

**EFFECTS OF ORGANIC MANURES AND BIO-FERTILIZERS ON
GROWTH, FLOWERING AND YIELD OF CHINA ASTER
(*CALLISTEPHUS CHINENSIS* L. NEES VAR. KAMINI)**

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Abstract

Effects of organic manures and bio-fertilizers on growth, flowering and yield of China aster (*Callistephus chinensis*) var. kamini was investigated. The experiment with 12 treatment combinations comprising of FYM, vermicompost and bio-fertilizers viz., phosphate solubilizing bacteria (PSB) and *Azospirillum* was conducted. All the treatment combinations showed significant response in vegetative, flowering and yield characters during the entire investigation. The treatment combinations of *Azospirillum* + PSB + vermicompost + 50% RDF was found to be promising for maximum plant height (63.97 cm), plant spread (21.50 cm), stem girth (15.47 mm), number of primary branches per plants (12.33), number of secondary branches per plants (22.14), enhanced flower bud emergence (73.33 days), stalk length (32.20 cm), number of flowers per plant (24.35), flower diameter (46.18 mm), prolonged flower duration (23.05 days), flower yield (18.87 q/ha) and seed yield (2.44 q/ha) were on par with *Azospirillum* + PSB + FYM + 50% RDF.

Introduction

China aster (*Callistephus chinensis* L. cv. kamini), a member of Asteraceae, is one of the important commercial flower crops. It is hardy, free blooming and annual flower. The wide spectrum of forms, colours (pink, blue, violet and white) and their long vase life have made it as popular cut flower. Its cultivation is becoming popular around the cities for its extensive use in making bouquets, buttonholes and garlands. In ornamental gardening, it finds a place as bedding plant, edging pot plant and herbaceous border.

Nutritional management through organic manure is helpful for enhancing yield, quality of flowers and vase life in marigold (Kumar and Sharma 2013). Generally, China aster responds very well to the application of inorganic and organic fertilizers. Bio-fertilizer usually consists of live or latent cells of microorganisms which include biological nitrogen fixers, P-solubilizing, mineralization of nitrogen and transformation of several elements into available forms. *VAM*, *Azotobacter*, *Azospirillum* and phosphate solubilizing bacteria are commonly applied bio-fertilizers in horticultural crops (Zaredost *et al.* 2014). Use of bio-fertilizers reduces per unit consumption of inorganic fertilizers and increases the quality and quantity of flowers (Syamal *et al.* 2006). Organic and bio-fertilizer like vermicompost, farm yard manure *Azotobacter* and *Azospirillum* play an important role in improving the plant growth because of major constituent in chlorophyll, protein and amino acids, resulted in increased production of green leaves. Favorable effects of organic fertilizers on growth and flower production in China aster were emphasized by many workers (Ravindra *et al.* 2013, Bohra *et al.* 2016). Hence, the present study was carried out to investigate the performance of bio-fertilizers on growth, flowering and yield of China aster (*Callistephus chinensis* L.) cv. kamini.

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Materials and Methods

A field experiment on response of bio-fertilizers on growth, flowering and yield of China aster at Instructional farm, Department of Horticulture, North-Eastern Hill University, Tura campus, Chasingre, West Garo Hills district, Tura-794002, Meghalaya, India was conducted during September, 2017 to April, 2018. Twelve treatments *viz.*, Control (100% RDF), *Azospirillum* + 75% RD 'N' + 100% RD 'P' and 'K', PSB + 75% RD 'P' + 100% RD 'N' and 'K', FYM + 50% RDF, VC + 50% RDF, *Azospirillum* + FYM + 50% RDF, *Azospirillum* + VC + 50% RDF, PSB + FYM + 50% RDF, PSB + VC + 50% RDF, *Azospirillum* + PSB + 50% RD 'N' and 'P' + 100% RD 'K', *Azospirillum* + PSB + FYM + 50% RDF and *Azospirillum* + PSB + VC + 50% RDF were compared to find out suitable dose of organic fertilizers under agro-climatic conditions of Tura. Recommended dose of nitrogen (180 kg/ha), phosphorous (120 kg/ha) and potassium (60 kg/ha) in the form of urea, single super phosphate (SSP) and murate of potash (MOP), respectively, were applied into the soil before transplanting. The experiment was laid out in RCBD with three replications. Uniform size (10 - 15 cm) of China aster seedlings cv. kamini was transplanted on raised beds at spacing 30 × 20 cm. The observations on vegetative growth, flowering and yield characters were recorded and analysed statistically as suggested by Panse and Sukhatme (1995).

Results and Discussion

Significant response of organic manures and bio-fertilizers on growth characters is presented in Table 1. Maximum plant height (63.97 cm) was associated with application of *Azospirillum* + PSB + VC + 50% RDF followed by *Azospirillum* + PSB + FYM + 50% RDF (60.33 cm) and PSB + VC + 50% RDF (50.57 cm). The increase in plant height with combination of organic manure and bio-fertilizers might be due to the increase in transport of metabolites and rate of photosynthesis in the plant, which enables the plant to have quick and better upward vegetative growth. Combination of organic manure and bio-fertilizers proved to be the best for attaining the maximum plant height (Keisam *et al.* 2014) in gladiolus.

The highest plant spread (21.50 cm) was noticed with the application of *Azospirillum* + PSB + VC + 50% RDF followed by PSB + VC + 50% RDF (19.43 cm) and *Azospirillum* + VC + 50% RDF (17.83 cm). However, the plant spread with application of *Azospirillum* + PSB + VC + 50% RDF (21.50 cm) was on par with *Azospirillum* + PSB + FYM + 50% RDF (21.11 cm). Maximum plant spread obtained might be due to formation of new cells in meristem and increased in size resulted more production of cells (Barad *et al.* 2015). Lolasuramath (2014) reported that the maximum plant height and plant spread in China aster cv. poornima were obtained with organic manure and bio-fertilizers application. Maximum stem girth showed by *Azospirillum* + PSB + VC + 50% RDF (15.47 cm) was on par with *Azospirillum* + PSB + FYM + 50% RDF (15.40 cm), while, minimum stem girth was observed in control (13.13 cm). Ravindra *et al.* (2013) stated that combination of organic manures and bio-fertilizers along with inorganic fertilizers resulted in the tallest plant, maximum number of branches and thickest stem. Increased number of primary branch and secondary branch was observed in the plot which received *Azospirillum* + PSB + VC + 50% RDF (22.14, 12.33) which was on par with the *Azospirillum* + PSB + FYM + 50% RDF (22.00, 11.67) and the *Azospirillum* + PSB + 50% RD 'N' and 'P' + 100% RD 'K' (21.67, 11.67). Significant response in vegetative growth, flowering characters and quality parameters in China aster cv. kamini was also observed by Kumar *et al.* (2016), Tomar *et al.* (2013) in marigold cv. dwarf orange.

Significant responses of organic manures and bio-fertilizers on flowering characters is presented in Table 2. Earliness in flower bud initiation showed by *Azospirillum* + PSB + VC +

50% RDF (73.33 days) followed by *Azospirillum* + PSB + 50% RD 'N' and 'P' + 100% RD 'K' (83.00 days), but was on par with VC + 50% RDF (76.33 days). The delayed flowering was observed in control (93.00 days). Earliness in flower bud initiation with organic manure and bio-fertilizer applications was also observed by Keisam *et al.* (2014) in gladiolus, Kumari *et al.* (2014) in chrysanthemum and Zaredost *et al.* (2014) in marigold.

Table 1. Effect of organic manure and bio-fertilizers on vegetative growth of China aster at Tura.

Treatments	Plant height (cm)	Plant spread (cm)	Stem girth (mm)	No. of primary branch	Number of secondary branch
T ₁ control (100% RDF)	46.20	15.40	13.13	14.33	11.08
T ₂ (<i>Azospirillum</i> + 75% RDF 'N' + 100% RD 'P' and 'K')	48.10	16.97	14.43	15.67	11.00
T ₃ (PSB + 75% RD 'P' + 100% RD 'N' and 'K')	45.07	15.13	13.20	13.33	11.18
T ₄ (FYM + 50% RDF)	49.43	16.07	15.17	20.33	12.33
T ₅ (VC + 50% RDF)	54.50	18.53	15.30	18.00	11.33
T ₆ (<i>Azospirillum</i> + FYM + 50% RDF)	54.67	20.43	15.16	16.33	12.00
T ₇ (<i>Azospirillum</i> + VC + 50% RDF)	49.47	17.83	14.82	17.00	11.67
T ₈ (PSB + FYM + 50% RDF)	52.17	20.30	15.32	18.33	12.00
T ₉ (PSB + VC + 50% RDF)	50.57	19.43	15.18	19.00	11.67
T ₁₀ (<i>Azospirillum</i> + PSB + 50% RD 'N' and 'P' + 100% RD 'K')	59.83	20.78	14.84	21.67	11.67
T ₁₁ (<i>Azospirillum</i> + PSB + FYM + 50% RDF)	60.33	21.11	15.40	22.00	11.67
T ₁₂ (<i>Azospirillum</i> + PSB + VC + 50% RDF)	63.97	21.50	15.47	22.14	12.33
C.D (p = 0.05)	2.01	1.46	0.86	1.09	0.88
CV (%)	6.63	6.31	5.24	5.79	6.77

Minimum days for colour break stage (83.74 days) was noticed under treatment with *Azospirillum* + PSB + VC + 50% RDF (83.74 cm) followed by FYM + 50% RDF (87.20 days) but was on par with PSB + FYM + 50% RDF (84.40 days). While, reduced number of days for bloom was associated with *Azospirillum* + PSB + VC + 50% RDF (91.58 days) which was on par with VC + 50% RDF (97.20 days) and *Azospirillum* + VC + 50% RDF (97.40 days). Reduction in days taken for flowering was also reported by Pandey *et al.* (2010) in chrysanthemum and Kumar *et al.* (2015) in *Dendrobium* orchid. However, highest flower stalk length (34.00 cm) was noticed with *Azospirillum* + PSB + VC + 50% RDF (32.20 cm) which was on par with *Azospirillum* + PSB + 50% RD 'N' and 'P' + 100% RD 'K' (31.50 cm) and *Azospirillum* + PSB + FYM + 50% RDF (31.51 cm). The lowest flower stalk length was observed in control (27.99 cm). These results corroborate with the findings of Dalve *et al.* (2009) where it was revealed that spike length and rachis length in gladiolus significantly increased with the application of organic manures and bio-fertilizers.

The maximum flower diameter (46.18 cm) was associated with *Azospirillum* + PSB + VC + 50% RDF (46.18 mm) which was on par with, *Azospirillum* + PSB + FYM + 50% RDF (46.14 mm) and *Azospirillum* + PSB + 50% RD 'N' and 'P' + 100% RD 'K' (45.91 mm), whereas, minimum flower diameter was noticed under control (17.79 cm). The beneficial effect on earliness

Table 2. Effect of organic manure and bio-fertilizers on flowering and yield parameters of China aster at Tura.

Treatments	Initiation of flower bud (days)	Colour break stage (days)	Full bloom (days)	Flower stalk length (cm)	Flower diameter (mm)	No. of flower buds/plant	Duration of flower (Days)	Fresh wt. of single flower (g)	Dry wt. of single flower (g)	Flower yield (q/ha)	Seed yield (q/ha)
T ₁ Control (100% RDF)	93.00	93.60	102.00	28.99	34.75	15.32	18.00	1.46	0.50	10.23	1.41
T ₂ (<i>Azospirillum</i> + 75% RDF 'N' + 100% RD 'P' and 'K')	87.00	99.00	103.80	29.52	45.13	16.65	18.33	1.54	0.64	13.06	1.31
T ₃ (PSB + 75% RD 'P' + 100% RD 'N' and 'K')	91.80	95.00	105.40	28.07	44.52	14.33	17.35	1.35	0.49	12.42	1.59
T ₄ (FYM + 50% RDF)	81.80	87.20	103.00	31.53	46.01	22.68	20.36	3.02	0.86	11.53	2.07
T ₅ (VC + 50% RDF)	82.00	88.60	97.20	30.72	45.26	19.32	20.00	1.93	0.57	13.57	2.19
T ₆ (<i>Azospirillum</i> + FYM + 50% RDF)	83.20	91.00	99.27	29.65	45.63	18.36	20.40	2.15	0.45	15.42	2.37
T ₇ (<i>Azospirillum</i> + VC + 50% RDF)	83.00	92.00	97.40	29.72	45.53	18.64	20.67	2.14	0.42	16.12	2.26
T ₈ (PSB + FYM + 50% RDF)	76.33	84.40	98.13	30.32	45.88	20.34	21.20	2.88	0.57	12.56	1.86
T ₉ (PSB + VC + 50% RDF)	87.60	92.80	99.80	29.85	45.78	20.67	20.30	2.84	0.53	12.76	1.61
T ₁₀ (<i>Azospirillum</i> + PSB + 50% RD 'N' and 'P' + 100% RD 'K')	83.00	91.20	101.40	31.50	45.91	23.33	21.32	2.59	0.59	14.20	1.27
T ₁₁ (<i>Azospirillum</i> + PSB + FYM + 50% RDF)	84.67	94.26	100.75	31.51	46.14	23.69	22.68	3.15	0.75	15.99	2.82
T ₁₂ (<i>Azospirillum</i> + PSB + VC + 50% RDF)	73.33	83.74	91.58	32.20	46.18	24.35	23.05	3.10	0.87	18.87	2.44
CD (p = 0.05)	5.50	3.88	7.76	1.18	0.69	1.46	1.86	0.18	0.05	2.99	0.13
CV (%)	5.77	3.76	6.82	6.83	7.37	7.08	7.22	7.65	7.69	7.60	6.34

in flower bud initiation, improving flower stalk length, large sized flower and number of flower buds might be due to early breaking of apical dominance followed by easy and better translocation of nutrients to the flowers, better plant growth by the increased availability of nutrients and accelerated mobility of photosynthates from source to sink as influenced by the growth hormones released or synthesized from organic manures and bio-fertilizers. These results are in accordance with the findings of Panchal *et al.* (2010) in chrysanthemum, Sharma *et al.* (2009) in China aster and Deshmukh *et al.* (2008) in gaillardia.

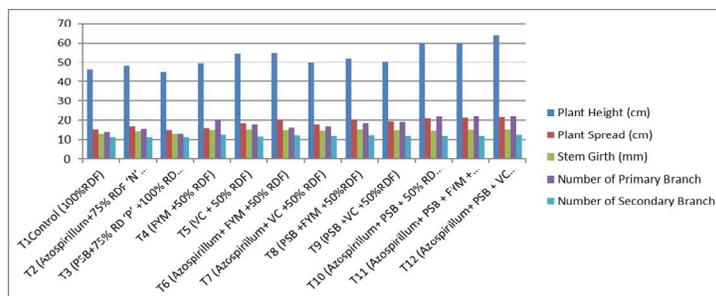


Fig. 1. Effect of bio-fertilizers on vegetative growth of China aster.

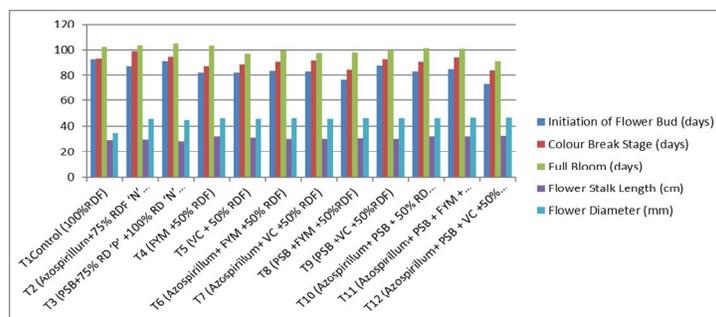


Fig. 2. Effect of bio-fertilizers on flowering parameters of China aster.

Use of *Azospirillum* + PSB + VC + 50% RDF produced highest number of flower buds per plant (24.35) which was on par with *Azospirillum* + PSB + FYM + 50% RDF (23.69) and *Azospirillum* + PSB + 50% RD 'N' and 'P' + 100% RD 'K' (23.33). Similar results were noticed by Ali *et al.* (2014) who stated that application of biofertilizers resulted in the maximum number of flowers in gladiolus. Keisam *et al.* (2014) also reported the maximum length of flower stalk, number of flowers per plant and flower weight in gladiolus, obtained with the application of organic nutrients.

Prolonged duration of flowering recorded with *Azospirillum* + PSB + VC + 50% RDF produced highest number of flower buds per plant (23.05 days) which was on par with *Azospirillum* + PSB + FYM + 50% RDF (22.68 days) and *Azospirillum* + PSB + 50% RD 'N' and 'P' + 100% RD 'K' (21.32 days). Use of *Azospirillum* + PSB + FYM + 50% RDF showed increased fresh weight of single flower (3.15 g) which was on par with *Azospirillum* + PSB + VC + 50% RDF (3.10 g) and followed by *Azospirillum* + PSB + 50% RD 'N' and 'P' + 100% RD 'K' (2.59 g). Hadwani *et al.* 2013 stated that application of integrated nutrients resulted in the longest flowering duration. Maximum number of flowers and increased fresh weight might be due to the direct response of organic fertilization which may promote cell proliferation efficiently. Moreover,

Azospirillum + PSB + VC + 50% RDF recorded maximum dry weight of single flower (0.87 g) followed by *Azospirillum* + PSB + FYM + 50% RDF (0.75 g) and *Azospirillum* + PSB + 50% RD 'N' and 'P' +100% RD 'K' (0.59 g). The minimum dry weight of single flower was associated with control (0.50 g). The increase in dry weight might be due to luxurious vegetative growth in terms of plant height, stem girth and number of branches. These results corroborate with the findings of Panchal *et al.* (2010) in chrysanthemum and Ali *et al.* (2014) in gladiolus which revealed that application of organic nutrients increased significantly fresh and dry weights. Enhanced flower yield was noted with *Azospirillum* + PSB + VC + 50% RDF (18.87q/ha) followed by *Azospirillum* + VC + 50% RDF (16.12 q/ha) which was on par with *Azospirillum* + PSB + FYM + 50% RDF (15.99q/ha), whilst lowest flower yield was associated with control (10.23 q/ha). Nevertheless, maximum seed yield was obtained from *Azospirillum* + PSB + FYM + 50% RDF (2.82 q/ha) followed by *Azospirillum* + PSB + VC +50% RDF (2.44 q/ha) which was on par with *Azospirillum* + FYM + 50% RDF (2.37 q/ha). These results are in close conformity with the findings of Thumar *et al.* (2013) in marigold and Sharma *et al.* (2009) in China aster which revealed that application of organic manures and bio-fertilizers increased significantly flower yield per plant and flower yield per hectare.

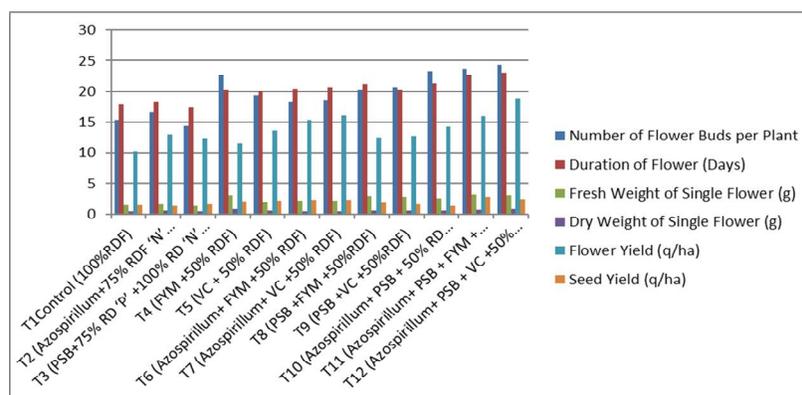


Fig. 3. Effect of bio-fertilizers on yield parameters of China aster.

Thus, the application of *Azospirillum* + PSB + VC + 50% RDF and *Azospirillum* + PSB + FYM + 50% RDF was significantly associated with growth, flowering and yield parameters of China aster. Organic manures and bio-fertilizers enhanced the growth, flowering and yield parameters of China aster as compared to inorganic used.

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