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RESEARCH ARTICLE

IMPACT OF BIOSTIMULANTS& BIOFERTILIZERS ON GROWTH, YIELD AND QUALITY OF CHINA ASTER (*CALLISTEPHUS CHINENSIS* (L.) NEES) CV. ARKA KAMINI

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Abstract: The present investigation carried out on China aster cv. Arka Kamini to know the effect of Biostimulants and biofertilizers on growth, flowering, yield, and quality. The result indicated that among the treatment plant sprayed with the interaction T_3 Humic Acid (0.5%) combination with Phosphate solubilizing bacteria (PSB) 200 g/lof water + Potassium solubilizing bacteria (KSB) 200 g/lof water was recorded significantly maximum plant height(65.22 cm), number of leaves per plant(115.65), leaf area(1419.76), number of primary branches per plant(10.97) and number of secondary branches per plant(13.05). minimum number of days to first flower bud initiation(59.92 days), minimum days to 50% flowering(71.21 days) and highest duration of flowering(70.00 days), flower diameter(7.38 cm), fresh weight of flower(2.74 g), total number of flowers per plant(69.76), flower yield per plant(295.56 g), flower yield per plot(20.95 kg), flower yield per hectare(15.19 t/ha), shelf life of loose flowers(69.76 hours) and vase life of cut flowers(8.12 days). Thus, combined application of Biostimulant and biofertilizers could be considered as a suitable treatment for enhanced growth, flowering, yield, and quality of China aster.

Keywords: China aster, Biostimulants, Biofertilizers, Humic acid, Vase life

INTRODUCTION

China aster (*Callistephus chinensis* L. Nees) is a semi-hardy commercial flower crop belonging to the Asteraceae family having chromosome number 2n=18. It is a free blooming annual crop with erect, spreading growth habit and getting wider acceptance because of its cut and loose flowers. It is used as fillers in bouquets, flower arrangements, flower shows, exhibitions and for the preparation of garlands. It is popular as a bedding plant and used in herbaceous borders in gardens. It is grown as a potted plant and its dwarf cultivars are suitable for edges. Soil nutrient status plays an important role in determining its fertility level, as most of the soils in the world are known to be deficient in most of the nutrients, there will be a great demand to fulfill nutrient deficiency through different sources. Thus, use of different sources of nutrients in an integrated manner helps to produce sustainable yield with good quality flowers. An appropriate fertilizer combination is essential for producing vigorous plants with many shoots and leaves, which improve bloom quality and prolong the flowering time. (Sultana *et al*., 2006 and Zhang *et al*., 2010).

Use of biofertilizers, such as Azotobacter, Azospirillum, and Phosphobacteria, together with organic manures and a moderate number of inorganic fertilizers that can increase flower yield. The biofertilizers are cost-effective, eco- friendly. and easily accessible formulations of organic origin. Biofertilizers produce several growth promoting hormones and increase the nitrogen and phosphorus availability to the plants resulting in better growth. When applied to seed or soil, biofertilizers colonize the rhizosphere or interior of the plant and encourage growth by increasing the supply or availability of primary nutrients to the host plant. In addition, the microorganisms in biofertilizers help to rebuild soil organic matter and restore the soil's natural nutrient cycle and its application under proper condition can increase the yield. Biofertilizers can improve soil health and enable protection against drought and some soil borne diseases (Sowmya and Prasad, 2017). It reduces per unit consumption of inorganic fertilizers and increases the quality and quantity of flowers. Biofertilizers have been found helpful in proliferation and survival of beneficial microorganisms and improves soil properties leading to sustained soil fertility (Harris *et al*, 1966). By the

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addition of PSB, the unavailable form of phosphorus is converted to the available forms, improving phosphorus absorption, and leading to enhanced yield. A widespread requirement for ecologically friendly agriculture is required to supply the rising demand for high-quality flowers. Thus, efforts are underway for the sustainable way of crop production with organic fertilizers and bio-stimulants from natural resources to enhance the production of commercially important flower crops.

Bio-stimulants are the materials other than the fertilizers that promote the plant growth when applied in minute quantities and are also referred as metabolic enhancers. They promote plant growth besides improving yield and quality. The use of bio-stimulants, which has the capacity to beneficially modify plant growth, has grown dramatically over the past decade. However, to the best of our knowledge, there is no report on the "Effect of Biostimulants & Biofertilizers on Growth, Flowering Yield and Quality of China Aster (*Callistephus chinensis* L. Nees) Cv. Arka Kamini." Therefore, the objective of this work was to assess the effect of combination of biostimulants and biofertilizer as foliar spray, soil drenching on growth, flowering, and yield of China aster.

MATERIAL AND METHODS

Raw material, biostimulants and biofertilizers preparation and treatments

The pure, bold, and disease-free seeds of China aster cultivar 'Arka Kamini' were used for conducting the studies which have been procured from Indian Institute of Horticultural Research, Bangalore (Karnataka) and its brief description is given below: The China aster cultivar 'Arka Kamini' produces deep pink colour flowers that are more attractive than other cultivars. It takes about 120-140 days to flower production and attains a height of 60 cm. Its flowers are 5.5-6.5 cm in diameter and the weight of each individual flower is about 2 g. Each plant produces about 40-50 flowers.

Humic Acid (0.5%): To prepare 0.5 per cent Humic Acid, 5 mL of humic acid was dissolved in distilled water and the volume made up to 1000 ml. The biostimulants solutions were applied two times. First spray was given at 40 days after transplanting (DAT) and second spray was given at 20 days intervals after first spray. The solutions were applied uniformly to the subtending leaves and buds till they were wet with the help of hand sprayer (one liter sprayer).

PSB200 g per l of water: For application of PSB biofertilizer, slurry prepared by mixing 200 g PSB culture in one liter of water and it was applied two times. First soil drenching was given at 40 days after transplanting (DAT) and second were given at 20 days intervals after first drenching it is applied to the root portion.

KSB 200 g per l of water: For application of KSB biofertilizer, slurry prepared by mixing 200 g KSB culture in one liter of water and it was applied two times. First soil drenching was given at 40 days after transplanting (DAT) and second were given at 20 days intervals after first drenching are applied to the root portion. The experiment was carried out at PG Students Research Farm, College of Horticulture, Rajendranagar, Hyderabadsituated at an altitude of 536 m above mean sea level on 78 °.40' East longitude and 17 °.32' North latitude. The experiment was laid out in Factorial Randomized Block Design with three replicates as follows, Factor A-(Biostimulants) A_1. Humic acid - 0.5 % A_2. No spray (water) Factor B-(Biofertilizers) B_1. PSB 200 g per l of water B_2. KSB 200 g per l of water B_3. PSB + KSB 200 g per l of water B_4. No Drench (water).The plants were given followings combination treatments viz., Treatments combinations: T_1- Humic Acid (0.5%) + PSB 200 g per l of water. T_2- Humic Acid (0.5%) + KSB 200 g per l of water. T_3- Humic Acid (0.5%) + PSB 200 g per l of water+ KSB 200 g per l of water. T_4- Humic Acid (0.5%). T_5- PSB 200 g per l of water. T_6- KSB 200 g per l of water. T_7- PSB 200 g per l of water + KSB 200 g per l of water. T_8-Control (No spray). Among the plants of the experimental plot, five plants were selected randomly and tagged for collection of data on all the vegetative and yield parameters. The detailed observations were grouped into growth, flowering yield, and quality of flower.

Vegetative Parameters

Plant height:

Plant height was measured from the base of the plant at ground level to the tip of the plant at 60, 75, 90 and 105 DAT with the help of a standard metric scale and mean value of five tagged plants was expressed in centimeters (cm).

Number of leaves per plant:

The total number of leaves per plant was counted in each treatment from the selected five plants at 60, 75, 90 and 105 DAT and expressed in number.

Leaf area (cm^2):

Leaf area of five tagged plants at 60,75, 90 and 105 DAT was measured by using an CI- 202 Laser area meter (USA) and expressed in square centimeters.

Number of primary branches per plant:

The total number of primary at 75, 90 and 105 DAT of five tagged plants per plot were counted and their averages were expressed in numbers.

Number of Secondary branches per plant:

The total number of primary at 75, 90 and 105 DAT of five tagged plants per plot were counted and their averages were expressed in numbers.

Flowering Parameters

Days to first flower bud initiation:

Number of days taken for the first flower opening was recorded by counting the number of days taken from the date of transplanting to the stage at which the first flower bud bloomed. This was recorded from the tagged five plants and average was worked out.

Days to 50 % flowering:

The average number of days taken for 50 per cent of the plants to reach for flowering stage was recorded from five tagged plants and expressed in days.

Duration of flowering:

Duration of flowering was measured by counting the average number of days from the date of flower bud initiation up to the end of the flowering of five tagged plants.

Total number of flowers per plant:

The total number of healthy flowers per plant was counted for five tagged plants and averages were worked out and presented as the total number of flowers per plant.

Flower diameter (cm):

Size of randomly selected flowers in each plot was recorded in centimetres at the time of peak flowering as the average of distances in East-West and North-South directions.

Fresh weight of flowers (g)

Weight of individual, fully opened flowers was recorded and their average was calculated to get the fresh weight of individual flower heads.

Flower yield per plant (g)

Total weight of fresh flowers was recorded separately from the five tagged plants and their mean values were worked out and expressed in grams.

Flower yield per plot (kg)

Flower yield per plot was computed based on pooled fresh weight of flowers plucked from plants of the plot at different times and expressed in kilograms.

Quality Parameters

Shelf life of loose flowers at room temperature

Five randomly selected flowers in each treatment were kept under open condition in a 150-gauge thick polythene bag (having 5-6 holes for the aeration). Number of hours at which flowers in different treatments were found unfit for use was recorded as the shelf life of loose flowers.

Vase life of cut flowers (days)

The point of termination of vase life varied from the first sign of wilting or fading to the death of flowers. Wilting of one or two petals was taken as the end of vase life. Number of days at which flowers in different treatments were found unfit for continuing in the vase was recorded as vase life. For this purpose, flowers were harvested at half open stage. The stalks were cut to a uniform length and lower leaves were removed leaving only a few upper leaves and then the flowers were placed in 500 ml of tap water in conical flasks separately.

STATISTICAL ANALYSIS

The experimental data on all vegetative growth, flowering yield and quality parameters were tabulated and subjected to analysis of variance (ANOVA) using the module of ICAR CCARI WASP for Factorial Randomized Block Design (FRBD). Whenever the 'F' test was found significant, for comparing the means of two treatments, critical difference (CD at 5%) was used to analyses and results were presented accordingly.

RESULTS & DISCUSSION

Vegetative Parameters

Plant height (cm)

Plant height is an important growth parameter and contributes much towards the vigour of the plant. Height of the plant was recorded at 60, 75, 90 and 105 days after transplanting (DAT) and recorded significant effect (Table 1). Among the treatment significantly maximum plant height of 30.39 cm, 56.45 cm, 60.68 cm and 65.22 cm was recorded in $T_3(A_1B_3)$ Humic Acid (0.5%) combination with PSB 200 g/l of water + KSB 200 g/l of water at 60, 75, 90 and 105 DAT followed by T_7 which recorded 29.05 cm, 51.99 cm, 59.64 cm and 62.46 cm during 60 ,75, 90 and 105 DAT. Minimum plant height of 20.27 cm, 31.18 cm, 32.55 cm and 36.00 cm was recorded at 60, 75, 90 and 105 DAT in T_8 control (no spray and no drenching). The increase in plant height in T3 may be due to favorable action of biofertilizers with biostimulants which resulted in more availability of phosphorus and potassiumcertain growth substances like auxins, gibberellins, vitamins, and organic acids secreted by bioinoculants. The inoculation of KSB and PSB enhanced the cell division and enlargement and produced growth hormones while, the increase in the plant height may be due to availability of sufficient nutrients at critical stages to the plant for its luxuriant growth. These findings are in conformity with the findings of Kulkarni (1994) in China Aster, Wangs and Patil (1994) and Wangs *et al*. (1995) in Tuberose, Gupta *et al*. (1999) in Marigold.

Number of leaves per plant

The data recorded the number of leaves per plant of China Aster at 60, 75, 90 and 105 days after transplanting (DAT) as affected by biostimulants and biofertilizers with its interactions and recorded significant effect (Table 1). Among the treatment significantly maximum number of leaves per plant of 59.64, 78.51, 87.57 and 115.65 was recorded in T_3 Humic Acid (0.5%) combination with PSB 200 g/lof water + KSB 200 g/lof water at 60, 75, 90 and 105 DAT followed by T_7 which recorded 58.20, 77.43, 86.17 and 111.36 during 60 ,75, 90 and 105 DAT. Minimum number of leaves per plant of 32.73, 49.47, 60.85 and 71.31 was recorded at 60, 75, 90 and 105 DAT in T_8 control (no spray and no drenching). The results might be since organic manures are good sources of various macro and micro elements which may have resulted in maximum number of leaves. Present findings are in conformity with Chaitra and Patil (2007) in China Aster, who found an increased number of leaves in

China Aster by the application of FYM + Azotobacter + PSB and 50% RDF. Similar results were also obtained by Singh (2007) in Rose.

Leaf area (cm^2)

The data recorded the number of leaves per plant of China Aster at 60, 75, 90 and 105 days after transplanting (DAT) as affected by biostimulants and biofertilizers with its interactions and recorded significant effect (Table 1). Among the treatment significantly maximum leaf area of 364.57 cm^2, 669.00 cm^2, 1033.22 cm^2 and 1419.76 cm^2 was recorded in T_3 Humic Acid (0.5%) combination with PSB 200 g/lof water + KSB 200 g/lof water at 60, 75, 90 and 105 DAT followed by T_7 which recorded 345.35 cm^2,667.45 cm^2, 1016.39 cm^2 and 1395.72 cm^2 during 60 ,75, 90 and 105 DAT. Minimum leaf area of 211.84 cm^2, 440.00 cm^2, 642.64 cm^2 and 1119.78 cm^2 was recorded at 60, 75, 90 and 105 DAT in T_8 control (no spray and no drenching). This may be due to the effect of humic acid, KSB and PSB by stimulating the division and elongation of new cells formed on the plants. This might have increased the capacity of nutrients to induce mRNA synthesis pertaining to hydrolytic enzymes leading to increase in size of the meristematic region and thus magnify biomass production and, due to subsequent plant growth and accumulation of dry matter, stem girth occurs. This result agrees with Chandrappa *et al*. (2006) in Anthurium.

Number of primary branches per plant and Number of Secondary branches per plant:

The data recorded on stem girth of China Aster at 75, 90 and 105 days after transplanting (DAT) as affected by biostimulants and biofertilizers with its interactions and recorded significant effect (Table 2). Among the treatment significantly maximum number of primary branches per plant of 9.17, 10.67 and 10.97 was recorded in T_3 Humic Acid (0.5%) combination with PSB 200 g/lof water + KSB 200 g/lof water at 75, 90 and 105 DAT followed by T_7 which recorded 7.87, 9.47 and 10.14 during 75, 90 and 105 DAT. Minimum number of primary branches per plant of 3.10, 3.69 and 4.26 was recorded at 75, 90 and 105 DAT in T_8 control (no spray and no drenching).

The data recorded the number of secondary branches per plant of China Aster at 75, 90 and 105 days after transplanting (DAT) as affected by biostimulants and biofertilizers with its interactions and recorded significant effect (Table 2). Among the treatment significantly maximum number of secondary branches per plant of 11.23, 12.09 and 13.05 was recorded in T_3 Humic Acid (0.5%) combination with PSB 200 g/lof water + KSB 200 g/lof water at 75, 90 and 105 DAT followed by T_7 which recorded 10.33, 11.34 and 12.64 during 75, 90 and 105 DAT. Minimum number of secondary branches per plant of 5.60, 6.81 and 7.59 was recorded at 75, 90 and 105 DAT in T_8 control (no spray and no drenching). Humic substances (HS) are the major fraction of the soil organic matter which represents the final stage of a complex interaction between non-living organic matter and microbial communities. Humic acid and biofertilizer have great influence on the production of gladiolus crops. Humic acid and biofertilizer improve the ability of soil to solubilize phosphorus, potash, and nitrogen for better crop production. Different characteristics of maize were increased in the treatments where different concentrations of PSB biofertilizer were applied with humic acid. The results of the present study are in close conformity with findings of Bhalla *et al*. (2006) in gladiolus; Bihari *et al*. (2009) in rose and Jadhav *et al*. (2014) in marigold.

Flowering Parameters

Days to first flower bud initiation, Days to 50% flowering and Duration of flowering:

The data with respect to the number of days to first flower bud initiation was influenced by biostimulants and biofertilizers with its interactions and recorded significant effect (Table 3). Among the treatment significantly minimum number of days to first flower bud initiation (59.92 days) was recorded in T_3 Humic Acid (0.5%) combination with PSB 200 g/lof water + KSB 200 g/lof water followed by T_7 which recorded (60.46 days). Maximum number of days to first flower bud initiation (71.64 days) was recorded in T_8 control (no spray and no drenching).

The data with respect to the number of days to 50% flowering was influenced by biostimulants and biofertilizers with its interactions and recorded significant effect (Table 3). Among the treatment significantly minimum number of days to 50% flowering (71.21 days) was recorded in T_3 Humic Acid (0.5%) combination with PSB 200 g/lof water + KSB 200 g/l of water at 75, 90 and 105 DAT followed by T_7 which recorded (72.43 days). Maximum number of days to 50% flowering (89.48 days) was recorded in T_8 control (no spray and no drenching).

The data with respect to number of durations of flowering as influenced by biostimulants and biofertilizers with its interactions and recorded significant effect (Table 3). Among the treatment significantly maximum duration of flowering (70.00 days) was recorded in T_3 Humic Acid (0.5%) combination with PSB 200 g/lof water + KSB 200 g/lof water at 75, 90 and 105 DAT followed by T_7 which recorded (68.88 days). Minimum duration of flowering (50.84 days) was recorded in T_8 control (no spray and no drenching).

The minimum number of days to first flower bud initiation and days to 50 per cent flowering was recorded with humic acid 0.5 % and number of days to first flower bud initiation, was observed with control (71.64). This might be due to the effect of biostimulants that might have caused flower bud initiation and lead to early flowering by decreasing the concentration of ABA in plant shoots (Phengphachanh *et al.*, 2012). Moreover, as the number of leaves increased, it resulted in more photosynthesizing to initiate early flowering and complete the life cycle of the plant. The findings are in line with Sharifuzzaman *et al*. (2011) in chrysanthemum and Kumar *et al*. (2011) in carnation. The earliness of bud initiation in biofertilizers inoculated plants may be described to easy uptake of nutrients and simultaneous transport of growth promoting substances like cyotokinin to the axillary buds, resulting in breakage of apical dormancy ultimately, this has resulted in better sink for faster mobilization of photosynthetic and early transformation of plant part from vegetative to reproductive phase. The results are in line with the findings of Chanrikupure*et al*. (1999) in Limonium; Gayathri *et al*. (2004); Chaitra and Patil (2007) in China Aster; and Selva *et al*. (2007) in China Aster. The maximum duration of flowering was recorded with Humic acid @ 0.5 per cent and minimum flowering duration was observed with control. This might be due to the presence of humates which enhanced nutrient uptake, improved soil structure. The present findings are in conformity with Gupta *et al*. (2013) in chrysanthemum.

Flower diameter (cm) and Fresh weight of flower (g)

The data with respect to flower diameter was influenced by biostimulants and biofertilizers with its interactions and recorded significant effect (Table 4). Among the treatments, the highest flower diameter (7.38 cm) was recorded in T_3 Humic Acid (0.5%) combination with PSB 200 g/lof water + KSB 200 g/lof water followed by T_7 which recorded (7.19 cm). the lowest flower diameter (5.60 cm) was recorded in T_8 control (no spray and no drenching).

The data with respect to fresh weight of flower was influenced by biostimulants and biofertilizers with its interactions and recorded significant effect (Table 4). Among the treatments, the highest fresh weight of flower (2.74 g) was recorded in T_3 Humic Acid (0.5%) combination with PSB 200 g/lof water + KSB 200 g/lof water followed by T_7 which recorded (2.49 g). The lowest fresh weight of flower (1.32 g) was recorded in T_8 control (no spray and no drenching). Flower diameter and fresh weight of flowers are important parameters. The results might be due to the role of humic acid. By the application of humic substance to plants, the growing plants are supplied with food, its application also results in productive and fertile soil, which increases the water holding capacity of soil and increases the quality of flowers. Increase in the protein and mineral contents of most crops is possible by the application of humic substances. The improvement of soil properties resulted in better growth which also enhances the flowering parameters including flower diameter and fresh weight of flower. Humic acid might have increased the carbohydrate accumulation and which in turn would have hastened the flower emergence and produced a quality flower. Similar results were also obtained by Vijayalakshmi and Mathan (1997) in sunflower; Sankari *et al*. (2015) in gladiolus; Yasser *et al*. (2011) in roselle plants (hibiscus); Khenizy *et al*. (2013) in gerbera and Ahmad Ali *et al*. (2014) in tulip.

Total number of flowers per plant, Flower yield per plant (g) and Flower yield per plot (kg)

The data with respect to total number of flowers per plant was influenced by biostimulants and biofertilizers with its interactions and recorded significant effect (Table 4). Among the treatments, the significantly highest number of flowers per plant (69.76) was recorded in T_3 Humic Acid (0.5%) combination with PSB 200 g/lof water + KSB 200 g/lof water followed by T_7 which recorded (64.78). The lowest number of flowers per plant (51.31) was recorded in T_8 control (no spray and no drenching).

The data with respect to flower yield per plant was influenced by biostimulants and biofertilizers with its interactions and recorded significant effect (Figure A). Among the treatments, the highest flower yield per plant (295.56 g) was recorded in T_3 Humic Acid (0.5%) combination with PSB 200 g/lof water + KSB 200 g/lof water followed by T_7 which recorded (267.50 g). lowest flower yield per plant (110.73 g) was recorded in T_8 control (no spray and no drenching).

The data with respect to flower yield per plot was influenced by biostimulants and biofertilizers with its interactions and recorded significant effect (Figure B). Among the treatments, significantly flower yield per plot (20.95 kg) was recorded in T_3 Humic Acid (0.5%) combination with PSB 200 g/lof water + KSB 200 g/lof water followed by T_7 which recorded (17.24 kg). lowest flower yield per plot (4.70 kg) was recorded in T_8 control (no spray and no drenching). This result might be due to the positive effect of biofertilizer on soil which resulted in better yield. Bio inoculants improve the nutrient availability of the plant by addition of atmospheric nitrogen to the soil and promote vegetative growth and yield of the plant. The conversion of photosynthates into proteins results in more flower primordia and development of flower buds attributing to higher flower yield. The increase in number of spikes might be due to possible role of Azotobacter through atmospheric nitrogen fixation, better root proliferation, uptake of nutrients and water and attribute of PSB to the increased availability of phosphorus and KSB to the increased availability of potash. The results of present study are in close conformity with findings of Bhavanisankar and Vanangamudi (1999) in crossandra; Bhaskaran *et al*. (2002) in marigold; Dongardive*et al*. (2007), Srivastava and Govil (2007) and Kaushik et al. (2016) in gladiolus; Singh et al. (2008) in calendula; Meshram Nammidevi*et al*. (2008), Palagani*et al*. (2013) in chrysanthemum; Renukaradya*et al*. (2011) in carnation.

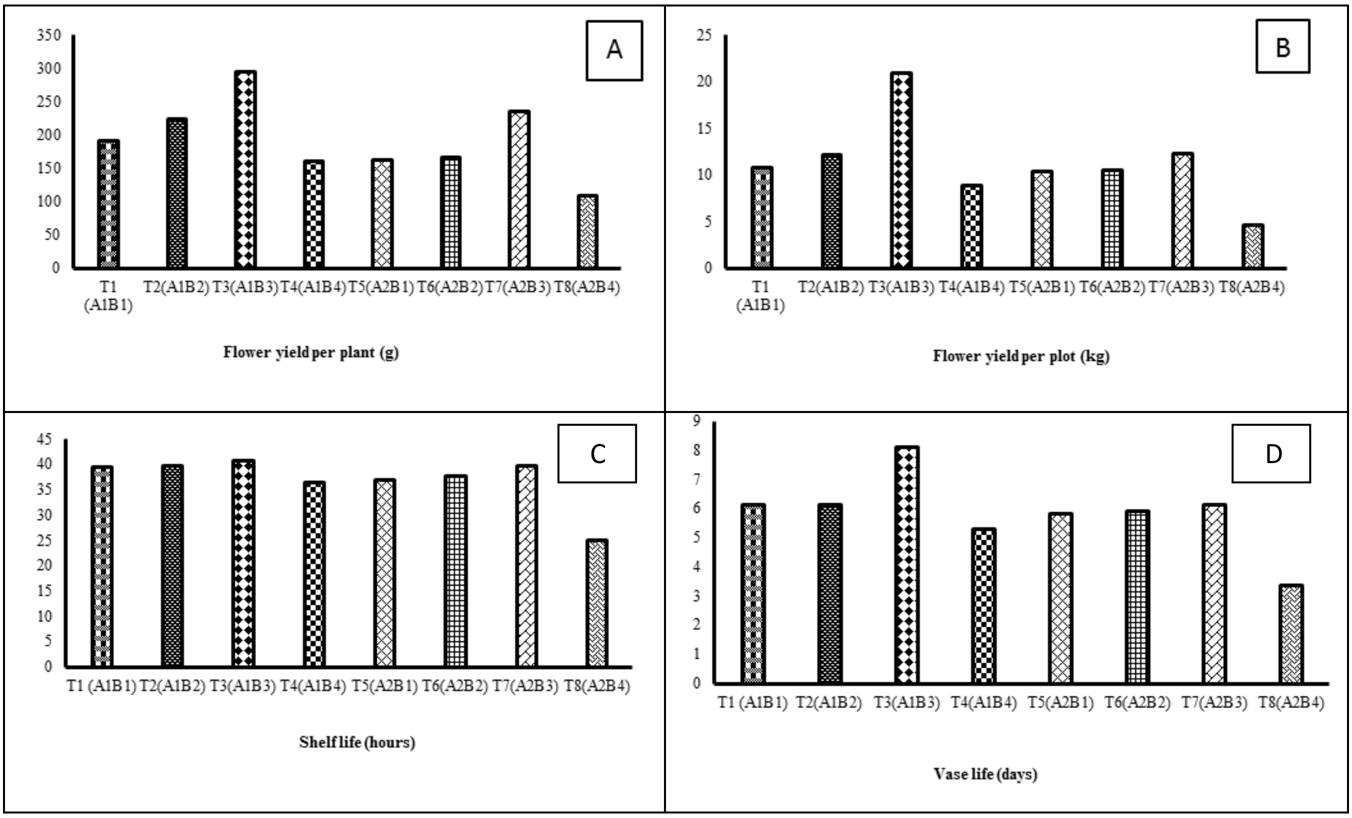
Quality Parameters

Shelf life of loose flowers at room temperature (hours) and Vase life of cut flowers (days)

The data with respect to shelf life of loose flowers was influenced by biostimulants and biofertilizers with its interactions and recorded significant effect (Figure C). Among the treatment significantly, maximum shelf life of loose flowers (69.76) was recorded in T_3 Humic Acid (0.5%) combination with PSB 200 g/lof water + KSB 200 g/lof water followed by T_7 which recorded (64.78). Minimum shelf life of loose flowers (51.31) was recorded in T_8 control (no spray and no drenching).

The data with respect to vase life of cut flowers was influenced by biostimulants and biofertilizers with its interactions and recorded significant effect (Figure D). Among the treatment significantly, maximum vase life of cut flowers (8.12 days) was recorded in T_3 Humic Acid (0.5%) combination with PSB 200 g/lof water + KSB 200 g/lof water followed by T_7 which recorded (64.78). Minimum vase life of cut flowers (51.31) was recorded in T_8 control (no spray and no drenching). This may be due to biostimulant induced photosynthesis that might have led to recombination of nutrients in flowers that is used for remaining long days. Entry of seaweed extract into the plant, might have mediated the respiration by acting as a hydrogen acceptor, thus altering the carbohydrate metabolism of plants promoting the accumulation of sugar and seaweed extract contain cytokinin and auxin that might have increased the antioxidant levels and resistance to senescence leading to enhanced longevity of stem.

Figure 1. A) Flower yield per plant, B) Flower yield per plot, C) Shelf life and D) Vase life in China aster cv.



Arka Kamini.

Table 1. Effect of biostimulants and biofertilizers on plant height (cm), number of leaves per plant and leaf area per plant (cm^2) of China aster cv. 'Arka Kamini'

Parameter	Biofertilizers / Biostimulants	Transplanting intervals											
		60 DAT			75 DAT			90 DAT			105 DAT		
		A_1	A_2	Mean	A_1	A_2	Mean	A_1	A_2	Mean	A_1	A_2	Mean
Plant height (cm)	B_1	25.77	24.81	25.29	41.68	38.96	61.16	46.27	43.56	44.91	51.49	44.78	48.13
	B_2	26.05	25.23	25.64	45.83	40.46	43.14	51.61	44.57	48.09	52.66	50.71	51.68
	B_3	30.39	27.61	29.00	56.45	46.25	51.35	60.68	58.27	59.47	65.22	59.50	62.36
	B_4	24.28	20.27	22.27	33.91	31.18	32.54	43.25	32.55	37.90	49.70	36.00	42.85
	Mean	26.62	24.48		44.47	39.21		50.45	44.74		54.77	47.75	
	CD at 5 %	Biostimulant (A) = 0.219 Biofertilizer (B) = 0.253 A X B = 0.438			Biostimulant (A) = 0.527 Biofertilizer (B) = 0.609 A X B = 1.055			Biostimulant (A) = 0.755 Biofertilizer (B) = 0.872 A X B = 0.515			Biostimulant (A) = 0.833 Biofertilizer (B) = 0.961 A X B = 1.665		
Number of leaves per plant	B_1	53.01	50.49	51.75	72.78	66.99	69.88	82.56	81.48	82.02	98.98	84.00	91.49
	B_2	55.19	51.00	53.09	74.55	69.06	71.80	84.51	81.87	83.19	102.66	88.98	95.82

	B3	59.64	56.54	58.09	78.51	75.99	77.25	87.57	84.75	86.16	115.65	106.98	111.31
	B4	40.83	32.73	36.78	58.65	49.47	54.06	65.67	60.85	63.26	83.61	71.31	77.46
	Mean	52.17	47.69		71.12	65.38		80.08	77.24		100.23	87.82	
	CD at 5 %	Biostimulant (A) = 0.602 Biofertilizer (B) = 0.696 A X B = 0.411			Biostimulant (A) = 0.740 Biofertilizer (B) = 0.854 A X B = 1.479			Biostimulant (A) = 0.626 Biofertilizer (B) = 0.722 A X B = 1.251			Biostimulant (A) = 0.821 Biofertilizer (B) = 0.948 A X B = 1.642		
Leaf Area per plant (cm^2)	**B1**	302.19	286.13	294.16	615.00	503.33	559.16	927.73	899.02	913.37	1349.40	1286.91	1318.15
	B2	325.08	292.63	308.85	629.77	561.11	595.44	998.25	917.82	958.03	1367.69	1319.48	1343.58
	B3	364.57	325.33	344.95	669.00	665.89	667.44	1033.22	999.53	1016.37	1419.76	1369.09	1394.42
	B4	233.40	211.84	222.62	483.11	440.00	461.55	708.77	672.64	690.70	1177.35	1119.78	1148.56
	Mean	306.31	278.98		599.22	542.88		916.99	872.25		1328.55	1273.82	
	CD at 5 %	Biostimulant (A) = 1.198 Biofertilizer (B) = 1.383 A X B = 2.396			Biostimulant (A) = 0.038 Biofertilizer (B) = 0.044 A X B = 0.077			Biostimulant (A) = 0.381 Biofertilizer (B) = 0.440 A X B =0.763			Biostimulant (A) = 0.667 Biofertilizer (B) = 0.771 A X B =1.335		

Table 2. Effect of biostimulants and biofertilizers on number of primary and secondary branches per plant of China aster cv. 'Arka Kamini'

Parameter	Biofertilizer / Biostimulants	Transplanting intervals								
		75 DAT			90 DAT			105 DAT		
		A1	**A2**	**Mean**	**A1**	**A2**	**Mean**	**A1**	**A2**	**Mean**
Number of Primary branches per plant	**B1**	5.49	4.96	5.22	6.84	4.96	5.90	8.15	6.64	7.39
	B2	6.34	5.22	5.78	7.67	5.22	6.44	9.00	7.56	8.28
	B3	9.17	6.42	7.79	10.67	6.42	8.54	10.97	9.18	10.07
	B4	4.83	3.10	3.96	5.00	3.10	6.55	5.16	4.26	4.71
	Mean	6.46	4.93		7.55	4.93		8.32	6.91	
	CD at 5 %	Biostimulant (A) = 0.423 Biofertilizer (B) = 0.488 A X B = 0.846			Biostimulant (A) = 0.242 Biofertilizer (B) = 0.280 A X B = 0.485			Biostimulant (A) = 0.136 Biofertilizer (B) = 0.157 A X B = 0.271		
Number of Secondary branches per plant	**B1**	8.84	7.62	8.23	10.05	8.76	9.40	10.95	9.60	10.27
	B2	9.34	8.26	8.80	10.49	9.15	9.82	11.30	9.75	10.52
	B3	11.23	9.36	10.29	12.09	10.55	11.32	13.05	12.07	12.56
	B4	6.82	5.60	6.21	7.53	6.81	7.17	8.55	7.59	8.07
	Mean	9.06	7.71		10.04	8.82		10.96	9.75	
	CD at 5 %	Biostimulant (A) = 0.157 Biofertilizer (B) = 0.182 A X B = 0.315			Biostimulant (A) = 0.142 Biofertilizer (B) = 0.164 A X B = 0.284			Biostimulant (A) = 0.107 Biofertilizer (B) = 0.124 A X B = 0.214		

Table 3. Effect of biostimulants and biofertilizers on Flowering parameters of China aster cv. 'Arka Kamini'

Parameters	Days to first flower bud initiation			Days to 50% flowering			Duration of flowering		
Biofertilizer / Biostimulant	A1	**A2**	**Mean**	A1	**A2**	**Mean**	**A1**	**A2**	**Mean**
B1	64.17	65.54	64.85	74.87	77.63	76.25	64.47	63.12	63.79
B2	60.76	65.18	62.97	74.43	75.66	75.04	65.59	63.65	64.62
B3	59.92	61.05	60.48	71.21	74.32	72.76	70.00	66.98	68.49
B4	62.99	71.64	67.31	78.99	89.48	84.23	62.67	50.84	56.75
Mean	61.96	65.85		74.88	79.27		65.68	61.15	
CD at 5 %	Biostimulant (A) = 0.707 Biofertilizer (B) = 0.816 A X B = 1.413			Biostimulant (A) = 0.678 Biofertilizer (B) = 0.783 A X B = 1.357			Biostimulant (A) = 0.754 Biofertilizer (B) = 0.870 A X B = 1.508		

Table 4. Effect of biostimulants and biofertilizers on Flowering parameters of China aster cv. 'Arka Kamini'

Parameters	Flower diameter (cm)			Fresh weight of flower (g)			Total number of flowers per plant		
Biofertilizer / Biostimulant	A1	**A2**	**Mean**	A1	**A2**	**Mean**	**A1**	**A2**	**Mean**
B1	6.51	5.63	6.07	2.11	1.92	2.01	56.46	52.99	54.72
B2	6.86	6.12	6.49	2.13	1.94	2.03	58.89	53.02	55.95
B3	7.38	7.00	7.19	2.74	2.19	2.46	69.76	59.21	64.48
B4	5.64	5.60	5.62	1.52	1.32	1.42	52.12	51.31	51.71
Mean	6.60	6.09		2.13	1.84		59.31	54.13	
CD at 5 %	Biostimulant (A) = 0.126 Biofertilizer (B) = 0.146 A X B = 0.253			Biostimulant (A) = 0.123 Biofertilizer (B) = 0.142 A X B = 0.246			Biostimulant (A) = 0.720 Biofertilizer (B) = 0.831 A X B = 1.440		

CONCLUSION

Bio-stimulants and bio-fertilizers are being widely used to enhance the overall quality of vegetative growth and flowers with extended shelf life. It could be concluded from the present investigation that, T_3 treatment sprayed with combined application of humic acid 0.5% with PSB @ 200 g + KSB @ 200 g at first spray at 40 DAT and second spray at 60 DAT of biostimulants (humic acid 0.5%) and soil application of biofertilizers (PSB @ 200 g + KSB @ 200 g) at the time of 40 days and 60 days after transplanting recorded highest vegetative growth, flowering, yield, and quality in China Aster cv. Arka Kamini. Which is followed by T_7 i.e., the combination of PSB @ 200 g + KSB @ 200 g.

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