Effect of pinching on growth, flowering and yield of China aster (*Callistephus chinensis* L. Nees).

THESIS

submitted to the

Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya

In partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE

AGRICULTURE

In

HORTICULTURE

(FLORICULTURE AND LANDSCAPE ARCHITECTURE)

by

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2022

CERTIFICATE - I

This is to certify that the thesis entitled **"Effect of pinching on growth, flowering and yield of China aster (*Callistephus chinensis* L. Nees)."** submitted in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **HORTICULTURE** (**Floriculture and Landscape Architecture)** of Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.) is a record of the bona-fide research work carried out by **Mr. SURAJ JAISWAL,** under my guidance and supervision. The subject of the thesis has been approved by the student's Advisory Committee and the Director of Instruction.

No part of the thesis has been submitted for any other degree or diploma or has been published. All the assistance and help received during the course of this investigation has been acknowledged by the scholar.

(Anuj Kumar)
Chairman of the Advisory Committee

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This is to certify that the thesis entitled **"Effect of pinching on growth, flowering and yield of China aster (*Callistephus chinensis* L. Nees)."** submitted by **Mr. SURAJ JAISWAL;** to the Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.) in partial fulfilment of the requirements for the degree of Master of Science **(AGRICULTURE)** in **HORTICULTURE** in the department of **Floriculture and Landscape Architecture** has been accepted after evaluation by the External Examiner and approved by the Student's Advisory Committee after an oral examination on the same.

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Acknowledgement

First of all I express my deep sense of adoration towards the Omniscient and Almighty god for giving me the opportunity of doing M.Sc. (Hort.) Floriculture and Landscape Architecture.

I express my profound sense of gratitude and indebtedness from the core of my heart towards my most respected guide and chairman of my advisory committee **Dr. Anuj Kumar,** Assistant Professor and Head of the Department of Floriculture and Landscape Architecture, K.N.K. College of Horticulture, (Mandsaur), R.V.S.K.V.V. Gwalior for their praiseworthy guidance, valuable suggestions, overwhelming help, inspiration and encouragement during the course of investigation without which it would have not been possible to accomplish this stupendous task.

I feel deeply honoured in expressing my sincere thanks to my co-chairman **Dr. Nitin Soni,** Assistant Professor, Department of Fruit Science and I owe whole hearted gratitude to venerable members of my Advisory committee, **Dr. Roshan Gallani**, Assistant Professor, Department of Soil Science and Agricultural Chemistry and **Dr. G. P. S. Rathore**, Professor, Department of Statistics and Computer Science, for their relevant guidance, inspiring suggestion, ever available generous help during the tenure of work.

Words I am privileged to express sincere and deep sense of gratitude to **Dr. S.K. Rao**, Hon'ble Vice Chancellor, R.V.S.K.V.V., Gwalior and **Dr. A. K. Singh**, Director of Instruction, R.V.S.K.V.V., Gwalior, with deepest sense of humility and gratefulness, I feel myself duly bound to express my heartfelt and sincere thanks to Dean **Dr. Mridula Billore** Dean, K.N.K. College of Horticulture, Mandsaur.

Words cannot express the heartfelt gratitude for my most revered family members; my father **Shri. Goverdhan Jaiswal**, my mother **Smt. Briz Bai**, my elder sister **Hemlata Jaiswal,** my younger sister **Shalu, Neha, Sheetala, Ragini, Radhika, Kalyani, Jagriti** and my Younger brother **Vikas, Mahi** who gave me sincere affection, love, blessings and constant inspiration which enabled me to achieve this seemingly invincible goal, made my education possible and brought me to the present level.

I would also like to express my gratitude for the co-operation and encouragement of my beloved seniors Komal sir, Tarun sir, Kamlesh sir, Dinesh sir and Menka mam who have directly or indirectly co-operated with me during the tenure of work.

Express my sincere thanks to my batch mates and all of my friends, especially, Harsh Wardhan, Dushyant, Aditya, Khilesh, Nilesh, Ashish, Anil, Deepak, Bhola, Hemant, Preeti, Anjana, Nisha, Pushpa, Shweta. My Childhood friend, Ganesh, Vikash, Kaushal, Hemant, Dinesh, Santosh, Suraj, Vijay, Bhupesh, Vikrant and Khuman for rendering their constant support, co-operation and valuable help throughout the course of investigation.

I also place on record, my sense of gratitude to one and all who, directly or indirectly have lent their helping hands in this venture.

Place: Mandsaur
Date:-…./…./……

(Suraj jaiswal)

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LIST OF ABBREVIATIONS/SYMBOLS

Symbol	Abbreviation	Stands for
/	-	Per
@	-	At the rate of
%	-	Percent
°C	-	Degree Celsius
-	ANOVA	Analysis of Variance
-	CD	Critical Difference
-	cm	Centimeter
-	cm^2	Centimeter square
-	FRBD	Factorial Randomized Block Design
-	CV	Coefficient of Variance
-	cv.	Cultivar
-	DAT	Days After Transplanting
-	Df	Degrees of freedom
-	DW	Distilled Water
-	EMS	Error Mean Sum of Squares
-	*et al.*	et-alii (And others)
-	Fig.	Figure
-	g	Gram
-	H	Hour
-	ha	Hectare
-	*i.e.*	That is
-	l	Liter
-	Max.	Maximum

-	mg	Milligram
-	Min.	Minimum
-	Ml	Milliliter
-	Mm	Millimeter
-	MSS	Mean Sum of Squares
-	NS	Non-significant
-	RVSKVV	Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya
-	S.Ed.	Standard error of difference
-	S.Em ±	Standard error of mean
-	SS	Sum of Squares
-	var.	Variety
-	*Viz.*	Videlicet (Namely)

Chapter - I

INTRODUCTION

A flower can say lots of words to express our emotions as it represents the symbol of pure love, romance and friendship. It is one of the most beautiful gifts of the nature which has great importance in all stages of our life. The demand for flowers is always there and it is increasing every year by 15-20 percent (Singh, 1994).

China aster (*Callistephus chinensis* L.) one of the most similar flowering annuals, is a member of Asteraceae family and is native to China. The present day asters have been developed from a single form of wild species and their plant behaviour is classified as diploid (2n=18). Linnaeus named it *Aster chinensis* at first, but it was renamed to *Callistephus chinensis* by Nees. The single species chinensis belong to the genus *Callistephus* (Munikrishnappa and Chandrasheker, 2014).

It is believed to have originated in China. Among the annual flowers, it ranks next to chrysanthemum and marigold and is mainly grown by marginal and small farmers (Bailey, 1963).

It was first introduced in Europe in 1731 and then spread to other parts of the world (Desai, 1967). The name *Callistephus* is derivative from two Greek words: Kalistos, which means most attractive and Stephus, which means crown. It symbolizes purity, love, peace, beauty and passion (Naikwad *et al.* 2018). Among the wide range of commercial flower crops, China aster occupies a selective position because of its prettiness, elegance, diverse form and varied attractive colors ranges. It is native to China and has spread to Europe and other tropical countries during 1731 A.D. (Desai, 1967).

Flowers are solitary, the plants range in height from 15 cm to about 1 m with pompon flowers, about the size of a button to a large flower head having single, double, anemone-flowered, peony-flowered, incurved, quilled or shaggy flower types. The different colours of flower include pure white, many shades of pink, prime-rose, pale blue, mauve, purple, dark blue and scarlet.

Its cultivation becoming popular around the cities for cut flower as well as loose flowers for making garland, venies and bouquets. It can easily be grown in the open field for cut and loose flower. In ornamental gardening, it is used for a bedding plant, edging pot-plant and herbaceous border hence aster is short duration crop acclimated to varying agro-climatic condition. Flower with more petals is ideal for use as loose flowers in garlands, buttonholes and veni for hair ornamentation. It has got very beautiful effect when grown large masses in beds. China aster grown for its prettiness, elegance divers form varied attractive colours. Among annual flower its rank next to chrysanthemum and marigold (Joseph *et al.,* 2019).

Its commercial grown is being done in states *viz.*, Uttar Pradesh, West Bengal, Odisha, Chhattisgarh, Haryana and Maharashtra. The total area of flower crop in India during the year 2020-21 was 322 thousand hectares with the production of 2980 thousand metric tonnes of loose and cut flowers. The total area of flower crop in Madhya Pradesh during the year 2020-21 was 30.07 thousand hectares with the production of 350.88 thousand metric tonnes of loose and cut flower (Anonymous, 2020-21)

Successful cultivation of China aster depends upon proper selection of varieties. In recent years, several new cultivars of aster with wide range of colours have entered the market but all the cultivars cannot be grown everywhere successfully. Hence, it is necessary to identify the suitable cultivar for commercial cultivation and even it is felt necessary to find out suitable pinching time for different varieties for better yield (Sailaja and Panchbhai, 2014).

Special horticultural practices are important for optimum growth, high yield and good quality flowers. Pinching is one of the most suitable practices for successful cultivation of cut flowers as well as potted plants. Pinching simply mean removing the terminal growing portion of stem due to apical dominance. Productivity and quality of flower crop can be improved by either high yielding cultivar or improved horticulture practices including proper agriculture inputs and practices as proper spacing and pinching apical

dominance in aster has been one of the factor limiting production of flower (Narayana Gowda, 1990).

To keeping the above facts in view a study was designed with title **"Effect of pinching on growth, flowering and yield of China aster (*Callistephus chinensis* L. Nees)"** with the following objectives.

1. To assess the effect of pinching on growth of China aster.
2. To study the effect of pinching on flowering of China aster.
3. To find out the effect of pinching on yield of China aster.

Chapter – II

REVIEW OF LITERATURE

The research investigation entitled “Effect of pinching on growth, flowering and yield of China aster (*Callistephus chinensis* L. Nees).” has been reviewed and presented in this chapter. An attempt has been made to review all the available literature on effect of pinching on growth, flowering and yield of China aster. Hence, the review of research on other Horticulture crops been done. The review done has been presented with following titles.

2.1 Growth parameters

2.2 Flowering and yield parameters

2.1 Growth parameters

Physical manipulation of the size and shape of transplants by removing the top portion (apical bud) of shoot during raising the plants has been claimed to be advantageous in obtaining higher yield in several crops.

Kumar *et al.* (2002) reported that pinching (removal of 2.0-2.5 cm shoot apex once in every 4 weeks or twice in 4 and 8 weeks) of carnation cv. Red Corso gave shorter plants but increased the number of branches and leaves, due to suppression of apical dominance and production of more number of branches.

Srivaistava *et al*. (2002) studied the effect of pinching in marigold cv. Pusa Narangi Gainda and observed that pinching reduced the plant height significantly being maximum with pinching at 20 days after planting followed by 30 and 40 days after planting.

Khandelwal *et al.* (2003) studied two pinching treatments *i.e.*, early pinching at 20 days after planting and late pinching at 30 days after planting in African Marigold cv. Pusa Narangi Gainda. Pinching treatments significantly reduced the plant height at 20 days after planting and 30 days after planting compared to control.

Rakesh *et al.* (2003) reported less plant height in chrysanthemum cv. Flirt and Gauri when plants were pinched at 35 and 45 DAT as compared to unpinched plant.

Sehrawat *et al*. (2003) reported that pinching in marigold cv. “African Giant Double Orange” increased the number of branches and reduced plant height.

Singh and Baboo (2003) observed the response of pinching levels in chrysanthemum cv. Jayanthi. The data recorded for all parameters with the delay in pinching except for plant height which was highest with pinching at 10 days after potting over without pinching at 20 and 30 days after potting plant height increased.

Naik *et al*. (2004) studied the effect of pinching in African marigold and observed that plant height was maximum in unpinched plants compared to pinched plants.

Dilta and Gupta (2010) reported that, maximum plant height and stem length was recorded in carnation cv. Impala when planted in the month of December employing single pinching while minimum plant height in cv. Dark Tempo and minimum stem length in cv. Madras in the January planted crop practicing pinch and a half method in carnation.

Kumar *et al.* (2011) reported that, in calendula pinching reduced plant height, length of flower stalk and flower diameter of calendula; however, bud initiation and opening of first floret were delayed due to pinching operation. Significantly more numbers of flowers per plant and yield of flower per ha were recorded when pinching operation was exercised at 30 DAT, showing an increase of 14.2 and 11.6% over the control, respectively.

Maharnor *et al.* (2011) concluded that, maximum number of primary branches and spread of plant was recorded with 150 kg N ha^{-1} and pinching at 30 DAT in African marigold.

Dorajeerao and Mokashi (2012) pinching at 20 DAS recorded maximum plant height at final stage. Pinching in nursery at 20 DAS recorded

the highest number of branches, plant spread and stem girth were at maximum levels in garland chrysanthemum (*Chrysanthemum coronarium* L.).

Habiba (2012) observed that with pinching obtained the shortest plant and maximum number of leaves in (*Chrysanthemum indicum* L.).

Khobragade *et al.* (2012) reported that, pinching in China aster reduced the plant height and double pinching delayed flowering. Pinched plant yields more than unpinched plant. The interaction of spacing and pinching was found that closer spacing with pinching gave higher yield and economically best than wider spacing with unpinched plants. Wider spacing with pinched plants gives more number, weight and diameter of flowers.

Kumar *et al.* (2013) studied that among pinching and disbudding treatment in chrysanthemum the plant height was retarded pinching at 30 days after transplanting such variation may be due to the fact that this operation (pinching) overcomes apical dominance of the main stem, which checks in turn the vertical growth of the pinched, spread of the plant was recorded with pinching at 30 days after transplanting, the height of point of origin of first primary branches from ground surface was obtained with disbudding. The number of secondary branch on the longest primary branch and number of leaves on the longest primary branches were observed under in control.

Sailaja *et al.* (2013) carried out an experiment to study the effect of pinching on different varieties of China aster data revealed that effect of varieties and pinching was statistically significant. Among the varieties Phule Ganesh Purple performed best with respect of plant height with no pinching. While, single pinching at 30 days after transplanting showed that the best result with respect of spread of plant was found maximum in Phule Ganesh Pink.

Badge *et al.* (2014) found that in African marigold, among the pinching treatments, significantly reduced plant height was recorded in pinching at 22 DAT whereas, pinching at 15 DAT was found best for improving other growth

parameters *viz*., number of branches per plant, diameter of main stem and leaf area at 50% flowering stage.

Kumar *et al.* (2014) observed the China aster significantly higher plant height at 90 DAT in unpinched plants, while plants pinched at 20 DAT recorded significantly higher number of primary branches per plant, number of secondary branches per plant and plant spread when compared to other pinching treatments.

Sailaja *et al.* (2014) investigated that, number of primary branches, diameter, were recorded maximum in Phule Ganesh White with single pinching at 30 days after transplanting. Whereas, spread of plant was found maximum in Phule Ganesh Pink in single pinching at 30 days after transplanting.

Ona *et al.* (2015) recorded significant variation among all characteristics, also revealed that in chrysanthemum maximum chlorophyll content and leaves were obtained from P_2 (twice pinching) respectively and the minimum chlorophyll content and leaf area was observed from P_0 (no pinching) respectively. Maximum number of flowers was found from P_2 and minimum was from P_0. Finally, twice pinching showed the good impact on flowering of chrysanthemum.

Salve *et al.* (2016) revealed that, significantly minimum plant height was recorded in double pinching of chrysanthemum at 30 and 45 days after planting compared to the other pinching time and maximum plant height was recorded in no pinching treatment. Number of branches per plant, stem diameter, spread of plant and leaf area per plant was recorded significantly maximum in single pinching at 30 days after transplanting compared to the other pinching treatments and minimum number of branches plant^{-1} stem diameter, spread of plant and leaf area were recorded in the no pinching treatment. This might be due to pinching reduces the plant height and encourages the side branches due to removal of apical dominance, which might have favoured in increasing the stem diameter, primary branches, spread of plant.

Palekar *et al.* (2018) observed that effect of pinching on the performance of China aster was statistically significant. The maximum stem diameter, primary and secondary branches plant^{-1} and flower yield plant^{-1} were noted in the plants treated with double pinching + 125 kg N ha^{-1}, maximum weight of flower, number of petals flower^{-1} and longevity of flower were recorded in the plants treated with no pinching + 125 kg N ha^{-1}.

Wani *et al.* (2018) significantly improves plant spread, leaf area, chlorophyll content, number of primary and secondary branches, increasing planting density increased plant height and leaf area index. On the other hand wider planting density significantly improved, plant spread, leaf area, leaf chlorophyll content, number of primary and secondary branches. Pinching results in tangible reduction of plant height, but improves the net photo assimilation and overall vigour vegetative growth of China aster.

Chopde *et al.* (2019) Arka Archana, single pinching was carried out on 30th days and double pinching on 30th and 45th days after transplanting. The results revealed that significantly maximum plant spread was recorded with the variety Arka Archana. Respect of pinching methods, plant spread, stem diameter, flower yield plant^{-1}.

Lakshmaiah *et al.* (2019) conducted an experiment to see the effect of pinching on growth and flowering of China aster and observed that the vegetative growth characters namely, plant height and internodal length and quality character namely, flower stem length were highest in the treatment T_5 (Single pinching + GA_3 @ 150 ppm). The highest number of side shoots and number of leaves per plant were recorded with T_9 (Double pinching + GA_3 @ 150 ppm).

Thakare *et al.* (2020) results obtained in the present investigation indicated that, the growth parameters in terms of height of plant was recorded maximum in 150 kg N ha^{-1} and no pinching whereas, the maximum stem diameter, number of branches, spread of plant and leaf area were recorded with pinching at 20 DAT and 150 kg N ha^{-1}. China aster as regards yield parameters, the maximum flower yield plant^{-1}.

2.2 Flowering and yield parameters

Joshi *et al.* (2002) reported that pinching significantly increased fresh and dry weight of the plant compared to no pinching in marigold.

Kumar *et al.* (2002) reported in carnation that, pinching twice resulted in higher dry weight of plant compared to unpinched plants.

Srivastava *et al.* (2002) studied the effect of pinching in marigold cv. Pusa Narangi Gainda and observed that the number of days required for initiation of flowers was maximum with pinching at 40 days after pinching over no pinching and pinching at 20 and 30 days after planting and also maximum flower size was observed in control followed by pinching at 40, 30 and 20 DAP.

Verma *et al.* (2002) reported in carnation cv. Impale that between two pinching methods (single pinch and one and a half pinch), single pinch method produced flowers of better quality but total yield per square meter was maximum in one and a half pinch method.

Khandelwal *et al.* (2003) observed in the pinching effect in marigold that the number of days taken for first flowering was early in control and also flower size was maximum in control as compared to pinching at 20 DAT and 40 DAT.

Kumar and Singh (2003) reported in carnation that, double pinching of shoot tip delayed the flowering. But, flower production was enhanced by pinching.

Rakesh *et al.* (2003) reported that yield of flowers/plant were increased over control when plants were pinched at 35 DAT.

Sehrawat *et al.* (2003) reported that pinching in marigold cv. “African Giant Double Orange” increased the number of days to flower bud initiation, number of days to 50% flowering and flowering duration. Highest number of flowers obtained when plant was pinched at 30 DAT.

Singh and Baboo (2003) worked on yield of chrysanthemum indicated that maximum number of flowers per plant was obtained with pinching at 20 days after planting over pinching at 10 and 30 days after planting.

Grawal *et al.* (2004) studied the effect of pinching in chrysanthemum (*Dendranthema grandiflora* Ramat) cv. Flirt and indicated that pinching at 30 days after planting recorded more number of days for bud break, more stalk length and more number flowers over control.

Shinde *et al.* (2004) reported in carnation that the number of days for first flower bud appearance was early in control over the single pinching and double pinching.

Beniwal *et al.* (2005) reported that in chrysanthemum cv. “Flirt” maximum number of buds and flowers were observed with pinching at 25 days after planting over control and pinching at 35 and 45 days after planting.

Rakesh *et al.* (2005) studied the effect of pinching in chrysanthemum cv. Flirt and reported that pinching at 35 days after planting significantly increased the number of flowers per plant over control.

Dilta and Gupta (2010) reported that, January planted carnation cv. Madras produced earliest flowers with single pinching whereas carnation cv. Impala took maximum time for flower production. Maximum flowering stems/plant was recorded in cv. Lavender Lace and minimum yield was found in cv. “Salmanca”. Maximum flower size was recorded in cv. “Madras” with single pinch method when planted in December and minimum flower size in cv. “Rubesco” in January planted crop employing pinch and a half method. Maximum flowering duration was found in cv. “Dark Tempo” with pinch and a half method planted in December and minimum in cv. “Raggio-de-Sole” planted in December with single pinch method.

Rathore *et al.* (2011) found that, pinching significantly decreased the plant height and increased number of primary branches, more number of flowers per plant and higher estimated flower yield per hectare in marigold (*Tagetes erecta* L.) cv. Pusa Basanti Gainda.

Habiba (2012) observed that the plant height was decreased with pinching treatment, while number of leaves was increased.

Sailaja *et al.* (2014 a) observed that effect of pinching on the performance of China aster plant height was significantly reduced with double pinching compare to control treatment. Whereas, spread of plant was found maximum under the treatment of single pinching at 30 days after transplanting.

Sailaja *et al.* (2014 b) concluded that, maximum flowering span was found in Phule Ganesh White with treatment of double pinching at 30 and 45 days after transplanting. The yield characters like number of flowers per plant, and flower yield per hectare were recorded maximum in Phule Ganesh White under single pinching at 30 days after transplanting.

Mohanty *et al.* (2015) concluded that, shoot pinching at 30 days after transplanting improved plant spread, number of leaves, as well as weight of flowers per plot and yield of flowers per hectare. Interaction effect of November planting with single pinching was found beneficial in improving flower yield per hectare in African marigold cv. Sirakole.

Jindal *et al.* (2018) conducted on experiment to see the effect of pinching and planting time on growth and flowering of chrysanthemum. The experiment consist four planting time and three pinching. Data revealed that later planting (3rd week of November) showed the better result with respect of days taken to flowering and diameter of flower. Earlier planting on 1st week of October showed maximum duration of flowering span, length of flower stalk, vase life, shelf life, in situ longevity of flowers.

Singh *et al.* (2018) observed that African marigold flowering parameters *i.e.* flower diameter, flower weight, flowers per plant and flowers weight per plant were not significantly affected by spacing and pinching combinations but flowers yield was significantly maximum with 30x45 and earlier pinching (130 DAT).

Chopde *et al.* (2019) carried out an experiment to test the effect of pinching on growth and flowering of China aster the single pinching was

carried out on 30th days and double pinching on 30th and 45th days after transplanting. The results revealed that significantly the earliest commencement of flowering and 50 per cent flowering were recorded with the variety Arka Archana. In respect of pinching methods, flower yield plant^{-1} and blooming period were noticed significantly maximum with double pinching.

Mounika *et al.* (2019) observed that the minimum number of days taken for first flower bud appearance, days taken for 50% flowering, days taken for first harvest of flowers and maximum plant height in chrysanthemum was recorded in plants without pinching and sprayed with GA_3 @ 200 ppm. Among the floral parameters single pinched plants sprayed with GA_3 @ 200 ppm recorded the maximum flower stalk length and vase life.

Gaidhani *et al.* (2020 a) observed the China aster plants in respect of yield parameters *viz.* number of flowers plant^{-1}, flower yield plant^{-1}, plot^{-1} and ha^{-1} were noticed maximum in 15th September planting date and single pinching at 20 DAT treatments.

Gaidhani *et al.* (2020 b) conducted an experiment to analyse the effect of time of planting and pinching on growth and flowering of China aster. Data indicate the most of the flowering parameters days for emergence of first flower bud, days required to full opening of flower from bud initiation, days for 50% flowering and days to first harvesting were recorded performed best on 15th September planting date and no pinching treatment.

Jena *et al.* (2021) number of flowers per plot as well as per hectare was observed to be maximum under this double pinching treatment. Different levels of pinching could not influence the plant spread significantly.

Chapter– III
MATERIALS AND METHODS

An investigation to study the **"Effect of pinching on growth, flowering and yield of China aster (*Callistephus chinensis* L. Nees)"** was carried out at PG Research Block Bahadari Farm, K.N.K. College of Horticulture, Mandsaur (M.P.) during *rabi* season 2021-22. The details of the material and methods followed during to the present experiment are furnished in this chapter.

3.1 Geographical location of the experimental site

The present investigation was carried out at PG Research Block Bahadari Farm, K.N.K. College of Horticulture, Mandsaur (M.P.) situated in Malwa plateau in western part of M.P. at north latitude of 23.45° to 24.13° and 74.44° to 75.18° East longitude and altitude at 435.02 meters above sea levels. This region falls under agro-climate zone no.11 of the state.

3.2 Climate of the region

Mandsaur belongs to sub-tropical climate having a mean temperature range of minimum 5°C and maximum 44°C in winter and summer, respectively. In this area, most of the rainfall is received during mid-June to early-October with occasional showers in winter. South-west monsoon is responsible for major part of annual precipitation. The average annual rainfall is 714.8 mm. In this region, the relative humidity reaches up to 92% during the months of August-September.

3.3 Meteorological data

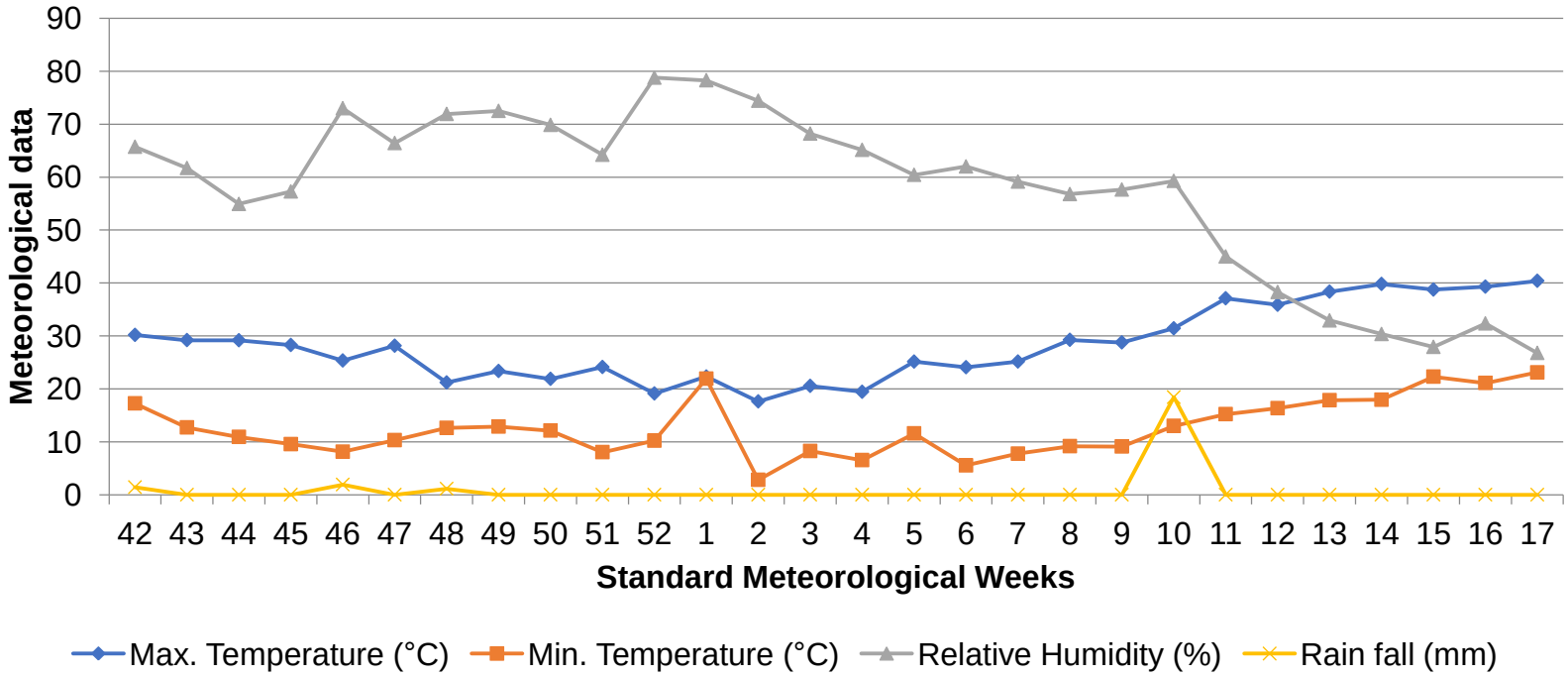
Table 3.1: Weekly meteorological data recorded during the periods of investigation (18th October, 2021 to 30th April, 2022).

Standard Meteorological Weeks	Duration	Average Temperature (°C)		Relative Humidity (%)	Rain fall (mm)
		Max.	Min.		
42	18 Oct. to 24 Oct. 2021	30.18	17.25	65.72	1.42
43	25 Oct. to 31 Oct. 2021	29.2	12.71	61.71	0
44	01 Nov. to 7 Nov. 2021	29.17	10.92	54.92	0
45	08 Nov.to 14 Nov. 2021	28.28	9.55	57.28	0
46	15 Nov. to 21 Nov. 2021	25.35	8.12	73	1.92
47	22 Nov. to 28 Nov. 2021	28.14	10.31	66.42	0
48	29 Nov. to 05 Dec. 2021	21.2	12.62	71.92	1.14
49	06 Dec. to 12 Dec. 2021	23.37	12.87	72.5	0
50	13 Dec. to 19 Dec. 2021	21.88	12.12	69.85	0
51	20 Dec. to 26 Dec. 2021	24.12	8.04	64.21	0
52	27 Dec. to 02 Jan. 2022	19.12	10.21	78.78	0
01	03 Jan. to 09 Jan. 2022	22.32	21.92	78.28	0
02	10 Jan. to 16 Jan. 2022	17.62	2.81	74.42	0
03	17 Jan. to 23 Jan. 2022	20.55	8.25	68.21	0
04	24 Jan. to 30 Jan. 2022	19.44	6.54	65.14	0
05	31 Jan. to 06 Feb. 2022	25.14	11.58	60.42	0
06	07 Feb. to 13 Feb. 2022	24.08	5.54	62	0
07	14 Feb. to 20 Feb. 2022	25.15	7.75	59.14	0
08	21 Feb. to 27 Feb. 2022	29.25	9.17	56.78	0
09	28 Feb. to 06 Mar. 2022	28.77	9.11	57.64	0
10	07 Mar. to 13 Mar. 2022	31.42	13	59.28	18.42
11	14 Mar. to 20 Mar. 2022	37.1	15.22	45	0
12	21 Mar. to 27 Mar. 2022	35.87	16.34	38.28	0
13	28 Mar. to 03 Apr. 2022	38.35	17.85	32.92	0

14	04 Apr. to 10 Apr. 2022	39.81	17.94	30.35	0
15	11 Apr. to 17 Apr. 2022	38.74	22.3	27.92	0
16	18 Apr. to 24 Apr. 2022	39.3	21.11	32.35	0
17	25 Apr. to 30 Apr. 2022	40.4	23.1	26.78	0

Source: Meteorological observatory of the College of Horticulture, Mandsaur (M.P.

Fig 3.1: Weekly meteorological data recorded during the periods of investigation (18th October, 2021 to 30th April, 2022)



3.4 Soil characteristics of the experimental site

The experiment was conducted in black soil. The physical and chemical composition of soil is presented in Table 3.2. To ascertain physical-chemical characteristics of the soil during the year of study, soil sample from 0-15 cm depth were taken from different spots of the experimental field before application of fertilizer. A representative composite sample was analysed for physical and chemical properties.

Table 3.2: Physical and chemical composition of the soil sample of experimental site

Particulars	Value obtained	Method
Physical characters		
Sand%	47%	By international Pipette method (Piper,1950)
Silt%	24%	
Clay%	29%	
Chemical characters		
Soil pH	7.3	Method No. 4 USDA handbook No. 60 (Richards, 1954)
Electrical Conductivity (dsm^{-1})	0.38	EC Meter
Available Nitrogen (kg N ha^{-1})	166.5	Alkaline $KMnO_4$ (Subbiah & Asija, 1956)
Available phosphorus (kg P_2O_5 ha^{-1})	20.5	Olsen extraction method (Olsen *et al.* 1954)
Available potash (kg K_2O ha^{-1})	341	Flame photometer method (Metson, 1956)

3.5 Experimental details

3.5.1 Design and experimental layout

The experiment was laid out by adopting factorial randomized block design (FRBD) with three replications. The experimental layout plan is given in Table and Fig. 3.2.

Particulars	**Details**
Location	PG Research Block, Bahadari Farm, College of Horticulture, Mandsaur (M.P)
Name of crop	China aster (*Callistephus chinensis* L. Nees)
Name of cultivars	Arka Poornima & Arka Archana
Season	*Rabi* season 2021-22
Experimental design	Factorial Randomized Block Design
Number of treatments	08
Number of replication	3
Total number of plot	24
Number of plant per plot	42
Number of plant selected for study	05 per plot
Total number of plant	1008
Planting distance	30 × 30 cm (row to row x plant to plant)
Net plot size	3.78 m^2
Total experimental area	150.20 m^2
Distance between replication	01 meter
Distance Between Plot	0.5 meter
Date of nursery raising	22th October, 2021
Date of transplanting	15th December, 2021

3.6: Details of layout

1. Varieties:

V_1 – Arka Poornima

V_2 – Arka Archana

2. Pinching:

P_0- Control

P_1 - At 30 DAP

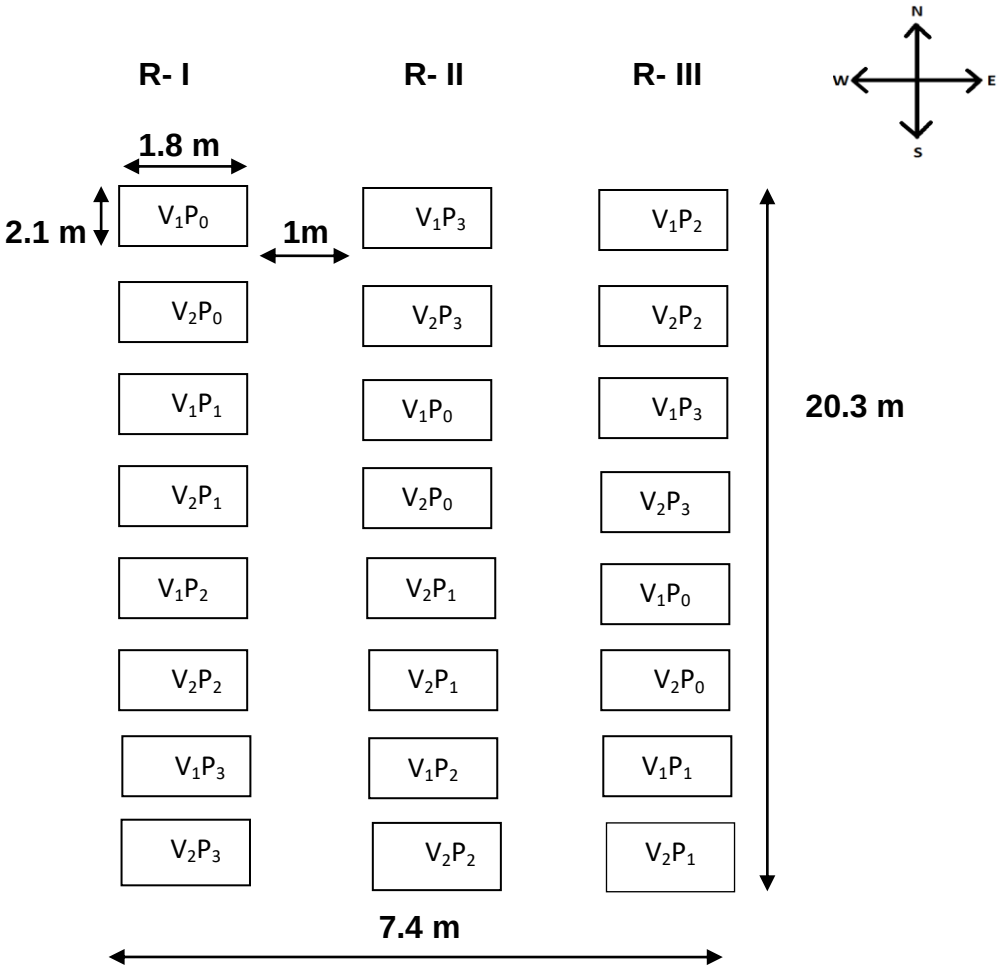
P_2 - At 45 DAP

P_3 - At 30 & 45 DAP

Symbol	Name of treatments
T_1	V_1P_0
T_2	V_2P_0
T_3	V_1P_1
T_4	V_2P_1
T_5	V_1P_2
T_6	V_2P_2
T_7	V_1P_3
T_8	V_2P_3

Fig 3.2 Details of layout

The experiment was laid out in factorial randomized block design (FRBD) with 8 treatments for 4 different types of pinching, which were replicated 3 times.



Layout of experimental field of China aster

3.7 Cultural practices

3.7.1 Nursery raising

Raised nursery bed of size 3m x 1m was first prepared. The seeds were sown in line and covered with a fine mixture of soil and vermicompost on 22th October, 2021. The nursery bed was watered daily twice for first 10 days and daily once for the remaining period. Hand weeding was done twice. The seedlings were ready for transplanting after 45 days of seed sowing.

3.7.2 Field preparation

The experimental area was ploughed twice with the help of tractor drawn implements in both directions and harrowing was done to break the clods and leveling was done.

3.7.3 Layout

The experimental area was finally leveled and divided into replications, channels, block borders and bunds. The plan of layout as shown in Fig.3.2 was executed on 14th December, 2021.

3.7.4 Application of manures and fertilizers

After executing the plan of layout, the calculated quantities of fertilizers were applied to the respective plots marked for giving the nutrient treatments mentioned. The sources of nitrogen, phosphorus and potash were urea (46% N), di-ammonium phosphate (46% P_2O_5 and 18% N) and muriate of potash (60% K_2O) respectively. The half dose of nitrogen with full doses of P_2O_5 and K_2O were applied as basal, at the time of transplanting. The remaining dose of N was top dressed at 30 days of transplanting (DAT). The calculated quantities of FYM and vermicompost were added to the respective plots before transplanting and were mixed well with the soil.

3.7.5 Transplanting

Healthy seedlings were transplanted in the main field at a spacing of (30 x 30 cm) on 15th December, 2021. Immediately after transplanting, light irrigation was given to the crop for better establishment of the seedlings in the field.

3.7.6 Gap filling

The damaged and dead seedlings were replaced by healthy and vigorous seedlings after 10 days of transplanting on 25th December, 2021 to maintain optimum plant population in the plot.

3.7.7 Weeding and irrigation

The plots were kept free from weeds by periodic hand weeding. Irrigations were given at an interval of 7-10 days throughout the period of experimentation.

3.7.8 Plant protection

Timely and suitable plant protection measures were followed to protect the experimental plants from the attack of pests and diseases.

3.7.9 Pinching

Pinching was done after 30 days of transplanting and 45 days after transplanting to encourage the emergence of lateral branches. When the plant attains 6 nodes, the first pinch is given 5-7 cm of apical portion has to be pinched off. This would give rise to 4-6 lateral shoots.

3.7.10 Harvesting

The flowers were harvested at weekly intervals when the central whorls of petals were in open condition.

3.8 Collection of experimental data

Sampling procedure

Five plants in each replication in each treatment were randomly selected and tagged for recording the observations. The observations are recorded during the research given below.

3.8.1 Growth parameters (at 75 DAT)

1. Plant height (cm)
2. Plant spread (cm)
3. Number of leaves/plant
4. Number of branches/plant

3.8.2 Flowering parameters

1. Days taken to 1st flower bud initiation
2. Days taken to opening of flower from bud emergence
3. Blooming period (days)

3.8.3 Quality parameters

1. Flower stalk length (cm)
2. Fresh weight of flower (g)
3. Flower diameter (cm)

3.8.4 Yield parameters

1. Number of flower/plant
2. Fresh yield/plant (g)
3. Flower yield/plot (kg)

3.8.1 Growth parameters (at 75 DAT)

3.8.1.1 Plant height (cm)

The plant heights of the five randomly selected plants was measured from the base to the growing tip of the plant at 75 days after transplanting and at harvesting stage and mean plant height was computed and expressed in centimetres.

3.8.1.2 Plant spread (cm)

Plant spread was calculated by measuring the spread of foliage in East-West and North-South direction at 75 days after transplanting with the help of meter scale in cm and average was determined.

3.8.1.3 Number of leaves

The total number of leaves of five tagged plants was counted at 75 days after transplanting and at harvesting stage and mean number of leaves per plant were computed.

3.8.1.4 Number of branches

The total number of branches of five tagged plants was counted at 75 days after transplanting and mean number of branches per plant were computed.

3.8.2 Flowering parameters

3.8.2.1 Days taken to 1st flower bud initiation

This observation was recorded from the tagged plants in each plot by counting the days from date of transplanting to the stage at which the first flower bud was formed.

3.8.2.2 Days taken to opening of flower from bud emergence

In this observation days taken to opening of flower from bud emergence was counted from the first pea stage flower bud formation on the plant to the opening of flower.

3.8.2.3 Blooming period (days)

Blooming period was counted from initiation of first flower on the plant to the last flower on the plant.

3.8.3 Quality parameters

3.8.3.1 Flower stalk length (cm)

The stalk length of the flower was taken from the origin of the stalk from the main stem to the neck of the flower and expressed in centimetre.

3.8.3.2 Fresh weight of flower (g)

Flower weight in each of the randomly selected plants was measured in grams with the help of physical balance and mean value was taken as flower weight.

3.8.3.3 Flower diameter (cm)

Diameter of the flower was measured at the point of maximum breath across the head of the flower. This was measured by measuring scale and average diameter in centimetre was computed.

3.8.5 Yield parameters

3.8.5.1 Number of flowers/plant

The total number of flowers per plant was counted in tagged plants and averages were worked out and presented as total number of flower per plant.

3.8.5.2 Flower yield/plant (g)

Yield per plant from the tagged plants was worked out by recording the fresh weight of flowers and mean value was worked out.

3.8.5.3: Flower yield/plot (kg)

Flower yield per plot was calculated on the basis of fresh weight of flower per plant from each experimental plot.

3.9 Statistical analysis

The data obtained from present experiment were subjected to “Analysis of Variance” as advocated by Panse and Sukhatme (1984). The Skeleton of ANOVA as per design is as given in Table 3.5 below.

Table 3.3 Skeleton of analysis of variance

Source of variation	Degree of freedom	Sum of square	Mean sum of square	“F” Value Calculated	“F” tab at 5%
Replication	r-1	SSR	MSR	MSR/ MSE	
Varieties (V)	p-1	SSS	MSS	MSS/ MSE	
Pinching (P)	q-1	SSD	MSD	MSD /MSE	
Interaction (V x P)	(p-1) (q-1)	SSSD	MSSD	MSSD /MSE	
Error	(r-1) (pq-1)	SSE			
Total	Pqr-1	SST			

The critical difference (C.D.) was calculated to assess the significance of difference between treatments, whenever the results were found significant through ‘F’ test, CD at 5 % level of significance was determined. Standard error of mean and CD are calculated using the following formula.

Standard error of mean (S.Em. ±)

$$\text{(a) S.Em.} \pm \text{ for V} = \sqrt{\frac{\text{EMS}}{\text{No. of replication x Levels of V}}}$$

(b) S.Em ± for P = $\sqrt{\frac{\text{EMS}}{\text{No. of replication x Levels of P}}}$

(c) S.Em ± for V×P = $\sqrt{\frac{\text{EMS}}{\text{No. of replication}}}$

Critical difference (CD):

(a) CD for V = S.Em± (V) x $\sqrt{2}$ x $t_{5\%\ (edf)}$

(b) CD for P = S.Em± (P) x $\sqrt{2}$ x $t_{5\%\ (edf)}$

(c) CD for V×P = S.Em± (V×P) x $\sqrt{2}$ x $t_{5\%\ (edf)}$

Where:

R = Number of replications

V = Varieties

P = Pinching

t = 't' Table value at error degree of freedom

EMS = Error mean sum of square

S. Em. = Standard error of mean

CD = Critical Difference

Plate 1:- Panoramic view of experimental field of China aster

Chapter- IV

RESULTS

This chapter discusses the results of the investigation, entitled **"Effect of pinching on growth, flowering and yield of China aster (*Callistephus chinensis* L. Nees)."** Data recorded throughout the experiment were statistically investigated using a factorial randomized block design to govern the significance of different treatments using the analysis of variance technique. Various parameters were statistically analysed and accessible as follows:

4.1 Growth Parameters (at 75 DAT)

4.1.1 Plant height (cm)

The data related to plant height (cm) have been presented in Table 4.1 and illustrated in Figure 4.1.

It is evident from the data that effect of varieties on plant height was statistically significant. The maximum plant height (30.65 cm) was recorded with V_1 (Arka Poornima), while the minimum plant height (25.94 cm) was recorded with V_2 (Arka Archana).

Effect of pinching on plant height was statistically significant. The maximum plant height (34.75 cm) was recorded with P_0 (No pinching) and it was statistically superior to other treatments, followed by P_1 (Pinching at 30 days) 27.81 cm and P_2 (Pinching at 45 days) 26.97 cm. The minimum plant height (23.67 cm) was recorded in P_3 (Pinching at 30 & 45 days).

Interaction effect of variety and pinching

Effect of interaction on plant height was statistically non-significant. Numerically the maximum plant height (38.00 cm) was recorded under the treatment V_1P_0 and minimum plant height (21.37 cm) was recorded under the treatment V_2P_3.

4.1.2 Plant spread (cm)

The data related to plant spread (cm) have been presented in Table 4.1 and illustrated in Figure 4.2.

It is evident from the data that effect of varieties on plant spread (cm) was statistically significant. The variety V_2 (Arka Archana) recorded the maximum plant spread (25.63 cm), while the minimum plant spread (22.97 cm) was recorded in V_1 (Arka Poornima).

Effect of different pinching stages on plant spread (cm) was statistically significant. The maximum plant spread (29.37 cm) was recorded with P_3 (Pinching at 30 & 45 days) followed by P_2 (Pinching at 45 days) which recorded a value of 25.43 cm. The minimum plant spread (19.43 cm) was recorded in P_0 (No pinching).

Interaction effect of variety and pinching

Effect of interaction on plant spread (cm) was statistically non-significant. Numerically the maximum plant spread (32.00 cm) was recorded under the treatment V_2P_3, while. The minimum plant spread (18.65 cm) was recorded under the treatment V_1P_0.

Table 4.1: Effect of varieties, pinching and their interactions on plant height (cm) and plant spread (cm) in China aster

Treatment	Plant height (cm)	Plant spread (cm)
Varieties		
V_1	30.65	22.97
V_2	25.94	25.63
S.Em. (±)	0.57	0.26
C.D. at 5%	1.73	0.78
Pinching		
P_0	34.75	19.43
P_1	27.81	22.98
P_2	26.97	25.43
P_3	23.67	29.37
S.Em. (±)	0.81	0.36
C.D. at 5%	2.44	1.10
Varieties X Pinching		
V_1P_0	38.00	18.65
V_1P_1	29.28	22.14
V_1P_2	29.37	24.35
V_1P_3	25.97	26.74
V_2P_0	31.50	20.21
V_2P_1	26.33	23.83
V_2P_2	24.57	26.50
V_2P_3	21.37	32.00
S.Em. (±)	1.14	0.51
C.D. at 5%	3.45	1.56

Fig. 4.1 Effect of varieties, pinching and their interactions on plant height (cm) in China aster

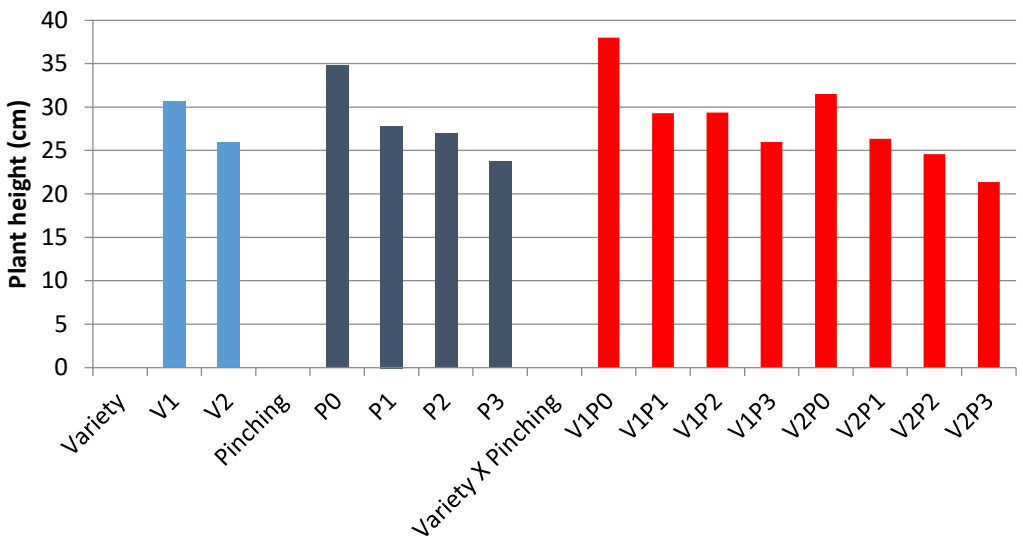
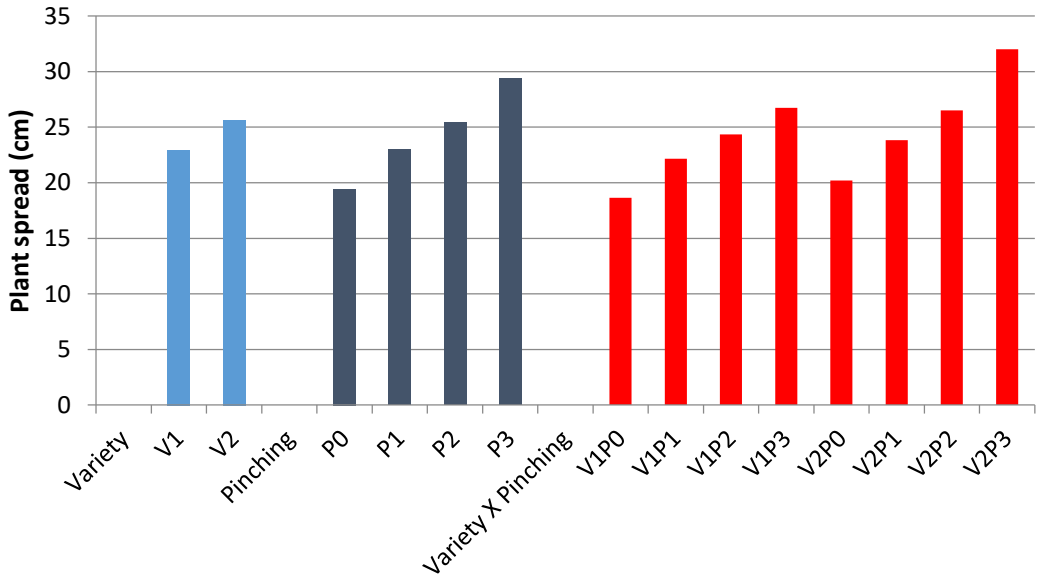


Fig. 4.2 Effect of varieties, pinching and their interactions on plant spread (cm) in China aster



4.1.3 Number of leaves/plant

The data related to number of leaves/plant have been presented in Table 4.2 and illustrated in Figure 4.3.

The data revealed that effect of varieties on number of leaves/plant was statistically significant. The maximum number of leaves/plant (154.85) was recorded with V_1 (Arka Poornima), while the minimum number of leaves/plant (133.00) was recorded in V_2 (Arka Archana).

The number of leaves/plant was significantly influenced by the pinching. The maximum number of leaves/plant (171.67) was recorded with P_3 (Pinching at 30 & 45 days) and it was statistically superior to other treatment, followed by P_2 (Pinching at 45 days) 150.66 and P_1 (Pinching at 30 days) 136.60. The minimum number of leaves/plant (116.77) was recorded in P_0 (No pinching).

Interaction effect of variety and pinching

Effect of interaction on number of leaves/plant was statistically significant. The maximum number of leaves/plant (186.67) was recorded under the treatment V_1P_3 followed by the treatment V_1P_2 and V_2P_3 which recorded values of 169.92 and 156.68 respectively. The minimum number of leaves/plant (112.67) was recorded under the treatment V_2P_0.

4.1.4 Number of branches/plant

The data related to number of branches/plant have been presented in Table 4.2 and illustrated in Figure 4.4.

The data depicted that effect of varieties on number of branches/plant was statistically significant. The maximum number of branches/plant (18.40) was recorded with V_2 (Arka Archana) and minimum number of branches/plant (16.27) was recorded in V_2 (Arka Poornima).

Effect of pinching on number of branches/plant was statistically significant. The maximum number of branches/plant (21.10) was recorded with P_3 (Pinching at 30 & 45 days) followed by P_2 (Pinching at 45 days) 18.50

and P_1 (Pinching at 30 days) 17.63. The minimum number of branches/plant (12.10) was recorded in P_0 (No pinching).

Interaction effect of variety and pinching

Effect of interaction on number of branches/plant was statistically significant. The maximum number of branches/plant (21.73) was recorded under the treatment V_2P_3 followed by the treatment V_1P_3 which recorded values of 20.47 and both of these are statistically at par to each other. The minimum number of branches/plant (10.13) was recorded under the treatment V_2P_0.

Table 4.2: Effect of varieties, pinching and their interactions on no. of leaves per plant and no. of branches per plant in China aster

Treatment	No. of leaves per plant	No. of branches per plant
Varieties		
V_1	154.85	16.27
V_2	133.00	18.40
S.Em. (±)	2.56	0.27
C.D. at 5%	7.77	0.83
Pinching		
P_0	116.77	12.10
P_1	136.60	17.63
P_2	150.66	18.50
P_3	171.67	21.10
S.Em. (±)	3.62	0.39
C.D. at 5%	10.99	1.18
Varieties X Pinching		
V_1P_0	120.87	14.07
V_1P_1	141.93	19.27
V_1P_2	169.92	19.80
V_1P_3	186.67	20.47
V_2P_0	112.67	10.13
V_2P_1	131.27	16.00
V_2P_2	131.40	17.20
V_2P_3	156.68	21.73
S.Em. (±)	5.13	0.55
C.D. at 5%	15.55	1.67

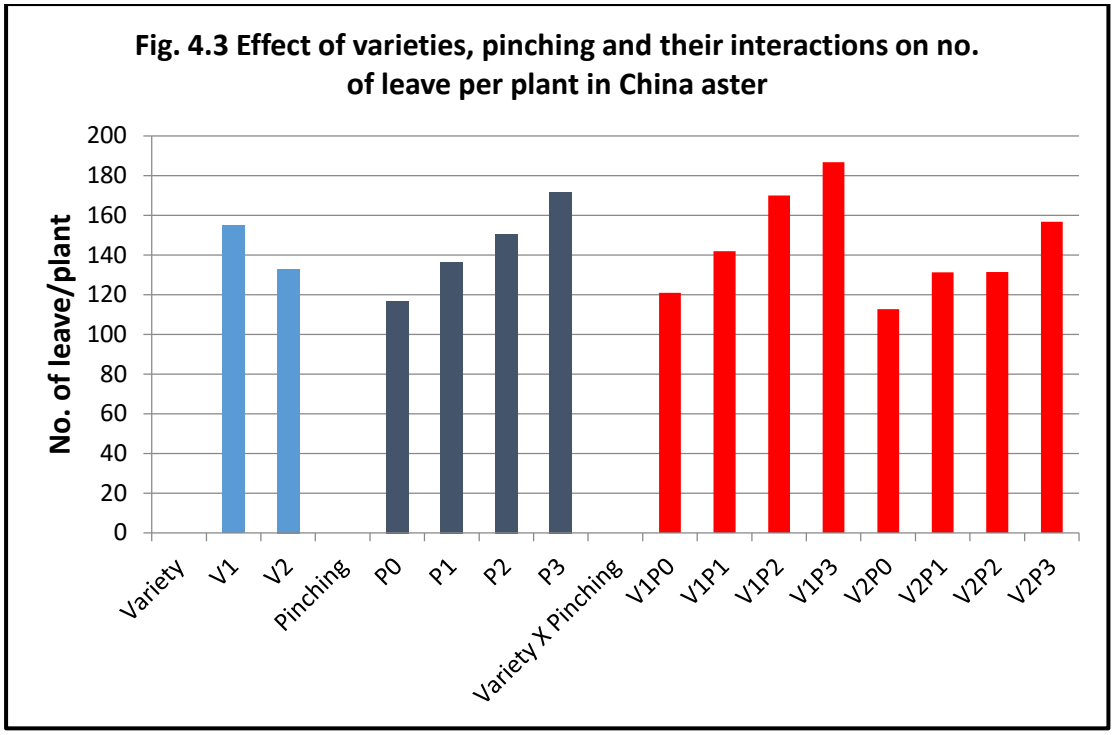


Fig. 4.3 Effect of varieties, pinching and their interactions on no. of leave per plant in China aster
No. of leave/plant
200
180
160
140
120
100
80
60
40
20
0
Variety
V1
V2
Pinching
P0
P1
P2
P3
Variety X Pinching
V1P0
V1P1
V1P2
V1P3
V2P0
V2P1
V2P2
V2P3

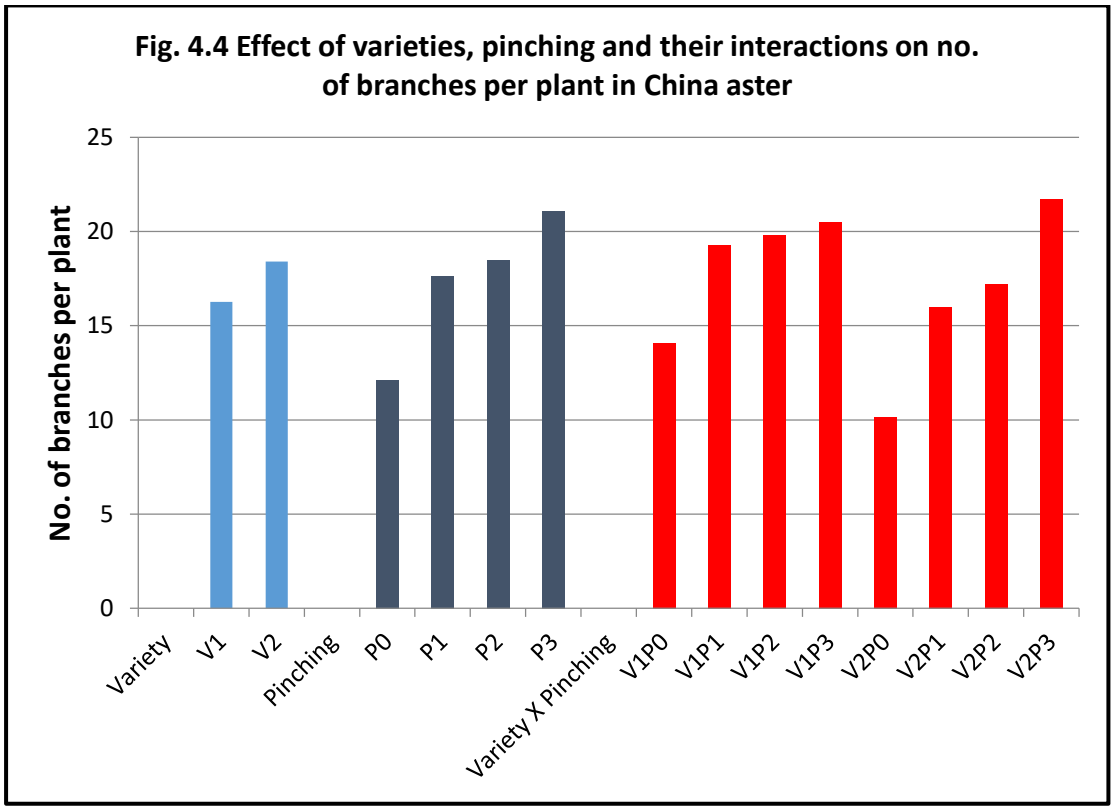


Fig. 4.4 Effect of varieties, pinching and their interactions on no. of branches per plant in China aster
No. of branches per plant
25
20
15
10
5
0
Variety
V1
V2
Pinching
P0
P1
P2
P3
Variety X Pinching
V1P0
V1P1
V1P2
V1P3
V2P0
V2P1
V2P2
V2P3

4.2 Flowering Parameters

4.2.1 Days taken to first flower bud initiation (days)

The data related to days taken to first flower bud initiation (days) have been presented in Table 4.3 and illustrated in Figure 4.5.

It is evident from the data that effect of varieties on days taken to first flower bud initiation (days) was statistically significant. The minimum days taken to first flower bud initiation (80.51) was recorded in V_2 (Arka Archana), while the maximum days taken to first flower bud initiation (87.60) was recorded with V_1 (Arka Poornima).

Effect of pinching on days taken to first flower bud initiation (days) was statistically significant. The minimum days taken to first flower bud initiation (77.47) was recorded with P_1 (Pinching at 30 days) followed by the treatment P_2 (Pinching at 45 days) which recorded value of 78.47 respectively. The maximum days taken to first flower bud initiation (95.33) was recorded in P_3 (Pinching at 30 & 45 days).

Interaction effect of variety and pinching

Effect of interaction on days taken to first flower bud initiation (days) was statistically non-significant. Numerically the minimum days taken to first flower bud initiation (74.40) was recorded under the treatment V_2P_1, V_2P_2. The maximum days taken to first flower bud initiation (98.87) was recorded under the treatment V_1P_3.

4.2.2 Days taken to opening of flower from bud emergence

The data related to days taken to opening of flower from bud emergence have been presented in Table 4.3 and illustrated in Figure 4.6.

It is evident from the data that effect of varieties on days taken to opening of flower from bud emergence was statistically non-significant. Numerically the minimum days taken to opening of flower from bud emergence (10.60) was recorded in V_2 (Arka Archana), while the maximum days taken to opening of flower from bud emergence (10.67) was recorded in V_1 (Arka Poornima).

Similarly effect of pinching on days taken to opening of flower from bud emergence was statistically non-significant. Numerically the minimum days taken to opening from bud emergence was recorded (10.60) P_2 (Pinching at 45 days) and P_3 (Pinching at 30 & 45 days). The maximum days taken to opening of flower from bud emergence (10.67) was recorded with P_1 (Pinching at 30 days).

Interaction effect of variety and pinching

Effect of interaction on days taken to opening of flower from bud emergence was statistically non-significant. The minimum days taken to opening of flower from bud emergence (10.40) was recorded under the treatment V_1P_0. The maximum days taken to opening of flower from bud emergence (10.93) was recorded under the treatment V_2P_0.

4.2.3 Blooming period (days)

The data related to blooming period (days) have been presented in Table 4.3 and illustrated in Figure 4.7.

It is evident from the data that effect of varieties on blooming period (days) was statistically non-significant. The maximum blooming period (23.79 days) was recorded in V_2 (Arka Archana), while the minimum blooming period (22.40 days) was recorded in V_1 (Arka Poornima).

Effect of pinching on blooming period (days) was statistically significant. The maximum blooming period (26.37 days) was recorded with P_3 (Pinching at 30 & 45 days) followed by P_2 (Pinching at 45 days) which recorded a value of 23.61 days and P_1 (Pinching at 30 days) recorded value of 22.02. The minimum blooming period (20.39) was recorded P_0 (No Pinching).

Interaction effect of variety and pinching

Effect of interaction on blooming period (days) was statistically non-significant. Numerically the maximum blooming period (28.53 days) was recorded with the treatment V_2P_3. The minimum blooming period was (20.07) recorded under the treatment V_1P_0.

Table 4.3: Effect of varieties, pinching and their interactions on days taken to first flower bud initiation, days taken to opening of flower from bud emergence and blooming period (days) in China aster

Treatment	Days taken to first flower bud initiation	Days taken to opening of flower from bud emergence	Blooming period (days)
Varieties			
V_1	87.60	10.67	22.40
V_2	80.51	10.60	23.79
S.Em. (±)	1.49	0.28	0.79
C.D. at 5%	4.51	0.86	2.40
Pinching			
P_0	84.94	10.67	20.39
P_1	77.47	10.67	22.02
P_2	78.47	10.60	23.61
P_3	95.33	10.60	26.37
S.Em. (±)	2.10	0.40	1.12
C.D. at 5%	6.38	1.22	3.40
Varieties X Pinching			
V_1P_0	88.45	10.40	20.07
V_1P_1	80.53	10.87	21.81
V_1P_2	82.53	10.67	23.53
V_1P_3	98.87	10.73	24.20
V_2P_0	81.43	10.93	20.72
V_2P_1	74.40	10.47	22.23
V_2P_2	74.40	10.53	23.69
V_2P_3	91.80	10.47	28.53
S.Em. (±)	2.98	0.57	1.58
C.D. at 5%	9.03	1.72	4.80

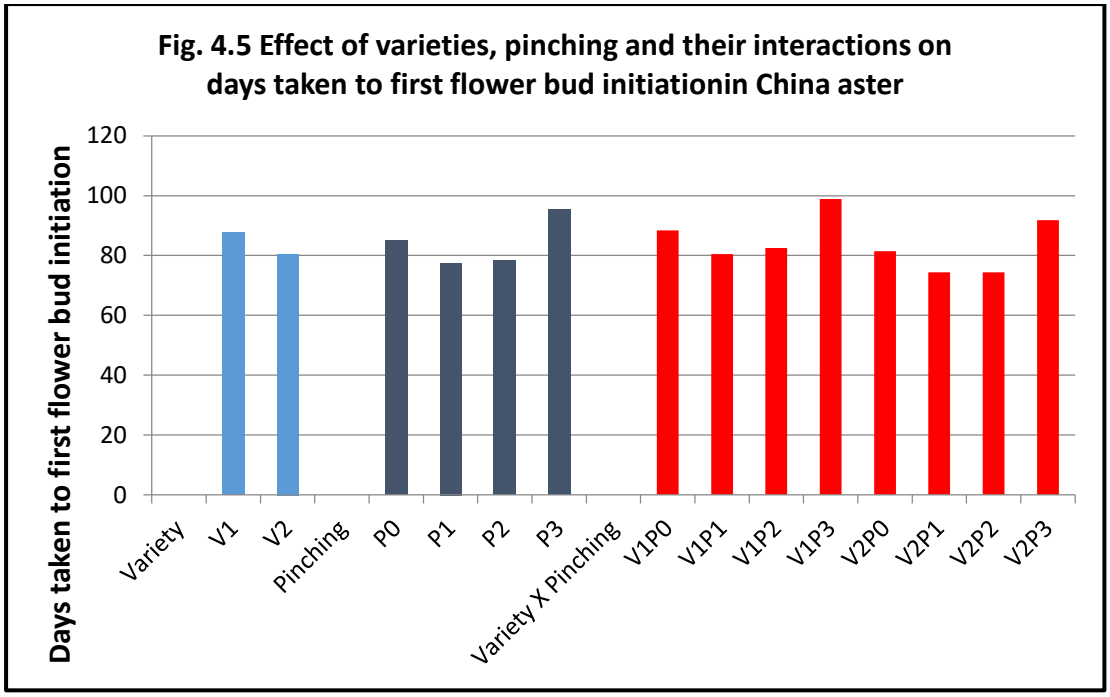


Fig. 4.5 Effect of varieties, pinching and their interactions on days taken to first flower bud initiationin China aster
Days taken to first flower bud initiation
120
100
80
60
40
20
0
Variety
V1
V2
Pinching
P0
P1
P2
P3
Variety X Pinching
V1P0
V1P1
V1P2
V1P3
V2P0
V2P1
V2P2
V2P3

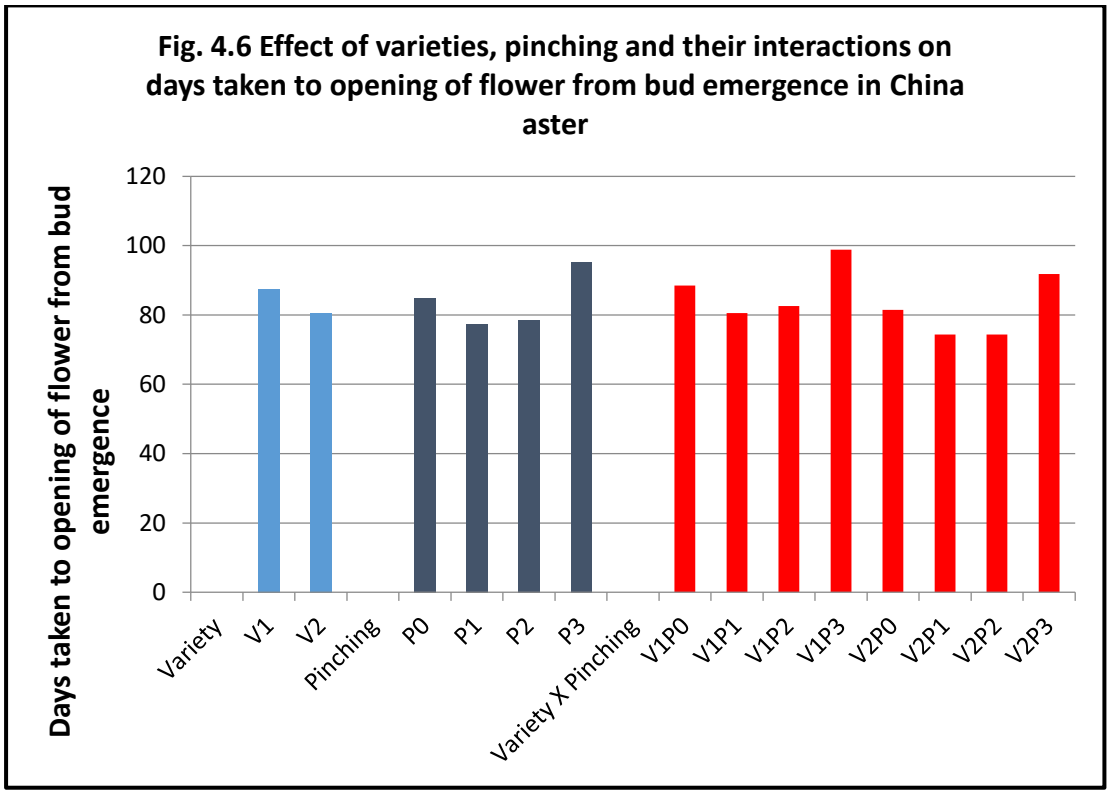


Fig. 4.6 Effect of varieties, pinching and their interactions on days taken to opening of flower from bud emergence in China aster
Days taken to opening of flower from bud emergence
120
100
80
60
40
20
0
Variety
V1
V2
Pinching
P0
P1
P2
P3
Variety X Pinching
V1P0
V1P1
V1P2
V1P3
V2P0
V2P1
V2P2
V2P3

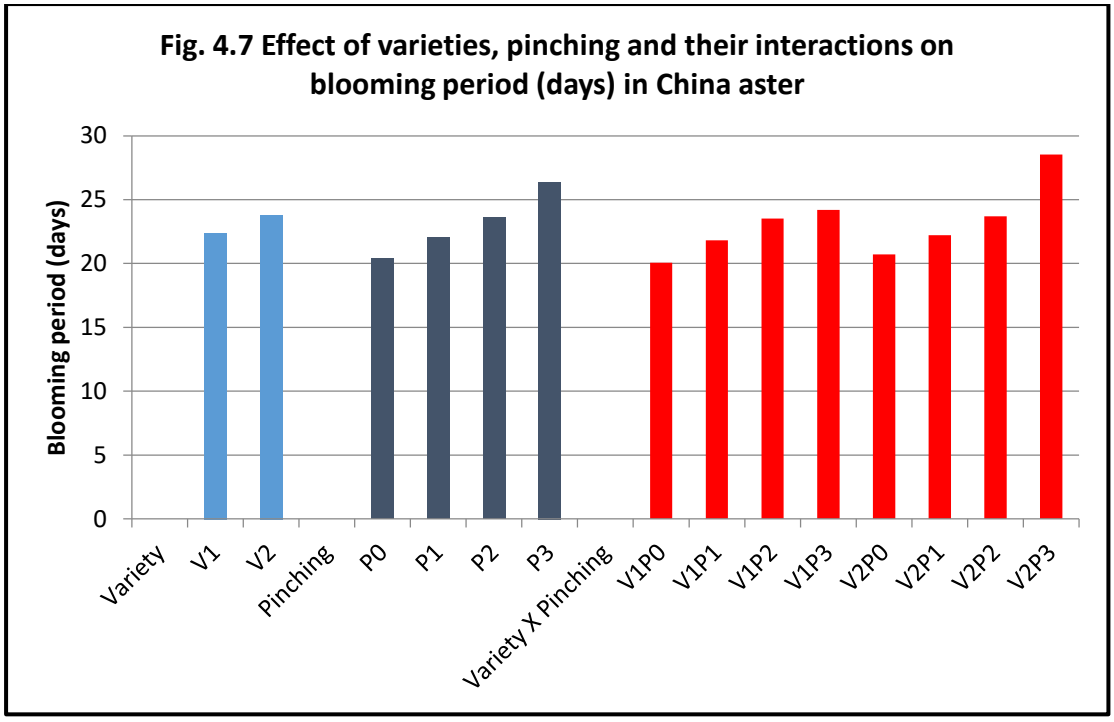


Fig. 4.7 Effect of varieties, pinching and their interactions on blooming period (days) in China aster
Blooming period (days)
30
25
20
15
10
5
0
Variety
V1
V2
Pinching
P0
P1
P2
P3
Variety X Pinching
V1P0
V1P1
V1P2
V1P3
V2P0
V2P1
V2P2
V2P3

4.3 Quality Parameters

4.3.1 Flower stalk length (cm)

The data related to flower stalk length (cm) have been presented in Table 4.4 and illustrated in Figure 4.8.

The data related that effect of varieties on flower stalk length (cm) was statistically significant. The maximum flower stalk length (24.88 cm) was recorded in V_1 (Arka Poornima), while the minimum flower stalk length (21.71 cm) was recorded in V_2 (Arka Archana).

There was significant difference was recorded on flower stalk length (cm) different stages of pinching. The maximum flower stalk length (29.93 cm) was recorded in P_0 (No pinching) and it was statistically superior to other treatments, followed by P_2 (Pinching at 45 days) 23.89 cm and P_1 (Pinching at 30 days) 23.05 cm. The minimum flower stalk length (16.31 cm) was recorded in P_3 (Pinching at 30 & 45 days).

Interaction effect of variety and pinching

Effect of interaction on flower stalk length (cm) was statistically non-significant. Numerically maximum flower stalk length (32.33 cm) was recorded under the treatment V_1P_0 and minimum flower stalk length (14.53 cm) was recorded under the treatment V_2P_3.

4.3.2 Fresh weight of flower (g)

The data related to fresh weight of flower (g) have been presented in Table 4.4 and illustrated in Figure 4.9.

It is evident from the data that effect of varieties on fresh weight of flower (g) was statistically non-significant. The maximum fresh weight of flower (2.90 g) was recorded in V_2 (Arka Archana), while the minimum fresh weight of flower (2.82 g) was recorded in V_1 (Arka Poornima).

Similar effect of pinching on fresh weight of flower (g) was statistically significant. The maximum fresh weight of flower (3.11 g) was recorded in P_0 (No pinching) followed by P_1 (Pinching at 30 days) which recorded a value of

2.89 g, while the minimum fresh weight of flower (2.69 g) was recorded in P_3 (Pinching at 30 & 45 days).

Interaction effect of variety and pinching

Effect of interaction on fresh weight of flower (g) was statistically non-significant. Numerically the maximum fresh weight of flower (3.21 g) was recorded under the treatment V_2P_0. The minimum fresh weight of flower (2.62) was recorded in V_1P_3.

4.3.3 Flower diameter (cm)

The data related to flower diameter (cm) have been presented in Table 4.4 and illustrated in Figure 4.10.

It is evident from the data that effect of varieties on flower diameter (cm) was statistically non-significant. The maximum flower diameter (4.92 cm) recorded with V_1 (Arka Poornima), while the minimum flower diameter (4.83 cm) was recorded in V_2 (Arka Archana).

Effect of pinching on flower diameter (cm) was statistically significant. The maximum flower diameter (5.11 cm) was recorded with P_0 (No pinching), followed by P_1 (Pinching at 30 days) which recorded a value of 4.83 cm, while the minimum flower diameter (4.75 cm) was recorded with P_3 (Pinching 30 & 45 days).

Interaction effect of variety and pinching

Effect of interaction on flower diameter (cm) was statistically non-significant. The maximum flower diameter (5.13 cm) was recorded under the treatment V_1P_0. The minimum flower diameter (4.71 cm) was recorded under the treatment V_2P_3.

Table 4.4: Effect of varieties, pinching and their interactions on flower stalk length (cm), fresh weight of flower (g) and flower diameter (cm) in China aster

Treatment	Flower stalk length (cm)	Fresh weight of flower (g)	Flower diameter (cm)
Varieties			
V_1	24.88	2.82	4.92
V_2	21.71	2.90	4.83
S.Em. (±)	0.56	0.07	0.06
C.D. at 5%	1.68	0.20	0.18
Pinching			
P_0	29.93	3.11	5.11
P_1	23.05	2.89	4.83
P_2	23.89	2.75	4.81
P_3	16.31	2.69	4.75
S.Em. (±)	0.79	0.09	0.09
C.D. at 5%	2.38	0.28	0.26
Varieties X Pinching			
V_1P_0	32.33	3.02	5.13
V_1P_1	24.51	2.88	4.89
V_1P_2	24.57	2.72	4.90
V_1P_3	18.10	2.62	4.79
V_2P_0	27.52	3.21	5.09
V_2P_1	21.58	2.90	4.77
V_2P_2	23.21	2.78	4.72
V_2P_3	14.53	2.72	4.71
S.Em. (±)	1.11	0.13	0.12
C.D. at 5%	3.37	0.40	0.37

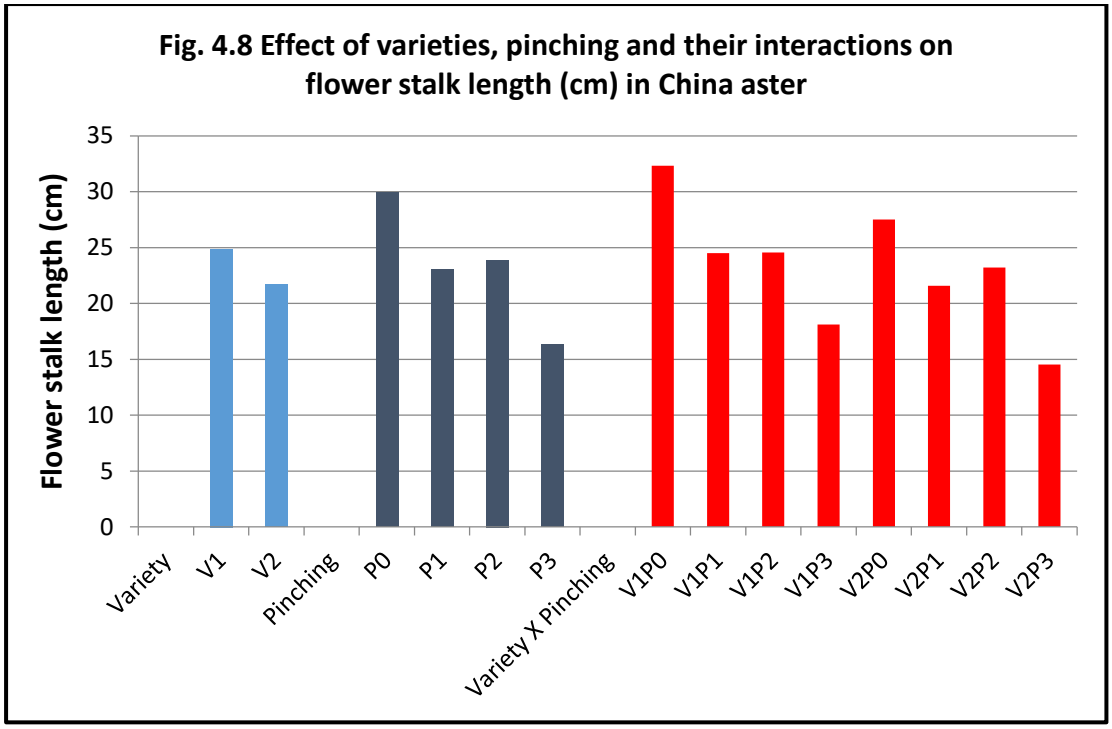


Fig. 4.8 Effect of varieties, pinching and their interactions on flower stalk length (cm) in China aster
Flower stalk length (cm)
35
30
25
20
15
10
5
0
Variety
V1
V2
Pinching
P0
P1
P2
P3
Variety X Pinching
V1P0
V1P1
V1P2
V1P3
V2P0
V2P1
V2P2
V2P3

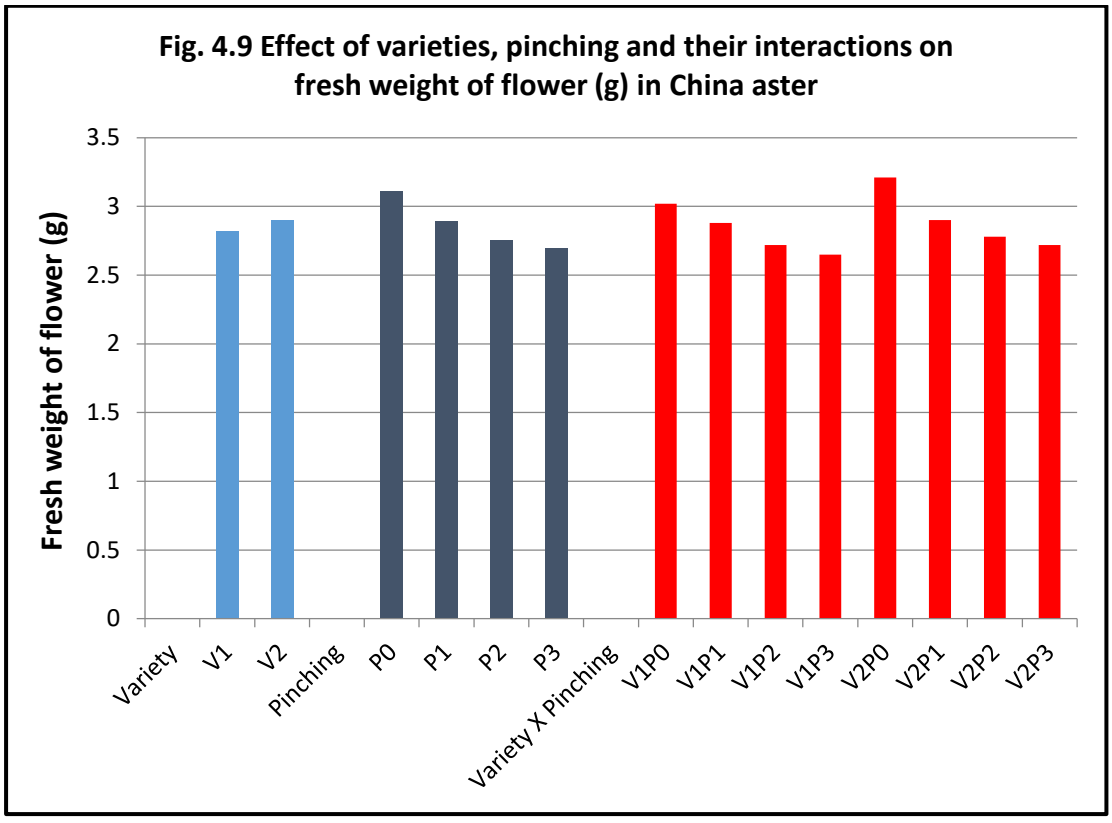
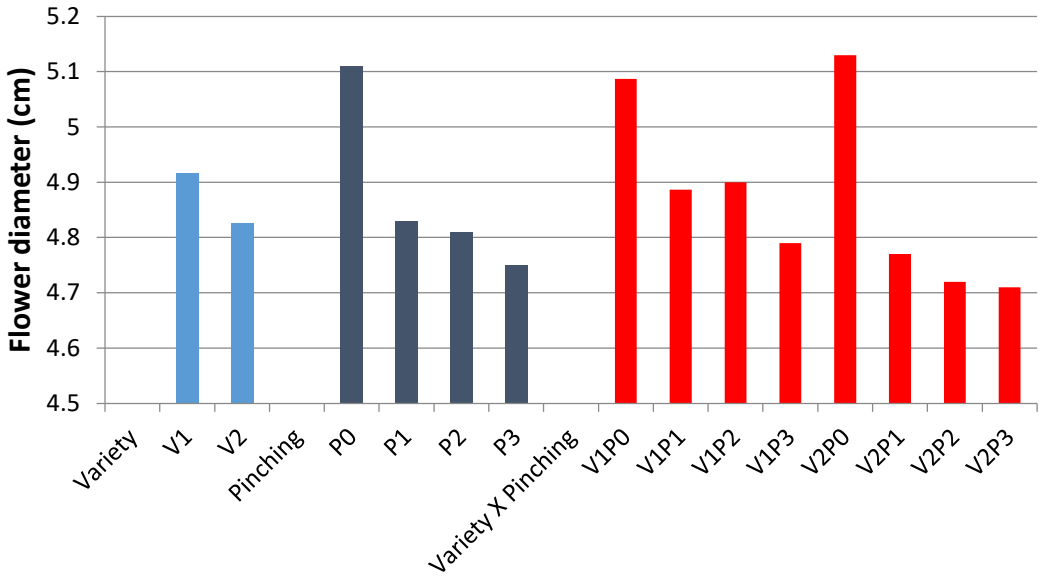


Fig. 4.9 Effect of varieties, pinching and their interactions on fresh weight of flower (g) in China aster
Fresh weight of flower (g)
3.5
3
2.5
2
1.5
1
0.5
0
Variety
V1
V2
Pinching
P0
P1
P2
P3
Variety X Pinching
V1P0
V1P1
V1P2
V1P3
V2P0
V2P1
V2P2
V2P3

Fig. 4.10 Effect of varieties, pinching and their interactions on flower diameter (cm) in China aster



4.4 Yield Parameters

4.4.1 Number of flower/plant

The data related to number of flower/plant have been presented in Table 4.5 and illustrated in Figure 4.11.

It is evident from the data that effect of varieties on number of flower/plant was statistically non-significant. Numerically the maximum number of flower/plant (48.05) was recorded in V_1 (Arka Poornima), while the minimum number of flower/plant (46.03) was recorded in V_2 (Arka Archana).

Effect of pinching on number of flower/plant was statistically significant. The maximum number of flower/plant (57.41) was recorded in P_3 (Pinching at 30 & 45 days) followed by 49.37 with P_2 (Pinching at 45 days) and 45.39 with P_1 (Pinching at 30 days). The minimum number of flower/plant (36.00) was recorded in P_0 (No pinching).

Interaction effect of variety and pinching

Effect of interaction on number of flower/plant was statistically non-significant. Numerically the maximum number of flower/plant (59.47) was recorded under the treatment V_1P_3. The minimum number of flower/plant (35.93) was recorded under the treatment V_2P_0.

4.4.2 Flower yield/plant (g)

The data related to flower yield/plant (g) have been presented in Table 4.5 and illustrated in Figure 4.12.

It is evident from the data that effect of varieties on flower yield/plant (g) was statistically non-significant. The maximum flower yield/plant (134.58 g) was recorded in V_1 (Arka Poornima), while the minimum flower yield/plant (132.56 g) was recorded in V_2 (Arka Archana).

Effect of pinching on flower yield/plant (g) was statistically significant. The maximum flower yield/plant (155.54 g) was recorded with P_3 (Pinching at 30 & 45 days) followed by 135.32 g recorded with P_2 (Pinching at 45 days). Both of these are statically at par with each other and superior to other

treatments. The minimum flower yield/plant (112.12 g) was recorded under the treatment P_0 (No pinching).

Interaction effect of variety and pinching

Effect of interaction on flower yield/plant (g) was statistically non-significant. The maximum flower yield/plant (160.22 g) was recorded under the treatment V_1P_3. The minimum flower yield/plant (108.91 g) was recorded under the treatment V_1P_0.

4.4.3 Fresh yield/plot (kg)

The data related to fresh yield/plot (kg) have been presented in Table 4.5 and illustrated in Figure 4.13.

It is evident from the data that effect of varieties on fresh yield/plot (kg) was statistically non-significant. Numerically the maximum fresh yield/plot (5.63 kg) was recorded in V_1 (Arka Poornima), while the minimum fresh yield/plot (5.55 kg) was recorded in V_2 (Arka Archana).

Effect of pinching on fresh yield/plot (kg) was statistically significant. The maximum fresh yield/plot (6.46 kg) was recorded with P_3 (Pinching at 30 & 45 days) followed by P_2 (Pinching at 45 days) which recorded a value of 5.68 kg both of these are statistically superior to other treatments. The minimum fresh yield/plot (4.71 kg) was recorded in P_0 (No Pinching).

Interaction effect of variety and pinching

Effect of interaction on fresh yield/plot (kg) was statistically non-significant. The maximum fresh yield/plot (6.57 kg) were recorded under the treatment V_1P_3 followed by V_2P_3 which recorded a value of 6.34 kg. The minimum fresh yield/plot (4.57 kg) were recorded under the treatment V_1P_0.

Table 4.5: Effect of varieties, pinching and their interactions on no. of flower/plant, fresh yield/plot (kg) and flower yield/plant (g) in China aster

Treatment	No. of flower/plant	Flower yield/plant (g)	Fresh yield/plot (kg)
Varieties			
V_1	48.05	134.58	5.63
V_2	46.03	132.56	5.55
S.Em. (±)	1.56	3.29	0.10
C.D. at 5%	4.72	9.97	0.32
Pinching			
P_0	36.00	112.12	4.71
P_1	45.39	131.32	5.51
P_2	49.37	135.32	5.68
P_3	57.41	155.54	6.46
S.Em. (±)	2.20	4.65	0.15
C.D. at 5%	6.68	14.10	0.45
Varieties X Pinching			
V_1P_0	36.06	108.91	4.57
V_1P_1	46.39	133.32	5.63
V_1P_2	50.28	135.88	5.74
V_1P_3	59.47	160.22	6.57
V_2P_0	35.93	115.34	4.85
V_2P_1	44.39	129.27	5.40
V_2P_2	48.45	134.76	5.61
V_2P_3	55.36	150.86	6.34
S.Em. (±)	3.12	6.58	0.21
C.D. at 5%	9.45	19.94	0.63

Fig. 4.11 Effect of varieties, pinching and their interactions on no. of flower/plant in China aster

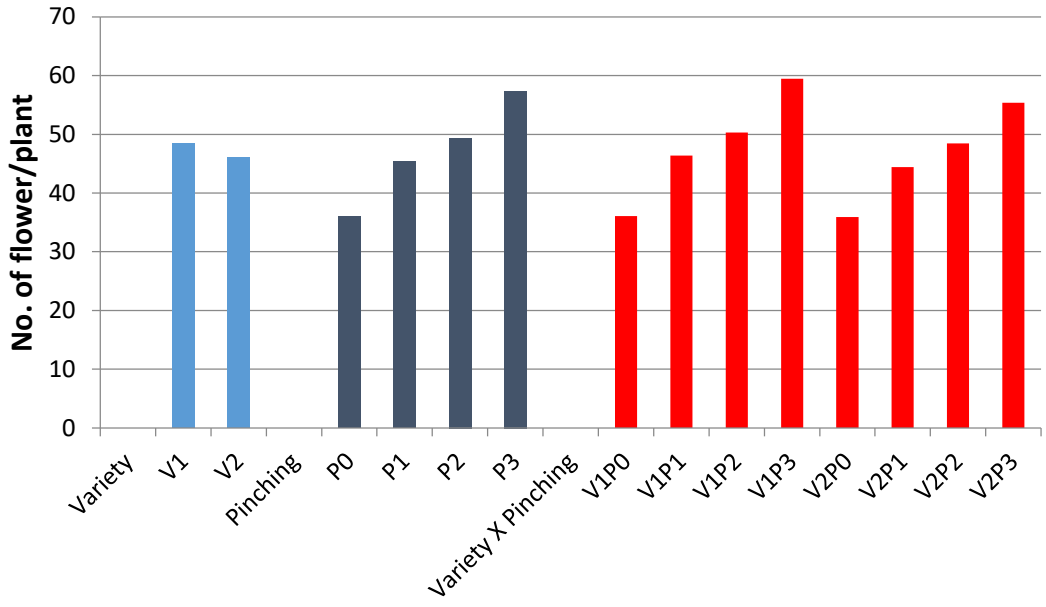


Fig. 4.12 Effect of varieties, pinching and their interactions on flower yield/plant (g) in China aster

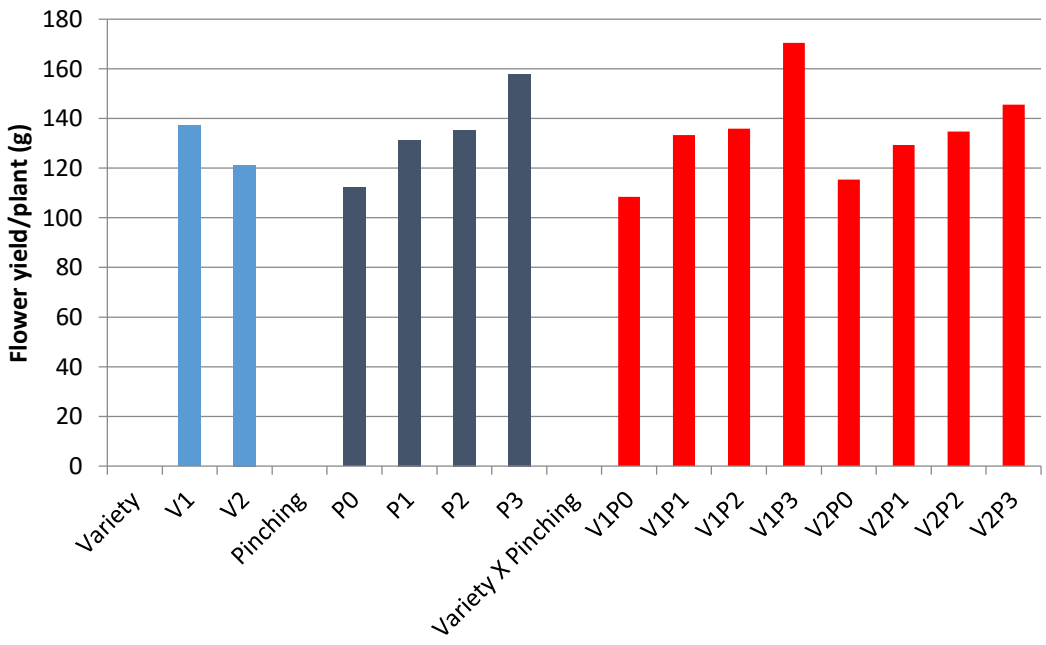
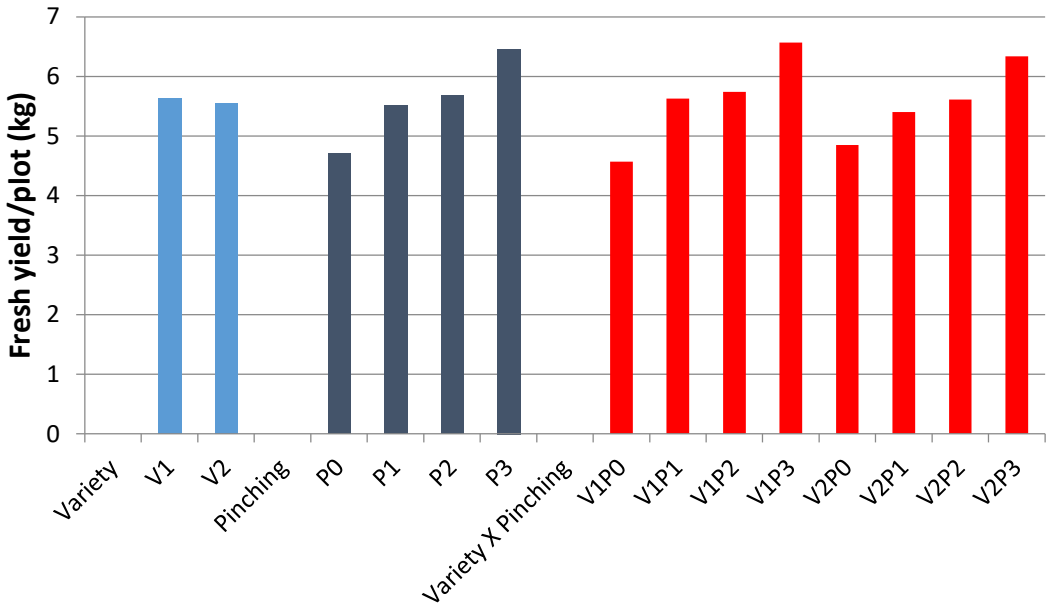


Fig. 4.13 Effect of varieties, pinching and their interactions on fresh yield/plot (kg) in China aster



Chapter – V

DISCUSSION

The present investigation entitled: **"Effect of pinching on growth, flowering and yield of China aster (*Callistephus chinensis* L. Nees)"** in the previous chapter, all findings that describe the same will be discussed in detail here.

5.1. Growth Parameters

The findings pertaining to growth parameters *viz.*, plant height, plant spread, number of leaves per plant and number of branches per plant at 75 DAT. All the parameters indicated significant influence of varieties and pinching.

5.1.1 Plant height

The plant height was significantly influenced by the varieties. The maximum plant height was recorded with V_1 (Arka poornima) and the minimum plant height was recorded in V_2 (Arka Archana). The variation in plant height among the varieties might be due to genotypic differences in phenotypic expression of plant height. These results are confirmed with the finding of Poornima *et al*. (2006), Kulkarni and Reddy (2006) in China aster.

The plant height was significantly influenced by the pinching. The maximum plant height was recorded justified P_0 (No pinching) and it was statistically superior to other treatment. The minimum plant height was recorded in P_3 (Pinching at 30 & 45 days). This observation is in line with the earlier reports in lisianthus (Sailaja and Panchbhai, 2014), chrysanthemum (Habiba *et al*. 2012) and Rakesh *et al*., 2003, in China aster.

The interaction impact of different China aster varieties and pinching was found to be non-significant for the plant height.

5.1.2 Plant spread

The plant spread was significantly influenced by the varieties. The variety V_2 (Arka Archana) recorded the maximum plant spread while minimum plant spread was recorded in V_1 (Arka Poornima). The difference in plant spread per plant may be attributed to varietal trait as it is governed by the genetical makeup of the plant (Munikrishnappa, 2013). Similar result was obtained by Pandey and Rao (2014), Kulkarni and Reddy (2006) and Swaroop *et al*. (2004) in China aster.

The plant spread was significantly influenced by the pinching. The maximum plant spread was recorded with P_3 (Pinching at 30 & 45 days). The minimum plant spread was recorded in P_0 (No pinching). It might be due to pinching reduces the apical dominance and encourages the growth of lateral buds and plant spread. The present findings are in line with the earlier findings of Kesav (2014) in marigold and Salve *et al.* (2016) in chrysanthemum.

The interaction impact of different China aster varieties and pinching was found to be non-significant for the plant spread.

5.1.3 Number of leaves per plant

The number of leaves per plant was significantly influenced by the varieties. The maximum number of leaves per plant was recorded with the variety V_1 (Arka Poornima) and minimum number of leaves per plant was recorded in V_2 (Arka Archana). The production of more number of leaves in these varieties may be due to vigorous growth, more number of branches and more plant spread, which in turn facilitates better harvest of sunshine by the plant to produce more number of leaves in China aster (Zosiamliana *et al.* 2013).

The number of leaves per plant was significantly influenced by pinching. The maximum number of leaves/plant was recorded with P_3 (Pinching at 30 & 45 days) and the minimum number of leaves / plant was recorded in P_0 (No pinching). This might be due to removal of apical dominance through pinching; it reduces the plant height and encourages the

development of lateral branches, which might have favoured the production of more number of leaves plant^{-1} (Salve et al 2016).

The number of leaves per plant was significantly influenced by varieties and pinching. The maximum number of leaves/plant was recorded under the treatment V_1P_3. The minimum number of leaves/plant was recorded under the treatment V_2P_0. The increased number of leaves might be due to translocation of photosynthesis to leaf auxiliary buds which resulted in production of more number of leaves per plant. The findings agree with the views of Singh *et al.,* (2015), Seharawat *et al.* (2003) in marigold and Gnyandev *et al.* (2014) in China aster.

5.1.4 Number of branches per plant

The number of branches/plant was significantly influenced by the varieties. The variety V_2 (Arka Archana) recorded the maximum number of branches/plant. The minimum number of branches/plant was recorded in V_1 (Arka Poornima). Number of branches is also a varietal character and its expression depends on the genotype of the plant. Poornima *et al.* (2006), Munikrishnappa *et al.* (2013) and Kumar (2002) observed significant variation for number of branches.

The number of branches/plant was significantly influenced by pinching. The maximum number of branches/plant was recorded with P_3 (Pinching at 30 & 45 days). The minimum number of branches/plant was recorded in P_0 (No pinching). Kumar *et al.* (2002) observed that pinching in carnation increased number of branches. Similar results were notice by Sehrawat *et al.* (2003) in Marigold.

The number of branches per plant was significantly influenced by varieties and pinching. The maximum number of branches/plant was recorded under the treatment V_2P_3 and minimum number of branches/plant was recorded under the treatment V_2P_0. In pinching, the apical portion of main stem was pinched and therefore, more side twigs were formed below pinched portion. This might be due to the diversion of carbohydrates or food material towards the auxiliary vegetative buds below pinched portion. The similar

results were also obtained with the finding of Dalal *et al.* (2006) in carnation, Kumar *et al.* (2014) in China aster.

5.2 Flowering Parameters

The finding pertaining to flowering parameters *viz.,* days taken to first flower bud initiation, days taken to opening of flower from bud emergence and blooming period (days).

5.2.1 Days taken to first flower bud initiation (days)

The data related to days taken to first flower bud initiation by varieties had significantly influenced. The minimum days taken to first flower bud initiation was recorded with V_2 (Arka Archana) and maximum days taken to first flower bud initiation was recorded in V_1 (Arka Poornima). Though, the number of days taken to first flower opening is a varietal trait, Dhiman (2003) suggested that supplementary dry matter accumulation during favourable climatic conditions might be the reason for earliness. Variation in day's first flower opening in China aster has also been reported by Rai *et al.* (2016) and Khangjarakpan *et al.* (2014).

Pinching significantly influenced the days taken to first flower bud initiation. The minimum days taken to first flower bud initiation was recorded with P_1 (Pinching at 30 days) and it was statistically superior to other treatment. The maximum days taken to first flower bud initiation was recorded in P_3 (Pinching at 30 & 45 days). Similar results were obtained by Jhon and Paul (1995) and observed that first pinching treatments show the early flowering.

The interaction effects between different China aster varieties and pinching were found to be data statistically non-significant for the days taken to first flower bud initiation.

5.2.2 Days taken to opening of flower from bud emergence

Statistical analysis revealed that, the days taken to opening of flower from bud emergence were found to be statistically non-significant numerically for varieties, pinching and interaction between varieties and pinching.

5.2.3 Blooming period

Statistical analysis revealed that, the blooming period of varieties was found to be non-significant.

The data related to blooming period was significant for pinching. Stages the maximum blooming period was recorded with P_3 (Pinching at 30 & 45 days) and minimum blooming period treatment was recorded in P_0 (No pinching). Blooming period was recorded at proper stages and the data was statistically analysed by the method suggested by Panse and Sukhatme (1995). Similar results were obtained by Sehrawat *et al.* (2003) who reported that pinching in marigold increased the flowering duration. The results are in conformity with Sailaja *et al.,* (2014)

The interaction effects between different China aster varieties and pinching were found to be data statistically non-significant for blooming period.

5.3 Quality Parameters

The findings pertaining to quality parameters *viz.*, flower stalk length (cm), fresh weight of flower (g) and flower diameter (cm).

5.3.1 Flower stalk length (cm)

The flower stalk length was significantly influenced by the varieties. The maximum flower stalk length was recorded with V_1 (Arka Poornima) and the minimum flower stalk length was recorded in V_2 (Arka Archana). This variation is due to genetic constitution of these varieties resulted in difference in stalk length of flowers. The variation among the cultivars might be due to genetic makeup. These findings are in accordance with Kulkarni and Reddy (2006) and Poornima *et al.* (2006) in China aster.

The flower stalk length was significantly influenced by the pinching. The maximum flower stalk length was recorded with P_0 (No pinching) and it was statistically superior to other treatments. The minimum flower stalk length was recorded in P_3 (Pinching at 30 & 45 days). The increase in length might be because of rapid elongation of internodes which may be again due to increase in cell division and enlargement, which is mostly confined to sub-apical meristem. This finding of flower stem length was in accordance with the results obtained by Singh (2018), Rakesh *et al*. (2003).

The interaction effects between different China aster varieties and pinching were found to be non-significant for the flower stalk length.

5.3.2 Fresh weight of flower (g)

Statistical analysis revealed that, the fresh weight of flower (g) of varieties was found to be non-significant.

The fresh weight of flower (g) was significantly influenced by the pinching. The maximum fresh weight of flower was recorded with P_0 (No pinching). The minimum fresh weight of flower was recorded in P_3 (Pinching at 30 & 45 days). The reason of increased weight of the flower and number of petals flower^{-1} with no pinching had more food material and better allocation of energy pertaining to lesser number of flowers. Similar results were revealed by Sailaja *et al.* (2013) in China aster and Singh *et al.* (2018) in African marigold. Similar reported were also recorded by Srivastava *et al*. (2002) in Pusa Naringa Gainda who noticed that, the flower weight of marigold maximum for unpinched plants.

The interaction effects between different China aster varieties and pinching were found to be non-significant for the fresh weight of flower.

5.3.3 Flower diameter (cm)

Statistical analysis revealed that, the flower diameter of varieties was found to be non-significant.

The flower diameter (cm) was significantly influenced by the pinching. The maximum flower diameter was recorded with P_0 (No pinching) and minimum flower diameter was recorded in P_3 (Pinching at 30 & 45 days).

Similar kinds of results were obtained by Srivastava *et al.* (2002). He reported on pinching effect in marigold (*Tagetes erecta*) cv. Pusa Narangi Gainda that maximum flower size was observed in Control. Rakesh *et al.* (2005) studied the effect of pinching on growth and yield in chrysanthemum and observed reduction in flower size in pinched plants as compared to unpinched plants.

The interaction effects between different China aster varieties and pinching were found to be non-significant for the flower diameter.

5.4 Yield Parameters

The findings pertaining to flowering parameters *viz.*, number of flower per plant, flower yield/plant (g) & fresh yield/plot (kg)

5.4.1 Number of flower/plant

Statistical analysis revealed that, the number of flower/plant of varieties was found to be non-significant.

The number of flower/plant was significantly influenced by the pinching. P_3 (Pinching at 30 & 45 days) recorded the maximum number of flower/plant and minimum number of flower/plant was recorded in P_0 (No pinching). Chavan *et al.* (2010) reported that pinching improved flower production in carnation. Linear increase in yield was recorded as the pinching severity increased. Double pinched plants were superior and recorded more yield per plant.

The interaction effects between different China aster varieties and different pinching were found to be non-significant for the number of flower per plant.

5.4.2 Flower yield/plant (g)

Statistical analysis revealed that, the flower yield/plant (g) of varieties was found to be non-significant.

Statistical data analysis revealed that, the flower yield was found to be significant for pinching. The maximum flower yield/plant was recorded with P_3 (Pinching at 30 & 45 days) and minimum flower yield/plant was recorded in P_0

(No pinching). Pinching produced more number of branches and more vegetative growth resulted in the production of maximum number of flowers per plant. These results are in conformity with the results obtained by Maharnor *et al.* (2011) in African marigold.

The interaction effects between different China aster varieties and different pinching were found to be non-significant for the flower yield/plant.

5.4.3 Fresh yield/plot (kg)

Statistical data analysis revealed that, the fresh yield/plot (kg) was found to be non-significant for varieties.

The number of flower/plot (kg) was significantly influenced by pinching. The maximum fresh yield/plot was recorded with P_3 (Pinching at 30 & 45 days). The minimum fresh yield/plot was recorded in P_0 (No pinching). Hence, more number of flowers per plot would be obviously expected. Similar findings have also been reported by Khobragade *et al.* (2012) in China aster and Mohanty *et al.* (2015) in marigold. Rakesh *et al.* (2005) studied the effect of pinching in chrysanthemum cv. Flirt and reported that pinching 35 days after pinching significantly increased the number of flowers over Control.

The interaction effects between different China aster varieties and different pinching were found to be non-significant for the fresh yield/plot.

Chapter – VI

SUMMARY, CONCLUSION AND SUGGESTIONS FOR FUTURE WORK

6.1: SUMMARY

An investigation entitled **"Effect of pinching on growth, flowering and yield of China aster (*Callistephus chinensis* L. Nees)"** was conducted at PG Research Block, Bahadari Farm, K.N.K. College of Horticulture, Mandsaur (M.P.) during November 2021 to May 2022.

The experiment was laid out in factorial randomized block design (FRBD) with three replications. Eight treatment combinations comprising of two plant varieties (V_1 Arka poornima, V_2 Arka Archana) and four type of pinching (P_0 No pinching, P_1 30 DAP pinching, P_2 45 DAP pinching and P_3 30 & 45 DAP) The observations on growth, flowering, quality and yield parameters were recorded and the results obtained are summarized in this chapter.

6.1.1 Growth Parameters

The maximum plant height was recorded with the variety V_1 (Arka Poornima), pinching P_0 (No pinching) and combined application of V_1P_0, while the minimum plant height was recorded with V_2 (Arka Archana), pinching P_3 (Pinching at 30 & 45 days) and interaction V_2P_3.

The maximum plant spread was recorded with the variety V_2 (Arka Archana), pinching P_3 (Pinching at 30 & 45 days) and combined application of V_2P_3, while the minimum plant spread was recorded with V_1 (Arka Poornima), pinching P_0 (No pinching) and interaction V_1P_0.

The maximum number of leaves/plant was recorded with the variety V_1 (Arka Poornima), pinching P_3 (pinching at 30 & 45 days) and combined application of V_1P_3, while the minimum number of leaves/plant was recorded with V_2 (Arka Archana), pinching P_0 (No pinching) and interaction V_2P_0.

The maximum number of branches/plant was recorded with the variety V_2 (Arka Archana), pinching P_3 (Pinching at 30 & 45 days) and interaction V_2P_3, while the minimum number of branches/plant was recorded with V_1 (Arka poornima), pinching P_0 (No pinching) and interaction V_2P_0.

6.1.2 Flowering Parameters

The minimum days taken to first flower bud initiation was recorded with the variety V_2 (Arka Archana), pinching P_1 (Pinching at 30 days) and interaction V_2P_1, while the maximum days taken to first flower bud initiation was recorded with V_1 (Arka Poornima), pinching P_3 (Pinching at 30 & 45 days) and combined application of V_1P_3.

The minimum days taken to opening of flower from bud emergence was recorded with the variety V_2 (Arka Archana), pinching P_2 (Pinching at 45 days) and interaction V_1P_0, while the maximum days taken to opening of flower from bud emergence was recorded with V_1 (Arka Poornima), pinching P_1 (Pinching at 30 days) and interaction V_2P_0.

The maximum blooming period was recorded with the variety V_2 (Arka Archana), pinching P_3 (Pinching at 30 & 45 days) and interaction V_2P_3, while the minimum blooming period was recorded with V_1 (Arka Poornima), pinching P_0 (No pinching) and combined application of V_1P_0.

6.1.3 Quality Parameters

The maximum flower stalk length (cm) was recorded with the variety V_1 (Arka Poornima), pinching P_0 (No pinching) and interaction V_1P_0, while the minimum flower stalk length (cm) was recorded with V_2 (Arka Archana), pinching P_3 (Pinching at 30 & 45 days) and interaction V_2P_3.

The maximum fresh weight of flower (g) was recorded with the variety V_2 (Arka Archana), pinching P_0 (No pinching) and interaction V_2P_0, while the minimum fresh weight of flower (g) was recorded with V_1 (Arka Poornima), pinching P_3 (Pinching at 30 & 45 days) and interaction V_1P_3.

The maximum flower diameter was recorded with the variety V_1 (Arka Poornima), pinching P_0 (No pinching) and interaction V_1P_0, while the minimum

flower diameter was recorded with V_2 (Arka Archana), pinching P_3 (Pinching at 30 & 45 days) and interaction V_2P_3.

6.1.4 Yield Parameters

The maximum number of flower/plant was recorded with the variety V_1 (Arka Poornima), pinching P_3 (Pinching at 30 & 45 days) and interaction V_1P_3, while the minimum number of flower/plant was recorded with V_2 (Arka Archana), pinching P_0 (No pinching) and combined application of V_2P_0.

The maximum flower yield per plant (g) was recorded with the variety V_1 (Arka Poornima), pinching P_3 (Pinching at 30 & 45 days) and interaction V_1P_3, while the minimum flower yield per yield was recorded with V_2 (Arka Archana), pinching P_0 (No pinching) and interaction V_1P_1.

The maximum fresh yield/plot (kg) was recorded with the variety V_1 (Arka Poornima), pinching P_3 (Pinching at 30 & 45 days) and interaction V_1P_3, while the minimum fresh yield/plot (kg) was recorded with V_2 (Arka Archana), pinching P_0 (No pinching) and combined application of V_1P_0.

6.2 CONCLUSION

From the experiment, it appeared that the varieties and different stages of pinching were significantly and non-significantly influenced the growth, flowering, quality and yield parameter of China aster. Hence, out of eight treatments variety V_1 (Arka Poornima) and pinching P_3 (Pinching at 30 & 45 days) and combine effect of variety V_1 (Arka Poornima) with pinching P_3 (Pinching at 30 & 45 days) were the best for enhanced growth, flowering, quality and yield parameter.

6.3. SUGGESTIONS FOR FURTHER WORK

The following future line of work is suggested in China aster for further improvement in the growth, flowering, quality and yield benefit for farmers.

1. Since it was the first year of the trial it is suggested that the findings of the present study must be tested over years and locations for confirmation.

2. Similar evaluation trial with new varieties along with the promising one from the current investigations should be conducted. This will help in the selection of suitable varieties for different purposes (like cut flower production, edging and bedding etc.) in this region.
3. The selected China aster genotype could be used in prepared education program for improving flower qualitative and quantitative parameters.
4. The vase life of the China aster with chemical preservatives can also be tried to spread the longevity for China aster vase life.
5. More number of varieties should be tried for Malwa region.

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APPENDICES

APPENDIX- I: Effect of varieties, pinching and their interactions on plant height (cm) and plant spread (cm) in China aster

Source of variation	D.F.	Mean Sum of Square	
		Plant height (cm)	Plant spread (cm)
Replication	2	7.81	2.67
Varieties (V)	1	133.20	53.83
Pinching (P)	3	130.07	118.59
Interaction (VxP)	3	3.17	3.79
Error	14	3.89	1.65
Total	**23**		

APPENDIX- II: Effect of varieties, pinching and their interactions on number of leaves / plant and number of branches / plant in China aster

Source of variation	D.F.	Mean Sum of Square	
		Number of leaves/plant	number of branches/plant
Replication	2	16.48	6.25
Varieties (V)	1	2862.79	27.31
Pinching (P)	3	3213.12	86.05
Interaction (VxP)	3	327.74	8.15
Error	14	78.80	0.90
Total	**23**		

APPENDIX- III: Effect of varieties, pinching and their interactions on days taken to first flower bud initiation, days taken to opening of flower bud emergence and blooming period (days) in China aster

Source of variation	D.F.	Mean Sum of Square		
		Days taken to first flower bud initiation	Days taken to opening of flower bud emergence	Blooming period (days)
Replication	2	27.28	1.17	3.02
Varieties (V)	1	301.40	0.03	1.87
Pinching (P)	3	405.23	0.01	21.24
Interaction (VxP)	3	1.00	0.26	0.19
Error	14	26.58	0.97	2.26
Total	**23**			

APPENDIX- IV: Effect of varieties, pinching and their interactions on flower stalks length (cm), fresh weight of flower (g) and flower diameter (cm) in China aster.

Source of variation	D.F.	Mean Sum of Square		
		Flower stalk length (cm)	Fresh weight of flower (g)	Flower diameter (cm)
Replication	2	0.02	0.03	0.02
Varieties (V)	1	60.29	0.04	0.04
Pinching (P)	3	186.28	0.21	0.15
Interaction (VxP)	3	3.10	0.01	0.01
Error	14	3.70	0.05	0.04
Total	**23**			

APPENDIX- V: Effect of varieties, pinching and their interactions on number of flower per plant, flower yield/plant (g) and fresh yield/plot (kg) in China aster.

Source of variation	D.F.	Mean Sum of Square		
		No. of flower/plant	Flower yield/plant (g)	Fresh yield/plot (kg)
Replication	2	3.87	62.33	0.25
Varieties (V)	1	24.44	24.52	0.04
Pinching (P)	3	475.25	1901.93	3.07
Interaction (VxP)	3	3.99	65.05	0.09
Error	14	29.12	129.70	0.13
Total	**23**			

VITA

The author of this thesis **Mr. Suraj Jaiswal, S/o Goverdhan Jaiswal** was born on 17th June 1997 at Nawagarh, District - Bemetara (Chhattisgarh). He passed his higher secondary school certificate examination in the year 2013 from Indian Public High School, Nawagarh and Higher Secondary School Examination in the year 2015 from Indian Public Higher Secondary School, Nawagarh with 62.33 % and 79.60%, respectively.

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For the partial fulfilment of the master's degree **"Effect of pinching on growth, flowering and yield of China aster (*Callistephus chinensis* L. Nees)."** This was successfully conducted by him and being submitted in the form of this thesis.

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