*Int.J.Curr.Microbiol.App.Sci* (2022) *11*(02): 297-305

*International Journal of Current Microbiology and Applied Sciences*
***ISSN: 2319-7706*** **Volume 11 Number 02 (2022)**
Journal homepage: http://www.ijcmas.com

**Original Research Article** https://doi.org/10.20546/ijcmas.2022.1102.034

# Effect of Different Plant Growth Regulators on Seed Germination and Growth Performance of China aster (*Callistephus chinensis* (L.) Nees) var. Kamini

**Rekha Bhandari, Mamta Bohra, K. C. Singh and Anand Singh Bisht***

*Department of Horticulture, VCSG, Uttarakhand University of Horticulture and Forestry, Bharsar, Pauri Garhwal, Uttarakhand - 246123, India*

**Corresponding author*

**Keywords**

Growth regulators, Shelf life, Vase life, Seed germination

**Article Info**

***Received:***
12 January 2022
***Accepted:***
05 February 2022
***Available Online:***
10 February 2022

**A B S T R A C T**

The present investigation was conducted to establish a protocol for studying the seed germination and growth performance of China aster var. Kamini at varied concentrations of plant growth regulators $GA_3$ (100ppm, 200ppm and 300ppm), NAA (100ppm, 200ppm and 300ppm), IBA (100ppm, 200ppm and 300ppm) and IAA (100ppm, 200ppm and 300ppm) in the Floriculture and Landscaping Block of College of Horticulture, Veer Chandra Singh Garhwali, Uttarakhand University of Horticulture and Forestry, Bharsar, Pauri Garhwal (Uttarakhand) during 2021. The experiment was laid out in Randomized Complete Block Design and each treatment was replicated thrice. The seeds were sown in pots of size 15 cm × 15 cm (length and diameter). Among the various concentrations used $GA_3$ @200 ppm showed the best germination per cent (93.33±3.52 %) in lab condition and $GA_3$ @ 300 ppm showed best germination per cent (94.00±0.57%) in field condition. In $GA_3$ @ 300 ppm observed best result in plant height (55.16±0.36cm), plant spread (12.60±0.19 cm), number of primary branches (11.77±0.40), number of secondary branches (15.66±0.50) and number of leaves per plant (148.00±2.72). In $GA_3$ @ 300 ppm revealed the best result in bud initiation in plant (162.00±0.19), bud showing colour (166.29±0.66), days of first flower opening (174.00±0.19), 50 % flowering (176.33±0.50), days of complete flowering (185.22±0.29), flower diameter (6.36±0.17), stalk length (33.03±0.93), number of flowers per plant (20.22±0.40), and weight of flower (3.41±0.12). In treatment IAA @ 300 ppm showed best result in vase life (10.77±0.72) of flower and in NAA @ 300 ppm showed best result in shelf life (6.33±0.19) of flowers. Thus, it can be concluded that in treatment $GA_3$ @ 200 ppm was found effective in seed germination. For best vegetative and flowering growth, the treatment containing $GA_3$ @ 300 ppm was found best. However, NAA @ 300 ppm was found effective for enhancing shelf life of the flower. Similarly, IAA @ 300 ppm was found suitable for increased vase life of China aster.

## Introduction

China Aster [*Callistephus chinensis* (L.) Nees] is commonly known as annual aster or China Aster. It belongs to Asteraceae family and it was introduced from China in the early 18$^{th}$ century. The genus *Callistephus* derived from two Greek words *kalistos* means most beautiful, and *stephos* means a crown,

referring to the flower. Cassini described the China aster as *C. hortensis*. It was first named by Linnaeus as *Aster chinensis* and Nees subsequently changed this name to *Callistephus chinensis* (Janakiram and Manjunath, 2001). The China aster is a semi hardy annual, plants are erect, having hispid hairy branches bearing alternate broadly ovate or triangular ovate, deeply and irregularly toothed leaves. The flowers are used for cut as well as loose flower purpose. The cut flowers last long in the water. The cut flowers are used for making bouquets. The plants grown for edging, pot plant, edging, pot plant and herbaceous border. Loose flowers are used in garland making (Randhawa and Mukhopadhyay, 1986). Application of plant growth regulators is playing a leading role in production and post-harvest handling of cut flowers. Use of plant growth hormones in flower crops should be specific and a plant growth regulator must be having toxic free and environment friendly action. Plant growth regulators are one of the cheap and widely used physiological manipulators which can be used for productivity and quality enhancement in China Aster. The application of growth regulators stimulates flowering and seed setting to yield better quality seeds (Sunitha, 2007). The growth, yield and flower quality, plant bio-regulators are an important aspect of crop production. Plant growth substances have been used as an effective tool to improve vegetative as well as reproductive function of plant. Plant growth regulators have been an essential part of floriculture and utilization of growth substances constituted one of the most important advances in agro-technology for improving the yield and quality parameters of flowers (Sharma *et al.*, 2001).

## Materials and Methods

The investigation was conducted at the Floriculture and Landscaping Block, College of Horticulture, Veer Chandra Singh Garhwali Uttarakhand University of Horticulture and Forestry, Bharsar, District Pauri Garhwal (Uttarakhand) in 2021. Bharsar is situated at the hills of Himalayas at 29º 20'-29º 75' N Latitude and 78º 10'-78º 80' E Longitude. The altitude of the place is 1900 meter above the mean sea level. The climate of the Bharsar represents the mild summer, higher precipitation and colder or severe cold prolonged winter. The climate factors such as precipitation, temperature, relative humidity and wind, in association with elevation (valleys or mountain range from temperate zone), proximity to Great Himalaya, slope aspects, drainage, vegetation etc. are responsible for the micro-climate of this area. Vegetative growth and flowering of China aster was studied under the open condition of Bharsar. In this experiment effect of plant growth regulators *viz.*, $GA_3$, NAA, IBA and IAA was observed. It consists of thirteen treatments with 3 replications. The experiment was plotted according to Randomized Complete Block Design (Gomez and Gomez, 1984). The seeds of China aster var. Kamini were treated for 24 hours in the solutions ($GA_3$, NAA, IBA and IAA) and sown in the pots in the first week of March, 2021. The size of the pots are 15 cm seeds were sown at a depth of 0.5 to 1 cm in each pot 8 to 10 seeds were sown and after sowing, seeds were covered with soil, mixed with farm yard manure. Watering was done twice a day. Weeding operations were done at regular intervals. The temperature range in field condition was 15-22ºC. The seed germination was expressed in percentage on the basis of the number of seeds germinated out of the sown.

## Results and Discussion

The result showed significant differences among the various treatments in germination counts in the Table 1. The highest germination percent (93.33 ±3.52) was recorded under the treatment $T_3$($GA_3$200 ppm), this may be due to the gibberellic acid stimulates cell elongation and helps increased enzyme activities and better supply of nutrients (Selvakumari *et al*., 2007; Dilip *et al.*, and Pangtu *et al*., 2017). The minimum days taken for initial germination count (1.00 ±0.00) was recorded under the treatment $T_2$, $T_3$, $T_4$ and $T_5$ respectively ($GA_3$100 ppm, $GA_3$ 200 ppm, $GA_3$300 ppm and IBA 100 ppm), this might be due to Gibberellic acid have cell elongation which altering the rheological properties of the cell wall, (Zahedi *et al.*, 2012 and

Selvakumari *et al.,* 2007). The minimum days taken for final germination count (12.33 ±0.66) was recorded under the treatment $T_3$ ($GA_3$ 200 ppm), this might be due to Gibberellic acid have cell elongation which altering the rheological properties of the cell wall. (Pungtu *et al.,* 2017). In field condition, the highest germination percent (94.00 ±0.57) was recorded under the treatment $T_4$($GA_3$300 ppm), this is possibly due to the gibberellins cause both cell-elongation and cell-division that stimulates elongation which eventually resulted in increase in seed germination percent. (Dilip *et al.,* 2017). The minimum days taken for initial germination count (11.66 ±0.33) was recorded under the treatment $T_4$ ($GA_3$300 ppm), this might be due to gibberellic acid have cell elongation which altering the rheological properties of the cell wall (Zahedi *et al.,* 2012). The minimum days taken for final germination count (27.66 ±1.45) was recorded under the treatment $T_4$ ($GA_3$300 ppm), this might be due to Gibberellic acid have cell elongation which altering the rheological properties of the cell wall (Zahedi *et al.,* 2012).

In the present study, the maximum plant height (55.16 ±0.36) was recorded under the treatment $T_4$ ($GA_3$ @ 300 ppm), this is possibly due to the gibberellins cause both cell-elongation and cell-division that stimulates elongation which eventually resulted in increase in plant height (Nandre *et al.,* 2009; Kumar *et al.,* 2015 and Sindhuja and Prasad, 2018). The maximum plant spread (12.61 ±0.19) was recorded under the treatment $T_4$ ($GA_3$ @ 300 ppm), this might be due to the gibberellic acid have influence pedicel growth in plant (Sindhuja and Prasad 2018; Palekar *et al.,* 2018). The maximum number of leaves (148.00 ±2.72) was recorded under the treatment $T_4$ ($GA_3$ @ 300 ppm), the increase in number of leaves per plant may be due to the optimum availability of gibberellic acid may be available for higher accumulation of carbohydrates, which improve the metabolic activities and increase the photosynthesis process in the leaves of plants (Ullah *et al.,* 2013; Sharma and Joshi, 2015 and Mishra *et al.,* 2018). The maximum number of primary branches (11.77 ±0.40) was recorded under the treatment $T_4$ ($GA_3$ @ 300 ppm), this might be due to the gibberellins stimulate cell elongation by altering the rheological properties of the cell wall, as a consequence, the water potential of the cell is lowered allowing for water uptake and therefore an increase in cell volume (Deepti *et al.,* 2021). The maximum number of secondary branches (15.66 ±0.50) was recorded under the treatment $T_4$ ($GA_3$ @ 300 ppm), this is possibly due to the characteristic property of gibberellic acid on shoot growth are increased inter node extension, increased leaf growth and enhanced apical dominance (Kumar *et al.,* 2015 and Deepti *et al.,* 2021).

The minimum days taken to first flower bud initiation (162.00 ±0.19) was recorded under the treatment $T_4$ ($GA_3$ @ 300 ppm), $GA_3$ are indeed floral inhibitors, IAA may stimulate their synthesis in the bud. (Palekar *et al.,* 2018). The minimum days taken to first flower bud showing colour (166.29 ±0.66) was recorded under the treatment $T_4$ ($GA_3$ @ 300 ppm), this is possibly due to the gibberellic acid have chemical that aids in stem development and the positive effect of gibberellins on plant growth has been reported by (Palekar *et al.,* 2018 and Mishra *et al.,* 2018). The minimum number of days taken to first flower opening (174.00 ±0.19) was recorded under the treatment $T_4$ ($GA_3$ @ 300 ppm), their involvement in flower initiation in long day and biennial plants is well established and there is growing insight into the mechanisms by which floral induction is achieved, (Imandi and Reddy, 2017 and Mishra *et al.,* 2018). The minimum number of days taken to 50 percent flowering (176.33 ±0.50) was recorded under the treatment $T_4$ ($GA_3$ @ 300 ppm), this is possibly due to $GA_3$ is a component of florigen which is required for formation of flowers in plant system and this is in conformity with the results of (Palekar *et al.,* 2018; Sindhuja *et al.,* 2018 and Mishra *et al.,* 2018).

**Table.1** Effect of $GA_3$, NAA, IBA and IAA on days taken to initial germination, days taken to final germination and germination percent in lab and field condition

| Treatments | Treatment details | Seed germination in lab condition% ±S.E. (m) | Days taken to initial germination in lab condition ±S.E. (m) | Days taken to final germination in lab condition ±S.E. (m) | Seed germination in field condition % ±S.E. (m) | Days taken to initial germination in field condition ±S.E. (m) | Days taken to final germination in field condition ±S.E. (m) |
|---|---|---|---|---|---|---|---|
| $T_1$ | Control | 30.66±6.66 | 3.00±0.00 | 18.33±0.88 | 57.66±2.02 | 20.33±0.88 | 38.66±1.45 |
| $T_2$ | $GA_3$ 100 ppm | 54.66*±2.66 | 1.00*±0.00 | 15.66±0.66 | 84.66*±1.45 | 16.00*±0.57 | 31.33*±0.66 |
| $T_3$ | $GA_3$ 200 ppm | 93.33*±3.52 | 1.00*±0.00 | 12.33*±0.66 | 92.66*±1.20 | 12.66*±0.88 | 28.33*±1.20 |
| $T_4$ | $GA_3$ 300 ppm | 61.33*±3.52 | 1.00*±0.00 | 15.00*±1.15 | 94.00*±0.57 | 11.66*±0.33 | 27.66*±1.45 |
| $T_5$ | IBA 100 ppm | 60.00*±10.06 | 1.00*±0.00 | 15.66±0.66 | 76.33*±0.88 | 15.66*±0.66 | 34.00*±0.57 |
| $T_6$ | IBA 200 ppm | 47.00±2.51 | 2.00*±0.00 | 14.33*±0.66 | 77.33*±2.72 | 14.66*±0.88 | 31.00*±0.55 |
| $T_7$ | IBA 300 ppm | 72.00*±10.06 | 2.00*±0.00 | 16.33±0.66 | 83.00*±1.52 | 14.33*±1.33 | 30.00*±0.57 |
| $T_8$ | NAA 100 ppm | 46.66±13.53 | 2.00*±0.00 | 13.00*±3.05 | 62.66±3.52 | 16.66*±0.88 | 33.66*±0.88 |
| $T_9$ | NAA 200 ppm | 51.33*±5.92 | 2.00*±0.00 | 17.00±0.00 | 74.33*±2.33 | 16.00*±0.57 | 31.33*±1.20 |
| $T_{10}$ | NAA 300 ppm | 60.00*±2.64 | 2.00*±0.00 | 15.66±0.66 | 78.00*±1.52 | 14.66*±0.88 | 29.66*±0.88 |
| $T_{11}$ | IAA 100 ppm | 68.00*±6.11 | 2.00*±0.00 | 15.66±0.66 | 79.00*±1.73 | 18.00*±1.15 | 34.33*±1.20 |
| $T_{12}$ | IAA 200 ppm | 41.33±2.66 | 1.66*±0.33 | 17.00±0.00 | 81.00*±2.08 | 17.66±0.88 | 31.66*±0.88 |
| $T_{13}$ | IAA 300 ppm | 38.66*±6.66 | 1.66*±0.33 | 16.33±0.66 | 86.66*±1.20 | 15.00*±1.15 | 30.33*±0.88 |
| **SE(d)** | | 9.45 | 0.18 | 1.54 | 2.55 | 1.30 | 1.40 |
| **C.D.** | | 19.63 | 0.39 | 3.19 | 5.30 | 2.70 | 2.92 |
| **C.V.** | | 20.76 | 13.45 | 12.11 | 3.95 | 10.20 | 5.43 |

**Table.2** Effect of different concentrations of $GA_3$, NAA, IBA and IAA on plant height (cm), number of primary branches, number of secondary branches, plant spread (cm) and number of leaves per plant

| Treatments | Treatment details | Plant height (cm) ±S.E. (m) | Number of primary branches plant$^{-1}$ ± S.E. (m) | Number of secondary branches plant$^{-1}$ ± S.E. (m) | Number of leaves per plant ± S.E. (m) | Plant spread (cm) ± S.E. (m) |
|---|---|---|---|---|---|---|
| **T1** | Control | 44.80 ±0.13 | 5.22 ± 0.29 | 9.66 ± 0.19 | 94.88 ±1.44 | 8.11 ± 0.23 |
| **T2** | GA3 100 ppm | 50.93* ± 0.82 | 8.00* ±0.19 | 12.44* ±0.77 | 128.55 * ±6.06 | 9.94* ±0.13 |
| **T3** | GA3 200 ppm | 53.55* ±0.62 | 8.55 * ±0.48 | 13.77* ±0.72 | 136.33* ±3.37 | 10.94* ±0.13 |
| **T4** | GA3 300 ppm | 55.16* ±0.36 | 11.77* ± 0.40 | 15.66* ±0.50 | 148.00* ±2.72 | 12.61* ±0.19 |
| **T5** | IBA 100 ppm | 49.74* ±0.82 | 7.22* ±0.29 | 12.55* ±0.29 | 129.77* ±5.69 | 9.23* ±0.17 |
| **T6** | IBA 200 ppm | 50.34* ±0.44 | 8.33* ±0.33 | 13.66* ±0.50 | 136.44* ±5.82 | 10.91* ±0.29 |
| **T7** | IBA 300 ppm | 52.48* ±0.19 | 9.44* ±0.48 | 14.00* ±0.50 | 140.66* ±3.65 | 11.93* ±0.26 |
| **T8** | NAA 100 ppm | 50.48* ±0.56 | 7.33* ±0.19 | 12.33* ±0.66 | 140.44* ±4.08 | 9.64* ±0.04 |
| **T9** | NAA 200 ppm | 52.38* ±0.52 | 8.33* ±0.38 | 13.55* ±0.22 | 143.66* ±3.20 | 10.44* ±0.21 |
| **T10** | NAA 300 ppm | 53.26* ±0.42 | 10.11* ± 0.29 | 14.66* ±0.19 | 146.77* ±2.66 | 11.92* ±0.22 |
| **T11** | IAA 100 ppm | 49.15* ±0.39 | 7.11* ±0.29 | 11.77* ± 0.40 | 128.22* ±1.73 | 9.53* ±0.22 |
| **T12** | IAA 200 ppm | 50.91* ±0.21 | 8.33* ±0.19 | 13.00* ±0.19 | 134.22* ±1.35 | 11.20* ±0.25 |
| **T13** | IAA 300 ppm | 52.38* ±0.13 | 10.44* ±0.29 | 14.11* ±0.29 | 136.77* ±1.23 | 11.67* ±0.28 |
| **SE(d)** | | 0.63 | 0.47 | 0.64 | 3.16 | 0.28 |
| **C.D.** | | 1.31 | 0.99 | 1.34 | 6.56 | 0.59 |
| **C.V.** | | 1.50 | 6.93 | 6.00 | 2.88 | 3.31 |

**Table.3** Effect of different concentrations of $GA_3$, NAA, IBA and IAA on Days taken to first flower bud initiation, days taken to first flower bud showing colour, number of days taken to first flower opening, 50 % flowering and 100 % flowering

| Treatments | Treatment details | Days taken to first flower bud initiation ±S.E. (m) | Days taken to first flower bud showing colour ±S.E. (m) | Number of days taken to first flower opening ±S.E. (m) | Number of days taken to 50% flowering ± S.E. (m) | Number of days taken to 100 % flowering ± S.E. (m) |
|---|---|---|---|---|---|---|
| $T_1$ | Control | 166.00±0.69 | 171.66 ±0.50 | 185.44 ±0.21 | 198.29±0.18 | 209.22 ±0.29 |
| $T_2$ | $GA_3$ 100 ppm | 164.00* ±0.50 | 169.47*±0.64 | 177.55*±0.11 | 183.88*±0.96 | 192.12 ±0.40 |
| $T_3$ | $GA_3$ 200 ppm | 163.11* ±0.29 | 167.88*±0.80 | 175.44*±0.29 | 178.51*±0.41 | 187.33 ±0.33 |
| $T_4$ | $GA_3$ 300 ppm | 162.00* ±0.19 | 166.29*±0.66 | 174.00*±0.19 | 176.33*±0.50 | 185.22 ±0.29 |
| $T_5$ | IBA 100 ppm | 163.88* ±0.77 | 169.44*±0.29 | 181.81*± 0.32 | 187.22*±0.55 | 194.22 ±0.29 |
| $T_6$ | IBA 200 ppm | 163.22* ±0.77 | 168.55*±0.40 | 180.66*±0.19 | 184.25*±0.61 | 192.33 ±0.33 |
| $T_7$ | IBA 300 ppm | 162.00* ±0.50 | 167.11*±1.05 | 178.44*±0.21 | 182.66*±0.74 | 190.29 ±0.80 |
| $T_8$ | NAA 100 ppm | 164.00* ±0.38 | 169.55*±0.55 | 177.22*±0.11 | 184.88*±1.28 | 194.03 ±0.38 |
| $T_9$ | NAA 200 ppm | 163.33* ±0.38 | 168.88*±0.29 | 176.44*±0.11 | 183.07*±0.43 | 192.22 ±1.23 |
| $T_{10}$ | NAA 300 ppm | 162.55* ±0.67 | 167.81*±0.79 | 174.55*±0.22 | 180.55*±0.21 | 188.70 ±0.48 |
| $T_{11}$ | IAA 100 ppm | 164.33* ±0.19 | 169.77*±0.22 | 180.55*±0.22 | 185.81*±2.85 | 197.33 ±0.57 |
| $T_{12}$ | IAA 200 ppm | 163.22* ±0.11 | 167.55*±0.29 | 179.00*±0.19 | 185.70*±0.22 | 195.11 ±0.39 |
| $T_{13}$ | IAA 300 ppm | 162.22* ±0.22 | 166.92*±0.25 | 176.55*±0.29 | 182.66*±0.19 | 191.55 ±0.59 |
| **SE(d)** | | 0.65 | 0.72 | 0.31 | 1.35 | 0.80 |
| **C.D.** | | 1.36 | 1.50 | 0.65 | 2.81 | 1.66 |
| **C.V.** | | 0.49 | 0.52 | 0.21 | 0.90 | 0.50 |

**Table.4** Effect of different concentrations of $GA_3$, NAA, IBA and IAA on flower diameter, stalk length, number of flowers per plant, vase life (days), shelf life (days) and weight of flower (g) of China aster var. Kamini

| Treatments | Treatment details | Flower diameter (cm) ± S.E. (m) | Stalk length (cm) ± S.E. (m) | Number of flowers per plant ± S.E. (m) | Vase life (days) ± S.E. (m) | Shelf life (days) ± S.E. (m) | Weight of flower(g) ± S.E. (m) |
|---|---|---|---|---|---|---|---|
| $T_1$ | Control | 4.37 ± 0.28 | 27.77 ± 1.03 | 14.88 ± 0.40 | 4.55 ± 0.40 | 2.00 ± 0.19 | 1.84 ± 0.00 |
| $T_2$ | $GA_3$ 100 ppm | 5.21* ± 0.19 | 30.63* ± 0.34 | 16.66* ± 0.33 | 6.77* ± 1.11 | 3.88* ± 0.22 | 2.71* ± 0.06 |
| $T_3$ | $GA_3$ 200 ppm | 5.97* ± 0.22 | 32.96* ±0.41 | 17.22* ± 0.40 | 8.44* ± 1.16 | 5.22 * ±0.29 | 3.10* ± 0.04 |
| $T_4$ | $GA_3$ 300 ppm | 6.36* ± 0.17 | 33.03* ± 0.93 | 20.22* ± 0.40 | 10.33* ± 1.45 | 5.77 * ± 0.22 | 3.41* ± 0.12 |
| $T_5$ | IBA 100 ppm | 5.74* ± 0.17 | 31.15* ± 0.59 | 16.55* ± 0.48 | 6.88* ± 1.06 | 4.88 * ±0.11 | 2.47* ± 0.09 |
| $T_6$ | IBA 200 ppm | 5.76* ± 0.24 | 31.28* ± 0.12 | 16.88* ± 0.48 | 8.55* ± 1.16 | 5.22 * ±0.11 | 2.85* ± 0.14 |
| $T_7$ | IBA 300 ppm | 6.19* ± 0.04 | 31.78* ± 0.73 | 18.77* ± 0.40 | 9.44* ± 1.16 | 5.55 * ±0.11 | 2.98* ± 0.08 |
| $T_8$ | NAA 100 ppm | 6.23* ± 0.13 | 29.61 ±0.59 | 17.77* ± 0.48 | 8.88* ± 1.54 | 5.33 * ±0.19 | 2.78* ± 0.05 |
| $T_9$ | NAA 200 ppm | 5.94* ± 0.07 | 30.25* ± 0.46 | 18.33* ± 0.57 | 9.77* ± 0.67 | 5.88* ± 0.40 | 2.92* ± 0.11 |
| $T_{10}$ | NAA 300 ppm | 5.94* ± 0.34 | 30.56 * ± 0.81 | 19.22* ± 0.22 | 10.55* ± 1.63 | 6.33* ± 0.19 | 3.06* ± 0.12 |
| $T_{11}$ | IAA 100 ppm | 5.65* ± 0.22 | 30.33 * ± 0.47 | 18.22* ± 0.22 | 8.11* ± 1.44 | 5.22* ± 0.11 | 2.55* ±0.11 |
| $T_{12}$ | IAA 200 ppm | 6.22* ± 0.10 | 30.45* ± 0.34 | 18.77* ± 0.22 | 9.11* ± 0.88 | 5.88* ± 0.22 | 2.87* ±0.10 |
| $T_{13}$ | IAA 300 ppm | 6.31* ± 0.13 | 31.24* ± 0.58 | 20.11* ± 0.22 | 10.77* ± 0.72 | 6.11* ± 0.11 | 3.09* ± 0.13 |
| **SE(d)** | | 0.20 | 0.90 | 0.41 | 0.96 | 0.26 | 0.11 |
| **C.D.** | | 0.42 | 1.87 | 0.86 | 2.00 | 0.55 | 0.22 |
| **C.V.** | | 4.24 | 3.57 | 2.83 | 13.69 | 6.31 | 4.77 |

The data obtained from the research field revealed that the minimum number of days taken to 100 % flowering (185.22 ±0.29), this might be due to the presence of gibberellins like substances in floral parts and demonstrations that gibberellic acid can promote the growth of sepals and petals have indicated that gibberellins are involved in the growth of flowers. (Imandi and Reddy, 2017 and Mishra *et al.,* 2018). The maximum flower diameter (6.36 ±0.17) was recorded under the treatment $T_4$ ($GA_3$ @ 300 ppm), this may be due to growth promoting substances which might have led to better root development, better transportation of water, deposition, and uptake of nutrients. (Aparna *et al.*,

2018 and Sindhuja *et al.,* 2018). The maximum number of flowers per plant (20.22 ±0.40) was recorded under the treatment $T_4$ ($GA_3$ @ 300 ppm), this is possibly due to the combined application of hormonal treatments helped in stimulating the vegetative and reproductive phase of the plants, (Imandi and Reddy, 2017 and Mishra *et al.,* 2018). The maximum stalk length (33.03 ±0.93) was recorded under the treatment $T_4$ ($GA_3$ @ 300 ppm), this may be due to the gibberellic acid stimulates cell elongation by altering the rheological properties of the cell wall as a consequence, the water potential of the cell is lowered allowing for water uptake and therefore an increase in cell volume (Mishra *et al.,* 2018).

The maximum days counts of vase life (10.77 ±0.72) was recorded under the treatment $T_{13}$ (IAA@ 300 ppm), this may be possibly due to gibberellins promote flowering in Arabidopsis through the activation of genes encoding the floral integrators flowering locust in the inflorescence and floral meristems and in leaves (Sindhuja *et al.,* 2018 and Sindhuja and Prasad, 2018).

The maximum days of shelf life of flowers was recorded in treatment $T_{10}$ (6.33 ±0.19) NAA @ 300 ppm, this might be due to the environment performance of plant hormones; carbohydrates content and water relations are the main factors that play a critical role in the senescence regulation of the flower (Imandi and Reddy 2017 and Kumar *et al.,* 2018). The maximum weight of flower (3.41 ±0.12) was recorded under the treatment $T_4$ ($GA_3$ @ 300 ppm), this may be possibly due to the gibberellins have a number of effects on plant development. They can stimulate rapid stem and root growth, induce mitotic division in the leaves of some plants, and increase the weight of flowers, (Sharma and Joshi, 2015 and Mishra *et al.,* 2018).

Based upon the results recorded in the investigation it could be concluded that the treatment $T_4$ ($GA_3$ @ 300 ppm) was found best treatment with reference to germination, vegetative and flowering parameters in China aster var. Kamini. as compared to control and other treatments. Therefore, it is recommended that different concentrations of $GA_3$ i.e., $T_4$ ($GA_3$ @ 300 ppm) may be recommended for obtaining the maximum yield for the commercial cultivation of China aster crop.

## References


Aparna, V., Prakash, K., Neema, M, Arora, A., Kumar, P. N. And Singh, M. C. 2018. Effect of Gibberellic Acid on plant growth and flowering of Chrysanthemum cv. Thai Chen Queen under short day planting conditions. *International Journal of Agriculture Sciences*.10(11): 6274-6278.

Deepti, S., Tirkey, T. and Kumar, A. 2021.Effect of varieties and plant growth regulators on vegetative growth of China aster (*Callistephus chinensis* (L.) Nees). *The Journal of Pharma Innovation.*10(3): 441-445.

Dilip, W. S., Singh, D., Moharana, D., Rout, S. and Patra, S. S. 2017. Effect of gibbrelic acid (GA) different concentration at different time intervals on seed germination and seedling growth of Rangpur lime. *Journal of Agroecology and Natural Resource Management.* 4(2): 157-165.

Gomez, K. A. and Gomez, A. A. 1984. Statistical procedures for agricultural research. 2nd ed. John wiley and sons inc. New York, USA.

Imandi, S. and Subba Reddy, G. V. 2017.Effect of Plant Growth Regulators on Vegetative Growth, Flowering, Yield and Shelf Life of the Marigold cv. Siracole. *International Journal of Agricultural Science and Research*. 7(4): 65-70.

Janakiram, T. and Manjunath, R. T. 2001. China aster. Advances in Ornamental Horticulture. *Indian Institute of Horticultural Research, Bangalore*. Vol. 2, pp 47-48.

Kumar, P. K., Padmalatha, T., and Pratap, M. and Reddy, S. N. 2015. Effect of plant bio-regulators on growth, flowering and seed yield in China aster (*Callistephus chinensis* (L.) Nees) cv. Kamini. *Indian Journal of*

*Agricultural Research*.49(4): 348-352.

Kumar, S. Singh, A. K., Vishwakarma, G. and Singh, A. 2018. PGR's consequence on yield attributing trait of China aster (*Callistephus chinensis* (L.) Nees). *International Journal of Chemical Studies.* 6(4): 2234-2236.

Mishra, P. K., Pandey, G., Kumar, A., Naik, R. and Pujahari, L. P. 2018.Effect of foliar application of gibberellic acid ($GA_3$) concentrations and spraying frequencies on vegetative and floral attributes of China aster [*Callistephus chinensis* (L.) Nees.] *International Journal of Current Microbiology and Applied Science*. 7(1): 1889-1894.

Nandre, D. R., Navandar, U. O. and Watane, A. D. 2009. Effect of growth regulators on growth, flowering and yield of China aster. *The Asian Journal of Horticulture*. 4(1): 50-51.

Palekar, A. R., Raut, V. U., Watane, A. A. and Thakre, S. A. 2018. Growth, flowering and quality of China aster flower influenced by various plant growth regulators. *International Journal of Chemical Studies.* 6(5): 1182-1184.

Pangtu, S., Sharma, B. P., Dilta, B. S. and Chaudhary, S. V. S. 2017. Effect of seed priming on seed parameters of China aster, *Callistephus chinensis* (L.) Nees. *Agric International*. 5(1): 43-48.

Randhawa, G. S. and Mukhopadhyay, A. 1986. Floriculture in India, New Delhi. *Allied Publishers Private Limited*. pp. 358-359.

Selvakumari, A., Vijaykumar, A. and Geetha, R. 2007. Seed fortification with botanicals on vigour and viability of China aster (*Callistephus chinensis*) cv. Poornima. *Plant Archives*. 7(1): 195-196.

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

Sharma, M. K. and Joshi, K. I. 2015. Effect of Foliar Spray of $GA_3$ and NAA on Growth Flowering and Yield of China Aster (*Callistephus Chinensis* Nees) cultivars. *International Journal of Agricultural Science and Research*. 5(4):105-110.

Sindhuja, M. and Prasad, V. M. 2018. Effect of different plant growth regulators and their levels on vegetative growth, floral yield and vase life of China aster (*Callistephus chinensis* (L.) Nees). *The Journal of Pharmacognosy and Phytochemistry*.7(6): 1490-1492.

Sunitha, H. M. 2007. Effect of plant population, nutrition and growth regulators on plant growth, seed yield and quality of African marigold (*Tagetes erecta* Linn.), thesis, M.Sc. (Agri.). University of Agricultural Science, Dharwad, Karnataka (India).

Ullah, Z., Abbas, S. J., Naeem, N., Lutfullah, G., Malik, T., Khan, M. A. U. and Khan, I. 2013.Effect of indole butyric acid (IBA) and naphthaleneacetic acid (NAA) plant growth regulators on Marigold (*Tagetes erecta* L.) *African Journal of Agricultural Research*, 8(23):4015-4019.

Zahedi, S. M., Azizi, M. and Gheysari, H. 2012. Effect of seed priming on germination and initial growth of Sweet William (*Dianthus barbatus*). *Annals of Biological Research*. 3(8): 4192-4194.

**How to cite this article:**

Rekha Bhandari, Mamta Bohra, K. C. Singh and Anand Singh Bisht. 2022. Effect of Different Plant Growth Regulators on Seed Germination and Growth Performance of China aster (*Callistephus chinensis* (L.) Nees) var. Kamini. *Int.J.Curr.Microbiol.App.Sci*. 11(02): 297-305.
doi: https://doi.org/10.20546/ijcmas.2022.1102.034