

Original Research Article

Effect of *Durvillaeapotatorum* and *Ascophyllumnodosum* seaweed extracts on growth and yield of China aster cv. Arka Archana under Prayagraj agro climatic conditions

ABSTRACT

The present investigation entitled, **Effect of *Durvillaeapotatorum* and *Ascophyllumnodosum* seaweed extracts on growth and yield of China aster cv. Arka Archana under Prayagraj agro climatic conditions** was undertaken in the Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during rabi season (2022). The experiment was laid out in Randomized block design (RBD) with 13 treatments and each treatment was replicated thrice. The treatments comprised of 2ML/L & 4ML/L *Ascophyllumnodosum* and 2ML/L & 4ML/L *Durvillaeapotatorum* seaweed extracts at 5, 10 and 15 days interval along with control. Among the treatments, treatment T9 (2ML/L *Ascophyllumnodosum* @ 15 days) recorded maximum plant height (53.41cm), number of leaves (172.78), number of branches (25.40), plant spread (53.33cm), flower yield per plant (367.15g), flower yield per plot (2202.92g), flower yield per hectare (23.13t). However, control (water spray) recorded minimum in all the parameters. Thus, it was concluded that foliar applications of 2ML/L *Ascophyllumnodosum* @ 15 days interval seaweed extract could be a promising option for yield enhancement.

Keywords: *Ascophyllumnodosum*, *Durvillaeapotatorum*, *China aster*, *Seaweed extracts*.

Introduction

China aster, scientifically known as *Callistephus chinensis*, belongs to the family Asteraceae, is one of the most demanding winter annual flowers ranks third just next to Chrysanthemum and Marigold (Sheela, 2008). The genus named 'Callistephus' was derived from the Greek words 'Kalistos' meaning 'most beautiful' and 'Stephos' meaning 'a crown'. China aster name indicates a star and the flower is no less than a star in its appearance and vibrance. It is

Comment [A1]: Include general objective at the beginning, Experimental design used, treatments (quantity and its repetitions), parameters evaluated, analyzes used and the most important results.

Comment [A2]: Include results of other previous studies, in addition the general objective is not observed at the end of the introduction

native to China and has spread to Europe and other tropical countries during 1731 AD (**Desai, 1967**). It was first named by Linnaeus as *Aster chinensis* and later Nees changed this name to *Callistephus chinensis* (**Janakiram, 2001**). The present-day asters have been developed from a single form of wild species, *Callistephus chinensis*.

China aster (*Callistephus chinensis*) is a half-hardy annual, plant with erect, branches having hispid hair, leaves are rearranged alternately on branches, broadly ovate or triangular-ovate, deeply and irregularly toothed and the flowers are solitary. The evolution of China aster was a history of remarkable variations. The original plant had single flowers with two or four rows of blue, violet or white ray florets. The stature was medium tall, 18 to 24 inches in height. The first change in the flower type had been the prolongation or development of central florets and the production of quality flowers. The aster blooms contain two kinds of florets, ray florets and disc florets. The disc florets are short while, the ray florets are usually long. The bloom type depends mainly upon the relative number of the two kinds of florets and their shapes.

Plant growth has been said to benefit from the use of liquid seaweed extract (**Mettinger et al., 1990**). It has been used in agriculture for many years (**Crouch, 1990**). In the North Atlantic Ocean, *Ascophyllum nodosum* is a well-known species of brown algae (Phaeochyceae) (**Verkleij, 1992**). Seaweed extracts have been used as soil conditioners and as a foliar spray to increase growth, yield, and productivity of many crops (**Norrie and Keathley, 2006**). According to a report by FAO (2006), a significant amount of seaweeds (15 million metric tonnes annually) are used as supplements for nutrients and biostimulants for the production of agricultural and horticultural crops.

The use of bio-stimulants generally increases nutrient uptake as well as nutrient use efficiency, thereby reducing the consumption of artificial fertilizers, which affect soil health tremendously. Plant biostimulants (PBs) such as protein hydrolysates and seaweed extracts are attracting the increasing interest of scientists and vegetable growers for their potential to enhance yield and nutritional quality. The concept of biostimulants has been researched since 1933 (**Yakhinet et al., 2017**) but has gained attention more in recent years as a potential solution to mitigate the negative impacts of a changing climate on agriculture. Seaweed extracts are but one of the inputs that are classed as biostimulants. Biostimulants are the materials other than the fertilizers that promote the plant growth when applied in minute quantities and are also referred as metabolic enhancers. Further, they promote the plant

growth besides improving yield and quality. The use of biostimulants, which has the capacity to beneficially modify plant growth, has grown dramatically over the past decade (Vinuthaet al, 2017)

Moreover, seaweed and seaweed-derived products have been widely used as amendments in crop production systems due to the presence of a number of plant growth-stimulating compounds. Seaweeds, as compared to terrestrial organisms, produce different stress-related compounds that are essential for their survival in these environments (Shukla et al., 2016). As such, selected seaweed resources are important sources of plant biostimulants and are widely used to promote agricultural productivity (Khan et al., 2009; Sharma et al., 2014; Van Oosten et al., 2017). Concerning their growth and flowering possibilities, the effectiveness of algae in ornamental plants has been validated.

However, the research related to use of seaweed extracts in China aster is meagre. Hence, in view of the above facts the present study was formulated to study the effect of seaweed extracts on growth, flower quality and yield of China aster cv. 'ArkaArchana'

Materials and Methods

The present investigation entitled “Effect of *Durvillaeapotorum* and *Ascophyllumnodosum* seaweed extracts on growth and yield of China aster cv. ArkaArchana under Prayagraj agro climatic conditions” was conducted during the winter season 2022, at Horticulture research field, Department of Horticulture, Naini Agricultural Institute, SHUATS, Prayagraj (U.P). Under open field condition, the soil was prepared to a fine tilth and raised beds of 3.0 m x 1.0 m were prepared. Healthy seedlings of China aster cv. ArkaArchana (White) 45 days old were planted at 30 cm x 30 cm spacing. The experiment used a Randomized Block Design (RBD), with thirteen treatments and three replications. Treatments consisted of T0-Control, T1 -2ML/L *Durvillaeapotorum* @ 5 days interval, T2 - 2ML/L *Durvillaeapotorum* @ 10 days interval, T3 -2ML/L *Durvillaeapotorum* @ 15 days interval, T4 -4ML/L *Durvillaeapotorum* @ 5 days interval, T5 - 4ML/L *Durvillaeapotorum* @ 10 days interval T6 -4ML/L *Durvillaeapotorum* @ 15 days interval T7 -2ML/L *Ascophyllumnodosum* @ 5 days interval, T8 - 2ML/L *Ascophyllumnodosum* @ 10 days interval T9 - 2ML/L *Ascophyllumnodosum* @ 15 days interval, T10 - 4ML/L *Ascophyllumnodosum* @ 5 days interval ,T11 -4ML/L *Ascophyllumnodosum* @ 10 days interval ,T12 - 4ML/L *Ascophyllumnodosum* @ 15 days

Comment [A3]: More procedurally describe the experiment setup process so that readers can replicate the experiment

used statistical analysis and software?

list the formulas used

interval. The observations that were recorded are plant height (cm), number of leaves, number of branches, plant spread (cm), flower yield per plant (g), flower yield per plot (g), flower yield per hectare (t) at 90 DAT and were statistically analyzed.

Results and discussion

The effect of seaweed extract on growth and yield of China aster cv. Arka Archana are presented in Table 1 and 2 respectively.

Growth parameters

Plant height (cm) – At 90 DAT, among all the treatments T₉ (2ML/L *Ascophyllum nodosum* @ 15 days interval) recorded maximum plant height (53.41 cm) which was significantly superior to all the treatments and it was followed by T₁₂ (4ML/L *Ascophyllum nodosum* @ 15 days interval) (52.39 cm). Whereas T₀- Control (Water spray) recorded minimum plant height (39.73 cm). The possible reason for the better plant height might be due to *Ascophyllum nodosum*, which is responsible for cell enlargement, cell division, and internodal elongation due to the presence of growth regulators such as auxins and cytokinins. It contains macro and micro nutrients that improve the use of chemical fertilizers by increasing cell division and cell expansion. As a result, plant height increases and vegetative development accelerates. **Hegdeet al. (2018)** found similar results in chrysanthemum, **Tartilet al. (2016)** in pot marigold, **Kahkashanet al. (2017)** in tuberose, and **Praveen et al. (2020)** in rose.

Number of leaves per plant – At 90 DAT, among all the treatments T₉ (2ML/L *Ascophyllum nodosum* @ 15 days interval) recorded maximum number of leaves (172.78) which was significantly superior to all the treatments and it was followed by T₁₂ (4ML/L *Ascophyllum nodosum* @ 15 days interval) (159.55). Whereas T₀- Control (Water spray) recorded minimum number of leaves (90.00). The presence of cytokinins and auxin precursors, as well as macro and micronutrients, resulted in increased cell division and cell expansion, resulting in rapid vegetative development. Auxin and cytokinins also have a direct impact on plant architecture by directing the establishment, maintenance, and growth of shoot apical and axillary meristems. The findings are consistent with previous findings in marigold by **Machado et al. (2014)** and **Rajarajan et al. (2014)**.

Number of branches – At 90 DAT, among all the treatments, T₉ (2ML/L *Ascophyllum nodosum* @ 15 days interval) recorded maximum number of branches (25.40) which was significantly superior to all the treatments and it was followed by T₁₂ (4ML/L

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Improve reference format

Improve considering material and methods

Ascophyllumnodosum @ 15 days interval) (24.07). Whereas T₀- Control (Water spray) recorded minimum number of branches (18.41).

It is possible that *Ascophyllumnodosum* includes auxins, specifically IAA, which aids in the production of adventitious roots and promotes greater growth. Cytokinins found in the seaweed extract *Ascophyllumnodosum* stimulated lateral growth by triggering axillary bud sprouting (Selvakumari and Venkatesan, 2017). Bhargavi et al. (2018) reported similar findings in chrysanthemum, Hegde et al. (2018) in chrysanthemum, Praveen et al. (2020) in rose, and Tartilet et al. (2016) in pot marigold.

Plant spread (cm) - At 90 DAT, among all the treatments, T₉ (2ML/L *Ascophyllumnodosum* @ 15 days interval) recorded maximum plant spread (53.33 cm) which was significantly superior to all the treatments and it was followed by T₁₂ (4ML/L *Ascophyllumnodosum* @ 15 days interval) (52.00 cm). Whereas T₀- Control (Water spray) recorded minimum plant spread (44.00 cm). The presence of plant growth regulators and nutrients in seaweed extract *Ascophyllumnodosum* may be responsible for the increase in vegetative development in terms of plant spread. These could have influenced cellular metabolism in treated plants, resulting in improved vigour and growth. Similar effects were observed in rose by Praveen et al. (2020).

Flower yield parameters

Number of flower yield /plant (g)- Among all the treatments, T₉ (2ML/L *Ascophyllumnodosum* @ 15 days interval) recorded maximum flower yield per plant (367.15g) which was significantly superior to all the treatments and it was followed by T₁₂ (4ML/L *Ascophyllumnodosum* @ 15 days interval) (290.92 g). Whereas T₀- Control (Water spray) recorded minimum flower yield per plant (159.99 g). The increase might be attributed to increased vegetative development, which generated more photosynthates and likely directed them towards increased flower output. More leaves per plant might be the cause of the rise in flowers since more leaves would produce and accumulate more photosynthates in the sink, where they would be used to create new cells and increase the number of flowers produced. Similar findings were reported by Russo et al. (1994) in marigold, Hegde et al. (2016) in chrysanthemum, Tartilet et al. (2016) in pot marigold, Bhargavi et al. (2018) in chrysanthemum, Praveen et al. (2020) in rose and Majeed Khadim Al-Hamzawi (2019) in Chinese carnation and Gazania splendor.

Number of flower yield/plot (g) – Among all the treatments, T₉ (2ML/L *Ascophyllumnodosum* @ 15 days interval) recorded maximum flower yield per plot (2202.92g) which was significantly superior to all the treatments and it was followed by T₁₂ (4ML/L *Ascophyllumnodosum* @ 15 days interval) (1745.54g). Whereas T₀- Control (Water spray) recorded minimum flower yield per plant (959.92g). The increase could be attributable to an increase in vegetative growth that resulted in the production of more photosynthates, which were likely redirected toward increasing flower production. The increased number of flowers could be attributed to the plant having more leaves, which would have led to the production and accumulation of maximum photosynthates for the sink and their utilization for the construction of new cells, resulting in an increase in flower production. Similar findings were reported by **Russo et al. (1994)** in marigold, **Pruthviet al. (2016)** in chrysanthemum, **Tartilet al. (2016)** in pot marigold, **Bhargaviet al. (2018)** in chrysanthemum, **Praveen et al. (2020)** in rose and **MajeedKhadim Al-Hamzawi (2019)** in Chinese carnation and *Gazania splender*.

Number of flower yield /hectare (t) -Among all the treatments, T₉ (2ML/L *Ascophyllumnodosum* @ 15 days interval) recorded maximum flower yield per hectare (23.13 t) which was significantly superior to all the treatments and it was followed by T₁₂ (4ML/L *Ascophyllumnodosum* @ 15 days interval) (18.32 t). Whereas T₀- Control (Water spray) recorded minimum flower yield per hectare (10.08 t). The higher yield may be due to better uptake of nutrients like nitrogen, phosphorus and synthesis of carbohydrates, proteins. This resulted in the better growth of plant in terms of plant height, plant spread, number of branches. There by it results in the higher yield according to the findings of **Pruthviet al. (2016)** in chrysanthemum, **Bhargaviet al. (2018)** in chrysanthemum and **Haideret al. (2012)** in potato.

CONCLUSION

Based on the findings of the current study, it can be concluded that treatment T₉ (2 ML/L *Ascophyllumnodosum* @ 15 days interval) was effective in enhancing China aster growth and yield. The usage of seaweed as a method to increase crop yield is an environmentally beneficial practice, according to the current study. In order to get the maximum flower yield, it may be advised to spray the China aster plants with (2 ML/L *Ascophyllumnodosum* at 15-day intervals).

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Table 1. Growth parameters of effect of seaweed extracts on China aster cv. ArkaArchana

Notation	Treatment combination	Plant height (cm)	Number of leaves per plant	Number of branches	Plant spread (cm)
T ₀	Control	39.73	90.00	18.41	44.00
T ₁	2 ML/L <i>Durvillaeaprotatorum</i> @ 5 days interval	48.92	100.11	19.10	51.44
T ₂	2 ML/L <i>Durvillaeaprotatorum</i> @ 10 days interval	47.86	99.44	19.75	44.44
T ₃	2 ML/L <i>Durvillaeaprotatorum</i> @ 15 days interval	44.24	104.55	21.09	51.00
T ₄	4 ML/L <i>Durvillaeaprotatorum</i> @ 5 days interval	49.00	102.00	20.87	44.33
T ₅	4 ML/L <i>Durvillaeaprotatorum</i> @ 10 days interval	46.94	119.33	23.30	49.77
T ₆	4 ML/L <i>Durvillaeaprotatorum</i> @ 15 days interval	48.70	129.00	20.30	47.77
T ₇	2 ML/L <i>Ascophyllumnodosum</i> @ 5 days interval	47.84	91.67	20.17	48.44
T ₈	2 ML/L <i>Ascophyllumnodosum</i> @ 10 days interval	50.13	133.77	22.63	50.00
T ₉	2 ML/L <i>Ascophyllumnodosum</i> @ 15 days interval	53.41	172.78	25.40	53.33
T ₁₀	4 ML/L <i>Ascophyllumnodosum</i> @ 5 days interval	46.64	139.44	21.53	44.66
T ₁₁	4 ML/L <i>Ascophyllumnodosum</i> @ 10 days interval	48.92	141.00	22.07	51.22
T ₁₂	4 ML/L <i>Ascophyllumnodosum</i> @ 15 days interval	52.39	159.55	24.07	52.00
	Sem (±)	2.05	1.98	0.42	2.06
	CD (5%)	6.01	5.80	1.22	6.02

Table 2. Yield parameters of effect of seaweed extracts on China aster cv. ArkaArchana

Notation	Treatment combination	Flower yield/plant (g)	Flower yield/plot (g)	Flower yield/hectare (t)
T ₀	Control	159.99	959.92	10.08
T ₁	2 ML/L <i>Durvillaeaprotatorum</i> @ 5 days interval	218.90	1313.38	13.79
T ₂	2 ML/L <i>Durvillaeaprotatorum</i> @ 10 days interval	206.86	1241.14	13.03
T ₃	2 ML/L <i>Durvillaeaprotatorum</i> @ 15 days interval	201.55	1209.28	12.69
T ₄	4 ML/L <i>Durvillaeaprotatorum</i> @ 5 days interval	206.52	1239.14	13.01
T ₅	4 ML/L <i>Durvillaeaprotatorum</i> @ 10 days interval	256.73	1540.40	16.17
T ₆	4 ML/L <i>Durvillaeaprotatorum</i> @ 15 days interval	265.59	1593.53	16.73
T ₇	2 ML/L <i>Ascophyllumnodosum</i> @ 5 days interval	206.72	1240.30	13.07
T ₈	2 ML/L <i>Ascophyllumnodosum</i> @ 10 days interval	228.08	1368.50	14.37
T ₉	2 ML/L <i>Ascophyllumnodosum</i> @ 15 days interval	367.15	2202.92	23.13
T ₁₀	4 ML/L <i>Ascophyllumnodosum</i> @ 5 days interval	186.61	1119.66	11.75
T ₁₁	4 ML/L <i>Ascophyllumnodosum</i> @ 10 days interval	221.96	1331.76	13.98
T ₁₂	4 ML/L <i>Ascophyllumnodosum</i> @ 15 days interval	290.92	1745.54	18.32
	Sem (±)	13.23	79.43	0.83
	CD (5%)	38.64	231.85	2.43

UNDER PEER REVIEW

