# Effect of Different Dates of Planting on Growth and Flowering of China aster [*Callistephus chinensis* (L.) Nees] cv. Arka Archana

*A*

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*BY*

*RUDRAMADHAB NAIK*

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DEPARTMENT OF FLORICULTURE AND LANDSCAPING

COLLEGE OF AGRICULTURE

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# CERTIFICATE – I

This is to certify that the thesis entitled **"Effect of Different Dates of Planting on Growth and Flowering of China aster [*Callistephus chinensis (*L. *)*Nees] cv. Arka Archana"** submitted in partial fulfilment of the requirements for the award of the degree of **MASTER OF SCIENCE IN AGRICULTURE (FLORICULTURE AND LANDSCAPING)** to the ORISSA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY, Bhubaneswar is a faithful record of bona fide and original research work carried out by **RUDRAMADHAB NAIK, Adm. No. 10FLS/16** under my guidance and supervision.

No part of the thesis has been submitted for the award of any other degree or diploma. The assistance and help received during the course of the investigation have been duly acknowledged.

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**Chairman**

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# CERTIFICATE-II

This is to certify that the thesis entitled **"Effect of Different Dates of Planting on Growth and Flowering of China aster [*Callistephus chinensis* (L.) Nees] cv. Arka Archana"** submitted by **RUDRAMADHAB NAIK, Adm. No. 10FLS/16** to the Orissa University of Agriculture and Technology, Bhubaneswar in partial fulfilment of the requirements for the award of degree of **MASTER OF SCIENCE IN AGRICULTURE (FLORICULTURE AND LANDSCAPING)** has been approved by the Students' Advisory Committee after an oral examination on the same in collaboration with an External examiner.

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**Date:** **Adm. No.-10FLS/16**

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| | |
|---|---|
| % | Per cent |
| / | Per |
| @ | At the rate |
| $^0$C | Degree Celsius |
| C.D. | Critical difference |
| cm | Centimetre |
| $cm^2$ | Centimetre square |
| DAT | Days after transplanting |
| e.g. | (*exempli gratia*) For example |
| et al. | (*et alia*) And others |
| etc. | (et cetera) And other similar things |
| Fig. | Figure |
| FYM | Farm yard manure |
| G | Gram |
| i.e. | (*id est*.) That is |
| L | Litre |
| m | Metre |
| mm | Millimetre |
| No. | Number |
| N.B. | (*nota bene*) Note well |
| OUAT | Orissa University of Agriculture andTechnology |
| RH | Relative Humidity |
| S.Em. | Standard Error of Mean |
| Sl. | Serial |
| Viz. | *videlicet* (Namely) |

# ABSTRACT

An experiment entitled “Effect of Different Dates of Planting on Growth and Flowering of China aster [*Callistephus chinensis* (L.) Nees] cv. Arka Archana” was carried out at the Department of Floriculture and Landscaping, College of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha during October, 2017 to May, 2018. The experiment consisted of nine planting dates (10$^{th}$ October, 20$^{th}$ October, 30$^{th}$ October, 10$^{th}$ November, 20$^{th}$ November, 30$^{th}$ November, 10$^{th}$ December, 20$^{th}$ December and 30$^{th}$ December). The study was conducted as a pot culture trial in form of Completely Randomized Design with nine treatments replicated thrice in cv. Arka Archana of china aster. The results indicated significantly higher plant height (42.11 cm), maximum stem girth (2.70 cm), maximum leaf area (32.99 cm$^2$), highest number of flowers per plant (50.16), longest flower stalk length (26.18 cm) and longest flowering duration (41.90 days) under 10$^{th}$ November planting. Maximum number of leaves (292.93), maximum plant spread in E-W direction (32.82 cm) and N-S direction (33.14 cm), earliest bud initiation (65.17 days), earliest bud showing colour (75.55 days) and earliest flowering (78.33 days) was recorded under 30$^{th}$ November planting. Seedlings planted on 30$^{th}$ October recorded maximum fresh weight (6.87 g) and dry weight (1.28 g) of leaves, maximum flower diameter (5.90cm), maximum shelf life of flowers (3.09 days) and maximum vase life of cut flowers (12.83days). Maximum number of branches (15.89) and longest bloom life (20.6 days) was recorded under 20$^{th}$ November planting. Seedlings planted in 20$^{th}$ October recorded maximum fresh weight (3.73 g) and dry weight (0.76 g) of flowers. Thousand seed weight (2.51 g) was recorded maximum under 10$^{th}$ October planting. Minimum results for almost all parameters like plant height, leaf area, number of branches per plant, fresh weight and dry weight of leaves, length of flower stalk, flower diameter, flowering duration, fresh weight and dry weight of flowers, shelf life of flowers, vase life of flowers, thousand seed weight and delay in bud initiation, bud showing colour and first flowering was recorded under 30$^{th}$ December planting. However, parameters like plant spread (E-W and N-S), stem girth, number of leaves per plant, number of branches per plant and number of flowers per plant were recorded minimum under 10$^{th}$ October planting while bloom life was shortest in 30$^{th}$ October and 10$^{th}$ November planting.

# INTRODUCTION

Flowers are symbol of sentiments and an essential part of religious and social ceremonies. They constitute an integral part of age old tradition and culture of Indian society symbolizing purity, peace, passion, love and beauty. A flower can say lot of words to express our emotions. It has great importance in all stages of our life. The demand for flowers has always been increasing due to growing awareness of people and the standard of living. Due to their aesthetic, economic and social values, the demand for flowers is increasing tremendously in the global market.

China aster belongs to the family 'Asteraceae' and it is native to China and has spread to Europe and other tropical countries during 1731 AD (Desai, 1967). The genus Callistephus derives its name from two Greek words 'kalistos' meaning most beautiful, and 'stephos' meaning a crown. Linnaeus first named it as *Aster chinensis* which was subsequently changed to *Callistephus chinensis*. It is a very popular annual flower crop and is mainly cultivated for production of cut flowers, loose flowers, as pot plant and for bedding plant purposes in landscape. Due to its wider adoptability to varying soil and climatic conditions, it can be grown successfully under different agro-climatic conditions. Since the flowers last longer, they are used for various purposes like keeping in vases, flower decoration, preparation of bouquets, garlands and also popularly as buttons etc., in addition to their utility in landscape gardening to provide mass aesthetic effect. It is also a very good garden plant due to attractive flower colours. The dwarf types are highly suitable for edging and window boxes. The behaviour of this plant is reported as a diploid (2n = 18). China aster is a half hardy annual, erect plant with hispid hairy branches bearing alternate, broadly ovate or triangular ovate, deeply or irregular toothed leaves. The plants of China aster are erect and attain a maximum height of 60-80 cm depending upon the genotypes. Flowers are solitary covering wide range of colours starting from white, rose, red, lavender, magenta and blue to their innumerable variations (Desai, 1967). The aster blooms consist of two kinds of florets: ray florets and disc florets. The disc florets are short while the ray florets are usually long. The most suitable character for the classification of China aster is by the shape of ray florets.

China aster is commercially cultivated in India, France, Germany, Netherlands, U.K., Siberia, Russia, Japan, North America, Switzerland and Europe. In India, it is largely grown on commercial scale in Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra and West Bengal (Karade, 2011). Among the annual flowers, it ranks next to chrysanthemum and marigold (Sheela, 2008) and is mainly grown by marginal or small farmers.

Planting dates depend upon the environmental factors and geographical location of the area affecting growth and flowering. There is a great variation in plant growth and flowering dates due to natural environmental conditions, therefore planting time cannot be standardized on national scale. Environmental conditions vary from one location to other which brings the necessity to work out the planting time for particular zone to get the best growth, flowering and seed yield of different annuals. Therefore, keeping in view the importance of planting scheduling, attempts were made to examine an applied possibility of planting schedule of china aster by planting it at different dates to find out the optimum date of planting for growth, flowering and seed production. Different planting schedules supply china aster steadily to the market as well as it adds to the beauty of the landscape longer. The timing of flowering from various planting dates is quite predictable under ideal environmental conditions. Growth and yield patterns of the plant are influenced by changes in climatic conditions as aster is a long day plant.

In South Indian conditions, winter is the most suitable planting season for growing China aster. In places which receives less rainfall i.e. below 75cm and experience cool weather conditions, China asters are grown without difficulty in monsoon. In hills, China asters are grown from February to July.

Growth and flowering of china aster are influenced mainly by light and temperature. Flower quality is primarily a varietal trait and is influenced by climatic conditions prevailing during the growing period. Optimum temperature and requisite photoperiod go a long way in obtaining better blooms of good size and high quality (Nagaraju *et al*., 2004). The range of temperature which allows successful conduct of progressive transpiration, cell enlargement, cell differentiation, photosynthesis, respiration and cell division may be termed as optimum temperature range. A day temperature 10- 12 $^{0}$C is favourable to develop large size flower. Flower colour develop

in temperature range of 20- 30 $^0$ C during day and 15- 17 $^0$ C in night with a relative humidity 50-60 %.

Laurie *et al*. (1958) suggested that fully double flowers with strong stem will be produced at a night temperature of $10^0$ C. It can be grown year round in areas where night temperature is maintained around $10^0$ C. Guruprasad and Ready (2001) reported that November and October planting reduced tallest plants with highest number of primary and secondary branches, number of leaf, leaf area and flower yield. China aster needs bright sunlight for longer period for its growth and flowering (Janaki ram, 2006). A day length of less than 14 hours caused resetting of leaves of aster. Supplementary light caused early flowering. Earliness in flowering was associated with shorter stems and smaller number of flowers. China aster is a long day plant and night break of 2 hours improved vegetative and flowering characteristic of the plant.

Improved quality of flowers, enhanced flower production and productivity, good quality acceptable plant, increase in keeping quality of flowers and seed formations are some of the important objectives, to be reckoned during commercial flower production. Early or late flowering, tall or spreading plants, compact growth habitat with lust green leaves, long duration flowering, higher yield of flowers per plant and per unit area, varied sizes, shapes and colors of flowers are some of the requirements to meet the present day needs of china aster. In parallel, large compact flowers with straight stalks are considered ideal for cut flower industry, while the thickness of flower is of vital importance for making garlands. Vase life of cut flowers is largely determined by their genetic makeup and environmental conditions especially light and temperatures prevailing during the crop growth.

However, no work has been done so far in Odisha to find the best time for planting of china aster. So, keeping in view the importance of china aster in present scenario, an experiment entitled "Effect of different dates of planting on growth and flowering of china aster [*Callistephus chinensis* (L.) Nees] cv. Arka Archana" has been conducted under Bhubaneswar conditions with the following objectives:

1. To study the effect of different planting dates on vegetative parameters of china aster cv. Arka Archana.
2. To study the effect of different planting dates on floral characters of china aster cv. Arka Archana.

3. To study the effect of different planting dates on post-harvest life of china aster cv. Arka Archana.

# REVIEW OF LITERATURE

Plant growth and development of any crop depends mainly on climatic conditions like photoperiod, temperature, sunshine hours, rainfall and other climatic factors. Time of planting plays significant role in improving the yield of many crops and governs the crop phonological development and total biomass production along with efficient conversion of biomass in to economic yield. The literature available on Effect of different dates of planting on growth and flowering of China aster [*Callistephus chinensis* (L.) Nees] and other flower crops is reviewed here under the following sections.

**2.1 Effect of Different Dates of Planting on the Growth and Flowering of China aster [*Callistephus chinensis* (L.) Nees]**

Patil *et al*. (1987) studied the influence of planting dates and planting density on flower and seed yield of China aster cv. 'Ostrich Plume Blue' as influenced by planting dates and planting density. They reported that October and November transplanted aster seedlings of cultivar 'Ostrich Plume Blue' gave highest number of flowers per plant (30 and 33, respectively) and maximum seed yield (119.2 and 121.7 kg $ha^{-1}$, respectively) as compared to December planting.

Golds berry *et al*. (1988) observed improvement of stem length in china aster with 29$^{th}$ March planting when compared to planting done on 4$^{th}$ December, 15$^{th}$ January and 6$^{th}$ February.

Gowda (1990) used 25 days old seedlings of *Callistephus chinensis* cv. 'Ostrich Plume Purple' and transplanted at fortnightly intervals from 1$^{st}$ January, 1980 to 14$^{th}$ May, 1982. It was reported that the highest plant height at flowering was obtained from August, September and July planting, the maximum branches per plant were reported from November planting and maximum leaves per plant from August and October plantings. He also concluded that maximum number of flowers per plants (58.82) and maximum flower yield (12128 Kg $ha^{-1}$) were obtained from July planting. However, maximum flower diameter was obtained from 1st August planting. It is concluded that July, August and September are the best months for transplanting aster seedlings under Bangalore conditions.

Dhemre *et al.* (1997) observed that winter planting of China aster cv. 'White Powder' resulted in early emergence of flower buds (76.39 days) when compared with summer and monsoon season planting. The tallest plants of China aster were obtained when planted during November and October as compared to earlier plantings i.e. July, August and September under Karnataka conditions.

Guruprasad and Reddy (2001) recorded the maximum leaves (166.69) per plant in November planting among the five different planting dates July, August, September, October and November in China aster. Also, the maximum leaf area (2170.26 $cm^2$) per plant was recorded in November planting.

Dhawle *et al.* (2003) studied the effect of planting time for better seed yield and quality of China aster. They observed that highest plant height (69.42 cm), plant spread (31.10 cm), stem diameter (1.707 cm), number of primary branches per plant (18.66), flower diameter (7.71 cm), total number of flowers per plant (48.25) and total number of flowers $ha^{-1}$ (53.61 lakhs) with first November planting. This study conducted in Dr. PDKV institute Akola, under the condition of Maharashtra.

Hughar *et al.* (2003) observed the higher flower yield in second week of August planting, which was followed by fourth week of September Planting. Flower yield also varied with the varieties Kamini and Astle Purple recorded higher flower yield, while, Aster White resulted in less flower yield.

An experiment was conducted by Nagaraju *et al.* (2004) to study the effect of planting dates on flowering and flower quality of China aster have been undertaken during 2001-2002 at progressive farmer's field Sanganakeri village near K.R.C. college of Horticulture, Arabhabi. They observed that plants of September planting were early to flower, followed by August planting while plants of October planting were late. May planting produced the highest number of flowers per plant, followed by October planting, while minimum was recorded in August planting.

Gupta (2005) while studying the effect of planting dates on seed production of China aster observed that seed yield and 1000 seed weight was comparatively more in case of June 20 planting as compared to March 15 and April 20 plantings.

Dilta *et al.* (2007) while studying the influence of planting dates on performance of China aster varieties under low hill conditions of Himachal Pradesh observed maximum

plant height and spread in cv. 'Kamini' when planted in April. They also reported earlier flowering in August planting than in February, April and June. Maximum number of flowers per plant and flower diameter was recorded in cv. 'Violet Cushion' in June planting. Maximum seed yield per plant (1.66 g) was obtained in August 10 planting as compared to earlier plantings i.e. February 10, April 10 and June 10.

Rakesh *et al.* (2008) have under taken 4 dates of planting (September, October, November and December) in China aster under Dharwad (Karnataka) conditions. They observed that October planting resulted in significantly maximum plant height, higher yield of flower per plant, weight of flowers and diameter of flowers.

Kaushal *et al.* (2014) carried out an experiment at Solan, Himachal Pradesh, on effect of seven planting dates viz., 6$^{th}$ April, 16$^{th}$ April, 26$^{th}$ April, 6$^{th}$ May, 16$^{th}$ May, 26$^{th}$ May and 5$^{th}$ June and three varieties of China aster namely 'Kamini', 'Shashank' and 'Violet Cushion'. Among different planting dates 6thApril gave best results for plant height (88.10 cm), plant spread (47.44 cm), number of flowering stems per plant (7.91), number of flowers per plant (37.58) and yield of flower cut stems per plot (158.10). However, 5$^{th}$ June gave best results for flower size (5.51 cm) and vase life (10.12 days). Among the varieties Kamini gave best results for plant height (83.87 cm), plant spread (46.07 cm), number of flowering stems per plant (8.17), number of flowers per plant (41.97), flower size (5.79 cm) and yield of cut flower stems per plot (163.20). The most desirable planting time for China aster cultivar 'Kamini' was found to be 6$^{th}$April.

**2.2 Effect of Different Dates of Planting on the Growth and Flowering of Different Flowers of Asteraceae Family**:

**2.2.1** CHRYSANTHEMUM

Anjum *et al.* (2007) planted suckers of chrysanthemum on four different planting date i.e. 18$^{th}$ February, 18$^{th}$ April, 17$^{th}$ June and 16$^{th}$ August and observed that the first planting (18$^{th}$ February) took more time to initiate flowers with prolonged blooming period, greater number of flowers and extended vase life. On the other hand, the late planting (16$^{th}$ August) gave flowers with increased diameter and maximum fresh and dry weight/flower.

Kulkarni and Reddy (2008) conducted an experiment to found the best time of planting for chrysanthemum cv. "saraval" and concluded that the plants of April had optimum vegetative growth. The plants were tall, spreading, and sturdy had more number of branches and more leaf area. The duration of flowering decreased gradually from April (65.67 days) planting to December (13.67 days) planting. However, the plants of April were late to flower (145.20 days) after planting, while the planting of December (42.93 days after planting) and November (47.27 days after planting) plantings flowered early.

Aamir *et al.* (2009) observed that early planting resulted in increased plant height among 4 different planting dates (18$^{th}$ February, 18$^{th}$ April, 17$^{th}$ June and 16$^{th}$ August), more number of branches per plant, highest biomass production and higher flower yields in early planting 18th February over late planting dates *viz.*,18$^{th}$ April, 17$^{th}$ June and 16$^{th}$ August in *Chrysanthemum morifolium*.

Nawaz *et al.* (2009) studied four different dates, i.e. 18$^{th}$ February, 18$^{th}$ April, 17$^{th}$ June and 16th August by planting small and large sized suckers of *Chrysanthemum morifolium*. Early planting resulted in increased plant height (103.82 cm), more number of primary branches (16.70), number of leaves/plant (609.67) and higher fresh flower yield/plant (283.57 g) but reduced leaf area (12.30 cm$^2$) as compared to late plantings.

Balaji *et al.* (2010) studied the effect of different dates of planting from April to December on flower production in chrysanthemum and found that maximum number of flowers produced per plant, the maximum flower yield (g/plant) and maximum flower yield per hectare was higher in plants planted in April and May as compared to later planting dates.

Pattnaik *et al.* (2010) found that early emergence of flower bud and largest flower bud with August 25$^{th}$ planting in chrysanthemum and obtained more number of quality flowers per square meter with 25$^{th}$ July planting date under polyshade condition in chrysanthemum cv. Kenroku Kangiku.

Laxmi and Pratap (2011) revealed that 15th July planting resulted in highest plant height (25.89 cm), maximum plant spread (21.37 cm), highest number of branches (13.25), maximum number of days to first flower bud initiation (75.00), maximum flower diameter (3.88 cm), longest duration of flowering (58.67 days) , maximum flower yield per plant (157.94 g) and yield per plot (6.02 kg) , among four different

planting dates *viz*., 15th July, 15th August, 15th September and 15th October in chrysanthemum.

**2.2.2** MARIGOLD

Jain and Gupta (2003) planted African marigold (*Tagetes erecta* L.) cv. 'Pusa Narangi Gainda' on 15th July, 2000 and 15th Feb, 2001. They observed that planting done in February had maximum flower size, number of flowers per plant and flower yield per square meter, whereas, July planting resulted in maximum plant height, plant spread, seed yield per square meter and seed number per head.

Sharma *et al.* (2003) reported the highest flower yield (10.73 tonnes/ha), earliest 50% flowering in August planting followed by September planting in African marigold (*Tagetes erecta*). They also obtained maximum flowers per plant as well as flower yield per plant in August planting followed by September and October planting under low hills of H.P.

Mor *et al.* (2006) observed the maximum test weight and germination of the seeds, greatest vigour index, field emergence index and seedling establishment obtained and greatest seedling height, dry matter per 10 seedlings during spring planting in marigold.

Raju *et al.* (2006) planted French marigold (*Tagetes patula*) in different months i.e. May, June, July and August to study the effect of planting time on its growth and flowering parameters under Delhi conditions. Flower yield/plant was maximum (173.0 g) in June planting and flower diameter (5.12cm) and weight (6.84 g) were highest in August planting. However, July planting was found to be best for seed production (0.271 g/flower).

Sreekanth *et al.* (2006) observed that November planting resulted in maximum plant height among three different planting dates *viz.*, October, November and December and early flower bud initiation (57.04 days), early 50 % flowering (70.66 days) maximum duration of flowering (20.96 days) in December planting and maximum flower yield per plant (0.23 kg), maximum yield per plot (2.83 kg), maximum flower yield per hectare (118.29 q/ha) and maximum flower weight in October planting in African marigold (*Tagetes erecta*) cv. Sierra Orange.

Padma *et al.* (2007) recorded the highest number of flowers per plant with October planting, early flower bud initiation and early 50 % flowering with December planting in African marigold *(Tagetes erecta*) cv. Sierra orange.

Ghosh and Pal (2008) noticed that more flowers per plant were produced when planting was accomplished on 12$^{th}$ October, maximum flower diameter (5.80cm) in October planting when compared to other planting dates *viz,*.10$^{th}$ December, 10$^{th}$ February, 12$^{th}$ April, 10$^{th}$ June, 10$^{th}$ August and 12$^{th}$ October in African marigold (*Tagetes erecta*) cv. siracole under west Bengal conditions.

Ramesh and Singh (2008) studied the effect of planting time on duration of growth and development in wild marigold (*Tagetes minuta*). Among the 7 planting times viz., from last week of July (23$^{th}$-29$^{th}$ July) to 2nd week of September (3rd-9$^{th}$ September), the second week of planting (30$^{th}$ July-5$^{th}$ August) gave the maximum biomass yield (612 kg/ha), whereas highest oil content was observed on the fifth week of planting (20$^{th}$-26$^{th}$ August) i.e. 0.62%.

Chauhan (2011) studied the effect of different planting dates and planting densities on marigold cultivars 'Pusa Narangi Gainda' and 'FM-786'. Out of eight planting dates (mid-March to mid-October) it was found that African marigold (*Tagetes erecta*) cv. Pusa Narangi Gainda gave maximum flower size in September planted crop whereas, longest flowering duration and flower yield was obtained for 16$^{th}$ April planting. On the other hand, for cultivar 'FM-786', April planted crop attained maximum flower size. However, March planting recorded maximum number of flowers/plant and flower yield for the same cultivar.

Pramila *et al.* (2011) reported that Rabi season significantly influenced the flower quality, flower size seed yield (14.51 g) per plant, highest germination percentage, the seedling quality parameters viz., vigour index I and vigour index II and seed quality parameters viz., seedling length and seedling dry weight in marigold.

Deshmane *et al.* (2012) studied the effect of planting time (April, May, June and July) and spacing (45 cm × 30 cm, 45 cm × 45 cm, 60 cm × 45 cm) on quality and yield of French marigold (*Tagetes patula* Linn.) at Horticulture Section, College of Agriculture, Nagpur (Maharashtra, India). They reported that among the four different dates of planting viz., April, May, June and July, the maximum flower diameter and

weight of fully opened flower, longevity of flowers, length of flower stalk, yield per plant and yield per ha were maximum in July planting.

Kumar *et al.* (2012) recorded the maximum leaf area per plant with early transplanting date (April) in *Tagetes minuta* L.

Panchbhai *et al*. (2012) observed maximum flower weight of fully opened flower and maximum flower yield in July planting over the other planting dates (April, May and June) in french marigold (*Tagetes patula*).

Smita *et al.* (2012) recorded that October planting showed maximum plant spread (54.25 cm), maximum flowers per plant (348.6 g), maximum flower yield per hectare (19.15 t) over the June, August, and September planting dates in African marigold (*Tagetes erecta*) cv. African Double Orange.

Ismail *et al.* (2013) recorded the greatest plant spread, greatest plant height, more number of branches fresh and dry yield of plant herb in April planting among the three different planting dates viz., February, March and April in Mexican marigold (*Tagetes lucida* L.).

Lakshmi *et al.* (2014) observed that 1st October planting resulted in maximum plant height (71.70cm), maximum number of primary branches per plant (16.89), maximum plant spread (48.33 cm) , early 50 per cent flowering (56.37 days), shortest time taken to 100 percent flowering, maximum duration of flowering (54.67 days), maximum flowers per plant (50.10), maximum flower yield per plot (20.97 kg) maximum flower yield per hectare (25903.31 kg), maximum flower diameter (6.89cm) among the four different planting dates *viz,* 1st September, 1st October, 1st November and 1st December in African marigold(*Tagetes erecta*) cv. Pusa Narangi Gainda. The present investigation was carried out at the Ex-perimental Farm of the Division of Vegetables science& Floriculture, SKUAST- jammu during the year 2011-12.

Pratibha *et al*. (2014) recorded maximum flower diameter (5.17 cm) in September planting among the eight different planting dates viz, 16$^{th}$ March, 16$^{th}$ April, 16$^{th}$ May, 16$^{th}$ June, 16$^{th}$July, 16$^{th}$ August, 16$^{th}$ September and 16$^{th}$ October in African marigold (*Tagetes erecta*) cv. Pusa Narangi Gainda. This study was carried out an experimental farm of Department of floriculture and Landscaping, Dr.Y.S. Parmar university of Horticulture and forestry, Nuani, solan (H.P).

Rajyalakshmi and Rajasekhar (2014) reported that maximum number of flowers per plant (36.03), maximum of flower yield per plant, maximum flower yield (6.5 t) in September planting dates over the August and October planting dates in African marigold (*Tagetes erecta*) cv. Pusa Narangi Gainda.

Anil *et al.* (2015) reported that highest number of flowers (56.07) per plant, highest flower yield (19.20 kg) per plot, higher flower diameter (4.56 cm) in September planting among the six different planting dates viz, 1st March, 1st May, 1st July, 1st September, 1st November and 1st January in African marigold (*Tagetes erecta*) cv. Pusa Narangi Gainda. This study was conducted under the North Bihar agro- ecological conditions.

Joshna *et al*. (2015) studied the effect of four planting dates (12th April, 16th May, 12th June, 12th October) on the growth, flowering, yield and quality of African marigold (*Tagetes erecta*) cv. Siracole. The crop planted on 12 June was found to have the highest plant height (96.93 cm) whereas the maximum number of primary (5.3) and secondary (14.15) branches per plant, total fresh weight (502.00 g/plant), higher dry (126.25 g/plant) matter accumulation were found maximum with 12 April planting.

Mohanty *et al.* (2015) reported that maximum number of primary branches (16.61), maximum number of secondary branches (52.37), maximum plant spread (35.31 cm and 34.62 North to South and East and West respectively), and maximum number of leaves (240.04), maximum flower yield per hectare (20.08 t), maximum flower diameter (5.00 cm) in November planting date when compared to other planting dates from November 2007 to June 2008 in African marigold (*Tagetes erecta*) cv. Sirakole. The present investigation was undertaken in form of a field experiment at the Department of Horticulture, College of Agriculture, Orissa University of Agriculture and Technology Bhubaneswar during 2007-2008.

Yadram *et al.* (2015) recorded the maximum plant height (57.75 cm) and minimum number of days to flower opening (66.70 days) during 15th September planting compared to 15th October and 15th November, maximum number of primary branches (18.79) during 15th October planting compared to 15th September and 15th November planting dates in African marigold (*Tagetes erecta*) cv. Pusa Narangi Gainda.

**2.3 Effect of Different Dates of Planting on the Growth and Flowering of other ornamental crops.**

Muhammad *et al.* (2005) studied the influence of planting dates (1st November, 1st December and 1st January) on gladiolus cultivars 'Peters Pears', 'White Friendship', 'Madonna', 'Jessica', 'Deciso', 'Rose Supreme', 'Hong Kong' and 'Jester Ruffled' at NWFP Agricultural University, Peshawar, Pakistan. Largest florets (12.11 cm) were observed in 'Rose Supreme' planted on 1st January. The highest average number of florets/spike was also observed for 1st January planting in 'Peter Pears' and 'Rose Supreme' (16.43 and 16.22, respectively).

Nijasure and Ranpise (2005) evaluated the effect of planting dates (15$^{th}$ September, 1st October and 15$^{th}$ October) on the growth, flowering and flower yield of gladiolus (*Gladiolus grandiflorus)* cultivar 'American Beauty', under the agro climatic conditions of Konkan, Maharashtra. Planting corms on 15$^{th}$ October was found to be superior with respect to early flowering (79.08 days), spike length (95.06 cm), number of florets/spike (14.30), floret size (11.41 cm) and other floral parameters. Corms planted on 15$^{th}$ September showed the lowest values for most of the floral parameters.

Sheikh and Jhon (2005) on the effect of six dates of planting along with four genotypes on vegetative and floral characters of gladiolus at Srinagar, Kashmir. It was observed that planting on 31st March resulted into the maximum plant height (119.12 cm), spike length (98.06 cm), floret number/spike (13.20) and floret diameter (9.77 cm). Among the four genotypes evaluated, 'Red Majesty' was significantly superior to other genotypes in respect of plant height (117.71 cm) and spike length (92.47 cm), whereas, the number of florets per spike (12.29) and floret diameter (9.93 cm) was significantly higher in 'Big Time Supreme'.

Khan *et al*. (2008) planted bulbs of tulip cultivar 'Apeldoorn' at Srinagar, Kashmir on seven different planting dates at 15 days' intervals starting from 15$^{th}$ October to 15$^{th}$ January which revealed that maximum scape length, wrapper leaf area, vase-life and bulblets' weight/plant were recorded under 15$^{th}$ November planting and tulips planted on 30$^{th}$ October resulted in the maximum stem thickness and tepal diameter followed by 15$^{th}$ October planting.

Bagde *et al*. (2009) investigated the effect of ten different planting dates on gladiolus, at Nagpur, Maharashtra, which was repeated at a 7-day interval starting from

1st September to 3rd November. They noted that flower quality and yield contributing characters like spike length, rachis length and florets/spike were maximum for 13$^{th}$ October planting. Moreover, 13$^{th}$ October and 6$^{th}$ October planting was at par with each other in respect of flower yield and floret diameter of gladiolus. Earlier planting dates produced maximum yield of corms and cormels. while September to mid-October planting recorded maximum weight of corms and cormels.

Gurav *et al*. (2006) carried out an experiment at Ganeshkhind, Pune to study the effect of different planting times (1st April, 1st June, 1st August, 1st October, 1st December and 1st February) on tuberose cultivar 'Shringar' and reported that planting done on 1st April gave superior results in terms of plant height (78.8 cm), minimum days taken to flowering (90.0 days), maximum number of flower stalks/plant (10.0), length of flower stalk (72.6 cm), number of florets/stalk (44.5) and number of bulbs/plant (33.0).

Kour (2009) conducted an experiment to study the effect of different planting dates *viz.,* 15$^{th}$ September, 1st October and 15$^{th}$ October on growth and flowering parameters of gladiolus cv. White Prosperity and found that the minimum number of days for sprouting of corms (16.75), maximum plant height (102.31 cm), maximum number of leaves (10.58), leaf breadth (2.50 cm), minimum days to flowering (80.08), maximum spike length (96.08), number of florets per spike (14.28), spike yield per plant (1.14) and floret size (9.62 cm) were found maximum with 15$^{th}$ October planting as compared to other planting dates.

Seghatoleslami and Mousavi (2009) investigated the influence of sowing dates (30$^{th}$ March, 14$^{th}$ April and 30$^{th}$ April) and three planting densities on pot marigold (Calendula officinalis L.). It was observed that sowing date had significant effects on flower and seed harvest index. The early sowing date had the highest seed yield (276.5 g/m$^2$) whereas, the latest sowing date (30$^{th}$ April) had the highest seed harvest index (27.7). The result showed that the first sowing date, with 25 plants/m$^2$, had the highest grain and flower yield.

Dhatt and Kumar (2010) investigated to standardize the planting time of *Delphinium ajacus* L.) using five planting dates viz., 20$^{th}$ October, 5$^{th}$ November, 20$^{th}$ November, 5$^{th}$ December and 20$^{th}$ December and found that maximum seed yield (14.41g/m$^2$) was obtained when planting was carried out on 20th October.

Ahmad *et al*. (2011) was studied the effect of planting dates on growth of gladiolus corms in Peshawar, Pakistan. Cormels of gladiolus cultivar 'White Friendship' were planted on five planting dates i.e. 18$^{th}$ February, 5$^{th}$ March, 20$^{th}$ March, 4$^{th}$ April and 19$^{th}$ April. Best results in terms of parameters like sprouting percentage (77.12%), number of leaves/plant (7.06), survival percentage (82.96%), leaf area (65.76 cm$^2$), plant height (67.39 cm), diameter of corms (3.19 cm), percent increase in cormel size (139.58%) and corm weight (10.76 g) was observed for 18th February planting. On the other hand, maximum numbers of cormels/plant were observed in those planted on 4$^{th}$ April (3.83).

Akpinar and Bulut (2011) carried out a study to determine the effect of planting time (10$^{th}$, 20$^{th}$ and 30$^{th}$ June) on plant growth and floret quality of four commercial varieties of gladiolus cultivars 'White Prosperity', 'Amsterdam', 'Nova Lux' and 'Victor Borge', planted in open field of Erzurum by comparing varieties for their sprouting time, spiking time, stem length, number of florets and harvesting time. The result showed that, 20th June was found to be most suitable planting time considering sprouting (12.41 days), spiking time (80.24 days), floret number (13.04) and stem length (78.09 cm).

Berimavandi *et al.* (2011) ascertained the effects of planting density (20, 40, 60 and 80 plants m$^{-2}$) and sowing dates (April 19 and 29, and May 10, 2010) on growth, flowering and quantity of essential oil of *Calendula officinalis* L. They observed no significant effects of sowing dates and significant effects of interaction of sowing dates and planting density for all the characters of growth and flowering. The best interaction treatment was 20 plants m$^{-2}$ planted on 19th April, 2010.

Mirshekari *et al.* (2012). Observed head diameter, seed number per head, 1000 seed weight and seed yield in sunflower was recorded maximum when planted early in April and first week of May as compared to late planting.

Sharma (2012) made studies on the effect of seed priming and planting dates on seed characters of pansy, and observed that among four different planting dates i.e. October 17, November 2, November 17 and December 2 maximum number of capsules per plant (67.01), seeds per capsule (53.24) and seed yield per plant (3.64 g) was obtained when planted on November 2 as compared to other planting dates.

Adil *et al*. (2013) studied on gladiolus cultivars 'Rose Supreme' and 'White Prosperity', it was noticed that different planting dates have significant effect on various floral and vegetative characters. Among the six planting dates (25$^{th}$ August, 10$^{th}$ September, 25$^{th}$ September, 10$^{th}$ October, 25$^{th}$ October and 10$^{th}$ November), 10$^{th}$ September showed highest number of florets/spike (17.16) whereas, 10$^{th}$ November showed the lowest (12.75). Maximum spike length (55.66 cm), plant height (115.33 cm), floret diameter (97.81 mm), corm weight (63.82 g) and number of cormels/plant (63.82) was recorded for 10$^{th}$ September planting as well. The floral and vegetative parameters decreased with the delay in planting.

Zubair *et al.* (2013), on eight cultivars of gladiolus planted on 1st November, 1st December and 1st January revealed that a delay in planting date (1st November, 1st December and 1st January) resulted in earlier spike emergence (130.3, 129.0 and 121.9 days, respectively), earlier first floret opening (146.2, 142.3 and 134.1 days, respectively), earlier full spike opening (161.2, 154.7 and 146.1 days, respectively) and decreased number of spikes (1.4, 1.2 and 1.0, respectively) per corm. Gladiolus cultivar 'Jessica' when planted on 1st November resulted in more number of spikes/mother corm (2.5). However, 'Rose Supreme' planted on 1st November produced the tallest plants (154.3 cm).

Pavani *et al.* (2014) at Hyderabad, Andhra Pradesh with gladiolus varieties 'Advance', 'Spic and Span', 'Peter Pears' and 'White Knight', which were planted on 15$^{th}$ September, 15$^{th}$ October, 15$^{th}$ November and 15$^{th}$ December plantings reported that spikes harvested from 15thSeptember planting recorded maximum vase life and more number of days taken for wilting of the spikes. The flower initiation and development were confronted with high temperature intensities during the months of late plantings.

Sudhakar and Kumar (2014) carried out an experiment to investigate the yield parameters of two gladiolus varieties 'White Friendship' and 'American Beauty' in early and late growing seasons (1st week of July, September, December and February) at Annamalai Nagar, Tamil Nadu. Among the varieties 'White Friendship' produced the highest values of all the yield parameters viz., spike length, number of florets/spike, length of rachis, number of daughter corms/plant, weight of daughter corms/plant, number of cormels/plant and number of marketable spikes. Among different seasons compared, December planting showed better performance. The results of the correlation between the mean value of yield parameters in different seasons and weather

parameters exhibited that the spike characters and corm characters were negatively correlated with maximum temperature (within a range of 29.9°C - 35.02°C) minimum temperature (within a range of 22.12°C - 25.70°C) and bright sunshine hours (within a range of 6.25-8.85 hrs).

Alkurdi *et al.* (2015) studied the influence of planting date on growth and flowering parameters of *Mathiola incana* L. at Erbil, Iraq. The experiment included 16 treatments, the combination between four planting dates i.e. 1st October, 15$^{th}$ October, 30$^{th}$ October and 15$^{th}$ November, and maintaining different number of main stems viz., one stem, two stems, three stems and four stems/plant. After selection of the main stems, all new shoots were removed twice a week. Maximum values of plant heights were obtained from 1st October, while there was a decrease in height of plants planted in 15$^{th}$ November. 1$^{st}$ October planting led to an increase in the number of flowers/plant. The height of plants was increased significantly for plants with one stem, while the number of flowers/plant increased with an increasing number of stems. The planting date did not impact on flower time.

Dhatt (2015) studied the effect of planting time on plant growth and seed yield of five week old seedlings of *Coreopsis lanceolata*, *Gaillardia aristata, Matthiola incana*, *Nemesia strumosa*, *Verbena hybrida* and *Viola tricolor* which were transplanted on five dates i.e. 20$^{th}$ October, 5$^{th}$ November, 20$^{th}$ November, 5$^{th}$ December and 20$^{th}$ December and reported that the planting time significantly affected the plant growth and seed yield. The optimum transplanting time for *C. lanceolata* and *M. incana* was 20$^{th}$ October and it resulted into with maximum seed yield (77.12 g/m$^2$ and 20.25 g/m$^2$, respectively). The highest yield of 105.62 g/m$^2$ was obtained from 20$^{th}$ November planting in *G. aristata*. Early planting of *V. tricolor* and *V. hybrida* on 20$^{th}$ October resulted in vigorous plants, more number of branches and maximum seed yield.

Kocira *et al.* (2015) conducted an experiment to study the effect of planting dates and planting depth on *Acidanthera bicolor* var. murielae perry at Lublin, Poland. Corms were planted on four planting dates i.e. 19-20$^{th}$ April, 29-30$^{th}$ April, 8-9$^{th}$ May and 18-19$^{th}$ May and three planting depths i.e. 4, 8 and 12 cm. It was found that planting corms in 19-20$^{th}$ April at a depth of 12 cm increased the number of corms in the total yield as well as the number and weight of marketable corms. It also increased the percentage and weight of the largest corms with a circumference of over 16 cm in comparison to other planting dates.

Kumar *et al.* (2015) conducted an experiment to evaluate the response of two prominent varieties and three planting dates on growth and flowering of gladiolus and revealed that the variety "Summer Rose" performed excellently well as regards to vegetative and floral characters. The variety "Friendship" also exhibited good performance in terms of growth and flowering and could be quite suitable for flower production for the Ethiopian domestic markets. Among three planting dates tested, planting corms during mid-April indicated better growth performance and produced good quality flower spike.

Rocky and Singh (2015) conducted an experiment to study the effect of suitable planting dates and depths for tuberose under Manipur conditions. Early ($20^{th}$ April) and shallow planting (4cm) recorded the maximum values for vegetative growth, floral and bulb parameters. Among the treatment combinations, April 20th planting at 4 cm depth ($P_1D_1$) significantly improved the spike length (91.2 cm), rachis length (17.73 cm) and spikes yield per hectare (3, 14, 000 spikes) as compared to other planting dates and depths.

Sharma *et al.* (2015) revealed that maximum plant height (75.45 cm), maximum number of leaves (146.75), early flower bud initiation (53.86 days), minimum number of days to flower opening (82.08 days), shortest time taken to 100 percent flowering (82.08 days), maximum duration of flowering (110.52 days), maximum number of flowers (179.69) per plant, maximum flower yield per plant (519.00 g ), maximum flower diameter (5.40 cm) and maximum flower weight (43.62 g / 10 flowers) in 1st October planting compared 1st September and 1st November planting dates in Gaillardia (*Gaillardia pulchella* Fouger) cv. Double Yellow.

Taye *et al.* (2015) at eastern Ethiopia studied the effect of three planting dates on growth, production and quality of gladiolus flowers. Two prominent gladiolus varieties viz., 'Summer Rose' and 'Friendship' planted on three planting dates i.e. mid-February, mid-March and mid- April were tested during 2014, and the experiments extended up to the end of July. Among three planting dates tested, planting corms during mid-April indicated better growth performance and produced good quality flower spikes, earliest sprouting of all corms (32.67 days), plant height (77.27 cm) and number of leaves/plant (8.62).

Thakur *et al.* (2015) evaluated traits for corm and cormel production by planting twelve gladiolus genotypes under five different planting times i.e. 10th October, 25th October, 10th November, 25th November and 10th December at Ludhiana, Punjab. The number of corms and cormels/plant were maximum under 10th October planting (1.75 and 24.37, respectively) and in cultivar 'Punjab Lemon Delight' (2.01) and 'Punjab Glance' (41.52), respectively. Maximum corm weight and corm size was found in cultivar 'Rose Supreme' (102.70 g and 5.66 cm respectively) and under 10th October planting (76.07 g and 4.39 cm, respectively). It was concluded that the best planting time with respect to corm and cormel production was 10th October, while 10th December was least favourable.

Thokchom and Singh (2015) at Imphal, Manipur, studied the effect of planting dates and depths for tuberose under Manipur conditions. Among the five planting dates from 20th April to 30th May, 20th April and shallow planting (4 cm) recorded significantly the maximum values for observations like plant height (49.02 cm), number of leaves/plant (45.61), number of tillers/plant (2.73), number of florets/spike (26.53), number of spikes/plant (1.47) and yield of spikes (298,000 cut numbers/ha).

Prasana *et al.* (2016) on two different growing seasons i.e. Kharif (29th July planting date) and winter season (18th October planting date) in the terrace garden of the Department of Floriculture and Landscaping, College of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar to evaluate the bloom life of five Asiatic lily hybrid varieties viz., 'New Wave', 'Orange Matrix', 'Alaska', 'Nov Cento' and 'Monte Negro'. Results of the study indicated that winter planted bulbs gave better performance in terms of leaf area, flower buds/shoot, bloom life and duration of flowering. Whereas, Kharif season planting accounted for taller plants and earliest appearance of flower buds.

# MATERIALS AND METHODS

The present investigation on "Effect of Different Dates of Planting on Growth and Flowering of China aster [*Callistephus chinensis* (L.) Nees] cv. Arka Archana" was carried out in form of a pot experiment at the Department of Floriculture and Landscaping, College of Agriculture, OUAT, Bhubaneswar, Odisha during October, 2017 to May 2018. The materials used and the techniques adopted during course of investigation are described in this chapter.

## 3.1 EXPERIMENTAL SITE

The experiment entitled "Effect of Different dates of planting on growth and flowering of China aster [*Callistephus chinensis* (L.) Nees] cv. Arka Archana" was carried out on the rooftop and laboratory of Department of Floriculture and Landscaping, College of Agriculture, OUAT, Bhubaneswar, Odisha during October, 2017 to May, 2018.

## 3.2 GEOGRAPHICAL LOCATION OF THE EXPERIMENTAL SITE

The Orissa University of Agriculture and Technology, Bhubaneswar is situated 63 kilometres away from the Bay of Bengal at an elevation of 25.5 m above the mean sea level. Geographically it is located at $20^0$ 15' North latitude and $85^0$ 15' East longitude.

## 3.3 CLIMATE

Bhubaneswar comes under tropical climatic zone. The mean annual rainfall is 1522 mm out of which about 85% is received within July to September and the rest is within October to June. The average maximum temperature ranges from 35 $^0$C to 45 $^0$C during May to June while the minimum temperature ranges from 13 $^0$C to 15 $^0$C during December and January. The relative humidity varies between 40% in summer to 90% in rainy season.

## 3.4 VARIETAL DESCRIPTION

Arka Archana: This variety of china aster has been released from IIHR, Bangalore. It produces white colour flowers with an average yield of 220-225 g/plant. The maturity period of the variety ranges from 68- 75 days.

## 3.5 EXPERIMENTAL DETAILS

The present experiment was conducted to study the "Effect of Different Dates of Planting on Growth and Flowering of China aster [*callistephus chinensis* (L.) Nees] cv. Arka Archana"

The experimental details are as follows:

Name of the crop: China aster [*Callistephus chinensis* (L.) Nees]

Number of varieties: 1

Name of variety: Arka Archana

Number of treatments: 09

Number of replications: 03

Pot size: 22 cm X 16 cm

Total number of pots: 135

Experimental design: Completely Randomised Design (CRD)

### 3.5.1 TRETMENT DETAILS

The one month old seedlings were transplanted in the pot according to the treatments, the details of which are tabulated below:

Table3.1 Details of Treatment

| Treatment Code (T) | Date of Planting |
|---|---|
| $T_1$ | $10^{th}$ October |
| $T_2$ | $20^{th}$ October |
| $T_3$ | $30^{th}$ October |
| $T_4$ | $10^{th}$ November |
| $T_5$ | $20^{th}$ November |
| $T_6$ | $30^{th}$ November |

| | |
|---|---|
| $T_7$ | 10th December |
| $T_8$ | 20th December |
| $T_9$ | 30th December |

## 3.6 EXECUTION OF THE EXPERIMENT

### 3.6.1 Preparation of media for seed sowing

The media were prepared by mixing the soil, sand and farm yard manure in the desired proportion. Sand and farm yard manure were mixed thoroughly with the soil by the help of trench hoe. Corks were placed in the bottom of the hole of the seed pan and some amount of sand was placed over it to facilitate for easy drainage of water. Then the media were filled in the seed pan.

### 3.6.2 Sowing of seeds for raising seedlings

The corks were placed in the hole of the seed pan and some amount of sand was placed over it. Then the media were filled in the seed pan in required amount and watered by the help of rose cane and then line was made by the help of stick and seeds were sown. The first sowing was done on 10.09.2017 and this would be continuing up to 30.11.2017 as per the requirement. After sowing, the seed pans were watered by the help of rose cane regularly.

### 3.6.3 Preparation of potting media

The media were prepared by mixing the soil, sand and farm yard manure in the desired proportion i.e. 2:1/2:1 ratio respectively. Corks was placed with concave sides down over the drainage hole at the bottom of the pot before filling the media to facilitate proper drainage. The media were filled in required number of pots leaving 2.5 cm at the top to facilitate irrigation.

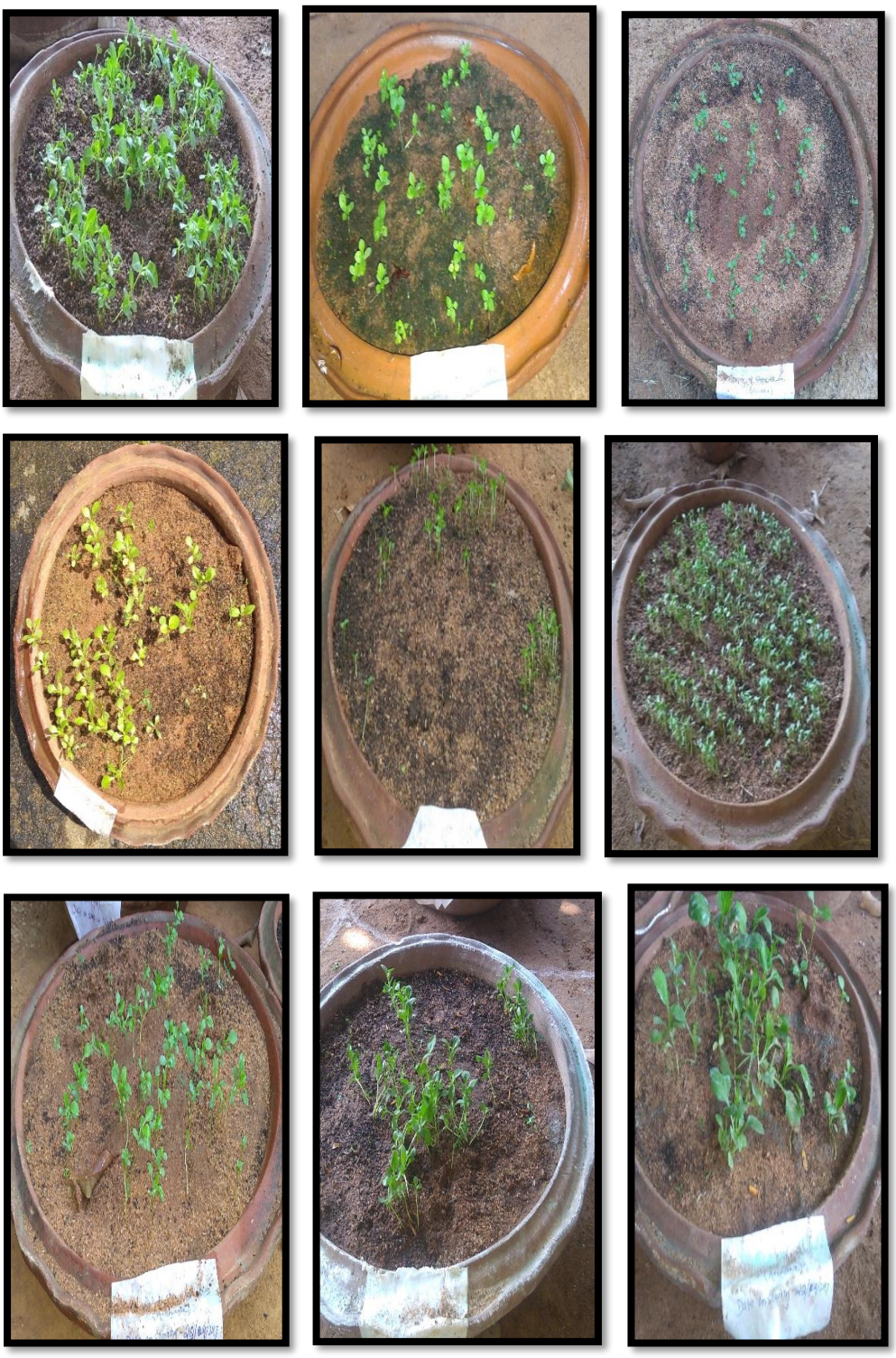

**Fig.3.1 China aster variety in seedling stage**

### 3.6.4 Transplanting of seedling in the pots

One month old seedlings were transplanted in the pots of size 22 cm x 16 cm in the evening hours. Then the pots were watered by the help of rose cane regularly. The first transplanting was done on 10.10.2017 and subsequent transplanting was done at as per the treatments till 30.12.2017.

### 3.6.5 Fertilizer application

Each plant in the individual pot was applied with 2g urea, 4g single super phosphate and 1g of muriate of potash. The fertilizer mixture was given after one month of transplanting. The fertilizers were given in the plant in circular ring around the plant and hoeing was done. Then the pots were watered by the help of the rose cane.

### 3.6.6 AFTERCARE OF THE PLANTS

#### 3.6.6.1 Irrigation

Immediately after transplanting, the pots were watered by the help of a rose cane in the morning or evening hours. Thereafter, watering was done in alternate days depending on the soil moisture condition. Plants were gently irrigated regularly during the growth period.

#### 3.6.6.2 Plant protection

No disease was observed during the experiment period. However, the control of caterpillar and thrips was done by the Dimethoate (Rogour) 2ml/L, Fipronil 2ml/L and Ektara 1g/ 3L of water and Totoneem 2ml/L. The chemicals were sprayed in the plant after fortnight interval by the help of hand sprayer.

## 3.7 INTERCULTURAL OPERATION

### 3.7.1 Hoeing

Hoeing was started after few days from establishment of seedlings and practised regularly to break the hard crust formed over the soil surface and keep the pots aerated.

### 3.7.2 Weeding

Weeds were removed regularly with the help of khurpi to keep the pots free from weeds.

### 3.7.3 Staking

Staking of individual plant was done with bamboo sticks before flowering which minimises the damage from wind. Staking is generally done to keep the stem in upright position as the stem is much affected by wind.

## 3.8 COLLECTION OF EXPERIMENTAL DATA

### 3.8.1 Observations on vegetative characters

#### 3.8.1.1 Plant height (cm):

The height of the plant was recorded with the help of metre scale from ground level to the tip of the plant in each plant. Mean plant height was calculated and expressed in centimetres.

#### 3.8.1.2 Number of leaves in the plant

The number of leaves in the plant was recorded at the peak flowering stages. Total number of leaves in each plant was recorded and its average was calculated.

#### 3.8.1.3 Number of branches per plant

Total number of primary branches from each plant were counted and mean value was calculated.

#### 3.8.1.4 Spread of the plant(cm)

The spread of each plant was measured in cm in the East-West and North-South directions. The means of these observations was calculated for determining the spread of the plant in the East-West and North-South directions.

**Fig3.2 China aster plant in vegetative stage**


**Fig3.3 China aster plants in flowering stage**

#### 3.8.1.5 Leaf area ($cm^2$)

Within each plants in each treatment, the leaf area was measured in $cm^2$ with the help of graph paper. The average value was calculated and expressed in square centimetres.

#### 3.8.1.6 Fresh weight of leaves(g)

Fresh weight of leaves was taken in fully grown stage of each plant in each treatment was measured in grams with the help of physical balance and mean value was taken as fresh weight of leaves. Four leaves were taken for the measurement of fresh weight of leaves.

#### 3.8.1.7 Dry weight of leaves(g)

Dry weight of leaves was taken by weighing in fully dried leaves with the help of physical balance. The average value was calculated and expressed in grams.

#### 3.8.1.8 Stem girth(cm)

The stem diameter was measured by the help of Vernier calliper at the base of the main stem of each plants in each treatment, multiplied by $\pi$ and the girth was calculated. The mean was calculated and expressed in centimetres.

### 3.8.2 Observations on floral characters

#### 3.8.2.1 Days taken for visible bud formation

The days taken to first flower bud formation were counted. The days taken for floral bud initiation is defined as the number of days taken from the date of transplanting to the appearance of first flower bud in each plant in each treatment. Then the average value was calculated.

#### 3.8.2.2 Days to bud showing colour

The Days taken for first bud showing colour from the date of transplanting was recorded in each plants of each treatment and mean value was recorded.

### 3.8.2.3 Days taken for first flowering

The days taken for first flowering were counted as the number of days taken from the date of transplanting to the appearance of first flower in each plant of each treatment and the average was calculated.

### 3.8.2.4 Number of flowers per plant

Within plant in each treatment, the number of flowers was counted at full bloom stage and mean value was recorded.

### 3.8.2.5 Flower diameter (cm)

The diameter of flowers on each plant was recorded at the time of peak flowering in the full bloom stage in East - West and North - South directions and measured in centimetres by the help of measuring scale. The average was calculated and expressed in centimetres.

### 3.8.2.6 Length of flower stem (cm)

Flower stem length in selected plants was measured in centimetres from the base of flower stalk to the tip and mean value was taken as flower stem length.

### 3.8.2.7 Fresh weight of flowers (g)

Fresh weight of flowers was taken in fully grown stage of each plant in each treatment was measured in grams with the help of physical balance and mean value was taken as fresh weight of flowers. Two flowers were taken for the measurement of fresh weight of flowers.

### 3.8.2.8 Dry weight of flowers (g)

Dry weight of flowers was taken by weighing in the fully dried flowers with the help of physical balance. Two flowers were taken per treatment for this purpose and the average was calculated and expressed in grams.


**Fig3.4 China aster plant Bud stage and flowering stage**


**Fig.3.5 China aster plant in flowering stage**

### 3.8.2.9 Bloom life (days)

The flowers opening to freshness of the flowers in the plant is known as bloom life of flowers. Bloom life of flowers was taken in each plant in each treatment and mean value was recorded.

### 3.8.2.10 Shelf life (days)

The freshness of the flowers to the drying and wilting of the flowers in the room temperature is known as shelf life of flowers. Fully opened flowers were harvested and kept at ambient room temperature in well ventilated room and shelf life was recorded in hours and mean value was recorded.

### 3.8.2.11 Vase life (days)

For the vase life, the flowers were harvested when florets were fully open. The harvested flower stalks were given a slanting cut at the basal end and were put in tap water and the number of days taken for withering of the flowers was recorded and was expressed as vase life in days and mean value was recorded.

### 3.8.2.12 Duration of flowering (days)

The number of days taken from the first opening of flower till to the last flowers of outer ray florets showed wilting/senescence of the tips is known as duration of flowering and mean value was recorded in each plant in each replication of this treatment.

## 3.9 Thousand seed weight (g)

The fully matured, dried flowers were harvested randomly from plants in each replication from each treatment the seed were separated manually, cleaned and Weight of thousand seeds of china aster in each replication and each treatment were counted. The average weight of three replications of thousand seeds was weighed in an electronic analytical balance and expressed in grams.

## 3.13 Statistical Analysis

The data obtained from various growth and yield parameters were statistically analysed in a complete randomized design to obtain the analysis of variance. The variance was tested at 5% level of significance. Standard error of mean and critical

differences (0.05) were calculated for comparing the mean value following the method of Gomez and Gomez (1984). To find out significant difference between mean values, critical difference was calculated from the appropriate standard error SE (m+) by using the following formula:

$$CV = \sqrt{EMS}/MEAN \times 100$$

$$SE(m)\pm = \sqrt{EMS}/R$$

$$CD\ (0.05) = t_{er}\ df\ 5\% \times \sqrt{2} \times SE\ (m)\pm$$

$$= 2.06 \times 1.414 \times SE\ (m)\pm$$

Table 3.2 Meteorological data on weather parameters for the period from October,2017 to April,2018

| Date | Temperature( $^0$C) | | | | Day Length | Rainfall | Relative Humidity% |
|---|---|---|---|---|---|---|---|
| | Max. | Min. | Avg. Day Temperature | Avg. Night Temperature | | Daily (mm) | |
| 10-Oct-2017 | 34.0 | 25.2 | 31.0 | 22.0 | 11h 47m | 24.6 | 68 |
| 11-Oct-2017 | 32.0 | 25.4 | 31.0 | 22.0 | 11h 45m | 0.0 | 69 |
| 12-Oct-2017 | 33.8 | 25.6 | 31.0 | 21.0 | 11h 44m | 0.0 | 66 |
| 13-Oct-2017 | 34.6 | 25.6 | 31.0 | 21.0 | 11h 43m | 0.0 | 56 |
| 14-Oct-2017 | 34.4 | 25.6 | 31.0 | 21.0 | 11h 42m | 0.0 | 56 |
| 15-Oct-2017 | 34.4 | 25.2 | 31.0 | 21.0 | 11h 41m | 0.0 | 56 |
| 16-Oct-2017 | 33.4 | 25.0 | 31.0 | 21.0 | 11h 40m | 0.0 | 55 |
| 17-Oct-2017 | 33.6 | 25.0 | 31.0 | 21.0 | 11h 39m | 0.0 | 58 |
| 18-Oct-2017 | 33.6 | 24.2 | 31.0 | 21.0 | 11h 38m | 0.0 | 65 |
| 19-Oct-2017 | 31.4 | 25.6 | 31.0 | 20.0 | 11h 36m | 0.0 | 86 |
| 20-Oct-2017 | 27.0 | 24.4 | 31.0 | 20.0 | 11h 34m | 8.0 | 97 |
| 21-Oct-2017 | 26.8 | 24.0 | 31.0 | 20.0 | 11h 33m | 75.2 | 90 |
| 22-Oct-2017 | 32.8 | 23.6 | 31.0 | 20.0 | 11h 32m | 19.0 | 67 |
| 23-Oct-2017 | 34.8 | 24.0 | 30.0 | 20.0 | 11h 31m | 0.0 | 57 |
| 24-Oct-2017 | 34.6 | 23.4 | 30.0 | 20.0 | 11h 30m | 0.0 | 63 |
| 25-Oct-2017 | 33.8 | 22.8 | 30.0 | 20.0 | 11h 29m | 0.0 | 60 |
| 26-Oct-2017 | 33.8 | 23.0 | 30.0 | 20.0 | 11h 28m | 0.0 | 65 |
| 27-Oct-2017 | 33.0 | 23.6 | 30.0 | 19.0 | 11h 27m | 0.0 | 69 |
| 28-Oct-2017 | 32.0 | 22.0 | 30.0 | 19.0 | 11h 26m | 0.0 | 63 |
| 29-Oct-2017 | 31.5 | 20.5 | 30.0 | 19.0 | 11h 25m | 0.0 | 63 |
| 30-Oct-2017 | 32.0 | 22.2 | 30.0 | 19.0 | 11h 24m | 0.0 | 65 |
| 31-Oct-2017 | 32.0 | 21.6 | 30.0 | 19.0 | 11h 23m | 0.0 | 59 |
| 01-Nov-2017 | 31.8 | 21.0 | 30.0 | 19.0 | 11h 23m | 0.0 | 65 |
| 02-Nov-2017 | 29.8 | 21.0 | 30.0 | 19.0 | 11h 22m | 0.0 | 66 |
| 03-Nov-2017 | 29.6 | 19.0 | 30.0 | 19.0 | 11h 21m | 0.0 | 53 |
| 04-Nov-2017 | 31.2 | 19.1 | 30.0 | 19.0 | 11h 20m | 0.0 | 63 |
| 05-Nov-2017 | 31.2 | 19.6 | 30.0 | 18.0 | 11h 19m | 0.0 | 53 |
| 06-Nov-2017 | 32.6 | 21.6 | 30.0 | 18.0 | 11h 18m | 0.0 | 55 |
| 07-Nov-2017 | 32.0 | 20.0 | 30.0 | 18.0 | 11h 17m | 0.0 | 58 |
| 08-Nov-2017 | 32.4 | 19.2 | 29.0 | 18.0 | 11h 16m | 0.0 | 57 |
| 09-Nov-2017 | 31.0 | 18.8 | 29.0 | 18.0 | 11h 15m | 0.0 | 45 |
| 10-Nov-2017 | 30.9 | 18.0 | 29.0 | 18.0 | 11h 15m | 0.0 | 49 |
| 11-Nov-2017 | 29.8 | 19.0 | 29.0 | 18.0 | 11h 14m | 0.0 | 48 |
| 12-Nov-2017 | 30.0 | 19.4 | 29.0 | 18.0 | 11h 13m | 0.0 | 49 |
| 13-Nov-2017 | 30.6 | 20.6 | 29.0 | 18.0 | 11h 12m | 0.0 | 53 |
| 14-Nov-2017 | 30.8 | 20.0 | 29.0 | 18.0 | 11h 11m | 0.0 | 52 |
| 15-Nov-2017 | 27.4 | 19.6 | 29.0 | 18.0 | 11h 10m | 9.7 | 67 |
| 16-Nov-2017 | 23.0 | 21.6 | 29.0 | 17.0 | 11h 09m | 32.8 | 88 |
| 17-Nov-2017 | 25.0 | 21.4 | 29.0 | 17.0 | 11h 09m | 6.6 | 80 |
| 18-Nov-2017 | 24.0 | 22.0 | 29.0 | 17.0 | 11h 08m | 6.1 | 74 |
| 19-Nov-2017 | 27.4 | 22.6 | 29.0 | 17.0 | 11h 07m | 0.0 | 70 |
| 20-Nov-2017 | 31.8 | 23.0 | 29.0 | 17.0 | 11h 06m | 0.0 | 67 |

| Date | Temperature($^0$C) | | | | Day Length | Rainfall | Relative Humidity % |
|---|---|---|---|---|---|---|---|
| | Max. | Min. | Avg. Day Temperature | Avg. Night Temperature | | Daily (mm) | |
| 21-Nov-2017 | 31.4 | 21.0 | 29.0 | 17.0 | 11h 06m | 0.0 | 61 |
| 22-Nov-2017 | 31.0 | 18.2 | 29.0 | 17.0 | 11h 05m | 0.0 | 56 |
| 23-Nov-2017 | 29.2 | 16.8 | 28.0 | 17.0 | 11h 04m | 0.0 | 52 |
| 24-Nov-2017 | 27.8 | 14.8 | 28.0 | 17.0 | 11h 04m | 0.0 | 51 |
| 25-Nov-2017 | 28.4 | 14.6 | 28.0 | 16.0 | 11h 03m | 0.0 | 33 |
| 26-Nov-2017 | 28.6 | 14.6 | 28.0 | 16.0 | 11h 02m | 0.0 | 38 |
| 27-Nov-2017 | 29.4 | 13.4 | 28.0 | 16.0 | 11h 02m | 0.0 | 35 |
| 28-Nov-2017 | 29.6 | 14.0 | 28.0 | 16.0 | 11h 01m | 0.0 | 51 |
| 29-Nov-2017 | 30.6 | 14.2 | 28.0 | 16.0 | 11h 01m | 0.0 | 38 |
| 30-Nov-2017 | 30.2 | 14.0 | 28.0 | 16.0 | 11h 00m | 0.0 | 39 |
| 01-Dec-2017 | 29.4 | 14.2 | 28.0 | 16.0 | 10h 59m | 0.0 | 41 |
| 02-Dec-2017 | 28.0 | 12.8 | 28.0 | 16.0 | 10h 59m | 0.0 | 39 |
| 03-Dec-2017 | 27.8 | 12.2 | 28.0 | 16.0 | 10h 58m | 0.0 | 37 |
| 04-Dec-2017 | 28.2 | 12.0 | 28.0 | 16.0 | 10h 58m | 0.0 | 37 |
| 05-Dec-2017 | 27.5 | 11.8 | 28.0 | 16.0 | 10h 58m | 0.0 | 39 |
| 06-Dec-2017 | 27.8 | 12.2 | 28.0 | 16.0 | 10h 57m | 0.0 | 35 |
| 07-Dec-2017 | 27.8 | 12.8 | 28.0 | 16.0 | 10h 57m | 0.0 | 44 |
| 08-Dec-2017 | 25.3 | 19.6 | 28.0 | 16.0 | 10h 56m | 0.0 | 50 |
| 09-Dec-2017 | 25.6 | 17.2 | 28.0 | 16.0 | 10h 56m | Trace | 98 |
| 10-Dec-2017 | 23.4 | 20.6 | 28.0 | 16.0 | 10h 56m | 36.3 | 75 |
| 11-Dec-2017 | 30.2 | 17.8 | 28.0 | 16.0 | 10h 55m | 0.0 | 55 |
| 12-Dec-2017 | 31.0 | 17.6 | 28.0 | 16.0 | 10h 55m | 0.0 | 67 |
| 13-Dec-2017 | 31.2 | 20.4 | 28.0 | 16.0 | 10h 55m | 0.0 | 57 |
| 14-Dec-2017 | 29.6 | 18.8 | 28.0 | 16.0 | 10h 55m | 0.0 | 56 |
| 15-Dec-2017 | 30.6 | 17.0 | 28.0 | 16.0 | 10h 55m | 0.0 | 53 |
| 16-Dec-2017 | 30.4 | 15.6 | 29.0 | 16.0 | 10h 54m | 0.0 | 47 |
| 17-Dec-2017 | 30.0 | 14.8 | 29.0 | 16.0 | 10h 54m | 0.0 | 40 |
| 18-Dec-2017 | 29.4 | 15.0 | 29.0 | 16.0 | 10h 54m | 0.0 | 41 |
| 19-Dec-2017 | 27.0 | 11.2 | 29.0 | 16.0 | 10h 54m | 0.0 | 36 |
| 20-Dec-2017 | 27.2 | 12.0 | 29.0 | 16.0 | 10h 54m | 0.0 | 42 |
| 21-Dec-2017 | 26.8 | 13.2 | 29.0 | 16.0 | 10h 54m | 0.0 | 44 |
| 22-Dec-2017 | 27.0 | 14.0 | 29.0 | 16.0 | 10h 54m | 0.0 | 51 |
| 23-Dec-2017 | 28.4 | 15.2 | 29.0 | 16.0 | 10h 54m | 0.0 | 48 |
| 24-Dec-2017 | 27.8 | 14.8 | 29.0 | 16.0 | 10h 54m | 0.0 | 51 |
| 25-Dec-2017 | 28.0 | 13.4 | 29.0 | 16.0 | 10h 54m | 0.0 | 52 |
| 26-Dec-2017 | 28.4 | 14.6 | 29.0 | 16.0 | 10h 54m | 0.0 | 50 |
| 27-Dec-2017 | 27.6 | 10.0 | 29.0 | 16.0 | 10h 54m | 0.0 | 40 |
| 28-Dec-2017 | 28.0 | 10.6 | 29.0 | 16.0 | 10h 55m | 0.0 | 34 |
| 29-Dec-2017 | 27.4 | 11.6 | 29.0 | 16.0 | 10h 55m | 0.0 | 37 |

| Date | Temperature($^0$C) | | | | Day Length | Rainfall | Relative Humidity % |
|---|---|---|---|---|---|---|---|
| | Max. | Min. | Avg. Day Temperature | Avg. Night Temperature | | Daily (mm) | |
| 30-Dec-2017 | 28.2 | 11.6 | 29.0 | 16.0 | 10h 55m | 0.0 | 41 |
| 31-Dec-2017 | 28.4 | 13.0 | 29.0 | 16.0 | 10h 55m | 0.0 | 38 |
| 01-Jan-2018 | 27.6 | 16.8 | 29.0 | 16.0 | 10h 55m | 0.0 | 37 |
| 02-Jan-2018 | 25.2 | 16.4 | 29.0 | 16.0 | 10h 56m | 0.0 | 52 |
| 03-Jan-2018 | 27.0 | 11.0 | 29.0 | 16.0 | 10h 56m | 0.0 | 32 |
| 04-Jan-2018 | 27.2 | 11.6 | 29.0 | 16.0 | 10h 56m | 0.0 | 33 |
| 05-Jan-2018 | 26.2 | 9.8 | 29.0 | 16.0 | 10h 57m | 0.0 | 36 |
| 06-Jan-2018 | 25.6 | 10.6 | 29.0 | 17.0 | 10h 57m | 0.0 | 38 |
| 07-Jan-2018 | 27.0 | 11.8 | 29.0 | 17.0 | 10h 58m | 0.0 | 38 |
| 08-Jan-2018 | 26.8 | 10.2 | 30.0 | 17.0 | 10h 58m | 0.0 | 36 |
| 09-Jan-2018 | 26.4 | 9.8 | 30.0 | 17.0 | 10h 59m | 0.0 | 31 |
| 10-Jan-2018 | 26.2 | 9.8 | 30.0 | 17.0 | 10h 59m | 0.0 | 37 |
| 11-Jan-2018 | 28.0 | 10.2 | 30.0 | 17.0 | 11h 00m | 0.0 | 33 |
| 12-Jan-2018 | 29.4 | 11.3 | 30.0 | 17.0 | 11h 00m | 0.0 | 34 |
| 13-Jan-2018 | 29.6 | 14.4 | 30.0 | 17.0 | 11h 01m | 0.0 | 36 |
| 14-Jan-2018 | 29.6 | 12.6 | 30.0 | 17.0 | 11h 01m | 0.0 | 34 |
| 15-Jan-2018 | 27.4 | 10.4 | 30.0 | 18.0 | 11h 02m | 0.0 | 41 |
| 16-Jan-2018 | 29.2 | 11.8 | 30.0 | 18.0 | 11h 02m | 0.0 | 24 |
| 17-Jan-2018 | 28.4 | 12.0 | 30.0 | 18.0 | 11h 03m | 0.0 | 39 |
| 18-Jan-2018 | 28.6 | 11.2 | 30.0 | 18.0 | 11h 04m | 0.0 | 34 |
| 19-Jan-2018 | 29.0 | 10.4 | 30.0 | 18.0 | 11h 04m | 0.0 | 36 |
| 20-Jan-2018 | 28.6 | 10.4 | 30.0 | 18.0 | 11h 05m | 0.0 | 33 |
| 21-Jan-2018 | 21.8 | 10.8 | 30.0 | 18.0 | 11h 06m | 0.0 | 35 |
| 22-Jan-2018 | 29.2 | 11.6 | 30.0 | 18.0 | 11h 07m | 0.0 | 34 |
| 23-Jan-2018 | 28.8 | 12.8 | 31.0 | 18.0 | 11h 07m | 0.0 | 39 |
| 24-Jan-2018 | 29.4 | 14.0 | 31.0 | 18.0 | 11h 08m | 0.0 | 35 |
| 25-Jan-2018 | 31.0 | 15.0 | 31.0 | 18.0 | 11h 09m | 0.0 | 35 |
| 26-Jan-2018 | 28.4 | 12.0 | 31.0 | 19.0 | 11h 10m | 0.0 | 32 |
| 27-Jan-2018 | 29.2 | 14.8 | 31.0 | 19.0 | 11h 11m | 0.0 | 33 |
| 28-Jan-2018 | 27.6 | 13.4 | 31.0 | 19.0 | 11h 11m | 0.0 | 39 |
| 29-Jan-2018 | 29.2 | 12.6 | 31.0 | 19.0 | 11h 12m | 0.0 | 37 |
| 30-Jan-2018 | 30.2 | 11.8 | 31.0 | 19.0 | 11h 13m | 0.0 | 23 |
| 31-Jan-2018 | 30.4 | 10.6 | 31.0 | 19.0 | 11h 14m | 0.0 | 21 |
| 01-Feb-2018 | 31.8 | 11.6 | 31.0 | 19.0 | 11h 15m | 0.0 | 20 |
| 02-Feb-2018 | 31.2 | 12.2 | 31.0 | 19.0 | 11h 16m | 0.0 | 20 |
| 03-Feb-2018 | 32.4 | 12.6 | 31.0 | 19.0 | 11h 17m | 0.0 | 18 |
| 04-Feb-2018 | 32.6 | 12.4 | 32.0 | 19.0 | 11h 18m | 0.0 | 26 |
| 05-Feb-2018 | 33.4 | 13.4 | 32.0 | 20.0 | 11h 19m | 0.0 | 19 |
| 06-Feb-2018 | 33.6 | 13.8 | 32.0 | 20.0 | 11h 20m | 0.0 | 24 |
| 07-Feb-2018 | 34.6 | 16.2 | 32.0 | 20.0 | 11h 21m | 0.0 | 21 |
| 08-Feb-2018 | 34.8 | 20.0 | 32.0 | 20.0 | 11h 22m | 0.0 | 30 |
| 09-Feb-2018 | 33.6 | 17.8 | 32.0 | 20.0 | 11h 23m | 0.0 | 40 |

| Date | Temperature($^0$C) | | | | Day Length | Rainfall | Relative Humidity % |
|---|---|---|---|---|---|---|---|
| | Max. | Min. | Avg. Day Temperature | Avg. Night Temperature | | Daily (mm) | |
| 10-Feb-2018 | 33.4 | 18.4 | 32.0 | 20.0 | 11h 24m | 0.0 | 39 |
| 11-Feb-2018 | 31.0 | 20.0 | 32.0 | 20.0 | 11h 25m | 0.0 | 42 |
| 12-Feb-2018 | 28.2 | 14.6 | 33.0 | 20.0 | 11h 26m | 0.0 | 41 |
| 13-Feb-2018 | 31.2 | 14.4 | 33.0 | 20.0 | 11h 27m | 0.0 | 28 |
| 14-Feb-2018 | 30.8 | 15.4 | 33.0 | 20.0 | 11h 28m | 0.0 | 32 |
| 15-Feb-2018 | 33.0 | 15.0 | 33.0 | 20.0 | 11h 29m | 0.0 | 30 |
| 16-Feb-2018 | 32.0 | 15.6 | 33.0 | 21.0 | 11h 30m | 0.0 | 32 |
| 17-Feb-2018 | 32.2 | 14.6 | 33.0 | 21.0 | 11h 31m | 0.0 | 32 |
| 18-Feb-2018 | 33.6 | 15.2 | 33.0 | 21.0 | 11h 32m | 0.0 | 34 |
| 19-Feb-2018 | 34.0 | 16.8 | 34.0 | 21.0 | 11h 33m | 0.0 | 27 |
| 20-Feb-2018 | 33.2 | 17.4 | 34.0 | 21.0 | 11h 34m | 0.0 | 31 |
| 21-Feb-2018 | 34.2 | 16.6 | 34.0 | 21.0 | 11h 35m | 0.0 | 36 |
| 22-Feb-2018 | 35.4 | 15.0 | 34.0 | 21.0 | 11h 36m | 0.0 | 31 |
| 23-Feb-2018 | 35.8 | 17.0 | 34.0 | 21.0 | 11h 37m | 0.0 | 29 |
| 24-Feb-2018 | 36.4 | 16.8 | 34.0 | 21.0 | 11h 38m | 0.0 | 23 |
| 25-Feb-2018 | 37.4 | 15.6 | 34.0 | 22.0 | 11h 40m | 0.0 | 25 |
| 26-Feb-2018 | 38.4 | 16.8 | 34.0 | 22.0 | 11h 41m | 0.0 | 22 |
| 27-Feb-2018 | 37.4 | 22.0 | 35.0 | 22.0 | 11h 42m | 0.0 | 25 |
| 28-Feb-2018 | 36.8 | 19.2 | 35.0 | 22.0 | 11h 43m | 0.0 | 32 |
| 01-Mar-2018 | 36.8 | 18.0 | 35.0 | 22.0 | 11h 44m | 0.0 | 30 |
| 02-Mar-2018 | 36.4 | 20.6 | 35.0 | 22.0 | 11h 45m | 0.0 | 25 |
| 03-Mar-2018 | 37.6 | 20.4 | 35.0 | 22.0 | 11h 46m | 0.0 | 31 |
| 04-Mar-2018 | 38.6 | 20.2 | 35.0 | 22.0 | 11h 47m | 0.0 | 21 |
| 05-Mar-2018 | 38.8 | 20.6 | 35.0 | 22.0 | 11h 49m | 0.0 | 30 |
| 06-Mar-2018 | 38.6 | 20.4 | 35.0 | 23.0 | 11h 50m | 0.0 | 24 |
| 07-Mar-2018 | 35.6 | 20.6 | 35.0 | 23.0 | 11h 51m | 0.0 | 32 |
| 08-Mar-2018 | 34.6 | 19.6 | 36.0 | 23.0 | 11h 52m | 0.0 | 25 |
| 09-Mar-2018 | 34.4 | 19.6 | 36.0 | 23.0 | 11h 53m | 0.0 | 38 |
| 10-Mar-2018 | 34.8 | 20.4 | 36.0 | 23.0 | 11h 54m | 0.0 | 39 |
| 11-Mar-2018 | 38.2 | 21.4 | 36.0 | 23.0 | 11h 56m | 0.0 | 26 |
| 12-Mar-2018 | 37.0 | 23.6 | 36.0 | 23.0 | 11h 57m | 0.0 | 22 |
| 13-Mar-2018 | 35.6 | 22.4 | 36.0 | 23.0 | 11h 58m | 0.0 | 24 |
| 14-Mar-2018 | 39.0 | 19.4 | 36.0 | 23.0 | 11h 59m | 0.0 | 23 |
| 15-Mar-2018 | 38.9 | 19.8 | 36.0 | 24.0 | 12h 00m | 0.0 | 24 |
| 16-Mar-2018 | 37.0 | 21.0 | 36.0 | 24.0 | 12h 01m | 0.0 | 35 |
| 17-Mar-2018 | 30.8 | 21.6 | 36.0 | 24.0 | 12h 02m | Trace | 36 |
| 18-Mar-2018 | 36.0 | 21.0 | 36.0 | 24.0 | 12h 04m | 0.0 | 28 |
| 19-Mar-2018 | 37.6 | 21.4 | 36.0 | 24.0 | 12h 05m | 0.0 | 25 |
| 20-Mar-2018 | 36.4 | 21.0 | 36.0 | 24.0 | 12h 06m | 0.0 | 38 |
| 21-Mar-2018 | 39.2 | 19.6 | 36.0 | 24.0 | 12h 07m | 0.0 | 14 |
| 22-Mar-2018 | 37.4 | 25.0 | 36.0 | 24.0 | 12h 08m | 0.0 | 30 |

| Date | Temperature($^0$C) | | | | Day Length | Rainfall | Relative Humidity % |
|---|---|---|---|---|---|---|---|
| | Max. | Min. | Avg. Day Temperature | Avg. Night Temperature | | Daily (mm) | |
| 23-Mar-2018 | 36.4 | 25.2 | 37.0 | 24.0 | 12h 09m | 0.0 | 48 |
| 24-Mar-2018 | 39.5 | 24.6 | 37.0 | 24.0 | 12h 11m | 0.0 | 40 |
| 25-Mar-2018 | 37.0 | 25.4 | 37.0 | 24.0 | 12h 12m | 0.0 | 43 |
| 26-Mar-2018 | 35.8 | 24.2 | 37.0 | 25.0 | 12h 13m | 0.0 | 49 |
| 27-Mar-2018 | 37.6 | 25.6 | 37.0 | 25.0 | 12h 14m | 0.0 | 51 |
| 28-Mar-2018 | 39.2 | 24.8 | 37.0 | 25.0 | 12h 15m | 0.0 | 43 |
| 29-Mar-2018 | 39.0 | 25.6 | 37.0 | 25.0 | 12h 16m | 0.0 | 36 |
| 30-Mar-2018 | 35.2 | 27.0 | 37.0 | 25.0 | 12h 18m | 0.0 | 52 |
| 31-Mar-2018 | 35.0 | 26.8 | 37.0 | 25.0 | 12h 19m | 0.0 | 51 |
| 01-Apr-2018 | 36.6 | 24.6 | 37.0 | 25.0 | 12h 20m | 0.0 | 53 |
| 02-Apr-2018 | 36.0 | 20.2 | 37.0 | 25.0 | 12h 21m | 7.1 | 55 |
| 03-Apr-2018 | 33.6 | 22.6 | 37.0 | 25.0 | 12h 22m | 0.0 | 44 |
| 04-Apr-2018 | 35.4 | 25.0 | 37.0 | 25.0 | 12h 23m | 0.0 | 48 |
| 05-Apr-2018 | 35.0 | 20.0 | 37.0 | 25.0 | 12h 24m | 14.8 | 51 |
| 06-Apr-2018 | 35.2 | 25.0 | 37.0 | 25.0 | 12h 25m | 0.0 | 56 |
| 07-Apr-2018 | 35.6 | 22.4 | 37.0 | 25.0 | 12h 26m | 0.0 | 55 |
| 08-Apr-2018 | 36.0 | 22.8 | 37.0 | 25.0 | 12h 28m | 4.8 | 53 |
| 09-Apr-2018 | 34.4 | 24.6 | 37.0 | 25.0 | 12h 29m | 0.0 | 51 |
| 10-Apr-2018 | 36.6 | 22.4 | 37.0 | 25.0 | 12h 30m | 3.3 | 48 |
| 11-Apr-2018 | 35.0 | 24.0 | 37.0 | 25.0 | 12h 31m | 0.0 | 49 |
| 12-Apr-2018 | 36.8 | 25.2 | 37.0 | 25.0 | 12h 32m | 0.0 | 39 |
| 13-Apr-2018 | 36.8 | 22.6 | 37.0 | 25.0 | 12h 34m | 5.2 | 50 |
| 14-Apr-2018 | 36.8 | 25.4 | 37.0 | 25.0 | 12h 35m | 0.0 | 56 |
| 15-Apr-2018 | 38.8 | 24.0 | 37.0 | 26.0 | 12h 36m | 1.8 | 46 |
| 16-Apr-2018 | 39.2 | 26.4 | 37.0 | 26.0 | 12h 37m | 0.0 | 35 |
| 17-Apr-2018 | 41.0 | 27.2 | 37.0 | 26.0 | 12h 38m | 0.0 | 31 |
| 18-Apr-2018 | 40.8 | 26.8 | 37.0 | 26.0 | 12h 39m | 0.0 | 31 |
| 19-Apr-2018 | 38.6 | 26.4 | 37.0 | 26.0 | 12h 40m | 0.0 | 51 |
| 20-Apr-2018 | 38.2 | 26.8 | 37.0 | 26.0 | 12h 41m | 0.0 | 47 |
| 21-Apr-2018 | 37.6 | 26.6 | 37.0 | 26.0 | 12h 42m | 0.0 | 53 |
| 22-Apr-2018 | 39.2 | 27.2 | 37.0 | 26.0 | 12h 43m | 0.0 | 45 |
| 23-Apr-2018 | 39.4 | 27.8 | 37.0 | 26.0 | 12h 44m | 0.0 | 45 |
| 24-Apr-2018 | 38.8 | 23.6 | 37.0 | 26.0 | 12h 45m | 3.3 | 46 |
| 25-Apr-2018 | 38.6 | 24.0 | 37.0 | 26.0 | 12h 46m | 0.0 | 43 |
| 26-Apr-2018 | 39.4 | 26.6 | 37.0 | 26.0 | 12h 47m | 0.0 | 33 |
| 27-Apr-2018 | 38.6 | 27.0 | 37.0 | 26.0 | 12h 48m | 0.0 | 48 |
| 28-Apr-2018 | 37.2 | 25.2 | 37.0 | 26.0 | 12h 49m | 0.0 | 49 |
| 29-Apr-2018 | 37.4 | 23.0 | 37.0 | 26.0 | 12h 50m | 3.6 | 37 |
| 30-Apr-2018 | 37.0 | 25.0 | 37.0 | 26.0 | 12h 51m | 0.0 | 49 |


**Fig.3.6 Flowering stage in china aster on 10th October planting**


**Fig.3.7 Flowering stage of china aster plant on 20th October planting**


**Fig.3.8 Flowering stage of china aster plant on 30th October planting**


**Fig.3.9 Flowering stage of china aster plant on 10th November planting**


**Fig.3.10 Flowering stage of china aster on 20th November planting**


**Fig.3.11 flowering stage of china aster plant on 30th November planting**

# RESULTS

The experimental findings of the present investigation entitled "Effect of Different Dates of Planting on Growth and Flowering of China aster [*Callistephus chinensis* (L.) Nees)] cv. Arka Archana" is presented in this chapter. An endeavour has been made to elicit the effect of different planting dates on growth and yield parameters.

The observations recorded during course of investigation were analyzed statistically and are presented in tables and figures. It is clear from the data presented in tables that growth and yield characters were significantly affected by different planting dates.

## 4.1 Effect of different planting dates on vegetative growth

### 4.1.1 Plant height

Data presented in Table 4.1 clearly reveals significant difference in plant height due to planting dates. The tallest (42.11cm) plant were produced when the planting was done on 10$^{th}$ November ($T_4$) which was statistically at par with 20$^{th}$ November (41.17 cm) and 30$^{th}$ October (40.41cm) plantings. However, shortest (30.32 cm) plants were observed when the planting was done on 30$^{th}$ December.

### 4.1.2 Plant spread (cm) in E-W and N-S direction

The data (Table 4.1) on average plant spread (E-W and N-S) reveals that there was significant effect of date of planting on the average plant spread. The maximum (32.82cm) plant spread in E-W direction was recorded with 30$^{th}$ November($T_6$) planting which was statistically at par with 20$^{th}$ November (32.40 cm) planting. It was followed by 10$^{th}$ November (30.19 cm) and 30$^{th}$ October (30.16 cm) planting, respectively. The minimum (23.77cm). plant spread in E-W direction was noticed when planting was done on 10$^{th}$ October ($T_1$). Similar trend has been recorded for the average plant spread in N-S direction. The plants with maximum (33.14cm) spread in N-S direction were produced when planting was done on 30$^{th}$ November ($T_6$) which was statistically at par with 20$^{th}$ November planting (32.84 cm). In contrast, minimum plant spread (26.19cm) in N-S direction was recorded in 10$^{th}$ October ($T_1$) planting.

### 4.1.3 Stem girth (cm)

Data enumerated in Table 4.1 shows significant variation in average stem girth due to planting time. Perusal of data reveals that maximum (2.70 cm) stem girth was recorded in 10$^{th}$ November ($T_4$) planting which was statistically at par with 30$^{th}$ October (2.65 cm), 20$^{th}$ November (2.60 cm) and 30$^{th}$ November (2.59 cm). However, 10$^{th}$ October ($T_1$) planted crop produced minimum (2.18 cm) stem girth which was statistically at par with 20$^{th}$ October (2.38 cm), 30$^{th}$ December (2.39 cm) and 20$^{th}$ December (2.43 cm) planting, respectively.

### 4.1.4 **Number of leaves**

An appraisal of data presented in Table 4.2 reveals that average number of leaves per plant was significantly affected by planting time. Maximum (292.93) number of leaves per plant was recorded with 30$^{th}$ November ($T_6$) planting which was found to be statistically at par with 20$^{th}$ November (290.43) planting. The minimum (116.80) number of leaves per plant was recorded in 10$^{th}$ October ($T_1$) planting. However, planting on 20$^{th}$ December (210.53), 30$^{th}$ December (207.27) and 30$^{th}$ October (207.17) gave the same response with respect to number of leaves.

### 4.1.5 Leaf area (cm$^2$)

Data presented in Table 4.2 clearly reveals significant difference in leaf area due to planting dates. Among different planting dates, 10$^{th}$ November ($T_4$) planted crop resulted in maximum (32.99 cm$^2$) leaf area which was statistically at par with 30$^{th}$ October (31.47 cm$^2$) planting. Whereas, minimum (21.44 cm$^2$) leaf area was recorded when the crop was planted on 30$^{th}$ December ($T_9$) which was found to be statistically at par with 10$^{th}$ October planting (22.07 cm$^2$).

### 4.1.6 Number of branches per plant

The data presented in the Table 4.2 show that number of branches differed significantly due to planting time. Maximum (15.89) number of branches was recorded in 20$^{th}$ November planting ($T_5$) which was statistically at par with 10$^{th}$ November (15.33) and 30$^{th}$ November (15.03) planting. However, non-significant differences were observed in number of branches when china aster was planted on 10$^{th}$ November (15.33), 30$^{th}$ November (15.03) and 10$^{th}$ December (14.50). Minimum (10.26) number of branches were observed when planting was done on 10$^{th}$ October ($T_1$).

### 4.1.7 Fresh weight of leaves (g)

Data compiled in Table 4.2 envisages that planting dates significantly influenced the average fresh weight of leaf. The fresh weight of leaf was found to be highest (6.87 g) in 30$^{th}$ October planted crop ($T_3$) which was statistically at par with 10$^{th}$ November (6.60 g) and followed by 20$^{th}$ November (6.43 g) planting, respectively. Lowest (4.28 g) fresh weight of leaf was obtained in 30$^{th}$ December planting ($T_9$).

### 4.1.8 Dry weight of leaves (g)

Data presented in Table 4.2 shows significant effect of planting dates on dry weight of leaves. Among different planting dates, maximum (1.28 g) dry weight of leaves obtained with 30$^{th}$ October ($T_3$) planting followed by 10$^{th}$ November (1.20 g) and 20$^{th}$ October planting (1.16 g). Minimum (0.81 g) dry weight of leaves was recorded in case of 30$^{th}$ December($T_9$) planted crop.

**Table 4.1: Effect of different dates of planting on plant height, plant spread (E-W and N-S) and stem girth in china aster cv. Arka Archana**

| Treatment | | Plant height (cm) | Plant spread E-W(cm) | Plant spread N-S(cm) | Stem girth ( cm) |
|---|---|---|---|---|---|
| $T_1$ | 10$^{th}$ October | 37.30 | 23.77 | 26.19 | 2.18 |
| $T_2$ | 20$^{th}$ October | 38.11 | 25.90 | 26.66 | 2.38 |
| $T_3$ | 30$^{th}$ October | 40.41 | 30.16 | 30.45 | 2.65 |
| $T_4$ | 10$^{th}$ November | 42.11 | 30.19 | 31.70 | 2.70 |
| $T_5$ | 20$^{th}$ November | 41.17 | 32.40 | 32.84 | 2.60 |
| $T_6$ | 30$^{th}$ November | 39.28 | 32.82 | 33.14 | 2.59 |
| $T_7$ | 10$^{th}$ December | 34.58 | 29.47 | 31.07 | 2.46 |
| $T_8$ | 20$^{th}$ December | 32.86 | 28.33 | 29.07 | 2.43 |
| $T_9$ | 30$^{th}$ December | 30.32 | 27.40 | 28.00 | 2.39 |
| Mean | | 33.61 | 26.04 | 26.91 | 2.24 |
| SE (m) ± | | 0.63 | 0.67 | 0.56 | 0.05 |
| CD at 5% | | 1.91 | 2.02 | 1.71 | 0.16 |

**Table 4.2: Effect of different dates of planting on number of leaves per plant, leaf area, number of branches per plant, fresh weight and dry weight of leaves in china aster cv. Arka Archana**

| Treatment | | Number of leaves per plant | Leaf area ($cm^2$) | Number of branches per plant | Fresh weight of leaves (g) | Dry weight of leaves (g) |
|---|---|---|---|---|---|---|
| $T_1$ | $10^{th}$ October | 116.80 | 22.07 | 10.26 | 5.06 | 0.99 |
| $T_2$ | $20^{th}$ October | 147.50 | 26.94 | 11.89 | 5.44 | 1.11 |
| $T_3$ | $30^{th}$ October | 207.17 | 31.47 | 13.87 | 6.87 | 1.28 |
| $T_4$ | $10^{th}$ November | 273.57 | 32.99 | 15.33 | 6.60 | 1.20 |
| $T_5$ | $20^{th}$ November | 290.43 | 30.87 | 15.89 | 6.43 | 1.16 |
| $T_6$ | $30^{th}$ November | 292.93 | 28.31 | 15.03 | 6.17 | 1.05 |
| $T_7$ | $10^{th}$ December | 247.87 | 24.49 | 14.50 | 5.39 | 1.00 |
| $T_8$ | $20^{th}$ December | 210.53 | 23.59 | 14.08 | 5.08 | 0.97 |
| $T_9$ | $30^{th}$ December | 207.27 | 21.44 | 13.25 | 4.28 | 0.81 |
| Mean | | 199.41 | 24.22 | 12.41 | 5.13 | 0.96 |
| SE (m)± | | 5.16 | 0.69 | 0.35 | 0.13 | 0.02 |
| CD at 5% | | 15.47 | 2.07 | 1.06 | 0.40 | 0.07 |

## 4.2 Effect of different planting dates on floral characters

### 4.2.1 Days taken for visible bud formation

As indicated from the Table 4. 3 various planting dates influenced the days taken for visible bud formation. Days to visible bud formation was observed earliest (65.17 days) in 30$^{th}$ November ($T_6$) planting followed by 10$^{th}$ November (66.74 days) and 20$^{th}$ November (68.91 days) planting, respectively. However, days to visible bud formation was most delayed (74.66 days) in 30$^{th}$ December planting which was statistically at par with 10$^{th}$ October (73.84 days) and 20$^{th}$ December (72.27 days) planting, respectively.

### 4.2.2 Days to bud showing colour

The data (Table 4.3) on days to bud showing colour reveals that, there was significant effect of planting dates on days to bud showing colour. Among different planting dates, this stage was found to reach earliest (75.55 days) in 30$^{th}$ November ($T_6$) planting followed by 20$^{th}$ November (82.44 days) and 10$^{th}$ November (84.66 days) planting, respectively. However, maximum (93.97) days to bud showing colour was observed when crop was planted on 30$^{th}$ December ($T_9$) which was statistically at par with 10$^{th}$ October (92.89 days) and 20$^{th}$ December (91.22 days) planting, respectively.

### 4.2.3 Days taken for first flowering

Data recorded on days taken for first flowering is depicted in Table 4.3. It may be inferred from the data that, days taken for first flowering was influenced significantly by different dates of planting. Appearance of first flower was found to be earliest (78.33 days) in 30$^{th}$ November ($T_6$) planted crop followed by 20$^{th}$ November (86.00 days) and 10$^{th}$ November (88.44 days) planting, respectively. However, maximum (97.77 days) days for blooming was observed when planting was done on 30$^{th}$ December ($T_9$) which was statistically at par with 10$^{th}$ October (97.06 days), 20$^{th}$ December (95.03 days) and 20$^{th}$ October (94.00 days) planting, respectively.

### 4.2.4 Number of flowers per plant

The data presented in Table 4.3 envisage that number of flowers varied significantly with different planting dates. Highest (50.16) value for number of flowers per plant was recorded in 10$^{th}$ November planting ($T_4$) followed by 20$^{th}$ November

(46.26) and 30th November (45.50) planting. Whereas, number of flowers per plant was found to be lowest (21.23) in case of 10th October planting ($T_1$).

### 4.2.5 Flower stalk length (cm)

On perusal of data tabulated in Table 4.4, it is evident that date of planting had significant effect on stalk length. Planting on 10th November ($T_4$) produced longest (26.18 cm) flower stalk followed by planting on 30th October (24.61 cm) and 20th November (23.85 cm) planting. Flower stalk length was found to be shortest (17.22 cm) in case of 30th December planting ($T_9$). However, it was at par with 20th and 10th December planting (17.81 cm and 18.40 cm, respectively).

### 4.2.6 Flower diameter

Data recorded on flower diameter is depicted in Table 4.3. It may be inferred from the data that flower diameter was influenced significantly by different dates of planting. Diameter of the flower was found to be maximum (5.90 cm) in 30th October($T_3$) planted crop which was statistically at par with 10th November (5.82 cm), 20th October (5.78 cm) and 10th October (5.72 cm) planting, respectively. However, minimum (3.55 cm) flower diameter was observed when planting was done on 30th December which was statistically at par with 20th December (3.85 cm) planting.

### 4.2.7 Bloom life(days)

The data presented in Table 4.3 show that bloom life of the china aster cultivar Arka Archana varied significantly due to different planting dates. The bloom life of the flower was highest (20.6 days) with 20th November($T_5$) planting which was at par with 30th October and 10th November planting (20.3 days and 20.3 days, respectively) and significantly higher than rest of the treatments. However, the bloom life was found to be lowest in 30th December (14.5 days) planted crop which was significantly lower than rest of the treatments.

### 4.2.8 Flowering duration(days)

Data recorded on days taken on flowering duration is depicted in Table 4.4. It may be inferred from the data that, flowering duration was influenced significantly by different dates of planting. Flowering duration was found to be maximum (41.90 days) in 10th November($T_4$) planted crop followed by 20th November (40.70 days) and 30th

November (39.10 days) planting, respectively. However, minimum (19.90 days) flowering duration was observed in 30th December($T_9$) which was statistically at par with 20th December (21.90 days) and 10th December (25.40 days) planting, respectively.

**Table 4.3: Effect of different dates of planting on days to visible bud initiation, days to bud colour, days to first flowering and number of flowers per plant in china aster cv. Arka Archana**

| Treatment | | Days taken for floral bud initiation (days) | Days to bud showing colour (days) | Days to first flowering (days) | Number of flowers per plant |
|---|---|---|---|---|---|
| $T_1$ | 10th October | 73.84 | 92.89 | 97.06 | 21.23 |
| $T_2$ | 20th October | 71.33 | 90.11 | 94.00 | 25.68 |
| $T_3$ | 30th October | 69.87 | 88.22 | 92.00 | 36.83 |
| $T_4$ | 10th November | 66.74 | 84.66 | 88.44 | 50.16 |
| $T_5$ | 20th November | 68.91 | 82.44 | 86.00 | 46.26 |
| $T_6$ | 30th November | 65.17 | 75.55 | 78.33 | 45.50 |
| $T_7$ | 10th December | 69.27 | 86.43 | 89.99 | 43.27 |
| $T_8$ | 20th December | 72.27 | 91.22 | 95.03 | 36.65 |
| $T_9$ | 30th December | 74.66 | 93.97 | 97.77 | 27.87 |
| Mean | | 62.21 | 78.55 | 81.86 | 33.34 |
| SE(m)± | | 1.64 | 1.56 | 1.59 | 0.76 |
| CD at 5% | | 4.93 | 4.68 | 4.78 | 2.281 |

**Table 4.4: Effect of different dates of planting on length of flower stalk, flower diameter, bloom life and flowering duration in china aster cv. Arka Archana**

| Treatment | | Length of flower stalk (cm) | Flower diameter (cm) | Bloom life (days) | Flowering duration (days) |
|---|---|---|---|---|---|
| $T_1$ | $10^{th}$ October | 19.05 | 5.72 | 19.0 | 32.2 |
| $T_2$ | $20^{th}$ October | 23.50 | 5.78 | 19.6 | 34.0 |
| $T_3$ | $30^{th}$ October | 24.61 | 5.90 | 20.3 | 36.4 |
| $T_4$ | $10^{th}$ November | 26.18 | 5.82 | 20.3 | 41.9 |
| $T_5$ | $20^{th}$ November | 23.85 | 5.48 | 20.6 | 40.7 |
| $T_6$ | $30^{th}$ November | 22.26 | 5.37 | 19.5 | 39.1 |
| $T_7$ | $10^{th}$ December | 18.40 | 4.41 | 15.7 | 25.4 |
| $T_8$ | $20^{th}$ December | 17.81 | 3.85 | 15.0 | 21.9 |
| $T_9$ | $30^{th}$ December | 17.22 | 3.55 | 14.5 | 19.9 |
| Mean | | 19.29 | 4.59 | 16.5 | 29.2 |
| SE(m)± | | 0.50 | 0.10 | 0.30 | 0.59 |
| CD at 5% | | 1.50 | 0.31 | 0.91 | 1.76 |

### 4.3 Effect of different planting dates on post harvest characters

#### 4.3.1 Shelf life of flowers(days)

The data presented in Table 4.5 clearly reveals significant difference in shelf life of flower due to planting dates. Flowers harvested from 30$^{th}$ October planted crop exhibited maximum (3.09 days) shelf life followed by 20$^{th}$ October (2.73 days), 10$^{th}$ October (2.65 days) and 10$^{th}$ November (2.53 days) planting, respectively. However, minimum shelf life of the flowers was recorded with 30$^{th}$ December (1.30 days) planting, which was found to be statistically at par with 20$^{th}$ December (1.33 days) and 10$^{th}$ December (1.36 days) planting, respectively.

#### 4.3.2 Fresh weight of flower (g)

The data (Table 4.5) on the average fresh weight of flower shows significant variation due to different planting dates. The fresh weight of the flower was found to be highest in 20$^{th}$ October (3.73 g) planted crop which was statistically at par with planting on 30$^{th}$ October (3.67 g), 10$^{th}$ November (3.64 g) and 10$^{th}$ October (3.62 g). The lowest (1.60) fresh weight of flower was recorded when the crop was planted on 30$^{th}$ December($T_9$) which was statistically at par with planting on 20$^{th}$ December (1.62 g).

#### 4.3.3 Dry weight of flower (g)

The data compiled in Table 4.5 exhibits decrease in dry weight of flower with delay in planting time. The maximum (0.76 g) dry weight of flower was obtained in 20$^{th}$ October($T_2$) which was statistically at par with 30$^{th}$ October (0.75 g), 10$^{th}$ November (0.74 g) and 10$^{th}$ October (0.73 g). However, minimum (0.35 g) dry weight of flower was recorded in 30$^{th}$ December which was statistically at par with on 20$^{th}$ December (0.36 g) planting.

#### 4.3.4 Vase life(days)

A critical evaluation of the results obtained from the data given in Table 4.5 shows that various planting dates significantly influenced the vase life of the cut flower. Maximum vase life of cut flower was recorded in 30$^{th}$ October (12.83 days) planting which was statistically at par with 20$^{th}$ October (12.50 days) planting and followed by 10$^{th}$ November (12.13 days) and 10$^{th}$ October (12.17 days) planting, respectively.

However, minimum vase life of the flowers was recorded with 30th December (6.70 days) planting, which was found to be statistically at par with 20th December (7.00 days) planting.

**Table 4.5: Effect of different dates of planting on shelf life, fresh weight of flowers, dry weight of flowers and vase life of flowers of china aster cv. Arka Archana**

| Treatment | | Shelf life of flowers (days) | Vase life of flowers (days) | Fresh weight of flower (g) | Dry weight of Flower (g) |
|---|---|---|---|---|---|
| $T_1$ | 10th October | 2.65 | 12.17 | 3.62 | 0.73 |
| $T_2$ | 20th October | 2.73 | 12.50 | 3.73 | 0.76 |
| $T_3$ | 30th October | 3.09 | 12.83 | 3.67 | 0.75 |
| $T_4$ | 10th November | 2.53 | 12.13 | 3.64 | 0.74 |
| $T_5$ | 20th November | 2.46 | 11.93 | 3.50 | 0.70 |
| $T_6$ | 30th November | 2.28 | 10.83 | 3.40 | 0.68 |
| $T_7$ | 10th December | 1.36 | 7.40 | 2.05 | 0.49 |
| $T_8$ | 20th December | 1.33 | 7.00 | 1.62 | 0.36 |
| $T_9$ | 30th December | 1.30 | 6.70 | 1.60 | 0.35 |
| Mean | | 1.97 | 9.35 | 2.68 | 0.56 |
| SE(m)± | | 0.04 | 0.19 | 0.07 | 0.01 |
| CD at 5% | | 0.13 | 0.56 | 0.21 | 0.04 |

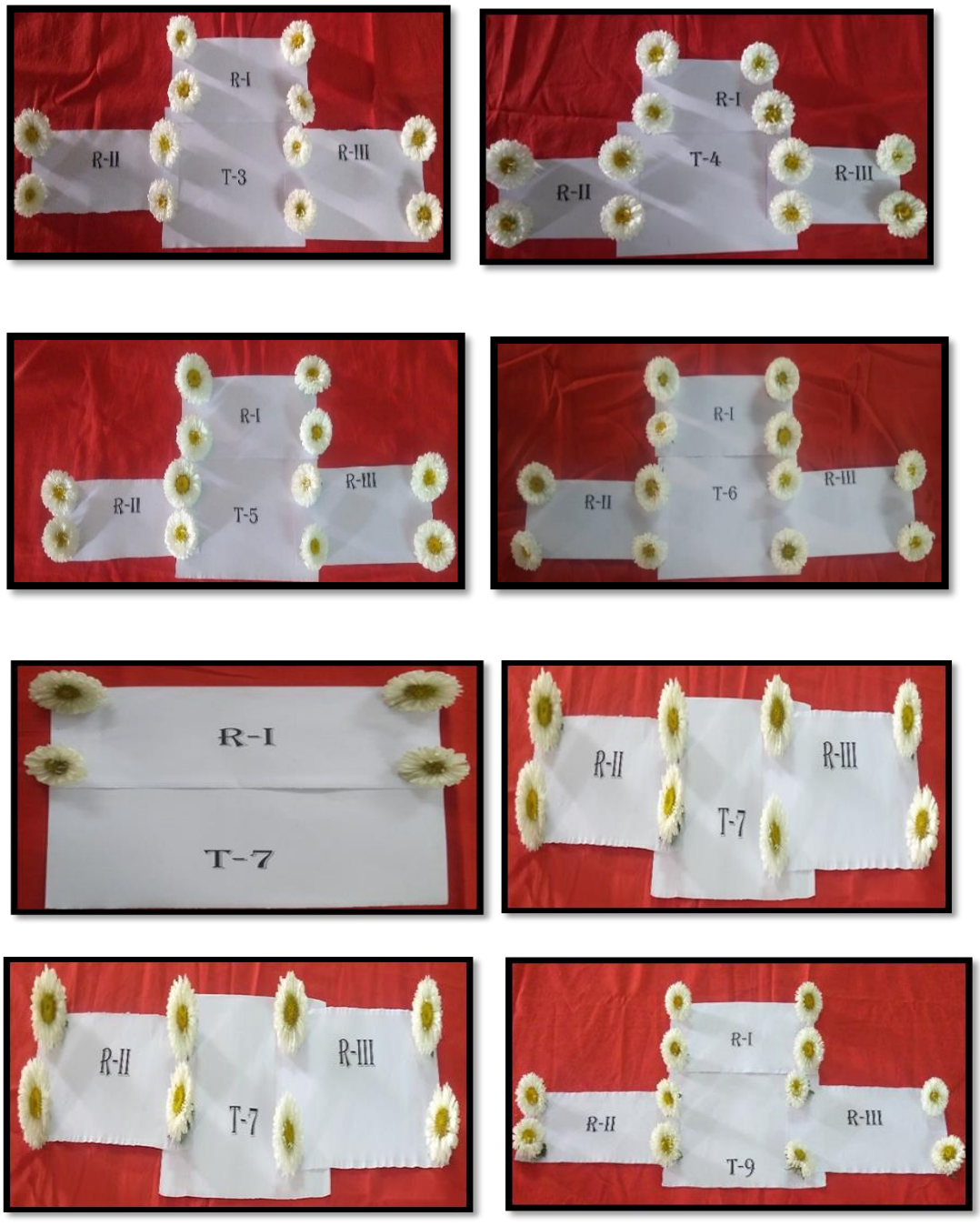


**Fig.4.1 Shelf life of china aster flowers**

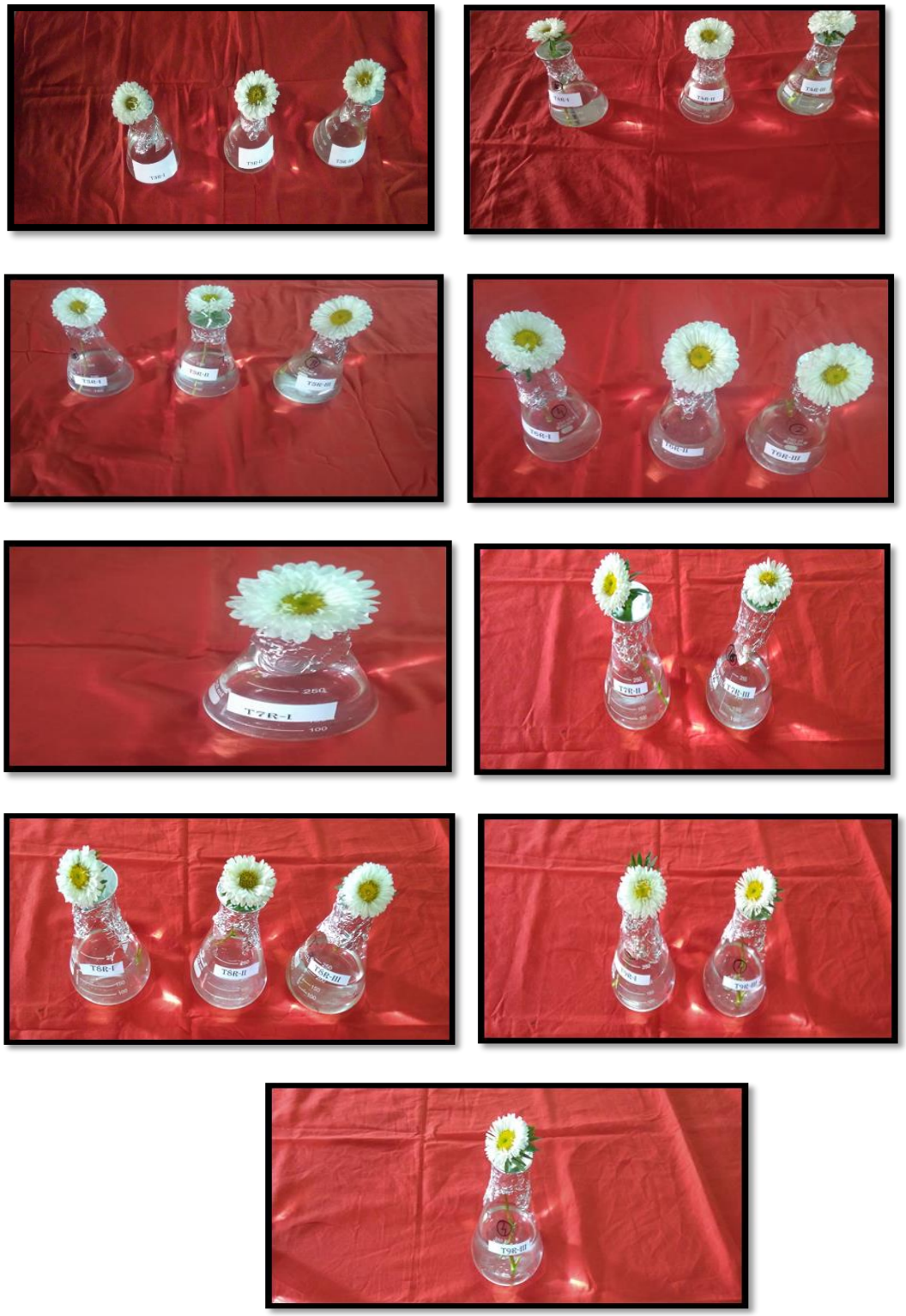


**Fig.4.2 Vase life of china aster flower**

## 5. Effect of different planting dates on seed characters

### 5.1 Thousand Seed Weight

A critical evaluation of the results obtained from the data given in Table 4.6 shows that various planting dates significantly influenced the thousand seed weight. The maximum thousand seed weight (2.51 g) was recorded from early planting time on 10$^{th}$ October ($T_1$) which was statistically at par with 20$^{th}$ October (2.46 g) planting date. However, the minimum thousand seed weight (1.07 g) was recorded from crop planted on 30$^{th}$ December ($T_9$) planting date.

**Table 4.6: Effect of different dates of planting on thousand seed weight of china aster cv. Arka Archana**

| Treatment | | Thousand seed weight (g) |
|---|---|---|
| $T_1$ | 10$^{th}$ October | 2.51 |
| $T_2$ | 20$^{th}$ October | 2.46 |
| $T_3$ | 30$^{th}$ October | 1.93 |
| $T_4$ | 10$^{th}$ November | 1.71 |
| $T_5$ | 20$^{th}$ November | 1.64 |
| $T_6$ | 30$^{th}$ November | 1.65 |
| $T_7$ | 10$^{th}$ December | 1.47 |
| $T_8$ | 20$^{th}$ December | 1.23 |
| $T_9$ | 30$^{th}$ December | 1.07 |
| Mean | | 1.57 |
| SE(m)± | | 0.048 |
| CD at 5% | | 0.14 |

# DISCUSSION

The findings presented in experimental results gave a detail account of the vegetative growth, yield and quality of china aster flowers as influenced by different planting dates under Bhubaneswar conditions. In this chapter, an attempt has been made to discuss the experimental findings to offer possible explanation for the effect of different treatments with regard to different attributes studied in light of work done by other scientists.

**5.1 Effect of different dates of planting on vegetative characters of china aster cultivar Arka Archana**

The present investigation clearly indicates that different planting dates significantly influenced the vegetative characters like plant height, plant spread, number of branches, stem girth, number of leaves, leaf area, fresh weight of leaves and dry weight of leaves. Difference in planting dates in the present investigation induced great variations in all the vegetative characters studied.

The results from the study indicated that the height of the plant in china aster cv. Arka Archana was significantly influenced by the date of planting. At peak flowering stage of crop growth, the plants of 10$^{th}$ November planting were the tallest (42.11cm), followed by those of 20$^{th}$ November (41.17cm) and 30$^{th}$ October (40.41cm) plantings. The plants planted during 30$^{th}$ December (30.32 cm) followed by 20$^{th}$ December (32.9 cm) were dwarf. It may be due to the fact that the plants planted on 10$^{th}$ November, 20$^{th}$ November and 30$^{th}$ October experienced favourable climatic conditions, particularly the day length accompanied by optimum temperature and relative humidity. Less height in early October planting may be due to low light intensity and duration. However, in case of December planting, the day length was optimum but the high temperature restricted the growth of the plants. Beibel (1936) stated that china asters will flower at high temperatures even on the shortest day lengths of the year, but stems produced are short. These results are also in conformation with those of Guruprasad and Reddy (2001) and Gowda (1990) in china aster.

Plant spread and number of branches was influenced significantly by different dates of planting in china aster cv. Arka Archana. The plant spread both in East -West and North -South direction and number of branches increased with delay in planting

date till 20th November thereafter it started decreasing. The number of branches was found to be maximum in the 20th November (15.89) planting while minimum branches were recorded in the 10th October (10.26) planting. The maximum plant spread in E-W and N-S direction was recorded in 30th November (32.82cm and 33.14 cm, respectively) planting, followed by 20th November (32.40cm and 32.84 cm, respectively) and 10th November (30.19cm and 31.70 cm, respectively) planting. The vigorous growth in plants of November plantings was mainly due to increased production of branches. In spite of having optimum day and night temperature throughout the growth stage of 10th October planted crop, it recorded minimum (23.77 cm and 26.19 cm, respectively) plant spread in E-W and N-S direction which may be attributed to short day condition prevailing during the growth stage. Comparatively, reduced growth was observed in plants planted in December because of reduction in number of branches which could be due to their exposure to less congenial weather conditions during their growth period, which coincided with high temperature. Maximum plant spread and branches in November planting have been reported by Sreekanth *et al.* (2006) in African marigold cv. Sierra Orange and Mohanty *et al*. (2015) in African marigold cv. Sirakole.

Stem girth was significantly influenced by different planting dates. The maximum stem girth was recorded in the 10th November(2.70cm) planting, followed by 30th October(2.65cm) and 20th November (2.60cm) which may be due to enhanced synchronisation of vegetative growth of plants with optimum day length and intensity, temperature and relative humidity which favoured the development of plants. The plants planted on 10th October recorded minimum (2.18 cm) stem girth which may be attributed to low light intensity and duration in winter months. These findings are corroborated by Guruprasad and Reddy (2001) in china aster.

The number of leaves produced per plant increased with delay in planting from 10th October to 20th November thereafter the number was reduced in December planting. The number of leaves developed were maximum in 30th November (292.93) planting, followed by 20th November (290.43) and 10th November (273.57) planting. The minimum (116.80) number of leaves in the plant was recorded in the 10th October planting. The increased number of leaves on 20th November planting date could be directly correlated to the fact that plants had increased number of leaf bearing capacity due to increased number of branches per plant. The plants planted in December and October produced less number of leaves, probably due to the fact that they did not

experience favourable growing conditions during their grand vegetative growth period. The results are in conformity with the findings of Patil *et al.* (2005) and Sharma *et al.* (2015) in Gaillardia and Mohanty *et al.* (2015) in African marigold. Gowda (1990) also recorded increased number of leaves in china aster with November planting under Bangalore conditions.

Planting of china aster at different dates resulted in significant difference in leaf area. Significantly higher leaf area per plant was recorded in 20$^{th}$ November (32.99 cm$^2$) planting date as compared to other planting dates. The increase in leaf area in 20$^{th}$ November planted crop can be attributed to more number of leaves, which in turn might have promoted more uptake of nutrients, thereby, leading to maximum leaf area and more photosynthetic area. The minimum leaf area was recorded in the 30$^{th}$ December (21.44 cm$^2$) planting. The reason for this observation is attributed to high temperature during the growth and development of the crop. These observations are in alignment to Hematzadet *et al.* (2007) findings, which demonstrates that the time of planting might have significant effect on leaf area of the plants. Similar trend has been noticed in the weight of fresh and dry leaves, where the planting dates significantly influenced these characteristics. The fresh and dry weight of leaves was highest in 30$^{th}$ October (6.87 g and 1.28 g, respectively) planting. This might be due to the presence of more number of leaves coupled with high leaf area which would have significantly helped in enhanced development of the leaves, thus increasing the fresh and dry weight of the leaves. The lowest fresh and dry weight of leaves was recorded in the 30$^{th}$ December (4.28 g and 0.81 g, respectively), the reason for which may be attributed to the increasing temperature during the growth period of the crop, in comparison from other planting dates, as a result of which, number of leaves and leaf area was least, thus, reduced the fresh and dry weight of leaves.

## 5.2 Effect of different dates of planting on floral characters of china aster cultivar Arka Archana

Days taken to visible flower bud initiation, flower bud showing colour and days taken to flowering also differed due to different planting dates. Mean days taken to visible flower bud initiation, flower bud showing colour and days taken to flowering were observed earliest (65.17 days, 75.55 days and 78.33 days, respectively) with 30$^{th}$ November planting followed by 20$^{th}$ November (68.91days, 82.44 days and 86.00 days,

respectively) and 10th November (66.74days, 84.66 days and 88.44 days, respectively) planting dates. However, these flowering parameters were most delayed (74.66 days, 93.97 days and 97.77 days, respectively) in 30th December planting. Exposure to high day and night temperature during the time of initiation of reproductive phase in 30th December planted crop might have resulted in delay of these parameters. The earliness in floral meristem differentiation may be attributed to the fact that plant requirement of temperature for formation of flower bud was fulfilled by November planting dates and the plants might have attained the juvenile phase required for flower bud formation during that favourable period. Similar results were reported by Kumar *et al.* (2012) and Rao and Reddy (2002) in African marigold.

The number of flowers, an important floral characteristic, was significantly influenced by the date of planting. The maximum (50.16) number of flowers in the plant was recorded for 10th November planting date, followed by 20th November (46.26) and 30th November (45.50) planting. However, the minimum (21.23) number of flowers per plant was recorded in 10th October planting. It may be attributed to the fact that 10th November planted crop experienced congenial climatic conditions, had luxurious vegetative growth in terms of number of branches, plant spread (E-W and N-S), number of leaves and leaf area, which enabled them to produce increased amount of photosynthates and in turn resulted in more flower yield. Less number of flower in 10th October planting might be due to less light duration which have resulted in fewer number of branches per plant, there by decreased the number of flowers per plant. Similar findings were recorded by Balaji and Kulakarni (2010) in Chrysanthemum.

Different planting dates sequence significantly influenced the flower stalk length. The maximum (26.18cm) flower stalk length was recorded in the 10th November planting, followed by 30th October (24.61cm) planting. The probable reason for this influence might be accredited to the increased photosynthates activity underpinned by adequate temperature and light duration which ultimately increased the stalk length of flower. However, the minimum (17.22cm) flower stalk length was recorded in 30th December, followed by 20th December(17.81cm) and 10th December (18.40cm) plantings respectively, and the reason is attributed to low light duration during initial vegetative growth stage as compared to November and October planting dates and high temperature at later stage thatled to decrease in the photosynthates, thus potentially decreasing the stalk length of flower. (Handley *et al,* 1995).

Diameter of the flower was significantly influenced by different dates of planting. The maximum (5.90cm) flower diameter was recorded in 30th October which was at par with 10th November (5.82 cm) planting. The best fitting probable reason for this trend might be due to the enhanced crop exposure to most favourable climatic conditions for longer duration which resulted in increased photosynthesis and translocation of photosynthates to the sink (flower) there by increased the flower size. The minimum flower diameter was recorded in 30th December (3.55cm), followed by 20th December(3.85cm) and the reason can be attributed to exposure of crop to higher temperature in comparison to other planting dates. The increase in temperature during the later stages of plant development have deleterious effect on plant quality, which in turn would reduce flower size (Pearson *et al*., 1995). Flower size variations due to planting dates have been reported by Samantaray *et al.* (1999) in African marigold and Sharma *et al.* (2013) in (*Helichrysam bracteatum*.).

Bloom life of flowers was significantly influenced due to different dates of planting. The maximum (20.6 days) mean bloom life was observed on 20th November planting followed by 30th October and 10th November (20.3 days and 20.3 days, respectively). This may be due to 20th November planted crop get congenial climatic conditions like adequate temperature and light duration ultimately get more time for wilting of the flowers. The minimum (14.5 days) mean bloom life observed on 30th December planting. This may due to the high temperature at the time of flowering, which ultimately get less time for wilting of the flowers. (Adams *et al,* 1995)

### 5.3 Effect of different dates of planting on post harvest characters of china aster cultivar Arka Archana

Flowering duration also exhibited significant differences amongst different planting dates. The maximum (41.90days) mean flowering duration was observed when planting was done on 10th November which was at par with 20th November planting (40.70 days). However, minimum (19.90 days) mean flowering duration was recorded with 30th December planting. Enhancement in flowering duration can be attributed to the optimum temperature and day length throughout the flowering period. The increase in flowering duration can also be due to more number of flower bearing shoots in November planted crop. Minimum flowering duration with 30th December planting can be attributed to high temperature at the time of flowering which might have resulted in

quicker opening of the flowers thereby reducing the flowering duration. These findings are corroborated by Cevallos and Reid (2000) in *narcissus.*

The fresh weight and dry weight of flowers was significantly influenced by the different dates of planting. The maximum (3.73g and 0.76 g respectively) fresh and dry weight of flowers was recorded in the 20$^{th}$ October planting. Exposure to most favourable climatic conditions for longer duration might have resulted in increased photosynthetic activity and more translocation of photosynthates towards the sink (flower), which in return, resulted in maximum fresh and dry weight of the flowers in 20$^{th}$ October planting. The minimum (1.60g and 0.35g respectively) fresh and dry weight of flowers was recorded with 30$^{th}$ December which was at par with 20$^{th}$ December planting (1.62g and 0.35g respectively). Reduction in fresh and dry weight of flower in December planting may be due to high temperature. Increased carbohydrate consumption by the respiration through various parts (i.e., roots, flower buds and leaves) may be responsible for the decrease in flower dry weight at higher temperatures. High evapotranspiration rate at high temperature could be another factor affecting the decrease in flower weight. (Shin *et al*., 2001)

The shelf and vase life of flowers was significantly influenced by adopting different dates of planting. Both shelf and vase life decreased with delay in planting. The maximum (3.09 days and 12.83 days, respectively) shelf life and vase life of flowers was recorded on 30$^{th}$ October. It might be due to the fact that low temperature after harvesting of flowers in this planting date aided in reducing the respiration rate of the flower thereby resulting in slow opening and higher vase and shelf life. On the contrary, the minimum shelf and vase life of flowers was recorded for 30$^{th}$ December (1.30 days and 6.70 days, respectively) which may be due to high prevalent temperatures during post-harvest time which increased the rate of respiration thus increasing the wilting of flowers more quickly. These findings are in line with those of Tihana (2003) in rose and carnation, of UshaBala *et al.,* (2002) and Sheikh and Jhon (2005) in gladiolus.

## 5.4 Effect of different dates of planting on seed characters of china aster cultivar Arka Archana

Different planting time significantly influenced the thousand seed weight. The maximum thousand seed weight (2.51g) was recorded from early planting time on 10$^{th}$

October which was at par with 20th October planting (2.46g). However, the minimum thousand seed weight (1.07g) was recorded from crop planted on 30th December. This might be attributed to the climatic condition prevailing during the seed filling stage. Therefore, early planting results in well-filled seeds compared to late plantings. In addition, the seed filling period of late planting dates was significantly shorter than early planting time. Further, cool temperature for flower development in early planting time and subsequent favourable temperature could have increased the final seed weight on early planting dates. High atmospheric temperature might have caused the early drying of flowers before attaining sufficient maturity, thereby resulting in low seed weight in china aster. (Pearson *et al.*,1995)

# SUMMARY AND CONCLUSION

The present investigation on "Effect of Different Dates of Planting on Growth and Flowering of China aster [*Callistephus chinensis* (L.) Nees] cv. Arka Archana" was carried out in form of a pot experiment at the Department of Floriculture and Landscaping, College of Agriculture, OUAT, Bhubaneswar, Odisha during, 2017 to May, 2018. The experiment was conducted in form of Completely Randomised Design (CRD) involving one variety of china aster cv. Arka Archana with three replications and nine treatments. The treatments consisted of Different date of planting that is $10^{th}$ October, $20^{th}$ October, $30^{th}$ October, $10^{th}$ November, $20^{th}$ November, $30^{th}$ November, $10^{th}$ December, $20^{th}$ December and $30^{th}$ December.

The data on different parameters like plant height (cm), number of leaves per plant, number of branches per plant, spread of the plant E-W and N-S (cm), leaf area ($cm^2$), stem girth (cm), fresh weight of leaves (g), dry weight of leaves (g), days taken for floral bud initiation, days to bud showing colour, days taken for first flowering , number of flowers per plant, flower diameter (cm) ,length of flower stalk (cm), fresh weight of flower (g), dry weight of flower (g), shelf life of flower (days),Vase life (days), Bloom life (days), duration of flowering (days) and Thousand seed weight (g) were recorded from all the plants for each variety and replication.

**Effect of different planting dates on vegetative growth of china aster cv. Arka Archana**

1. Plant height in china aster was significantly influence by different dates of planting. The plant height was observed to be maximum (42.11cm) when the planting was done on $10^{th}$ November ($T_4$) while it was minimum (30.32 cm) when the planting was done on $30^{th}$ December($T_9$).
2. Plant spread of china aster in N-S and E-W direction was influenced by different dates of planting. The maximum plant spread in E-W direction(32.82cm) when planting was done in $30^{th}$ November($T_6$) and minimum plant spread in E-W direction(23.77cm) when planting was done on $10^{th}$ October ($T_1$). The plants spread in N-S direction was maximum (33.14cm) when planting was done on $30^{th}$ November ($T_6$) and minimum plant spread in N-S direction (26.19cm) when planting was done in $10^{th}$ October ($T_1$) planting.

3. Stem girth of china aster plant was significantly influenced by different date of planting time. The maximum stem girth (2.70 cm) was observed in 10th November ($T_4$) planting and minimum stem girth (2.18 cm) was observed in 10th October ($T_1$) planting.
4. Significant influence of planting date was observed on number of leaves in the china aster plant. The number of leaves per plant was observed to be maximum (292.93) under 30th November ($T_6$) planting and minimum number of leaves per plant (116.80) was observed 10th October ($T_1$) planting.
5. Leaf area of china aster plant was significantly influence in due to different planting dates. The leaf area was observed to be maximum (32.99 $cm^2$) under 10th November ($T_4$) planting while it was minimum (21.44 $cm^2$) under 30th December ($T_9$) planting.
6. Number of branches per plant was significantly maximum (15.89) when planting was done in 20th November ($T_5$) while it was minimum (10.26) when planting was done in 10th October ($T_1$) planting.
7. Fresh weight of leaves was significantly influenced due to different date of planting. The fresh weight of leaf was observed to be highest (6.87g) when planting was done in 30th October ($T_3$) while it was Lowest (4.28 g) when planting was done in 30th December ($T_9$).
8. Dry weight of leaves was significantly influenced by planting dates. The maximum dry weight of leaves (1.28 g) was observed with 30th October($T_3$) planting while it was minimum (0.81 g) with 30th December($T_9$) planting.

**Effect of different planting dates on floral characters of china aster cv. Arka Archana**

1. Days taken for visible bud formation in china aster plant was significantly influenced by planting dates. The days to visible bud formation was observed earliest (65.17 days) in 30th November($T_6$) planting while it was most delayed (74.66 days) in 30th December($T_9$) planting.
2. Significant of planting dates was observed on days to bud showing colour in china aster plant. The days to bud showing colour was earliest (75.55 days) in 30th November($T_6$) planting while it was maximum (93.97 days) in 30th December($T_9$) planting.

3. The days taken for first flowering was significantly influenced by different dates of planting. The minimum days taken for first flowering in china aster plant (78.33 days) when planting was done in 30th November($T_6$) while it was maximum (97.77 days) when planting was done on 30th December($T_9$).
4. The number of flowers significantly influenced the different dates of planting. The maximum number of flowers per plant (50.16) was observed when planting on 10th November ($T_4$) while it was minimum (21.23) on 10th October($T_1$) planting.
5. Length of flower stalk was significantly influenced by different dates of planting. The flower stalk was maximum (26.18 cm) when planting was done in 10th November ($T_4$) while it was minimum (17.22 cm) when planting was done in 30th December planting ($T_9$).
6. The flower diameter was significantly influenced by different dates of planting. The flower Diameter was observed to be maximum (5.90 cm) on 30th October($T_3$) planting while it was minimum in minimum (3.55 cm) in 30th December($T_9$).
7. Bloom life of flower was significantly influenced due to different dates of planting. The maximum (20.6 days) bloom life of flower was observed when planting on 20th November ($T_5$) while it was minimum (14.5 days) when planting on 30th December($T_9$).
8. Flowering duration was significantly influenced the different dates of planting. The maximum (41.90 days) mean flowering duration was observed when planting was done on 10th November($T_4$) while it was minimum(19.90days) in 30th December($T_9$) planting.

**Effect of different planting dates on post harvest characters china aster cv. Arka Archana**

1. The shelf life of flowers was significantly influenced due to planting dates. The shelf life of flowers was maximum (3.09 days) when planting was done in 30th October($T_3$) while it was minimum (1.03 days) while planting was done in 30th December($T_9$) planting.
2. The fresh weight of flower was significantly influenced due to different planting dates. The fresh weight of the flower was maximum (3.73 g) when planting was

done in 20th October($T_2$) while it was minimum(1.60g) when planting was done in 30th December($T_9$).

3. The dry weight of flower was significantly influenced due to different dates of planting. The dry weight of flower was maximum(0.76g) on 20th October ($T_2$) while it was minimum(0.35g) when planting was done on 30th December ($T_9$).
4. Significant vase life of flowers in china aster plant was influenced due to different date of planting. The Maximum vase life of cut flower (12.83 days) was observed on 30th October($T_3$) planting while it was minimum (6.70 days) was observed on 30th December($T_9$) planting.

**Effect of different planting dates on seed characters of china aster cv. Arka Archana**

**1.** Different planting dates significantly influenced thousand seed weight. The maximum thousand seed weight(2.51g) was observed on 10th October($T_1$) while minimum thousand seed weight (1.07g) was observed on 30th December($T_9$).

## CONCLUSION

From the present studies, following conclusions have been drawn which may be beneficial and economical for the commercial cultivation of China aster under Bhubaneswar conditions of Odisha.

Among the nine planting dates, 10th November, 2017 planting was found to be the most suitable time because highest number of flowers per plant and desirable growth with respect to all parameters which performs well in china aster cv. Arka Archana was recorded under this treatment.

# REFERENCES


Aamir NSG, Anjum MA and Farrukh N. 2009. Effect of various sucker sizes and planting timeson growth and flower yield of chrysanthemum, *Pakistan Journal of Agricultural Sciences*, **46** (1):7-12.

Adil M, Ahmad W, Ahmad KS, Shafi J, Shehzad MA, Sarwar MA, Salman M, Ghani M I and Iqabal M. 2013. Effect of different dates on growth and development of *Gladiolus grandiflorus* under the ecological conditions of Faisalabad, Pakistan, *Universal Journal of Agricultural Research,* **1**(3): 110-117.

Ahmad I, Khattak AM, Ara N and Amin NU. 2011. Effect of planting dates on the growth of gladiolus corms in Peshawar, *Sarhad Journal of Agriculture*, **27**(2): 195-199.

Akpinar E and Bulut Y. 2011. A study on the growth and development of some gladiolus (*Gladiolus L.*) varieties planted in different time under the ecological conditions of Erzurum, *African Journal of Agricultural Research*, **6**(13): 3143-3148.

Alkurdi M, Hassan K and Supuka J. 2015. Influence of planting date on growth, stem number formation and flower appearance of *Matthiola incana L*. Thaiszia, *Journal of Botany*, **25**(1): 29-39.

Anil KS, Udit K and Arun K. 2015. Effect of planting date and spacing on performance of African marigold (*Tagetes erecta Linn*) cv. Pusa Narangi Gainda under North Bihar agro-ecological conditions, *International Journal of Forestry and Crop Improvement*,**6**(1):16-20.

Anjum MA, Nawaz A, Shaheena G and Farrukh N. 2007. Effect of various sucker sizes and planting times of flowering and vase life of chrysanthemum, *Pakistan Journal of Agricultural Science,* **44** (3): 475-480.

Bagde MS, Golliwar VJ, Yadgirwar BM and Wankhede MN. 2009. Effect of planting dates on flower quality and yield parameters of gladiolus, *Journal of Soil and Crops,* **19**(2): 351-354.

Balaji SK and Reddy BS 2010. Effect of date of planting on yield and quality of chrysanthemum (*Chrysanthemum morifolium Ramat*) cv. Saraval, *Karnataka* j*ournal of Agricultural Science*,**23**(2): 402-404.

Berimavandi AR, Hashemabadi D, Ghaziani MVF and Kaviani B. 2011. Effects of plant density and sowing date on the growth, flowering and quantity of essential oil of *Calendula officinalis* L, *Journal of Medicinal Plants Research*, **5** (20): 5110-5115.

Chauhan P. 2011. Effect of planting time and spacing on growth and flowering of marigold. M.Sc. Thesis submitted to Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (H.P).

Desai B L. 1967. Seasonal flowers, ICAR. New Delhi, **237**p.

Deshmane S, Khiratkar SD, Panchbhai DM, Prarthana J, Smita P and Tayade BB. 2012. Effect of planting time and spacing on quality and yield of French Marigold, *Journal of Soil and Crops*, **22** (1): 172-176.

Dhatt KK and Kumar R. 2010. Effect of planting time and growth regulators on growth and seed quality parameters of Larkspar, *Journal of Ornamental Horticulture*, **13**(1): 50-54.

Dhatt KK 2015. Effect of planting time on plant growth and seed yield of flowering annuals, *Indian. journal. Com*, **52**(4): 52-55.

Dhawle DU, Damke MM and Panchbhai DM. 2003.Effect of planting dates on growth, flowering and seed yield of China Aster, *PKV Research Journal*, **25** (1): 35-38.

Dhemre JK, Shrisath NS and Naphade AS. 1997. Effect of different planting densities and season on flowering of China aster, *Journal of Soils and crops*, **7** (2): 136-138.

Dilta BS, Gupta YC and Sharma P. 2007. Effect of different planting dates on performance of China aster (*Callistephus chinensis Nees*.), *Asian Journal of Horticulture*, **2** (2): 245-248.

Ghosh P and Pal P. 2008. Performance of *Tagetes erecta* Linn. cv. Siracole as influenced by planting time and spacing under West Bengal conditions, *Natural Product Radiance*, **7**(5): 437-443.

Goldsberry KL, Keil-gunderson L and Silver R. 1988. Scheduling single stem Japanese cut asters Part I. Winter and spring responses of Japanese cut asters, *Research Bulletin Colorado Greenhouse Growers Association,* **462**: 1-3.

Gomez KA and Gomez AA. 1984. Statistical procedures for agricultural research, 2nd edition, pp. 680, John wiley and sons, Newyork.

Gowda JVN. 1990. Effect of planting dates on growth and flower production of China aster [*Callistephus chinensis* L. Nees], *Mysore Journal of Agricultural Sciences,* **24** (1): 72-78.

Gupta S. 2005. Evaluation of cultivars, planting dates and GA3 on flowering and seed yield of China aster (*Callistephus chinensis* L. Nees). M. Sc. thesis, Dr. Y. S. Parmar University of horticulture and Forestry, Nauni, Solan (H.P.)

Gurav SB, Singh BR, Desai UT, Katwate SM, Kakade DS, Dhane AV and Kanade VD. 2005. Influence of planting time on the yield and quality of tuberose, *Indian Journal of Horticulture,* **62**(2): 216-217.

Guruprasad G and Reddy BS. 2001. Influence of planting dates on growth and flower yield of China aster, *Karnataka Journal of Agriculture Sciences,* **14** (3): 843-845.

Hazarika K, Preethi H, Paswan L and Kalitha P. 2003. Comparision of dates of planting and growing conditions on growth and flowering of African marigold (*Tagetes erecta L.*), *National Symposium on recent Advances in Indian Floriulture*., pp.**13**.

Hughar AH, Prasanna MP, Patil MG, Reddy PN and Pampanna Y. 2003. Performance of China aster varieties at different dates of planting under north-eastern dry zone of Karnataka, *Abstracts, National Symposium on recent Advances in Indian Floriculture,* **11.**

Ismail RF, Kandeel AM, Ibrahim AK and Omer EA. 2013. Effect of planting date and plant spacing on growth, yield and essential oil of Mexican marigold (*Tagetes lucida L.*) cultivated in Egypt, *Journal of Applied Sciences Research,***9**(1):330-340.

Jain R. and Gupta YC. 2003. Effect of different dates of planting and sources of nitrogen on flower and seed yield in African marigold (*Tagetes erecta L.*) cv. 'Pusa Narangi' Gainda, *Abstracts, National Symposium on recent Advance in Indian Floriculture,* **29**.

Janakiram T. 2006. China aster, Advances in ornamental Horticulture, *S.K. pointer pubishers, Jaipur,* pp.**359.**

Joshna K and Pal P. 2015. Effect of planting date on growth, development, aerial biomass partitioning and flower productivity of marigold (*Tagetes erecta L.*) cv. Siracole in Indo-gangetic plains of West Bengal, *Journal of Applied Horticulture,***17** (2):151-154.

Karade R. 2011. Response of different cultivars of china aster (Callistephus chinensis L. Nees) to Gibberellic Acid, M.Sc. (Hort.) thesis, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, College of Horticulture, Mandsaur (MP).

Kaushal S, Dilta BS, Chaudhary SV, Sharma BP and Gupta YC. 2014. Effect of planting dates on growth and flowering of China aster *Callistephus chinensis* (L) Nees, *International Journal of Farm Science*, **4**(1): 60-71.

Khan FU, Jhon AQ, Khan FA and Mir MM. 2008. Effect of planting time on flowering and bulb production of tulip under poly house conditions in Kashmir, *Indian Journal of Horticulture*, **65**(1): 79-82.

Kocira A, Laskowska H, and Kocira S. 2015. Yield of corms of *Acidanthera bicolor* var. murielae perry depending on the date and depth of planting corms, *Acta Agrobotanica*, **8** (1): 89-96.

Kour (2009). Impact of date of planting on growth, flowering and spike yield of Gladiolus Cv. White prosperity, *International Journal of Agricultural Science,* **5** (2): 651-652.

Kulkarni BS and Reddy BS. 2008. Effect of different dates of planting on growth and flowering of chrysanthemum, *Ornamental Horticulture,* **11**(3): 177-180.

Kumar A, Kumar J, Mohan B, Singh JP, Rajbeer and Ram N. 2012. Studies on the effect of plant growth regulators on growth, flowering and yield of African

marigold (*Tagetes erecta L.)* cv. Pusa Narangi Gainda, *Annals of Horticulture*,**5**(1): 47-52.

Kumar VK, Bezu T and Bekele A. 2015. Response of varieties and planting dates on growth and flowering of gladiolus (*Gladiolus grandiflorus* L.) under the ecological conditions of Haramaya University, *Eastern Ethiopia, Journal of Horticultural Forest,* **7**(5): 112-117.

Lakshmi R, Pandey K, Dogra S, Laishram N, Bhat D, Singh A and Jamwal S. 2014.Studies on effects of planting dates and spacing in African marigold (*Tagetes erecta L*.), *Progressive Horticulture*, **46**(1): 149-152.

Laurie A, Kiplinger DC and Nelson KS. 1958. Commercial flower forcing, *MC Graw-Hill Book co. Inc, Newyork.*

Laxmi P and Pratap M. 2011. Effect of dates of planting on growth, flowering and yield of different chrysanthemum (*Dendranthema grandiflora L.)* cultivars, *Research on Crops*,**12**(3):813-816.

Mirshekari M, Hosseini NM, Amiri R and Zandvakili OR. 2012. Study the effects of planting date and low irrigation stress on quantitative traits of spring sunflower (*Helianthus annuus* L.), *Romanian Agricultural Research*, **29**: 189-199.

Mohanty CR, Behara TK and Parhi R. 2015. Effect of planting dates and pinching on growth and flowering in African marigold (*Tagetus erecta L.)* cv. Sirakole, *The Asian Journal of Horticulture*,**10** (1):95-99.

Mor VS, Beniwal BS, Deswal DP and Dahiya BS. 2006. Impact of crop seasons on quality seed production in marigold (*Tagetes spp.), Research on Crops*, **7**(3): 792-797.

Muhammad Z, Wazir F K and Goyar A. 2005. Influence of planting dates on the floral characteristics of Gladiolus under the climatic conditions of Peshawar, *Sarhad Journal of Agriculture*, **21**(4): 569-575.

Nagaraju D, Reddy BS, Patil RT, Gangadharappa PM and Kulakarni BS. 2004. Effect of dates of planting on flowering and flower quality of China Aster *(Callistephus chinensis Ness.)* cv. 'Kamini', *Journal of Ornamental Horticulture*, **7** (3-4): 132-134.

Nato G and Romeno D. 1989. Timing of snapdragon (*Antirrhinum majus* L.) in cold greenhouse cultivation, *Acta Horticulturae*, **246**: 175-181.

Nawaz A, Gul S, Anjum NA and Naveed F. 2009. Effect of various sucker sizes and planting times on growth and flower yield of chrysanthemum, *Pakistan Journal of Agricultural Sciences*, **46** (1): 712.

Nijasure SN and Ranpise SA. 2005. Effect of date of planting on growth, flowering and spike yield of gladiolus cv. 'American Beauty' under Konkan conditions of Maharashtra, *Haryana Journal of Horticultural Sciences*, **34**(1/2): 73-74.

Padma M, Sreekanth P, Chandrasekhar R and Madhulety TY. 2007. Effect of planting time, spacing and nitrogen levels on flowering of African marigold (*Tagetes erecta*) cv. Sierra orange, *Journal of Research ANGRAU,* **35**(1):15-21.

Panchbhai DM, Deshmane S, Khiratkar SD, Jibhakate P, Pakhale S and Tayade BB. 2012. Effect of planting time and spacing on quality and yield of French marigold, *Journal of Soils and Crops*, 2012. **22**(1):172-176.

Patil JD, Dhat NR, Chougle BB and Patil BA. 1987. Flower and seed yield in China aster. (*Callistephus chinensis L.)* cv. 'Ostrich Plume Blue' as influenced by planting dares and planting density, *Current Research Reporter*, **3** (2): 46-48.

Pattanaik MR, Tarap RK and Pal P. 2010. Effect of planting time and plant density on growth and quality of cut flower production of chrysanthemum (*Dendranthema grandiflora*) cv Kenroku Kangiku under polyshade in West Bengal, *Environment and Ecology,* **28**(3):1451-1454.

Pavani U, Pratap M and Rao M. 2014. Influence of planting dates and vase chemicals on post harvest quality of gladiolus (*Gladiolus grandiflorus* L.), *The Journal of Research ANGRAU,* **42**(2): 43-45.

Pramila CK, Prasanna KPR, Jayanthi R and Ramachandra R. 2011. Seed production in marigold with special reference to seasons, *International Journal of Agricultural Sciences*, **7**(2): 400-403.

Prasanna VL, Mohanty C, Beura S and Thriveni V. 2016. Effect of different growing seasons on bloom life of flowers in Asiatic lily hybrids, *International Journal of Farm Sciences*, **6**(2): 137-141.

Pratibha C, Gupta YC, Dhiman SR and Gupta RK. 2014. Effect of planting dates and spacing on growth and flowering of African marigold cv. Pusa Narangi Gainda, *Annals of Horticulture,* **7**(2): 119-122.

Raju DVS, Singh KP and Swaroop K. 2006. Performance of French marigold *(Tagetes patula Linn.)* in different planting months under Delhi conditions, *Journal of Ornamental Horticulture,* **10** (2): 215-217.

Rajyalakshmi R and Rajasekhar M. 2014. Effect of different growth regulators and pinching on growth and flowering of African marigold (*Tagetes erecta L.)* cv. Pusa Narangi Gainda in different dates of planting, *The Journal of Research ANGRU,***42**(1):52-54.

Rakesh C, Mathad V, Yakaranahal BS and Deshpande VK. 2008. Influence of planting dates and picking stages on seed yield and quality in aster genotypes, *Indian Journal of Agricultural Research,* **42** (3): 224-227.

Ramesh K and Singh V. 2008. Effect of planting date on growth, development, aerial biomass partitioning and essential oil productivity of wild marigold (*Tagetes minuta*) in mid hills of Indian western Himalaya, *Industrial crops and products,* **27**: 380-384.

Seghatoleslami MJ and Mousavi GR. 2009. The effects of sowing date and plant density on seed and flower yield of pot marigold (*Calendula officinalis L*.), *Acta Horticulturae,* **826**: 371-376.

Sheela VL. 2008. China aster, In: Flowers for Trade, Horticultural Science Series, Vol-10, New India Publishing Agency, New Delhi, pp. **113.**

Sharma AK, Gupta YCRS and Sud G. 2003. Effect of planting time on growth and flower yield of marigold (*Tagetes erecta*) under sub-montane low hills of Himachal Pradesh, *Indian Journal of Agricultural Sciences,* **73**(2):94-96.

Sharma MK, Parmar PB and Singh A. 2015.Effect of planting time and nitrogen on growth, flowering and yield of gaillardia (Gaillardia pulchella Fouger) cv. Double Yellow under south Gujarat climatic conditions, *International Journal of Botany and Reasearch*,**5**(4):1-6.

Sharma R. 2012. Effect of seed priming and planting dates on growth and flowering of Pansy (Viola × wittrockiana Gams.). M. Sc. thesis, Dr. Y. S. Parmar University of horticulture and Forestry, Nauni, Solan (H.P.).

Sheikh MQ and Jhon AQ. 2005. Response of planting dates and genotypes on vegetative and floral characters in gladiolus, *Joumal of Ornamental Horticulture*, **8**(3): 219-221.

Smita P, Golliwar VJ, Panchabhai DM, Prarthana J and Sonali D. 2012. Response of African marigold varieties to different planting time on growth and yield under vidarbha conditions (Maharashtra), *Journal of Soils and Crops*,**22**(1):183 -187.

Sreenivasulu GB, Balaji SK, Reddy BS and Adiga JD. 2004. Yield and quality parameters as influenced by seasons and genotypes in China aster, *Journal of Ornamental Horticulture***,7** (3-4): 122-124.

Sreekanth P, Padma M, Chandrashekhar R and Madhulety TY. 2006. Effect of planting time, spacing and nitrogen levels on flowering of African marigold (*Tagetes erecta*), *Journal of Ornamental Horticulture***, 9**(2): 97-101.

Sudhakar M and Kumar SR. 2014. Studies on the influence of planting season and weather parameters on yield parameters of two different varieties of *G. grandiflorus L*, *Plant Archives*, **14**(2): 951-954.

Taye MG, Negera SA, Iticha G, and Tadese FO. 2015. A study of the performance of two prominent cultivars of Gladiolus grandiflorus and to find the effect of three planting dates on growth, production and quality of flowers, *African Journal of Wood Science and Forestry*, **3**(7): 165-169.

Thakur T, Dhatt KK and Ahmed S. 2015. Effect of planting time on growth and flowering of Gladiolus, *International journal of current research and academic review***, 3**(5): 145-152.

Thokchom R and Singh UC. 2015. Effect of time and depth of planting on growth, flowering and yield of tuberose cv. Single, *Indian Journal of Horticulture*,**72**(4): 581-585.

Thomson JR. 1979. An Introduction to Seed Technology, Leonard Hill, Glasgow.

Yadram M, Sirohi HS, Tomar BS and Sanjay K. 2015. Effect of planting time, spacing and pinching on growth and seed yield traits in African marigold (*Tagetes erecta*) cv. Pusa Narangi Gainda, *Indian Journal of Agricultural Sciences*,**85** (6): 797–801.

Zubair M, Ayub G, Rab A, Amin NU, Ahmad M and Ara N. 2013. Pre flowering growth of gladiolus in response to staggered planting, *Pakistan Journal of Botany*, **45**(4): 1329-1338.