EFFECT OF NPK FERTILIZER AND SOME NATURAL EXTRACT TREATMENTS ON THE VEGETATIVE GROWTH AND FLOWERING OF AFRICAN MARIGOLD (*TAGETES ERECTA* L. VAR. DWARF CHRYSANTHEMUM)

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Abstract. A pot experiment was carried out during the two successive seasons of 2017 and 2018 at the Nursery of the Ornamental Plants Research Department, Horticultural Research Institute, Giza, Egypt, to investigate the effect of applying NPK fertilization at the rates of zero and 2 g/pot as a soil drench and natural extracts of seaweed, *Moringa oleifera* leaves and dry yeast thrice as a foliar application at concentrations of zero, 1 and 2 g/l individually or in combination with NPK fertilizer on vegetative growth and flowering characteristics of African marigold (*Tagetes erecta* L. var dwarf chrysanthemum). Results revealed that supplying plants with NPK at 2 g/pot in combination with seaweed extract at 2 g/l or applying such extract individually significantly stimulated vegetative growth parameters as well as the rooting parameters. Moreover, seaweed extract promoted some flower characteristics. However, the most effective treatments to achieve the significantly earliest flowering in both seasons was concomitant to plants supplied with NPK at 2 g/pot combined with yeast extract at 2 g/l, followed by those treated with the same extract alone when compared to control.
Keywords: *seaweed extract, moringa leaves extract, yeast extract*

Introduction

Tagetes erecta L. is an annual summer plant belonging to the Asteraceae Family, native to Mexico. It is characterized by the short period it requires to produce marketable flowers, wide spectrum of colours, shape and size. Marigold is used for beatification and in landscaping activities. Flowers are single to fully double and large-sized to globular head, flower colour varies from yellow to orange. The average height of dwarf double chrysanthemum flowers is 20-30 cm (Bose and Yadav, 1989).

Natural extracts play an essential role as bio fertilizer in reducing chemical fertilizer application, resulting in an eco-friendly natural substance and increasing plant growth and yield productivity. Seaweed extract has become an effective tool as a fertilizer as a foliar spray to enhance growth and yield to induce nutrients uptake from soil and motivate antioxidant properties (Rathore et al., 2009). They include auxins, cytokinins, trace elements, vitamins and amino acids. As well as having in significant impact on seed germination, growth and yield parameters and post-harvest shelf life enhancement (Norrie and Keathley, 2006). Moringa leaves extract is considered as growth enhancer due to its richness in zeatin and cytokinins (Fuglie, 1999). Also, it includes ascorbates, carotenoids, phenols as well as minerals such as calcium and potassium in its structure which provide the plants with growth stimulatory powers (Foidle et al., 2001).

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Dry yeast extract is a safety source of phytohormons particularly cytokinins which stimulate cell division and expansion (Khedr and Farid, 2000) and delay the aging of leaves by retarding the degradation of chlorophyll and promoting the synthesis of protein and RNA as well as including high levels of amino acids, vitamins, enzymes and minerals (Dawood et al., 2013, Marzauk et al., 2014).

NPK fertilizer is the most common chemical item used for improving plant growth and productivity with its three important nutrients (nitrogen, phosphorus and potassium) that play very substantial role in altering various growth, yield and quality attributes (Marschner, 1986). Nitrogen (N), is an essential element to improve the growth during the vegetative phase and protein synthesis (Inugraha et al., 2014). Phosphorus (P) plays a vital role in determining plant growth and productivity and helps in cell division, enzyme activation and carbohydrates metabolism through partitioning with ATP (Razaqu et al., 2017). Potassium (K) has a favorable effect on metabolism of nucleic acid, protein, vitamins and growth substances energy transfer, phloem transport as well as cation and anion balance (Wang et al., 2013).

The present work aimed to study the effect of applying the extracts of seaweed, moringa leaves and dry yeast as a foliar application and NPK (Krystalon of 19:19:19) as a soil drench in different concentrations on growth and flowering of *Tagetes erecta* L. var. dwarf chrysanthemum to find out the most effective treatments that induce the highest growth and flowering characteristics in order to reduce chemical fertilizers application and helps in decreasing pollution rates.

Materials and methods

This investigation was carried out in Ornamental Plant Research Department, Horticulture Research Institute, Giza, Egypt during 2017 and 2018 seasons. The aim was to study the effect of seaweed, *Moringa oleifera* Lam. leaves and dry yeast extract at concentrations of 0, 1 and 2 g/l as individual application or in combination with NPK fertilizer at 2 g/pot (each pot has 2 kg soil) on vegetative growth and flowering characteristics of *Tagetes erecta* L. var. dwarf chrysanthemum. Seedlings of 7-10 cm with 3-4 leaves were transplanted on Dec 6th and 9th in the first and second seasons, respectively in 14 cm diameter plastic pot of 12 cm height filled with a mixture of clay : peatmoss and sand (1:1:1, v/v/v) as one seedling per pot. The physical and chemical characteristics of the soil mixture revealed that the texture of the soil used in both seasons was sandy loam. The chemical and physical properties of the growing medium are presented in *Table 1a,b*. The analysis was carried out according to the methods described by Cottenie et al. (1982).

Table 1a. *Chemical composition of extracted soil sample*

Cations (meq/l)				Anions (meq/l)				SP	EC Ds/m	pH 1:2.5
K^+	Na^+	Mg^{++}	Ca^{++}	$SO4^=$	Cl^-	$HCO3^-$	$CO3^=$			
0.9	18.1	4.8	9.2	3.2	28.5	1.1	-	37.00	3.3	7.99

Table 1b. *Physical properties of the used soil*

Texture	Soil particles %			
	clay	silt	Sweet sand	Rough sand
Loamy sand	7.3	15.3	40.4	37.0

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Preparation of the natural extracts

1- Seaweed extract. A commercial product of seaweed extract that included biostimulant components such as vitamins, free amino acids, hormones and alginates processed out of selected seaweeds (*Sargassum sp*., *Ascophythum nodosum* and *Luminaria sp*.) applied as a foliar spray as prepared by dissolving 1 and 2 g in one liter of tap water, obtaining 2 concentrations (1 and 2 g/l) using tap water as a control treatment.

2- Moringa extract fresh leaves of moringa (*Moringa oleifera* Lam.) were collected from a certain mother tree. The sample was cleaned by tap water, dried in a shaded place and ground in an electrical grinder to give a powder used at 1 and 2 g with tap water, and then the extracts were shaken for 4 hours by shaker and kept in dark place for 24 hours. In the next day, the extract was filtered through a filter paper.

3- Active dry yeast extract was prepared from the commercial product at 1 and 2 g and dissolved in one liter of tap water, then provided with sugar at the ratio of 1:1 (g/g) and kept 24 hours in a dark warm place to obtain two levels (1 and 2 g/l).

4- Chemical fertilization. A commercial compound Kristalon as NPK fertilizer (19:19:19) was used as a recommended dose by ministry of agriculture, Egypt in trail to reduce this dose by using eco-friendly stimulators.

The two tested concentrations of the previous natural extracts were applied as a foliar application alone or combined with NPK fertilizer (Kristalon) at the rate of 2 g/l used a soil drench either alone or in a combination with the aforementioned extracts. The treatments were thrice applied the first one was after 15 days from transplanting followed by two fortnightly intervals. The treatments of this investigation were carried out as follows:

Control (tap water) – Seaweed extract at 1 and 2 g/l – Moringa leaves extract at 1 and 2 g/l – Yeast extract at 1 and 2 g/l – Seaweed extract at 1 and 2 g/l + 2 g NPK/pot – Moringa leaves extract at 1 and 2 g + 2 NPK/pot – Yeast extract at 1 and 2 g/l + 2 g NPK/pot – 2 g NPK/pot (*Figure 1*).

Moringa leaves Dry Yeast Kristalon seaweed extract

Figure 1. *Photos of the equipment used in this study*

Data recorded in both seasons on Jan 22nd and 25th in the first and second seasons, respectively on

– *Vegetative and rooting growth parameters* (Plant height (cm) – stem diameter (cm) – number of leaves/plant – root length (cm) for the longest root– fresh and dry weights (g) of shoots, roots and flowers) as the soil removed by tab water and left to dry.

– *Flowering parameters* (Number of days from planting to flowering – flower diameter (cm) was measured for the master flower.

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– Experimental design

The experiment layout was factorial in a complete randomized design with three replicates for each treatment, each replicate contained three pots and each pot contained one plant.

The NPK treatments represented the main factor, while the natural extract treatments represented the sub factor.

– Statistical analysis

Analysis of variances was performed and comparisons among means of treatments were performed using the new multiple range test at the 5% level of significance as described by Duncan (1955) and Steel et al. (1997).

Results

Effect of NPK and some natural extract treatments on some vegetative growth and flowering characteristics of African marigold

Vegetative growth traits

Plant height, stem diameter and No. leaves/plant

Data presented in *Table 2* showed that the highest NPK level (2 g/pot) gave the tallest plants, the thicker stems and the highest No. leaves/plant when compared to control plants in both seasons. For the effect of natural extracts data in the same *Table* showed that all treatments significantly increased plant height and raised stem diameter as well as No. leaves/plant in the two seasons as the significantly highest records resulted from seaweed extract at 2 g/l followed by seaweed extract at 1 g/l, with the superiority of moringa leaves extract at 2 g/l in this concern.

Table 2. *Effect of NPK and some natural extract treatments on some vegetative growth characteristics of Tagetes erecta L. var. dwarf chrysanthemum in two seasons*

Parameters	**Plant height (cm)**			**Stem diameter (cm)**			**No. of leaves/plant**		
Fertilizers	**NPK**			**NPK**			**NPK**		
Natural extracts (g/l)	**0.00 g**	**2.00 g**	**Mean**	**0.00 g**	**2.00 g**	**Mean**	**0.00 g**	**2.00 g**	**Mean**
	First season								
Control	9.00j	9.17j	9.08F	0.280j	0.330i	0.305F	7.00j	8.00i	7.50G
Seaweed 1g	14.00e	16.40b	15.20B	0.387f	0.540b	0.463B	13.00c	14.00b	13.50B
Seaweed 2g	15.50c	17.07a	16.28A	0.443d	0.573a	0.508A	14.20b	15.00a	14.60A
Moringa 1 g	12.83gh	13.77ef	13.30D	0.370g	0.410e	0.390D	11.50e	12.00d	11.75D
Moringa 2g	13.97e	14.74d	14.35C	0.440d	0.440d	0.440C	11.33e	13.00c	12.17C
Yeast 1g	12.07i	12.78gh	12.43E	0.350h	0.360gh	0.355E	9.10h	10.60f	9.85F
Yeast 2g	12.39hi	13.23fg	12.81E	0.400ef	0.470c	0.435C	10.20g	11.20e	10.70E
Mean	12.82B	13.88A		0.381B	0.446A		10.90B	11.97A	
	Second season								
Control	10.07h	10.90g	10.48F	0.300k	0.350ij	0.325E	7.67k	8.33j	8.00G
Seaweed 1g	14.47c	15.60b	15.03B	0.370hi	0.497c	0.433B	13.33c	14.10b	13.72B
Seaweed 2g	15.30b	16.31a	15.80A	0.553b	0.627a	0.590A	14.00b	15.20a	14.60A
Moringa 1g	13.83de	14.40cd	14.12CD	0.350ij	0.430e	0.390C	11.00ef	12.10d	11.55D
Moringa 2g	14.10c-e	14.61c	14.35C	0.400fg	0.460d	0.430B	10.67fg	13.10c	11.88C
Yeast 1g	13.14f	13.80de	13.47E	0.337j	0.407ef	0.372D	9.00i	10.40gh	9.70F
Yeast 2g	13.57ef	14.30cd	13.93D	0.380gh	0.423ef	0.402C	10.00h	11.30e	10.65E
Mean	13.50B	14.27A		0.384B	0.456A		10.81B	12.08A	

Within a column means having the same letter are not significantly different at 5% level, according to Duncan's multiple range test

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Regarding the effect of the interaction between NPK and natural extract treatments, data cleared that the significantly highest values were obtained from the treatment of NPK at 2 g/pot combined with seaweed extract at 2 g/l. The second position in this respect was concomitant to plants which received NPK at 2 g/pot in combination with seaweed extract at 1 g/l, while applying seaweed extract at 2 g/l without NPK achieved such position in raising stem diameter in the second season as compared to control.

Fresh and dry weights of aerial parts

Data presented in *Table 3* showed that the highest NPK level (2 g/pot) led to the significantly heaviest fresh and dry weight in both seasons compared to untreated plants.

Table 3. *Effect of NPK and some natural extracts on aerial parts fresh and dry weights of Tagetes erecta L. var. dwarf chrysanthemum during two seasons*

Parameters	**Aerial parts fresh weight (g)**			**Aerial parts dry weight (g)**		
Fertilizers	**NPK**			**NPK**		
Natural extracts (g/l)	**0.00 g**	**2.00 g**	**Mean**	**0.00 g**	**2.00 g**	**Mean**
	First season					
Control	2.75j	2.93j	2.84G	0.47m	0.58l	0.525G
Seaweed 1g	8.33c	8.61b	8.47B	2.97cd	3.20b	3.09B
Seaweed 2g	8.53bc	9.64a	9.08A	3.02c	3.59a	3.31A
Moringa 1 g	6.28e	6.42e	6.35D	2.21g	2.87de	3.54D
Moringa 2g	6.49e	7.71d	7.10C	2.75f	2.85ef	2.80C
Yeast 1g	3.51i	3.83h	3.67F	0.81k	0.99j	0.90F
Yeast 2g	4.38g	4.60f	4.49E	1.29i	1.98h	1.64E
Mean	5.75B	6.25A		1.93B	2.29A	
	Second season					
Control	2.67j	2.85j	2.76G	0.35m	0.58l	0.465G
Seaweed 1g	8.40c	8.62b	8.51B	2.99d	3.21c	3.10B
Seaweed 2g	9.06a	9.02a	9.04A	3.41b	3.99a	3.70A
Moringa 1g	6.15f	6.30ef	6.23D	2.22g	2.45f	2.34D
Moringa 2g	6.42e	7.56d	6.99C	2.74e	2.81e	2.77C
Yeast 1g	3.23i	3.99h	3.61F	0.85k	0.97j	0.912F
Yeast 2g	4.13h	4.90g	4.52E	1.65i	1.97h	1.81E
Mean	5.72B	6.18A		2.03B	2.28A	

Within a column means having the same letter are not significantly different at 5% level, according to Duncan's multiple range test

Concerning the effect of some natural extracts, data in the same *Table* exhibited that all natural extract treatments showed their superiority in increasing fresh and dry weights of aerial parts when compared to control in the two seasons. Treating plants with seaweed extract at 2 g/l significantly resulted in the heaviest aerial parts fresh and dry weights. However, the second rank was belonged to plants supplied with seaweed extract at 1 g/l.

With regard to the interaction between NPK and natural extract treatments, data demonstrated that the significantly heaviest aerial parts fresh and dry weights resulted from the treatment of NPK at 2 g/pot combined with seaweed extract at 2 g/l in both seasons, without significant differences between the combinations and the individual applications of seaweed at 2 g/l on aerial parts fresh weight in the second season.

The second position was occupied by plants treated with NPK at 2 g/pot in combination with seaweed extract at 1 g/l in the two seasons, while the individual

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application of seaweed extract at 2 g/l occupied this position in elevating aerial parts dry weight in the second season. However, the significantly lowest records were observed in control treatment of zero NPK without using natural extracts.

Rooting parameters

Data presented in *Table 4* clarified that the highest rate of NPK at 2 g/pot registered the longest root as well as the heaviest fresh and dry weights of roots in both seasons.

Table 4. *Effect of NPK and some natural extracts on root parameters of Tagetes erecta L. var. dwarf chrysanthemum during two seasons*

Parameters	**Root length (cm)**			**Root fresh weight (gm)**			**Root dry weight (gm)**		
Fertilizers	**NPK**			**NPK**			**NPK**		
Natural extracts (g/l)	**0.00 g**	**2.00 g**	**Mean**	**0.00 g**	**2.00 g**	**Mean**	**0.00 g**	**2.00 g**	**Mean**
	First season								
Control	16.33m	17.33l	16.83F	1.24m	1.59l	1.42G	0.310l	0.393l	0.352F
Seaweed 1g	25.00h	27.33e	26.17C	7.28c	7.52b	7.40B	4.13e	4.32d	4.22B
Seaweed 2g	30.00c	35.03a	32.52A	8.12a	8.27a	8.20A	4.77b	5.54a	5.16A
Moringa 1 g	24.57i	26.27g	25.42D	4.11h	5.27f	4.69D	3.00h	3.58g	3.29C
Moringa 2g	27.03f	33.53b	30.28B	6.16e	6.98d	6.57C	3.99f	4.50c	4.24B
Yeast 1g	23.13k	24.23j	23.68E	2.81k	3.21j	3.01F	1.20k	1.99j	1.60E
Yeast 2g	24.70i	28.03d	26.37C	3.66i	4.63g	4.14E	2.01j	2.77i	3.39D
Mean	24.39B	26.73A		4.77B	5.35A		2.77B	3.30A	
	Second season								
Control	17.20n	18.20m	17.70G	1.20l	1.50k	1.35G	0.307j	0.380j	0.343G
Seaweed 1g	24.10g	26.13e	25.12C	7.10d	8.04c	7.57B	3.53d	4.27b	3.90B
Seaweed 2g	28.97c	36.60a	32.79A	8.36b	9.04a	8.70A	4.00c	5.00a	4.50A
Moringa 1g	22.10d	24.53f	23.32D	4.51g	6.32e	5.42D	2.16g	3.00f	2.58D
Moringa 2g	27.10d	35.10b	31.10B	6.26e	7.07d	6.67C	3.04f	3.25e	3.15C
Yeast 1g	20.00k	20.84j	20.42F	3.07j	3.65i	3.36F	1.06i	1.99h	1.53F
Yeast 2g	19.03l	23.03h	21.03E	4.03h	4.92f	4.48E	2.00h	2.12gh	2.06E
Mean	22.64B	26.35A		4.93B	5.79A		2.30B	2.86A	

Within a column means having the same letter are not significantly different at 5% level, according to Duncan's multiple range test

Referring to the effect of some natural extracts, data showed that all treatments recorded significantly longer roots when compared to control in the two seasons. Supplying the plants with seaweed extract at 2 g/l led to the longest root followed by the treatment of moringa extract at 2 g/l in this regard. Referring to the interaction data showed that the plants treated with NPK at 2 g/pot combined with seaweed extract at 2 g/l recorded the significantly longest roots followed by the plants supplied with NPK at 2 g/pot combined with moringa leaves extract at 2 g/l with significant differences in between in both seasons.

The remainder treatments achieved lower records but higher than control. Data in the same Table indicated that the significantly heaviest fresh and dry weights of roots were due to supplying plants with the seaweed extract at 2 g/l followed by seaweed extract at 1 g/l when compared to control plants with significant differences in between in both seasons. Concerning the interaction between NPK and natural extract treatments, data revealed that the significantly maximum influence on fresh and dry weights of roots was concurrent to plants supplied with NPK at 2 g/pot combined with seaweed extract at 2 g/l.

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The second rank for enhancing root fresh weight in the first season and root dry weight in the second one was belonged to plants which received NPK at 2 g/pot combined with seaweed extract at 1 g/l, while plants supplied with zero NPK in combination with seaweed extract at 2 g/l achieved the second position in raising root dry weight in the first season and root fresh weight in the second one. The remainder treatments recorded lower values but higher than control which registered the lowest records in this concern.

Flowering characters

Data exhibited in *Table 5* showed that the significantly earliest flowering, largest flower diameter as well as the heaviest fresh and dry weights of flower were obtained from supplying plants with NPK at 2 g/pot in both seasons when compared to control plants. For natural extracts, data cleared that the significantly shortest period from planting till flowering was obtained from supplying plants with yeast extract at 2 g/l followed by yeast extract at 1 g/l as compared to control which gave the latest flowering in both seasons.

Table 5. *Effect of NPK and some natural extracts on some flowering characteristics of Tagetes erecta L. var. dwarf chrysanthemum during two seasons*

Parameters	**Date of flowering (days)**			**Flower diameter (cm)**			**Flower fresh weight (gm)**			**Flower dry weight (gm)**		
Fertilizers	**NPK**			**NPK**			**NPK**			**NPK**		
Natural extracts (g/l)	**0.00 g**	**2.00 g**	**Mean**	**0.00 g**	**2.00 g**	**Mean**	**0.00 g**	**2.00 g**	**Mean**	**0.00 g**	**2.00 g**	**Mean**
	First season											
Control	61.00a	59.67b	60.33A	3.04i	3.21hi	3.13G	1.12i	1.36i	1.24G	0.43j	0.94i	0.69D
Seaweed 1g	59.00c	57.00e	58.00B	4.34f	5.82bc	5.08C	7.09d	7.93c	7.51B	1.20g	1.74b	1.47B
Seaweed 2g	58.00d	56.00fg	57.00C	5.19d	6.66a	5.93A	8.31b	8.61a	8.46A	1.62c	1.91a	1.77A
Moringa 1 g	57.00e	56.33f	56.67C	3.63g	5.72c	4.67D	5.11f	6.25e	5.68D	1.10h	1.51d	1.31C
Moringa 2g	55.67g	55.00h	55.33D	4.71e	6.02b	5.37B	6.23e	6.96d	6.60C	1.27fg	1.61c	1.44B
Yeast 1g	54.00i	53.00j	53.50E	3.41gh	3.53g	3.47F	3.72h	3.74h	3.73F	1.30f	1.33ef	1.32C
Yeast 2g	52.67j	51.00k	51.83F	3.61g	4.33f	3.97E	4.10g	4.24g	4.17E	1.34ef	1.39e	1.37C
Mean	56.76A	55.43B		3.99B	5.04A		5.10B	5.58A		1.18B	1.49A	
	Second season											
Control	62.00a	61.00b	61.50A	3.02h	3.22h	3.12G	1.39h	1.48h	1.44G	0.51k	0.96j	0.74E
Seaweed 1g	60.00c	58.00e	59.00B	4.23f	5.82c	5.02C	8.43c	8.57c	8.50B	1.44e	1.78b	1.61B
Seaweed 2g	59.00d	57.33f	58.17C	5.23d	6.66a	5.94A	9.18b	9.50a	9.34A	1.64c	1.96a	1.80A
Moringa 1g	58.00e	56.67g	57.33D	3.54g	5.72c	4.63D	6.07e	6.20e	6.14D	1.15i	1.53d	1.34D
Moringa 2g	56.67g	56.00h	56.33E	4.71e	6.10b	5.41B	7.11d	7.24d	7.17C	1.28h	1.65c	1.46C
Yeast 1g	55.00i	54.00j	54.50F	3.49g	3.57g	3.53F	3.95g	4.07g	4.01F	1.31gh	1.43ef	1.37D
Yeast 2g	53.67j	52.33k	53.00G	3.59g	4.32f	3.96E	4.82f	4.96f	4.89E	1.37fg	1.55d	1.46C
Mean	57.76A	56.48B		3.97B	5.06A		5.85B	6.00A		1.24B	1.55A	

Within a column means having the same letter are not significantly different at 5% level, according to Duncan's multiple range test

As for the interaction between NPK and natural extract treatments, data in the same Table showed that the significantly earliest flowering was registered for plants which received NPK at 2 g/pot combined with yeast extract at 2 g/l. The remainder treatments resulted in later flowering but earlier than control with significant differences among themselves in most cases.

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The significantly best treatments in increasing flower diameter was obtained from plants which received seaweed extract at 2 g/l followed by moringa extract at 2 g/l. Moreover, fertilizing the plants with NPK at 2 g/pot combined with seaweed extract at 2 g/l led to the significantly largest flower diameter followed by those provided with NPK at 2 g/pot combined with moringa extract at 2 g/L. The remainder treatments significantly decreased the flower diameter but was greater than control which scored the lowest value with significant differences among themselves. The stimulatory effect of natural extracts and their interaction with NPK was reflected on fresh and dry weight of flowers. The significantly heaviest fresh and dry weight of flower/plant was concomitant to plants supplied with seaweed extract at 2 g/l followed by those with seaweed extract at 1 g/l. As for the interaction, the significantly heaviest fresh and dry weight of flowers was obtained from treating plants with NPK at 2 g/pot combined with seaweed extract at 2 g/l. The second rank in elevating flower fresh weight was belonged to plants supplied with seaweed extract at 2 g and deprived from NPK fertilizer in both seasons, while providing plants with NPK at 2 g/pot in combination with seaweed extract at 1 g/l occupied the second position in raising flower dry weight in the two seasons when compared to control plants.

Discussion

The aforementioned results of some vegetative growth parameters i.e., plant height, stem diameter and No. leaves/plant, fresh and dry weights of aerial parts as well as root parameters i.e., root length, fresh and dry weight of roots in both seasons of this study showed that the treatment of NPK at 2 g/plant combined with seaweed extract at 2 g/l proved their mastery in achieving the significantly maximum effect in this regard in all cases followed by the treatment of seaweed at 2 g/l as an individual application and preceded by moringa leaves extract treatment in most cases. This may be due to the stimulative effect of NPK on the vegetative growth characteristics. Nitrogen (N) plays a very serious role in plant growth forming new cells, thus increasing number of leaves/plant during vegetative growth stage (Inugraha et al., 2014). Phosphorus (P) is a prime component of energy compounds, nucleic acids, phospholipids and co-enzymes, these portions motivate accumulating of dry matter and enhancing dry weight of leaves (Cho et al., 2000). Potassium (K) is an essential element involved in peptide bond synthesis as well as protein and carbohydrates metabolism, in addition to its vital role in increasing number of leaves as a result organizing the opening and closing of stomata in photosynthesis and subsequently regulates carbon dioxide uptake (Csirzinsky, 1997).

This is accordance with the results of Abd-El-Azim (2003) on *Salvia officinalis* L., El-Nagar and El-Nasharty (2009) on *Hibpeastrum vittatum* Herb, and Hendawy et al. (2014) on lovage plants who revealed that treating plants with different levels of NPK fertilizer significantly increased vegetative growth parameters. For seaweed extract its promotive effect on vegetative growth and rooting parameters might be attributed to the stimulative impact on growth hormones (auxins and cytokinins) involved in seaweed extract which improved cell metabolic processes, in addition to the principle role of auxin in motivating rooting parameters (Crouch and van Staden, 1991). Moreover, it includes some macro and micro nutrients and amino acids that keep photosynthesis ratios, motivating plant resistance and retarding senescence (Challen and Hemingway, 1965). The obtained results were in a harmony with the findings of El-Aidy et al. (2002) on sweet pepper and Awad et al. (2006) on potato plants who found that supplying the plants with seaweed

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extract increased plant height and dry weight of leaves/plant. Sridhar and Rangasamy (2010) on *Tagetes erecta* L. and Abdel-Aziz et al. (2011) on *Amaranthus tricolor* reported that a significant improvement in number of leaves was obtained as a result of applying seaweed extract. Concerning the profitable effect of moringa leaves extract on enhancing vegetative growth parameters and improving root traits might be due to its content of essential macro-and micro elements such as P, K, Ca and Zn, in addition to the presence of the growth regulating substances (indolle3 acetic acid, gibberellins and zeatin) which promote plant cell division and enlargement (Phiri, 2010). Moreover, it is plentiful with amino acids which are vital for protoplasm formulation (Moyo et al., 2011), in addition to its function as antioxidant level enhancer (Azra et al., 2013). On the other hand, it consists of several phenolic compounds in its construction (Nascimento et al., 2017) hence mitigated the stimulative effects on vegetative characters. This is in accordance with the results of Foidle et al. (2001) who mentioned that spraying moringa leaves extract (MLE) diluted with water resulted in remarkable impact on vegetative growth. Moreover, Taha et al. (2015) on jojoba and Ali et al. (2018) on *Pelargonium graveolens* L. Herit attributed the growth parameters enhancement to the application of moringa leaves extract at different levels. The previous findings of some flowering characters revealed that the treatment of NPK at 2 g/pot combined with seaweed extract at 2 g/l occupied the first position in elevating flowering characteristics, except for the treatments of yeast extract and their combinations with NPK at 2 g/pot which succeeded to give the significantly earliest flowering in both seasons, as this may be due to important role of NPK in providing plants with sufficient nutrition during growth stages as nitrogen which is a major part of chlorophyll and is accountable for photosynthetic process (Sharma et al., 2017). Phosphorus acts a vital role in improving nutrient uptake and motivating blooming (Mahariya et al., 2004).

Potassium plays an essential function in increasing photosynthesis efficiency and keeping the normal balance between carbohydrates and protein, resulting in reducing number of days required to flower bud appearance (Nayak et al., 2005), in addition to its serious role as an osmotic ingredient in plant cells which led to increase plant cells capacity, consequently, improves flower and stalk diameter. Similar results were reported by Hassan (2016) on chamomile, Ayemi et al. (2017) on *Grebera jamesonii* and Meena et al. (2018) on tuberose plants. Regarding the effect of seaweed extract which occupied the first position in improving some flowering characters i.e., flower diameter, fresh and dry weight of flower. Its inductive influence may be due to the direct impact of cytokinins existed on its structure (Featonby-Smith and van-Standen, 1983a,b, 1984). The recorded results are in conformity with the findings stated by van-Standen et al. (1994) on *Tagests patula*, Sridhar and Rengasamy (2010) on *Tegetes erecta* L. and Emam (2016) on *Calendula officinalis* L. who mentioned that supplying the plants with seaweed extract succeeded to enhance flowering parameters. With respect to moringa leaves extract (MLE) which was categorized in the second rank in this concern, this induction may be due to the high content of macro and micro-nutrients in its leaves as well as the presence of phytohormones such as auxins and cytokinin. Moreover, it consists of various phenolic compounds in its structure, explaining the mitigation of the stimulative effect on flowering characteristics compared to seaweeds extract (Ferreia et al., 2008).

The previous findings were in accordance with those reported by Soliman and Shanan (2017) on *Lagerstroemia indica* L. who indicated that moringa extract treatments increased number of inflorescences per plant and inflorescence diameter. Similarly, were the results of Ali et al. (2018) on *Pelargonium graveolens* L. who revealed that applying

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moringa extract at rate of 1:20 enhanced plant growth and productivity. Moreover, Ahmad et al. (2019) on *Freesia hybrida* L. observed that soaking corms in moringa leaves extract (MLE) at 2% or spraying the preharvest plants with MLE at 3% significantly increased flower diameter. Dealing with the effect of yeast extract which proved its notability in occupying the first position in precocity of flowering this may be attributed to the presence of phytohormones particularly cytokinins which had a beneficial role in enhancing flower formation and maturity (Abo-El-Yazied and Mady, 2012). Moreover, the valuable function of yeast extract in raising carbohydrate accumulation in plants as a result of existing sugars, amino acids and vitamins as a cryoprotective agents in its structure (Barnett et al., 1990). The results are correspondent to those obtained by Hammady (2005) and Nofal et al. (2015) on *Colendula officinalis* L. who reported that applying yeast extract showed its efficiency in elevating floral characters. In addition, Ghareeb (2019) on rose mentioned that supplying the plants with active dry yeast extract improved flower quality and enhanced plant productivity.

Conclusion

It could be concluded that the treatment of NPK at 2 g/pot combined with seaweed extract at 2 g/l succeeded to give the significantly highest vegetative, rooting and flowering characters with the notability of moringa leaves extract treatments in this regard. The treatment of NPK at 2 g/pot in combination with yeast extract at 2 g/l or as individual application for such extract led to the significantly shortest period from planting till flowering, resulted in the earliest flowering in the two seasons when compared to control plants deprived from fertilization. Hence the NPK dose was sustained by the stimulators as proved to be must and this needs a future work to increase the stimulators doses.

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