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Effect of different growing media and gibberellic acid on flowering parameters of China aster (*Callistephus chinensis* (L.) Nees cv. Arka Poornima for pot plant production

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Abstract
The experiment was conducted to study the effect of different growing media and gibberellic acid on flowering parameters of China aster (*Callistephus chinensis* (L.) Nees cv. Arka Poornima for pot plant production. The plant where grown using different growing media *viz* soil, sand, FYM, vermicompost, rice husk and different concentration of gibberellic acid. 25 different treatment combinations were replicated thrice in a factorial completely randomized design. The observations showed that in media containing vermicompost perform superior as compare to other media combination and GA3 400 ppm performed better for number of flower per plants, individual flower weight, flower diameter.

Keywords: China aster, gibberellic acid, soil media, soilless media, vermicompost, flowering

Introduction
China aster belongs to the family of Asteraceae and its botanical name is *Callistephus chinensis* (L.) Nees. It is ranked third next to Chrysanthemum and marigold and is one of the most famous annual flowering plants around the globe. China aster is propagated by seeds and germination takes around a week after sowing. Its seeds cannot be stored for long in normal conditions (Singh, 2006) [22]. Aster cuts are generally used for flora decoration and vases decoration as they last longer than many other flowers cuts. It can be easily grown in open fields and lath houses. When asters are grown in large mass, they make very show bedding plants and valuable for filling up gap in mixed herbaceous border. Some varieties are used as pot plants. The prominent colours of flowers are blue, violet, lavender, rose pink etc.
For the quality production of flowers in floriculture, the most important factors are potting soil mixes (Sachin *et al*., 2020) [18]. Potted plants are the only category of plants that can provide freshness even in small spaces and are a good source of reducing indoor air pollution (Jones, 1999) [8]. Growing media plays a very essential role in growth and flowering of different cut flowers. There are two types of growing media, first Soil based media in which growing media is combined with soil for growth and development of plants. Second Soilless media is a form of media in which soil is not present which is further divided into two categories organic (derived from nature) and inorganic (man-made) (Ghohil *et al*., 2018) [5]. When selecting media, the grower needs to find the optimum balance between their requirement and those of the plants to be grown.
Gibberellic acid is a well-known plant growth regulator for flower stimulation in many herbaceous flower crops. The flower development from long day or short day plant can be controlled by changing the level of GA3 and also induces quantity of flowering and length of flower stalk (Prakash *et al*., 2015) [17]. Exogenous application of growth regulators increases flowering, pollination, fertilization and seed setting in China aster. The most common method for PGRs application is foliar application as it is easy, convenient, cheap and economical (Doddagoudar *et al*., 2004) [3].

Material and Methods

The experiment was conducted at Pt. Kishorilal Shukla College of Horticulture and Research station, Rajnandgaon (C.G.), IGKV, Raipur Chhattishgarh. During the year of 2021-2022. The experiment was carried out in factorial completely randomized design, which included 25 treatment with 3 replications, there were 2 factors which comprised 5 levels. Factor (A) growing media, soil: sand(50:50) (M0), soil: sand: FYM (25:25:50) (M1), soil: sand: vermicompost (25:25:50) (M2), Soil: sand: Cocopeat (25:25:50) (M3), soil:sand: Rice husk
(25:25:50) (M4) and factor (B) gibberellic acid, Water (G0), GA3 100ppm (G1), GA3200 ppm (G2), GA3 300ppm (G3), GA3 400ppm (G4). seedlings were transplanted in polybag of size 8" x 10" on mid December, gibberellic acid of the respective concentration were foliar spraying at 25 DAT with the help of hand sprayer.

The observations regarding flowering parameters were recorded during flowering period, Data on flowering parameters *viz*. Days to first flower bud initiation, Number of days taken for first flower opening, Days to 50% flowering, Blooming period (days), Number of flower per plant, Individual flower weight (g), Flower diameter (cm).

Result and Discussion

Effect of growing media and GA3 on flowering parameters Days to first flower bud initiation

Minimum number of days required for first flower bud initiation (27days) was observed in growing media containg soil: sand: vermicompost (25:25:50) (M2), while maximum (65.27days) was recorded in soil: sand (50:50)(M0). The combined influence of soil with sand improve drainage and aeration, lower compactness along with vermicompost bring down the pH, to optimum level for the availability of macro and micro nutrients uptake by plant root system with the help of improvement water holding capacity and higher photosynthetic activity resulted in better C:N ratio, Simultaneously foreign plant hormone level also improve, which is responsible for earliest flower bud initiation A similar result was obtained Chauhan *et al*. (2014) [2] on Gerbera.

Minimum days to first flower bud initiation (42.88 days) was recorded with GA3 100 ppm (G1), which was statistically superior over other, The maximum time required for bud initiation (51.92 days) was recorded in water. Earliest flower bud initiation was due to the reduction in juvenile period through reduction of s-phase in the interphase of cell cycle inducing the shoot apical meristem instead of producing leaves and branches to start producing bud Khangjarakpam *et al*. (2019) [11]. A Similar result was found by Chauhan *et al*. (2014) [2] and Sangma *et al*. (2017) [19] on Gerbera.

The combination of growing media and GA3 had a significant effect for bud initiation. The minimum number of days (26.73) required for bud initiation was recorded in Soil: Sand: Vermicompost (25:25:50) along with GA3 100 ppm (M2G1), which is at par with same media along with different concentration GA3 200 ppm, while treatment Soil: Sand (50:50) with GA3 100 ppm (M0G1) took the maximum number of days (65.27) for bud initiation.

Number of days taken for first flower opening

Among varied growing media, soil: sand: vermicompost (25:25:50) (M2) took the shortest time (47.82 days) to first flower open, which was found significantly superior to others and the longest time (74.98 days) taken in soil: sand (50:50) (M0). The earliness of flowering might also be attributed to supply of macro and micro nutrients, enzymes and growth hormones by vermicompost. Vermicompost also contains humic acid which is known to increase nutrient accumulation in conditions of limited nutrient availability and when additional nutrients were supplied. It might be due to higher content of nitrogen which might have accelerated protein synthesis, thus promoting earlier floral primordial development (Mittal *et al.*, 2010) [14]. The results are conformity with finding of Arha *et al.* (2021) [1] on Gaillardia.

Different concentrations of GA3 had a significant effect on first flower opening. The minimum time for first flower open (61.80 days) was recorded in GA3 100 ppm, which was found significantly superior to others, while the maximum time (68.87 days) was observed in water. Early flowering owing to GA3 may be due to gibberellins reducing juvenile period. The termination of juvenile phase convert the shoot apical meristem into the flower primordia instead of producing leaves (Sigh *et al.*, 2021). The mentioned result is in accordance with Kumar *et al.* (2014) [12] and Kuri *et al*. (2018) [13] on China aster.

Significant effect on days taken for first flower opening was observed due to interaction of growing media and GA3, The combination of Soil: Sand: Vermicompost (25:25:50) with GA3 100 ppm (M2G1) took the shortest time for first flower opening (43.06 days), which was significantly superior over others, while the longest time (77.06 days) recorded in Soil: Sand (50:50) with water (M0G0).

Days to 50% flowering

Growing China aster in media containing soil: sand: vermicompost (25:25:50) (M2) took 53.01 days to 50% flowering, which was found significantly superior to others, and the longest time days) taken in soil: sand (50:50) (M0) growing media. Number of days to 50% flowering might be due to the application of sufficient quantity of vermicompost as it is rich in humic acid which helps in production of auxins and growth substances at an early phase of growth. Easy uptake of different nutrients and simultaneous transportation of growth promoting substances like cytokinin to the auxiliary buds resulted in breakage of apical dominance in plant, thus leads to earliness of bud initiation. Ultimately, these processes result in better site for mobilization of photosynthesis and conversion of vegetative parts of plant to reproductive phase (Patel *et al*., 2011) [16]. The finding was closely in agreement with Arha *et al.* (2022) [1] on Gaillardia.

Different concentrations of GA3 had a significant effect on days to 50% flowering. The minimum time for 50% flowering (69.02 days) was recorded in GA3 100 ppm (G1), which was found significantly superior to others, while the maximum time (76.83 days) was observed in water (G0).The results are also conformity with the results of Kalaimani *et al.* (2017) [10] on Marigold and Hande *et al.* (2022) [6] on China aster.

The combination of growing media and GA3 had a significant effect for days to 50% flowering. The minimum days (47.43) required for 50% flowering was recorded in Soil: Sand: Vermicompost (25:25:50) along with GA3 100 ppm (M2G1) while treatment Soil: Sand (50:50) with GA3 100 ppm (M0G0) took the maximum number of days (88.40) for 50% flowering.

Blooming periods (days)

Among various growing media Soil: Sand: Vermicompost (25:25:50) (M2) had the maximum blooming period (72.08 days), which was at par with Soil: Sand: FYM (25:25:50) (M1) meanwhile minimum flower blooming duration was recorded in Soil: Sand (50:50) (M0). This might be due to application of vermicompost and it contains several nutrients, hormones, enzymes which prolong bloom life of flower (Giri *et al.*, 2014) [4].

Different concentrations of GA3 had a significant effect on blooming period. The maximum blooming period (63.08 days) was recorded in GA3 100 ppm (G1), which was at par with GA3 200 ppm (G2) while the minimum blooming period (59.17) was observed in water (G0). This result is parallel with the finding of Singh *et al.* (2021) on China aster.

Among different treatment combinations, Soil: Sand: Vermicompost (25:25:50) along with GA3 100 ppm (M2G1) noted the maximum blooming period (74.40 days), which was statistically at par with same growing media along with GA3 200 ppm and 300 ppm. This result was also at par with Soil: Sand: FYM (25:25:50) along with GA3 100 ppm, 200 ppm and 300 ppm. However, Soil: Sand (50:50) with water (M0G0) gave the minimum blooming period (46.00 days) during the experiment.

Number of flower per plants

Maximum number of flower per plant (13.94)was recorded in media containing soil: sand: vermicompost (25:25:50)(M2) and minimum was recorded in soil:sand (50:50) (M0), An increase in number of flowers per plant could be attributed to vigorous vegetative growth of China aster growing in this media and increasing carbohydrate reserve material with proper uptake of all available nutrients. Similarly, increased availability of essential elements at critical growth stages could have led to increase in number of flowers. These results are in agreement with the findings of Sardoie *et al.* (2014) [20] on Calendula and Himja *et al.* (2021) [7] on Marigold Different concentrations of GA3 had a significant effect on number of flowers. The maximum number of flower (10.46) was recorded in GA3 400 ppm (G4) and the minimum number of flower (4.72) in water (G0). Increased number of flower when treated with GA3 400 ppm was because this treatment resulted in maximum chlorophyll content and protein content in leaf and had stimulatory role to decrease the activity of chlorophyllase enzymes thus prevents chlorophyll and protein degradation leading to enhancement of rate of photosynthesis. Under the control of GA3, partitioning of photosynthesis to reproductive sink occurred which resulted in maximum number of flowers per plant (Morris, 1996) [15].

The interaction effect of growing media and GA3 resulted in a significant increase in number of flowers. The maximum number of flowers (16.13) was observed in treatment combinations Soil: Sand: Vermicompost (25:25:50) along with GA3 400 ppm (M2G4), which was statistically superior over others.

Individual flower weight (g)

Among various growing media Soil: Sand: Vermicompost (25:25:50) (M2) had the maximum flower weight (16.98g) while the minimum flower weight (3.47g) was recorded in Soil: Sand (50:50) (M0). Maximum flower weight might be due to more availability of nutrients contained in vermicompost including N, P, K, Ca, Mg, Fe, Mn, Zn, Cu and B, the uptake of which has a positive effect on plant nutrition, photosynthesis, the chlorophyll content of the leaves and improve the content of the different plant component like flower. The finding is closely in agreement with Mitthal *et al.* (2010) [14] on marigold and Kala *et al.* (2020) [9] on Chrysanthemum. Effect of different concentration of GA3 on flower weight of China aster was found non- significant.

The interaction effect of growing media and GA3 indicating that flower weight significantly increased with this combination. Soil: Sand: Vermicompost (25:25:50) along with GA3 400 ppm (M2G4) noted the maximum flower weight (17.40 g), which was statistically at par with same media along with other GA3 concentration used in research while soil: sand along with water (M0G0) gave the minimum flower weight (2.30 g).

Flower Diameter (cm)

Among various growing media, Soil: Sand: Vermicompost (25:25:50) (M2) produce significantly maximum flowers diameter (5.91 cm), while media Soil: Sand (50:50) (M0) produced minimum flowers diameter (3.78 cm). The increase in flower head diameter may be related to the optimum growing condition of the medium i.e. lower bulk density, high porosity, high water holding capacity as well as better nutrient uptake. Vermicompost contains several nutrients, hormones which promote growth and accumulate photosynthates in flowers (Shadanpour *et al.*, 2011) [21]. The finding was closely in agreement with Mittal *et al.* (2010) [14] on Chrysanthemum. Flower diameter of China aster was not statistically stimulated by different concentration of GA3 and combination impact of growing media and GA3 concentration.

Table 1: Effect of different growing and GA3 and their intraction on flowering parameters

Treatment	Days to first flower bud initiation	Days taken for first flower opening	Days to 50% flowering	Blooming period(days)	Number of flower/plant	Individual flower weight(g)	Flower Diameter (cm)
M0	58.50	74.98	85.77	47.48	6.00	3.47	3.78
M1	43.29	63.12	69.13	71.09	10.84	15.95	5.45
M2	33.71	47.82	53.01	72.08	13.94	16.98	5.91
M3	43.73	68.18	74.62	59.83	7.24	9.64	4.74
M4	56.37	73.04	80.82	56.36	6.64	9.32	4.63
SE(m)	0.342	0.40	0.46	0.47	0.05	0.13	0.24
CD (p=0.05)	0.975	1.14	1.33	1.36	0.14	0.38	0.09
G0	51.92	68.86	76.83	59.17	6.78	10.57	4.62
G1	42.88	61.8	69.02	63.08	8.39	10.82	4.81
G2	45.75	64.57	71.42	62.39	9.14	11.16	4.90
G3	46.91	65.44	72.44	61.88	9.88	11.28	4.95
G4	48.13	66.48	73.64	60.32	10.46	11.53	5.24
SE(m)	0.342	0.40	0.46	0.47	0.05	0.13	0.09

CD (p=0.05)	0.975	1.14	1.33	1.36	0.14	N/A	N/A
M0G0	65.27	77.06	88.40	46.00	4.46	2.30	3.54
M0G1	53.53	72.2	84.40	48.60	5.60	2.83	3.59
M0G2	56.60	74.46	84.46	48.53	6.07	3.83	3.64
M0G3	58.30	75.26	85.66	47.60	6.70	3.87	3.69
M0G4	58.80	75.93	85.93	46.67	7.16	4.50	4.43
M1G0	46.83	64.73	71.36	67.67	9.56	15.60	5.26
M1G1	40.87	61.26	66.80	73.07	10.16	15.87	5.31
M1G2	42.26	62.33	67.93	72.40	10.76	16.07	5.51
M1G3	42.70	63.26	69.36	71.93	11.60	16.07	5.58
M1G4	43.80	64.00	70.20	70.40	12.10	16.15	5.60
M2G0	38.00	51.13	57.40	70.13	9.80	16.40	5.55
M2G1	27.00	43.06	47.43	74.40	13.76	16.73	5.83
M2G2	33.70	48.13	52.66	72.87	14.70	17.12	5.97
M2G3	34.53	48.33	53.26	72.07	15.33	17.27	5.99
M2G4	35.53	48.46	54.30	70.93	16.13	17.40	6.22
M3G0	47.90	75.33	82.20	56.87	4.83	9.40	4.57
M3G1	41.07	65.26	71.46	61.47	6.53	9.47	4.67
M3G2	42.53	65.53	71.8	61.40	7.70	9.53	4.73
M3G3	43.27	66.20	72.53	61.07	8.23	9.80	4.85
M3G4	43.87	68.60	75.1	58.33	8.90	10.00	4.90
M4G0	61.60	76.06	84.8	55.20	5.23	9.13	4.18
M4G1	51.93	67.20	75.00	57.87	5.90	9.20	4.63
M4G2	53.67	72.40	80.26	56.73	6.50	9.27	4.66
M4G3	55.77	74.13	81.4	56.73	7.53	9.40	4.66
M4G4	58.87	75.40	82.6	55.27	8.03	9.60	5.03
SE(m)	0.765	0.89	1.04	1.07	0.11	0.30	0.19
CD (p=0.05)	2.18	2.54	2.97	3.05	0.31	0.85	N/A
CV%	2.81	2.37	2.49	3.02	2.18	4.66	6.76

Conclusion

According to the results obtained in this experiment, it may be concluded that among different growing media, vermicompost based combination performed superior to all flowering parameters and GA3 100 ppm was found to be the most appropriate in initial stage of the plant but flowering stage were improved by using GA3 400 ppm. The treatment combination soil: sand: vermicompost along with GA3 400 ppm showed better results for number of flower per plants, individual flower weight and flower diameter.

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