581
Arab Univ.
J. Agric. Sci.,
Ain Shams Univ.,
Cairo, 24(2), 581-591, 2016

RESPONSE OF POT MARIGOLD (*Calendula officinalis* L.) TO DIFFERENT APPLICATION METHODS AND CONCENTRATIONS OF SEAWEED EXTRACT

[40]

Tartil, M. Emam; A.M. Hosni; A.K. Ibrahim and M. Hewidy
Horticulture. Dept., Fac. Agric., Ain Shams Univ., Cairo, Egypt
*Corresponding author, email: Tartil_Emam@yahoo.com

Keywords: Pot marigold, *Calendula officinalis*, Seaweed extracts, Flowering, Vase life, Carotenoids, Nitrogen, Phosphorus, Postharvest life, Biostimulant

ABSTRACT

This research study was carried out in the open field during the two successive seasons of 2012/2013 and 2013/2014. The aim of this investigation was to study the response of pot marigold (*Calendula officinalis* L.) to different application methods and concentrations of seaweed extracts applied as a commercial compound. Seven treatments were initiated, i.e. three concentrations of seaweed extracts (500, 1000, 1500) were used either as foliar spray or as soil drench in addition to the control treatment (tap water). Results indicated that foliar spray with 1500 ppm of seaweed extract increased significantly plant height, number of flowers per plant and vase life in the two tested seasons. However, foliar spray with the lowest concentration of seaweed extract (500 ppm) resulted in significant increments in flower stalk length, flower diameter and carbohydrates content. Moreover, the same concentration showed significant increases in total carotenoids, nitrogen, and phosphorus percentage when used as soil drench in the two tested seasons.

INTRODUCTION

Pot marigold (*Calendula officinalis* L.) is an herbaceous plant belongs to family *Asteraceae*. Pot marigold has been cultivated in Egypt for its importance as an ornamental, medicinal and decorative plant. In recent years a growing interest has been observed with natural biostimulanting substances. The groups of leading biological factors showing a favorable effect on many plants include seaweed extract. Liquid extracts obtained from seaweeds have recently gained importance as foliar spray or soil drench applications for many crops including various grasses, cereals, flowers and vegetable species(**Norrie & Keathley, 2006 and Battacharyya et al 2015)**.The seaweed extracts contain some plant growth hormones, regulators, promoters, macro and micro nutrients, carbohydrates, amino acids, antibiotics, auxins, gibberellins, cytokinins, natural enzymes and vitamins consequently which enhance yield and quality as reported by **Shaaban (2011), Ordog et al (2004) and Jensen (2004)**. **Van Staden et al (1994)** tested the effect of seaweed extract at 0.0, 0.5, 1.0 and 2.0 ml/L as foliar application or soil drench on Marigold (*Tagetespatula)* and found that 1.0 ml/L increased significantly plant height and number of flowers/plant. However, the application method was not effective. In the study conducted by **Jones et al (1998)**, seaweed foliar application on sturt's desert pea flowers (*Swainsona formosa*) increased significantly chlorophyll content while the increase in vase life was not significant. In the study of **Crouch (1990)**seaweed extracts applied as a soil drench, improved plant vigor, increased significantly shoot and root fresh weights of tomato plants, moreover, plants treated with a foliar spray showed improved total yield by over 10%. In this respect, **Abdel Mawgoud et al (2010)** reported that seaweed extract at 1, 2, 3 g/l increased plant height, number of branches and fresh weight of cucumber. The application of seaweed extract as foliar spray

(Received 30 January, 2016)
(Revised 14 February, 2016)
(Accepted 15 February, 2016)

at 0.5% increased plant height, number of branches and total carbohydrates of *Tageteserecta* while spraying with 0.1% increased plant length, total chlorophyll, N, P and K persentages specially when used with only 50% of the recommended chemical fertilization rate **(Sridhar and Rengasamy, 2011)**. Seaweed liquid fertilizer increased significantly number of shoots, fresh and dry weight of plant, chlorophyll a, b, total chlorophyll, number of flowers/plant and seed yield of *Vigna radiate* L. as mentioned by **Renuka et al (2011)**. Moreover, **Sarhan (2011)** found that two seaweed extracts at 3ml/L increased plant height, fresh weight/plant and number of shoots of watermelon. Seaweed extracts increased chlorophyll and carotenoids contents when used at 20% as foliar spray on bean, barley and tomato **(Hussein et al 2011)**. They added also that seaweed extracts increased significantly shoot weight and chlorophyll content in *Zeamays* L. when sprayed twice at 1 cm/l. **Mancuso et al (2006)** noted increased uptake of N, P, K and Mg in grapevines and cucumber with application of seaweed extract, they added also that the presence of bioactive substances in seaweed extract improves stomata uptake efficiency in treated plants compared to non-treated plants. **Machado et al (2014)** applied a biostimulant consisted of cytokinin (90 mg/L), auxin (50 mg/L) and gibberellic acid (50 mg/L) as foliar spray at 0,3,6,9,12 and 15 ml/L increased significantly plant length, number of flowers and flavinoids content of marigold *(Calendula officinalis L.)*. Foliar application of seaweed extract at 10% increased nutrient uptake N, P, K, Fe, Mn and Mg in *Vigna mungo* L. as reported by **Jadhao et al (2015) and Battacharyya et al (2015). Mohy El-din (2015)** concluded that the seaweed liquid fertilizers are effective with low cost that can be promoted as eco-friendly bio fertilizers in Egypt since it increased growth and pigments of wheat seedlings. In a recent study, **Venkata et al (2015)** investigated the effect of different concentrations of seaweed on productivity of cow pea and found that plant height, number of branches and yield increased by 10% as compared with control. In this respect, **Dirya et al (2015)** reported that seaweed extract was found effective in increasing the biomass growth of roots, shoots, number of leaves, flowers and yield of *Solanum melongena* at 5% when applied as foliar spray. Recently, seaweed extract at 1 cm/L as foliar spray improved plant height, number of branches and number and diameter of floresences in *Calendula officinalis* under saline and non saline conditions as found by **Nofal et al (2015)**. Therefore, the main objective of this study was to evaluate the application method of different concentrations of seaweed extracts in enhancing growth, flowering and nutrient content of *calendula officinalis* plants.

MATERIALS AND METHODS

Location and duration

This study was conducted in Faculty of Agriculture, Ain Shams University, Shoubra El Khima, Qalubia governorate during the two successive seasons of 2012-2013 and 2013-2014.

Plant material

Seeds of local origin of Pot marigold *(Calendula officinalis* L.) were obtained from the ornamental plants nursery, Ministry of Irrigation, El-Kanater El-khairia, Qalubia

Seaweed extract

A commercial seaweed extract containing natural bioactive substances like vitamins, free amino acids, hormones and alginates processed out of selected seaweeds (*Sargassum sp., Ascophyllum nodosum and luminaria sp*.). Seaweed extract was kindly donated by the Union for Agricultural Development (UAD) company, Cairo, Egypt. The chemical composition of commercial seaweed extract is presented in **Table (A)**.

Seeds of local origin of pot marigold were sown on September 10^{th} and 15^{th} in the first and second growing seasons, respectively in 30 cm plastic pots as a nursery. Pots were filled with a medium which contains a mixture of peat moss, sand and vermiculite (2:1:1 by volume) and seeds were covered with 0.5 cm of the medium and irrigated. Then pots were kept in the uncontrolled greenhouse.

Seedlings were pricked out in 25 cm plastic pots filled beforehand with the same above medium as one seedling per pot on October 20^{th} and 25^{th} in the first and second growing seasons, respectively.

Experimental seaweed treatments

The tested seaweed concentrations for both foliar application and soil drench were prepared from powder seaweed extract in detail, 0.5 g, 1 g and 1.5 g were each dissolved in 1Litre of water to prepare 500, 1000 and 1500 ppm respectively, each

Table A. Chemical and biochemical analysis of a commercial seaweed extract powder

Organic matter		Growth regulators		Macro and micro elements	
Total amino acid	6%	IAA	0.03%	Organic (N)	3.12%
Carbohydrates	35%	Cytokinins	0.02%	P_2O_5	2.61%
Alginic acid	10%			k_2O	4.71%
Manitol	4%			Ca	0.25%
Betaines	0.04%			S	3.56%
				Mg	0.58%
				Fe	150ppm
				Zn	70ppm
				Mn	13ppm
				B	60ppm
				I	30ppm

concentration was studied twice i.e., either foliar spray or soil drench The control treatment was tap water. Treatments were applied three times: the first application was applied three weeks from transplanting followed by a second application administered one month after and the third one applied one month late. All agricultural practices, i.e. irrigation, fertilization, pest and disease control were carried out as recommended in the leaflet of Horticulture Research Institute, Agriculture Research Center (ARC), Ministry of Agriculture.

Data Recorded

Vegetative growth parameters

A random sample of three plants from each replicate for each treatment was taken at the beginning of flowering for vegetative growth data, i.e. plant height (cm), number of shoots/plant and fresh weight (g) of foliage aerial parts (stem, leaves and flowers).

Flowering traits

Number of flowers per plant, flower stalk length (cm) and flower diameter (cm) were recorded.

Postharvest flower vase life

Vase life was determined whereas, flowers were harvested between 7:00 Am and 10:00 Am at the optimum stage of development (outer ring of ray florets opened). The lower half of the stem was stripped of its leaves and then placed into vases as ten flowers per replicate within 5 minutes of being cut. Vases were filled with tap water. Flowers were discarded daily until reaching 50% of their number based on petal wilt, turning brown or stem bent as described by **Erin et al (2010).**

Chemical analysis

A representative sample of 100 grams of plant foliage was taken, and oven dried. The total nitrogen percentage was determined in dry samples using micro-kjeldahl apparatus according to **FAO (1980)**. Phosphorus percentage was estimated using a colorimetric method according to the method described by **Jackson (1976).** Potassium was evaluated using the flame photometer device as explained by **Brown and Lilleland (1946).** Determination of potassium and sodium in plant material and soil extract by flame photometry. Proc. Amer. Soc., [C.F. Hort. Sci., 73: 813]. Chlorophyll 'a' and chlorophyll 'b' were estimated marigold according to the method set out by **Arnon (1949)**. Total carotenoids were determined as mg/100g fresh weight from flower petals by using a colori-

metric method stated by **A.O.A.C. (2005)**. Total carbohydrates percentage was estimated according to **Dubois et al (1956).**

Experimental Design

Treatments were arranged in a randomized complete block design (RCBD) with three replicates for each treatment. Each block contained the seven seaweed treatments that were allocated randomly. Each replicate contained eight pots, each pot containing one plant.

Statistical Analysis

Data were statistically analyzed using the analysis of variance (ANOVA) described by **Snedecor and Cochran, (1990)**. The method of Duncan's multiple range tests was applied for the comparison between means according to **(Waller and Duncan, 1969).**

RESULTS AND DISCUSSION

1- Plant height

Results presented in **Table (1)** clearly indicate that all tested treatments of seaweed extract increased significantly calendula plant height as compared with control plants. However, the highest values were obtained in plants sprayed with 1500 ppm of seaweed extract in the two tested seasons in addition to those administed with 1500 ppm as soil drench in the second season. The results agree with those found by **Abdel-Mawgoud et al (2010), Sridher and Rengasamy (2011), Sarhan (2011) and Venkata (2015)**. Such increament in plant height may be attributed to the plant growth hormones, auxins, gibberellins and plant nutrients present in the seaweed extracts as mentioned by **Shaaban (2011), Ordog et al (2004)** and **Jensen (2004).**

2- Number of shoots / plant

Results presented in **Table (1)** indicate also that foliar spray of seaweed extract at 500 ppm and soil drench at 1000 ppm showed the highest significant values of number of shoots / plant without significant differences between them in the first season, nevertheless the control treatment gave the lowest value. In the second season, a significant increment in shoot number / plant was found using 500 ppm of seaweed extract as foliar spray as compared to all tested treatments. Our results are in the same direction with those obtained by **Crouch (1990)**, **Abdel-Mawgoud et al (2010), Sarhan (2011), Renuka *et al* (2011)** and **Venkata et al (2015).**

Such increment in shoot number / plant due to seaweed application may be attributed to that seaweed extracts contain some plant growth hormones, macro and micro nutrients, carbohydrates, amino acids, antibiotics, cytokinins, auxins, natural enzymes and vitamins as reported by **Shaaban (2011, Ordog et al (2004)** and **Jensen (2004)**. Such auxins and cytokinins promote growth via rapidly speeding up the process of cell division. They allow to areas of elongation where they allow the walls of cells to stretch. **(Johri and Mitra, 2001).**

3- Number of flowers / plant

Results in **Table (2)** indicate that the high concentrations of seaweed extract, i.e. 1000 and 1500 ppm showed significant increments in number of flowers / plant for pot marigold in the two tested seasons regardless of the application method when compared to the control treatment. In this respect, foliar spray of seaweed extract at 1500 ppm reflected a significant increases in number of flowers / plant in both the two tested seasons without significant differences with plants sprayed with 1000 ppm or soil drenched with 1500ppm in the second season only. However, the control treatment showed the lowest values in the two experimental seasons. Such results are in the same line with those obtained by **Sridhar & Rengasamy (2011)** and **Dirya et al (2015)**

The increment in number of flower / plant treated with seaweed extract may be due to the increased plant height and high number of shoots / plant in these plants as shown in **Table (1)** in addition to the plant growth regulators in the seaweed extract as stated in **Table (A)**.

4- Flower stalk length

In **Table (2)**, data of results reveal that spraying pot marigold plants with 500 ppm of seaweed extract showed higher significant values of flower stalk length as compared with non-treated plants in the two experimental seasons. These results are in agreement with those of **Diryae*t al* (2015).** This increment may be attributed to the stimulant effect of seaweed extract because it contains many growth promoters such as auxins, gibberellins and cytokinins.

Table 1. Effect of application method and concentration of seaweed extract on plant height and number of shoots/plant for *Calendula officinalis* plants during 2012/2013 and 2013/2014 seasons

Treatments (ppm)	Plant height (cm)		No. of shoots/plant	
	2012/2013	2013/2014	2012/2013	2013/2014
Control	30.77d	30.20d	7.53d	11.10cd
F.S.500	43.63c	40.07c	12.77bc	17.83a
S.D.500	43.07c	44.40b	13.53bc	12.10bc
F.S.1000	49.30b	44.97b	12.77bc	13.83b
S.D.1000	51.73b	47.77b	14.07ab	9.67d
F.S.1500	63.77a	55.87a	15.30a	13.63b
S.D.1500	49.63b	55.07a	12.20c	10.63cd

F.S. = Foliar spray S.D = Soil drench

Values in the same column followed by the same letter (s) are not statistically different according to Duncan's multiple range tests.

Table 2. Effect of application method and concentration of seaweed extract on number of flowers/plant and flower stalk length (cm) for *Calendula officinalis* plants during 2012/2013 and 2013/2014 seasons

Treatments (ppm)	Number of flowers/plant		Flower stalk length (cm)	
	2012/2013	2013/2014	2012/2013	2013/2014
Control	11.17c	11.40c	17.50d	19.60cd
F.S.500	14.30b	13.53c	33.77a	29.63a
S.D.500	14.73b	18.20b	20.53cd	16.70d
F.S.1000	16.60b	24.30a	27.93b	22.20bc
S.D.1000	15.53b	22.83a	22.00c	25.87ab
F.S.1500	20.77a	21.83a	22.20c	20.97c
S.D.1500	15.07b	16.97b	27.20b	22.17bc

F. S. = Foliar spray S.D = Soil drench

Values in the same column followed by the same letter (s) are not statistically different according to Duncan's multiple range tests.

5- Vase life

As for the effect of seaweed extract on vase life, i.e. postharvest flower life results in **Table (3)** revealed that 1000 ppm as soil drench and 1500 ppm as foliar spray led to a significant increment in vase life of pot marigold flowers as compared with all other tested treatments. The results are in agreement with those of **Jones et al (1998)** who mentioned that the vase life of Sturt's Desert Bea flowers increased by five days when treated with seaweed concentrate.

6- Flower diameter

The addition of seaweed extract at 500 ppm as soil drench to *Calendula* plants resulted in a significant increment in the two tested seasons. The control plants showed the lowest value flower diameter in the two tested seasons. The results are similar to those reported by **Norrie and Keathley (2006), Delucia and Vecchietti (2012)** and **Nofal et al (2015).**

Table 3. Effect of application method and concentration of seaweed extract on vase life (day) and flower diameter (cm) for *Calendula officinalis* plants during 2012/2013 and 2013/2014 seasons

Treatments (ppm)	Vase life (day)		Flower diameter (cm)	
	2012/2013	2013/2014	2012/2013	2013/2014
Control	6.00c	4.67d	4.47d	4.53d
F.S.500	6.67b	6.67a	5.27b	5.20c
S.D.500	6.00c	6.00bc	5.80a	6.10a
F.S.1000	6.00c	5.67c	5.47b	5.63b
S.D.1000	7.33a	6.67a	5.00c	4.73d
F.S.1500	7.33a	6.33ab	4.83c	5.27c
S.D.1500	6.00c	6.33ab	4.87c	5.50b

F. S. = Foliar spray S.D = Soil drench

Values in the same column followed by the same letter (s) are not statistically different according to Duncan's multiple range test.

7- Carbohydrates content

Concerning carbohydrates content, data resulted presented in **Table (4)** denate that using foliar spray of seaweed extract at 500 ppm gave the highest values in the two tested seasons without significant differences between them and those of the control plants as well as plants that had received 1500 ppm as soil drench. Our results are true with those obtained by **Sridhar and Rengasamy (2010)** and **Venkata et al (2015)**. These results may be due to the positive effect of seaweed extract on plant height, number of shoots, flower stalk length and fresh weight / plant, such plants showed high photosynthesis and net assimilation rate and finally produced more carbohydrates content.

8- Vegetative fresh weight

With respect to vegetative fresh weight per plant, results in **Table (4)** show clearly that seaweed extract at 1500 ppm as foliar spray showed the highest values; on the other hand, control plants indicated the lowest values in the two tested seasons. Such results are in the same line with those of **Crouch (1990), Norrie and Keathley (2006), Hussein et al (2011), and Delucia and Vecchietti (2012).**

This increment in vegetative fresh weight/plant due to seaweed application may be due to the positive effect of seaweed extract on increasing most vegetative growth characters i.e., plant height, number of shoots and flower stalk length as seaweed extract contains many growth regulators, macro and micro nutrients as found by **Shaaban (2011), Ordog et al (2004) and Jensen (2004**).

9- Chlorophyll content

Data shown in **Table (5)** indicate that there was a slight significant effect for seaweed extract on chlorophyll (a) content. Moreover, the highest values of chlorophyll (a) content were recorded when plants were sprayed with 500 ppm in the first season. Meanwhile, soil drench of seaweed at 1000 ppm gave the highest values in the second season. Regarding chlorophyll (b) content, the results in Table (5) showed no clear effect for seaweed extract application as for total chlorophyll. Results in Table (5) showed that the highest values were found when plants were sprayed with 500 ppm in the first season and with the same concentration but as soil drench in the second season. Our results confirm those of **Jones et al (1998), Sridhar and Rangasamy (2010), Renuka et al (2011), Sarban (2011)** and **Delucia and Vecchietti (2012).**

Table 4. Effect of application method and concentration with seaweed extract on carbohydrates (mg/g) and fresh weight/plant (g) for *Calendula officinalis* plants during 2013 and 2014 seasons

Treatments (ppm)	Total Carbohydrates (mg/g)		Fresh weight/plant (g)	
	2012/2013	2013/2014	2012/2013	2013/2014
Control	22.90f	36.44c	566.7f	494.3f
F.S.500	57.81a	55.20a	716.7d	539.3e
S.D.500	38.34d	40.52b	1183.3b	888.7b
F.S.1000	37.77d	41.43b	816.7c	444.3g
S.D.1000	31.45e	55.68a	833.3c	854.3c
F.S.1500	48.31c	23.14d	1250.0a	1005.2a
S.D.1500	52.63b	54.25a	691.7e	722.0d

F. S. = Foliar spray S.D = Soil drench

Values in the same column followed by the same letter (s) are not statistically different according to Duncan's multiple range test.

Table 5. Effect of application method and concentration of seaweed extract on chlorophyll and carotenoid contents (mg/100 g fresh weight) for *Calendula officinalis* plants during 2012/2013 and 2013/2014 seasons

Treatments (ppm)	Chlorophyll (a)		Chlorophyll (b)		Total chlorophyll		Carotenoids	
	(mg/100 g fresh weight)							
	2012/2013	2013/2014	2012/2013	2013/2014	2012/2013	2013/2014	2012/2013	2013/2014
Control	0.62c	0.64b	0.66a-d	0.29c	1.28cd	0.93de	7.36d	6.33c
F.S. 500	1.51a	0.44c	0.79a-c	0.85b	2.31a	1.28cd	13.53bc	12.90b
S.D.500	0.71c	0.63b	0.37cd	1.57a	1.08de	2.20a	16.92a	15.81a
F.S. 1000	1.16b	0.60b	0.46b-d	0.24c	1.62bc	0.85e	13.55bc	17.15a
S.D. 1000	0.57c	0.84a	0.27d	0.65bc	0.84e	1.49bc	12.20c	16.16a
F.S. 1500	0.76c	0.68b	0.98a	1.08b	1.74b	1.76b	14.29b	13.50b
S.D. 1500	0.73c	0.72b	0.89ab	0.23c	1.61bc	0.95de	14.81b	16.13a

F. S. = Foliar spray S.D = Soil drench

Values in the same column followed by the same letter (s) are not statistically different according to Duncan's multiple range test.

10- Total carotenoids

Results presented in **Table (5)** point out clearly that the addition of seaweed extract at 500 ppm as soil drench showed the highest significant values of total carotenoids in calendula plants in the first season as compared with all other tested treatments. However, in the second season, all tested seaweed treatments increased significantly total carotenoids as compared with the control. The results here agree with those of **Hussein *et al* (2011)**, **Machado *et al* (2014)** and **Mohy El-Din (2015)**.

11- Nitrogen, phosphorus and potassium content

All used concentrations of seaweed extract by the two tested application methods increased significantly nitrogen percentage in calendula plants

as compared with the control **(Table 6)**. Concerning the effect of seaweed extract on phosphorus percentage, data in **Table (6)** revealed that the lowest used concentration i.e., 500 ppm either foliar spray or soil drench resulted in the highest significant values in the two tested seasons. Moreover no significant differences were detected between control treatment and most of the used treatments in both seasons.

It is clear from results tabulated in **Table (6)** that all used concentrations of seaweed extract increased significantly potassium percentage than the control in the two tested season when used as foliar spray or as soil drench. In this regard, no significant differences were detected in most of seaweed application treatments. The results are in agreement with those of **Battacharyya et al (2015)** and **Jadhau et al (2015)**.

Such increase in microelements due to seaweed application may be attributed to improving stomata uptake efficiency in the treated plants as mentioned by **Mancuso et al (2006)**.

12- Fe, Zn and Mncontent

The highest used concentration of seaweed extract (1500 ppm) resulted in the highest Fe content in pot marigold foliage in the two tested seasons in addition to the control treatment in the second season with significant differences between them **(Table 7)**. As regards to Zn content, results in **Table (7)** showed also that calendula plants treated with 500 ppm as foliar spray showed the highest values in the first season without significant difference among them. While in the second season, the highest value was detected to those plants received 1000 ppm as soil drench. Control plants gave the highest values in the two experimental seasons in addition to those treated with 1500 ppm as soil drench in the second season. Seaweed extract had no significant effect on Mn content of calendula plants. Such results are in the same line with those obtained by **Battacharyya et al (2015)** who found no effect of seaweed on Mn concentration on Spinach.

Table 6. Effect of application method and concentration of seaweed extract on nitrogen, phosphorus and potassium content as percentages in foliage samples of *Calendula officinalis* plants during 2012/2013 and 2013/2014 seasons

Treatments (ppm)	N (%)		P (%)		K (%)	
	2012/2013	2013/2014	2012/2013	2013/2014	2012/2013	2013/2014
Control	1.05c	1.06c	0.19d	0.18d	0.29d	0.29c
F.S.500	2.42b	2.46b	1.52b	1.41b	1.85c	1.56b
S.D.500	2.99a	2.99a	1.94a	1.71a	1.87c	1.67b
F.S.1000	2.81a	2.79a	0.39d	0.41d	2.71a	2.70a
S.D.1000	2.24b	2.26b	0.31d	0.27d	2.29b	2.30ab
F.S.1500	2.99a	3.01a	0.96c	0.95c	2.46b	1.80b
S.D.1500	2.91a	2.92a	0.27d	0.26d	2.43b	1.44ab

F.S. = Foliar spray S.D = Soil drench

Values in the same column followed by the same letter (s) are not statistically different according to Duncan's multiple range test.

Table 7. Effect of application method and concentration of seaweed extract on iron, zinc and manganese (mg/l) for *Calendula officinalis* plants during 2013 and 2014 seasons

Treatments (ppm)	Fe (mg/l)		Zn (mg/l)		Mn (mg/l)	
	2012/2013	2013/2014	2012/2013	2013/2014	2012/2013	2013/2014
Control	32.55e	40.00f	14.67d	6.51f	29.30a	31.50a
F.S. 500	51.63c	53.98e	21.50a	16.83d	27.33c	28.53b
S.D.500	33.68e	62.58d	18.67b	18.67c	28.70ab	27.63bc
F.S.1000	56.25bc	78.18c	17.00c	21.33b	27.60bc	28.03d
S.D.1000	60.62b	67.80d	21.50a	22.67a	27.27c	25.83d
F.S.1500	80.25a	105.33b	19.83ab	16.17d	29.37a	27.33bc
S.D.1500	39.90d	125.58a	18.83b	12.12e	26.70c	26.67cd

F.S. = Foliar spray S.D = Soil drench

Values in the same column followed by the same letter (s) are not statistically different according to Duncan's multiple range test.

Conclusion and recommendation

The study here with recommends using 500 ppm of seaweed extract to increase flower diameter and flower stalk length as foliar spray or as soil drench to increase carotein content in flowers when Pot marigold is used for medicinal purposes. Whereas, if used as a cut-flower for decoration purposes the study concludes also that 1500 ppm as foliar spray increase plant height, flower number and vase life.

REFERENCES

A.O.A.C, 2005. Official methods of analysis.15th ed. Association Agricultural Chemists.12th Ed., Washington, D.C., USA.

Abdel-Mawgoud, A.M.R., Tantaway, A.S., Hafez, M.M. and Habib, H.A. 2010. Seaweed extract improves growth, yield and quality of different watermelon hybrids. **Research J. Agric. and Biolog. Sci., 6(2), 161-168.**

Arnon, D.L. 1949. Copper enzymes in isolated chloroplast, polyphenol oxidase in Beta vulgarise. **Plant Physiology, 2, 1-15.**

Battacharyya, D., Babgohari, M.Z., Rathor, P. and Prithiriraj, B. 2015. Seaweed extract as biostimulants in horticulture. **Scientia Horticulturae. 196, 39-48.**

Brown, J.D. and Lilleland, O. 1946. Determination of potassium and sodium in plant material and soil extract by flame photometry. **Proc. Amer. Soc., J. Hort. Sci., 73, 813.**

Crouch, I.J. 1990. The effect of seaweed concentrate on plant growth. Ph.D. Thesis. Dept. of Botany, Faculty of Science, University of Natal, pietermari Tzburg.

Delucia, B. and Vecchietti, L. 2012. Type of bio stimulant and application method effects on stem quality and root system growth in L.A. Lily. Europ. **J. Hort. Sci., 77(1), 10-15**.

Dirya, K., Roja, N.M. and Padal, S.B. 2015. Effect of seaweed liquid fertilizer of *sargassum wightii*on germination, growth and productivity of brinjal *Solanum melongena*. **International J. of Advanced Research in Science, Engineering and Technology 2(10), 868-871.**

Dubois, M., Gilles, K.A., Hamilton, J.K., Rebers, P.A. and Smith, F. 1956. Colourimetric method for determination of sugars and related substances. **Ann. Chem., 28, 350.**

Erin, M.R. Clark, Jonhn, M. Dole, Alicain S. Carlson, Erin P. Moody, Ingram F. McCall, Frankie L. Fanelli and William C. Fonteno, 2010. Hort. Technology 20(6), 101- 102.

FAO, 1980. Soil and Plant Testing and Analysis. **FAO Soil Bulletin, 38(1), 250.**

Hussien, A.A., Ismail, A.A. and Sabra, F.S. 2011. Bioactive substances extracted from seaweeds as a biocontrol agent's effects and identification. **J. Agric. Res. Kafer El-sheikh Univ. 37(1), 183-208.**

Jackson, M.L. 1973. Soil chemical analysis Prentice-Hall of India private limited M-97, New Delhi, India, **498 p.**

Jadhao, R.G., Chaudhary, D.R., Khadse, V.A. and Zodape, S.T. 2015. Utilization of seaweed in enhancing productivity and quality of black gram (*Vigna mungo* L. Hepper) for sustainable agriculture. **Indian Journal of Natural Products and Resources, 6(1), 16-22.**

Jensen, E. 2004. Fact or fancy.From the organic broad caster. Midwest organic and Sustainable **Education. 12(3), 164-170.**

Johri, M.M. and Mitra, D. 2001. Action of plant hormones. **Curr. Sci., (80), 199-205.**

Jones, P.N., Taja, A.M. and Faint, M.J. 1998. The effect of Natrakelp (seaweed) concentrate and cultar on the vas life of sturt's desert pea flowers (*Swainsona formosa*). **Acta Hort. 454, 383-390.**

Machado, V.P., Pacheco, A.C. and Carvalho, M.E.A. 2014. Effect of bio-stimulant application on production and flavonoid content of marigold *(Calendula officinalis L.)*. **Rev. Ceres, Vicosa, 61(6), 983-988.**

Mancouso, S., Azzarelto, E., Mugnai, S. and Briand, X. 2006. Marine bioactive substances (IPA extract) improve foliar ion uptake and water tolerance in *potted Vitisvinifera* plants. **Advances in Horticultural Science 20, 156-161.**

Mohy El-Din, S.M. 2015. Utilization of seaweed extracts as bio-fertilizers to stimulate the growth of wheat seedlings. **Egyptian J. Exp. Biol. 11(1), 31-39.**

Nofal, F.H., El-Segai, M.U. and Seleem, E.A. 2015. Response of *Calendula officinalis* L. plants to growth stimulants under salinity stress. **American-Eurasian J. Agric. & Environ. Sci., 15(9), 1767-1778.**

Norrie, J. and Keathley, J. 2006. Benefit of *Ascophyllumnodosum*marin plant extract application to Thompson seedless grape production. **Acta Hort. 727, 243-247.**

Ordog, V., Stirk, W.A., VanStaden, J., Novak, O. and Strand, M. 2004. Endogenous cytokinins in the three genera of microalgae from the chlorophyte. **J. Physiol., 40, 88-95.**

Renuka, B.N., Christ, R.M. and Kala, T.C. 2011. Seaweed liquid fertilizer as an alternative source of chemical fertilizer in improving the yield of *Vigna radiate* L. **Plant Archives, 11(2), 895-898.**

Sarhan, T.Z. 2011. Effect of humic acid and seaweed extracts on growth and yield of potato plants (*Solanumtubersum* L.). **Mesopotamia J. Agric, 39(2), 19-25.**

Shaaban, M.M. 2011. Green microalgae water extract as foliar feeding to wheat plants. **Pakistan J. Biol. Sci., 4, 628-632.**

Snedecor, G.W. and Cochran, W.G. 1990. Statistical Methods.11th. Ed. Iowa State College Press. Ames, Iowa, U.S.A. **pp. 369-373.**

Sridhar, S. and Rengasamy, R. 2011. Effect of seaweed liquid fertilizer (slf) on the germination and growth of seedling of some agriculture crops. **International J. of Recent Scientific Research, 12, 297-291.**

Tarraf. S.A., Talaat, I.M., El-Sayed, A.B. and Balbaa, L.K. 2015. Influence of foliar application of algae extract and amino acids mixture on fenugreek plants in sandy and clay soils. **Nusantara Bioscience. 7, 33-37.**

Van Staden, J., Upfold, S.J. and Drewes, F.E. 1994. Effect of seaweed concentrate on growth and development of the marigold *Tagetespatula* **J. of Applied Phycology, 6, 427-428.**

Venkata, R.P., Raddyand, A.S. and Kotaswara, R.Y. 2015. Effect of seaweed liquid fertilizers on productivity of *Vignaradiate* L. **International J. Res. Chem. Environm., 5(4), 91-94.**

Waller, R.A. and Duncan, D.B. 1969. A Bayes rule for the symmetric multiple comparisons problem. **J. Am. Stat. Assoc. 46, 1484-1503.**