

Singh and Arora (1980) studied the effect of plant spacing (i.e. 40 x 30, 40 x 40 or 40 x 50 cm) on the growth and flower production of African marigold cv. “African Giant Double Orange” and found that flower yield per plant was significantly higher in plants which were planted at the widest spacing and pinched after 40 days of transplanting.

Namikawa (1980) reported that when the carnation plants were pinched once, resulted in greatest number of flowers per plant than pinched twice but there was no significant difference in the flower quality of plants either pinched once or twice.

Similarly, Mynett (1982) reported that pinched minature carnation plants had more flower stems than unpinched plants.

Rajasekhran *et al*. (1983) reported that pinching of gomphrena plants after 15 days of transplanting registered high yield (3165 g), number of flowers (602.05) and bigger sized flowers and also found that pinching delay the flowering by 10-20 days.

Wainwright and Irwin (1987) reported that *Antirrhinum majus* when pinched at 3, 5 or 7 pairs of leaf stage plant produced a greater number of flower spike and delay flowering.

Evans *et al*. (1989) studied with 7 cultivars of poinsettia and found that plants of all cultivars treated with hard pinching took longer time to reach anthesis.

Noto and Romano (1989) studied with 6 cultivars of *Antirrhinum majus* L. and found that pinching delay flowering about 20 days.

Song *et al*. (1990) found that pinching delayed and shortened the flowering period in G. *axillareflora, A. yomena and A. koraiensis* but only delayed it in *I. britannina and Portulaca grandijlorus* and also found that pinching on 20 May increased the number of flowers per plant in *I. britannia, A. yomena, Portulaca grandijlorus, A. koraiensis* and *chrysanthemum* compared with pinching in, June- July or August (12.85 cm) whereas lowest yield (2455 g), number of flowers (518.5) and flower size (1.5 cm) were recorded under non pinched plants.

Cermeno (1990) also reported that pinched plants of chrysanthemum had more number of flowers per plant than unpinched plants.

Jangra (1993) tried pinching on marigold plants after 30, 40 and 50 days of transplanting and obtained maximum yield per unit area in early pinching (30 days after transplanting).

Khandelwal *et al*. (2003) carried out a field experiment to study the effect of pinching (at 20 and 30 days after transplanting) on yield of African Marigold and found that the flower weight, intact flower longevity, number of flower and yield per plant were observed higher with early pinching as compare to late pinching while, the number of days to first flowering and duration of flowering were found lower with early pinching than late pinching.

Sehrawat *et al*. (2003) during an investigation trial tested five level of N_2 (0, 10, 20, 30 and 50 g/m^2 through urea) and three level of pinching (at 30, 40, 50 days after transplanting) on *Tagetes erect* cv. "African Giant Double Orange" and observed that pinching at 30 DAT exhibited significantly the highest number of flower per plant (30.17) and flower yield (322.62 g $plant^{-1}$).

Beniwal *et al*. (2005) noticed in an experiment on chrysanthemum that plant pinched at 25 days after transplanting exhibited flowers with maximum size, weight and yield of flower as compared to other pinching treatments i.e., pinching at 35 and 45 days after transplanting.

Rakesh *et al.* (2005) carried out an experiment on chrysanthemum cv. “Flirt” and “Gouri” for cut flower production and reviewed that number of flower per plant and yield of flower per plant in both the cultivars were recorded maximum when plants were pinched at 35 days after transplanting as compared to other pinching treatment (No pinching and pinching at 45 after transplanting). However, the maximum weight of flower in both the cultivars was recorded in no pinching treatment as compared to other treatment (pinching at 35 and 45 days after transplanting).

2.2 EFFECT OF GROWTH RETARDANTS :

2.2.1 On vegetative characters :

Sen and Maharana (1971) found that plant height and number of branches per plant of *Chrysanthemum cv.* “Early yellow” by application of 1000 ppm MH, 1.0 per cent CCC, 0.1 per cent phosfon – D and 0.5 per cent B-9 significantly reduced and increased, respectively over control.

Working with *Chrysanthemum* Sen and Maharana (1972) observed that 0.2,0.4 and 0.5 per cent B-9 and 0.25, 0.5 and 1.0 per cent CCC significantly increased the diameter of stem. They also observed that the spray of phosfon-D (0.01 %, 0.02 %) and 0.1 %), MH 1000 ppm, CCC *(*1.0 %*)* and daminozide (0.5%) significantly reduced the plant height.

Shanmugam *et a1.* (1973) observed that application of 5000, 10000 and 15000 ppm chloromequat chloride significantly increased the number of branches when sprayed on *Chrysanthemum* at 30,45 and 60 days after transplanting. Where as, Pappaih and Muthuswamy (1974) observed slight effect on the number of branches per plant when *Dahlia* plants treated with 3 applications of 1000 and 2000 ppm CCC at 45 days after transplanting.

Working with *Chrysanthemum* cv. “Doone valley” Zvirblis (1976) observed that internode were shortened most effectively by chlormequat application when plants reached 5-8 cm and between the second pinching.

Pappaih and Muthuswamy (1977) observed that application of growth retardants to *Jasminum. grandiflorum* with 1000, 2000 and 3000 ppm MH and 500 and 1000 ppm CCC increased number of internodes per plant i.e. 10.95, 26.02 and 30.13 per cent with MH and 20.54 and 12.32 per cent, respective1y with CCC, But CCC at 1500 ppm reduced the number of internodes by 5.47 percent over control.

Sen and Naik (1977) working with *Chrysanthemum* observed that the number of branches and number of leaves per plant were maximum with application of B-9 at 10000 ppm.

Morioka *et al*. (1978) conducted on experiments on pot plants for controlling height and they found that the growth of dwarf *Carnation* was retarded by CCC as a foliar spray at 200 ppm or as a soil drench at 50 mg per pot.

Parmar and Singh (1983) found that plant size was influenced when seedlings of *Tagetes. erecta* cv. "Fantastic" were treated with CCC at 10 days after transplanting and the moderate growth reduction were obtained with CCC at 500 ppm.

Shedded *et al*. (1986) found some reduction in plant height of Zinnia and Marigold with application of Alar (B-9) at 250 to 2000 ppm. Witt (1989) studied the effect of Alar (B-9) on various beddings plants and reported that 2 doses of 1 per cent Alar in *Calceolaria rugosa* and *Impatiens walleriana* cv. "Fortuna Scarlet" showed a highest reduction upto 14 per cent plant height while, *Tagetes patula* responded well to 3 does of 0.25 per cent Alar giving good quality plants.

Novoselova *et al*. (1985) observed that spraying *Tagetes patula* grown as a pot plant in winter and spring with CCC at start of bud formation had a marked effect on growth, best results were obtained when 2.5 per cent solutions were used twice as soil drench.. The treated plants were uniform in growth, dwarf and bushy with more number of branches.

Pal *et al*. (1986) studied the effect of various growth regulator on *Calendula officinalis* and found that MH 250 ppm caused a marked increased in plant height as compared to control.

Shi and Li (1987) observed that application of B-9 and CCC have retarding effect on petunia plants when plants were sprayed with B-9 at 1500 - 6000 ppm and CCC at 2500 - 10000 ppm. Armitage *et al*. (1978) reported that daminozide 3500 ppm applied 4-5 weeks from sowing and again at the visible bud stage in *Calendula officinalis* cv. "Mandarin" reduced internodal elongation.

Witt (1989) reported that in *Calceolaria rugosa*, 2 doses of 1 percent Alar reduced plant height by 8 per cent but did not affect plant diameter while the *Tagetes patula* responded well to 3 doses of 0.25 % Alar giving good quality plants.

Gowda *et al*. (1990) conducted research on marigold cv. "Bangalore Local" and applied cycocel (1000 or 2000 ppm) and maleic hydrazide (500 or 1500 ppm) twice at 2 and 4 weeks after transplanting and observed increased thickness of leaves with the growth retardants as compare to untreated control.

Syamal *et al*. (1990) investigated that MH at 400 ppm level suppressed vegetative growth of *Tagetes erecta* and *Callistephus chinensis* when seedling of both crops were transplanted on third November and sprayed with GA_3 (100 or 200 ppm) and MH (200 or 400 ppm), 15 days after transplanting and twice more at 10 days interval.

Eume (1990) treated *Dianthus caryophyllus* plant with cycocel resulted more compact plant.

Girwani *et al*. (1990) conducted an experiment on marigold (*Tagetes erecta* L.) cv. “African Giant Double Orange” and found that when CCC (500 or 1000 ppm) were sprayed on 30 days old seedling at 20 days after transplanting, it resulted in the shortest plants height (100.7 cm) and highest plant dry weight (66.8 g).

Reimherr and Graoner (1991) treated four *Companulla species* with CCC or Alar, once or twice at 0.3 per cent and found that both Alar and CCC were effective in retarding growth.

Gowda and Jayanthi (1991) carried out an experiment on marigold cv. 'Bangalore Local' with foliar application of cycocel (1000, 1500 or 2000 ppm) at 3 and 5 weeks after transplanting. All treatments reduced plant height compared with control.

Narayana *et al*. (1991) observed that all treatments of MH increased the number of branches in an experiment on Marigold cv. “Bangalore local” which were treated with 500, 1000 and 1500 ppm of MH.

Suma and Joshua (1994) observed that when one month old *Dahlia variabilis cv.* “Formal Decorative” rooted cuttings were transplanted into 12 inch pots and sprayed one month later with 500, 1000, 2000 or 4000 ppm B-9 or 250, 500, 1000, 2000 ppm CCC and the treatments were repeated 15 days after first spray. The greatest tuber production (lowest shoot : root) was obtained with 4000 ppm Alar. The average tuber fresh weight was 41.26 g with Alar treatment compared with 30.35 g with CCC.

Brown *et al*. (1992) conducted experiment in which moisture stress was compared with B-nine (daminozide) as a method of height control for *Tagetes erecta* cv. “Janie Gold”. Treatments include moisture stress, 2 concentration of B-9 (2500 ppm applied twice and 5000 ppm applied once) and an untreated control and found that the method of height control and type of medium had an interactive influence on height.

Gregov *et al*. (1992) applied Alar 85 (B-9) at 2125 ppm or CCC at 400-1200 ppm once, twice and thrice on two cultivars i.e., “Clingo” and “Dark West Land” of all year round chrysanthemum to improve the commercial quality. They reported that Alar was effective in reducing height when applied one week before or after the short day treatment.

Singh and Rathore (1992) reported maximum decrease in plant height of African marigold with the application of MH at 200 ppm at three weeks after transplanting.

Larsen and Lieth (1993) studied the retardation effect of daminozide on potted chrysanthemum cv. “Bright Golden Anne” and predicted that two spray application of daminozide (0.25%) would result in maximum shoot length reduction of 19 to 23 per cent. While, 3 spray applications resulted in 22 to 30 per cent reduction in shoot length.

Tomar (1993) reported that three sprays of B-9 at 4000 ppm reduced plant height and increased the number of branches in marigold.

Aswath *et al*. (1994) observed maximum reduction in plant height in China aster with the application of MH at 500 ppm, sprayed at 25, 40 and 55 days after sowing.

Ojeda and Trione (1994) observed that when CCC supplied as soil drench to young guayale *parthenium orgentaton* plants @ 250, 500 or 1000 ppm increased the chlorophyll content as compared to the control. Bhattacharjee and Singh (1995) recorded that there was increase in number of secondary shoots in rose cv. “Raktagandha” by 13.33 and 27.33 per cent respectively with the treatment of daminozide 1000 ppm and CCC 2000 ppm over control.

The rooted cuttings of chrysanthemum were sprayed with 0.125 per cent solution of daminozide (B-9) three times at three weeks interval had greatest effect in reducing plant height as compared to control, CCC and paclobutrazol treatments (Zalewska, 1994).

Singh *et al.* (1994) conducted an experiment on *Dahlia variabilis* and the plant were sprayed with GA_3 (25, 50 or 75 ppm) or Alar (50, 100, 150 ppm) at 25 days and 35 days after transplanting and compared with untreated plants and reported that plant sprayed with Alar at 150 ppm resulted in to shortest plants with widest stem diameter and largest number of branches.

Sharma *et al.* (1995) reported that increasing concentrations of MH (250-1000 ppm) decreased the plant height of charysanthemum cv. "Move-in-Carvin" over control.

Whipker *et al*. (1995) observed that daminozide at 5000 mg/l caused the greatest height reduction by 29 per cent in *Aster novibelgii* cv. "Butterfly Blue" and by 24 per cent in *Aster novibelgii* cv. "Purple Monarch" than control. Similarly the internodal length decreased upto 16 per cent over control in *Coleus blumel* by 2100 ppm daminozide and number of internodes reduced by 8-12 per cent (Caro and Herrera, 1996). The increased chlorophyll content and maximum reduction in height by dal11inozide (1000-4000 mg/kg) in *Campamulla takesimana* was noticed by Song Jeong Seob *et al.* (1997).

Talukdar and Paswan (1996) observed that when rooted chrysanthemum cv. "Tumrulli" were sprayed with GA_3 (10, 20 or 40 ppm) or CCC (5000, 10000 or 15000 ppm) 35 days after planting in pots, then GA_3 at 20 ppm produced the tallest plants (31.3 cm) and CCC at 5000 ppm resulted in the shortest plant (16.8 cm) compared with 19.8 cm plant height under control. Similarly, in chrysanthemum cv. "Mini Nero", Zalewska (1994) reported that shortest and best shaped plants were those potted in July, pinched on 16th August and again on 6th September and treated with Alar 85 at 0.3 per cent on 28th September and again on 11th October.

Hosni (1996) observed that chloromequat at 1000 and 3000 mg/l reduced plant height of chrysanthemum cv. "Galaxy" by 18.3 to 18.7 and 35 to 37 per cent, respectively when applied as soil drench. Further, foliar spray had no significant effect on plant height.

Liu Wei Yun *et al.* (1996) observed that mini potted *Chrysanthemum* when sprayed with daminozide (1200-5000 mg/l) produced thick dark green leaves indicating increase in chlorophyll content.

Dutta and Ramdas (1998) revealed that foliar application of MH (250-1000 ppm) sprayed at 30 and 45 days after planting suppressed the plant height in chrysanthemum over control.

Kumar (1998) observed maximum suppression of plant height with the application of MH at 750 ppm over control in chrysanthemum cv. "HHR-6".

Nair (1998) reported that two sprays of 1500 ppm CCC have resulted into an attractive and balanced plant growth in marigold.

The large flowering decorative dahlia (*Dahlia pinnata*) cvs. "Prime minister" and "Thelma" were sprayed three times with 1000,2000 or 4000 ppm cycocel, then cycocel at 4000 ppm reduced plant height (Hossain *et al*. 1999).

Meher *et al*. (1999) reported that spraying of MH (150, 300 and 450 ppm) decreased plant higher in chrysanthemum, when compared with control.

Gohel (2001) reported decrease in plant height with increasing concentrations of MH and the lowest plant height was recorded with 1000 ppm MH in chrysanthemum.

Mahalle *et al*. (2001) carried out a field trail on *Chrysanthemum indicum* cv. White Ball, Flirtation, Kamal, Beauty, Raja and Achievement with application of B-9 (0, 1000, 2000, 3000 and 4000 ppm), one month after planting. B-9 at 4000 ppm was found most effective in reducing height and increasing thickness of stem and leaves and chlorophyll content of leaves in cv. Achievement. However, B-9 at 4000 ppm recorded with the least number of leaves and lowest dry weight of plant, excluding, flower in cv. Raja and least number of internodes and leaf area per plant in cv. Flirtation.

Patel (2001) observed that MH reduced plant height at 400 ppm when applied at 15 days after transplanting in chrysanthemum.

Khandelwal *et al*. (2003) carried out a field experiment to study the effect of chlormequat (1000, 2000 or 3000 pm) and maleic hydrazide (500, 750 or 1000 ppm) and growth and yield of African marigold and found that plant height and length of internode decreased where as stem diameter and number of branches per plant increase with increasing levels of MH and chlormequat. Further, the value of yield attributes also increased with increasing level of MH and chlormequat.

Mathew *et al*. (2004) conducted a field experiment to study the effect of growth retardants and micronutrients on the growth and yield of African marigold cv. “Pusa Basanti Gainda” and found that out of 17 treatment combinations comprised of two levels each of CCC (1000 or 1500 ppm), B-9 (1000 or 1500 ppm), $ZnSO_4$ (0.2 or 0.5%) and $CuSO_4$ (0.2 and 0.5 %) with absolute control and observed significant effect on flower yield under the combined application of 1500 ppm B-9 + 0.5 % $ZnSO_4$ as compare to all other treatment combination.

2.2.2 On floral characters :

Matous (1971) recorded that when “Ophelia” and “Electra” cultivars of Japanese *Azalea*, treated with 0.3 or 0.5 per cent CCC, 16 weeks after pinching delayed flower opening by 5-7 days over control.

Johansson (1973) working with *Chrysanthemum* cv. “Margurite” observed that the application of 0.125g and 0.375 g a.i./10 cm pot, cycocel reduced the diameter of flower by 3-6 percent than control.

According to Tawagan and Hassan (1974) spraying of *Chrysanthemum* plants with 2000 ppm cycocel both under short and natural day length it caused delay in flowering by 7- 14 days in comparison to control.

Shanmugam and Muthuswamy (1974) observed longer period of flowering in chrysanthemum when plants were sprayed with growth retardant particularly at 2000 ppm CCC and also observed that CCC at 1500 ppm significantly increased flower size.

Pappaih and Muthuswamy (1976) investigated the effect of CCC on *Althea rosea* plants and the noticed that CCC at 2000 ppm increased the flower diameter, however higher concentrations of CCC decreased flower weight. Further in 1977, they treated plants of *Jasminum grandiflorum* L. clone “Thimmapuram” with 500, 1000 and 1500 ppm CCC and reported that all the concentrations of CCC registered a longer duration of flowering than the controls.

Sen and Naik (1977) observed in chrysanthemum that flowering was hastened by application cycocel at 1000 ppm.

Armitage *et al.* (1978) also reported that early flowering by 17 days over control when chrysanthemum plants were treated twice with 1500 ppm cycocel as soil drench.

Bhattacharjee *et al*. (1979) applied CCC as a soil drench @ 2500 ppm and 5000 ppm on 10 cvs of *Rosa sinensis* and reported that CCC was effective in increasing flower size of all cvs. In addition to this the flower remained fresh for a longer period of time in comparison to control plants.

Parmar and Singh (1983) reported that MH at 1000 ppm delayed flowering in marigold (*Tagetes erecta* L.).

Novoselova *et al*. (1985) reported that CCC at 2.5 per cent was found effective in increasing the size of flowers in *Tagetes patula*. Similarly Yadav (1997) studied the effect of MH and CCC on African marigold and observed that cycocel 750 ppm resulted in increased flower diameter (8.2 cm) and highest flower weight (10.8g/flower).

Working with *Calendula officinalis* Pal *et al*. (1986) reported that MH at 250 ppm and 500 ppm caused a marked increase in the number of flower per plant.

Shawarer *et al.* (1988) studied the response of B-9 to pot chrysanthemum and observed that B-9 (1250-5000 ppm) as a soil drench or foliar spray reduced inflorescence diameter.

Nagarjuna *et al*. (1988) conducted an experiment on *Chrysanthemum indicum* and found that application of MH (250 and 500 ppm) either as root dip for 1 hour before transplanting or foliar spray at 17 days after transplanting delayed flowering by 17-25 days as compare to control.

Gowda and Jayanthi (1991) obtained greatest flower diameter with 1000 ppm and 1500 ppm MH treatments in African marigold (*Tagetes erecta* L.)

Latimer (1991) studied the effect of growth retardants on seedling of *Tagetes erecta* cv. "Papaya Crush" and found that the flower quality was affected by B-9 (500 ppm) treatment when sprayed to seedlings.

Gregov (1992) found "Clingo" and "Dark West Land" cultivars of chrysanthemum treated with 2125 ppm Alar 85 at one week before or after from the start of short day treatment delayed flowering by 2-5 days over control.

Dutta *et al*. (1993) observed that MH at 250,500 and 1000 ppm and CCC at 2000, 3000 and 4000 ppm caused delayed flowering in Chrysanthemum cv. "Co-1". The flower size and stalk length were improved by most of the treatments.

Tomar (1993) tried CCC and B-9 thrice as foliar spray, each at two concentrations i.e., 2000 and 4000 ppm and recorded the maximum flower diameter. While, the maximum flower weight was recorded with single spray of CCC at 2000 ppm in marigold plants.

Aswath *et al*. (1994) reported that increasing concentrations of MH (500-1500 ppm) extended the number of days for flower bud appearance in China aster.

Whipker *et al.* (1995) reported that rooted cuttings of *Aster novibelgii* when sprayed with 5000mg/l B-9 delayed flowering by 5 days over control. Bhattacharjee and Singh (1995) observed that daminozide and chloromequat significantly enhanced early flowering as compared to control in rose cv. "Raktagandha".

Sharma *et al*. (1995) found that foliar application of MH (250-1000 ppm) significantly prolonged the duration of bud emergence in chrysanthemum.

Talukdar and Paswan (1996) studied the effect GA_3 (10, 20 or 40 ppm) and CCC (5000, 10000 or 15000 ppm) on pot chrysanthemum cv. “Prof. Harris”. They reported that all treatments significantly increased fresh and dry weight of individual flowers and the largest flower size (7.8 cm) was observed under 5000 ppm CCC as compared to control (7. 1 cm). Hosni (1996) recorded that days to flowering in chrysanthemum cv. “Galaxy” reduced by about 5-6 days as a result of CCC at 1000 and 3000 ppm.

Kumar (1998) reported that foliar application of MH 750 ppm took minimum days for flower formation, whereas all levels of MH application (250-750 ppm) delayed 50 per cent flowering in chrysanthemum cv. “IIHR-6” under North Gujarat conditions.

Meher *et al.* (1999) working with chrysanthemum observed that application of MH at 30 and 45 days after transplanting delayed first flowering.

Mahalle *et al.* (2000) conducted research work on chrysanthemum and tried 5 level of B-9 (at 0, 1000, 2000, 3000 and 4000 ppm) one month after planting. A significant improvement was observed in flower size, flowering season and biomass production with the increasing concentration of B-9 in comparison to no treatment or zero treatment.

Gohel (2001) reported that MH 1000 ppm required maximum days for first flowering in chrysanthemum.

Patel (2001) reported that plants treated with MH 400 ppm took minimum number of days to first flower in African marigold (*Tagetes erecta* L.).

2.2. 3 On yield characters :

Sen and Maharana (1971) found that application of 0.2., 0.4 and 0.5 per cent B-9 and 0.25, 0.5 and 1 per cent CCC to chrysanthemum resulted in a significant increase in number of flower per plant by 19.63 to 71.16 per cent with B-9 and 6. 13 to 43.55 per cent with CCC treatment over control. They also observed that all concentrations delayed flowering by 2 to 11 days over control. They further reported that application of 0.4 or 0.5 per cent B-9 and 1 per cent CCC in “Early White” chrysanthemum caused significant increase in number of flowers per plant by 15.84, 48.63 and 24.04 per cent, respectively over control. Both chemicals at all concentrations delayed the flowering by 4.9 days (Sen and Maharana, 1972).

Pappaih and Muthuswamy (1974) working with dahlia plants observed that spray of 1000 and 2000 ppm MH, 1000 and 2000 ppm CCC, 500 and 1000 ppm ethrel caused significant increase in the number of flowers by 48.57, 59.43, 46.31, 52.91, 79.53 and 89.98 per cent, respectively over control. Similar effects of MH (2000 and 3000 ppm) and CCC (500, 1000 and 1500 ppm) were recorded by Pappaih and Muthuswamy (1977) in *Jasminum grandijlorum.L.*

Kumar *et al*. (1976) reported a significant increase in flower yield of marigold compared to control when plants were treated with 500-1000 ppm CCC. They recorded significant increase in yield by 41 and 63 per cent with 1000 and 2000 ppm CCC, respectively, over control.

Reddy and Sulladmath (1983) reported that MH at 750 ppm reduced flower production but MH at 500 ppm increased the flower yield in China aster.

Parmar and Singh (1983) investigated the role of CCC, MH or TIBA on growth and flowering of marigold cv. “Fantastic” and found moderate growth reduction and the maximum number of flower per plant with the application of CCC at 500 ppm or TIBA at 750 ppm.

Mohandas (1986) conducted experiment on 60 days old *Chrysanthemum cinerarifolium* seedlings which were transplanted in the field and growth regulators were applied a month later again at monthly intervals until flowering. Satisfactory yield of flowers were obtained with CCC at 250 ppm.

Pal *et al*. (1986) studied the effect of various growth regulator on *Calendula officinalis* and found that the significant increased number of flower per plant was obtained by the application of MH at 250 and 500 ppm.

Shi and Li (1987) studied the effect of daminozide (B-9) and CCC on petunia plants and concluded that B-9 at 1500-1000 ppm increased the number of flowers but CCC at 2500-10000 ppm slightly reduced the number of flowers.

Bhattacharjee (1989) treated 4 Yrs. Old plants of *Jasminum grandiflorum* L. with foliar spray of 1000-1500 ppm CCC in the early February and again repeated one month later. The flower yield of 369.6 g/ plant annually was obtained with 1000 ppm CCC against control yield (298) g/ plant annually.

Gowda and Gowda (1990) treated *Jasminum sambac* with 1000 and 2000 ppm cycocel or MH as foliar spray 15 days before pruning and 15 days after pruning. With both levels of CCC the flower yield was higher.

Pal and Das (1990) observed markedly increase in flower production of potted plants of *Lilium longiflorum,* when plants were sprayed with MH 100 or 200 ppm at 5-6 cm height of stem.

Syamal *et al*. (1990) revealed that all levels of MH (200-400 ppm) decreased flower number per plant in China aster.

Girwani *et al*. (1990) conducted an experiment on marigold (*Tagetes erecta* L.) cv. "African Giant Double Orange" and found that when CCC (500 or 1000 ppm) were sprayed on 30 days old seedling at 20 days after transplanting, it resulted in the maximum dry weight of 10 flower (68.2 g), highest number of flowers per plant (19.3) and flower yield (37.1 t/ha) at 100 ppm level.

Gowda and Jayanthi (1991) applied CCC 1000,1500 or 2000 ppm or MH 500, 1000 or 1500 ppm at three and five weeks after transplanting on African marigold cv. "Banglore local" and observed an increased number of flower and yield with 2000 ppm cycocel.

Dutta *et al*. (1993) applied CCC (1000, 2000, 3000 or 4000 ppm), MH (250,500 or 1000 ppm) on 45 days old, sand rooted cuttings of *Chrysanthemum* cv. "Co-1" at 30 and 45 days after planting and observed that flower quality and yield were improved by most of treatments.

Khimani and Patil (1993) applied Alar, CCC and MH each at 500, 1000 and 1500 ppm on *Gaillardia* to know the seasonal variation on the yield attributing characters and yield on *Kharif* and *Rabi* seasons. They recorded significant increase in flower yield due to application of CCC at 1000 and 1500 ppm. The increase in yield was 10 per cent in *Rabi* and 20 per cent in *Kharif* season over control.

In gaillardia, Khimani *et al*. (1994) found that Alar and CCC or MH each at 500,1000 and 1500 ppm treatments produced significantly more flowers than controls. They obtained highest flower numbers 160.6 flower/plant) and flower yield (165.20g/plant and 27.43 t/ha) with 500 ppm Alar treatment.

Aswath *et al*. (1994) reported that China aster when treated with MH at 500 and 1000 ppm recorded increased number of flowers per plant.

Sharma *et al*. (1995) found that MH at different concentrations (250, 500, 750 and 1000 ppm) significantly increased the number of flowers per plant over control.

Yadav *et al*. (1997) carried out a field trial on African marigold (*Tagetes erecta*) and observed that cycocel 750 ppm resulted in to the highest flower weight ie. 10.8 g per flower and 10.84 per plant as compare the other treatments.

Dutta and Ramdas (1998) observed that increasing MH concentrations (250-1000 ppm) significantly increased the flower yield per plant (0.552 kg) over control (0.263 kg) in chrysanthemum.

Kumar (1998) revealed that lower (250 ppm) and medium (500 ppm) concentrations of MH recorded significantly higher flower yield per plant (97.35 g and 89.72 g, respectively) whereas, higher concentration reduced the flower yield (75.0 g) in chrysanthemum cv. "IIHR-6" over control (87.20 g).

Hungar and Nalawadi (1999) studied the effect of growth regulators in gaillardia and found that MH at 50 ppm produced significantly higher flower yield as compared to control.

Meher *et al*. (1999) reported that the maximum yield in chrysanthemum was obtained when plants were sprayed with lowest concentration, but yield decreased when the concentration of MH was increased.

Gohel (2001) found minimum flowers per plant in chrysanthemum with the application of MH at 1000 mg/l.

Mathew *et al*. (2004) conducted a field experiment to study the effect of growth retardants and micronutrients on the growth and yield of African marigold cv. "Pusa Basanti Gainda" and found that out of 17 treatment combinations comprised of two levels each of CCC (1000 or 1500 ppm), B-9 (1000 or 1500 ppm), $ZnSO_4$ (0.2 or 0.5%) and $CuSO_4$ (0.2 and 0.5 %) with absolute control plant height, number of branches per plant were significantly affected under the combined application of 1500 ppm B-9 + 0.5 % $ZnSO_4$ as compare to all other treatment combination.

3. MATERIALS AND METHODS

A field experiment entitled "Effect of pinching and growth retardants on growth, flowering and yield of African marigold (*Tagetes erecta* L.) cv. 'Pusa Narangi Gainda" was carried out at the Horticulture Farm, Rajasthan College of Agriculture, Udaipur from October 2006 to March 2007. The details of the techniques followed and materials used during the course of investigation are described in this chapter under suitable heads.

3.1 EXPERIMENTAL SITE :

The experiment was laid out at Horticulture Farm, Rajasthan College of Agriculture, Udaipur which is situated at an elevation of 559.65 meters above mean sea level at latitude of 24 º North and longitude of 75 º East.

3.2 CLIMATE CONDITIONS :

Udaipur has a typical sub-tropical climate characterized by mild winters and summers. The average rainfall ranges between 65 to 75 cm per year and the maximum relative humidity varies from 75 to 90 per cent while minimum from 40 to 60 per cent. More than 90 per cent rainfall is received during the period of mid June to September. The minimum temperature varies from 0.5-25 ºC in winter and maximum from 42-45 ºC in summer. The summer is dry but not desiccating.

Meteorological mean weekly weather parameters i.e. temperature, relative humidity, rainfall, evaporation and sunshine as recorded during the course of experimentation are given in Table 3.1 and depicted Fig.3.1.

3.3 SOIL :

The soil of the experimental plot was clay loam with good water holding capacity and with good humus content. The pH of the experimental plot was 8.2. The details of mechanical, physical and chemical properties of the soil is presented in Table 3.2.

3.4 EXPERIMENTS :

Effect of pinching and growth retardant on growth, flowering and yield of African marigold cv. “Pusa Narangi Gainda”.

(A) Treatment Details

	(a) Pinching	**Notation**
(i)	No pinching	P_0
(ii)	Pinching at 30 days after transplanting	P_1
(iii)	Pinching at 45 days after transplanting	P_2

b. Growth retardant

(i)	CCC 500 ppm	R_1
(ii)	CCC 1000 ppm	R_2
(iii)	CCC 1500 ppm	R_3
(iv)	B-9 500 ppm	R_4
(v)	B-9 1000 ppm	R_5
(vi)	B-9 1500 ppm	R_6
(vii)	MH 500 ppm	R_7
(viii)	MH 1000 ppm	R_8
(ix)	MH 1500 ppm	R_9

B. Treatment combinations :

All possible combination of the above treatments i.e. 3 x 9 = 27 treatment combination were made and notation were given.

Treatments	Treatment combination	Notation
T_1	No pinching + CCC 500 ppm	P_0R_1
T_2	No pinching + CCC 1000 ppm	P_0R_2
T_3	No pinching + CCC 1500 ppm	P_0R_3
T_4	No pinching + B-9 500 ppm	P_0R_4
T_5	No pinching + B-9 1000 ppm	P_0R_5
T_6	No pinching + B-9 1500 ppm	P_0R_6
T_7	No pinching + MH 500 ppm	P_0R_7
T_8	No pinching + MH 1000 ppm	P_0R_8

T_9	No pinching + MH 1500 ppm	P_0R_9
T_{10}	Pinching at 30 DAT + CCC 500 ppm	P_1R_1
T_{11}	Pinching at 30 DAT + CCC 1000 ppm	P_1R_2
T_{12}	Pinching at 30 DAT + CCC 1500 ppm	P_1R_3
T_{13}	Pinching at 30 DAT + B-9 500 ppm	P_1R_4
T_{14}	Pinching at 30 DAT + B-91000 ppm	P_1R_5
T_{15}	Pinching at 30 DAT + B-9 1500 ppm	P_1R_6
T_{16}	Pinching at 30 DAT + MH 500 ppm	P_1R_7
T_{17}	Pinching at 30 DAT + MH 1000 ppm	P_1R_8
T_{18}	Pinching at 30 DAT + MH 1500 ppm	P_1R_9
T_{19}	Pinching at 45 DAT + CCC 500 ppm	P_2R_1
T_{20}	Pinching at 45 DAT + CCC 1000 ppm	P_2R_2
T_{21}	Pinching at 45 DAT + CCC 1500 ppm	P_2R_3
T_{22}	Pinching at 45 DAT + B-9 500 ppm	P_2R_4
T_{23}	Pinching at 45 DAT + B-9 1000 ppm	P_2R_5
T_{24}	Pinching at 45 DAT + B-9 1500 ppm	P_2R_6
T_{25}	Pinching at 45 DAT + MH 500 ppm	P_2R_7
T_{26}	Pinching at 45 DAT + MH 1000 ppm	P_2R_8
T_{27}	Pinching at 45 DAT + MH 1500 ppm	P_2R_9

Layout of the experiment :

The experiment was laid out in the factorial randomized block design with three replications. The plan of layout of the experiment is given in Fig. 3.2. The details of layout are as follows.

1.	Levels of pinching	-	3
2.	Levels of growth retardants	-	9
3.	Design of layout	-	Factorial RBD
4.	Factors	-	2
5.	Treatment combination	-	3 x 9 = 27
6.	No. of replication	-	3
7.	Total number of experimental plots	-	27 x 3 = 81
8.	Net plot size	-	1.80 m x 1.50 m = 2.70 m^2
9.	Total area of experimental plots	-	20.2 m x 13.5 m

10. Cultivar used	-	“Pusa Narangi Gainda”
11. Spacing	-	45 cm x 30 cm (R x P)
12. Number of plants/plot	-	4 x 5 = 20

3.4 RAISING OF SEEDLINGS :

The seed beds of 0.5 x 1.5 m size were prepared by digging the soil and mixing with well rotten FYM @ 50 kg per bed in soil and raising the level of beds to about 15 cm. The seeds of marigold cv. “Pusa Narangi Gainda” were obtained from IARI, New Delhi and were sown on 10th October 2006. Seed germination was completed within 10 days. To maintain proper moisture, the beds were frequently irrigated by watering can fitted with fine nozzle. The seed beds were kept free from weeds by regular hand weeding. The seedlings attained a height of about 15 cm in 30 days and they were transplanted in the prepared beds.

3.5 FIELD PREPARATION :

The field selected for experiment was ploughed once by tractor driven mould board plough followed by 2-3 cross harrowing and planking. The FYM @ 250 q/ha was applied uniformly and again the field was ploughed by cultivar to bring the field to proper tilth. Thereafter, the layout of experiment was done with the plot size of 1.80 x 1.50 m each so as to accommodate 20 plants in each plot at a spacing of 45 cm row to row and 30 cm plant to plant (Fig. 3.2).

3.6 TRANSPLANTING :

The seedlings of 30 days old were transplanted during the evening hours of on 10th November 2006 and immediately after transplanting, a light irrigation was applied.

Before uprooting the seedling from nursery, the beds were irrigated so that the seedlings may be lifted with little root injury. Only healthy seedlings of uniform growth were transplanted. The seedlings were transplanted in the plots at a spacing at 45 cm row to row and 30 cm plant to plant.

3.7 FERTILIZER APPLICATION :

In addition to FYM application, at the time of bed preparation, 10 g m^{-2} nitrogen (through urea), 20 g m^{-2} phosphorus (through SSP) and 20 g m^{-2} potash (through muriate of potash) were also applied to each bed. These fertilizers were thoroughly mixed in the soil and the beds were finally leveled. The second dose of nitrogen i.e. 10 g m^{-2} nitrogen through urea was applied at 30 days after transplanting.

3.8 IRRIGATION :

The field was irrigated immediately after transplanting. The plants were given uniform irrigation thereafter at an interval of one week through out the crop period.

3.9 AFTER CARE OF SEEDLINGS :

Since the marigold plants are very hardy so except gap filling no special care was needed. Three hoeings were done and weeding was done regularly as and when required. To control insect-pest and diseases the spray of insecticide (Rogor) and fungicide (Dithane M 45) was applied as per requirement.

3.10 TREATMENT TECHNIQUES :

(a) Chemical used :

Three retardants *viz.*, maleic hydrazide, N-dimethylaminosuccinamic acid (B-9) and 2-chloroethyle trimethyl ammonium chloride (CCC) were used for experimentation. All three growth retardants were used at three different levels of the concentrations i.e. 500, 1000 and 1500 ppm each, separately.

(b) Preparation of solutions :

For the preparation of 1000 ppm MH, CCC and B-9 solutions 1 g of MH, CCC and B-9 each were weighed separately and dissolved in a little quantity of dilute ammonium hydroxide. Then the volume was raised up to 1 litre by addition of distilled water. Similarly, for the preparation of 1500 ppm MH, CCC and B-9 solutions 1.5 gm MH, CCC and B-9 were weighed separately and dissolved in a little quantity of ammonium hydroxide. Then volume was raised up to 1 litre by addition of distilled water. For the preparation of 500 ppm concentration of all three retardants the standard solution of 1000 ppm MH, CCC and B-9 were diluted with double amount of distilled water.

(c) Treatment application :

The solution of growth retardants was uniformly sprayed on foliage of the plant with a fine nozzle sprayer. The spray was done in such a way that all the parts of the plant covered with a fine mist of solution. A few drop of Teepol (adhesive soap) was mixed in the solution as a sticker. The 1st spraying was done at 30 days after transplanting i.e. on 25th November 2005 and 2nd spray was done at 45 DAT i.e. on 10th December 2006.

3.11 CHARACTERS STUDIED AND TECHNIQUES USED FOR STUDY :

For recording the observations on different aspects of the study 5 plants from each plot were selected at random and were tagged. The study was undertaken with respect to following characters.

(A) Vegetative characters :

All the observations on vegetative characters *viz*., plant height, length of internodes, number of internodes on main soot, diameter of stem, number of branches per plant were recorded at 30, 45, 60, 75, 90, 105, 120 and 135 (i.e. at last picking stage) during the course of investigation. The details of technique followed for recording the observations are as follows :

1. Height of the plant (cm) :

A mark was put on the stem of the plant with red ink pen, above ground level to take uniform measurement of all the five plants. From the marked point height was measured to growing tip of the main stem. A meter scale was used for this purpose. The height was measured for all the five plants in each plot which were tagged and later on average was calculated.

2. Number of branches per plant :

The total number of branches coming out from the main stem were counted and recorded. This was done for all tagged plants in each treatment. Later on their average was calculated.

3. Number of internodes of main shoot :

The total number of internodes on each tagged plant was counted and recorded for all and later on the average was calculated.

4. Length of internodes of main shoot (cm) :

The length of third internode of all the five tagged plants was measured with the help of a scale and later on the average is calculated.

5. Diameter of main shoot (cm) :

The stem diameter was taken at 1 cm above from ground level in all the five tagged plants in each plot. It was recorded with the help of vernier caliper and late on average was calculate.

(B) Floral characters :

1. Appearance of first flower bud after transplanting (days) :

The number of days taken from transplanting to appearance of first flower bud on all five tagged plants was recorded and then average was calculated.

2. Number of days required for opening of first flower after transplanting (days):

The number of days taken from transplanting to first flowering was recorded on all five tagged plants and then average was calculated.

3. Number of days required for 50 % flowering (days):

The number of days required for 50% flowering was assumed when 50% plants of each plot got flower after transplanting.

4. Duration of flowering (days) :

Duration of bloom was calculated on the basis of days taken from first flowering to the last picking stage (i.e. 135 DAT) in each treatment and number of days were recorded.

5. Diameter of flower (cm) :

Five flowers picked from each tagged plants and their flower diameter was measured and the recorded data were used for calculation of average.

(C) Yield characters :

1. Number of flowers per plant :

The total number of flowers from each tagged plant were counted at every picking. The cumulative number of flower were added after the last picking then average for each treatment was calculated.

2. Fresh weight of flower (g) :

Five flower of each tagged plants were picked and weighed to calculated the average flower weight.

3. Yield of flower per plant (g) :

The flower harvested from all the tagged plant of each treatment were weighed after each picking and their cumulative weight were summed up at the end of crop to find out the average flower yield per plant.

4. Yield of flower per plot (kg) :

The flower harvested from all the tagged plant of each treatment were weighed after each picking and their cumulative weight were summed up at the end of crop to find out the average flower yield per plant, finally it was multiplied with total number of plants per plot to find out the average yield of flower per plot.

5. Yield of flower per hectare (tonnes) :

After calculating the yield of flowers per plot, the estimated yield of flower per hectare of each treatment was calculated.

(D) Relative economics of the treatments :

The total cost (cost of cultivation plus cost of treatment) and gross return (from sale of flowers) were calculated for each treatment for unit area (one hectare). For calculating the net return, the total cost was deducted from gross return and B:C ratio was calculated by dividing gross return with total cost, for each treatment :

Net returns = Gross returns – Total cost

$$\text{B:C ratio} = \frac{\text{Gross return}}{\text{Total cost}}$$

Statistical analysis and Presentation of Data :

In order to evaluate the effect of different treatments on vegetative and floral characters, the data were statistically analyzed using analysis of variance test (Cocharan and Cox, 1967). The critical difference was calculated to find out the significance of different treatments over control.

Table 3.2. Mechanical, physical and chemical characteristics of the experimental soil

		Characteristics	Value	Method employed
A.		**Mechanical composition**		
	1.	Sand (%)	39.90	
	2.	Silt (%)	24.52	Piper (1950)
	3.	Clay (%)	35.58	
B.		**Physical composition**		
	1.	Bulk density (g cm^{-3})	1.40	Core sampler method
	2.	Particle density (g cm^{-3})	2.62	Piper (1950)
C.		**Chemical**		
	1.	Organic carbon (%)	0.72	Walkley and Black (1947)
	2.	Total nitrogen (%)	0.073	Bremner (1960)
	3.	Available phosphorus (kg ha^{-1})	12.11	Olsen *et al.* (1954)
	4.	Available potassium (kg ha^{-1})	252.0	Richards (1954)
	5.	Electrical conductivity (m. mhos cm^{-1} at 25ºC)	0.53	Davis and Bryan (1910)
	6.	pH (1:2 soil water suspension)	8.2	Glass electrode pH meter (Richards, 1954)
	7.	CEC meq/100 g soil	16.60	Jackson (1973)

4. EXPERIMENTAL RESULTS

The results of the field experiment entitled "Effect of pinching and growth retardants on growth, flowering and yield of African marigold (*Tagetes erecta* L.) cv. "Pusa Narangi Gainda" have been presented in this chapter. The data pertaining to growth, yield and quality characters were subjected to statistical analysis and the analysis of variance have been presented in Appendices from I to XII at the end of thesis. In support of tabular representation of data few graphs have also been included for better understanding.

4.1 EFFECT OF PINCHING AND GROWTH RETARDANTS ON VEGETATIVE CHARACTERS:

4.1.1 Height of the plant (cm) :

The data on average plant height as affected by pinching (no pinching, pinching at 30 DAT and pinching at 45 DAT), growth retardants (CCC, B-9 and MH) and their interaction have been presented in Table 4.1 and depicted in Fig. 4.1 and its analysis of variance is given in Appendix-I.

A perusal of data presented in Table 4.1 reveal that pinching exhibited non-significant effect on plant height at 30 days after transplanting (DAT) but it was found significant at 45, 60, 75, 90, 105, 120 and 135 DAT (i.e. last picking stage). The plant height was found minimum i.e. 57.96 cm under P_1 (pinching at 30 DAT) treatment while, it was noted maximum (79.48 cm) at P_0 (no pinching) on 135 days after transplanting (i.e. at last picking stage).

It is evident from the data presented in Table 4.1 that the different growth retardants also exhibited significant effect on plant height at all growth stages viz., 45, 60, 75, 90, 105, 120 and 135 DAT (at last picking stage) except on 30 DAT. The lowest plant height (55.90 cm) was observed in R_6 (B-9 1500 ppm) treatment whereas, the highest plant height i.e. 71.31 cm was recorded under R_7 (MH 500 ppm) treatment on 135 DAT i.e. at last picking stage.

Further, the combined effect of pinching and growth retardant was also found significant on plant height at all the growth stages i.e. 60, 75, 90, 105, 120 and 135 DAT (i.e. at last picking stage) except on 30 and 45 DAT. A minimum plant height i.e. 43.67 cm was observed in T_{15} treatment while, the maximum plant height (82.56 cm) was found at T_7 treatment at last picking stage(135 DAT).

4.1.2 Number of branches per plant :

The data with regards to effect of pinching depicted in growth retardants and its interaction on number of branches per plant have been presented in Table 4.2 and depicted in Fig. 4.2 and its analysis of variance is given in Appendix-II.

A keen observation of data given in Table 4.2 reveal that initially the effect of pinching on number of branches per plant was found non-significant i.e. on 30 days after transplanting (DAT) but later on, its effect become significant at 45, 60, 75, 90, 105, 120 and 135 DAT (at last picking stage). The number of branches per plant was found significantly maximum (43.89) in P_1 (pinching at 30 DAT) treatment while, minimum number of branches per plant 34.10 i.e. was recorded under P_0 (no pinching) treatment on 135 DAT.

Similarly, a significant effect of growth retardants on number of branches per plant was also recorded at all the growth stage *viz.* 45, 60, 75, 90, 105, 120 and 135 DAT except on 30 DAT. Among various growth retardants the highest number of branches per plant 48.30 was observed under R_6 (B-9 1500 ppm) treatment whereas, the lowest number of branches per plant i.e. 34.41 was obtained in R_7 (MH 500 ppm) treatment during last picking stage i.e. on 135 DAT.

Further, the interaction effect of pinching and growth retardants on number of branches per plant was found to be significant at 45, 60, 75, 90, 105, 120 and 135 DAT but it was observed non significant at 30 DAT. The lowest number of branches per plant (28.94) was observed in T_7 treatment while, the highest number of branches per plant i.e. 54.73 was found at T_{15} treatment on last picking stage (135 DAT).

4.1.3 Number of internodes of main shoot :

The data regarding effect of pinching, growth retardants and its interaction on number of internodes on main shoot have been shown in Table 4.3 and depicted in Fig.4.3 and its analysis of variance is given in Appendix III.

The perusal of the data presented in Table 4.3 reveal that pinching shown non significant effect on number of internodes on main shoot at 30 DAT but it was found significant at 45, 60, 75, 90, 105, 120 and 135 DAT. The number of internodes was recorded significantly minimum (15.06) under P_1 (pinching at 30 DAT) treatment whereas, the maximum number of 15.51 internodes on main shoot was noted in P_0 (no pinching) treatment at last picking stage i.e. on 135 DAT.

A close examination of data given in the Table 4.3 indicate that the different growth retardants exhibited their significant effect on number of internodes on main shoot at all growth stages *viz.* 45, 60, 75, 105, 120 and 135 DAT except on 30 DAT. The minimum number of internodes on main shoot i.e. 13.98 was found in R_6 (B-9 1500 ppm) treatment while, maximum number of internodes on main shoot (16.80) was reported at R_7 (MH 500 ppm) treatment on 135 DAT (i.e. at last picking stage).

The combined effect of pinching and growth retardants was found non-significant on number of internodes on main shoot at 30, 45, 60, 75, 90 and 105 DAT but later on it become significant at 120 and 135 DAT at last picking) DAT. The lowest number of internodes on main shoot (13.81) was reported under T_{15} treatment while, the highest number of internodes on main shoot i.e. 16.98 was recorded at T_7 treatment during last picking stage (on 135 DAT).

4.1.4 Length of internodes of main shoot (cm) :

The data on length of internodes of main shoot as influenced by pinching, growth retardants and its interaction have been given in Table 4.4 and depicted in fig. 4.4 and its analysis of variance is presented in Appendix IV.

It is clear from the data (Table 4.4) that pinching exhibited non significant effect on 30 days after transplanting but its effect was found significant at 45, 60, 75, 90, 105, 120 and 135 (at last picking) DAT with regards to the internodal length of main shoot. The internodal length of main shoot was found significantly minimum i.e. 4.53 cm under P_1 (pinching at 30 DAT) treatment. Whereas, maximum internodal length of main shoot (5.19 cm) was recorded in P_0 (no pinching) treatment on 135 DAT (at last picking stage).

It is explicit from the data given in Table 4.4 that the growth retardant treatments gave significant effect on length of internodes of main shoot at all growth stage viz. 45, 60, 75, 90, 105, 120 and 135 DAT except on 30 DAT. However, the minimum internodal length of main shoot i.e. 4.35 cm was observed in R_6 (B-9 1500 ppm) treatment whereas, the maximum internodal length of main shoot (5.18 cm) was recorded under R_7 (MH 500 ppm) treatment on 135 DAT (i.e. at last picking stage).

The interaction effect of pinching and growth retardants was also found significant on length of internodes of main shoot at the growth stage of 105, 120 and

135 DAT but earlier it was found non-significant on 30, 45, 60, 75 and 90 DAT. The minimum internodal length of main shoot was recorded in T_{15} treatment i.e. 4.02 cm whereas, the maximum length of internode (5.55 cm) was found in T_7 treatment at last picking stage i.e. on 135 DAT.

4.1.5 Diameter of main shoot (cm):

The data pertaining to the influence of pinching, growth retardants and their combined treatments on diameter of main shoot have been presented in Table 4.5 and Figure 4.5 while, the analysis of variance is given in Appendix-V.

A bird eye view of the data (Table 4.5) clearly indicate that there was a significant effect of pinching on the diameter of main shoot on 45, 60, 75, 90, 105, 120 and 135 DAT (at last picking stage) but initially its effect was found non-significant on 30 DAT. The diameter of main shoot was reported significantly highest (1.78 cm) under P_1 (pinching at 30 DAT) treatment while, minimum diameter of main shoot i.e. 1.61 cm was noticed under in P_0 (no pinching) treatment on 135 DAT (i.e. at last picking stage).

Similarly, the significant effect of growth retardants on diameter of main shoot was also obtained at all growth stage *viz.* 45, 60, 75, 90, 105, 120 and 135 DAT except on 30 DAT. Among the various growth retardants the maximum diameter of main shoot i.e. 2.00cm was observed in R_6 (B-9 1500 ppm) treatment. Whereas, the minimum diameter of main shoot (1.56 cm) was noted at in R7 (MH 500 ppm) treatment stages i.e. 135 DAT (at last picking stage).

The combined effect of pinching and growth retardants on diameter of main shoot was recorded to be significant at 120 and 135 DAT but earlier i.e., at 30, 45, 60, 75, 90 and 105 DAT it was found non-significant. The maximum diameter of main shoot (2.10 cm) was found at T_{15} treatment while, the minimum diameter of main shoot i.e. 1.46 cm was noted in T_7 treatment at last picking stage i.e., on 135 DAT .

4.2 EFFECT OF PINCHING AND GROWTH RETARDANT ON FLORAL CHARACTERS:

4.2.1 Appearance of first flower bud after transplanting (days) :

The data on appearance of first flower bud after transplanting as influenced by different treatments of pinching , growth retardants and their combined application have been presented in Table 4.6 and depicted in Fig. 4.6 whereas , its analysis of variance is given in appendix VI.

A keen observation of the data (Table 4.6) clearly indicate that the appearance of first flower bud was significantly affected by the pinching treatment. A delayed appearance of first flower bud after transplanting (53.90 days) was recorded in P_1 (pinching at 30 DAT) treatment whereas, earliest appearance of first flower bud after transplanting (40.20) was observed under P_0 (no pinching) treatment .

It is also evident from the data given in Table 4.6 that the appearance of first flower bud after transplanting was significantly influenced as a result of different growth retardants. The maximum days required for appearance of first flower bud after transplanting (54.40 days) was noted in R_6 (B-9 1500 ppm) whereas, minimum days required for appearance of first flower bud after transplanting was observed at R_7 (MH 500 ppm) treatment i.e. 42.50 days after transplanting.

Further, the data clearly indicate that the combined application of pinching and growth retardant also had a significant effect on appearance of first flower bud after transplanting. The highest number of days required to appearance of first flower bud after transplanting i.e. 59.38 days was observed in T_{15} treatment whereas, the lowest number i.e. 34.98 days was required at T_7 treatment for appearance of first flower bud after transplanting..

4.2.2 Number of days required for opening of first flower after transplanting (days) :

The data with respect to the effect of pinching growth retardants and its interaction have been presented in Table 4.6 and depicted in Fig. 4.6 and its analysis of variance is given in Appendix VI.

It is evident from the keen observation of the data (Table 4.6) that pinching treatment had significantly delayed the opening of first flower after transplanting. The earliest anthesis or opening of first flower was recorded at P_0 (no pinching) treatment i.e. 44.89 days after transplanting. Whereas, significantly delayed anthesis of first flower was found with P_1 (pinching at 30 DAT) treatment i.e., 55.67 days after transplanting.

The data pertaining to number of days required for first flowering as presented in Table 4.6 reveal that flowering of marigold was significantly delayed by the treatment of growth retardants. The minimum number of days taken to first flowering

(45.75 days) was recorded in R_7 (MH 500 ppm) treatment whereas, the maximum number of days taken to first flowering i.e., 57.35 days after transplanting was noted under R_6 (B-9 1500 ppm) treatment.

Further, a bird eye view of the data (Table 4.6) clearly indicate that the combined application of pinching and growth retardants had a significant effect on days taken to first flowering. The least number of days taken to first flowering (39.89 days) was recorded in T_7 treatment while, the highest number of 61.38 days was taken to first flowering after transplanting by T_{12} (P_1R_3) treatment.

4.2.3 Number of days required for 50% flowering (days) :

An appraisal of the data (Table 4.6, Fig. 4.6 and Appendix VI) clearly reveal that number of days required for 50% flowering was significantly influenced by pinching, growth retardants and their interaction.

A perusal of the data given in Table 4.6 reveals that pinching treatment significantly increased the number of days required for 50% flowering. The earliest 50% flowering i.e., 55.35 days after transplanting was observed in P_0 (no pinching) treatment while, the delayed 50% flowering (60.00 days after transplanting) was found in P_1 (pinching at 30 DAT) treatment.

A keen observation of the data (Table 4.6) clearly indicate that growth retardant had significantly delayed 50% flowering. The minimum number of days required for 50% flowering was recorded in R_7 (MH 500 ppm) treatment i.e., 55.75 days after transplanting whereas, the maximum number of days required for 50% flower was noted under R_6 (B-9 1500 ppm) treatment i.e., 66.10 days after transplanting.

Further, the interaction of pinching and growth retardants also had a significant effect on number of days required for 50% flowering. The lowest number of day required for 50% flowering i.e., 50.35 days after transplanting was reported in T_7 treatment whereas, the highest number of days required for 50% flowering (70.03 days after transplanting) was noted with T_{15} treatment.

4.2.4 Duration of flowering (days) :

The data with concerned to duration of flowering as affected by pinching , growth retardants and its interaction have been presented in Table 4.6 and depicted in Fig. 4.6 and its analysis of variance is shown in Appendix VI.

An appraisal of the data given in Table 4.6 soundly proved that the duration of flowering was significantly increased as results of pinching treatments. The minimum duration of flowering (79.33 days) was recorded in P_1 (pinching at 30 DAT) treatment whereas, the maximum duration of flowering i.e., 90.10 days was found under P_0 (no pinching) treatment.

The data pertaining to duration of flowering as presented in Table 4.6 clearly the reveal that duration of flowering was significantly influenced by the application of growth retardants. The least duration of flowering (77.65 days) was observed in R_6 (B-9 1500 ppm) while, the highest duration of flowering i.e., 89.21 days was found in R_7 (MH 500 ppm) treatment.

Further, the data given in Table 4.6 indicate that the combined effect of pinching and growth retardants had a significant effect on duration of flowering. The minimum duration of flowering (73.62 days) was reported in T_{12} (P_1R_3) treatment whereas, maximum duration of flowering i.e., 95.00 days was observed at T_7 (P_0R_7) treatment.

4.2.5 Diameter of flower (cm) :

The data pertaining to the effect of pinching, growth retardants and their combined treatments on flower diameter have been presented in Table 4.6 and depicted in Fig. 4.6 and its analysis of variance is given in Appendix VII.

A perusal of data presented in Table 4.6 reveal that different pinching treatment had a significant effect on flower diameter. Among the various pinching treatment the maximum flower diameter of 5.31 cm was observed in P_2 (pinching at 45 DAT) treatment while, the minimum flower diameter i.e., 4.74 cm was found at P_0 (no pinching) treatment.

A bird eye view of the data clearly indicate that the effect of growth retardants on diameter of flower was also found significant. The highest diameter of flower i.e., 5.60 cm was observed in R_3 (CCC 1500 ppm) treatment while, the lowest diameter of flower (4.50 cm) was found with R_7 (MH 500 ppm) treatment.

Further, the diameter of flower was also significantly influenced due to combined application of pinching and growth retardant. The minimum diameter of flower (4.01 cm) was recorded in T_7 treatment whereas, the maximum diameter of flower i.e., 5.78 cm was noted under T_{21} treatment.

4.3 EFFECT OF PINCHING AND GROWTH RETARDENTS ON YEILD CHARACTER :

4.3.1 Number of flowers per plant :

The data in respect of the number of flowers per plant as influenced by different treatment of pinching (no pinching, pinching at 30 DAT and pinching at 45 DAT) and growth retardants (CCC, B-9 and MH) and their combinations are presented in Table 4.7 and Fig. 4.7 and its analysis of variance in Appendix-VII.

An appraisal of the data given in Table 4.7 indicate that the number of flowers per plant were significantly increased due to pinching treatments. The highest number of flowers per plant (44.61) was recorded in P_1 (pinching at 30 DAT) treatment whereas, the lowest number of flowers per plant i.e., 32.13 was observed in P_0 (no pinching) treatment.

Similarly, the number of flowers per plant were significantly affected by different growth retardants. The maximum number of flowers per plant (47.10) was observed in R_6 (B-9 1500 ppm) treatment whereas, the minimum number of number of flower per plant i.e., 34.10 was found in R_7 (MH 500 ppm) treatment.

Further, the interaction effect of pinching and growth retardants on number of flowers per plant was found to be significant. The maximum number of flowers per plant (54.08) was obtained in T_{15} treatment while the minimum number of flower per plant (26.84) was under T_7 treatment.

4.3.2 Fresh weight of flower (g) :

The data about the effect of pinching, growth retardants and their interaction on weight of flower have been given in Table 4.7 and depicted in Fig. 4.7 while their analysis of variance is presented in Appendix VII.

A bird eye view of the data (Table 4.7) clearly reveal that weight of flower was significantly affected by pinching treatments. The highest weight of flower (4.89 g) was recorded at P_2 (pinching at 45 DAT) treatment while, the lowest weight of flower i.e. 4.20 g was found under P_0 (no pinching) treatment.

Meanwhile, the weight of flower was significantly increased as a result of the application of the growth retardants. The least weight of flower i.e. 4.35 g was observed in R_7 (MH 500 ppm) treatment whereas, the highest weight of flower (5.00 g) was found at R_3 (CCC 1500 ppm) treatment.

Moreover, the interaction of pinching and growth retardant also gave the significant effect on weight of flower. The maximum weight of flower (5.33 g) was recorded in T_{21} treatment while, the minimum weight of flower i.e. 3.91 g was found under T_7 treatment.

4.3.2 Yield of flower per plant (g) :

The data on yield of flower per plant as influenced by pinching, growth retardants and their interaction have been presented in Table 4.7 and depicted in Fig. 4.7 and its analysis of variance is given in Appendix-VIII.

A appraisal of the data (Table 4.7) clearly reveal that the yield of flower per plant was significantly increased by pinching treatment. The maximum yield of flowers (203.14 g/plant) was recorded in P_1 (pinching 30 DAT) treatment while, the minimum flower yield i.e. 134.49 g/plant was recorded in P_0 (no pinching) treatment.

Likewise, the yield of flowers per plant significantly increased as a result of different growth retardant treatments. The highest yield of flower per plant (224.33 g/plant) was recorded in R_6 (B-9 1500 ppm) treatment whereas, the lowest yield of flower i.e. 148.49 g/plant was found in R_7 (MH 500 ppm) treatment.

The interaction effect of pinching and growth retardant on yield of flower per plant was also found significant. The superior yield of flower per plant (256.52 g) was recorded in T_{15} treatment whereas, the inferior yield of flower per plant (109.87 g) was found in T_7 treatment.

4.3.3 Yield of flower per plot (kg) :

The data with concerned to the effect of pinching, growth retardant and their combined application on yield of flower per plot (1.80x 1.50 m, size) have been presented in Table 4.7 and depicted in Fig. 4.7 while, its analysis of variance is given in Appendix VIII.

A perusal of data (Table 4.7) indicate that the yield of flower per plot was significantly increased due to pinching treatment. The lowest yield of flower (2.71 kg/plot) was obtained at P_0 (No pinching) treatment whereas, the highest yield of flower i.e. 4.09 kg/plot was found under P_1 (pinching at 30 DAT) treatment.

An appraisal of the data given in Table 4.7 clearly reveal that the yield of flower per plot was significantly increased as a result of different growth retardants treatments. The maximum yield of flower (4.48 kg/plot) was recorded in R_6 (B-9 1500 ppm) treatment while, the minimum yield of flower i.e. 3.01 kg/plot was recorded with R_7 (MH 500 ppm) treatment.

Moreover, it is evident from the data (Table 4.7) that pinching and growth retardants in combination had a significant effect on yield of flower per plot. The superior yield of flower i.e. 4.82 kg per plot was obtained in T_{15} treatment whereas, the inferior yield of flower per plot was recorded under T_7 treatment i.e. 2.10 kg/plot.

4.3.4 Yield of flower per hectare (t) :

The data pertaining to the effect of pinching, growth retardants and their combined application on the estimated yield of flower per hectare have been presented in Table 4.7 and depicted in Fig. 4.7 and their analysis of variance is given in Appendix VIII.

A bird eye view of data given in Table 4.7 reveal that yield of flower per hectare was significantly increased by pinching treatments. The lowest yield of flower i.e., 10.09 t ha^{-1} was obtained at P_0 (no pinching) treatment whereas, the highest yield of flower (14.78 t ha^{-1}) was obtained in P_1 (pinching at 30 DAT) treatment.

An appraisal of the data (Table 4.7) indicate that the yield of flower per hectare was significantly increased as a result of application of the growth retardants. The maximum yield of flower per hectare i.e. 16.30 t ha^{-1} was recorded in R_6 (B-9 1500 ppm) treatment while, the minimum yield of flower per hectare (11.12 t ha^{-1}) was observed with R_7 (MH 500 ppm) treatment.

Further, the interaction of pinching and growth retardant also exhibited a significant effect on yield of flower per hectare. The superior yield of flower per hectare (17.41 t ha^{-1}) was obtained with T_{15} treatment whereas, the inferior yield of flower per hectare i.e., 8.02 t ha^{-1} was recorded in T_7 treatment.

4.3.5 Relative economics of the treatments :

The data regarding to the relative economics of different treatment combination of pinching and growth retardants have been presented in Table 4.8. It is evident from the data that maximum net return of Rs. 1,58,762 per hectare was obtained from T_{21} (P_1R_3) treatment as compared to minimum net return of Rs. 70,005 per hectare as found in T_1 (P_0R_1) treatment. The highest net returns as gave by T_{12} (P_1R_3) treatment is due to low cost of chemical like CCC.

Although, the maximum gross return of Rs. 2,08,932 was recorded in T_{15} (P_1R_6) treatment but due to higher cost of the chemical like B-9, this particular treatment was found uneconomical as compared to all other the treatment combination with CCC.

5. DISCUSSION

During the course of presenting result of the experiment entitled "Effect of pinching and growth retardants on growth, flowering and yield of African marigold (*Tagetes erecta* L.) cv. "Pusa Narangi Gainda" in preceding chapter, many significant variation were observed due to the effect of different treatments of pinching and growth retardant, which are being discussed in this chapter in the light of finding of the research workers.

5.1 VEGETATIVE CHARACTERS :

5.1.1 Height of the plant (cm) :

A reference to the data (Table 4.1) on average plant height as influenced by the pinching i.e. P_0 (no pinching), P_1 (pinching at 30 DAT) and P_2 (pinching at 45 DAT) treatments reveal that the minimum plant height (57.96 cm) was recorded in P_1 (pinching at 30 DAT) treatment while, the maximum plant height (79.48 cm) was observed in P_0 (no pinching) treatment.

Significant effect of pinching at 30 DAT may be due to timely removal of terminal growing part which resulted into inhibition of plant height. Similar findings were obtained by Sain and Naik (1977) in chrysanthemum cv. "Early White", Sekhan (1981) in marigold, Bhati and Chitkara (1987) in African marigold cvs. "African Giant Orange", "African Giant Yellow" and "French Dwarf Red", Jangra (1993) in marigold and Sehrawat *et al.* (2003) in African marigold.

A keen observation of data with respect to plant height as shown in the previous chapter indicate that foliar application of growth retardant (CCC, B-9 and MH) had significantly reduced the average plant height.The maximum plant height of 71.31 cm was recorded in R_7 (MH 500 ppm) treatment while, the minimum plant height (55.90 cm) was recorded in R_6 (B-9 1500 ppm) treatment.

The reduction in plant height as a result of application of growth retardant may be correlated with the formation of shorter internodal length (Luckwill and Cutting, 1968) because of inhibitory action of the retardants on cell division (Kher, 1973) and due to antigibberellin action of growth retardant, thereby activities like apical growth and cell elongation are reduced. A similar response of growth retardants with respect to average plant height have been reported by Shi and Li (1987) in petunia, Brown *et* *al.* (1992) in African marigold, Gregov (1992) in chrysanthemum, Whipker *et al.* (1998) in sunflower, Mahalle *et al.* (2001) in chrysanthemum and Mathew *et al.* (2004) in African marigold.

It is further evident from the present study that the interaction effect of pinching and growth retardant on average plant height was significant at 60, 75, 90, 105, 120 and 135 DAT (i.e., last picking stage) but it was found non significant at 30 and 45 DAT. The inferior plant height (43.67 cm) was recorded in T_{15} (P_1R_6) treatment while, the superior plant height i.e., 82.56 cm was found at T_7 (P_0R_7) treatment which indicates that pinching at 30 DAT followed with growth retardant (B-9) predominantly reduced the average plant height of marigold and it might be due to the combined effect of both factors *viz.*, pinching and growth retardants.

5.1.2 Number of branches per plant :

The data on number of branches per plant as influenced by pinching treatments (Table 4.2) reveal that significantly maximum number of branches per plant (43.89) was recorded in P_1 (pinching at 30 DAT) treatment while, the minimum number of branches per plant i.e., 34.10 was found under P_0 (no pinching) treatment.

The increase in number of branches per plant by pinching treatments (P_1) might be due to the fact that after removing the apical portion of the plant, axillary buds present on the main shoot became free from correlative inhibition which were suppressed due to the apical dominance phenomenon and started growing, resulted in an increased number of branches due to pinching. Similar profuse axillary branch development due to pinching has also been reported by Singh and Arora (1980) in marigold, Chezhiyan *et al.* (1986) in chrysanthemum, Khanna *et al.* (1986) in marigold, Noto and Romano (1989) in *Antirrhinum majus* and Jangra (1993) in marigold.

The effect of application of growth retardants on number of branches per plant was also found significant. The highest number of branches per plant (48.30) was recorded with R_6 (B-9 1500 ppm) treatment whereas, the lowest number of branches per plant i.e. 34.41 was observed in R_7 (MH 500 ppm) treatment. Increasing concentration of B-9 significantly increased the number of branches per plant. This improvement in the number of branches per plant may be due to cause of suppressing effect of growth retardants CCC, B-9 and MH on apical buds thereby reducing terminal growth and thus more auxin would have been available to lateral buds, which after sprouting might have produced more branches (Shanmugam *et al.*, 1973). Secondly this increase in number of branches may be attributed to the cessation of apical dominance of the plant, because of the inhibition of auxin and GA synthesis and reducing the buds to the extend that apical growth is checked thereby permitting the lateral buds to sprout. The above result are in close conformity with the finding of Sen and Maharana (1971) in chrysanthemum, Gowda and Jayanthi (1991) in marigold cv. "Banglore local", Tomar (1993) in African marigold, Bhattacharjee and Singh (1995) in rose cv. "Raktagandha" and Mathew *et al.* (2004) in African marigold.

In the present investigation, the interaction effect of pinching and growth retardants was also found significant at all growth stage i.e. 45, 60, 75, 90, 105, 120 and 135 DAT except on 30 DAT. The maximum number of branches per plant (54.73) was recorded in T_{15} (P_1R_6) treatment while, the minimum number of branches per plant i.e. 28.94 was found in T_7 (P_0R_7) treatment. It might be due to the interactive effect of both factors *viz.* pinching at 30 DAT and plant sprayed twice with B-9 @ 1500 ppm.

5.1.3 Number of internodes of main shoot:

The data presented in Table 4.3 reveal that pinching (no pinching, pinching at 30 DAT and pinching at 45 DAT) had significantly reduced the average number of internodes on main shoot in marigold. The lowest number of internodes on main shoot (15.06) was observed in P_1 (pinching at 30 DAT) treatment while, the highest number of internodes on main shoot i.e. 15.51 was recorded in P_0 (no pinching) treatment. The decrease in number of internodes as a result of pinching treatment lends support from previous discussions on plant height as pinching treatments significantly decreased the plant height. The decrease in plant height has always been associated with decrease in number of internodes. Such decrease in number of internodes on main stem due to pinching treatment are in close agreement with finding of Sain and Naik (1977) in chrysanthemum cv. "Early White".

The number of internodes were significantly influenced by different growth retardant treatments (Table 4.3). Comparing the effect of different treatments on number of internodes reveal that application of B-9 1500 ppm (R_6) was found more effective than other treatments. The maximum number of internodes i.e., 16.80 was recorded in R_7 (MH 500 ppm) treatment while, the minimum number of internodes (13.98) was observed in R_6 (B-9 1500 ppm) treatment. The decrease in number of internodes on main shoot due to the application of B-9 1500 ppm might have caused a significant reduction on in plant height as compared to other retardant and its reason is well discussed under previous character *viz.* plant height. The results as achieved from the present study are in close conformity with the finding of Whipker *et al.* (1995) in China aster, Caro and Herrera (1996) in *Coleus blumei* and Mahalle *et al.* (2001) in chrysanthemum cv. "Flirtation".

The combined effect of pinching and growth retardants was found to be significant at 120 and 135 DAS (i.e. last pinking stage). The lowest number of internodes on main shoot (13.81) was recorded in T_{15} (P_0R_6) treatment while, the highest number of internodes on main shoot i.e., 16.98 was found in T_7 (P_0R_7) treatment. The reason behind such response of the treatments is may be the interactive effect of the both factors namely pinching and growth retardants.

5.1.4 Length of internodes of main shoot (cm) :

It is evident from the data (Table 4.4) that the length of internode was significantly reduced by the pinching treatments. The inferior length of internode (4.53 cm) was recorded in P_1 (pinching at 30 DAT) treatment whereas, the superior length of internodes i.e., 5.19 was found in P_0 (no pinching) treatment. The reduction in internodal length due to pinching might be attributed to the fact that by removing apical portion of the plant, upward growth of the main shoot stopped as the site of auxin synthesis removed which caused a cessation of growth and shorter internodes of the plants. These results are in close conformity with the findings of Bhati and Chitkara (1987) in marigold, Noto and Romano (1989) in *Antirrhinum majus* and Khandelwal *et al.* (2003) in African marigold.

As reported earlier in previous chapter that the internodal length of main shoot was significantly affected by the application of growth retardants. Application of B-9 produced shorter internodes as compared to MH application. The minimum length of internodes (4.35 cm) was recorded in R_6 (B-9 1500 ppm) treatment while, the maximum length of internode was observed at R_7 (MH 500 ppm) treatment i.e. 5.18 cm.

The reduction in internodal length due to growth retardant treatment may be due to inhibitory action of growth retardants which might have inhibited the apical growth and cell elongation in main stem which ultimately reduced internodal length (Luckwill and Cutting, 1968). These results are quite comparable to some earlier reports of Sen and Sen (1968) in petunia, Armitage *et al.* (1978) in *Calendula officinalis* cv. “Mandarin” and Whipker *et al.* (1995) in China aster.

The interaction effect of pinching and growth retardants on length of internode of main shoot was found to be significant at 105, 120 and 135 DAT (i.e. last picking stage) but earlier it found non-significant at 30, 45, 60, 75 and 90 DAT. Under present investigation, the minimum length of internodes of main shoot (4.02 cm) was recorded in T_{15} (P_1R_6) treatment as compared to maximum length of internode i.e. 5.55 cm was exhibited under T_7 (P_0R_7) treatment. Thus it is clear from the present investigation that growth retardant treatments are more pronounced in reduction of internodal length of the main shoot which ultimately reduced the plant height of marigold. This reduction in internodal length it supported by Pergola (1976) in chrysanthemum and Caro and Herrera (1996) in *Coleus blumei*.

5.1.5 Diameter of main shoot (cm):

As evident from the data (Table 4.5) that the stem diameter of marigold was significantly increased due to pinching (no pinching, pinching at 30 DAT and pinching at 45 DAT) and growth retardant (CCC, B-9 and MH) treatments. At last picking stage (i.e. 135 DAT), the maximum diameter of main shoot (1.78 cm) was recorded in P_1 (pinching at 30 DAT) treatment whereas, the lowest diameter of main shoot i.e., 1.61 cm was observed in P_0 (no pinching) treatment. The increase in stem diameter as a result of pinching treatment lends support from the previous discussion on plant height. The decrease in plant height is always associated with increase in stem diameter because shorter the height thicker the stem and vice versa. These findings are lend support by Khandelwal *et al.* (2003) in African marigold.

Though, the application of different growth retardant treatment had a beneficial effect on the stem diameter of marigold. The superior diameter of main shoot (2.00 cm) was recorded in R_6 (B-9 1500 ppm) treatment while, significantly inferior diameter of main shoot (1.56 cm) was found in R_7 (MH 500 ppm) treatment. The increase in stem diameter as a result of growth retardant treatments lends support from the previous discussion on plant height. The increase in stem diameter may also be related to the increasing mitotic activity cell division resulting in increased stem diameter. These findings are in close conformity with the results obtained by Sen and Maharana (1972) in chrysanthemum, Singh *et al.* (1994) in dahlia, Wilfret and Barrett (1995) in azalea and Mahalle *et al.* (2001) in chrysanthemum.

The interaction of pinching and growth retardants showed significant effect at 120 and 135 DAT (i.e. last pinching stage) but earlier their combined treatment exhibited non significant effect on diameter of main shoot at 30, 45, 60, 75, 90 and 105 DAT. The maximum diameter of main shoot (2.10 cm) was recorded in T_{15} (P_1R_6) treatment whereas, the minimum diameter of main shoot i.e. 1.46 cm was observed in T_7 (P_0R_7) treatment. The significant effect of interaction on diameter of main shoot probably due to the combined effect of both factors at later growth stage of the plant.

5.2 FLORAL CHARACTERS:

5.2.1 Appearance of first flower bud after transplanting (days) :

A keen observation of data shown in the previous chapter reported that pinching showed significant effect on appearance of first flower bud. The maximum days required for appearance of first flower bud i.e. 53.90 days was recorded in P_1 (i.e. pinching at 30 DAT) treatment while, the minimum number of days required for appearance of first flower bud (40.20 days) was found in P_0 (no pinching) treatment. The delay in appearance of first flower bud might be attributed to the fact that application of pinching, might have suppressed the bud initiation process by way of inhibition in cell division in the sub apical meristem during the period when the floral stimulus was present, thus preventing the expression of the stimulus in flower primordial, which would have ultimately resulted in delayed initiation of first flower bud (Zeewart, 1967). The result of present investigation are in close agreement with the findings of Raskauskas and Knyvience (1983) in sim carnation, Arora and Khanna (1986) in African marigold and Ress and Lewis (1986) in chrysanthemum.

It is evident from the data as presented in previous chapter that the earliest bud appearance i.e. 42.50 days was recorded in R_7 (MH 500 ppm) treatment while the delayed appearance of first flower bud (54.40 days) was observed in R_6 (B-9 1500 ppm) treatment. This delay in appearance of first flower bud might also due to action of growth retardant which by virtue suppress the activities of GA, which is a growth regulator effective in bud initiation. These findings are lends support by Sen and Maharana (1972) in chrysanthemum. Gregov (1992) in chrysanthemum cvs. “Clingo” and “Dark West Land” and Whipker *et al.* (1995) in *Aster novibelgii*.

The combined effect of pinching and growth retardant was also significantly delayed the appearance of first flower bud. The highest days required for appearance of first flower bud (59.38 days) was recorded in T_{15} (P_1R_6) treatment whereas, the lowest days required for appearance of first flower bud i.e. 34.98 days was recorded under T_7 (P_0R_7) treatment. These findings are lends support by the earlier discussion about the combined effect of both factors *viz.* pinching and growth retardants on the growth characters of marigold.

5.2.2 Number of days required for opening of first flower after transplanting (days):

Number of days taken to first flower opening was significantly affected by pinching, growth retardants and their combined treatments (Table 4.6). In the present study the average days taken to first flower opening was significantly delayed by pinching treatments. The earliest flower opening (44.89 days) was recorded in P_0 (no pinching) treatment while, delayed flowering (55.67 days) was recorded under P_1 (pinching at 30 DAT) treatment. This delayed in flowering due to pinching might be attributed to the fact that during the process of pinching, physiological mature portion of the shoot was removed and new shoots which emerged out from the pinched plants took more time to become physiologically mature. That is why the flowering were delayed in pinched plants. These results are in close conformity with the findings of Arora and Khanna (1986) in marigold, Wainwright and Irwin (1987) in antirrhinum and Jangra (1993) in marigold.

It is evident from the data given in Table 4.6 that the maximum number of days (57.35 days) taken to first flower opening was recorded in R_6 (B-9 1500 ppm) treatment whereas, the minimum number of 45.75 days taken to first flower opening was recorded in R_7 (MH 500 ppm) treatment. This delay in flowering might be attributed to the fact that application of higher concentration of growth retardant might have suppressed the flowering process by way of inhibition of cell division in the sub apical meristem during the period when the floral stimulus was present thus preventing the expression of the stimulus in flowering primordia which would have ultimately resulted in delayed flowering (Zeewart, 1967). These findings are lends support by Sen and Maharana (1972) in chrysanthemum, Gregov (1992) in chrysanthemum cvs. “Clingo” and “Dark West Land” and Whipker *et al.* (1995) in *Aster novibelgii.*

The combined effect of pinching and growth retardants also exhibited a significant effect on days taken to first flower opening. The highest number of 61.38

days were taken to first flower opening was recorded in T_{12} (P_1R_3) treatment while, the lowest number of days taken to first flower opening i.e., 39.89 days was observed in T_7 (P_0R_7) treatment. The advance flower opening might be due to the interactive effect of both factors *viz* .pinching and growth retardants.

5.2.3 Number of days required for 50% flowering (days) :

A keen observation of data shown in the previous chapter (Table 4.6) reported that pinching, growth retardants and their combination had significant effect on number of days required for 50% flowering.

The highest number of days required for 50% flowering (66.00 days) was recorded in P_1 (pinching at 30 DAT) treatment while, the lowest number of days required for 50% flowering i.e., 55.35 days was observed in P_0 (no pinching) treatment. This delayed in 50% flowering due to pinching might be attributed to the fact that during the process of pinching, physiological mature portion of the shoot was removed and new shoots which emerged out from the pinched plants took more time to become physiological mature. That is why the flowering were delayed in pinched plants and ultimately it resulted in to delayed 50% flowering of plants in the field. These results are in close conformity with the findings of Arora and Khanna (1986) in marigold, Wainwright and Irwin (1987) in antirrhinum and Jangra (1993) in marigold.

A bird eye view of the data shown in the previous chapter reveal that growth retardants had a significant effect on number of days taken to 50% flowering. Under R_6 (B-9 1500ppm) treatment, significantly maximum number of days required for 50% flowering i.e. 66.10 days while, in R_7 (MH 500 ppm) treatment minimum number of days was recorded for 50% flowering (55.75 days). This delay in flowering due to application of growth retardant might be attributed to the fact that plant treatment with higher concentration of growth retardants might have suppressed the flowering process by way of inhibition in cell division in the sub apical meristem during the period when the floral stimulus was present thus preventing the expression of the stimulus in flowering primordial which would have ultimately resulted in delayed 50% flowering. These findings are in close conformity with the result obtained by Sen Maharana (1972) in chrysanthemum, Gregov (1992) in chrysanthemum cvs. “Clingo” and “Dark West Land” and Whipker *et al.* (1995) in *Aster novibelgii.*

Combined effect of pinching and growth retardant also exhibited a significant effect on days taken to 50% flowering. The lowest number of days taken to 50% flowering was observed in T_7 (P_0R_7) treatment i.e. 50.35 days. While, the highest number of days taken to 50% flowering was recorded in T_{15} (P_1R_6) treatment i.e. 72.03 days. It may be due to the combined effect of both factors.

5.2.4 Duration of flowering:

The data presented in preceding chapter (Table 4.6) reveal that average duration of flowering in marigold increased significantly by the treatment of pinching, growth retardant and their combinations. The longest duration of flowering i.e. 90.10 days was recorded with P_o (no pinching) treatment whereas, the shortest duration of flowering (79.33 days) was observed under P_1 (pinching at 30 DAT) treatment. This might to due to the reason that by removing the apical portion of the plant, the plant enters again into vegetative phase and the new shoots took longer time to become physiologically mature which in turn bear flowers for a shorter time and thus resulted in shortest duration of flowering. These results are in close conformity with the findings of Arora and Khanna (1986) in marigold. Similar observations have also been noted by several other workers like Bunt (1979) in carnation, Gowda and Jayanthi (1988) in gladiolus.

The duration of flowering was significantly increased with the application of growth retardants. Among different growth retardant R_7 (MH 1500 ppm) treatment registered with maximum duration of flowering i.e. 89.21 days whereas, the minimum duration of the flowering i.e. 77.65 days was found in R_6 (B-9 1500 ppm). This increase in duration of flowering in marigold due to B-9 application lends support from earlier discussion on vegetative growth characters, where the B-9 have significantly retarded plant height and increased more number of branches with thick stem and dark green colour, which might have kept the treated plants more sturdy, fresh and green for a longer period and this might have maintained the supply of flowering inducing hormones for longer period and might have increased the duration of flowering Dutta *et al*. (1993) in chrysanthemum.

Combined application of pinching and growth retardants showed significant effect on duration of flowering. The maximum duration of flowering (95.00 days) was observed in T_7 (P_0R_7) treatment while, the minimum duration of flowering

(73.62 days) was found in T_{12} (P_1R_3) treatment. It might be due to the interactive effect of both factors *viz.* pinching and growth retardants.

5.2.5 Diameter of flower (cm) :

The diameter of flower has been significantly affected by the pinching, growth retardants and their combined treatments (Table 4.6). All the treatments of pinching have exhibited the increased diameter of flower as compared to P_0 (no pinching) treatment where the lowest diameter of flower i.e. 4.74 cm was observed. While, the highest diameter of flower was recorded in P_2 (pinching at 45 DAT) treatment i.e. 5.31 cm. This might be due to fact that pinching at 45 DAT increased vegetative growth as compared to pinching at 30 DAT and it lead to production of more food material which in turn may have been utilized for better development of flowers of better sized. Another reason, it may be pointed out that in P_1 (pinching at 30 DAT) treatment, there was increment in the number of flowers per plant, hence the developing flower might have been supplied with comparatively lesser quantities of plant produced growth regulators, resulting in reduction of flower diameter. Similar result were also reported by Sain and Naik (1977) in chrysanthemum cv. “Early White” and Jangra (1993) in marigold.

Various treatments of growth retardants also showed the significant effect on flower diameter. The maximum flower diameter (5.60 cm) was observed in R_3 (CCC 1500 ppm) treatment while, minimum flower diameter i.e., 4.50 cm was found in R_7 (MH 500 ppm) treatment. The reduction in flower diameter in B-9 treatment seems to be linked with inhibition of GA biosynthesis, which is essential at the time of flower development. It may be pointed out that the B-9 treatments have increased the number of flowers per plant, hence the developing flower might have been supplied with comparatively lesser quantity of growth regulators resulting in reduction of flower diameter. The present results are supported by Sen and Maharana (1972) in chrysanthemum, Pappaih and Muthuswamy (1976) in *Althea rosea*, Bhattacharjee *et al.* (1979), plant Novselova *et al.* (1985) in *Tagetes patula* and Talukdar and Paswan (1996) in chrysanthemum.

It is evident from the data (Table 4.6) that the combined effect of pinching and growth retardant was also found significant on diameter of flower. The highest diameter of flowers (5.78 cm) was recorded in T_{21} (P_2R_3) treatment as compared to the lowest diameter of flower i.e. 4.01 cm as obtained under T_7 (P_0R_7) treatment. A comparatively inferior size of flower in T_{15} (P_1R_6) treatment (i.e. 4.01 cm) might be due to predominant effect of B-9 which increased the yield of flower by increasing total number of flower per plant but ultimately reduced the diameter of flower. Similar results were also reported by Shawarer and Qrunfleh (1988) in chrysanthemum.

5.3 YIELD CHARACTERS :

5.3.1 Number of flower per plant :

The number of flowers per plant had significantly increased by pinching, growth retardants and their combined treatment (Table 4.7). In the present experiment the minimum number of flowers (32.13/plant) were recorded in P_0 (no pinching) treatment while, the maximum number of flowers per plant i.e. 44.61 were observed at P_1 (pinching at 30 DAT) treatments. The increase in number of flowers may be due to termination of vertical growth, more lateral branches might have produced more axis from where flowers originate thereby producing more number of flower per plant. Increase in number of flowers have also been reported by Rajasekhran *et al.* (1983) in gompherna plants, Khandelwal *et al.* (2003) in African marigold, Sehrawat *et al.* (2003) in African marigold cv. "African Giant Double Orange".

Application of growth retardants significantly increased the number of flowers per plant. The highest number of flowers per plant (47.10) was recorded in R_6 (B-9 1500 ppm) treatment whereas, the lowest number of flowers per plant i.e., 34.10 was found in R_7 (MH 500 ppm) treatment. The increase in number of flower due to the growth retardants application may be correlated with the vegetative growth characters like number of branches, stem diameter and length of internodes where the treatment exhibited significant effect. As a result of this the plant had a comparatively higher level of organic reserves conductive for better floral development and thereby increased the number of flowers. Increase in number of flowers by B-9 sprays have also been reported by Sen and Maharana (1972) in chrysanthemum, Khimani *et al.* (1994) in gaillardia and Shi and Li (1987) in petunia.

The different interactive treatments of pinching and growth retardants have been tried in the present experiment and they also exhibited a significant effect on number of flowers per plant. The maximum number of flower per plant (54.08) were recorded in T_{15} (P_1R_6) treatment while, the minimum, number of flowers per plant i.e. 26.84 were observed in T_7 (P_0R_7) treatment. Probably this type of result trends, with regards to the number of flower per plant is due to the combined effect of both factors viz. pinching and B-9 application.

5.3.2 Fresh weight of flower (g) :

The weight of flower has been significantly affected by the pinching, growth retardants and their combination (Table 4.7). All the pinching treatments under study were resulted in to the increased weight of flower as compared to no pinching treatment (P_0). The highest flower weight (4.89 g) was noted in P_2 (pinching at 45 DAT) treatment while, the lowest flower weight i.e., 4.20 g was recorded at P_0 (no pinching) treatment. The reduction in flower weight in P_1 (pinching at 30 DAT) treatment might be due to the reason that P_1 treatment increased the number of flowers per plant, hence the developing flower might have been supplied with comparatively lesser quantities of growth regulator and food reserve hence, resulting in reduction of flower weight. The present results are supported by Sain and Naik (1977) in chrysanthemum and Jangra (1993) in marigold.

Similarly, various treatments of growth retardants also produced a significant effect on flower weight. The maximum flower weight (5.00 g) was observed in R_3 (CCC 1500 ppm) whereas, the minimum weight of flower was observed in R_7 (MH 500 ppm) tratment i.e. 4.35 g. The reduced flower weight in B-9 treatment seems to be linked with inhibition of GA biosynthesis essential at the time of flower development. The findings of Pappaih and Muthuswamy (1976) in *Althea rosea*, Novoselova *et al.* (1985) and Tomar (1993) in marigold strongly support the present results.

Further, combined application of pinching and growth retardants also exhibited significant effect on weight of flower. The highest weight of flower (5.33 g) was found in T_{21} (P_2R_3) treatment as compared to the lowest weight of flower i.e. 3.91 g as recorded under T_7 (P_0R_7) treatment. The reduction in weight of flower in T_{15} (P_1R_6) treatment might be due to predominant effect of early pinching and B-9 treatment which increased the yield flowers by increasing the number of flower per plant but ultimately it reduced the weight of flower.

5.3.3 Flower yield per plant (g) :

The average yield of flower per plant significantly increased with the application of pinching, growth retardants and their combinations. It is evident from the data presented in previous chapter that the maximum yield of flower per plant was observed in P_1 (pinching at 30 DAT) treatment i.e. 203.14 g while, the minimum yield of flower per plant (134.49 g) was recorded in P_0 (no pinching) treatment. The increased yield of flowers lends support from previous discussions on number of flowers per plants, where pinching had significantly increased the number of flowers per plant. This increase in number of flowers per plant may be associated with increase in flower yield. The present result are in close agreement with the findings of Rajasekhran *et al.* (1983) in gomphrena plants, Jangra (1993) in marigold, Khandelwal *et al.* (2003) in African marigold and Sehrawat *et al.* (2003) in African marigold cv. “African Giant Double Orange”.

Likewise, different growth retardants also significantly increased the yield of flower per plant. Among the various treatment of growth retardants the maximum yield of flowers per plant i.e. 224.33 g was recorded in R_6 (B-9 1500 ppm) treatment whereas, the minimum yield of flower per plant was found in R_7 (MH 500 ppm) treatment i.e. 148.49 g. The increases in the yield of flower lends support from previous discussion on number of flower per plant as increased by B-9 application. The increase in the number of laterals under different growth retardant treatments may helped in the development of compact and bushy plants which might also help in increasing the number and yield of flowers. The present result are in close conformity with the findings of Bhattacharjee (1989) in *Jasminum grandiflorum*, Gowda and Gowda (1990) in *Jasminum grandiflorum*, Khimani and Patil (1993) in gaillardlia. Khimani *et al.* (1994) in gaillardia and Mathew *et al.* (2004) in African marigold.

Similarly, the combined application of pinching and growth retardants also significantly increased the yield of flowers per plant. Among all the treatments attempted the maximum yield of flower per plant (256.52 g) was observed in T_{15} (P_1R_6) treatment while, the minimum yield of flower per plant i.e., 109.87 g was recorded in T_7 (P_0R_7) treatment. This might be due to the intrective effect of the both factors *viz.*, pinching and growth retardants.

5.3.4 Flower yield per plot (kg) :

A perusal of the data given in the previous chapter (Table 4.7) indicate that pinching, growth retardants and their combination resulted in to a significant increment in the yield of flower per plot (kg). Under P_1 (pinching at 30 DAT) treatment, significantly highest yield of flower per plot (4.09 kg) was recorded in comparison of the lowest yield of flower per plot i.e. 2.71 kg as observed at P_0 (no pinching) treatment. This increase in flower yield per plot lends support from previous discussion on number of flowers and yield of flowers per plant (g). The increased in yield of flower due to pinching treatments was also reported by Jangra (1993) in marigold, Khandelwal *et al.* (2003) in African marigold and Sehrawat *et al.* (2003) in African marigold cv. “African Giant Double Orange”.

A bird eye view of data given in the previous chapter (Table 4.7) clearly reveal that growth retardants were also exhibited their significant effect on yield of flower per plot. The R_6 (B-9 1500 ppm) treatment gave significantly maximum yield of flower per plot (4.48 kg) while, the minimum yield of flower per plot i.e. 3.01 kg was observed in R_7 (MH 500 ppm) treatment. The increase in flower yield per plot lends support form pervious discussion on number of flower per plant and yield of flower per plant. These findings are in accordance with Khimani and Patil (1993) in gaillardia, Khimani *et al.* (1994) in gaillardia, Gowda and Gowda (1990*) Jasminum grandiflorum* and Mathew *et al*. (2004) in African marigold.

Further, the combined application of pinching and growth retardants (Table 4.7) significantly increased the yield of flower per plot . The highest yield of flower per plot (4.82 kg) was observed in T_{15} (P_1R_6) treatment while, the lowest yield of flower per plot i.e. 2.10 kg was noted under T_7 (P_0R_7) treatment. The cause behind such trend of the treatments is probably combined effect of the both factors *viz.*, pinching and growth retardants.

5.3.5 Flower yield per hectare (t) :

A keen observation of data shown in previous chapter (Table 4.7) clearly indicate that pinching, growth retardants and their combination had a significant effect on the estimated yield of flower per hectare.

The maximum estimated yield of flower per hectare was recorded in P_1 (pinching at 30 DAT) treatment i.e. 14.78 t ha^{-1} whereas, the minimum estimated yield of flower per hectare (10.09 t) was found at P_0 (no pinching) treatment. The increase in the yield of flowers lend support from previous discussions on number of flowers per plant, where pinching had significantly increased the number of flowers per plant. This increase in number of flowers per plant may be associated with increase in flower yield per plant, per plot and ultimately per hectare. The present result are in agreement with the findings of Jangra (1993) in marigold, Khandelwal *et al*. (2003) in African marigold and Sehrawat *et al*. (2003) in African marigold cv. “African Giant Double Orange”.

It is evident from the data presented in previous chapter that the growth retardant also significantly increase the estimated yield of flower per hectare. The highest estimated yield of flower per hectare (16.30 t) was recorded in R_6 (B-9 1500 ppm) treatment whereas, the lowest estimated yield of flower per hectare i.e. 11.12 t was observed under R_7 (MH 500 ppm) treatment. This increase in flower yield per hectare lends support from previous discussion on the characters *viz.*, number of flowers per plant, yield of flower per plant and yield of flowers per plot. Similar findings i.e. improvement in the yield of flower due to growth retardants application was also reported by Khimani *et al.* (1994) in gaillardia, Gowda and Gowda (1990) in *Jasminum grandiflorum* and Mathew *et al.* (2004) in African marigold.

Moreover, the interaction effect of pinching and growth retardant (Table 4.7) was also found significant on the estimated yield of flower per hectare. The superior estimated yield of flower per hectare i.e. 17.41 t was observed in T_{15} (P_1R_6) treatment while, the inferior estimated yield of flower per hectare (8.02 t) was recorded under T_7 (P_0R_7) treatment. Once again, this might be due to the interactive effect of the both factors *viz.* pinching and growth retardants.

6. SUMMARY

A field experiment entitled “Effect of pinching and growth retardants on growth, flowering and yield of African marigold (*Tagetes erecta* L.) cv. “Pusa Narangi Gainda” was conducted at Horticulture Farm, Rajasthan College of Agriculture, Udaipur from October, 2006 to March 2007.During the course of investigation three levels of the pinching (i.e. no pinching, pinching at 30 DAT and pinching at 45 DAT), nine levels of the growth retardants (CCC B-9 and MH each at 500, 1000 and 1500 ppm) and their all possible combinations were used for experimentation. The growth retardants spray was done twice i.e., 30 and 45 DAT. The salient findings of this investigation at last picking stage i.e. 135 DAT are summarized here:

- T_{15} (P_1R_6) treatment was recorded with minimum plant height of 43.67 cm while, T_7 (P_0R_7) treatment was noted with the maximum plant height of 82.56 cm.
- The highest number of branches per plant (54.73) was recorded in T_{15} (P_1R_6) treatment whereas, the lowest number of branches per plant i.e., 28.94 was obtained at T_7 (P_0R_7) treatment.
- The lowest number of internodes (13.81) was recorded in T_{15} (P_1R_6) treatment as compared to the highest number of internodes i.e. 16.98 as noticed with T_7 (P_0R_7) treatment.
- The minimum internodal length (4.02 cm) was recorded in T_{15} (P_1R_6) treatment which was significantly less as compared to maximum internodal length of 5.55 cm as noted under T_7 (P_0R_7) treatment.
- T_{15} (P_1R_6) treatment resulted in maximum diameter of main shoot 2.10 cm which was significantly more as compared to the minimum diameter of main shoot i.e., 1.46 cm as recorded under T_7 (P_0R_7) treatment.
- The maximum days required for appearance of first flower bud (59.38 days) was recorded under T_{15} (P_1R_6) treatment while, the minimum days required for appearance of first flower bud i.e., 34.98 days was observed at T_7 (P_0R_7) treatment.

- The highest number of days required for opening of first flower (61.38 days) was observed in T_{12} (P_1R_3) treatment while, the lowest number of days required for opening of first flower i.e., 39.89 days was recorded in T_7 (P_0R_7) treatment.
- The maximum number of days required for 50% flowering (72.03 days) was recorded in T_{15} (P_1R_6) treatment while, the minimum number of days required for 50% flowering i.e., 50.35 days was noted at T_7 (P_0R_7) treatment.
- The minimum duration of flowering (73.62 days) was recorded in T_{12} (P_1R_3) treatment while, the maximum duration of flowering i.e. 95.00 days was observed at T_7 (P_0R_7) treatment.
- The maximum flower diameter (5.78 cm) was recorded under T_{21} (P_2R_3) treatment while, the minimum flower diameter i.e. 4.01 cm was noted at T_7 (P_0R_7) treatment.
- The highest number of flowers per plant (54.08) was recorded in T_{15} (P_1R_6) treatment whereas, the lowest number of flowers per plant i.e., 26.84 was reported with T_7 (P_0R_7) treatment.
- The maximum weight of flower (5.33 g) was observed in T_{21} (P_2R_3) treatment whereas, the minimum weight of flower i.e. 3.91 g was recorded at T_7 (P_0R_7) treatment.
- The highest yield of flower per plant (256.52 g) was noticed at T_{15} (P_1R_6) treatment while, the lowest yield of flower per plant (109.87 g) was recorded at T_7 (P_0R_7) treatment.
- The maximum yield of flower (4.82 kg/plot and 17.41 t ha^{-1}) was obtained in T_{15} (P_1R_6) treatment as compared to minimum yield of flower i.e. 2.10 kg/plot, 8.02 t ha^{-1} as obtained at T_7 ($P_0R_{7)}$ treatment.

7. CONCLUSION

On the basis of the result obtained in the present investigation it may be concluded that T_{15} (P_1R_6) treatment resulted into an effective and balanced plant growth and production of the highest number of good quality flowers of African marigold cv. “Pusa Narangi Gainda”. Further, this treatment gave the maximum estimated flower yield of 17.41 t ha^{-1}, but it was found statistically at par with T_{12} (P_1R_3) and T_{24} (P_2R_6) treatments with the respective flower yields of 16.55 t ha^{-1} and 16.53 t ha^{-1}.

As far as the relative economic of the treatments is concerned the maximum net returns of Rs. 1,58,762 ha^{-1} was observed at T_{12} (P_1R_3) treatment but the highest B:C ratio (4.921:1) was recorded with T_{16} (P_1R_7) treatment.

Thus, it may be recommended that the African marigold cv. “Pusa Narangi Gainda” plants should be treated with T_{12} (P_1R_3) treatment i.e. pinching at 30 DAT + CCC 1500 ppm (spray twice at 30 & 45 DAT) to improve the growth, yield and quality of flowers as well as to get the maximum net returns.

Further, it is mentioned that one year experimentation results are only indicative, based only on one year investigation. Therefore, it is suggested to confirm the results to establish the validity of the above conclusion.

LITERATURE CITED

Anonymous. 1997. *The Hindu : Survey of Indian Agriculture*. The Hindu News Paper, Chennai. pp : 132.

Armitage, A.D., Tsujeta, M.J. and Harney, P.M. 1978. Effect of cycocel and high intensity lighting on flowering of seed propagated geranium. *Journal of Horticulture Science* **53** : 147-149.

Arora, J.S. and Khanna, K. 1986. Effect of nitrogen and pinching on growth and flower production of marigold (*Tagetes erecta* L.). *Indian Journal of Horticulture* **43** : 291-294.

Aswath, S., Narayana Gowda, J.V. and Anadmurthy, G.M. 1994. Effect of growth retardants on growth, flowering and flower quality of China aster (*Callistephus chinensis* L. Ness) cv. “Powder Puff Mixed”. *Journal of Ornamental Horticulture* **2** : 9-13.

Barman, D., Ghosh, S. and Pal, P. 1993. Effect of planting date and pinching height on flowering of chrysanthemum (*Chrysanthemum morifolium*) cv. “Chandrama”. *Horticultural Journal* **6** : 121.

Barrett, J.E. and Hertogh, De. A.A. 1978. Pinching forced tuberous rooted dahlias. *Journal of American Society of Horticulture Science* **103** : 775-778.

Beniwal, B.S., Ahlawat, V.P. and Rakesh. 2003. Studies on the effect of spacing and pinching on growth and flower production of chrysanthemum cv. “Flirt”. *Haryana Journal of Horticultural Sciences* **32** : 228-229.

Beniwal, B.S., Ahlawat, V.P. and Rakesh. 2005. Effect of spacing and pinching on flower production of chrysanthemum cv. “Flirt”. *Haryana Journal of Horticultural Sciences* **34** : 97-98.

Bhati, R.S. and Chitkara, S.D. 1987. Effect of pinching and planting distance on growth and yield of marigold (*Tagetes cerecta*). *Research and Development Reporter* **4** : 159-164.

Bhattacharjee, S.K. 1979. Influence of photoperiod and growth retardants. *Punjab Horticulture Journal* **19** : 28-32.

Bhattacharjee, S.K. 1989. Influence of growth retarding chemicals on growth and flowering of *Jasminum grandiflorum* L. *Indian Journal of Horticulture* **46** : 240-243.

Bhattacharjee, S.K. and Singh, U.C. 1995. Growth and flowering response of *Rosa hybrida* cv. "Raktagandha" to certain growth regulant spray. *The Orissa Journal of Horticulture* **23** : 21-25.

Bremner, J.H. 1960. Determination of nitrogen in soil by Kjeldals Method. *Journal of Agriculture Science* **55** : 11-13.

Brown, D.R., Eakes, D.J., Behe, B.K. and Gilliam, C.H. 1992. Moisture stress an alternative method of height control to B-9 (daminozide). *Journal of Environmental Horticulture* **10** : 232-235.

Bunt, A.C. 1979. Cropping of carnation (*Dianthus caryophyllus* L.) as affected by date of planting and by removing the apical bud. *Journal of Horticulture Science* **54** : 235-242.

Caro, A.M. and Herrera, C.J. 1996. Growth retardant action of daminozide in *Coleus blumet*. *Revesta dela facultrad de Agronomia* **15** : 149-152.

Cathey, H.M. 1964. Physiology of growth retarding chemicals. *Annual Review of Plant Physiology* **15** : 271-302.

Cermeno, P. 1940. Cultivation of chrysanthemum in winter in unheated green houses on the coast of the gulf of Cadiz, and areas of maritimes influence. *Acta Horticulture* **246** : 121-129.

Chezhiyan, N., Nanjan, K. and Abdul Khader. 1986. Effect of spacing and pinching in *Chrysanthemum indicum* L. cv. "CO-1". *South Indian Horticulture* **34** : 397-400.

Cocharan, W.G. and Cox. G.M. 1967. *Experimental designs* II, John Wiley and Sons. Inc., New York.

Davis, R.O.E. and Bryan, H. 1910. The electrical bridge for the determination of soluble salts in soils. *USDA Bur Soils Bulletin* **61** : 35.

Dutta, J.P. and Ramdas, S. 1998. Growth and flowering of chrysanthemum (*Dendranthema grandiflora* Tzelev.) to growth regulator treatments. *Orrisa Journal of Horticulture* **26** : 70-75.

Dutta, J.P., Seemanthini Ramdas and Khader, M.A. 1993. Regulation of flowering by growth regulators in chrysanthemum (*Chrysanthemum indicum* L.) cv. “Co-1”. *South Indian Horticulture* **41** : 293-299.

Eume, A. 1990. On the cultivation of pot carnation. *Deutscher Garteribau* **44** : 2752-2753 (c.f. *Horticulture Abstract* **27** : 7816, 1991).

Evans, M.r., Wilkins, H.F. and Dovle, P. 1989. Poinsettia cultivars trials reproductive phase. *Minnesoto State Flower Bulletin* **38** : 14-19.

Farina, E. and Paterniani, T. 1982. Trials on planting density and training system for “W. Turner Chrysanthemum”. *Annals of Dell Inst. Speri. Floriculture* **13** : 149-156.

Girwani, Babu, R.S. and Chandrasekhar, R. 1990. Response of marigold (*Tagetes erecta*) to growth regulators and zinc. *Indian Journal of Agriculture Science* **60** : 220-222.

Gohel. 2001. *Effect of GA_3, NAA and MH on growth, flower yield and quality of annual chrysanthemum (Chrysanthemum coronarium L.) cv. “Local White”*. M.Sc. (Agriculture) Thesis Submitted to Gujarat Agricultural University, Junagadh.

Gowda, J.V.N, Kumar, K.P. and Gowda, V.N. 1990. Effect of cycocel and maleic hydrazide on marigold (*Tagetes erecta* L.) cv. “Bangalore Local”. *Crop Research Hisar* **3** : 299-301.

Gowda, J.V.N. and Jayanthi, R. 1988. Studies on the effect of spacing and pinching on growth and flowering of chrysanthemum. *Current Research : University of Agriculture Science, Bangalore* **17** : 21-22.

Gowda, J.V.N. and Jayanthi, R. 1991. Effect of cycocel and maleic hydrazide on growth and flowering of African marigold (*Tagetes erecta* L.). *Progressive Horticulture* **20** : 269-273.

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

Gowda, V.N. and Gowda, J.V.N. 1990. Effect of cycocel and MH on the flowering and seasonal pattern of yield in gudumallige (*Jasminum sambac* Act.). *Indian Perfumer* **34** : 243-246.

Gregov, Z. 1992. Effect of growth retardants on the vegetative and reproductive growth of chrysanthemum. *Poljoprivredna Znans Smotra* **57** : 397-413.

Handricks, L. and Lemper, J. 1983. Pot Chrysanthemum : Late pinching improves plant quality. Gb + Gw **83** : 751-753.

Hosni, A.M. 1996. Response of potted chrysanthemum [*Dendranthema grandiflorum* (Ramet.) Kitamura] cv. "Galaxy" to uniconazole and chloromequat sprays or medium drenches. *Annals of Agricultural Sciences* (Cairo) **41** : 367-385.

Hossain, M.M., Mukherjee, D. and Mohanty, B.K. 1999. Effect of cycocel on growth and flowering of dahlia (*Dahlia variabilis*). *Advances in Plant Sciences* **12** : 355-359.

Hungar, A.H. and Nalawadi, V.G. 1999. Effect of growth regulators on morphological characters, flower production and seed yield of gaillardia. *Karnataka Journal of Agriculture Science* **12** : 226-229.

Imamura, J.S. and Higaki. 1988. Effect of GA_3 and BA on lateral shoot production on antirrhinum. *Horticulture Science* **23** : 353-354.

Jackson, M.L. 1973. *Soil chemical analysis*. Prentice Hall of Indian Pvt. Ltd., New Delhi, India.

Jangra, R.K. 1993. *Effect of nitrogen and pinching on growth and flowering behaviours of marigold (Tagetes erecta L.) cv. "African Giant Double Orange"*. M.Sc. (Ag.) Thesis Submitted to CCS, Haryana Agricultural University, Hissar.

Johansson, J. 1973. "Margurite", *Chrysanthemum frutescens* hybrid as a pot and bedding plant. *Lantbrukshogs Kolans Meddelanden* A **24** : 184 (*c.f. Horticulture Abstract* **43** : 7854, 1979.

Joshi, A.S., Barad, A.V., Mishra, R.L. (Ed.) and Sanyat, Misra. 2002. Effect of N, P and pinching on the nutrient composition and uptake by African marigold. *Floriculture research trend in India*. *Proceedings of the national symposium on Indian floriculture in the new millennium, Lal Bagh, Bangalore,* 25-27 Feb, 2002 : 334-335.

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

Khanna, K., Arora, J.S. and Jaswinder Singh 1986. Effect of spacing and pinching on growth and flower production of carnation (*Dianthus caryophyllus*) cv. “Marguerite Scarlet”. *Indian Journal of Horticulture* **43** : 148-152.

Kher, M.A. 1973. Effect of B-9 and Ethrel on the growth and flowering in chrysanthemum. *Progressive Horticulture* **5** : 77-84.

Khimani, R.A. and Patil, A.A. 1993. Seasonal variation in respect to gaillardia to different growth retardants. bid. cMtkR;k. 227.

Khimani, R.A., Patil, A.A. and Chetty, M.B. 1994. Influence of CCC, Alar and MH on yield and physiological growth parameters of gaillardia during rabi season. *Recent Horticulture* **1** : 95-96.

Krishnamoorthy, H.N. 1975. *Gibberellin and plant growth*. Halster Press, John Willey and Sons Inc. New York.

Kumar, K. 1998. *Regulation of growth and flowering in chrysanthemum (Chrysanthemum morifolium Ram.) cv. IIHR-6 by* GA_3*, NAA, MH and Ethrel application.* M.Sc. (Agriculture) Thesis submitted to Gujarat Agriculture University, Sardarkrushinagar.

Kumar, V., Doraipandian, A., Muthuswamy, S. and Tirulappan, I. 1976. Effect of some plant growth regulants on two species of marigold (*Tagetes erecta* L. and *Tagetes patula* L.). *South Indian Horticulture* **24** : 152-154.

Kumpe, J. and Langhans, R.W. 1970. “One crop” Carnation : When to pinch. *Bulletin of New York Street Flower Growers* **292** : 2.

Larsen, R.V. and Lieth, J.H. 1993. Shoot elongation retardation owing to daminozide in chrysanthemum modeling single application. *Scientia Horticulturae* **53** : 109-125.

Latimer, J.G. 1991. Growth retardants effect landscape performance of zinnia, marigold and impatiens. *Horticulture Science* **26** : 557-560.

Liu, Wei Yun, and Zhang Ming Peng 1996. The commercial production technique of mini potted chrysanthemum. *Acta Horticulture Sinica* **23** : 269-273.

Luckwill, L.C. and Cutting, C.V. 1968. Growth retardants, chlormequat having a pronounced influence on apical dominance control of growth and fruit fullness of apple tree. *Physiology of Tree crops* 239.

Mahalle, B.V., Kidke, S.S., Khobraagade, H.M. and Belorkar, P.V. 2001. Effect of foliar spray of B-9 on growth parameter and chlorophyll content of chrysanthemum. *Journal of Soils and Crops* **11** : 120-124.

Mahalle, B.V., Seema Tidake, Belorkar, P.V. and Dahake, A.K. 2000. Effect of B-9 foliar spray on flowering, biomass production and size of chrysanthemum flower. *Journal of Soils and Crops* **10** : 265-268.

Maleeva, A. and Ivanova, M. 2000. Alternative methods for control of root knot nematodes *Meloidogney* spp. *Acta Horticulture* **532** : 109-111.

Mathew Reena, Dashora, L.K. and Piyush, Verma 2004. Effect of growth retardants and micronutrients on growth and yield of African marigold (*Tagetes erecta* L.) cv. “Pusa Basanti Gainda”. *Scientific Horticulture* **9** : 213-212.

Matous, J. 1971. The effect of growth retardants on the growth and flowering of cultivated *Rhododendron obtusum. Acta Pruhoniciana* **24** : 35-52.

Meher, S.P., Jiatode, D.J., Turkhede, A.B., Dhawad and Darange, S.O. 1999. Effect of planting time and growth regulators on growth of chrysanthemum. *Crop Research* **18** : 486-489.

Mohandas, S. 1986. Effect of some growth regulants on the growth and flowering behaviours in pyrethrum (*Chrysanthemum cinerarifoloum* Vis.). *Madras Agricultural Journal* **73** : 281-283.

Morioka, K., Yonemura, K., Fukudu, M. and Iliguchi, H. 1978. Controlling height of some pot plant by the use of growth retardants. *Research Bulletin of the Aichi Ken Agricultural and Research Centre,* B-Horticulture **32** : 154-157.

Mynett, K.J. 1982. Growing standard and miniature carnations under plastic tunnel without heanting. *International Society of Horticulture Science* **2** : 160.

Nair, A. 1998. *Effect of growth retardants on growth, flower yield and quality of African marigold (Tagetes erecta Linn.).* M.Sc. (Ag.) Thesis Submitted Rajasthan Agricultural University, Bikaner.

Namikawa, O. 1980. Evaluation of spray carnation cv. "In Kanagawa prefecture" (I) Effect of pinching and long day treatment on yield and quality of different cultivars. *Bulletin Kanagawa Horticulture Exp. St.* **27** : 45-51.

Narayana Gowda, J.V. and Jayanthi, R. 1991. Effect of cycocel and maleic hydrazide on growth and flowering of African marigold (*Tagetes erecta* L.). *Progress Horticulture* **23** : 114-118.

Noto, G. and Romano, D. 1989. Timing of snapdragon (*Antirrhinum majus* L.) in cold green house cultivation. *Acta Horticulture* **246** : 175-181.

Novoselova, A.N., Sevrova, O.K. and Pyatitskaya, L. 1985. Chlorocholine chloride application for improving the ornamental properties of *Tagetes erecta*. *Bulletin Glavnogo Botaniches* Kogosada **138** : 41-44.

Ojeda, H. and Trione, S.O. 1994. Effect of CCC on the growth bio-chemistry and rubber yield of guayale plants (*Parthenium orgentatum* Gray). *Journal of Arid Environments* **28** : 129-138.

Olsen, S.R., Cole, C.V., Watanable, F.S. and Dean, L.A. 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonates. *USDA Circular* **993** : 1-19.

Pal, A.K. and Das, S.N. 1990. Effect of growth regulator on growth and flowering of *Lilum logiflorum. Orissa Journal of Horticulture* **18** : 18-21.

Pal, P., Hore, J. and Poi, A.K. 1986. Effect of growth regulating chemicals on growth and yield of flower of *Calenduda officinalis. Environment and Ecology* : 541-543.

Panse, V.G. and Sukhatme, P.V. 1989. *Statistical methods for agricultural workers,* ICAR Publications, New Delhi.

Pappaih, C.M. and Muthuswamy, S. 1974. Effect of some plant growth regulators on growth and flowering of dahlia. *South Indian Horticulture* **22** : 77-80.

Pappaih, C.M. and Muthuswamy, S. 1977. Effect of some growth regulants on growth and flowering of *Jasmimum grandiflorum* L. clone "Thimanpuram". *South Indian Horticulture* **25** : 68-74.

Parmar, A.S. and Singh, S.N. 1983. Effect of plant growth regulators on growth and flowering of *Tagetes erecta*. *South Indian Horticulture* **31** : 53-54.

Patel, N.V. 2001. *Effect of growth retardants on growth and flower production of African marigold (Tagetes erecta L.) cv. "Pusa Basanti Gainda" Under South Gujarat conditions*. M.Sc. (Agriculture) Thesis Submitted to Gujarat Agriculture University, Navsari.

Pergola, G. 1976. Growth retardants in the culture of chrysanthemum for cut flowers and container flowering. *Annalidelel Institute Spermentale Perla Floriculture* **7** : 159-163.

Piper, C.S. 1950. *Soil and plant analysis.* The University of Adelaide, Australia.

Puppaih, C.M. and Musthuswamy, S. 1976. Effect of plant growth regulants on growth regulant on growth and flowering of hollyhock (*Althoea rosea* L.). *South Indian Horticulture* **4** : 105.

Rajasekaran, L.R., Shanmugavelu, K.G. and Nambisan, K.M.P. 1983. Studies on pinching in gomphrena (*Gomohrena globosa* L.). *South Indian Horticulture* **31** : 248-249.

Rakesh, Singhrot, R.S., Sukhbir Singh and Jeet Ram Sharma. 2005. Effect of GA_3 and pinching on flowering of chrysanthemum. *Haryana Journal of Horticulture Science* **34** : 95-96.

Ramesh Kumar, Kartar Singh and Reddy, B.S. 2002. Effect of planting time, photo – period, GA_3 and pinching on carnation. *Journal of Ornamental Horticulture New Series* **5** : 21-23.

Randhawa, G.S. and Mukhopadhyay, A. 1986. Chrysanthemum. *Floriculture in India*. Allied Publishers Pvt. Ltd., New Delhi, Bombay, Calcutta, Madras pp. 362-363.

Raskauskas, V., Knyviene, A. and Zalatoriute, G. 1983. Effect of pinching back of Sim carnation. *Biologia* **21** : 16-22.

Reddy, Y.T.N. and Sulladmath, U.V. 1983. Effect of growth regulators on growth and flowering of China aster. *South Indian Horticulture* **31** : 95-98.

Reimherr, P. and Graoner, U.C. 1991. Induction of early flowering in potted companula, *Deutscher Gartenbue* 43 : 88-89.

Reiss-Bubenheium, D. and Lewis, A.J. 1986. Pre plant application of growth retardants to pinched and upinched chrysanthemum cuttings. *Scientia Horticulture* **28** : 159-164.

Richards, L.A. 1954. Diagnosis and improvement of saline and alkaline soils. *USDA Hand Book* 60.

Sehrawat, S.K., Dahiya, D.S., Sukhbir, Singh and Rana, G.S. 2003. Effect of nitrogen and pinching on the growth, flowering and yield of marigold (*Tagetes erecta* L.) cv. "African Gaint Double Orange". *Haryana Journal of Horticultural Science* **32** : 59-61.

Sekhan, P.S. 1981. The effect of nitrogen and pinching on growth and flower production of marigold cv. "African Giant Double Orange". M.Sc. Thesis submitted to Punjab Agriculture University, Ludhiana.

Sen, P.K. and Sen, S.K. 1968. Effect of growth retarding and promoting chemicals on growth and flowering of some annuals. *Indian Journal of Horticulture* **25** : 219-224.

Sen, S.K. and Maharana, T. 1971. Effect of some regulators on the growth and flowering of *Chrysanthemum morifolium* Ramat. *Indian Journal of Horticulture* **29** : 236-240.

Sen, S.K. and Maharana, T. 1971. Growth and flowering response of chrysanthemum to growth regulator treatments. *Punjab Horticulture Journal* **11** : 274-277.

Sen, S.K. and Naik, J. 1977. Effect of growth retardants on pinched and unpinched chrysanthemum plants. *Indian Journal of Horticulture* **34** : 86-90.

Shanmugam, A. and Muthuswamy, S., 1974. Effect of CCC and TIBA on *Chrysanthemum indicum* Linn. *Indian Journal of Horticulture* **31** : 370-374.

Shanmugan, A., Muthuswamy, S. and Rao, V.N.M. 1973. Effect of artificial light periods and growth substances on the shoot and root growth of chrysanthemum (*Chrysanthemum indicu*m Linn.) var. "White Prosperity". *Madras Agriculture Journal* **60** : 129-131.

Sharma, H.G., Verma, V., 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 Journal of Horticulture* **23** : 61-64.

Shawarer, M.N. and Qrunfleh, M.M. 1988. Effect of Alar on 4 cvs. of pot chrysanthemum. *Dirasat* **15** : 154-168.

Shedded, M.R., El-gamassy, K.M., Hashim, M.E. and Almula, A.M.N. 1986. Effect of some growth regulators on the growth, flowering and seed production of some summer annuals. *Annals of Agriculture Science* **31** : 679-689.

Shi, Z.Z. and Li, S.V. 1987. Effect of the plant growth inhibitors B-9 and CCC on dwarfing of petunia plants. *Acta Horticulture Sinica* **14** : 197-202.

Singh, J. and Arora, J.S. 1980. Effect of spacing and pinching on growth and flower production of marigold (*Tagetes erecta* L.) cv. "African Giant". *Indian Journal of Ornamental Horticulture* **12** : 44-47.

Singh, J.N., Singh, D.K. and Sharma, K.K. 1994. Effect of GA_3 and Alar on growth, flowering and seed production of dahlia. *Orissa Journal of Horticulture* **2** : 10-12.

Singh, R. and Rathore, S.V.S. 1992. Effect of different growth regulators on growth and flowering of African marigold (*Tagetes erecta* L.). *Progress Horticulture* **24** : 92-95.

Song Jeong Seob, Ryu Bucong Yeoul, Bang Chang Seok, Huh Kun Yong, Songh Cheom Yung and Kim Byeong Hyeon 1997. Effect of growth regulators on the growth of plug seedling of *Campanula takesimana* and *Elsholtzia splendena* cv. “Jahyarg”. *Journal of Horticulture Science* **39** : 95-100.

Song, J.S., Lee, M.S. and Hong, Y.P. 1990. Studies on the regulation of growth and flowering of Korean indigenous bedding plants. (1) The effects of pinching time on growth and flowering of native bedding plants. *Research Report of the Rural Division Administration, Horticulture* **32** : 44-53.

Srivastava, S.K., Singh, H.K. and Sriastava, A.K. 2002. Effect of spacing and pinching on growth and flowering of African marigold (*Tagetes erecta*) “Pusa Narangi Gainda”. *Indian Journal of Agricultural Science* **72** : 611-612.

Srivastava, S.K., Singh, H.K. and Sriastava, A.K. 2005. Spacing and pinching as factors for regulating flowering in marigold cv. “Pusa Basanti Gainda”. *Haryana Journal of Horticulture Science* **34** : 75-77.

Suma, B. and Joshua, P. 1994. Effect of growth retardants on tuber production of dahlia (*Dahlia variabilis*). *South Indian Horticulture* **42** : 340-341.

Syamal, M.M., Rajput, C.B.S., Upadhyay, R.K. and Singh, J.N. 1990. Effect of GA_3 and MH on growth, flowering and seed yield of marigold and China aster. *Indian Journal of Horticulture* **47** : 439-441.

Talukdar, M.C. and Paswan, L. 1996. Growth and flowering of chrysanthemum (*Dendrathemum grandiflora* Tzvelev) cv. “Prof. Harris” as influenced by growth regulators. *Horticulture Journal* **9** : 155-158.

Tawagen, A.M. and Hassan, H.A. 1974. Effect of temperature, day length and cycocel on chrysanthemum. *Egyptian Journal of Horticulture* **1** : 57-65.

Tomar, S.K. 1993. *A comparative study of pinching and growth retardants on growth and flowering in marigold (Tagetes erecta L.).* M.Sc. Thesis submitted to Rajasthan Agricultural University, Bikaner.

Tosar, M.V. 1989. *Effect of spacing with different level of nitrogen on growth and flower production of gaillardia (Gaillaridia pulchella) var. “Lorenziana”*. M.Sc. (Ag.) Thesis Submitted to GAU, Novasari.

Vital Statistical. 2004. Department of Horticulture, Govt. of Rajasthan, Pant Krishi Bhawan, Jaipur.

Wainwrigth, H. and Irwin, H.L. 1987. The effects of paclobutrazol and pinching on antirrhinum flowering pot plant. *Journal Horticulture Science* **62** : 401-404.

Walkley, A. and Black, C.A. 1947. A critical examination of a rapid method for determining organic carbon in soils. *Soil Science* **63** : 251-264.

Warden, W.W. and Windrich, W.A. 1974. Studies on nematological problem in horticulture. *Agriculture Cooperation Project Indonesia* pp. 393-402.

Whipker, B.E. and Dasju, S. 1998. Potted sunflower growth and flowering response of daminozide, paclobutrazol and uniconazole, *Horticulture Technology* **8** : 86-88.

Whipker, B.E., Eddy, R.T., Heraux, F. and Hammer, P.A. 1995. Chemical growth retardants for height control of pot asters. *Horticulture Science* **30** : 1039.

Wilfret, G.J. and Barrett, J.E. 1995. Effect of growth regulators on growth and flower development of potted azaleas. *Proceeding Horticulture of State Horticulture Science* **107** : 175-177.

Witt, H. 1989. Result with growth regulators in ornamental plants. *Ergenbnisse Mit Bioregulation Zeirpflanzen* **29** : 235-262.

Yadav, P.K. 1997. Note on the effect of cycocel and MH on growth and flowering of African marigold. *Current Agriculture* **21** : 113-114.

Zalewska, M. 1994. Shaping the miniature large flowered chrysanthemum, cv. “Mini Nero” in pot culture, *Zeszyty Problemowe Postepow nauk Rolinicych* **414** : 353-362.

Zeewaart, J.A.D. 1967. The relation of growth regulators to flowering : Growth retardants in physiology of flowering in *Pharbitis nil. Imanura Japanies Society of Plant Physiology* pp. 112-113.

Zvirblis, P. 1976. The effect of the chloromequat on internode length and number in the chrysanthemum cv. “Doone Valley”. *Mokslo-Darbu-Rinkiniani-Liet-zemes-Okio-Akad* pp. 124-135.

Effect of Pinching and Growth Retardants on Growth, Flowering and Yield of African Marigold (*Tagetes erecta* L.) cv. "Pusa Narangi Gainda"

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ABSTRACT

A field experiment entitled "Effect of pinching and growth retardants on growth, flowering and yield of African marigold (*Tagetes erecta* L.) cv. "Pusa Narangi Gainda" was conducted at Horticulture farm, Rajasthan College of Agriculture, Udaipur from October, 2006 to March, 2007. Twenty seventh treatment combination consisting of three levels of pinching (no pinching, pinching at 30 DAT and pinching at 45 DAT) and nine levels of growth retardants (i.e. three levels of each CCC, B-9 and MH @ 500, 1000 and 1500 ppm) were laid out in Factorial Randomized Block Design with three replications. According to the treatments pinching was done at 30 and 45 DAT and growth retardants were sprayed twice i.e. at 30 and 45 DAT.

On the basis of present investigation it may be concluded that pinching and growth retardants significantly affected growth, flower yield and quality of marigold. Pertaining to the yield of flower, T_{15} (P_1R_6) treatment performed the best with the highest yield of flower i.e., 256.52 g/plant, 4.82 kg/plot and 17.41 t/ha as compared to the T_7 (P_0R_7) treatment, where the lowest yield of flower (109.87 g/plant, 2.10 kg/plot and 8.02 t/ha) was recorded.

With respect to the net return , T_{12} (P_1R_3) treatment was found superior with the maximum net return of Rs. 1,58,762 per hectare in comparison of T_1 (P_0R_1) treatment in which the minimum net return of Rs.70,005 per hectare was obtained. If we concerned upon B:C ratio then T_{16} (P_1R_7) treatment was exhibited the highest B:C ratio of 4.921:1 while, the lowest B:C ratio (-0.699:1) was obtained with T_6 (P_0R_6) treatment.

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