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Studies on the effect of biostimulants on growth and yield of cut flower of Chrysanthemum (*Dendranthema grandiflora*) cv. Denjigar white

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Abstract
The experiment entitled- "Effect of Biostimulants on growth and yield of cut flower of Chrysanthemum (*Dendranthema grandiflora*) cv. Denjigar White" was conducted during the *Rabi* season of the year 2020-2021 at Ammapuram (V), Thorrur (M), Mahabubabad district. Among the treatments, the treatment T_2 (*Ascophyllum nodosum* @ 5 ml L^{-1}) recorded maximum plant height (64.49 cm), plant spread in North- South direction (29.50 cm), plant spread in East-West direction (29.43 cm), number of branches $plant^{-1}$ (16.37), minimum days taken for 1st bud initiation (66.28 days), days taken for 50% bud initiation (75.55 days), number of flowers $plant^{-1}$ (23.29), flower yield $hectare^{-1}$ (348.00 q) and maximum flowering duration (46.03 days) was recorded by T_8 treatment (Fulvic acid 10% + Seaweed 8% + Spirulina 6% @ 4 g L^{-1}). However, control (water spray) recorded minimum in all the parameters.

Keywords: Bio stimulants, chrysanthemum, Denjigar White, *Ascophyllum nodosum*

Introduction
Flowers and flowering plants have been a fascinating part of our life. Chrysanthemum (*Dendranthema grandiflora*) is a most beautiful and oldest flowering plant, commercially grown in different parts of the world. Chrysanthemum occupies a prominent place in ornamental horticulture and is one of the commercially exploited flower crop, belongs to the family 'Asteraceae' and referred as "Queen of the East", "Autumn Queen", and "Guldaudi" having diploid chromosome number 2n=18.

The word "Chrysanthemum" comes from two Greek words, *Chrysos* - golden and *anthos* - flower which means golden flower. It is native to the Northern hemisphere and is widely distributed in Europe and Asia. However, the origin of chrysanthemum is China (Carter, 1990) [2].

After green revolution, the indiscriminate use of chemical fertilizers has lead to negative impact on environment. To mitigate this, biostimulants have been emerged as a supplement to the mineral fertilizers and hold a promise to improve the yield as well as quality of the crop under protected conditions (Rawat and Vishal, 2002) [9].

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' (Zhang and Schmidt, 1997) [14]. Keeping in view, the need and importance of biostimulants, the present investigation was conducted with an objective to study the effect of biostimulants on growth, yield and quality of cut flower of Chrysanthemum (*Dendranthema grandiflora*) cv. Denjigar White.

Materials and Methods
The present investigation entitled "Effect of Biostimulants on growth and yield of cut flower of chrysanthemum (*Dendranthema grandiflora*), cv. Denjigar White" was carried out during the *Rabi* season of the year 2020-2021 at season of the year 2020-2021 at Ammapuram (V), Thorrur (M), Mahabubabad district. Healthy and rooted terminal cuttings were planted on the raised beds at a spacing of 15 cm x 15 cm under polyhouse. The design adopted was Randomized Block Design with nine treatments and replicated thrice. Treatments included T_1 - *Ascophyllum nodosum* @ 2.5 ml L^{-1}, T_2- *Ascophyllum nodosum* @ 5 ml L^{-1}, T_3- Rhodophyte extract @ 0.2 g L^{-1}, T_4- Rhodophyte extract @ 0.4 g L^{-1}, T_5- Potassium humate @ 1.5 g L^{-1}, T_6- Potassium humate @ 3 g L^{-1}, T_7- Fulvic acid 10% + Seaweed 8% +

Spirulina 6% @ 2 g L^{-1}, T_8- Fulvic acid 10% + Seaweed 8% + Spirulina 6% @ 4 g L^{-1}, T_9- Control (Water spray). These biostimulants were sprayed on the foliage at 3 intervals *i.e.*, @ 30, 45 and 60 days after transplanting (DAT) and the observations recorded were plant height (cm), plant spread N-S (cm), plant spread E-W (cm), number of branches $plant^{-1}$ at 45, 60 and 75 days after transplanting, days taken for 1st bud initiation and 50% bud initiation (days), number of flowers $plant^{-1}$, flower yield $hectare^{-1}$ (q) and flowering duration (days) were recorded and the data were statistically analysed.
Schedule of spray: 30, 45 and 60 days after transplanting (DAT).

Results and Discussion

The effect of biostimulants on growth and yield of cut flower of chrysanthemum (*Dendranthema grandiflora*), cv. Denjigar White and the results of the experiment were presented in Table 1 to 6.

Plant height (cm)

With respect to the growth parameters in chrysanthemum, treatment T_2 (*Ascophyllum nodosum* @ 5 ml L^{-1}) recorded maximum plant height 41.08 cm**,** 54.74 cm and 64.49 cm at 45, 60 and 75 days after transplanting respectively. Whereas T_9- Control (Water spray) recorded minimum plant height 28.62 cm, 45.68 cm and 53.77 cm at 45, 60 and 75 days after transplanting respectively. It is due *Ascophyllum nodosum* is responsible for the cell enlargement, cell division and internodal elongation because it contains growth regulators like auxins and cytokinins. It contains macro and micro nutrients which increases the cell division and cell enlargement with better utilization of chemical fertilizers. Thus it results in the increase of plant height and in rapid vegetative growth. Similar findings were reported by Hegde *et al*. (2018) [4] in chrysanthemum, Tartil *et al.* (2016) [12] in pot marigold, Kahkashan *et al.* (2017) [5] in tuberose and Praveen *et al.* (2020) [8] in rose.

Plant spread North – South (cm)

Irrespective of the treatments plant spread increased gradually after the foliar spray of biostimulants, among the treatments, T_2 (*Ascophyllum nodosum* @ 5 ml L^{-1}) recorded highest plant spread in North – South direction 18.98 cm, 25.05 cm and 29.50 cm at 45, 60 and 75 days after transplanting respectively. Whereas T_9- Control (Water spray) recorded lowest plant spread in North – South direction 13.56 cm, 18.35 cm and 22.71 cm at 45, 60 and 75 days after transplanting respectively. According to the findings were reported by Praveen *et al.* (2020) [8] in rose, Lingwal *et al.* (2017) in strawberry. The increase in vegetative growth in terms of plant spread in North-South direction may be attributed due to the presence of plant growth regulators and nutrients in sea weed extract *Ascophyllum nodosum.* These might have affected the cellular metabolism in treated plants leading to increased vigour and growth.

Plant spread East – West (cm)

The data recorded on plant spread East -West depicts that treatment T_2 (*Ascophyllum nodosum* @ 5 ml L^{-1}) recorded highest plant spread in East – West direction 19.05 cm, 26.64 cm and 29.43 cm at 45, 60 and 75 days after transplanting respectively. Whereas T_9- Control (Water spray) recorded lowest plant spread in East – West direction 14.82 cm, 18.77 cm and 22.39 cm at 45, 60 and 75 days after transplanting respectively. According to the findings were reported by Praveen *et al.* (2020) [8] in rose, Lingwal *et al*. (2017) in strawberry. The increase in vegetative growth in terms of plant spread in North-South direction may be attributed due to the presence of plant growth regulators and nutrients in sea weed extract *Ascophyllum nodosum.* These might have affected the cellular metabolism in treated plants leading to increased vigour and growth.

Number of branches $plant^{-1}$

Among the treatments, treatment T_2 (*Ascophyllum nodosum* @ 5 ml L^{-1}) recorded highest number of branches $plant^{-1}$ 9.27, 11.07 and 16.37 at 45, 60 and 75 days after transplanting respectively. Whereas T_9- Control (Water spray) recorded lowest number of branches $plant^{-1}$ 5.87, 6.93 and 10.43 at 45, 60 and 75 days after transplanting respectively. The increase in the number of branches in chrysanthemum due to foliar spray of *Ascophyllum nodosum* @ 5 ml L^{-1} was might be that *Ascophyllum nodosum* contains auxins i.e., in particular IAA helps in enhancement of adventitious root formation and helps in promotion of better growth. Cytokinins present in sea weed extract *Ascophyllum nodosum* promoted the production of laterals by inducing the axillary bud sprouting (Selvakumari and Venkatesan, 2017) [11]. Similar findings were reported by Bhargavi *et al.* (2018) [1] in chrysanthemum, Hegde *et al.* (2018) [4] in chrysanthemum, Praveen *et al.* (2020) [8] in rose and Tartil *et al.* (2016) [12] in pot marigold.

Days taken for 1st flower bud initiation (days)

It was observed to be minimum number of days taken for 1st flower bud initiation was recorded in T_2 (*Ascophyllum nodosum* @ 5 ml L^{-1}) (66.28 days). Whereas, maximum number of days taken for 1st flower bud initiation was recorded in T_9 - Control (Water spray) (78.34 days). Earliness is the one of the most important phenomenon, since early crop fetches a best market price. Early bud formation in the treated plants was might be due to the fact that treated plants were able to build suitable carbohydrate reserves early than the untreated ones. The presence of cytokinins in *Ascophyllum nodosum* might induce the production of lateral shoot growth there by inducing the sprouting of axillary buds (Selvakumari and Venkatesan, 2017) [11].

Days taken for 50% flower bud initiation (days)

Among all the treatments, T_2 (*Ascophyllum nodosum* @ 5 ml L^{-1}) recorded minimum number of days taken for 50% flower bud initiation (75.55 days). While the maximum number of days taken for 50% flower bud initiation was recorded in T_9 - Control (Water spray) (87.98 days). This is due to the availability of cytokinins which accumulates in the lateral buds would have made them more effective sink in the diversion of assimilates as well as other flower inducing hormones which ultimately resulted in 50% bud development in lesser duration. This ultimately resulted in early flowering (Selvakumari and Venkatesan, 2017) [11]. This ultimately leads to better flowering and results in good yields.

Flowering duration (days)

Among the yield parameters, the data regarding flowering duration shows that T_8 treatment (Fulvic acid 10% + Seaweed 8% + Spirulina 6% @ 4 g L^{-1}) recorded maximum flowering duration (46.03 days). While the minimum flowering duration was recorded significantly in T_9 - Control (Water spray) (41.89 days). This increase in the flowering duration was

might be due to that fulvic acid helps in the uptake of nutrients from plant surfaces to plant tissues. Fulvic acid directly transport the critical minerals to metabolic sites within the plants. The increase might be due to nutrient uptake, carbohydrates reserves in sea weed extract *Ascophyllum nodosum*. Fulvic acid in combination with sea weed and spirulina contains micro nutrients, macro nutrients N, P, K, amino acids there by helps in the development of plant growth. There by, these combination of biostimulants results in higher flowering duration. Similar findings were reported by Bhargavi *et al.* (2018) [1] in chrysanthemum**.**

Number of flowers plant^{-1}

The data on the number of flowers depicts that, T_2 treatment (*Ascophyllum nodosum* @ 5 ml L^{-1}) recorded maximum number of flowers plant^{-1} (23.29). Whereas the minimum number of flowers plant^{-1} was recorded in T_9 - Control (Water spray) (19.82). The increase might be due to increase of vegetative growth which produced more photosynthates which were probably diverted towards more flower production. The increase in number of flowers might be attributed by more number of leaves per plant and would have resulted in production and accumulation of maximum photosynthates to the sink and their utilization for build up of new cells, thereby increasing the production of more number of flowers. Similar findings were reported by Russo *et al.* (1994) [10] in marigold, Hegde *et al.* (2016) [3] in chrysanthemum, Tartil *et al.* (2016) [12] in pot marigold, Bhargavi *et al.* (2018) [1] in chrysanthemum, Praveen *et al.* (2020) [8] in rose and Majeed Khadim Al-Hamzawi (2019) [7] in Chinese carnation and *Gazania splender*.

Flower yield hectare^{-1} (q)

All the biostimulant treatments differed significantly with respect to flower yield hectare^{-1}. Among the treatments, T_2 treatment (*Ascophyllum nodosum* @ 5 ml L^{-1}) recorded maximum flower yield hectare^{-1} (348.00 q). On the other hand the minimum flower yield hectare^{-1} was recorded significantly in T_9 - Control (Water spray) (225.00 q). 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 Hegde *et al.* (2016) [3] in chrysanthemum, Bhargavi *et al.* (2018) [1] in chrysanthemum and Wasim Haider *et al.* (2012) [13] in potato.

Table 1: Effect of biostimulants on plant height (cm) of chrysanthemum cv. Denjigar White

Treatments / Biostiumlants (T)	At 45 DAT	At 60 DAT	At 75 DAT
T_1 - *Ascophyllum nodosum* @ 2.5 ml L^{-1}	37.37^b	50.17^b	62.24^a
T_2- *Ascophyllum nodosum* @ 5 ml L^{-1}	41.08^a	54.74^a	64.49^a
T_3- Rhodophyte extract @ 0.2 g L^{-1}	32.33^c	45.97^c	54.62^b
T_4- Rhodophyte extract @ 0.4 g L^{-1}	33.19^c	46.65^b	56.55^b
T_5- Potassium humate @ 1.5 g L^{-1}	34.43^b	46.94^b	57.42^b
T_6-Potassium humate @ 3 g L^{-1}	36.23^b	47.37^b	58.53^b
T_7- Fulvic acid 10% + Seaweed 8% + Spirulina 6% @ 2 g L^{-1}	36.60^b	48.87^b	60.50^a
T_8- Fulvic acid 10% + Seaweed 8% + Spirulina 6% @ 4 g L^{-1}	40.06^a	51.14^a	63.06^a
T_9- Control (Water spray)	28.62^d	45.68^c	53.77^b
S.E. m±	1.16	1.46	1.81
CD@ 5%	3.47	4.38	5.44

Table 2: Effect of biostimulants on plant spread N-S (cm) of chrysanthemum cv. Denjigar White

Treatments / Biostiumlants (T)	At 45 DAT	At 60 DAT	At 75 DAT
T_1 - *Ascophyllum nodosum* @ 2.5 ml L^{-1}	16.85^a	23.62^a	26.75^a
T_2- *Ascophyllum nodosum* @ 5 ml L^{-1}	18.98^a	25.05^a	29.50^a
T_3- Rhodophyte extract @ 0.2 g L^{-1}	14.28^c	20.15^b	23.37^b
T_4- Rhodophyte extract @ 0.4 g L^{-1}	15.57^b	21.09^b	24.28^b
T_5- Potassium humate @ 1.5 g L^{-1}	15.82^b	21.55^b	24.33^b
T_6- Potassium humate @ 3 g L^{-1}	16.35^b	22.47^a	24.59^b
T_7- Fulvic acid 10% + Seaweed 8% + Spirulina 6% @ 2 g L^{-1}	16.67^a	22.73^a	25.33^b
T_8- Fulvic acid 10% + Seaweed 8% + Spirulina 6% @ 4 g L^{-1}	17.27^a	24.33^a	27.32^a
T_9- Control (Water spray)	13.56^c	18.35^c	22.71^b
S.E. m±	0.77	1.01	1.32
CD@ 5%	2.32	3.04	4.00

Table 3: Effect of biostimulants on plant spread E-W (cm) of chrysanthemum cv. Denjigar White

Treatments / Biostiumlants (T)	At 45 DAT	At 60 DAT	At 75 DAT
T_1 - *Ascophyllum nodosum* @ 2.5 ml L^{-1}	17.61^a	23.27^b	26.21^b
T_2- *Ascophyllum nodosum* @ 5 ml L^{-1}	19.05^a	26.64^a	29.43^a
T_3- Rhodophyte extract @ 0.2 g L^{-1}	15.44^b	19.13^d	22.83^c
T_4- Rhodophyte extract @ 0.4 g L^{-1}	16.31^b	19.55^d	23.55^c
T_5- Potassium humate @ 1.5 g L^{-1}	16.64^a	20.80^c	24.33^c
T_6- Potassium humate @ 3 g L^{-1}	17.18^a	21.56^c	24.69^b
T_7- Fulvic acid 10% + Seaweed 8% + Spirulina 6% @ 2 g L^{-1}	17.36^a	22.43^b	25.11^b
T_8- Fulvic acid 10% + Seaweed 8% + Spirulina 6% @ 4 g L^{-1}	18.95^a	25.26^a	27.75^a
T_9- Control (Water spray)	14.82^b	18.77^d	22.39^c
S.E. m±	0.87	0.73	0.81
CD@ 5%	2.60	2.19	2.44

Table 4: Effect of biostimulants on number of branches plant $^{-1}$ of chrysanthemum cv. Denjigar White

Treatments / Biostiumlants (T)	At 45 DAT	At 60 DAT	At 75 DAT
T_1 - *Ascophyllum nodosum* @ 2.5 ml L^{-1}	8.37^a	9.03^a	15.00^a
T_2- *Ascophyllum nodosum* @ 5 ml L^{-1}	9.27^a	11.07^a	16.37^a
T_3- Rhodophyte extract @ 0.2 g L^{-1}	6.40^b	7.50^b	12.53^b
T_4- Rhodophyte extract @ 0.4 g L^{-1}	6.80^b	8.27^b	13.83^b
T_5- Potassium humate @ 1.5 g L^{-1}	6.97^b	8.33^b	14.27^b
T_6- Potassium humate @ 3 g L^{-1}	7.60^b	8.53^b	14.40^a
T_7- Fulvic acid 10% + Seaweed 8% + Spirulina 6% @ 2 g L^{-1}	7.80^b	8.70^b	14.70^a
T_8- Fulvic acid 10% + Seaweed 8% + Spirulina 6% @ 4 g L^{-1}	8.63^a	10.67^a	15.40^a
T_9- Control (Water spray)	5.87^c	6.93^b	10.43^c
S.E. m±	0.49	0.79	0.69
CD@ 5%	1.46	2.36	2.08

Table 5: Effect of biostimulants on days taken for 1st flower bud initiation and 50% flower bud initiation and flowering duration (days) chrysanthemum cv. Denjigar White

Treatments / Biostiumlants (T)	Days taken for 1st flower bud initiation (days)	Days taken for 50% flower bud initiation (days)	Flowering duration (days)
T_1 - *Ascophyllum nodosum* @ 2.5 ml L^{-1}	68.49^a	78.72^a	45.11^a
T_2- *Ascophyllum nodosum* @ 5 ml L^{-1}	66.28^a	75.55^a	45.68^a
T_3- Rhodophyte extract @ 0.2 g L^{-1}	76.51^d	85.60^c	42.93^c
T_4- Rhodophyte extract @ 0.4 g L^{-1}	75.06^d	84.71^c	43.33^c
T_5- Potassium humate @ 1.5 g L^{-1}	73.53^c	82.01^b	43.78^b
T_6- Potassium humate @ 3 g L^{-1}	71.50^b	80.03^b	44.26^b
T_7- Fulvic acid 10% + Seaweed 8% + Spirulina 6% @ 2 g L^{-1}	69.25^b	79.25^a	44.64^b
T_8- Fulvic acid 10% + Seaweed 8% + Spirulina 6% @ 4 g L^{-1}	67.67^a	77.46^a	46.03^a
T_9- Control (Water spray)	78.34^e	87.98^d	41.89^d
S.E. m±	0.87	1.31	0.41
CD@ 5%	2.64	3.95	1.25

Table 6: Effect of biostimulants on number of flowers plant^{-1} and flower yield hectare^{-1} (q) of chrysanthemum cv. Denjigar White

Treatments / Biostiumlants (T)	Number of flowers plant^{-1}	Flower yield hectare^{-1} (q)
T_1 - *Ascophyllum nodosum* @ 2.5 ml L^{-1}	22.28^a	305.50^b
T_2- *Ascophyllum nodosum* @ 5 ml L^{-1}	23.29^a	348.00^a
T_3- Rhodophyte extract @ 0.2 g L^{-1}	20.14^b	233.00^d
T_4- Rhodophyte extract @ 0.4 g L^{-1}	20.17^b	235.00^d
T_5- Potassium humate @ 1.5 g L^{-1}	20.69^b	244.00^d
T_6- Potassium humate @ 3 g L^{-1}	21.21^b	265.50^c
T_7- Fulvic acid 10% + Seaweed 8% + Spirulina 6% @ 2 g L^{-1}	21.44^b	281.50^c
T_8- Fulvic acid 10% + Seaweed 8% + Spirulina 6% @ 4 g L^{-1}	22.56^a	324.00^a
T_9- Control (Water spray)	19.82^b	225.00^e
S.E. m±	0.58	9.79
CD@ 5%	1.75	29.60

Conclusion

On the basis of the results obtained in the present investigation it is concluded that *Ascophyllum nodosum* @ 5 ml L^{-1} proved for improving the growth and yield of chrysanthemum, the present study also confirmed that the use of bio-stimulant is an eco-friendly technique to enhance crop production. Thus, it may be recommended that the chrysanthemum plants can be sprayed with *Ascophyllum nodosum* @ 5 ml L^{-1} to get maximum growth and yields in chrysanthemum.

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