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EFFECT OF FOLIAR APPLICATION OF LIQUID ORGANICS IN CHINA ASTER (*CALLISTEPUS CHINENSIS* L. NEES)

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ABSTRACT

A field experiment was conducted to evaluate foliar spraying of different liquid organics (Sea weed extract, *Jeevamrutha* and *Kunapajala*) in two cultivars (Arka Archna White and Phule Ganesh Violet) of China aster cultivated in plots fertilized with enriched FYM (15 t ha^{-1}) and enriched vermicompost (5 t ha^{-1}), separately. Three foliar spraying of sea weed extract (0.3%), *jeevamrutha* (3.0%) and *Kunapajala* (10.0%) were done at 20, 35 and 50 days after transplanting of China aster plants. The entire experiment was laid out in factorial randomized block design with three replications. The results of this experiment indicated that foliar spraying of *Jeevamrutha* (3.0%) enhanced the overall plant growth parameters (plant spread, number of leaves, branches, roots and length of root) in China aster. However, the maximum height of the plant in Arka Archna White was recorded with foliar application of sea weed extracts (0.3%) and in Phule Ganesh Violet with foliar application of *Jeevamrutha* (3.0%). The flowering parameters like days for first flower bud initiation, full blooming, wilting, flowering duration and flower diameter were found to best with foliar application of *Jeevamrutha* (3.0%) in both the cultivars. However, flowers with longest stalk were harvested from the plants received foliar application of sea weed extract (0.3%). The foliar application of *Jeevamrutha* (3.0 %) also resulted the maximum number of flowers per plant, maximum weight of 10 fresh flowers and maximum yield of flowers in both the cultivars. The highest benefit: cost ratio of 2.24 was calculated from the same treatment in the China aster variety Arka Archna White. The longest vase life China aster was recorded in the flowers harvested from plants received foliar application of *Kunapajala* (10.0 %). The plant growth parameters and flower quality in terms of flower diameter and stalk length were found to be better in Phule Ganesh Violet than Arka Archna White. However, the maximum yield of flower was recorded in the cultivar Arka Archna White.

Key words : China aster, Liquid organics, Foliar application.

Introduction

China aster (*Callistephus chinensis* L. Nees), popularly known as aster, belongs to the family Asteraceae and native of Northern China (Navalinskien *et al*., 2005). It is semi-hardywinter annual plant cultivated for attractive flowers. The flowers are borneither on erect or spreading type of branches either solitary or as in cluster. Thus,it offers uses both as cut and loose flowers. Further, a wide range coloursmake this flower among the top three popular flowers in India after chrysanthemum and marigold (Sheela, 2008). Successful cultivation of China aster can be carried out in varied agro-climatic conditions under open fields without affecting the flower quality and easily be propagated through seeds. Hence, it is becoming the one of the choicest commercial flowers to the growers' throughout India.

Nutritional aspect plays a vital role in respect of yield and quality flower production. Balanced nutrition along with high yielding varieties, China aster can produce higher yield with excellent quality of flowers. To restore the soil health using organic sources of fertilizers is the major goal of sustainable horticultural system. The key mechanism to harness sustained yield of high-quality flowers is the combined use of several nutrient sources for the growing plants. The right combination of nutrient sources is essential for production of healthy plants that can flower profusely for a prolonged period (Sultana *et al*., 2006 and Zhang *et al*., 2010). Presently, liquid sources organic fertilizers are widely practiced in sustainable horticultural system. Since, liquid organics have quick stimulating effects on plant growth and developmental process. Several kinds of liquid organics are popular among the growers. Among them, *Jeevamrutha* is cow-based liquid organic manure and known to one of the four pillars of ZBNF (Zero Budget Natural Farming) (FAO, 2016). Another, *Kunapajala*, a liquid organic manure reported to be good source of plant nutrientsderived from bone marrow, flesh from any horned animal (sheep, goat, fish, etc.), milk, honey, *Sesamum indicum* L. (*Tila*), and *Vigna mungo* (Masha) (Pathak and Ram, 2013; Biswas and Das, 2023). Additionally, both these organicshave insecticidal properties (Pathak and Ram, 2013). Further, extracts derived from marine brown algae (*Ascophyllum nodosum*) have made a significant position in the list of popular liquid organics under sustainable horticultural production due to presence of plant essential elements and phytohormones in the extracts (Bhattacharyya *et al*., 2015). Keeping the importance of the liquid organics in sustainable horticultural system, an investigation was carried out to find out the effects of liquid organics on growth and flower yield of China aster. The economics of the cultivation was also worked out.

Materials and Methods

The present investigation was carried out at Instructional Farm (26.40°N and 89.38°E), Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India. The soil of experimental site was sandy to sandy loam with pH 5.61. The available N, P and K of the experimental soil were 120.2, 15.88 and 106.11 kg ha^{-1}, respectively. Half of the parts of the experimental field were fertilized with enriched FYM @ 15 t ha^{-1} and rest part manured with enriched vermicompost @ 5 t ha^{-1} two weeks before transplanting. The control plots were fertilized with well-rotted FYM @ 15 t ha^{-1}. The enriched FYM and vermicompost were prepared by mixing the materials with 10 g Azophos (*Azotobacter chroococcum* and *Acinetobacter* sp.) and kept in shed for 20 days before application. The available NPK of applied FYM and vermicompost are mentioned in Table 1. Two varieties of China aster *viz*., Arka Archana White and Phule Ganesh Violet were transplanted in both the parts (*i.e.*, plots fertilized with enriched FYM and enriched vermicompost) of the entire experimental field in 1.2 m × 1.2 m plots at 30 cm × 30 cm spacing comprising 16 plants per plot during third week of December. The foliar spraying of liquid organics [*Jeevamrutha* (3.0%), *Kunapajala* (10.0%) and Seaweed Extract(0.3%)] were done at 20, 35, 50 days after transplanting (DAT). Thus, the treatments were plants transplanted in the plots fertilized with enriched FYM @ 15 t ha^{-1} receiving foliar application of *Jeevamrutha* (3.0%), *Kunapajala* (10.0%) and seaweed extract (0.3%) separately and plots fertilized with enriched vermicompost @ 5 t ha^{-1} receiving foliar application of the above-mentioned liquid organics separately, including control plots (well-rotted FYM @ 15 t ha^{-1}). The available nitrogen, phosphorus and potassium ofusedfarm yard manure (FYM) and vermicompost as well as enriched FYM and enriched vermicompost have been analysed before application in the experiment which is presented in Table 1. The entire experiment was laid out in Factorial Randomized Block Design (FRBD) with three replications (Gomez and Gomez, 1984).

Cost of cultivation of China aster was calculated based on the cost concepts given by the expert committee (GoI, 1980). The gross income was calculated on the basis of China aster yield for each treatment under 1.0 ha

Table 1 : Analysis of available NPK of used and applied enriched FYM and vermicompost.

Name of organic manures	N (%)	P (%)	K (%)
Farm yard manure	0.56	0.40	0.52
Vermicompost	1.50	0.80	0.65
Enriched Farm yard manure	0.81	0.52	0.74
Enriched Vermicompost	2.04	1.77	1.06
% increase in enriched FYM	44.64	30.00	42.30
% increase in enriched Vermicompost	36.00	121.25	63.07
Analysing methods	Jackson (1958)	Bray and Kurtz (1945)	Jackson (1958)

land area, considering the current selling price of China aster (Rs. 50.00 per kg as loose flower) through rigorous survey of local markets. The net income per hectare for each treatment was also worked out.

Results and Discussion

Effect of liquid organics on plant growth

The foliar application of liquid organics significantly improved the plan growth parameters of China aster (Table 2). The maximum height of China aster plant was recorded with foliar application of sea weed extract (0.3%) cultivated in the plots fertilized with enriched vermicompost (5 t ha^{-1}). Sea weed extract contains a significant amount of phytohormones like auxins and gibberellins that might be responsible for apical dominance and increasing the internodal length of the plant, resulting maximum height of the plant (Bhattacharyya *et al*., 2015). Similar finding is also reported in China aster (David *et al*., 2023). However, the plant spread of China aster was noted maximum with foliar application of *Jeevamrutha* (3.0%) in the plants cultivated in plots containing enriched vermicompost (5 t ha^{-1}). The same treatment combination also produced maximum number of leaves, branch and roots per plant. The maximum length of the root was recorded in the plants received foliar application of *Jeevamrutha* (3.0%) and cultivated in plots containing enriched vermicompost (5 t ha^{-1}). *Jeevamrutha* is considered to be an excellent source of cytokinins and gibberellins (Nitin and Purohit, 2021). The cytokinin in *Jeevamrutha* might regulate the auxin transport to promote number of shoots in China aster (Waldei and Leyser, 2018). Further, gibberellins in *Jeevamrutha* might be responsible for increasing the internodal length of the branches that ultimately increased plant spread of China aster, which received foliar application of *Jeevamrutha* (3.0%). Increased root length in *Jeevamrutha* (3.0%) treated plants might be due to action of cytokinin. Since, root apical dominance is reported to be regulated by cytokinin (Aloni *et al*., 2006). Application of *Jeevamrutha* helps to increase the plant growth parameters was also reported in tomato (Gopal and Gurusiddappa, 2014). All the plant growth parameters were found to be the best in Phule Ganesh Violet over Arka Archana White. Variations on growth habit in these China aster cultivars were also reported earlier (Rai *et al*., 2017).

Effect of liquid organics on flowering of China aster

Significant variations on flowering of China aster were recorded with the foliar application of liquid organics (Table 3). The earliest initiation of flower bud in Arka Archana White was recorded in the plants received foliar

Table 2 : Effect of foliar application of liquid organics on plant growth of China aster.

Treatments	Plant height (cm)		Plant spread (cm)		Leaves plant^{-1}		Branch plant^{-1}		Roots plant^{-1}		Root length (cm)	
	AAW	PGV	AAW	PGV	AAW	PGV	AAW	PGV	AAW	PGV	AAW	PGV
Control (well-rotted FYM @ 15 t ha^{-1})	57.13	109.00	59.34	54.22	126.56	166.00	19.78	22.33	20.75	21.67	14.79	17.03
Enriched FYM @ 15 t ha^{-1}+ *JM* @ 3 %	66.68	129.22	63.72	61.39	142.89	194.11	22.78	34.67	24.50	30.33	20.70	22.09
Enriched FYM @ 15 t ha^{-1}+ *KJ* @ 10 %	66.28	126.33	55.35	58.94	126.78	184.44	21.78	28.33	21.00	27.83	17.40	19.13
Enriched FYM @ 15 t ha^{-1}+ SWE @ 0.3%	68.66	131.50	62.67	60.00	132.44	187.33	22.33	31.44	22.50	27.50	18.52	20.80
Enriched VC @ 5 t ha^{-1}+ *JM* @ 3 %	67.40	128.89	57.70	61.00	148.22	200.00	24.11	34.78	27.33	29.17	21.52	22.50
Enriched VC @ 5 t ha^{-1}+ *KJ* @ 10%	65.99	125.89	59.11	59.67	127.78	185.44	21.22	30.56	21.17	26.17	18.90	17.60
Enriched VC @ 5 t ha^{-1}+ SWE @ 0.3%	71.19	131.78	56.58	57.50	130.00	193.00	22.89	33.00	22.17	28.17	20.86	21.57
CD @ 5.0 % Treatments (T)	5.42		3.21		6.78		2.81		1.55		0.55	
CD @ 5.0 % Variety (V)	2.89		2.54		3.62		1.50		0.83		1.02	
CD @ 5.0 % Treatments × Variety (T × V)	7.62		6.13		9.58		3.97		2.19		1.45	

FYM= Farm yard manure, VC= Vermicompost, *JM = Jeevamrutha*, *KJ= Kunapajala*, SWE= Sea weed extract; AAW = Arka Archana White, PGV = Phule Ganesh Violet.

Table 3 : Effect of foliar application of liquid organics on flowering of China aster.

Treatments	Days for first flower						Flowering duration (days)		Flower diameter (cm)		Stalk length (cm)	
	Bud initiation		Full blooming		Wilting							
	AAW	PGV	AAW	PGV	AAW	PGV	AAW	PGV	AAW	PGV	AAW	PGV
Control (well-rotted FYM @ 15 t ha^{-1})	79.11	79.62	18.59	25.70	9.44	11.00	58.71	61.67	4.55	4.88	18.08	25.63
Enriched FYM @ 15 t ha^{-1}+ *JM* @ 3%	74.47	73.44	15.56	18.00	13.44	19.89	60.00	67.33	5.12	5.86	21.53	30.92
Enriched FYM @ 15 t ha^{-1}+ *KJ* @ 10%	74.78	79.11	16.33	24.10	11.22	13.56	61.11	68.67	4.93	5.27	19.16	30.77
Enriched FYM @ 15 t ha^{-1}+ SWE @ 0.3%	72.53	77.22	16.44	22.22	13.33	18.67	60.00	66.33	5.69	6.05	21.97	33.39
Enriched VC @ 5 t ha^{-1}+ *JM* @ 3 %	74.22	73.03	15.11	17.22	12.67	19.78	61.78	67.67	5.32	5.35	20.49	33.60
Enriched VC @ 5 t ha^{-1}+ *KJ*@ 10%	75.89	77.33	15.89	24.67	10.67	14.22	63.56	68.33	4.84	5.15	18.74	29.23
Enriched VC @ 5 t ha^{-1}+ SWE @ 0.3%	76.71	74.52	16.00	23.89	12.11	17.44	59.18	63.22	6.08	6.12	24.30	33.39
CD @ 5.0 % Treatments (T)	1.68		1.60		1.82		0.55		0.23		1.53	
CD @ 5.0 % Variety (V)	0.90		0.85		0.97		0.83		0.13		0.83	
CD @ 5.0% Treatments × Variety (T × V)	2.38		2.26		2.57		2.19		3.39		2.17	

FYM= Farm yard manure, VC= Vermicompost, *JM = Jeevamrutha, KJ= Kunapajala,* SWE= Sea weed extract; AAW = Arka Archana White, PGV = Phule Ganesh Violet.

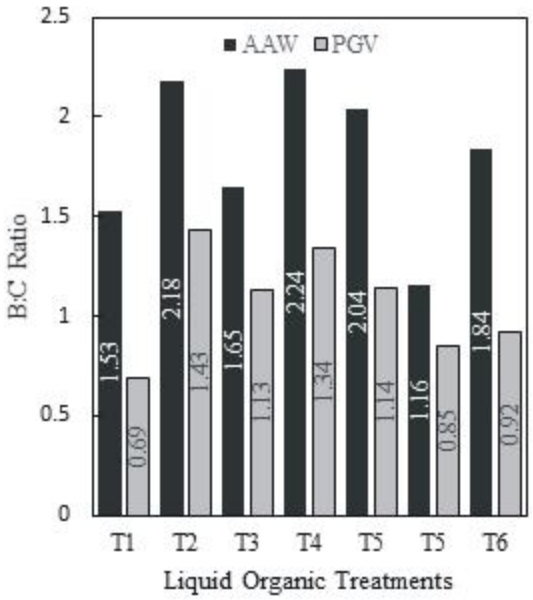

Fig. 1 : Effect of foliar application of liquid organics on B:C ratio of China aster [AAW = Arka Archana White, PGV = Phule Ganesh Violet].

application of sea weed extract (0.3%) cultivated in plots fertilized with enriched FYM @ 15 t ha^{-1}. Foliar application of sea weed extract induces earliness in flowering of China aster was also reported earlier (Pandya *et al.*, 2023). However, earliest flower bud initiation in Phule Ganesh Violet was observed with foliar application of *Jeevamrutha* (3.0%) cultivated in plots containing enriched vermicompost (5 t ha^{-1}). Earliness in flowering with the foliar application of *Jeevamrutha* is also reported earlier (Jhade *et al.*, 2020). This same treatment combination was also responsible for requirement of minimum days to come into full blooming of first flower bud in both the cultivars of China aster. The maximum days required to wilt the first flower bud in both the cultivars was recorded in the plants received foliar application of *Jeevamrutha* (3.0 %) planted in plots containing enriched FYM @ 15 t ha^{-1}. Overall, minimum days required to first flower bud initiation and first flower bud blooming were recorded in Arka Archana White than Phule Ganesh Violet. However, the first flower bud of China aster cultivar Phule Ganesh Violet wilted later than Arka Archana White. The China aster plants planted in plots containing enriched vermicompost (5 t ha^{-1}) and received foliar application of *Kunapajala* (10.0%) exhibited maximum duration of flowering. *Kunapajala* is a well-known growth promoter for plants since *Vedic*times (Sarkar *et al.*, 2014; Mukherjee *et al.*, 2023). These findings are in the line of the results reported on tomato by Deshmukh *et al.* (2012). The cultivar Phule Ganesh Violet had longer flowering duration than Arka Archana White. China aster cultivars are genetically

Table 4 : Effect of foliar application of liquid organics on flower yield and vase life of China aster.

Treatments	Flowers plant^{-1}		Flowers plot^{-1}		Weight of 10 fresh flowers (g)		Flower yield (t ha^{-1})		Vase life (days)	
	AAW	PGV	AAW	PGV	AAW	PGV	AAW	PGV	AAW	PGV
Control (Only well-rotted FYM @ 15 t ha^{-1})	73.44	50.13	1175.04	802.08	18.88	18.47	7.48	5.00	8.33	8.67
Enriched FYM @ 15 t ha^{-1}+ *JM* @ 3 %	86.22	59.67	1379.52	954.72	21.45	23.69	9.98	7.63	10.67	9.55
Enriched FYM @ 15 t ha^{-1}+ *KJ* @ 10 %	80.22	57.00	1283.52	912.00	20.30	22.98	8.79	7.07	10.89	10.78
Enriched FYM @ 15 t ha^{-1}+ SWE @ 0.3%	83.78	55.67	1340.48	890.67	22.74	24.75	10.28	7.44	8.67	9.89
Enriched VC @ 5 t ha^{-1}+ *JM* @ 3 %	86.33	61.11	1381.28	977.78	23.78	23.67	11.08	7.81	10.22	8.96
Enriched VC @ 5 t ha^{-1}+ *KJ*@ 10%	77.67	58.12	1242.72	929.92	19.73	22.57	8.27	7.08	11.33	10.18
Enriched VC @ 5 t ha^{-1}+ SWE @ 0.3%	81.44	52.46	1303.04	839.36	23.74	24.89	10.44	7.05	9.82	8.44
CD @ 5.0% Treatments (T)	1.96		31.34		1.01		1.06		0.88	
CD @ 5.0% Variety (V)	1.05		16.75		0.54		0.43		0.47	
CD @ 5.0% Treatments × Variety (T × V)	2.77		44.32		1.42		1.37		1.25	

FYM= Farm yard manure, VC= Vermicompost, *JM* = *Jeevamrutha*, *KJ*= *Kunapajala*, SWE= Sea weed extract; AAW = Arka Archana White, PGV = Phule Ganesh Violet.

diverse in nature and a significant variation on flowering parameters had been reported earlier (Rai *et al.*, 2017). The flowers with maximum floral diameter and longest stalk were harvested from the plants received foliar application sea weed extract (0.3%) planted in plots containing enriched vermicompost (5 t ha^{-1}). The flowers of Phule Ganesh Violet had maximum floral diameter with longest stalk. Similar findings were also reported by David *et al*. (2023).

Effect of liquid organics on flower yield and vase life

The foliar application of liquid organics significantly improved the flower yield and vase life of China aster (Table 4). The plant received foliar application of *Jeevumrutha* (3.0%) and planted in plots manured with enriched vermicompost produced maximum numbers flowers per plant, flowers per plot, maximum weight of flowers and flower yield irrespective of cultivars. Plant growth regulators (GA and cytokinin) present in liquid organic *Jeevumrutha* (3.0%) might be helped to increase the number of flower buds in China aster and thereby improve the yield of flowers (Nitin and Purohit, 2021). Further, microbes in *Jeevumrutha* (3.0%) and enriched vermicompost assisted theprocess of solubilization of the fixed form of plant essential elements present in soil (Sreenivasa *et al*., 2009). Moreover, application of vermicompost in soil helps to enhance the water retention capacity and boost up the fertility status of the field through addition of plant essential nutrients in the soil (Lazcano and Domínguez, 2011). Application of *Jeevumrutha* helped to increase the yield is also reported in ground nut (Veeranna *et al*., 2023). All the above flower yield parameters and vase life of flowers were recorded better in the China aster cultivar Arka Archna White than Phule Ganesh White. The longest vase life was noted in the flowers which were harvested from the plants received foliar application of *Kunapajala* (10.0%) and planted in plots manured with enriched vermicompost. Similar findings related to vase life of China aster were also reported in Arka Archana White (Santhosh *et al*., 2020) and Phule Ganesh Violet (Zosiamliana *et al*., 2012).

Effect of liquid organics on production economics of China aster

The data regarding economics of the experiment (treatment wise cost of cultivation, gross return and net return) for a one-hectare land area is presented in Table 5. Based on the highest flower yield recorded with foliar application of *Jeevumrutha* (3.0%) and planted in plots manured with enriched vermicompost (3 t^{-1}ha), the gross income and net income of China aster was also calculated

Table 5 : Effect of foliar application of liquid organics on gross and net return of China aster.

Treatments	Cost of cultivation (Rs)		Gross Return (Rs)		Net Return (Rs)	
	AAW	PGV	AAW	PGV	AAW	PGV
Control (Only well-rotted FYM @ 15 t ha^{-1})	148050	148050	374180.65	249868.36	226130.65	101818.36
Enriched FYM @ 15 t ha^{-1}+ *JM* @ 3 %	157050	157050	499093.58	381476.48	342043.58	224426.48
Enriched FYM @ 15 t ha^{-1}+ *KJ* @ 10 %	166050	166050	439466.09	353485.46	273416.09	187435.46
Enriched FYM @ 15 t ha^{-1}+ SWE @ 0.3%	158850	158850	514135.38	371806.60	355285.38	212956.60
Enriched VC @ 5 t ha^{-1}+ *JM* @ 3 %	182050	182050	554013.39	390359.82	371963.39	208309.82
Enriched VC @ 5 t ha^{-1}+ *KJ*@ 10%	191050	191050	413549.08	354000.47	222499.08	162950.47
Enriched VC @ 5 t ha^{-1}+ SWE @ 0.3%	183850	183850	521753.24	352370.75	337903.24	168520.75

FYM= Farm yard manure, VC= Vermicompost, *JM = Jeevamrutha*, *KJ= Kunapajala*, SWE= Sea weed extract; AAW = Arka Archana White, PGV = Phule Ganesh Violet.

to be the highest from the same plot. The variety Arka Archana White resulted the maximum net return as it recorded the maximum yield of flowers than Phule Ganesh Violet. The lowest income was recorded from the control plots. Similarly, the maximum benefit: cost ratio (BCR) was calculated from foliar application of *Jeevumrutha* (3.0%) and planted in plots manured with enriched vermicompost (3 t^{-1} ha) in the variety Arka Archna White (Table 5). The results are in the line of the findings of Singh *et al.* (2018).

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