Original Research Article

Effect of liquid jeevamrutha on growth yield and quality of China aster (*Callistephus chinensis* [L.] Nees.)

Abstract: The experiment on "Effect of liquid jeevamrutha on growth yield and quality of China aster (*Callistephus chinensis* [L.] Nees.)" was carried at Department of Floriculture and Landscape Aarchitecture, K. R. C. College of Horticulture, Arabhavi. Among all the treatments, application of liquid jeevamrutha at 1500 liter per hectare at an interval of 7 days (D_3F_1) was recorded significantly higher plant height (47.98 cm and 58.78 cm at 60 and 90 DAT, respectively), plant spread (N-S) *i.e*., 17.90 26.35 and 31.31 cm at 60 and 90 DAT, respectively, plant spread (E-W) *i.e*., 27.10 and 30.35 cm at 60 and 90 DAT, respectively, number of primary branches (7.45 and 10.28 at 60 and 90 DAT, respectively), number of flowers per plant (38.42), flower yield (111.39 g/plant, 5.41 kg/plot and 8.06 t/ha, respectively), flower diameter (5.76 cm), individual flower weight (3.04 g), shelf life (3.43 days) and vase life (8.79 days) in pooled data.

Key words: China aster, liquid jeevamrutha, dosage, frequency, growth, flower yield and quality

Introduction:

China aster is one of the most popular annuals in addition to chrysanthemum and marigold. The aster is cultivated commercially in India, France, Netherlands, United Kingdom, Siberia, Russia, North America, Japan, Europe and Switzerland. In India, China aster is grown extensively in Karnataka, Tamil Nadu, Telangana, Andhra Pradesh, Maharashtra and West Bengal. In Karnataka, it is cultivated in 316 hectares, producing around 2317 MT and productivity of 7.34 tonnes per hectare (Anon, 2022) [1]. China aster is cultivated throughout the year around Bengaluru area because of its suitability and market. It is adapted to a variety of agro-climatic situations and blooms round the year and is grown all over the world. It is effectively grown in open situations for the year-round production during *kharif*, *rabi* and summer, ensuring a steady supply of flowers for the market. Commercial cultivation of China aster demands excessive usage of synthetic inputs leading to soil and environmental degradation and

also agro-ecological imbalances.

At the same time, the cost of synthetic or inorganic fertilizers is increasing enormously. These inputs are also becoming non-affordable to farmers. The excessive and indiscriminate use of chemical fertilizers and pesticides affected the beneficial soil micro flora and fauna and polluted soil and groundwater. Due to mining of nutrients by high value and commercial crops farmers are forced to add fertilizers and inputs externally. If this trend continues, we will be left with little or no chemical fertilizer reserves in future. Hence, we have to find an alternate ways to suffice the nutrient needs of crops. This is compelling the farming community to find out an alternate method which is eco-friendly, low cost, locally adoptable and enhance or maintain productivity sustainably. Growing flower crops in natural ways by adopting natural farming principles is one of the recent approaches being adopted by some farmers. The use of beejamrutha, ghanajeevamrutha and liquid jeevamrutha, besides organic mulch application in crop production, are the core practices in natural farming which are to be standardized for sustainable flower production. In this regard present study was carried out with the objective to know the effect of liquid jeevamrutha on growth yield and quality of China aster (*Callistephus chinensis* [L.] Nees.).

Material and methods:

The present investigation was carried out at Kittur Rani Channamma College of Horticulture Arabhavi, Karnataka, under the University of Horticultural Sciences, Bagalkot during *Rabi* 2020-21 and *Kharif* 2021-22. The experiment was laid out in two Factorial Randomized Block Design with fourteen treatments (3×4+2) and three replications. Factor-A includes D_1: 500 litre/ha, D_2: 1000 litre/ha and D_3:1500 litre/ha, Factor-B includes F_1: Once in week (7 days), F_2: Once in two weeks (14 days), F_3: Once in three weeks (21 days) and F_4: Once in four weeks (30 days) and these treatment combinations were compared with control treatment *i.e.*, INM: Integrated nutrient management (50% RDN through FYM (9 t/ha) + 50% RDN through inorganic fertilizer (45 kg N/ha) + 120 kg P/ha + K @ 60 Kg/ha + 20 t FYM/ha + *Azospirillum* @ 2.5 kg/ha + PSB @ 2.5 kg/ha and RPP: Recommended package of

practice (NPK @ 90:120:60 kg/ha + 20 t FYM/ha). The treatment details were given in table 1. Vegetative parameter like plant height, plant spread (N-S and E-W) and number of primary branches were taken at 30, 60 and 90 days after planting.

Table 1. Treatment combinations (D x F)

T_1	$D_1 F_1$	Application of liquid jeevamrutha @ 500 l/ha once in a week
T_2	$D_1 F_2$	Application of liquid jeevamrutha @ 500 l/ha once in two week
T_3	$D_1 F_3$	Application of liquid jeevamrutha @ 500 l/ ha once in three week
T_4	$D_1 F_4$	Application of liquid jeevamrutha @ 500 l/ha once in four week (one month)
T_5	$D_2 F_1$	Application of liquid jeevamrutha @ 1000 l/ha once in a week
T_6	$D_2 F_2$	Application of liquid jeevamrutha @ 1000l/ ha once in two week
T_7	$D_2 F_3$	Application of liquid jeevamrutha @ 1000 l/ha once in three week
T_8	$D_2 F_4$	Application of liquid jeevamrutha @ 1000 l/ha once in four week (one month)
T_9	$D_3 F_1$	Application of liquid jeevamrutha @ 1500 l/ha once in a week
T_{10}	$D_3 F_2$	Application of liquid jeevamrutha @ 1500 l/ha once in two week
T_{11}	$D_3 F_3$	Application of liquid jeevamrutha @ 1500 l/ha once in three week
T_{12}	$D_3 F_4$	Application of liquid jeevamrutha @ 1500 l/ha once in four week (one month)
T_{13}	INM	Integrated nutrient management (INM) (50% RDN through FYM (9 t/ha) + 50% RDN through inorganic fertilizer (45kg N/ha) + P @ 120 kg/ha + K @ 60 kg/ha + 20 t FYM/ha + *Azospirillum* @ 2.5 kg/ha + PSB @ 2.5 kg/ha)
T_{14}	RPP	Control (Recommended package of practice) (RPP) (NPK @ 90:120:60 kg/ha + 20t FYM/ha)

Note: Beejamrutha treatment, ghanajeevamrutha @ 1000kg per hectare at the time of planting and application of mulch was common to all the treatments except T_{13} and T_{14}, treatments were

imposed after 15 DAT

Results and discussion:

The dosage of liquid jeevamrutha @ 1500 liters per hectare (D_3) and frequency of liquid jeevamrutha applied at 7 days interval (F_1) was found better in influencing the growth parameters significantly than other dosage and frequency levels. Further, the interaction treatment D_3F_1 (liquid jeevamrutha applied @ 1500 l/ha applied at 7 days interval) resulted in higher values for all the growth parameters. Based on the pooled analysis of the two years data it was observed that, significantly higher plant height (43.28 and 56.27 cm at 60 and 90 DAT, respectively), plant spread N-S (24.92 and 28.51 cm at 60 and 90 DAT, respectively), plant spread E-W (24.19 and 25.51 cm at 60 and 90 DAT, respectively) and number of primary branches per plant (6.23 and 9.34 at 60 and 90 DAT, respectively) was recorded in D_3 (liquid jeevamrutha applied @ 1500 l/ha). Similarly, frequency of liquid jeevamrutha applied at 7 days interval (F_1) also recorded higher plant height (46.13 and 56.64 cm at 60 and 90 DAT, respectively), plant spread in both North-South (25.19 and 31.86 cm at 60 and 90 DAT, respectively) and East-West directions (24.81 and 26.68 cm at 60 and 90 DAT, respectively) and number of primary branches per plant (7.03 and 10.23 at 60 and 90 DAT, respectively). The interaction of dosage and frequency of liquid jeevamrutha applied @ 1500 liter per hectare at an interval of 7 days (D_3F_1) resulted in significantly higher plant height (47.98 cm and 58.78 cm at 60 and 90 DAT, respectively), plant spread (N-S) *i.e.*, 17.90 26.35 and 31.31 cm at 60 and 90 DAT, respectively, plant spread E-W *i.e.*, 27.10 and 30.35 cm at 60 and 90 DAT, respectively and number of primary branches (7.45 and 10.28 at 60 and 90 DAT, respectively) in pooled data.

Among the different interaction treatments, the plants applied with liquid jeevamrutha @ 1500 liter per hectare at 7 days interval (D_3F_1) was observed maximum vegetative parameters like plant height, plant spread and number of primary branches. The higher growth parameters in the above treatment might be attributed to solubilization of nutrients in soil and absorption of the same and further maintenance of good soil moisture level due to the application of jeevamrutha. Similar observation was also made by Yogananda *et al.* (2015) [2] in cowpea and Biradar (2016) [3] in French bean. Further higher doses of liquid jeevamrutha applied at regular interval stimulate the activities of micro organisms to release the nitrogen in a synchronous manner, which might have stirred the cellular activity. Further, more the presence of growth promoting hormones *viz.*, IAA and GA_3 in jeevamrutha might have favored rapid cell division and multiplication contributing to increased growth parameters

among the different levels of liquid jeevamrutha which is in accordance with the results of Palekar (2006) [4] and Neelima and Sreenivas, (2011) [5]. It also enhances the microbial activity in soil and ultimately ensuring the availability and uptake of nutrients by the crop. These results are in accordance with the findings of earlier study done by Kumbar and Deavakumar (2016) [6] in French bean and Gangadhar *et al*. (2020) [7] in chilli (Table 2).

When interaction treatments were compared with RPP (recommended package of practice) and INM (integrated nutrient management) it was revealed that, INM recorded significantly highest plant (30.31, 68.43 and 77.80 cm at 30, 60 and 90 DAT, respectively), plant spread N-S *i.e.*, 30.76, 35.73 and 42.66 cm at 30, 60 and 90 DAT, respectively, plant spread (E-W) *i.e.*, 24.97, 35.98 and 40.97 cm at 30, 60 and 90 DAT, respectively, number of primary branches (5.51, 10.08 and 13.37 at 30, 60 and 90 DAT, respectively) and also in RPP plant height (28.37, 63.68 and 74.61 cm at 30, 60 and 90 DAT, respectively), plant spread in both North-South (23.72, 33.67 and 38.26 cm at 30, 60 and 90 DAT, respectively), East-West (23.82, 34.71 and 36.10 cm at 30, 60 and 90 DAT, respectively) directions and number of primary branches per plant (5.01, 9.42 and 12.71 at 30, 60 and 90 DAT, respectively) in pooled data. In INM and RPP, significantly maximum values recorded for all the growth parameters could be attributed to the higher uptake of nutrients, particularly nitrogen (Nalina *et al*., 2009) [8]. Improved growth parameters in the present study might be due to the fact that FYM besides supplying N, P and K improves the soil condition which enhances the source to sink relationship and also makes unavailable sources of elemental nitrogen, bound phosphates, micronutrients and decomposed plant residues into available form to facilitate the plants to absorb the nutrients. These results are in agreement with the findings of earlier works done by Singh *et al*. (2015) [9] and Siddappa (2015) [10].

Flower yield parameters like number of flowers per plant and flower yield differed significantly. Significantly maximum number of flowers per plant and flower yield (32.78, 93.09 g/plant, 4.52 kg/plot and 6.70 t/ha, respectively) were recorded in D_3 (liquid jeevamrutha applied @ 1500 l/ha), F_1 (frequency of liquid jeevamrutha applied at 7 days interval) *i.e.*, 35.95, 105.13 gram per plant, 4.76 kg per plot and 7.07 tonnes per hectare and in interaction treatment D_3F_1 (liquid jeevamrutha applied @ 1500 l/ha at an interval of 7 days) *i.e.*, 38.42, 111.39 gram per plant, 5.41 kg per plot and 8.06 tonnes per hectare, respectively in pooled data (Table 3). This might be due to favourable effects of macro and micronutrients, which helps in better availability of nutrients throughout the crop growth which

might be the result of improved microbial activity in the soil. These findings are in accordance with Kasbe *et al.* (2009) [11]. The effects of interaction of dosage and frequencies of liquid jeevamrutha was significant and was observed that higher dosage of liquid jeevamrutha applied @ 1500 liter per hectare at lesser intervals (7 days interval) produced more China aster flower yield than other levels. The higher microbial activities in the rhizosphere soil and further higher enzymatic activities might have resulted in higher release of adsorbed nutrients and their uptake and also higher vegetative growth by crop might be the reason for higher flower yield in the above treatments. This jeevamrutha might have helped in decomposition of organic matter and release of available nutrients for easy uptake and utilization by the plants. These findings are in agreement with earlier studies done by Fazeel *et al*. (2019) [12], Jhade *et al*. (2020) [13] and Chaithra and sujith (2021) [14].

Table 2: Growth parameters in China aster var. AAC-1 at different growth stages as influenced by dosage and frequency of liquid jeevamrutha

Treatment	Pooled data											
	Plant height (cm)			Plant spread (cm) (North-South)			Plant spread (cm) (East-West)			Number of primary branches		
	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
Factor A: Dosage of liquid jeevamrutha (D)												
D_1: Jeevamrutha@500 l/ha	17.58	40.68^{c}	50.95^{c}	15.34	22.56^{c}	28.36^{b}	11.50	19.70^{c}	21.47^{c}	3.01	5.48^{b}	8.04^{b}
D_2 : Jeevamrutha@1000 l/ha	17.85	40.74^{b}	52.70^{b}	15.80	23.65^{b}	28.48^{a}	12.79	22.99^{b}	24.12^{b}	3.11	5.94^{b}	8.73^{ab}
D_3: Jeevamrutha@1500 l/ha	19.00	43.28^{a}	56.27^{a}	16.57	24.92^{a}	28.51^{a}	13.50	24.19^{a}	25.51^{a}	3.16	6.23^{a}	9.34^{a}
S.Em±	**1.01**	**0.18**	**0.41**	**0.75**	**0.12**	**0.05**	**0.71**	**0.14**	**0.15**	**0.11**	**0.03**	**0.06**
C.D. @ 5%	**NS**	**0.52**	**1.21**	**NS**	**0.35**	**0.16**	**NS**	**0.40**	**0.44**	**NS**	**0.08**	**0.18**
Factor B: Frequency of liquid jeevamrutha application (F)												
F_1: Once in a week (7 days)	19.92	46.13^{a}	56.64^{a}	17.48	25.19^{a}	31.86^{a}	14.14	24.81^{a}	26.68^{a}	3.74	7.03^{a}	10.23^{a}
F_2: Once in two weeks (15 days)	18.50	42.73^{b}	53.63^{b}	16.38	24.38^{b}	28.90^{b}	13.08	22.56^{b}	24.09^{b}	3.19	5.75^{b}	8.72^{b}
F_3: Once in three week (21 days)	17.33	39.29^{b}	51.92^{c}	15.77	23.13^{c}	27.70^{b}	11.91	21.52^{c}	22.78^{c}	2.83	5.40^{b}	8.21^{b}
F_4: Once in a month (30 days)	16.83	38.14^{b}	51.16^{d}	13.99	22.16^{c}	26.23^{c}	11.24	20.29^{d}	21.25^{d}	2.64	5.37^{b}	7.68^{c}
S.Em±	**1.17**	**0.20**	**0.48**	**1.12**	**0.14**	**0.53**	**0.85**	**0.16**	**0.17**	**0.30**	**0.03**	**0.07**
C.D. @ 5%	**NS**	**0.60**	**1.39**	**NS**	**0.41**	**1.59**	**NS**	**0.46**	**0.51**	**NS**	**0.11**	**0.21**
Interaction (D x F)												
D_1 F_1	18.90	44.96^{abc}	54.50^{abc}	17.64	23.77^{b}	27.95^{a}	12.67	22.38^{e}	24.12^{de}	3.61	6.63^{cde}	8.45^{bc}
D_1 F_2	17.90	39.74^{bc}	51.15^{de}	15.96	23.79^{cde}	26.90^{bc}	12.25	19.35^{g}	22.12^{g}	3.06	5.05^{de}	8.40^{bc}
D_1 F_3	17.42	37.11^{c}	50.40^{de}	14.90	21.94^{f}	27.24^{cdef}	10.98	18.98^{g}	20.52^{h}	2.70	4.81^{e}	7.87^{cd}
D_1 F_4	16.12	35.80^{d}	47.61^{e}	13.41	20.80^{f}	24.80^{def}	10.08	18.08^{h}	19.12^{i}	2.70	4.72^{e}	7.78^{d}
D_2 F_1	20.15	45.79^{a}	56.49^{a}	17.38	25.46^{a}	29.80^{a}	14.20	24.93^{b}	26.57^{b}	3.61	7.00^{a}	9.39^{a}
D_2 F_2	17.94	40.00^{ab}	54.34	16.96	24.22^{ab}	27.15^{b}	13.20	23.80^{cd}	24.82^{cd}	3.37	6.21^{ab}	7.66^{bc}
D_2 F_3	16.76	39.20^{ab}	51.09^{ab}	16.30	22.81^{cd}	27.43^{bcd}	12.03	22.37^{e}	23.58^{ef}	2.83	5.98^{bc}	7.21^{cd}
D_2 F_4	16.55	38.41^{bc}	48.36^{bcd}	14.57	22.13^{f}	24.94^{bc}	11.72	20.87^{f}	21.52^{g}	2.66	5.95^{c}	6.35^{cd}
D_3 F_1	20.69	47.98^{a}	58.78^{a}	17.90	26.35^{a}	31.31^{a}	15.57	27.10^{a}	30.35^{a}	3.90	7.45^{a}	10.28^{a}
D_3 F_2	19.67	43.54^{ab}	55.40^{abc}	17.36	26.26^{a}	28.21^{bcde}	13.80	24.53^{bc}	25.33^{c}	3.13	5.81^{bc}	7.93^{bc}
D_3 F_3	17.82	41.14^{abc}	54.45^{bcd}	16.63	26.34^{ef}	27.16^{ef}	12.72	23.20^{d}	24.25^{de}	2.95	5.38^{cd}	7.65^{d}
D_3 F_4	17.83	40.49^{abc}	51.89^{cde}	14.39	23.54^{def}	25.29^{f}	11.93	21.92^{e}	23.12^{f}	2.58	5.03^{de}	6.50^{d}
S.Em±	**2.02**	**0.80**	**0.82**	**1.75**	**0.24**	**0.43**	**1.95**	**0.27**	**0.30**	**0.40**	**0.11**	**0.28**
C.D. @ 5%	**NS**	**2.56**	**2.41**	**NS**	**0.70**	**1.29**	**NS**	**0.79**	**0.88**	**NS**	**0.35**	**0.84**
INM	30.16	68.43	77.80	30.76	35.73	42.66	24.97	35.98	40.97	5.51	10.08	13.37
RPP	28.37	63.68	74.61	23.72	33.67	38.26	23.82	34.71	36.10	5.01	9.42	12.71
S.Em±	**1.88**	**1.65**	**1.30**	**1.43**	**0.32**	**0.27**	**1.30**	**0.38**	**1.67**	**0.22**	**0.40**	**0.16**
C.D. @ 5%	**5.47**	**4.80**	**3.90**	**4.16**	**0.94**	**0.78**	**3.79**	**1.11**	**5.01**	**0.66**	**1.20**	**0.47**

Note: INM: Integrated nutrient management (50% RDN through FYM (9 t/ha) + 50% RDN through inorganic fertilizer (45 kg N/ha) + 120 kg P/ha + K @ 60 Kg/ha + 20 t FYM/ha + *Azospirillum* @ 2.5 kg/ha + PSB @ 2.5 kg/ha RPP: Recommended package of practice (NPK @ 90:120:60 kg/ha + 20 t FYM/ha) DAT: Days after transplanting
NS: Non significant

Table 3. Yield parameters in China aster var. AAC-1 as influenced by dosage and frequency of liquid jeevamrutha

Treatment	Number of flowers/plant			Flower yield/plant (g)			Flower yield/ plot (kg)			Flower yield/ hectare (t)		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
Factor A: Dosage of liquid jeevamrutha (D)												
D_1: Jeevamrutha@ 500 l/ha	31.09^{b}	28.01^{b}	29.55^{b}	82.64^{c}	79.76^{b}	81.20^{c}	3.82^{c}	3.46^{c}	3.65^{c}	5.67^{c}	5.13^{c}	5.40^{c}
D_2 : Jeevamrutha@1000 l/ha	33.25^{b}	29.27^{b}	31.26^{b}	93.14^{b}	88.72^{a}	90.93^{b}	4.28^{b}	3.70^{b}	4.00^{b}	6.38^{b}	5.92^{b}	6.15^{b}
D_3: Jeevamrutha@1500 l/ha	35.80^{a}	29.77^{a}	32.78^{a}	97.78^{a}	89.01^{a}	93.09^{a}	4.71^{a}	4.31^{a}	4.52^{a}	6.98^{a}	6.41^{a}	6.70^{a}
S.Em±	**0.17**	**0.28**	**0.14**	**0.91**	**1.12**	**1.01**	**0.07**	**0.05**	**0.05**	**0.09**	**0.10**	**0.07**
C.D. @ 5%	**0.49**	**0.83**	**0.41**	**2.67**	**3.29**	**2.97**	**0.20**	**0.15**	**0.13**	**0.25**	**0.29**	**0.20**
Factor B: Frequency of liquid jeevamrutha application (F)												
F_1: Once in a week (7 days)	37.77^{a}	34.13^{a}	35.95^{a}	107.21^{a}	103.06^{a}	105.13^{a}	4.92^{a}	4.60^{a}	4.76^{a}	7.29^{a}	6.84^{a}	7.07^{a}
F_2: Once in two weeks (15 days)	34.24^{b}	28.49^{b}	31.36^{b}	91.72^{b}	86.04^{b}	88.88^{b}	4.37^{b}	3.84^{b}	4.11^{b}	6.49^{b}	5.70^{b}	6.09^{b}
F_3: Once in three week (21 days)	31.79^{b}	27.07^{c}	29.43^{c}	85.32^{c}	78.32^{c}	81.82^{c}	4.08^{c}	3.53^{c}	3.81^{c}	6.07^{c}	5.51^{c}	5.79^{c}
F_4: Once in a month (30 days)	29.73^{c}	26.39^{d}	28.06^{c}	80.52^{d}	75.10^{c}	77.81^{d}	3.74^{d}	3.34^{d}	3.54^{d}	5.56^{d}	5.26^{c}	5.41^{d}
S.Em±	**0.19**	**0.33**	**0.16**	**1.05**	**1.30**	**1.17**	**0.08**	**0.06**	**0.05**	**0.10**	**0.12**	**0.08**
C.D. @ 5%	**0.56**	**0.95**	**1.47**	**3.08**	**3.80**	**3.43**	**0.23**	**0.17**	**0.15**	**0.29**	**0.34**	**0.23**
Interaction (D x F)												
D_1 F_1	34.73^{bc}	31.97^{a}	33.35^{bc}	96.57^{b}	93.11^{b}	95.51^{ab}	4.23^{de}	3.90^{bc}	4.07^{de}	6.27^{de}	5.78^{bc}	6.02^{de}
D_1 F_2	30.33^{cd}	27.70^{bc}	29.02^{cd}	78.89^{cde}	76.00^{c}	77.45^{bc}	4.10^{def}	3.63^{cd}	3.87^{e}	6.12^{def}	5.68^{cd}	5.75^{e}
D_1 F_3	29.90^{def}	26.80^{c}	28.35^{g}	77.73^{ef}	75.61^{d}	76.67^{cd}	3.77^{f}	3.30^{de}	3.53^{f}	5.90^{f}	5.40^{de}	5.65^{f}
D_1 F_4	29.40^{f}	25.60^{c}	27.50^{fg}	76.39^{f}	74.00^{d}	75.20^{cd}	3.20^{g}	3.03^{ef}	3.12^{g}	4.74^{g}	4.49^{ef}	4.62^{g}
D_2 F_1	38.58^{b}	33.60^{b}	36.09^{ab}	110.61^{a}	106.40^{a}	108.51^{a}	5.00^{b}	4.60^{b}	4.80^{b}	7.41^{b}	6.81^{a}	7.11^{b}
D_2 F_2	34.17^{c}	29.00^{bc}	31.59^{def}	96.22^{b}	93.45^{b}	94.95^{ab}	4.20^{de}	3.80^{bc}	4.00^{de}	6.22^{de}	5.63^{bc}	5.93^{de}
D_2 F_3	30.47^{cde}	27.13^{cd}	28.80^{cde}	85.56^{def}	79.77^{c}	82.67^{bc}	3.96^{gh}	3.27^{fg}	3.60^{h}	5.97^{gh}	5.67^{eg}	5.82^{h}
D_2 F_4	29.95^{de}	27.37^{cd}	28.66^{g}	80.18^{f}	75.26^{d}	77.72^{cd}	3.95^{gh}	3.19^{g}	3.57^{h}	5.96^{h}	5.60^{g}	5.78^{h}
D_3 F_1	40.00^{a}	36.83^{a}	38.42^{a}	113.44^{a}	109.33^{a}	111.39^{a}	5.53^{a}	5.30^{a}	5.41^{a}	8.20^{a}	7.92^{a}	8.06^{a}
D_3 F_2	38.21^{b}	28.77^{bc}	33.49^{def}	100.04^{b}	88.67^{b}	94.36^{ab}	4.80^{bc}	4.10^{b}	4.45^{c}	7.11^{bc}	6.07^{b}	6.59^{c}
D_3 F_3	35.00^{c}	27.27^{c}	31.14^{cde}	92.67^{c}	79.56^{c}	86.12^{bc}	4.50^{cd}	4.03^{bc}	4.27^{cd}	6.67^{cd}	5.98^{bc}	6.32^{cd}
D_3 F_4	30.00^{ef}	26.21^{cd}	28.11^{efg}	85.00^{cd}	76.04^{c}	80.52^{bc}	4.03^{ef}	3.83^{bc}	3.93^{e}	5.98^{ef}	5.68^{bc}	5.83^{e}
S.Em±	**0.33**	**0.56**	**0.28**	**1.82**	**2.24**	**2.02**	**0.13**	**0.10**	**0.09**	**0.17**	**0.20**	**0.13**
C.D. @ 5%	**0.97**	**1.65**	**0.82**	**5.34**	**6.58**	**5.93**	**0.39**	**0.30**	**0.27**	**0.50**	**0.58**	**0.39**
INM	53.00	45.00	49.00	152.32	143.32	147.82	7.52	7.02	7.27	11.12	10.40	10.76
RPP	51.00	43.21	47.11	145.36	130.36	137.86	7.15	6.53	6.84	10.38	9.67	10.09
S.Em±	**0.55**	**1.69**	**0.79**	**1.86**	**2.10**	**1.95**	**0.22**	**0.17**	**0.13**	**0.16**	**0.19**	**0.25**
C.D. @ 5%	**1.59**	**4.92**	**2.30**	**5.40**	**6.11**	**5.66**	**0.63**	**0.35**	**0.37**	**0.47**	**0.55**	**0.76**

Note: INM: Integrated nutrient management (50% RDN through FYM (9 t/ha) + 50% RDN through inorganic fertilizer (45 kg N/ha) + 120 kg P/ha + K @ 60 Kg/ha + 20 t FYM/ha + *Azospirillum* @ 2.5 kg/ha + PSB @ 2.5 kg/ha RPP: Recommended package of practice (NPK @ 90:120:60 kg/ha +20 t FYM/ha)

Table 4. Flower diameter, individual flower weight, shelf life and vase life in China aster var. AAC-1 as influenced by dosage and frequency of liquid jeevamrutha

Treatment	Flower diameter (cm)			Individual flower weight (g)			Shelf life (Days)			Vase life (Days)		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
Factor A: Dosage of liquid jeevamrutha (D)												
D_1: Jeevamrutha@500 l/ha	4.58^{b}	5.13^{b}	4.85^{b}	2.52^{c}	2.56^{c}	2.54^{c}	2.62	2.72^{b}	2.66^{c}	7.34^{b}	7.21^{c}	7.28^{c}
D_2 : Jeevamrutha@1000 l/ha	4.75^{a}	5.27^{a}	5.09^{a}	2.64^{b}	2.77^{b}	2.71^{b}	2.57	2.79^{b}	2.68^{b}	7.44^{a}	7.67^{b}	7.55^{b}
D_3: Jeevamrutha@1500 l/ha	4.95^{a}	5.27^{a}	5.10^{a}	2.77^{a}	2.96^{a}	2.86^{a}	2.62	3.17^{a}	2.89^{a}	7.79^{a}	7.91^{a}	7.85^{a}
S.Em±	**0.10**	**0.04**	**0.06**	**0.02**	**0.02**	**0.01**	**0.10**	**0.05**	**0.04**	**0.03**	**0.08**	**0.04**
C.D. @ 5%	**0.29**	**0.13**	**0.20**	**0.06**	**0.07**	**0.04**	**NS**	**0.15**	**0.11**	**0.09**	**0.24**	**0.11**
Factor B: Frequency of liquid jeevamrutha application (F)												
F_1: Once in a week (7 days)	5.40^{a}	5.62^{a}	5.51^{a}	2.82^{a}	3.11^{a}	2.97^{a}	2.89^{a}	3.57^{a}	3.23^{a}	8.23^{a}	8.40^{a}	8.32^{a}
F_2: Once in two weeks (15 days)	5.15^{b}	5.39^{b}	5.27^{b}	2.72^{b}	2.81^{b}	2.76^{b}	2.67^{a}	3.00^{b}	2.83^{b}	7.61^{b}	7.53^{b}	7.57^{b}
F_3: Once in three week (21 days)	4.67^{c}	5.26^{b}	4.96^{c}	2.59^{c}	2.64^{c}	2.62^{c}	2.51^{b}	2.57^{c}	2.54^{c}	7.32^{b}	7.44^{b}	7.38^{c}
F_4: Once in a month (30 days)	3.82^{d}	4.63^{c}	4.22^{d}	2.45^{d}	2.51^{d}	2.48^{d}	2.35^{b}	2.45^{c}	2.40^{d}	6.95^{b}	7.04^{c}	7.00^{d}
S.Em±	**0.11**	**0.05**	**0.07**	**0.02**	**0.03**	**0.02**	**0.12**	**0.06**	**0.04**	**0.04**	**0.09**	**0.04**
C.D. @ 5%	**0.33**	**0.15**	**0.20**	**0.07**	**0.08**	**0.05**	**0.35**	**0.17**	**0.13**	**0.11**	**0.28**	**0.13**
Interaction (D x F)												
D_1 F_1	5.09^{ab}	5.53^{abc}	5.31^{ab}	2.76^{a}	3.01^{b}	2.88^{a}	2.77	3.23^{bcd}	3.00^{b}	8.02^{abc}	7.77^{ab}	7.89^{ab}
D_1 F_2	5.03^{abc}	5.29^{bc}	5.16^{abcd}	2.57^{abc}	2.56^{d}	2.57^{cd}	2.60	2.90^{de}	2.75^{bc}	7.35^{cde}	6.87^{cde}	7.11^{de}
D_1 F_3	4.53^{abcd}	5.05^{c}	4.80^{def}	2.42^{bc}	2.36^{d}	2.38^{d}	2.57	2.50^{ef}	2.53^{cd}	7.20^{cde}	7.27^{cdef}	7.23^{e}
D_1 F_4	3.68^{cde}	4.63^{f}	4.16^{ef}	2.35^{bc}	2.32^{d}	2.34^{d}	2.53	2.25^{f}	2.39^{cd}	6.83^{e}	6.97^{efg}	6.90^{e}
D_2 F_1	5.22^{abc}	5.62^{ab}	5.44^{a}	2.84^{a}	3.11^{a}	2.97^{a}	2.83	3.67^{a}	3.25^{a}	8.05^{ab}	8.50^{abc}	8.28^{b}
D_2 F_2	5.01^{bc}	5.42^{cde}	5.21^{abc}	2.76^{ab}	2.80^{cd}	2.79^{ab}	2.70	3.00^{de}	2.85^{bc}	7.53^{cde}	7.72^{abcd}	7.63^{abcd}
D_2 F_3	4.92^{abcd}	5.37^{bc}	5.11^{cdef}	2.65^{abc}	2.70^{cd}	2.66^{c}	2.57	2.30^{ef}	2.43^{cd}	7.30^{de}	7.53^{bcd}	7.43^{bcd}
D_2 F_4	3.83^{e}	4.62^{d}	4.23^{f}	2.35^{abc}	2.50^{bc}	2.43^{c}	2.20	2.20^{f}	2.19^{cd}	6.88^{e}	6.93^{g}	6.91^{g}
D_3 F_1	5.67^{a}	5.89^{a}	5.76^{a}	2.87^{a}	3.20^{a}	3.04^{a}	3.07	3.80^{ab}	3.43^{a}	8.63^{a}	8.94^{a}	8.79^{a}
D_3 F_2	5.43^{ab}	5.46^{ab}	5.44^{bcd}	2.83^{a}	3.07^{a}	2.94^{a}	2.70	3.10^{bcd}	2.90^{ab}	7.95^{abc}	8.00^{abc}	7.98^{abc}
D_3 F_3	4.53^{bcde}	5.34^{abc}	4.93^{bcd}	2.71^{a}	2.87^{cd}	2.80^{ab}	2.40	2.90^{de}	2.65^{cd}	7.46^{cde}	7.50^{def}	7.48^{def}
D_3 F_4	3.93^{de}	4.56^{d}	4.27^{def}	2.65^{abc}	2.70^{cd}	2.68^{ab}	2.33	2.90^{de}	2.62^{d}	7.15^{de}	7.23^{fg}	7.19^{fg}
S.Em±	**0.12**	**0.38**	**0.13**	**0.04**	**0.05**	**0.03**	**0.20**	**0.10**	**0.07**	**0.06**	**0.16**	**0.08**
C.D. @ 5%	**0.36**	**1.13**	**0.38**	**0.12**	**0.14**	**0.08**	**NS**	**0.30**	**0.22**	**0.19**	**0.48**	**0.23**
INM	6.91	7.21	7.06	3.30	3.42	3.36	2.90	3.10	3.00	7.47	8.17	7.87
RPP	6.81	7.10	6.95	3.25	3.39	3.32	2.30	2.80	2.55	7.00	7.80	7.40
S.Em±	**0.12**	**0.37**	**0.14**	**0.05**	**0.04**	**0.03**	**0.20**	**0.10**	**0.07**	**0.06**	**0.15**	**0.07**
C.D. @ 5%	**0.34**	**1.06**	**0.41**	**0.13**	**0.13**	**0.09**	**0.59**	**0.30**	**0.21**	**0.17**	**0.45**	**0.21**

Note: INM: Integrated nutrient management (50% RDN through FYM (9 t/ha) + 50% RDN through inorganic fertilizer (45 kg N/ha) + 120 kg P/ha + K @ 60 Kg/ha + 20 t FYM/ha + *Azospirillum* @ 2.5 kg/ha + PSB @ 2.5 kg/ha RPP: Recommended package of practice (NPK @ 90:120:60 kg/ha +20 t FYM/ha)

The interaction treatments were compared with RPP and INM showed that, significantly maximum number of flowers per plant and flower yield were recorded in INM (49.00, 147.82 g/plant, 7.27 kg/plot and 10.76 t/ha, respectively) and RPP (47.11, 137.86 g/plant, 6.84 kg/plot and 10.09 t/ha, respectively) in pooled data. In INM more yield was due to indirect effect of more number of branches as estimated and developed by the influence of inorganic fertilizers along with organic manures and biofertilizers and also may be due to proper nitrogen, phosphorus and potassium assimilation from the NPK in association with more nitrogen fixing and phosphorus solubilizing proficiency and secretion of hormones by the biofertilizers similar results were obtained by Kumar *et al*. (2022) [15] in China aster. The increased yield in RPP was due to the supply of nutrients through FYM and chemical fertilizer might be attributed to the quick release and availability of nutrients in required quantity with the application of fertilizers. Further, FYM acts as store house for various micro and macro nutrients that are released during the process of mineralization. The results are supported with the findings of Mahapatra *et al.* (2017) [16] and Gorabal (2020) [17].

The dosage and frequency of liquid jeevamrutha also influenced the flower diameter (cm) and individual flower weight (g) significantly. The dosage D_3 (liquid jeevamrutha applied @ 1500 l/ha) *i.e.*, 5.10 cm and 2.86 g, respectively, frequency F_1 (frequency of liquid jeevamrutha applied at 7 days interval) *i.e.*, 5.51 cm and 2.97 g, respectively and their interaction D_3F_1 (liquid jeevamrutha applied @ 1500 l/ha at an interval of 7 days) *i.e.*, 5.76 cm and 3.04 g, respectively, produced significantly maximum flower diameter and individual flower weight respectively than other levels and frequencies of liquid jeevamrutha application. This might be due to direct response of crop to organic manures which may promote cell proliferation efficiently. Cell division and cell enlargement are accelerated by ample supply of nitrogen which initiates meristematic activity in crop. Similar results were obtained by Chaupoo and Kumar (2020) [18] in marigold.

When INM and RPP were compared with other interaction treatments, it was found that significantly maximum flower diameter and individual flower weight was recorded in INM (7.06 cm and 3.36 g, respectively) and RPP (6.95 cm and 3.32 g, respectively) than rest of the interaction treatments (Table 4). In INM Inoculation of *Azospirillum* and PSB, enhanced the cell division and enlargement and also produced growth hormones, which is possible reason for increased floral characters. The beneficial effect of nitrogen and phosphorus nutrient on flower size and weight of flower might be due to the fact

that nitrogen increases the protein synthesis, thus promote the development of floral primordia, while phosphorus found involved in formation of floral premodial resulting increased flower diameter and weight. The results were inconfirmity with Chaitra and Patil (2007) [19] in China aster.

Shelf life and vase life of flower is an important parameter which decides the durability and marketability of flowers. In the present investigation jeevamrutha application @ 1500 liter per hectare once in 7 days led to higher shelf life (3.43 days) and vase life (8.79 days) of flower than other levels and frequencies of application in pooled data (Table 4). The higher shelf life and vase life in flowers might be due to application of organic manures which influenced flower longevity due to the increased nutrient uptake by plant and greater development of water conducting tissues. Similar results were reported by Sendhilnathan *et al.* (2017) [20] in marigold.

Conclusion:

From the present study it can be concluded that, among the jeevamrutha treatments, application of liquid jeevamrutha @ 1500 litre per hectare once in 7 days registered significantly the highest vegetative growth, floral characters and shelf life with more flower yield per hectare. However, INM and RPP registered significantly highest vegetative growth with more flower yield per hectare than all the natural farming treatments. Hence, for cultivation of China aster, soil application of liquid jeevamrutha @ 1500 litre per hectare once in 7 days was found better among all the natural farming treatments.

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