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Pramila Jogi
Department of Floriculture and Landscape Architecture, IGKV, Raipur, Chhattisgarh, India

Dr. T Tirkey
Department of Floriculture and Landscape Architecture, IGKV, Raipur, Chhattisgarh, India

Dr. SK Tamrakar
Department of Floriculture and Landscape Architecture, IGKV, Raipur, Chhattisgarh, India

Corresponding Author:
Pramila Jogi
Department of Floriculture and Landscape Architecture, IGKV, Raipur, Chhattisgarh, India

Impact of vermicompost and biofertilizer in combination with different levels of chemical fertilizers in flowering and yield attributes of China aster (*Callistephus chinensis* (L.) Nees) var. Arka Archana.

Pramila Jogi, Dr. T Tirkey and Dr. SK Tamrakar

Abstract
The present study was carried out at the Govt. Horticultural Nursery, Baghamuda, Mungeli (C.G.). The experiment was conducted during Rabi season of 2019-20 and laid out in randomized block design. The observations on various flowering and yield traits were recorded. The findings of the investigation clearly indicated that in flowering characteristics minimum days taken to bud initiation (57.32 days), days to first flowering (67.27 days), days to 50% flowering (70.75 days), maximum duration of flowering (46.40 days), maximum flower diameter (4.08 cm) and shelf life (7.50 days) were observed in treatment getting 75% RDF +VC + *Azotobacter* + PSB. Yield parameters *viz*. flower yield per plant (62.00 g), flower yield per plot (2.17 kg) and flower yield per quintal were found maximum with the treatment receiving 75% RDF + VC + *Azotobacter* + PSB. From the findings of this investigation it was noticed that the plant receiving 75% of RDF with 25% of RDF through vermicompost including *Azotobacter* and PSB recorded earliness in flowering with increased flower diameter, shelf life and provided maximum flower yield in China aster.

Keywords: China aster, RDF, *Azotobacter*, PSB, vermicompost.

1. Introduction

Floriculture is a vast field that includes cultivation and production of all types of ornamentals, *viz*., croton, cacti, orchids, grasses and bamboos. Floriculture is one of the most potential components of the horticulture industries, being important from aesthetic, social and economic points of view. Flowers symbolise passion, purity, beauty, innocence, peace, love, adoration etc. China aster (*Callistephus chinensis* (L.) Nees) belongs to the family Asteraceae and native to China. In importance China aster ranks next to chrysanthemum and marigold among the traditional flowers. It is a winter season half hardy annual flower crop. The genus *Callistephus* is derived from two Greek words *Kalistos* meaning 'most beautiful' and *Stephus*, 'a crown' referring to the flower head. Popularity is increasing in and around cities due to its short duration and bewitching colors. China aster is a self-pollinated crop, approximately 10% of natural crossing. Arka Archana is white coloured variety with early flowering and spreading growth habit.

Among the various factors affecting growth and development of plants nutrient management play a vital role. Therefore, attention is needed to play adequate quality of nutrients through proper nutrient sources. Integrated nutrient management play an important role for improving the soil structure, physic- chemical properties of soil. The use of chemical fertilizers also poses a major threat to sustain soil health and crop productivity. The continuous and discriminate use of chemical fertilizers leads to decrease in nutrient uptake and adversely affect the quality of produce (Agrawal, 2003). [1]. Now day's farmers using chemical fertilizers without measurement and because of that the soil is losing its fertility and micro flora and fauna. The application of vermicompost and biofertilizers improves the physical properties of soil and increases the availability of nutrients to the plants. The organic and microbial sources of nutrients have advantage of maintaining ideal C: N ratio as they release nutrients slowly and consistently [2]. Organic manure and biofertilizers enhanced the growth, flowering and yield parameters of China aster as compared to inorganic used Marak *et al*. (2020) [3]. Pithiya *et al*. (2016) [4] reported that the application of vermicompost, *Azotobacter* and PSB along with RDF helped in realizing better flower quality and higher flower yield of China aster cv. Phule Ganesh Pink under open field condition.

2. Materials and Methods

The investigation on iinfluence of vermicompost, biofertilizer in combination with different levels of recommended dose of fertilizers in flowering and yield attributes of China aster (*Callistephus chinensis* (L.) Nees) var. Arka Archana was conducted at Govt. Horticultural Nursery, Baghamuda, Mungeli (C.G.) during winter season from November to May 2019-20. The experiment was laid out in Randomized Block Design with 13 treatments and 3 replications. The climate of the area, in general, is tropical wet and dry characterized by clear dry season and hot round the year. The experiment comprises thirteen treatment combinations i.e. 100%, 75%, and 50% RDF along with vermicompost and different formulations of biofertilizer (*Azotobecter* + PSB) *viz*., T_1 (100% RDF (NPK) Control, T_2 (75% RDF + VC + PSB), T_3 (75% RDF + VC + *Azotobacter*), T_4 (75% RDF + VC+ *Azotobacter* + PSB), T_5 (50% RDF + VC+ PSB), T_6 (50% RDF + VC+ *Azotobacter*), T_7 (50% RDF + VC+ *Azotobacter* + PSB), T_8 (75% RDF + VC + Liquid PSB), T_9 (75% RDF + VC + Liquid *Azotobacter*), T_{10} (75% RDF + VC+ Liquid Azotobacter + Liquid PSB), T_{11} (50% RDF + VC+ Liquid PSB), T_{12} (50% RDF + VC+ Liquid *Azotobacter*), T_{13} (50% RDF + VC+ Liquid *Azotobacter* + Liquid PSB). The variety Arka Archana was used for experiment. The weather condition was favorable during the experimental period for growth development and production of China aster. The recommended fertilizer dose of 180:120:60 kg NPK/ha was applied in form of Urea, SSP and Muriate of Potash. As basal dose half dose of nitrogen and full dose of phosphorus and potash were applied in each experimental plot and the remaining half dose of nitrogen was applied in two equal split dose at 30 and 60 days after application of basal dose. Vermicompost was incorporated in the soil according to the treatments of respective plots. For the application of only one biofertilizer *Azotobacter* or PSB, slurry prepared by mixing 200 g *Azotobacter* or PSB culture in one liter of water and the root portion of seedlings was dipped in this for 30 minutes before transplanting. For application of both *Azotobacter* and PSB biofertilizer in combination, slurry prepared by mixing 100 g each of *Azotobacter* and PSB culture in one liter of water and the root portion of seedlings was dipped in this for 30 minutes before transplanting. The seedlings were transplanted after one month of sowing in their respective plots at the spacing of 30 cm x 20 cm. All the cultural practices were kept uniform for every treatment and standard practices were adopted. From the experimental plot ten plants were randomly selected from each plot and tagged for recording observations. The data were analyzed by simple statistical methods for interpretation of the data using the procedures described by Panse and Sukathme [5].

3. Results and Discussions

3.1 Flowering attributes

The analysis of data presented in Table 1 revealed that vermicompost, biofertilizer in combination with different levels of recommended dose of fertilizer significantly affected flowering attributes of China aster. Data showed that minimum day to bud initiation (57.32 days) was recorded in treatment T_4 followed by treatment T_{10} (58.50 days) and treatment T_2 (59.75 days). Similarly minimum days taken to first flowering (67.27 days) and minimum days taken to 50% flowering (70.75 days) were recorded in treatment T_4. While the maximum days taken to bud initiation (71.74 days), first flowering (84.20 days) and 50% flowering (89.45 days) was noted in treatment T_{12}. Minimum days to bud initiation and flowering might be due to sufficient availability of nutrient from vermicompost which boost up the translocation of phytohormone to the stem which results in early bud initiation and flowering. Subsequently *Azotobacter* and PSB helps in increasing the availability of Nitrogen and Phosphorus along with plant growth promoting substance which resulted in breaking the apical dominance followed by easy and better translocation of nutrients to the flowers. Moreover, phosphorus is an important element and essential for the initiation of flowering. Early flowering might be due to the altered C: N ratio which helped in balanced management of vegetative as well as reproductive phase and promote early flowering Mittal *et al*. [6] in African marigold. These results are in accordance with the findings of Panchal *et al*. (2010) [7], Singh *et al*. (2017) [8], and Bohra *et al*. (2019) [9] in China aster.

Significant difference was observed in duration of flowering with effect of integrated nutrient management. The extended duration of flowering (46.40 days) was registered in treatment T_4 which was found statistically at par with treatments T_2, T_3, T_8, T_9, and T_{10} (44.56, 42.30, 43.45, 41.40 and 45.20 days, respectively). However, the minimum duration of flowering (36.05 days) was observed in treatment T_{12}. The presence of biofertilizers especially *Azotobacter* and PSB might be the reason for more flowering duration. The combination of NPK along with biofertilizers assimilates photosynthates which accommodate more food material and that may increased the duration of flowering. These results are in conformity with the findings of Mohit *et al*. (2008) [10] and Kirar *et al*. (2009) [11] in China aster.

Table 1: Effect of integrated nutrient management on flowering attributes of China aster

Treatment	Days to bud initiation	Days to first flowering	Days to 50% flowering	Duration of flowering
T_1	64.71	76.85	81.10	39.30
T_2	59.75	70.32	74.24	44.56
T_3	61.51	72.75	76.65	42.30
T_4	57.32	67.27	70.75	46.40
T_5	68.08	80.12	85.35	36.85
T_6	70.51	82.76	88.50	36.30
T_7	66.65	78.38	83.45	37.85
T_8	60.24	71.55	75.65	43.45
T_9	62.00	73.85	77.80	41.40
T_{10}	58.50	68.75	72.54	45.20
T_{11}	69.42	81.64	86.84	36.56
T_{12}	71.74	84.20	89.45	36.05
T_{13}	67.42	79.01	84.15	37.52
SEm±	3.09	3.65	3.87	1.94
CD (0.05)	9.04	10.65	11.29	5.65

3.2 Yield attributes

Yield parameters *viz*. number of flower per plant (63.66), flower yield per plant (95.50 g), flower yield per plot (3.34 kg) and flower yield quintal per hectare (123.33q) was maximum in treatment T_4, whereas, treatment T_{12} received minimum number of flower per plant (49.23), flower yield per plant (73.84 g), per plot (2.58 kg) and (95.37 q) per hectare. This might be due to the application of NPK along with biofertilizer helps in more photosynthesis and rise food accumulation might have resulted in better growth. Further vermicompost act as source of macro and micro nutrients *viz*. Fe and Zn, growth hormones might have played important role in increasing flower yield. Increased number of flower per plant and yield might due to the indirect effect of more number of branches as influenced by inorganic fertilizer along with organic manure and biofertilizer. Increased flower yield might be attributed to the constant and optimal supply of nutrient influence better growth which in general has significant positive correlation with flowering and yield parameters. These findings are in conformity with the results of Pithiya *et al*. (2016) [4] in China aster, Akter *et al.* (2017) [12] in gladiolus and Kumari *et al*. (2017) [13] in petunia**.**

Table 2: Effect of integrated nutrient management on yield attributes of China aster

Treatment	number of flower per plant	Flower yield per plant (g)	Flower yield per plot (kg)	Flower yield (q/ha)
T_1	53.22	79.83	2.79	103.10
T_2	62.59	93.88	3.29	121.25
T_3	61.62	92.42	3.23	119.37
T_4	63.66	95.50	3.34	123.33
T_5	50.86	76.29	2.67	98.53
T_6	50.00	75.00	2.63	96.87
T_7	52.49	78.73	2.76	101.68
T_8	62.15	93.22	3.26	120.40
T_9	60.88	91.31	3.20	118.93
T_{10}	63.27	94.90	3.32	122.57
T_{11}	50.46	75.69	2.65	97.75
T_{12}	49.23	73.84	2.58	95.37
T_{13}	51.51	77.26	2.70	99.78
SEm±	2.71	4.06	0.14	5.16
CD (0.05)	7.90	11.85	0.41	15.08

T_1 (100% RDF (NPK) Control, T_2 (75% RDF + VC + PSB), T_3 (75% RDF + VC + *Azotobacter*), T_4 (75% RDF + VC+ *Azotobacter* + PSB), T_5 (50% RDF + VC+ PSB), T_6 (50% RDF + VC+ *Azotobacter*), T_7 (50% RDF + VC+ *Azotobacter* + PSB), T_8 (75% RDF + VC + Liquid PSB), T_9 (75% RDF + VC + Liquid *Azotobacter*), T_{10} (75% RDF + VC+ Liquid Azotobacter + Liquid PSB), T_{11} (50% RDF + VC+ Liquid PSB), T_{12} (50% RDF + VC+ Liquid *Azotobacter*), T_{13} (50% RDF + VC+ Liquid *Azotobacter* + Liquid PSB).

3.3 Quality attributes

With respect to quality attributes different treatments on vermicompost, biofertilizer in combination with different levels of recommended dose of fertilizer failed to significant variation on flower diameter. The diameters of all the plants of different treatments were nearly similar. While the shelf life of flowers showed significant difference. It was evident from the data presented in Table 2 that the maximum shelf life (5.63 days) was obtained with treatment T_4 followed by treatment T_{10}, T_2 and T_8 (5.56 days, 5.17 days and 5.32 days, respectively). However minimum shelf life (3.21 days) was recorded by treatment $T_{12.}$ This result may be due to *Azotobacter* which fix nitrogen from atmosphere same as PSB which helps in increasing phosphorus availability. Assimilation of photosynthates helps in more food storage, thus vase life might be increased. Similar beneficial effects of biofertilizer and vermicompost have also been reported by Mogal *et al*. (2006) [14] in China aster and Dalve *et al*. (2009) [15] in gladiolus**.**

Table 3: Effect of integrated nutrient management on quality attributes of China aster

Treatment	Flower diameter (cm)	Shelf life (days)
T_1	3.82	4.21
T_2	3.92	5.32
T_3	3.89	5.03
T_4	4.08	5.63
T_5	3.63	3.71
T_6	3.51	3.36
T_7	3.70	4.08
T_8	3.95	5.17
T_9	3.90	4.87
T_{10}	4.10	5.56
T_{11}	3.67	3.57
T_{12}	3.59	3.21
T_{13}	3.72	3.84
SEm±	0.18	0.21
CD (0.05)	NS	0.63

4. Conclusion

From the findings of present investigation it can be stated that the application of 75 per cent of recommended fertilizer dose along with 25 per cent dose through vermicompost with *Azotobacter* and phosphorus solubilizing bacteria is effective in improving the flower yield and quality of China aster var. Arka Archana.

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