Growth and Productivity of Garlic Crop under Different Fertilizers Type and Some Extracts

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Abstract: A field experiment was performed along two consecutive winter periods of 2016/2017 and 2017/2018 in the private Farm at Hehia Distract, Sharkia Governorate Egypt, to study the effect of different fertilizers type (complex and simple fertilizer) and foliar spray with some extracts (algae extract and moringa leaf extracts at 2% of each individually or in combination) on plant growth, bulb yield and its components of garlic. The interaction between fertilizing with simple mineral fertilizers at 54, 54 and 76.5 kg /fed. of N,P_2O_5 and K_2O, respectively and spraying garlic plants with moringa leaf extract or with algae + moringa leaf extract increased N,P and K uptake by leaves and bulb and total uptake by plant, grades 1 and 2, exportable, marketable and total yield as well as average bulb weight of garlic. While The interaction between fertilizing garlic plants with complex fertilizers (450 kg /fed. of Nitrophoska) and spraying with algae + moringa leaf extract increased dry weight of leaves, total dry weight/ plant, N,P, K and TSS in bulbs.
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1. Introduction

One of the most aromatic herbaceous annual spices is the garlic (*Allium sativum* L.), which belongs to a member of the Alliaceae family (**Kurian, 1995**). In addition, garlic is considered the second spice crop of Allium crops which cultivated most widely in the world, after to onion (**Purseglove, 1975**), which characterized by powerful spicy smell. In Egypt, the total cultivated area of garlic, was about 12657 hectare, during 2017 season which produced 274668 tons with average of 21.7 tons/ha. (**FAO, 2017**).

Many nutrient are essential for growth and development of crop plants such as nitrogen, potassium and phosphorous. in spite of these elements are important for pants, but excessive applications may lead to wasteful practice and cause abundant discharge in the ground and surrounding environment through water drainage and channels, and correspondingly affect adversely on the water, air quality, soil, biodiversity and human health (**Tian *et al*., 2016**). One of the systems for controlling of fertilizers usages is controlled-release fertilizer which considered as alternative method for soluble fertilizer for the purpose of augmenting the effecienciency of fertilizer utility and in addition, to decrease the losses of nutrients, particularly N, in the ground (**Zhao *et al*., 2013**). Some authors reported that, extreme fertilization can result in imbalance between different elements and great losses in N and P and their discharge in the soil which affect adversely on the surrounding environment including water, soil, aquaculture, air quality and biodiversity and risk for human being health (**Goulding *et al*., 2008**). Moreover,, accumulation of fertilizer elements in the soil, particularly N, can elevate lodging, leading to a drop in the quality and quantity of produced crops (**Ozer, 2003**). Generally, it s known that a complex fertilizers are containing many nutrient elements released at the same time with a definite ratios according to the deficiencies in the soil of specific region. It promising to forming a fertilizer with a ratio of nutrient elements available to the specific plant requires via applying of recent techniques for production of fertilizers (**Piwowar, 2011**). Compound fertilizers were not costly and are suitable economically with respect to efficiency and the ratios between different elements in the compound as compared with a simple combination of solid mineral fertilizers (**Wadas and Łęczycka, 2010**).

There were a significant differences between simple and complex fertilizers regarding dry weight, mineral contents and total yield (**Assefa *et al*., 2015** on garlic, **Pirogovskaya *et al.,* 2002** and **Jabłoński 2006**, **Wadas, and Dziugiel, 2013 and Tripolskaja *et al*., 2017** on potato**).**

Modern agricultures try to apply advanced biotechniques for the purpose of diminishing in the quantities of chemical fertilizers administered to the crop plants and supplementing alternative organic fertilizers without adverse impact on crop production or the farmers' income or environmental biodiversity. One of these trials applied recently is the use of natural algae as fertilizer that permitted to substitute partially the synthetic chemical fertilizers (**Zodape *et al*., 2011**). Moreover, different forms of extracts of algae are available commercially in the market with

different formulation as granular/powder form for soil conditioners and manure and as a liquid extracts used as foliar spray, soil drench, for using in horticulture and agriculture (**Thirumaran *et al.*, 2009**).

Spraying plant with algae extracts increased dry weight, N,P and K contents and its uptake and yield and its components as well as bulb quality than unsprayed plants (**Abou El-Khair *et al.*, 2010**, **Fawzy *et al.*, 2012** and **Mohsen 2012, Shalaby** and **El-Ramady 2014** on garlic, **Babilie *et al*. 2015**, **Shafeek, *et al.*, 2015**, **Hidangmayum** and **Sharma 2017** and **Yassen *et al*., 2018** on onion).

Many authors reported that Moringa leaves are rich with vitamins A and C, in addition to, calcium, iron, beta-carotene, phenolic acid and riboflavin (**Nambiar *et al*., 2005**). Also, **Njoku and Adikwu, 1997** found that leaves and oil of Moringa **are** containing strong natural antioxidants. Growth, N,P and K uptake, yield and quality **were** enhanced by moringa foliar application **(Culver *et al*., 2012** on tomato, **Mohammed *et al*., 2013** on onion**, Bashir *et al.*, 2014** on tomato**, Emongor (2015)** on snap bean**, Oluwagbenga and Odeghe, 2015** on pepper, **Hegazi *et al*., 2016** on garlic**, Abou El-Nour and Ewais, 2017** on pepper**).**

The aim of this study was to determine the suitable fertilizer type (complex and simple fertilizer) and best extracts (algae and moringa extracts) to obtain high growth, best productivity and good bulb quality of garlic.

2. Materials and Methods

A field experiment was carried out during the two successive winter seasons of 2016/2017 and 2017/2018 in the private Farm at Hehia Distract, Sharkia Governorate Egypt, to study the effect of fertilizer types (complex and simple fertilizer) and foliar spray with some extracts on growth and productivity of garlic (*Allium sativum* L.) cv. Balady. The physical and chemical analyses of the soil are presented in Table (A).

Table A: The physical and chemical properties of soil during 2016/2017 and 2017/2018 (average of the two seasons)

Physical analysis			**Soil texture**
Clay (%)	**Silt (%)**	**Sand (%)**	**Clay loam**
42.90	35.03	22.07	

Chemical analysis

pH	**E m.mohs/cm**	**C Organic (%)**	**mater**	**Soluble cations (meq./L)**			**Soluble anions (meq./L)**			**Available (ppm)**		
				Mg^{++}	**Ca^{++}**	**Na^{+}**	**Cl^{-}**	**HCO_3^{-}**	**SO_4^{--}**	**N**	**P**	**K**
8.21	1.18	1.23		1.64	2.56	2.09	1.69	0.76	4.02	78	14	172

This experiment included 8 treatments as follows:

a Fertilizer type: Complex fertilizer (Nitrophoska 12:12:17 % NPK, respectively) and simple fertilizers of NPK

b Extracts: Without (control), algae extract at 2 %, moringa leaf extract at 2% and algae + moringa extracts at 2 % of each.

These treatments were arranged in a split plot design with three replications. Fertilizer types were randomly arranged in the main plots and extracts were randomly distributed in the sub plots.

Complex fertilizer (450 kg /fed. of Nitrophoska 12:12:17% NPK, respectively which equal 54, 54 and 76.5 kg /fad. of N, P_2O_5 and K_2O, respectively) was added during soil preparation with 30 m^3/fed. Of farmyard manure (FYM), Simple fertilizers (263.41 kg of ammonium sulphate 20.6 % N /fed., 348.38 kg calcium superphosphate 15.5 % P_2O_5/fed. and 153. kg of potassium suphate 50 % K_2O/fed. which equal 54, 54 and 76.5 kg/N,P and K_2O, respectively). One third of simple fertilizers were added during soil preparation with the same rate of FYM and the rest amounts were added at three portions as soil application by one month intervals beginning one month after planting.

Feddan (fed.) equal 0.42 ha.

Green micro Algae extract and Moringa leaf extract from *Moringa oleifera* L were produced by National Res. Center (NRC), Giza, Egypt.

Garlic plants were sprayed with algae and moringa leaf extracts three times at 60, 80 and 100 days after planting. Balady cultivar was used in this study. Garlic cloves were selected for uniformity in shape and size. The cloves were sown at distance of 10 cm apart in both ridges at the first week of October in both seasons. The experiment unit area was 10.8 m^2. It contained three ridges with 6m length and 60 cm in width. One ridge was used for the samples to measure vegetative growth (dry weight) and the other two ridges were used for yield determination. The normal agricultural practices were carried out as commonly followed in district.

Data Recorded

Ten plants from each experimental unit were randomly taken at 105 and 135 days after planting and the following data were recorded:

1. Dry weight:

The different parts of garlic plant (bulb and leaves) were oven dried at 70° C till constant weight, and then the following data were recorded: bulb dry weight /plant (g), leaf dry weight /plant (g), and total dry weight (bulb +leaves) /plant (g).

2. Plant Chemical Composition:

N, P and K in leaves and bulb at 135 days after planting (DAP) in the 1st and 2nd seasons were determination according to the methods advocated **by Bremner and Mulvaney (1982), Olsen and Sommers (1982) and Jackson (1970),** respectively**.** N,P and K uptake and total uptake were calculated.

3. Yield and Its Components:

Bulbs in every experimental unit were harvested at proper maturity stage of bulbs (200 days after planting approximately), then translocated to a shady place on the same day for curing. Plants were placed for about two weeks in a shady place at 25 ± 5^{0}C and 60-75% R.H, and then graded into four categories according to the **Ministry of Economic for garlic exportation (1963)** as follows: Grade 1: Bulbs with diameter above 5.5 cm, grade 2: Bulbs with diameter between 4.5-5.5 cm, grade 3: Bulbs with diameter between 3.5-4.4 cm, and grade 4: Bulbs with diameter less than 3.5 cm.

After that, each grade was weighed separately in the same day and the following data were recorded: Exportable yield (grade 1+grade 2) tons /fed., marketable yield (grade 1+grade 2+grade 3) tons/fed., total yield was (grade 1+grade2+grade3 +grade4) tons/fed., and average bulb fresh weight.

4. Bulb quality:

At harvest time, five bulbs were randomly taken from each treatment and oven dried at 70^{0}C till constant weight and the chemical constituents of garlic bulbs in both seasons were determined as follows:

a. Nitrogen, phosphorus and potassium contents: They were determined by the same methods as previously mentioned in the plant chemical composition.

b. Total soluble solids (T.S.S.): A random sample of fresh bulbs from every experimental unit was blended and filtrated throughout muslin and then throughout filter paper No.1 to determine total soluble solids by Carle Zeis Refractometer.

c. Dry matter content (DM%): One hundred gram of fresh bulbs was oven driad at 105°C till constant weight and DM% was calculated.

Statistical analysis:

The data were subjected to proper statistical analysis of variance according to **Snedecor and Cochran (1980)** and means separation were done according to least significant differences (LSD) at 5 % level.

3. Results and Discussion

Dry weight

Effect of fertilizer type

Fertilizer types reflect significant effect on dry weight of leaves, bulb and total dry weight / plant at 105 and 135 days after planting (DAP) in both seasons (Table 1). Fertilizing garlic plants grown in clay soil with simple mineral fertilizers at 54,54 and 76.5 kg /fed. of N, P_2O_5 and K_2O, respectively increased dry weight of leaves, whereas fertilizing with complex fertilizer (450 kg /fed. Nitrophoska) increased dry weight of bulb and total dry weight/ plant in both season.

Wadas and Łęczycka (2010) proposed that simple solid mineral fertilizers are less in efficient economically than compound chemical fertilizers. In this connection**, Wadas and Dziugel (2013)** suggested that compound chemical fertilizers, are superior than simple fertilizers, where it improves greatly the growth of the aboveground part of potato.

Effect of some extracts

Spraying of garlic with algae, moringa leaf extract and algae+ moringa leaf extracts had significant effect on dry weight of leaves, bulb and total dry weight / plant at 105 and 135 DAP in both seasons (Table 1). Spraying with algae + moringa leaf extracts gave the highest values of dry weight of leaves, bulb and total dry weight / plant at 105 and 135 DAP in both seasons.

The probable cause which suggested for illustrating the enhancement in the growth rate, may be attributed to the active constituents present in moringa leaf extract such as growth promoting hormones (auxins and cytokinins) and crude proteins (**Moyo *et al*., 2011**), where proteins are important for creation of the protoplasm, whereas, growth hormones play an important role in acceleration of cell multiplication, cell division and development.

The results were in accordance with the findings of **Abou El-Khair *et al.*, (2010)**, **Fawzy *et al.*, (2012)** and **mohsen (2012) on garlic** regarding the effect of algae extract, and **Mohammed *et al*. (2013)** on onion with respect moringa leaf extracts.

Effect of the interaction between fertilizer type and some extracts

The interaction between fertilizing garlic plants with complex fertilizer (450 kg/fed. Nitrophoska) or with simple mineral fertilizers (54,54 and 76.5 kg /fed. of N, P_2O_5 and K_2O, respectively) and spraying with algae+ moringa leaf extract increased dry weight of leaves, total dry weight/ plant, whereas the interaction between simple mineral fertilizers and

spraying with algae+ moringa leaf extract increased dry weight of bulb in both seasons (Table 2).

Table (1): Effect of fertilizer types and some extracts on the dry weight of different parts of garlic at 105 and 135 days after planting during 2016/2017 and 2017/2018 seasons

Treatments	Dry weight of leaves (g)				Dry weight of bulb (g)				Total dry weight (g)			
	Days after planting											
	105		135		105		135		105		135	
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
	Effect of fertilizer types											
Complex fertilizer	2.36	1.70	5.55	5.30	1.57	2.37	5.17	6.01	3.93	4.07	10.71	11.31
Simple mineral fertilizers	2.72	1.86	5.73	5.31	1.80	2.73	4.45	5.42	4.52	4.59	10.18	10.72
LSD at 0.05 level	**0.10**	**NS**	**NS**	**0.52**	**0.05**	**0.19**	**0.29**	**0.17**	**0.15**	**0.51**	**0.60**	**0.59**
	Effect of extracts											
Without	2.09	1.30	4.82	3.95	1.19	2.09	3.91	5.01	3.28	3.39	8.73	8.95
Algae extract	2.43	1.72	5.30	5.21	1.59	2.51	4.69	5.46	4.02	4.23	9.99	10.67
Moringa leaf extract	2.69	1.91	5.86	5.87	1.82	2.73	5.20	6.03	4.50	4.64	11.06	11.90
Algae +moringa	2.98	2.36	6.50	6.42	2.17	2.95	5.69	6.37	5.15	5.30	12.19	12.79
LSD at 0.05 level	**0.09**	**0.29**	**0.29**	**0.28**	**0.10**	**0.06**	**0.38**	**0.22**	**0.14**	**0.29**	**0.49**	**0.44**

Complex fertilizers at 450 kg Nitrophoska /fed. (12:12:17 % NPK equal 54, 54 and 76.5 kg/fed. of N, P_2O_5 and K_2O, respectively**.** Simple mineral fertilizers at 263.41 kg ammonium sulphate 20.5 % N/fed., 348.38 kg calcium super phosphate 15.5 % P_2O_5 /fed. and 153 kg potassium sulphate 50 % K_2O /fed. equal 54, 54 and 76.5 kg /fed. N,P and K_2O, respectively. Algae extract at 2 % and Moringa leaf extract at 2 %, S1: 2016/2017 and S2: 2017/2018 season

Table (2): Effect of the interaction between fertilizer types and some extracts on the dry weight of different parts of garlic at 105 and 135 days after planting during 2016/2017 and 2017/2018 seasons

Treatments		Dry weight of leaves (g)				Dry weight of bulbs (g)				Total dry weight (g)			
		Days after planting											
Fer. types	Extracts	105		135		105		135		105		135	
		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Complex fertilizer	**Without**	1.87	1.24	4.69	3.60	1.09	1.82	4.17	5.36	2.96	3.06	8.86	8.96
	Algae extract	2.26	1.42	5.28	5.14	1.48	2.33	4.95	5.83	3.74	3.75	10.23	10.97
	Moringa leaf extract	2.49	1.77	5.74	5.92	1.67	2.54	5.40	6.31	4.16	4.31	11.14	12.23
	Algae +moringa	2.83	2.36	6.47	6.52	2.02	2.78	6.14	6.55	4.85	5.14	12.61	13.07
Simple mineral fertilizers	**Without**	2.31	1.36	4.94	4.29	1.28	2.35	3.65	4.65	3.59	3.71	8.59	8.94
	Algae extract	2.59	2.02	5.31	5.28	1.70	2.68	4.43	5.08	4.29	4.70	9.74	10.36
	Moringa leaf extract	2.88	2.04	5.97	5.81	1.96	2.92	5.00	5.75	4.84	4.96	10.97	11.56
	Algae +moringa	3.12	2.35	6.52	6.32	2.32	3.11	5.24	6.18	5.44	5.46	11.76	12.50
LSD at 0.05 level		**0.14**	**0.41**	**0.42**	**0.39**	**0.15**	**0.09**	**0.53**	**0.32**	**0.20**	**0.42**	**0.69**	**0.62**

Complex fertilizers at 450 kg Nitrophoska /fed. (12:12:17 % NPK equal 54, 54 and 76.5 kg/fed. of N, P_2O_5 and K_2O, respectively**.** Simple mineral fertilizers at 263.41 kg ammonium sulphate 20.5 % N/fed., 348.38 kg calcium super phosphate 15.5 % P_2O_5 /fed. and 153 kg potassium sulphate 50 % K_2O /fed. equal 54, 54 and 76.5 kg /fed. N,P and K_2O, respectively. Algae extract at 2 % and Moringa leaf extract at 2 %, S1: 2016/2017 and S2: 2017/2018 season

N,P and K uptake and total uptake

Effect of fertilizer type

Fertilizer type had significant effect on N,P and K uptake and total uptake by plant, except P total uptake in the 1st season, N, K and P uptake by bulb in the 2nd season and K total uptake via plant in both seasons (Table 3). Simple mineral fertilizers at 54, 54 and 76.5 kg/fed. of N, P_2O_5 and K_2O, respectively increased of N,P and K uptake by leaves and N total uptake by plant at 135 DAP in both seasons. The

present finding are in agreement with the results of **Albaho *et al.*, (2012)** on tomato and **Wadas and Dziugiel (2013)** on potato.

Effect of some extracts

In general, spraying garlic pants with moringa leaf extract or with algae + moringa leaf extracts increased N,P and K uptake by leaves and bulb and total uptake by plant at 135 DAP in both seasons (Table 4). The increase of mineral contents in leaves and bulb may be returned to the enhanced the absorption and accessibility of required elements (K,Ca, N, Na, Zn and Mg) found in the extracts of seaweed (**Anantharaj and Venkatesalu 2001**). However, moringa leaf extract possesses an essential elements such as proteins, amino acids minerals, vitamins, carotene, and various phenolic compounds and deliver a rich and infrequent union of zeatin with many flavonoid pigments and then increased N,P and K uptake by garlic different prates (**Anwar *et al.*, 2007**). The obtained results are in accordance with those of **Mohsen 2012, Shalaby and El-Ramady 2014** on garlic, respecting algae extract. As for moringa leaf extracts, **Culver *et al.* (2012)**, **Bashir *et al.* (2014)** on tomato **and Abou El-Nour and Ewais (2017)** on pepper**.**

Table (3): Effect of the fertilizer types on nitrogen, phosphorus and potassium uptake by leaves and bulb and their total uptake (mg) of garlic plants at 135 days after planting during 2016/2017 and 2017/2018 seasons

Treatments	N		P		K		Total uptake		
	Leaves	Bulb	Leaves	Bulb	Leaves	Bulb	N	P	K
Fertilizer types	**2016/2017 season**								
Complex fertilizer	153.75	131.05	16.91	12.09	140.71	114.30	284.79	29.00	255.01
Simple mineral fertilizers	182.46	124.58	20.63	11.31	153.59	102.74	307.04	31.93	256.34
LSD at 0.05 level	**9.94**	**6.08**	**2.65**	**1.14**	**12.22**	**10.52**	**15.91**	**NS**	**NS**
	2017/2018 season								
Complex fertilizer	145.30	161.06	17.00	14.37	132.65	134.76	306.35	31.36	267.41
Simple mineral fertilizers	166.97	153.38	18.65	14.93	142.94	133.95	320.35	33.57	276.90
LSD at 0.05 level	**20.75**	**NS**	**0.76**	**NS**	**8.35**	**12.21**	**11.18**	**1.69**	**NS**

Complex fertilizers at 450 kg Nitrophoska /fed. (12:12:17 % NPK equal 54, 54 and 76.5 kg/fed. of N, P_2O_5 and K_2O, respectively**.** Simple mineral fertilizers at 263.41 kg ammonium sulphate 20.5 % N/fed., 348.38 kg calcium super phosphate 15.5 % P_2O_5 /fed. and 153 kg potassium sulphate 50 % K_2O /fed. equal 54, 54 and 76.5 kg /fed. N,P and K_2O, respectively.

Table (4): Effect of some extracts on nitrogen, phosphorus and potassium uptake by different parts and their total uptake (mg) of garlic plants at 135 days after planting of garlic during 2016/2017 and 2017/2018 seasons

Treatments	N		P		K		Total uptake		
	Leaves	Bulb	Leaves	Bulb	Leaves	Bulb	N	P	K
Extracts	**2016/2017 season**								
Without	123.41	89.52	11.46	5.73	113.30	70.64	212.92	17.18	183.95
Algae extract	156.78	121.53	17.30	10.48	135.57	101.41	278.30	27.76	236.98
Moringa leaf extract	198.50	161.53	25.41	18.28	170.22	142.53	360.03	43.68	312.75
Algae +moringa	207.58	158.74	24.34	16.28	176.69	139.17	366.31	40.61	315.87
LSD at 0.05 level	**9.61**	**11.59**	**1.63**	**1.44**	**8.58**	**13.03**	**14.91**	**2.53**	**16.30**
	2017/2018 season								
Without	103.23	123.81	9.56	7.91	91.89	98.60	227.03	17.45	190.50
Algae extract	153.36	146.11	15.92	13.22	131.64	122.39	299.46	29.14	254.04
Moringa leaf extract	185.44	187.18	26.93	21.00	171.15	165.49	372.61	47.92	336.65
Algae +moringa	201.99	185.33	23.80	19.78	173.85	160.97	387.31	43.57	334.83
LSD at 0.05 level	**11.73**	**18.21**	**1.65**	**1.31**	**8.10**	**6.44**	**18.12**	**2.61**	**11.58**

Algae extract at 2 % and Moringa leaf extract at 2 %

Effect of the interaction between fertilizer type and some extracts

The interaction between fertilizing with simple mineral fertilizers at 54,54 and 76.5 kg /fed. of N, P_2O_5 and K_2O, respectively and spraying with moringa leaf extract or with algae + moringa leaf extract increased N,P and K uptake by leaves and bulb and total uptake by plant with no significant differences with the interaction between complex fertilizers (450 kg /fed. of Nitrophoska) and moringa

leaf extract or and algae + moringa leaf extracts with respect to N,P and K uptake by bulbs in both seasons (Tables 5 and 6).

Yield and its components

Effect of fertilizer type

There were significant differences between two fertilizer type with respect to yield of grades 1,2,3 and 4, exportable, marketable and total yield as well as average bulb weight, except yield of grade 1 in the 1st season, yield of grade 3 in the 2nd season and yield of grade 4 in both seasons (Table 7). Fertilizing with simple mineral fertilizers at 54, 54 and 76.5 kg /fed. of N,P_2O_5 and K_2O, respectively gave higher values of yield of grade 2, exportable, marketable and total yield as well as average bulb weight in both seasons. The increase in total yield about 4.74 and 7.00% for simple mineral fertilizers over complex fertilizers in the 1st and 2nd seasons, respectively.

Similar findings were obtained by **Assefa *et al*., (2015)** on garlic**.**

On the other hand, some investigators showed that complex fertilizers was superior than simple fertilizers, where it augmented the growth of tubers and the aboveground part, whereas, Nitrophoska Blue Special, belonging to the complex fertilizer, increased the yield of tuber (average 2.40 t/ ha) than simple fertilizers **(Wadas and Dziugel, 2013)**.

Also, **Tripolskaja *et al*., (2017)** showed that using complex fertilizers (Eurofertil 35, NovaTec classic and nitrogen phosphate NP 33:3) significantly increased (7.7%) the tuber yield of potatoes than simple NPK fertilizers

Table (5): Effect of the interaction between fertilizer types and some extracts on nitrogen, phosphorus and potassium uptake by leaves and bulb and their total uptake (mg) of garlic plants at 135 days after planting during 2016/2017 season

Treatments		N		P		K		Total uptake		
Fer. types	**Extracts**	**Leaves**	**Bulb**	**Leaves**	**Bulb**	**Leaves**	**Bulb**	**N**	**P**	**K**
Complex fertilizer	**Without**	105.53	83.40	8.58	5.25	104.59	70.47	188.93	13.84	175.06
	Algae extract	138.86	120.78	14.94	10.05	129.89	100.49	259.64	24.99	230.37
	Moringa leaf extract	179.09	156.06	22.39	16.90	160.15	142.56	335.15	39.29	302.71
	Algae +moringa	191.51	163.94	21.74	16.15	168.22	143.68	355.45	37.89	311.90
Simple mineral fertilizers	**Without**	141.28	95.63	14.33	6.21	122.02	70.81	236.91	20.53	192.83
	Algae extract	174.70	122.27	19.65	10.90	141.25	102.33	296.97	30.54	243.58
	Moringa leaf extract	217.91	167.00	28.42	19.65	180.29	142.50	384.91	48.07	322.79
	Algae +moringa	223.64	153.53	26.93	16.40	185.17	134.67	377.17	43.33	319.84
LSD at 0.05 level		**13.59**	**16.40**	**2.31**	**2.04**	**12.14**	**18.43**	**21.09**	**3.58**	**23.06**

Complex fertilizers at 450 kg Nitrophoska /fed. (12:12:17 % NPK equal 54, 54 and 76.5 kg/fed. of N, P_2O_5 and K_2O, respectively**.** Simple mineral fertilizers at 263.41 kg ammonium sulphate 20.5 % N/fed., 348.38 kg calcium super phosphate 15.5 % P_2O_5 /fed. and 153 kg potassium sulphate 50 % K_2O /fed. equal 54, 54 and 76.5 kg /fed. N,P and K_2O, respectively. Algae extract at 2 % and Moringa leaf extract at 2 %

Table (6): Effect of the interaction between fertilizer types and some extracts on nitrogen, phosphorus and potassium uptake by leaves and bulb and their total uptake (mg) of garlic at 135 days after planting during 2017/2018 season

Treatments		N		P		K		Total uptake		
Fer. types	**Extracts**	**Leaves**	**Bulb**	**Leaves**	**Bulb**	**Leaves**	**Bulb**	**N**	**P**	**K**
Complex fertilizer	**Without**	86.76	128.10	6.84	6.97	77.40	98.62	214.86	13.81	176.02
	Algae extract	137.75	151.00	13.36	12.42	123.36	121.85	288.75	25.78	245.21
	Moringa leaf extract	166.94	181.73	25.22	19.56	161.62	165.95	348.67	44.78	327.57
	Algae +moringa	189.73	183.40	22.56	18.54	168.22	152.62	373.13	41.10	320.83
Simple mineral fertilizers	**Without**	119.69	119.51	12.27	8.84	106.39	98.58	239.20	21.10	204.97
	Algae extract	168.96	141.22	18.48	14.02	139.92	122.94	310.18	32.50	262.86
	Moringa leaf extract	203.93	192.63	28.64	22.43	180.69	165.03	396.56	51.07	345.72
	Algae +moringa	214.25	187.25	25.03	21.01	179.49	169.33	401.50	46.04	348.82
LSD at 0.05 level		**16.59**	**18.21**	**2.33**	**1.86**	**11.46**	**9.11**	**25.63**	**3.69**	**16.38**

Complex fertilizers at 450 kg Nitrophoska /fed. (12:12:17 % NPK equal 54, 54 and 76.5 kg/fed. of N, P_2O_5 and K_2O, respectively**.** Simple mineral fertilizers at 263.41 kg ammonium sulphate 20.5 % N/fed., 348.38 kg calcium super phosphate 15.5 % P_2O_5 /fed. and 153 kg potassium sulphate 50 % K_2O /fed. equal 54, 54 and 76.5 kg /fed. N,P and K_2O, respectively. Algae extract at 2 % and Moringa leaf extract at 2 %

Effect of some extracts

Spraying garlic pants with moringa leaf extract increased yield of grades 1 and 2, exportable, marketable and total yield as well as average bulb weight with no significant differences between algae + moringa leaf extracts with respect to marketable yield in the 2nd season and total yield and average bulb weight in both seasons (Table 8). This means that spraying garlic pants with moringa leaf extract or with algae + moringa leaf extracts increased total yield /fed. and average bulb weight in both seasons. As for yield of grades 3 and 4, spraying with algae + moringa leaf extract increased yield of grades 3 and 4 in both seasons. The increase in total yield about 43.26 and 34.53% for spraying with moringa leaf extract and 39.77 and 33.79 % for spraying with algae + moringa leaf extract over unsprayed plants in the 1st and 2nd seasons, respectively.

The improvement of garlic plant yield in response to foliar application of seaweed extract may be attributed to its contents of cytokinins and trace elements (Zn, Fe, Mo, Cu, Mn, Ni, and Co) growth promoting hormones (IBA and IAA), in addition to amino acids and vitamins (**Zodape *et al.* 2011**). However, foliar application of moringa leaf extract is possible source of vitamin C and A, calcium, iron, beta-carotene, phenolic acid and riboflavin (**Nambiar *et al*., 2005**). Results are harmony with those reported with **Mohsen (2012), Shalaby** and **El-Ramady (2014)** on garlic as for the effect of algae extract and **Hegazi *et al.* (2016)** on garlic.

Table (7): Effect of fertilizer types on yield and its components of garlic during 2016/2017 and 2017/2018 seasons

Treatments	Yield and its components (ton/fed.*)								Average bulb weight (g)
	Grade (1)	Grade (2)	Grade (3)	Grade (4)	Exportable yield	Marketable yield	Total yield	Relative increases in total yield (%)	
Fertilizer types	**2016/2017 season**								
Complex fertilizer	1.908	1.922	1.850	0.987	3.83	5.680	6.667	0.00	44.43
Simple mineral fertilizers	2.054	2.181	1.729	1.019	4.235	5.964	6.983	4.74	46.55
LSD at 0.05 level	**NS**	**0.084**	**0.077**	**NS**	**0.129**	**0.202**	**0.238**	**--**	**1.57**
	2017/2018 season								
Complex fertilizer	1.874	1.907	1.613	1.016	3.781	5.394	6.410	0.00	42.72
Simple mineral fertilizers	2.128	2.083	1.624	1.024	4.211	5.835	6.859	7.00	45.72
LSD at 0.05 level	**0.197**	**0.230**	**NS**	**NS**	**0.220**	**0.644**	**0.726**	**--**	**2.28**

Complex fertilizers at 450 kg Nitrophoska /fed. (12:12:17 % NPK equal 54, 54 and 76.5 kg/fed. of N, P_2O_5 and K_2O, respectively**.** Simple mineral fertilizers at 263.41 kg ammonium sulphate 20.5 % N/fed., 348.38 kg calcium super phosphate 15.5 % P_2O_5 /fed. and 153 kg potassium sulphate 50 % K_2O /fed. equal 54, 54 and 76.5 kg /fed. N,P and K_2O, respectively. Feddan equal 0.42 ha.

Table (8): Effect of some extracts on yield and its components of garlic during 2016/2017 and 2017/2018 seasons

Treatments	Yield and its components (ton/fed.*)								Average bulb weight (g)
	Grade (1)	Grade (2)	Grade (3)	Grade (4)	Exportable yield	Marketable yield	Total yield	Relative increases in total yield (%)	
Extracts	**2016/2017 season**								
Without	1.684	1.621	1.240	0.751	3.305	4.545	5.296	00.00	35.30
Algae	1.793	2.282	2.048	0.894	4.075	6.123	7.017	32.50	46.77
Moringa	2.270	2.396	1.900	1.021	4.666	6.566	7.587	43.26	50.57
Algae +moringa	2.178	1.908	1.969	1.347	4.086	6.055	7.402	39.77	49.33
LSD at 0.05 level	**0.077**	**0.026**	**0.079**	**0.075**	**0.079**	**0.116**	**0.153**	**---**	**1.33**
	2017/2018 season								
Without	1.618	1.761	1.284	0.744	3.379	4.663	5.407	00.00	36.04
Algae	1.956	1.990	1.779	0.900	3.946	5.725	6.625	22.53	44.16
Moringa	2.255	2.234	1.746	1.039	4.489	6.235	7.274	34.53	48.48
Algae +moringa	2.177	1.995	1.666	1.396	4.172	5.838	7.234	33.79	48.22
LSD at 0.05 level	**0.063**	**0.128**	**0.393**	**0.048**	**0.130**	**0.460**	**0.457**	**--**	**3.33**

Algae extract at 2 % and Moringa leaf extract at 2 % *Fedden equal 0.42 ha.

Effect of the interaction between fertilizer type and some extracts

The interaction between fertilizing with simple mineral fertilizers at 54,54 and 76.5 kg /fed. of N,P_2O_5 and K_2O, respectively and spraying with moringa leaf extract increased grades 1,2, exportable, marketable and total yield as well as average bulb weight with no significant differences with the interaction between simple mineral fertilizers and algae + moringa leaf extract with respect to marketable and total as well as average bulb weight in the 2nd season (Tables 9 and 10). As for yield of grades 3 and 4, in general, the interaction between complex fertilizer or between simple mineral fertilizers and algae + moringa leaf extract increased yield of grades 3 and 4. The increase in total yield about 45.48 and 44.27% for the interaction between fertilizing with simple mineral fertilizers and spraying with moringa leaf extract over the interaction between fertilizing with complex fertilizers and unsprayed plants in the 1st and 2nd seasons, respectively.

Table (9): Effect of the interaction between fertilizer types and some extracts on yield and its components of garlic during 2016/2017 season

Treatments		Yield and its components (ton/fed.*)								Average bulb weight (g)
Fer. types	Extracts	Grade (1)	Grade (2)	Grade (3)	Grade (4)	Exportable yield	Marketable yield	Total yield	Relative increases in total yield (%)	
Complex fertilizer	Without	1.684	1.668	1.340	0.686	3.352	4.692	5.378	00.00	35.85
	Algae	1.731	1.948	1.922	0.86	3.679	5.601	6.461	20.14	43.07
	Moringa	2.160	2.058	2.066	1.064	4.218	6.284	7.348	36.63	48.99
	Algae+ moringa	2.055	2.014	2.070	1.337	4.069	6.139	7.476	39.01	49.84
Simple mineral fertilizers	Without	1.683	1.574	1.140	0.815	3.257	4.397	5.212	-3.09	34.75
	Algae	1.854	2.616	2.173	0.928	4.47	6.643	7.571	40.78	50.47
	Moringa	2.380	2.733	1.733	0.978	5.113	6.846	7.824	45.48	52.16
	Algae+ moringa	2.300	1.801	1.868	1.356	4.101	5.969	7.325	36.20	48.83
LSD at 0.05 level		**0.109**	**0.038**	**0.111**	**0.106**	**0.112**	**0.164**	**0.217**		**1.88**

Complex fertilizers at 450 kg Nitrophoska /fed. (12:12:17 % NPK equal 54, 54 and 76.5 kg/fed. of N, P_2O_5 and K_2O, respectively. Simple mineral fertilizers at 263.41 kg ammonium sulphate 20.5 % N/fed., 348.38 kg calcium super phosphate 15.5 % P_2O_5 /fed. and 153 kg potassium sulphate 50 % K_2O /fed equal 54, 54 and 76.5 kg /fed. N,P and K_2O, respectively. Algae extract at 2 % and Moringa leaf extract at 2 %
*Fedden equal 0.42 ha.

Table (10): Effect of the interaction between fertilizer types and some extracts on yield and its components of garlic during 2017/2018 season

Treatments		Yield and its components (ton/fed.*)								
Fer. types	Extracts	Grade (1)	Grade (2)	Grade (3)	Grade (4)	Exportable yield	Marketable yield	Total yield	Relative increases in total yield (%)	Average bulb weight (g)
Complex fertilizer	Without	1.580	1.654	1.333	0.667	3.234	4.567	5.234	00.00	34.89
	Algae	1.763	1.906	1.894	0.875	3.669	5.563	6.438	23.00	42.92
	Moringa	2.088	2.054	1.756	1.096	4.142	5.898	6.994	33.63	46.63
	Algae +moringa	2.065	2.013	1.469	1.424	4.078	5.547	6.971	33.19	46.47
Simple mineral fertilizers	Without	1.655	1.868	1.235	0.821	3.523	4.758	5.579	06.59	37.19
	Algae	2.148	2.073	1.664	0.925	4.221	5.885	6.81	30.11	45.40
	Moringa	2.421	2.414	1.735	0.981	4.835	6.57	7.551	44.27	50.34
	Algae +moringa	2.289	1.976	1.862	1.368	4.265	6.127	7.495	43.20	49.97
LSD at 0.05 level		**0.089**	**0.181**	**0.556**	**0.068**	**0.185**	**0.650**	**0.647**	**--**	**4.71**

Complex fertilizers at 450 kg Nitrophoska /fed. (12:12:17 % NPK equal 54, 54 and 76.5 kg/fed. of N, P_2O_5 and K_2O, respectively. Simple mineral fertilizers at 263.41 kg ammonium sulphate 20.5 % N/fed., 348.38 kg calcium super phosphate 15.5 % P_2O_5 /fed. and 153 kg potassium sulphate 50 % K_2O /fed. equal 54, 54 and 76.5 kg /fed. N,P and K_2O, respectively. Algae extract at 2 % and Moringa leaf extract at 2 % *Fedden equal 0.42 ha.

Bulb quality

Effect of fertilizer type

Complex fertilizer (450 kg/fed. Nitrophoska) gave higher values of TSS in bulbs in the 1st season, N % in the 2nd season and P % in both seasons than simple mineral fertilizer (Table 11). There were no significant differences between two fertilizer types with respect N % in the 1st season, K % and TSS in the 2nd season and DM % in both seasons.

In this regard, **Wadas (2011)** stated that treating with Nitrophoska Blue Special and Viking 13 belonging to nitrophoska group (multinutrient complex fertilizers) increased the concentration of nitrogen in tubers. In contrast, treatment with HydroComplex, not changed significantly the level of total nitrogen than that with simple fertilizer. Also, **Wadas *et al.* (2015)** found that by applying Nitrophoska Blue special which belonging to complex fertilizers type NPKMgS, induced a significant rise in uptake and utilization of nitrogen by potato tubers than usually used simple fertilizers.

4.2. Effect of some extracts

In general, spraying garlic plants with moringa leaf extracts or with algae + moringa leaf extract increased N,P, K and TSS in bulbs in both seasons (Table 11). There were no significant differences between three extracts and control with respect to DM % in both seasons.

The promoting effect of seaweed extract on chemical content of garlic bulb may be attributed to it`s high contents of micro elements, fatty acids, organic matter, and vitamins, in addition to growth promoters (e.g. gibberellins, cytokinin andauxins). The using of seaweed extract as natural fertilizer was found to be having efficient impact on garlic because it containing several elements that may work synergistically at various levels, in spite of the mechanism of action is unknown yet. (**Shehata *et al.*, 2011**). In this regard, **Hegazi *et al.* (2016)** found that sprayed garlic plants with moringa leaf extract gave the best results for enhancing bulb quality of garlic.

Effect of the interaction between fertilizer type and some extracts

In general, the interaction between complex fertilizers (450 kg /fed. of Nitrophoska) and spraying with moringa leaf extract or with algae + moringa leaf extract increased N,P, K and TSS in bulbs. The interaction between fertilizer type and some extracts had no significant effect on DM % in both seasons (Table 12).

Table (11): Effect of fertilizer types and some extracts on bulb quality of garlic at harvesting time during 2016/2017 and 2017/2018 seasons

Treatments	N (%)		P (%)		K (%)		TSS		DM (%)	
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Fertilizer type	**Effect of fertilizer types**									
Complex fertilizer	2.06	1.95	0.254	0.266	1.48	1.43	36.87	36.70	36.44	35.01
Simple mineral fertilizers	1.69	1.66	0.208	0.224	1.17	1.15	35.04	35.29	35.47	35.67
LSD at 0.05 level	**NS**	**0.27**	**0.015**	**0.023**	**0.29**	**NS**	**0.94**	**NS**	**NS**	**NS**
	Effect of extracts									
Without	1.58	1.46	0.131	0.136	1.09	1.06	34.75	34.58	35.84	35.78
Algae	1.77	1.76	0.205	0.230	1.09	1.06	35.50	35.33	35.57	35.95
Moringa	2.17	2.16	0.270	0.281	1.45	1.41	37.25	37.41	35.72	35.67
Algae +moringa	1.99	1.83	0.318	0.333	1.67	1.64	36.33	36.66	36.70	33.96
LSD at 0.05 level	**0.30**	**0.22**	**0.027**	**0.019**	**0.25**	**0.26**	**0.55**	**0.71**	**NS**	**NS**

Complex fertilizers at 450 kg Nitrophoska /fed. (12:12:17 % NPK equal 54, 54 and 76.5 kg/fed. of N, P_2O_5 and K_2O, respectively**.** Simple mineral fertilizers at 263.41 kg ammonium sulphate 20.5 % N/fed., 348.38 kg calcium super phosphate 15.5 % P_2O_5 /fed. and 153 kg potassium sulphate 50 % K_2O /fed. equal 54, 54 and 76.5 kg /fed. N,P and K_2O, respectively. Algae extract at 2 % and Moringa leaf extract at 2 %, S1: season 1, S2: season 2

Table (12): Effect of the interaction between fertilizer types and some extracts on bulb quality of garlic at harvesting time of garlic during 2016/2017 and 2017/2018 seasons

Treatments		N (%)		P (%)		K (%)		TSS		DM%	
Fer. types	**Extracts**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
Complex fertilizer	**Without**	1.72	1.70	0.153	0.150	1.31	1.28	36.00	35.66	36.57	31.56
	Algae	1.97	1.91	0.226	0.256	1.14	1.14	36.33	36.00	35.80	34.95
	Moringa	2.37	2.34	0.290	0.300	1.64	1.53	37.83	37.83	36.26	35.30
	Algae+ moringa	2.18	1.86	0.346	0.360	1.82	1.79	37.33	37.33	37.13	35.81
Simple mineral fertilizers	**Without**	1.44	1.23	0.110	0.123	0.87	0.85	33.50	33.50	35.11	36.27
	Algae	1.58	1.62	0.183	0.203	1.03	0.98	34.66	34.66	35.34	36.09
	Moringa	1.97	1.99	0.250	0.263	1.27	1.30	36.66	37.00	35.18	36.40
	Algae+ moringa	1.80	1.81	0.290	0.306	1.52	1.49	35.33	36.00	36.27	36.35
LSD at 0.05 level		**0.43**	**0.31**	**0.038**	**0.027**	**0.35**	**0.37**	**0.78**	**1.00**	**NS**	**NS**

Complex fertilizers at 450 kg Nitrophoska /fed. (12:12:17 % NPK equal 54, 54 and 76.5 kg/fed. of N, P_2O_5 and K_2O, respectively**.** Simple mineral fertilizers at 263.41 kg ammonium sulphate 20.5 % N/fed., 348.38 kg calcium super phosphate 15.5 % P_2O_5 /fed. and 153 kg potassium sulphate 50 % K_2O /fed. equal 54, 54 and 76.5 kg /fed. N,P and K_2O, respectively. Algae extract at 2 % and Moringa leaf extract at 2 %, S1: season 1, S2: season 2

References

1. Abou El-Khair, E. E., I. A. S. Al-Esaily and H.E.M. Ismail (2010). Effect of foliar spray with humic acid and green microalgae extract on growth and productivity of garlic plant grown in sandy soil. J. Product. and Dev.,15(3): 335- 354.
2. Abou El-Nour H. H. and N. A. Ewais (2017). Effect of *moringa oleifera* leaf extract (MLE) on pepper seed germination, seedlings improvement, growth, fruit yield and its quality. Middle East J. Agric. Res., 6(2): 448-463.
3. Albaho, M., D. Ghloum, B.Thomas, S.Isathali, and P. George (2012). Effect of two fertilizers on growth and yield of chilli pepper and cherry tomato grown in a closed insulated pallet system. Acta Hort., 927: 108.
4. Anantharaj M and V. Venkatesalu (2001). Effect of seaweed liquid fertilizer on Vigna catajung, Sea weed Res. Utiln, 23: 33–39.
5. Anwar F., S. Latif, M. Ashraf and A. H. Gilani (2007). *Moringa oleifera* a: A food plant with multiple medicinal uses. Phytother. Res. 21:17-25.
6. Assefa A. G., S. H. Mesgina and Y. W. Abrha (2015). Effect of inorganic and organic fertilizers on the growth and yield of garlic crop (*Allium sativum* l.) in Northern Ethiopia. J. Agric. Sci., 7 (4):80-86.
7. Babilie R., M. Jbour and B. Abu Trabi (2015). Effect of foliar spraying with licorice root and seaweed extracts on growth and seed production of onion (*Allium cepa* L.). Int. J. Chem. Tech. Res.,8(11): 557-563.
8. Bashir, K.A., J.A. Bawa and I. Mohammed, 2014. Efficacy of leaf extract of drumstick tree (*Moringa oleifera* L.) on the growth of local tomato (*Lycopersicon esculentum*) J. Pharmacy and Bio. Sci., 9(4): 74-79.
9. Bremner, J. M., and C. S. Mulvaney (1982). Total nitrogen In: Page, A. L., R. H. Miller, and D. R. Keeney (Eds.). Methods of Soil Analysis. Part 2, Amer. Soc. Agron. Madison, W. I. USA: pp. 595- 624.
10. Culver M., T. Fanue and A. Z. Chiteka (2012). Effect of moringa extract on growth and yield of tomato. Greener J. Agric. Sci., 2 (5): 207-211.
11. Emongor, V. E. (2015). Effects of moringa (*Moringa oleifera*) leaf extract on growth, yield and yield components of snap beans (*Phaseolus vulgaris*). BJAST, 6(2): 114-122,.
12. FAO (2017). Food and Agriculture Organization of the United Nations.
13. Fawzy, Z.F., Z.S., El-Shal, Li Yunsheng, O. Zhu and Omaima M. Sawan (2012). Response of garlic (*Allium sativum* L.) plants to foliar spraying of some biostimulants under sandy soil condition. J. Appl.Sci. Res., 8(2): 770-776.
14. Goulding K., S. Jarvis and A.Whitmore (2008). Optimizing nutrient management for farm systems. Philos Trans R Soc B.; 363 (1491):667–680.
15. Hegazi A. Z., S. Kh.H. Hasan and N. A.M. El-Said (2016). Response of garlic plants to foliar application of moringa leaves extract, glutamine and cysteine. J. Plant Production, Mansoura Univ., Vol. 7(1): 1 - 6,.
16. Hidangmayum A. and R. Sharma (2017). Effect of different concentrations of commercial seaweed liquid extract of Ascophyllum nodosum as a plant bio stimulant on growth, yield and biochemical constituents of onion (*Allium cepa* L.). J. Pharmacognosy and Phytochemistry, 6(4): 658-663.
17. Jabłoński, K. (2006) Agro technical and qualitive effects of potato fertilization with multi component fertilizers of new generation. Zeszyty Problemowe Postępów Nauk Rolniczych, (511): 309-315.
18. Jackson, M. L. (1970). Soil Chemical Analysis. Prentic Hall, Englewood Ceiffs, N. J.
19. Kurian, J.C. (1995). Plant that Heal (1 Ed.). Orienta I Watchman Publishing House, Pune, India, 31.
20. Ministry of Economy Egypt (1963). To control exported garlic. Ministerial order No.652.
21. Mohammed, R., M.M. Olorukooba, M.M. Akinyaju and E.A. Kambai (2013). Evaluation of different concentrations and frequency of foliar application of moringa extract on growth & yield of onion, *Allium cepa* Lam. Agrosearch, 13(3):196-205.
22. Mohsen, A.A.M. (2012). Response of garlic plant to nitrogen, phosphorus, potassium and some biofertilizer levels under sandy soil conditions. Ph.D. Thesis, Fac. Agric., Zagazig Univ., Egypt.
23. Moyo B., P.J. Masika, A.Hugo and V. Muchenje (2011). Nutritional characterization of moringa (*Moringa oleifera* Lam) leaves. Afr. J. Biotechnol.10(60):12925 – 12933.
24. Nambiar, V.S., R. Mehta and M. Daniel (2005). Polyphenol content of three Indian green leafy vegetables. J. Food Sci. Technol. 42(6): 312 - 315.
25. Njoku, O.U and M.U. Adikwu (1997). Investigation on some physico-chemical antioxidant and toxicological properties of *Moringa oleifera* seed oil. Acta Pharmaceutica. 47(4):287-290.

26. Olsen, S. R. and L. E. Sommers (1982). Phosphorus. In: Page. A. L., R. H. Miller, and D. R.Keeney (Eds.). Methods of Soil Analysis.Part 2 Amer. Soc. Agron. Madison, W. I. USA. pp. 403-430.
27. Oluwagbenga, D. and O.T. Odeghe (2015). Response of sweet bell pepper to moringa leaf extract and oregano bio-degradable fertilizer. Asian J. Agric. Biol., 3(4): 117-123.
28. Ozer H. (2003). Sowing date and nitrogen rate effects on growth, yield and yield components of two summer rapeseed cultivars. Eur J Agron. ;19(3):453–463.
29. Pirogovskaya, G.V., M.I. Yukhnevich, V.I. Soroko, A.M. Rusalovich, and L.I. Kostyukevich (2002). Effectiveness of application of organic and mineral fertilizers at potato cropping. Pochvovedenie i Agrokhimiya, 32, 162-176.
30. Piwowar, A. (2011). Innovations in the sphere of mineral fertilization and their practical application. Postępy Nauk Rolniczych, 3, 47-56.
31. Purseglove, J.W. (1975). Tropical Crops: Monocotyledons, ELBS Longman, London, 52-56.
32. Shafeek, M.R., Y.I. Helmy and Nadia M. Omar (2015). Use of some Bio-stimulants for improving the growth, yield and bulb quality of onion plants (*Allium cepa* L.) under sandy soil conditions. Middle East J. Appl. Sci., 5(1): 68-75.
33. Shalaby, T. A. and H. El-Ramady (2014). Effect of foliar application of bio-stimulants on growth, yield, yield components, and storability of garlic (*Allium sativum* L.). AJCS., 8 (2): 271-275.
34. Shehata, S.M., S. Heba, Abdel- Azem, A. Abou El-Yazied and A.M. El- Gizawy, (2011). Effect of foliar spraying with amino acids and seaweed extract on growth, chemical constitutes, yield and its quality of Celeriac plant. Europ. J. Sci. Res., 58(2): 257-265.
35. Snedecor, G.W., and W.G.Cochran (1980). Statistical Methods.7th (ed.) Iowa State Univ., Press, Ames., Iowa, U.S.A.
36. Thirumaran G., M. Arumugam, R. Arumugam and P. Anantharaman (2009). Effect of seaweed liquid fertilizer on growth and pigment concentration of *Abelmoschus esculentus* (I) Medikus. Am. Euras. J.Agron. 2:57–66.
37. Tripolskaja, L., A. Razukas, G. Sidlauskas and I. Verbyliene (2017). Effect of fertilizers with different chemical composition on crop yield, nitrogen uptake and leaching in a sandy loam Luvisol. Zemdirbyste-Agric., 104 (3): 203–208.
38. Tian, C, X. Zhou, Q.Liu, J. Peng, W. Wang, Z. Zhang,Y. Yang, H. Song, and Ch. Guan (2016). Effects of a controlled-release fertilizer on yield, nutrient uptake, and fertilizer usage efficiency in early ripening rapeseed (*Brassica napus* L.). J. Zhejiang Univ Sci. B., 17(10): 775–786.
39. Wadas W. and T. Dziugieł (2013). Effect of multi-nutrient complex fertilizers on growth and tuber yield of very early potato (*Solanum tuberosum* L.) cultivars. Acta Agrobotanical, 66 (3): 55–66.
40. Wadas, W., J. Raczuk and T. Dziugieł (2015). utilization of nitrogen, phosphorus and potassium from complex fertilizers by very early-maturing1 potato cultivars. Acta Sci. Pol. Agric., 14(2): 63-76.
41. Wadas W. (2011). Effect of multi-nutrient complex fertilizers on total nitrogen and nitrate. (V) Content in the tubers of very early potato cultivars. Ecological Chemistry and Engineering, 18 (1): 123–128.
42. Wadas, W. and T. Łęczycka (2010). The efficiency of application of complex multi-nutrient fertilizers in cultivation of very early potato cultivars. Biuletyn IHAR, 257/258, 167-175.
43. Yassen A.A., E.A.A. Abou ELNour, M.A. Abou Seeda, M.M.S. Abdallah and S.A.A. El- Sayed (2018). Effect of potassium fertilization levels and algae extract on growth, bulb yield and quality of onion (*Allium cepa* L.). Middle East J. Agric. Res., 7(2): 625-638.
44. Zhao B., S. Dong, J. Zhang and P. Liu (2013). Effects of controlled-release fertiliser on nitrogen use efficiency in summer maize. PLoS ONE 8(8): e70569. doi:10.1371/journal.pone.0070569.
45. Zodape, S.T., A. Gupta and S.C. Bhandari (2011). Foliar application of seaweed sap as biostimulant for enhancement of yield and quality of tomato (*Lycopersicon esculentum* Mill.). J Sci Ind Res 70: 215–219.

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