Scientific J. Flowers & Ornamental Plants
www.ssfop.com/journal
ISSN: 2356-7864
doi: 10.21608/SJFOP.2023.208770.1021

EFFECT OF FOLIAR APPLICATION OF SEAWEED EXTRACT AND SOME PLANT GROWTH REGULATORS ON THE PRODUCTIVITY AND QUALITY OF DAHLIA (*DAHLIA VARIABILIS* L.) PLANTS

M.M.M. Harhash[*], B.M. Weheda[**], M.K. Gaber[*] and H.F.K. El-Deeb[***]

[*] Plant Production Dept., Fac. Agric., Saba Basha, Alexandria Univ., Egypt
[**] Ornamental Plants and Landscape Gardening Res. Dept., Hort. Res. Inst., Agric. Res. Center, Egypt
[***] El Gemaeza Agricultural Research Station, Agric. Res. Center, El-Ghrbia, Egypt

Scientific J. Flowers & Ornamental Plants, 10(2):137-149 (2023).

Received:
26/4/2023
Accepted:
10/5/2023

Corresponding author:
H.F.K. El-Deeb
hanaeldeb321@gmail.com

ABSTRACT: This study examined the effects of seaweed extract and some plant growth regulators (GA_3) on dahlia during the two successive seasons (2021/2022 and 2022/2023). The experiment was conducted at the Ornamental Department of El Gemaeza Agricultural Research Station, Agric. Res. Center, El-Ghrbia Governorate, Egypt under open-field conditions in sunlight during the two seasons. Experiment with a completely randomized block design with five replicates for 15 treatments i.e., control, three levels of seaweed extracts (SWE) at 500, 1000, and 1500 mg/l, three levels of GA_3 (50, 100 and 150 mg/l), three levels of CPPU (50, 100 and 150 mg/l) and combinations of 500 mg/l SWE + 50 mg/l CPPU + 50 mg/l GA_3, 1000 mg/l SWE + 100 mg/l CPPU + 100 mg/l GA_3, 1500 mg/l SWE + 150 mg/l CPPU + 150 mg/l GA_3, 500 mg/l SWE + 100 mg/l CPPU + 150 mg/l GA_3 and 1500 mg/l SWE + 100 mg/l CPPU + 50 mg/l GA_3. Plant height, stem diameter, number of branches per plant, fresh and dry weights of shoots, total chlorophyll, and leaf area index were the vegetative growth parameters, while the flowering characters were flower length, flower diameter, stalk length, fresh and dry weights of flowers, number of flowers per plant, and number of days to flower, days of flower longevity and vase life. The results demonstrated that when compared to the control treatment (which was left untreated during both seasons), SWE at 1500 mg/l + CPPU at 150 mg/l + GA_3 at 150 mg/l recorded higher values for all vegetative growth and flowering characteristics.

Keywords: Flowering bulbs, *Dahlia variabilis* L., seaweed extract, gibberellic acid (GA_3), UPPC

INTRODUCTION

The dahlia (*Dahlia variabilis* L.) is a perennial herbaceous plant with tuberous roots that is half-hardy and has its origins in Mexico (Pandey *et al.*, 2017). The dahlia was named in honour of the Swedish botanist Dr. Andereas Dahl, a student of Linnaeus, where it was initially introduced into Madrid (Spain) in 1789 and other European countries. Its stems are generally erect, branching, glabrous, or scabrous. According to Malik *et al*. (2017), the Agric. Horticultural Society of Calcutta, India was responsible for introducing dahlia to India as early as 1857.

About 40 species of flowering plants in the Aster family (Asteraceae) belong to the dahlia genus, which is indigenous to Mexico and Central America on higher altitudes. The Dahlia genus has about six species that have been cultivated to be grown as decorative blooms and are widely used in gardens and the florist industry. Numerous categories are used to categorize the thousands of dahlia cultivars, including single, double, pompon, cactus, water lily, peony-flowered, and dinner plate varieties. Dahlia is a perennial tuberous plant with simple, serrated or cut leaves for the most part. The color of the complex flowers ranged from white to yellow to red to purple. The dahlia is a very lovely flower that has captured the attention of many people around the world due to its extraordinary qualities. It is a herbaceous perennial with a tuberous root structure and an upright growth habit (Marina, 2015).

In order to lessen the need for synthetic fertilizers, bio-stimulants offer an innovative and environmentally acceptable solution (Colla and Rouphael, 2020). In contemporary agriculture, plant bio-stimulants are of tremendous interest. According to Chiaiese *et al.* (2018), microalgae (blue-green algae) are gaining interest from both scientists and plant farmers. Seaweed extract is regarded as a crucial source of nourishment for sustainable agriculture because it is organic and biodegradable (Masoud and Abou-Zaid, 2017). According to Gawade *et al.* (2019), seaweed is a product that is extremely enriched with macro and micro-elements, amino acids, vitamins, cytokinin, auxins, and other growth factors that alter plants' metabolism and hence promote growth. It has been claimed that seaweeds have chelating properties that increase the use of mineral nutrients, enhance soil structure and aeration, and promote root growth. They function as biostimulants, promoting postharvest shelf life, biotic and abiotic stress tolerance, flower and fruit production, and postharvest shelf life (Kahkashan *et al.*, 2017). In order to increase efficiency by increasing the volume and performance of floral harvests, seaweed extracts contain a variety of micro components and plant growth hormones that support bloom initiation (Mohsin *et al.*, 2019).

According to Zahoor *et al.* (2011) plant growth regulators offer efficient ways to enhance and increase the productivity of both the qualitative and quantitative aspects of fruit growth. Since gibberellins are important endogenous regulators of plant growth and development, including seed germination, trichome development, stem and leaf elongation, flower induction, pollen development after anthesis, fruit and seed development (Singh *et al.*, 2002), gibberellins play a crucial role in the growth and development of plants. Gibberellins largely influence growth by regulating cell elongation and division, which has an impact on grape cultivar yield, its constituents, and fruit quality (Pires *et al.*, 2000). Cell elongation, not cell division, is caused by gibberellic acid (Kappel and MacDonald, 2002). By promoting cell division and cell elongation, forchlorfenuron (CPPU), a synthetic cytokinin with significant growth regulating actions, has been proven to be particularly helpful in promoting fruit growth. In some fruit crops, it was discovered to be incredibly successful at growing the size of the fruit (Cruz-Castillo *et al.*, 2002).

This study aimed to investigate the impact of using seaweed extract biotimoluats, gibberellic acid (GA_3) and Forchlorofenuronis (CPPU) as a foliar spray on vegetative growth, chemical character, flowers quality and vase life of *Dahlia variabilis* L. grown in the open field.

MATERIALS AND METHODS

This investigation was conducted at the Ornamental Department of El Gemaeza Agricultural Research Station, Agric. Res. Center, El-Ghrbia Governorate, Egypt during two successive seasons of 2021/2022 and 2022/2023 under the open field conditions in natural sunlight.

Dahlia (*Dahlia variabilis* L.) tubers were obtained from local nursery in uniform size, shape and weight. It was planted on 30/9/2021 and 30/9/2022, spaced at 1×1 m apart and irrigated by the immersion irrigation system.

This study aimed to investigate the impact of using seaweed extract biostimulants, gibberellic acid (GA_3) and forchlorofenuronis (CPPU)) as a foliar spray on vegetative growth, chemical character, flowers quality and vase life of *Dahlia variabilis* L.

Experimental design:

The experiment consisted of fifteen treatments including control, arranged in a randomized complete block design (RCBD) with five replicates for each treatment and contained one plant.

The applied treatments were as follows:

- Control
- Seaweed (SWE) at 500, 1000 and 1500 mg/l
- CPPU at 50, 100 and 150 mg/l
- GA_3 at 50, 100 and 150 mg/l
- SWE at 500 mg/l + CPPU at 50 mg/l + GA_3 at 50 mg/l
- SWE at 1000 mg/l + CPPU at 100 mg/l + GA_3 at 100 mg/l
- SWE at 1500 mg/l + CPPU at 150 mg/l + GA_3 at 150 mg/l
- SWE at 1500 mg/l + CPPU at 100 mg/l + GA_3 at 50 mg/l
- SWE at 500 mg/l + CPPU at 100 mg/l + GA_3 at 150 mg/l

Foliar spraying was conducted twice, the first one was 20 days after planting and the second one was after 20 days of the first one in both seasons.

Recorded data:

The recorded vegetative growth data were; plant height (cm), stem diameter (mm), shoots fresh and dry weights (g) and leaf area (cm^2). In addition, total chlorophyll content (SPAD units) was measured in the leaves according to the method described by Yadava (1986). While the flowering data included number of days to flowering, Number of flowers/plant, flower diameter (cm), stalk length (cm), flowers fresh and dry weights (g), flower duration and vase life (days).

Statistical analysis:

All the data collected were subjected to statistical analysis of variance as described by Gomez and Gomez (1984). The treatment means were compared using L.S.D. test at 0.05 level of significance according to Snedecor and Cochran (1990).

RESULTS AND DISCUSSION

Effect of seaweed extract, some plant growth regulators and their interaction on:

1. Vegetative growth characteristics:

Table (1) finding make it abundantly evident that foliar application of several applied treatments, including seaweed extracts (500, 1000, and 1500 mg/l), GA_3 (50, 100, and 150 mg/l), CPPU (50, 100, and 150 mg/L), and their combinations, greatly improved all vegetative development of dahlia (*Dahlia variabilis* L.). Results showed that seaweeds 1500 + CPPU 150 + GA_3 150 recorded the highest values of plant height (120.49 and 134.94 cm), fresh weight (170.76 and 191.25 g), dry weight (34.15 and 38.25 g), stem diameter (14.91 and 16.70 mm), followed by seaweeds 1500 + CPPU 100 + GA_3 50 plant height (108.44 and 121.45 cm), fresh weight (153.68 and 172.13 g), dry weight (30.74 and 34.42 g), stem diameter (13.42 and 15.03 mm), as compared with the control treatment (untreated plant) which recorded the minimum values of plant height (27.56 and 30.87 cm), fresh weight (45.94 and 51.46 g), dry weight (9.19 and 10.29 g), stem diameter (4.34 and 4.74 mm), respectively, during both seasons.

Results in Table (2) showed that combined treatment of seaweeds 1500 + CPPU 150 + GA_3 150 recorded the highest values of number of branches (15.22 and 17.04), leaf area (15.22 and 14.30 cm^2) and total chlorophyll (51.90 and 58.13 unit SPAD), followed by seaweeds 1500 + CPPU 1500 + GA_3 50 number of branches (13.70 and 15.34), leaf area (12.87 and 14.41 cm^2) and total chlorophyll (46.71 and 52.32 unit SPAD), as compared with the control treatment (untreated plant) which recorded the minimum values of number of branches (4.32 and 4.84), leaf area (4.06 and 4.55 cm^2) and total chlorophyll (11.87 and 13.30 unit SPAD), respectively, during both seasons.

Table 1. Effect of seaweed extract (SWE) and some plant growth regulators and their interaction on plant height(cm), fresh and dry weights (g) and stem diameter (mm) of *Dahlia variabilis* L. during 2021/2022 and 2022/2023 seasons.

Treatments (mg/l)	Plant height (cm)		Fresh weight (g)		Dry weight (g)		Stem diameter (mm)	
	2021/2022	2022/2023	2021/2022	2022/2023	2021/2022	2022/2023	2021/2022	2022/2023
Control	27.56	30.87	45.94	51.46	9.19	10.29	4.34	4.74
SWE 500	57.63	64.54	81.67	91.47	16.34	18.29	7.13	7.99
SWE 1000	64.03	71.71	90.75	101.64	18.15	20.33	7.93	8.88
SWE 1500	71.15	79.68	100.83	112.93	20.17	22.59	8.81	9.86
GA_3 50	34.03	38.11	50.91	57.02	10.18	11.40	4.69	5.26
GA_3 100	42.01	47.05	59.54	66.69	11.91	13.34	5.20	5.82
GA_3 150	51.87	58.09	73.51	82.33	14.70	16.47	6.42	7.19
CPPU 50	30.63	34.30	48.36	54.16	9.67	10.83	4.46	4.99
CPPU 100	37.81	42.35	53.59	60.02	10.72	12.00	4.94	5.53
CPPU 150	48.68	52.28	66.16	74.09	13.23	14.82	5.78	6.47
SWE 500 + CPPU 50 + GA_3 50	79.05	88.54	112.04	125.48	22.41	25.10	9.78	10.96
SWE 1000 + CPPU 100 + GA_3 100	97.59	109.31	136.32	154.91	27.66	30.98	12.08	13.53
SWE 1500 + CPPU 150 + GA_3 150	120.49	134.94	170.76	191.25	34.15	38.25	14.91	16.70
SWE 500 + CPPU 100 + GA_3 150	87.83	98.37	124.48	139.42	24.90	27.89	10.87	12.18
SWE 1500 + CPPU 100 + GA_3 50	108.44	121.45	153.68	172.13	30.74	34.42	13.42	15.03
$LSD_{(0.05)}$	0.58	0.65	3.17	3.55	0.64	0.71	0.20	0.22

Table 2. Effect of seaweed extract (SWE) and some plant growth regulators and their interaction on number of branches, leaf area(cm^2) and total chlorophyll of *Dahlia variabilis* L. during 2021/2022 and 2022/2023 seasons.

Treatments (mg/l)	Number of branches		Leaf area (cm^2)		Total chlorophyll (SPAD)	
	2021/2022	2022/2023	2021/2022	2022/2023	2021/2022	2022/2023
Control	4.32	4.84	4.06	4.55	11.87	13.30
SWE 500	7.28	8.15	6.84	7.66	24.82	27.80
SWE 1000	8.09	9.06	7.60	8.51	27.58	30.89
SWE 1500	8.99	10.06	8.44	9.46	30.65	34.32
GA_3 50	4.79	5.36	4.50	5.04	14.66	16.41
GA_3 100	5.30	9.94k	4.99	5.58	18.10	20.27
GA_3 150	6.55	7.33	6.16	6.89	22.34	25.02
CPPU 50	4.55	5.10	4.28	4.79	13.19	14.77
CPPU 100	5.04	5.65	4.74	5.31	16.28	18.24
CPPU 150	5.90	6.60	5.54	6.20	20.11	22.52
SWE 500 + CPPU 50 + GA_3 50	9.98	11.18	9.38	10.51	34.05	38.14
SWE 1000 + CPPU 100 + GA_3 100	12.33	13.81	11.58	12.97	42.04	47.08
SWE 1500 + CPPU 150 + GA_3 150	15.22	17.04	14.30	16.02	51.90	58.13
SWE 500 + CPPU 100 + GA_3 150	11.09	12.42	10.42	11.68	37.84	47.37
SWE 1500 + CPPU 100 + GA_3 50	13.70	15.34	12.87	14.41	46.71	52.32
$LSD_{(0.05)}$	0.15	0.16	0.16	0.18	0.40	0.45

According to James (1994) and Soliman *et al.* (2000), the essential role of seaweed extract in promoting cell division can be explained by the higher amounts of nutrients it contains, including N, P, K, Mg, Ca, S, Cu, Fe, Mn, B and hormones like cytokines, indole acetic acid (IAA) and GA_3, amino acids, vitamins, and antioxidants. These components are crucial in enhancing cell division and the manufacture of organic nutrients as well as protecting plant cells from harm and any environmental challenges (Strick and Staden, 1997). These findings of how seaweed extract affects growth characteristics concur with those found by Oraby (2013).

The use of GA_3 significantly increased the amount of chlorophyll in dahlia leaves, which may have slowed down chlorophyll oxidation, increased chlorophyll production, or stabilised the thylakoid membrane. By enhancing membrane stability and preventing chloroplasts from senescing, growth regulators may also delay floral senescence and hence reduce chlorophyll loss (Amin *et al.*, 2011).

Additionally, the cytokinin-like activity that causes rapid cell division and cell elongation may have contributed to the increases in several growth aspects with CPPU therapy (Thomas and Katterman, 1986). Strong cytokinin CPPU slows apical dominance, which promotes the formation of lateral shoots.

The findings demonstrate that GA_3 significantly enhanced cell division and chlorophyll accumulation to boost dahlia vegetative growth and flower production (Jahanbazi, 2014; Mohamed, 2017). By promoting cell division, foliar application of GA_3 may have aided stem elongation, which in turn increased vegetative growth (Al-Khassawaneh *et al.*, 2006). With the addition of GA_3, plants also had more branches per plant, which helped to start more leaves, which in turn led to more photosynthesis, starting early flowering and finishing the plant's life cycle.

These findings are consistent with those made by Sajid *et al.* (2016), who found that *Chrysanthemum morifolium* plant height increased when GA_3 concentrations rose. Schmidt *et al.* (2003) observed a 16.78% increase in plant height on chrysanthemum when GA_3 was treated at 300 mg/1. Both Padaganur *et al.* (2005) and Kumar *et al.* (2012) noted a similar pattern in tuberose and carnations, respectively.

It is evident from the current study that seaweed, which is a natural product that contains organic matter, numerous macro and micro components, and some plant growth regulators, was most beneficial, particularly at high extract levels (Gallen and Hemingway, 1965).

These findings may be attributed to the beneficial effects of seaweed extracts, which naturally contain nutrients, plant growth hormones (auxins, cytokines, and gibberellins), as well as other plant biostimulants, such as vitamins and amino acids, which can maintain photosynthetic rates, enhance plant resistances, postpone plant senescence, and regulate cell division (Crouch and Van Staden, 1993).

The added seaweed extract (SWE) at the recommended rate of 1% may have a positive effect because of its higher content of nutrients, particularly Mg, as well as amino acids and vitamins, which undoubtedly had an impact on enhancing the biosynthesis of plant pigments and total carbohydrates (Soliman *et al.*, 2000).

According to Dawczynski *et al.* (2007), the observed promoted effect of growth due to the use of seaweed extract may be attributable to its content of certain phytohormones, organic compounds, and some macro and micronutrients at different concentrations that together improve vegetative growth. Researchers have noted the value of seaweed extract in enhancing plant growth by increasing the uptake of nutrients from the soil (Turan and Kose, 2004). Ibrahim (2015) found that spraying Calendula plants with seaweed extract at 3 g/l caused a significant increase in plant height and number of leaves, and attributed that effect to its content of organic compounds and minerals required to activate the biochemical processes and in turn increase plant vegetative growth. These results are in agreement with Sridhar and Rengasamy (2010) findings when they treated *Tagetes erecta* L. with seaweed extract. Additionally, the beneficial effects of spraying micronutrients on plants may result from their influence on a variety of biological activities by way of their participation as a component of some significant biological molecules in plant cells, their function in the activation of certain enzymes, or their function as cofactors to speed up specific chemical reactions in plant cells.

The control plants had the lowest levels of chlorophyll content. Nitrogen is among the macro and micro components found in the seaweed extract used in this experiment. Because nitrogen is a component of the chlorophyll molecule, it is known to increase chlorophyll content (Abbas *et al*., 2013). Foliar application of seaweed extract containing ferrous facilitates the entry of Fe instantly to plant tissue, particularly given that Fe is known to be essential for chlorophyll biosynthesis in addition to its involvement in the activity of some enzymes, which offers energy required for cell division and elongation and subsequently enhance plant growth (Jones, 1991).

This favourable result may be attributed to the supporting function of seaweed extract, which contains a number of components, vitamins and macronutrients like NPK in addition to micronutrients that enhance plant vegetative growth and, as a result, increase the number of flowers, and this is consistent with Al Dullamy (2005) findings on dianthus.

According to Abbas and Ali (2013) the observed increase in the vegetative characters of dianthus, such as leaf number and chlorophyll content, as well as the efficiency and metabolism of photosynthesis and the translocation of food from leaves to flowers, which are reflected in flower number and other flower characters, is what is responsible for the observed increase in some flower characters of dianthus. These findings corroborated those of Jeffecoat (1977) on dianthus.

The rise in carbohydrates could be a result of the photosynthetic process becoming more efficient as a result of increased vegetative development, which increased the uptake of CO_2 by the leaves (Kandil *et al*., 2011). Additionally, seaweed extract has nitrogen and other macronutrients like potassium that are known to play a part in the activation of certain enzymes, the accumulation of carbohydrates, and ultimately a rise in the amount of carbohydrates in leaves. The findings of Abbas *et al*. (2013) on gazania and (Azza *et al*., 2014) on *Schefflera arboricola* plants are in agreement with this outcome.

The greater induction of leaf initial breaks, or the differentiation of leaf origins in the apical developing zone, may be the cause of the increased leaf number with GA_3. It might also be brought on by the plant becoming taller and having more main branches. Sajid *et al.* (2016) in chrysanthemum and Kumar *et al.* (2011) in African marigold produced findings that were comparable.

2. Flowering characteristics:

Results regarding different flowering parameters, i.e. number of flowers, fresh and dry weight of flowers, flower diameter are tabulated in Table (3). Results showed that treatment of combinations of seaweeds 1500 + CPPU 150 + GA_3 150 recorded the highest values of number of flowers (39.50 and 44.24), flower fresh weight (100.08 and 112.09 g), flower dry weight (20.02 and 22.42 g) and flower diameter (20.89 and 23.39 cm), followed by seaweeds 1500 + CPPU 100+ GA_3 50 number of flower (37.53 and 42.03), flower fresh weight (95.08 and 106.49 g), flower dry weight (19.02 and 21.30 g) and flower diameter (19.84 and 22.22 cm), as compared to control treatment which recorded the lower values of number of flower (12.37 and 13.86), flower fresh weight (54.62 and 61.17 g), flower dry weight (10.92 and 12.42 g) and flower diameter (5.87 and 6.58 cm), respectively, during both seasons.

In addition, results in Table (4) with several treatments that were administered, that foliar application was cleaned i.e., seaweed extracts (500, 1000 and 1500 mg/l), GA_3 (50, 100 and 150 mg/l), CPPU (50, 100 and 150 mg/l), and combinations significantly affected flowering parameters of dahlia. However, results observed that seaweed at 1500 + CPPU 150 + GA_3 150 recorded the higher flower duration, vase life and stalk length (58.61, 6.26 and 42.81) in the first season and (65.65, 7.01 and 47.95) in the second season, followed by seaweed at 1500 + CPPU 100 + GA_3 50 which recorded (56.85, 5.94 and 41.53) in the first season and (63.68, 6.66 and 46.51) in the second season, while control treatment recorded the higher number of days to flower (112.20 and 125.66), during both seasons.

It is evident from the current study that seaweed, which is a natural product that contains organic matter, numerous macro and micro components, and some plant growth regulators, was most beneficial, particularly at high extract levels (Gallen and Hemingway, 1965).

These findings indicate that SWE is effective at supplying plants with the nutrients and critical elements they need for biosynthesis, storing the byproducts in plant tissues, and increasing flower dry weight as a result (Soliman *et al.*, 2000). As a result, there is a connection between higher levels of endogenous cytokinin and the generation of more inflorescence meristematic cells. According to research by Blanchard and Runkle (2008), the application of exogenous cytokinin results in elevated levels of endogenous cytokinin.

These findings may be attributed to the beneficial effects of seaweed extracts, which naturally contain nutrients, plant growth hormones (auxins, cytokines, and gibberellins), as well as other plant

Table 3. Effect of seaweed extract (SWE) and some plant growth regulators and their interaction on number of flowers, fresh and dry weight of flowers (g) and flower diameter(cm) of *Dahlia variabilis* L. during 2021/2022 and 2022/2023 seasons.

Treatments (mg/l)	Number of flowers		Flower fresh weight (g)		Flower dry weight (g)		Flower diameter (cm)	
	2021/2022	2022/2023	2021/2022	2022/2023	2021/2022	2022/2023	2021/2022	2022/2023
Control	12.37	13.86	54.62	61.17	10.92	12.24	5.87	6.58
SWE 500	23.22	26.00	78.22	82.60	15.64	7.52	12.28	13.75
SWE 1000	25.80	28.89	73.57	82.40	14.71	6.48	13.64	15.28
SWE 1500	28.67	32.10	77.44	86.74	15.49	7.35	15.16	16.98
GA_3 50	15.28	17.11	60.52	67.78	12.10	13.56	7.25	8.12
GA_3 100	17.87	20.01	67.06	75.11	13.41	15.02	8.95	10.02
GA_3 150	20.90	23.40	74.30	83.22	14.86	16.65	11.05	12.37
CPPU 50	13.75	15.40	57.49	64.40	11.50	12.88	6.52	7.31
CPPU 100	16.08	18.01	63.71	71.35	12.74	14.27	8.06	9.02
CPPU 150	19.85	22.23	70.59	79.06	14.12	15.81	9.94	11.14
SWE 500 + CPPU 50 + GA_3 50	31.16	34.90	81.52	91.30	16.30	18.26	16.48	18.45
SWE 1000 + CPPU 100 + GA_3 100	35.65	39.93	90.32	101.16	18.06	20.23	18.85	21.11
SWE 1500 + CPPU 150 + GA_3 150	39.50	44.24	100.08	112.09	20.02	22.42	20.89	23.39
SWE 500 + CPPU 100 + GA_3 150	32.80	36.73	85.81	96.10	17.16	19.22	17.91	20.06
SWE 1500 + CPPU 100 + GA_3 50	37.53	42.03	95.08	106.49	19.02	21.30	19.84	22.22
$LSD_{(0.05)}$	1.10	1.23	10.00	11.31	2.02	2.26	0.33	0.37

Table 4. Effect of seaweed extract (SWE) and some plant growth regulators and their interaction on number of days to flowers (days), flower duration, vase life and stalk length (cm) of *Dahlia variabilis* L. during 2021/2022 and 2022/2023 seasons.

Treatments (mg/l)	Number of days to flower		Flower duration (g)		Vase life (days)		Stalk length (cm)	
	2021/2022	2022/2023	2021/2022	2022/2023	2021/2022	2022/2023	2021/2022	2022/2023
Control	112.20	125.66	31.99	35.83	3.50	3.91	19.69	22.05
SWE 500	78.35	87.76	46.38	51.95	4.41	4.94	32.16	36.02
SWE 1000	74.44	83.37	48.82	54.68	4.65	5.20	33.85	37.91
SWE 1500	72.95	81.70	50.33	56.37	4.89	5.48	35.26	39.49
GA_3 50	101.26	113.41	37.42	41.90	3.71	4.16	20.92	23.43
GA_3 100	91.39	102.35	41.46	46.43	3.95	4.42	25.83	28.93
GA_3 150	82.48	92.38	44.99	50.39	4.19	4.70	31.19	34.94
CPPU 50	106.59	119.38	35.55	39.81	3.60	4.03	20.29	22.73
CPPU 100	96.20	107.74	39.38	44.11	3.83	4.29	23.51	26.04
CPPU 150	86.82	97.24	42.74	47.87	4.07	4.56	28.70	32.14
SWE 500 + CPPU 50 + GA_3 50	70.76	79.25	51.89	58.12	5.15	5.77	37.12	41.57
SWE 1000 + CPPU 100 + GA_3 100	66.58	74.57	55.15	61.77	5.71	6.39	40.28	45.11
SWE 1500 + CPPU 150 + GA_3 150	59.63	66.78	58.61	65.65	6.26	7.01	42.81	47.95
SWE 500 + CPPU 100 + GA_3 150	68.63	76.871	53.49	59.91	5.42	6.07	39.07	43.76
SWE 1500 + CPPU 100 + GA_3 50	63.25	70.84	56.85	63.68	5.94	6.66	41.53	46.51
$LSD_{(0.05)}$	0.68	0.76	0.58	0.65	0.06	0.06	0.79	0.88

biostimulants, such as vitamins and amino acids, which can maintain photosynthetic rates, enhance plant resistances, postpone plant senescence, and regulate cell division (Crouch and Van Standen, 1993).

These findings indicate that SWE is effective at supplying plants with the nutrients and critical elements they need for biosynthesis, storing the byproducts in plant tissues, and increasing flower dry weight as a result (Soliman *et al*., 2000).

Mohamed (2009) showed that GA_3 at 300 ppm produced the highest fresh weight of the entire flower spike, the fresh weight of the flower spike with the floret, the fresh weight of the flower spike without the floret, the fresh weight of the third floret, the number of florets per spike, the length of the flower spike, the thickness of the flower spike, the dry weight of the entire flower spike, the dry weight of the flower spike with the floret, the dry weight of the flower spike. The early flowering could be attributed to the GA_3 application's enhancement of food translocation for the growth of floral precursors, which caused the early flowering. This could be a result of increased photosynthesis, respiration, and accelerated fixation by GA_3 that resulted in the beginning of flower buds (Sen and Sen, 1968). It might also result from the synergistic interaction between auxin and gibberellins that has been seen in plant shoots. According to Singh and Srivastav (2008), the enhanced flower production as a result of GA_3 treatment can be linked to the fact that GA_3 improves the induction of flower bud break, which is the differentiation of floral primordial in the apical growth zone. Early flower induction as a result of GA_3 replacing some vernalization could be the cause of the increased blooming length under GA_3 treatment. The outcomes are consistent with those from Kumar *et al.* (2003) and Sharma and Joshi (2015) in aster research in China.

CONCLUSION

From the obtained results, it might be concluded that the treatment of SWE at 1500 mg/l + CPPU at 150 mg/l + GA_3 at 150 mg/l gave the highest mean values of all vegetative growth and flower characters.

REFERENCES

Abbas, J.A. and Ali, J.H. (2013). Effect of media and naphthalene acetic acid on rooting, growth and flowering of carnation (*Dianthus caryophyllus* L.). J. Agric. Sci., 10(3):399-409.

Abbas, J.A.; Mushtaq, T. and Al-Khalili, A. (2013). Effect of nutritional solution "PRO.SOL" and chelated iron on growth and flowering of gazania plant *Gazania splenden* L. J. Agric. Tech., 3:814 -822.

Al-Dullamy, H.E. (2005). Effect of Some Nutrients, Culture Media and Breeding Method on Producing Dianthus Flowers. M.Sc. Thesis, Fac. Agric., Basrah Univ., Iraq, 112 p.

Al-Khassawaneh, N.M.; Karam, N. and Shibli, R. (2006). Growth and flowering of black iris (*Iris nigricans* Dinsm) following treatment with plant growth regulators. Sci Hort., 107:187-193.

Amin, A.; Fatma, A.E.; El-Awadi, M. and El-Sherbeny, M. (2011). Physiological response of onion plants to foliar application of putrescine and glutamine. Sci. Hort., 129:353-360.

Azza, A.M.; Nahed, G.A.; Effat, I.A.; Amal, A.N. and Samah, M. (2014). Effect of gibberellic acid and paclobutrazol on growth and chemical composition of *Schefflera arboricola* plants. Middle East J. Agric. Res., 3(4):782-792.

Blanchard, M.G. and Runkle, E.S. (2008). Benzyladenine promotes flowering in Doritaenopsis and Phalaenopsis orchids. J. Plant Growth Regul., 27:141-150.

Chiaiese, P.; Corrado, G.; Colla, G.; Kyriacou, M.C. and Rouphael, Y. (2018). Renewable sources of plant biostimulation: microalgae as a sustainable means to improve crop performance. Front. Plant Sci., 9:1-6.

Colla, G. and Rouphael, Y. (2020). Microalgae: new source of plant biostimulants. Agron., 10(9):1-4.

Crouch, I.J. and Van Staden, J. (1993). Evidence for the presence of plant growth regulators in commercial seaweed products. Plant Growth Regul., 13:21–28.

Cruz-Castillo, J.G.; Woolley, D.J. and Lawes, G.S. (2002). Kiwi fruit size 3 and CPPU response are influenced by the time of anthesis. Sci. Hortic., 95(1-2):23-30.

Dawczynski, S.C.; Schubert, R.P. and Jahreis, G.F. (2007). Amino acids, fatty acids and dietary fiber in edible seaweed products. J. Food Chem., 103: 891–900.

Gallen, S.B. and Hemingway, J.C. (1965). Growth of higher plants in response to feeding with seaweed extracts. Proc. 5th Indian Seaweed Symp., India.

Gawade, N.V.; Varu, D.K. and Devdhara, U. (2019). Response of biostimulants and biofertilizers on yield and quality of chrysanthemum cv. Ratlam selection. Int. J. Curr. Microbiol. App. Sci., 8(9):2732–2742.

Gomez, A.K. and Gomez, A.A. (1984). Statistical Procedures for Agricultural Research (2nd Edition). John Wiley and Sons, New York, USA, 690 p.

Ibrahim, M.M. (2015). Response of *Calendula officinalis* L. plants to spraying of liquorice and organic fertilizer for poultry dropping extracts. Diyala Agric. Sci. J., 7(2):133-142.

Jahanbazi, T.; Mortezaienejad, F. and Jafararpoor, M. (2014). Impact of salicylic acid and jasmonic acid on keeping quality of rose (cv. Angelina) flower. J. Novel Appl. Sci., 3:1328-1335.

James, B. (1994). Chapters from life. Ann. Rev. Physiol. Plant. Mol. Biolog., 4:1-23.

Jeffecoat, B. (1977). Influence of the cytokinin (6- benzylamino- 9-tetrahyropyran-2-yl) -9-11-purine, on the growth and development of some ornamental crops. J. Hort. Sci., 52(1):143-153.

Jones, E.R. (1991). A grower guide to the foliar feeding of plants. Washington and Oregon Farmer, 28:13-17.

Kahkashan, K.B.; Kumar, N.V.; Raghupati, B. and Pal, A.K. (2017). Effect of biostimulants on growth and floral attributes of tuberose (*Polianthes tuberosa* L.). cv. Prajwal. Int. J. Curr. Microbiol. App. Sci., 6(6):2557–2564.

Kandil, M.; El-Saady, M.; Mahgoub, M.B.; Habib, M.H. and El-Sayed, I.M. (2011). Effect of putrescine and uniconazole treatments on flower characters and photosynthetic pigments of *Chrysanthemum indicum* L. plant. J. Amer. Sci., 7(3):399-408.

Kappel, F. and MacDonald, R.A. (2002). Gibberellic acid increases fruit firmness, fruit size and delays maturity of sweetheart sweet cherry. J. Amer. Pomol. Soc., 56(4):219-222.

Kumar, A.; Kumar, J.; Mohan, B.; Singh, J.; Rajbeer, P. and Ram, N. (2011). Effect of plant growth regulators on growth, flowering and yield of African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda. Asian J. Hort., 6(2):418-422.

Kumar, P.; Raghava, S.P.S.; Mishra, R.L. and Singh, K.P. (2003). Effect of GA_3 on growth and yield of China aster. J. Ornam. Hort., 6(2):110-112.

Kumar, V.; Kumar, V.; Umrao, V. and Singh, M. (2012). Effect of GA_3 and IAA on growth and flowering of carnation. Hortflora Res. Spect., 1(1):69-72.

Malik, S.A.; Rather, Z.A.; Wani, M.A.; Din, A. and Nazki, I.T. (2017). Effect of Growth Regulators on Plant Growth and Flowering in Dahlia (*Dahlia variabilis*) cv. Charmit. J. Exp. Agric. Int., 15(3):1-7.

Marina, L.J. (2015). Cultivation of the dahlia. Cultivos Tropicales, 36(1):103-110.

Masoud, A.A.B. and Abou-Zaid, E.A.A. (2017). Effects of spraying yeast, algae and fish oil on growth and fruiting of ruby seedless grapevines. Assiut J. Agric. Sci., 48(2):104–114.

Mohamed, Y. (2017). Effect of some growth stimulants on growth, flowering and postharvest quality of aster (*Symphyotrichum novi-belgii* L.) cv. Purple Monarch. Middle East J. Agric. Res., 6(2):264-273.

Mohamed, Y.F. (2009). The Effect of Certain Agricultural Postharvest Treatments on Some Ornamental Plants. M.Sc. Thesis, Fac. Agric., Moshtohor, Benha Univ., Egypt, 124 p.

Mohsin, M.; Nazzal, K. and Al-nuaymi, S.B.I. (2019). Effect of spraying cytokinin and seaweed extract on some flower growth traits of roselle *Hibiscus sabdariffa* L. Plant Archives, 19(2):1864–1867.

Oraby, A.A.F. (2013). Partial Replacement of Inorganic Nitrogen Fertilizer by Spraying Some Vitamins, Yeast and Seaweed Extract in Ewaise Mango Orchard Under Upper Egypt Conditions. M.Sc. Thesis, Fac. Agric., Minia Univ., Egypt, 105 p.

Padaganur, V.G.; Mokashi, A.N. and Patil, V.S. (2005). Effect of preservative chemicals on postharvest behaviour and vase life of tuberose spikes. Karnataka J. Agric. Sci., 18:218-220.

Pandey, S.K.; Kumari, S.; Singh, D.; Singh, V.K. and Prasad, V.M. (2017). Effect of biofertilizers and organic manures on plant growth, flowering and tuber production of dahlia (*Dahlia variabilis* L.) cv. S.P. Kamala, Int. J. Pure. App. Biosci., 5(2):549-555.

Pires, E.J.P.; Botelho, R.V. and Terra, M.M. (2000). Effect of CPPU and gibberellic acid on the cluster characteristics of seedless table grapes. Cienciae Agrotecnologia, 27(2):305-311.

Sajid, M.; Amin, N.; Ahmad, H. and Khan, K. (2016). Effect of gibberellic acid on enhancing flowering time in *Chrysanthemum morifolium*, Pak. J. Bot., 48(2):477-483.

Salachna, P.; Zandawadzińska, A. (2014). Effect of chitosan on plant growth, flowering and corms yield of potted freesia. J. Ecol. Eng., 15(3):97-102.

Schmidt, C.; Belle, A.B.; Nardi, C. and Toledo, A.K. (2003). The gibberellic acid (GA_3) in the cut chrysanthemum (*Dedranthema grandiflora* Zevelev.) Viking: planting summer/autumn. Revista Sci. Rural., 33(2):1451-1455.

Sen, P.K. and Sen, S.K. (1968). Effect of growth retarding and promoting chemicals on growth and flowering of some annuals. Ind. J. Hort., 25:219-224.

Sharma, M.K. and Joshi, K.I. (2015). Effect of foliar spray of GA_3 and NAA on growth, flowering and yield of China aster (*Callistephus chinensis* Nees.) cultivars, Int. J. Agric. Sci. Res., 5(4):105-110.

Singh, B. and Srivastav, R. (2008). Effect of GA_3 and ethrel on the growth and flowering of African marigold (*Tagetes erecta* Linn). Haryana J. Hort., Sci., 20:81-84.

Singh, D.P.; Jermakow, A.M. and Swain, S.M. (2002). Gibberellins are required for seed development and pollen tube growth in Arabidopsis. Plant Cell, 14:3133-3147.

Snedecor, G.W. and Cochran, W.G. (1990). Statistical methods 8th Eds. Iowa State Univ., Press, Ames Iowa, U.S.A., 593 p.

Soliman, A.I.I.; Hussein, M.H.; Dessouki, S.A.S. and Torky, Y. (2000). Production of phytohormones by using some blue-green algae used as soil inoculants for rice fields in Egypt. J. Union Arab Biol., Physiology and Algae, 88:83-102.

Sridhar, S. and Rengasamy, R. (2010). Effect of seaweed liquid fertilizer on the growth, biochemical constituents and yield of *Tagetes erecta* under field trial. J. Phytol. 2(6):61-68.

Strick, W.A. and Staden, J. (1997). Screening of some South African seaweeds for cytokinin like activity. South Africa J. Botany., 63(3):161-164.

Thomas, J.C. and Katterman, F.R. (1986). Cytokinin activity induced by thidiazuron. Plant Physiol., 81(2):681-683.

Turan, M. and Köse, C. (2004). Seaweeds extracts improve copper uptake of grapevine. Acta Agriculturae Scandinavica, Soil and Plant Sci., 54:213-220.

Yadava, U.L. (1986). A raped and non-destructive method to determined chlorophyll in intact leaves. Horticultural Science, 21(6):1449-1450.

Zahoor, A.B.; Rizwan, R. and Javid, A.B. (2011). Effect of plant growth regulators on leaf number, leaf area and leaf dry matter in grape. Natl. Sci. Biol., 3:87-90.

Zidan, E. (1962). Evaluation of some Tomato Lines in Regard to Leaf Area Efficiency and Relation of Partial Defoliation to Early and Total Yield Fruit Size, Soluble Solids, Leaf Rolling and Blossom-end Rot. Ph. D. Thesis, Cornell Univ. Ithaca. New York, U.S.A., 172 p.

تأثير الرش الورقي بمستخلص الأعشاب البحرية و بعض منظمات النمو علي إنتاجية و جودة نبات الداليا

محمد محمد محمد حرحش*، بثينه محمد وحيده**، محمد قدرى*، هناء فوزي قطب الديب***
* قسم الإنتاج النباتي، كلية الزراعة (سابا باشا)، جامعة الإسكندرية، مصر
** قسم بحوث الزينه وتنسيق الحدائق، مركز البحوث الزراعية، مصر
*** محطة البحوث الزراعية بالجميزة، مركز البحوث الزراعية، الغربية، مصر

نفذت هذه التجربة خلال موسمين متتاليين (٢٠٢٢/٢٠٢١ و ٢٠٢٣/٢٠٢٢) بقسم بحوث الزينة وتنسيق الحدائق بمحطة بحوث الجميزة الزراعية، محافظة الغربية، مصر بهدف دراسة تأثير مستخلص الطحالب البحرية وبعض منظمات النمو على نمو وإزهار نباتات الداليا. صُممت التجربة بنظام القطاعات كاملة العشوائية مع خمس مكررات لكل معاملة وكانت المعاملات على النحو التالي: الكنترول، مستخلص الأعشاب البحرية SWE (٥٠٠ ، ١٠٠٠ و ١٥٠٠ مجم/لتر) ، GA_3 (٥٠ ، ١٠٠ و ١٥٠ مجم/لتر) ، CPPU (٥٠، ١٠٠،١٥٠ مجم / لتر)، معاملات التداخل بين ٥٠٠ مجم/لتر SWE + ٥٠ مجم/لتر CPPU + ٥٠ مجم/لتر GA_3 ، ١٠٠٠ مجم/لتر SWE + ١٠٠ مجم/لتر CPPU + ١٠٠ مجم/لتر GA_3 ، ١٥٠٠ مجم/لتر SWE + ١٥٠ مجم/لتر CPPU + ١٥٠ مجم/لتر GA_3 ، ٥٠٠ مجم/لتر SWE + ١٠٠ مجم/لترCPPU + ١٥٠ مجم/لتر GA_3 ، ١٥٠٠ مجم/لتر SWE + ١٠٠ مجم/لتر CPPU + ٥٠ مجم/لتر GA_3. كانت القياسات هي النمو الخضري (طول النبات ، قطر الساق ، عدد الأفرع / النبات ، الوزن الطازج والجاف للمجموع الخضري ودليل المساحة الورقية والكلوروفيل الكلي وصفات التزهير: طول الزهرة ، قطر الزهرة ، طول الساق، الوزن الطازج والجاف للأزهار، عدد الأزهار/ نبات، عدد الأيام لأول الزهرة ، مدة الزهرة ومدة بقاء الزهرة (أيام). أظهرت النتائج أن المعاملة ١٥٠٠ مجم/لتر SWE + ١٥٠ مجم/لتر CPPU + ١٥٠ مجم/لتر GA_3 سجلت أعلى القيم لجميع صفات النمو الخضري و صفات التزهير التي تمت دراستها مقارنة بمعاملة الكنترول، خلال كلا الموسمين.