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IMPACT OF MAGNETIZED WATER AND SOME NATURAL EXTRACT ON GROWTH AND PRODUCTIVITY OF GARLIC UNDER SALINE SANDY SOIL CONDITIONS

M.A.M. Elsagan[1], Rashed M.F. Suzan[2] and Hend N. Mohamed[3]

[1-2]Department of Plant Production, Desert Research Center, El-Mataria, Ciaro, Egypt.
[3]Marketing Department, Agricultural Economics Research Institute, Agricultural Research center, Giza, Egypt.

Abstract

The field work was carried out at privet farm at Tour city, South Sinai Governorate, during the two consecutive winter seasons of 2018/2019 and 2019/2020.The experiments were conducted to study the effect of two water treatment *i.e.*, magnetized water (MW) and non-magnetized water (NMW) with seven rates of foliar spray treatments by compost tea at the rate of 100 and 150g/L; sea algae at the rate of 1 and 1.5g/L; yeast extract at the rate of 5 and 7.5g/L beside control treatment sprayed with tap water on growth, yield and chemical composition of garlic cloves, Seeds 40 *cv.* planted in sandy soil conditions. Results revealed that magnetized water treatment superior significantly on plant height and weight, No. of leaves/plant, head fresh weight, head diameters, average of cloves weight, total yield and nitrogen (%) in both growing seasons while, calcium (%) increased in the first season only. In generally foliar spray treatments showed improvement on values in all growth parameters, yield and chemical content when compared with control treatment. The highest values were recorded with compost tea treatment at the rate of 150g/L which was superior significantly in plant weight, shoot and head fresh weight, neck and head diameters, average of cloves weight, total yield and N (%) in both seasons. Also, sea algae at the rate of 1.5g/L increased significantly in number of leaves/plant, shoot and bulb dry matter percent, number of cloves/plant, K (%) and T.S.S of cloves in both seasons. Moreover, yeast extract at the rate of 7.5g/l increased significantly in plant height and Ca (%) in both seasons. Using magnetized water treatment increased total output by (9.9 and 9.01%) and investment ratio by (8.33 and 6.93%) in both seasons respectively. Also, compost tea at the rate of 150g/l superior significantly total output and investment ratio in both seasons followed by foliar spray by yeast extract at the rate of 7.5g/l in the first season only, while and compost tea at the rate of 100g/l superior in the second season.

Key words: garlic – magnetized water – compost tea – yeast – sea algae- yield

Introduction

Garlic (*Allium sativum* L.), is a second vital cultivated from Alliaceae family worldwide. Garlic has abundant and unique medicinal properties and nutritional values. Garlic is rich in folic acid, vitamin C, calcium, iron, magnesium, potassium and small amounts of zinc. Garlic has been traditionally used for blood purification. Egypt ranks in the first ten leading country in the world for garlic production (FAO. STAT., 2018).

A great challenge for the agricultural sector is to produce more food from desert lands which is suffering from water scarcity. Utilization of magnetized water technology is considered as a promising technique to improve water use efficiency and crop productivity. The impact of magnetic fields on plant growth and development is not well-understood. Several theories have been proposed to explain magnetized water action, *i.e.* magnetic field stimulation of synthesis and transport of hormones and enzymes metabolism and increase the final plant yield, (Esitken 2003) also, activation of phytohormone such as gibberellic acid-equivalents, indole-3-acetic acid and activation of the bio-enzyme systems (Maheshwari and Grewal 2009), or magnetic fields caused variations in the ionic currents across the cellular membrane leads to change in the osmotic pressure and significant increase in the rate of water absorption (Taia *et al.*, 2007). Also, Selim (2008) stated that magnetically water has induced changes in the mobility of nutrient elements in root zone, with differences from one element to another according

Table 1: Some Physical and chemical properties of the experimental soil site.

Soil depth (cm)	Texture class	Soluble anions (me/l)			$pH^{soil\ paste}$	E.C dSm^{-1}	Soluble cations (me/l)			
		HCO_3^-	$SO_4^=$	Cl^-			Ca^{+2}	Mg^{+2}	Na^+	K^+
0 – 30	Sandy loam	2.10	17.65	23.64	7.24	4.36	8.23	12.56	20.20	2.4

pH: Acidity E.C.: Electrical conductivity me/l: milli equivalent per liter

to the element magnetic susceptibility.

However, magnetized water improved plant tolerance to salt stress conditions Lihua and Jixun (2001). Also, magnetized water increase plant metabolism in terms of photosynthesis and water uptake (Yano *et al.*, 2004). Moreover, De souza *et al.*, (2005) reported that at the fruit maturity stage, the magnetically treated seeds produced plants with more fruits significantly; increase in fruit weight and fruit yield per plant than untreated plants. Moreover, the irrigation by magnetized water increased significantly plant height, no. of leaves / plant, fresh and dry weight, as well as survival rate, N and P% than those irrigated by non- magnetized water on tomato (Carbonell, 2011and Ahmed 2013). In addition, the magnetized water increased the chemical constituents (chlorophyll a and b, carotenoids, total available carbohydrates, protein, total amino acids, proline content, total indoles, total phenols and inorganic minerals K, Ca+2 and P+3 contents) in all plant parts of broad bean (Elayed, 2015), also in pepper plants (Rawabdeh *et al.*, 2014).

Magnetic treatments for both tomato seeds and irrigation water under 75% NPK of recommended levels gave the best results, Abou El-Yazied *et al.*, (2012). Also, Negin *et al.*, (2015) reported that magnetic field has no positive effects on garlic growth, it can be used as a tool to increase helpful pharmaceutical essences and compounds. Moreover, El Sagan and Abd El Baset (2015) revealed that growth parameters of onion plant, chlorophyll contents, yield and its components, beside chemical contents increased with magnetic water when compared with non magnetized water. Also, Abdel Nabi *et al.*, (2019) recommended that irrigation garlic plants with magnetized water, 75% NK from the recommended dose and compost addition at 10 m3/fed for maximizing productivity and keep quality of storage parameters.

Study on compost tea technology began in 1980's in USA, Historically, home-made extract of compost tea were prepared by suspending a bag of compost in a container of water for 14 days to extract anaerobic microbes and nutrients which are used and applied to promote plant health and vitality in plants (Mahaffee, 2002). Also, compost extracts it can be applied with the irrigation water or pulverization that provides not only nutrients to plants but also favors the development of useful microorganism (Diver, 2002).

Table 2: Chemical analysis of the irrigation water.

Soluble anions (me/l)			pH	E.C	Soluble cations (me/l)			
HCO_3^-	$SO_4^=$	Cl^-		dSm^{-1}	Ca^{+2}	Mg^{+2}	Na^+	K^+
1.44	1.89	4.37	7.88	0.77	2.6	3.86	0.78	0.46

pH: Acidity, E.C.: Electrical conductivity, dSm^{-1}: decseime per meter.

Compost tea has been utilized in agriculture as a good source of organic matter and soil amendment that provide plants with mineral nutrients (Abbasi *et al.*, 2002). In addition, compost tea is very rich in phytohormones and growth regulators. It stimulates themicroorganisms that have a direct or indirect beneficial effect on plant rhizosphere, improves soil physical and chemical properties and suppress some plant diseases pathogen (Biocycle, 2004).

Moreover, Bayoumi and Hafez (2006) showed that compost tea and seaweed extracts (Algae) significantly increased all growth parameters of cucumber plants and chlorophyll content, especially at the earlier growth stage as compared to the control plants. Also, in modern terminology, majority of the studies have focused on plant disease control and suppressive ability of compost tea (Goonani *et al.*, 2011). In addition, Abou-El-Hassan *et al.*, (2014) revealed that compost tea improved cucumber yield and its quality in sandy soil as compared with recommended dose of nitrogen.

Many studies indicated that yeast is one of the richest sources of high quality protein, especially the essentialamino acids like lysine and tryptophan, essential minerals as calcium and trace elements as cobalt and iron. Yeast is the best source of the B-complex vitamins and a valuable source of bio-constituents especially cytokinins (Fathy and Farid, 1996 and Amer 2004). Also, foliar application of yeast increased growth, yield and quality of lettuce (Fawzy 2007), of eggplant (El-Tohamy *et al.*, 2008) and cucumber (Shehata *et al.*, 2012). Also, Application of yeast (2 g/L) showed the heaviest garlic bulb weight Tarek and Hassan (2014). Abou El-yazied and Mady (2012) found that yeast extract stimulated growth of broad bean and increased amino acids, auxins and cytokinins 75 days after sowing of broad bean. Moreover, Mahmoud *et al.*, (2013) found that yeast extracts improved pea vegetative growth, green pods yield and pod quality with using the highest level of yeast extract

(2%). as for, Shafeek, *et al.,* (2015) indicated that foliar application of yeast extract, sea weeds extract and licorice extract at the same line had the highest stimulation effect on onion plant growth characters *i.e.* (plant length and number of leaves, as well as fresh and dry weight of leaves, nick and pulps), total bulb yield and its components, besides content of the percentage of bulb tissues of nitrogen, protein and dry matter when compared to the control and other treatments.

Seaweed is the richest sources components such as macro- and microelement nutrients; amino acids; vitamins and complex polysaccharides, Blunden, (1991).Although many of the various chemical components of seaweed extracts and their modes of action remain unknown, it is plausible that these components exhibit synergistic activity, Vernieri *et al.,* (2005). Moreover, numerous studies revealed a wide range of beneficial effects of seaweed extract applications on plants, such as early seed germination, improved crop growth and yield, elevated resistance to biotic and abiotic stress and enhanced postharvest shelf-life of products (Beckett and Staden 1989; Blunden, 1991 and Norrie and Keathley, 2006). However, application of seaweed extract, as foliar spray increased, total soluble solid and vitamin C of two strawberry cultivars (Masny *et al.,* 2004), yield of two potato cultivars (Blunden and Paul, 2006), fruit size of pepper (Eris *et al.,* 2008), sex expression and total yield of cucumber (Al-Jebbouri, 2009) also, all growth parameters, total yield, fruit dry weight and its T.S.S of pepper (Mohammed, 2013).

Materials and Methods

The field work was carried out at privet farm at tour city South Sinai Governorate, during the two consecutive winter seasons of 2018/2019 and 2019/2020.

The physical and chemical soil characteristics of the studied site were determined according to Page *et al.,* (1982) and Klute (1986) respectively, as recorded in table 1. The chemical analysis of irrigation water was carried out using the standard method of Page *et al.,* (1982) and presented in table 2. In addition, the magnetic field treatments, irrigation water passed through a magnetic device, the device comprised of two magnets, arranged to the north and south poles. The directions of magnetic field generated at the flow rate diameter 2 inch the device is supplied by Nefertari Biomagnetic company and installed on the main irrigation line before the application to the plants.

Table 3: Effect of Magnetized water and foliar spray on plant height, weight and number of leaves/plant of garlic plants during 2018/2019 and 2019/2020 growing seasons.

Seasons	**1st season**								
Characters Treatments	**Plant height (cm)**			**Plant fresh weight (gm.)**			**Number of leaves/plant**		
Water treatment Foliar spray	**MW**	**NMW**	**$\bar{X}$**	**MW**	**NMW**	**$\bar{X}$**	**MW**	**NMW**	**$\bar{X}$**
Sea algae 1g/l	58.6	58.6	58.6	165.9	151.5	158.7	14.1	12.9	13.5
Sea algae 1.5g/l	64.1	61.5	62.8	177.8	167.7	172.8	14.2	13.8	14.0
Yeast extract 5g/l	63.1	54.4	58.8	173.7	160.6	167.2	12.2	11.9	12.1
Yeast extract 7.5g/l	70.7	65.4	68.0	176.1	165.8	171.0	12.9	13.4	13.1
Compost tea 100g/l	61.1	59.1	60.1	175.8	170.7	173.3	11.5	9.8	10.6
Compost tea 150g/l	62.3	59.1	60.7	197.3	172.1	184.7	13.2	12.9	13.1
Control	52.3	42.8	47.6	162.0	135.4	148.7	10.8	10.2	10.5
$\bar{X}$	61.7	57.3		175.5	160.6		12.7	12.1	
2nd season									
Sea algae 1g/l	62.4	59.4	60.9	183.9	165.5	174.7	12.5	12.3	12.4
Sea algae 1.5g/l	63.1	61.3	62.2	181.9	165.5	173.7	15.2	13.3	14.3
Yeast extract 5g/l	70.8	66.3	68.5	177.7	163.6	170.7	12.8	12.2	12.5
Yeast extract 7.5g/l	73.9	67.5	70.7	191.3	171.3	181.3	13.5	13.0	13.3
Compost tea 100g/l	65.8	61.1	63.5	188.9	184.3	186.6	12.1	11.4	11.8
Compost tea 150g/l	67.8	66.0	66.9	207.5	195.9	201.7	14.9	13.3	14.1
Control	59.0	57.6	58.3	161.6	162.0	161.8	12.1	10.8	11.5
$\bar{X}$	66.1	62.8		184.7	172.6		13.3	12.3	
L. S. D. (0.05) for:	Sea. 1	Sea. 2		Sea. 1	Sea. 2		Sea. 1	Sea. 2	
Water treatment	2.81	3.17		12.14	9.27		0.21	0.30	
foliar spray	4.77	3.73		15.04	8.85		1.00	1.08	
Interaction	NS	NS		NS	NS		NS	NS	

*Magnetized water = (MW) *Nonmagnetized water = (NMW)

Table 4: Effect of Magnetized water and foliar spray on shoot &head fresh weight and shoot &head dry matter percent of garlic plants during 2018/2019 and 2019/2020 growing seasons.

Characters Treatments	Shoot fresh weight (gm.)			Head fresh weight (gm.)			Shoot dry matter (%)			Head dry matter (%)		
Water treatment Foliar spray	MW	NMW	X̄	MW	NMW	X̄	MW	NMW	X̄	MW	NMW	X̄
1st season												
Sea algae 1g/l	47.4	43.2	45.3	118.5	108.3	113.4	26.2	24.1	25.2	34.8	33.6	34.2
Sea algae 1.5g/l	43.9	47.6	45.8	133.7	118.9	126.3	26.9	25.7	26.3	36.2	35.3	35.7
Yeast extract 5g/l	49.4	46.4	47.9	124.3	114.2	119.2	24.2	23.9	24.0	30.8	31.9	31.3
Yeast extract 7.5g/l	59.4	54.3	56.9	116.7	111.5	114.1	26.2	24.1	25.2	33.5	33.2	33.4
Compost tea 100g/l	58.4	57.3	57.9	117.4	113.4	115.4	21.9	21.7	21.8	33.8	31.1	32.4
Compost tea 150g/l	63.6	60.4	62.0	133.9	120.1	127.0	21.9	21.5	21.7	32.8	30.3	31.5
Control	44.1	50.2	47.1	117.9	85.2	101.6	23.7	22.0	22.9	32.0	31.5	31.8
X̄	47.4	43.2		123.2	110.2		24.4	23.3		33.4	32.4	
2nd season												
Sea algae 1g/l	46.2	45.4	45.8	137.7	120.2	128.9	25.9	24.8	25.4	35.3	34.7	35.0
Sea algae 1.5g/l	49.3	48.2	48.8	132.6	117.3	124.9	27.8	26.8	27.3	37.0	35.4	36.2
Yeast extract 5g/l	53.9	51.5	52.7	123.8	112.1	118.0	26.4	23.0	24.7	34.1	32.7	33.4
Yeast extract 7.5g/l	57.2	52.7	54.9	134.1	118.6	126.4	26.2	23.9	25.1	35.2	32.8	34.0
Compost tea 100g/l	60.1	59.5	59.8	128.8	124.8	126.8	23.4	22.1	22.8	33.3	32.3	32.8
Compost tea 150g/l	63.9	63.6	63.7	143.6	132.3	138.0	23.5	21.1	22.3	31.3	31.6	31.5
Control	50.1	46.5	48.3	111.5	115.5	113.5	22.9	24.1	23.5	32.4	32.3	32.4
X̄	54.4	52.5		130.3	120.1		25.2	23.7		34.1	33.1	
L. S. D. (0.05) for:	Sea. 1	Sea. 2		Sea. 1	Sea. 2		Sea. 1	Sea. 2		Sea. 1	Sea. 2	
Water treatment	NS	NS		7.27	7.89		NS	NS		NS	NS	
foliar spray	5.11	3.22		14.7	8.31		2.11	1.98		2.12	1.45	
Interaction	NS	NS		NS	NS		NS	NS		NS	NS	

*Magnetized water = (MW) *Nonmagnetized water = (NMW)

Organic manure was added at the rate of 20 m³/fed., while calcium super phosphate (15.5% P2O5) at the rate of 300 kg /fed., was added during land preparation. Potassium sulphate (48% K_2O) at the rate of 200 (kg/ fed.) and ammonium sulphate (20.5% N) at the rate of 300 (kg/ fed.), fertilizer quantities were divided and applied within drip irrigation system starting after 30 days from planting to end of maturity. Garlic cloves were planted in the first week of October through the two growing seasons respectively. Fourteen treatments were used which were the combination of two water treatment *i.e.*, magnetized water (MW) and non-magnetized water (NMW), alsos even rates of foliar treatments by compost tea at the rate of 100 and 150g/ L; seaalgae at the rate of 1 and 1.5g/L; yeast extract at the rate of 5 and 7.5g/L, beside control treatment sprayed with tap water. Experimental plot area was 32 m² (4m wide * 8m long), which is consisted of three ridges, each ridges width is 1m and had two drip irrigation lines, garlic cloves were soaked in warm water 12 hour before planting, then planted within eight lines for each ridge 10 cm apart between cloves. After 30; 60and 90 days from planting all foliar treatments were sprayed, while water was sprayed as a control treatment, all sprayed treatments were applied by hand dropping sprayer. The growing season extended for 150 days. All agricultural practices for garlic crop production were followed according to the recommendation of Egyptian Ministry of Agriculture.

Foliar treatments preparation

·Algae extract (Oligo-x) was

obtained from Union for Agricultural Development Company having the following composition: oligosaccharides 3%, algnic acid 5%, phytin 0.003% menthol 0.001%, natural growth regulators (Cytokinin 0.001%, indol acetic acid 0.0002%), pepsin 0.02 % and minerals (potassium oxide 12%, phosphorus oxide 0.5%, N1%, Zn 0.3%, Fe 0.2% and Mn 0.1%).

· Compost tea extract was prepared according to Al-Fartusy (2003) dissolving a certain weight of the compost in distilled water (weight/volume) and left in plastic containers for 24 hours, then contused well and was filtered through the filter paper type 12 Whatman.

·Yeast extract was prepared from brewer's yeast (Saccharomyces cerevisiae) by dissolving it in water followed by adding sugar at a ratio of 1:1 and kept 24 hours in a warm place for reproduction according to the methods of Morsi *et al.,* (2008).

Growth and yield parameters

1- After 120 days from planting, nine plants of each replicate were randomly taken for recording vegetative growth characteristics, *i.e.*, plant height and weight, number of leaves/plant, fresh weight of leaves and bulb and percentage of dry weight of the aerial vegetative parts and bulb.

2- At harvesting stage (150 days from planting date) a sample of 20 garlic plants were randomly taken from each experimental plot for yield characteristics, *i.e.*, neck and bulb diameter, blubbing ratio average clove fresh weight and number of cloves per head were recorded. In addition, total yield (ton/fed.), when 50% of leaves pended and turned to yellowish green color, irrigation was stopped at 15 days before harvest date.

Chemical composition

Three samples of garlic bulb from each subplot were taken and oven dried at 70ºC until stable weight then grinded to fine particles and used to determine chemical content such as minerals, (N, K and Ca), Total nitrogen was determined using the modified micro Kjeldahl method, potassium and calcium percentage were measured using flame photometer method as described by Brown and Lilliland (1964), while total soluble solids (TSS) of garlic cloves were determined using a JK-SR-113ATC digital Refractometer (Shanghi Co. Ld., China) at 20°C. (A.O.A.C., 1990).

Investment ratio

Investment Ratio (IR) = (total revenue, LE / total

Table 5: Effect of Magnetized water and foliar spray on neck and head diameter, blubbing ratio of garlic plants during 2018/2019 and 2019/2020 growing seasons.

Seasons	1st season								
CharactersTreatments	Neck diameter (mm)			Head diameter (mm)			Blubing ratio (%)		
Water treatment Foliar spray	MW	NMW	$\bar{X}$	MW	NMW	$\bar{X}$	MW	NMW	$\bar{X}$
Sea algae 1g/l	8.3	8.3	8.3	52.6	46.5	49.6	0.16	0.18	0.17
Sea algae 1.5g/l	9.7	11.0	10.3	53.6	40.8	47.2	0.18	0.27	0.22
Yeast extract 5g/l	11.7	11.3	11.5	58.7	46.2	52.4	0.20	0.25	0.22
Yeast extract 7.5g/l	12.3	12.0	12.2	61.6	48.1	54.9	0.20	0.25	0.23
Compost tea 100g/l	12.3	12.7	12.5	61.4	56.3	58.9	0.20	0.23	0.21
Compost tea 150g/l	14.3	13.3	13.8	65.4	59.3	62.3	0.22	0.23	0.22
Control	12.0	11.0	11.5	50.4	45.0	47.7	0.24	0.25	0.24
$\bar{X}$	11.5	11.4		57.7	48.9		0.20	0.23	
2nd season									
Sea algae 1g/l	9.7	10.3	10.0	60.2	56.8	58.5	0.16	0.18	0.17
Sea algae 1.5g/l	11.0	9.7	10.3	65.7	59.7	62.7	0.17	0.17	0.17
Yeast extract 5g/l	12.0	12.0	12.0	63.8	60.0	61.9	0.19	0.18	0.19
Yeast extract 7.5g/l	12.0	11.0	11.5	68.1	61.5	64.8	0.18	0.18	0.18
Compost tea 100g/l	12.0	12.0	12.0	70.5	65.8	68.2	0.17	0.18	0.18
Compost tea 150g/l	14.3	13.0	13.7	72.0	68.5	70.3	0.20	0.19	0.19
Control	11.0	9.0	10.0	57.0	53.0	55.0	0.19	0.17	0.18
$\bar{X}$	11.71	11.00		65.3	60.8				
L. S. D. (0.05) for:	Sea. 1	Sea. 2		Sea. 1	Sea. 2		Sea. 1	Sea. 2	
Water treatment	NS	NS		4.23	3.59		0.02	NS	
foliar spray	1.17	1.62		3.38	5.45		0.03	NS	
Interaction	NS	NS		4.78	NS		NS	NS	

*Magnetized water = (MW) *Nonmagnetized water = (NMW)

Table 6: Effect of Magnetized water and foliar spray on cloves number/head, cloves average weight and total yield of garlic plants during 2018/2019 and 2019/2020 growing seasons.

Seasons	1st season								
CharactersTreatments	cloves number/head			cloves average weight(gm)			Total yield ton/fed.		
Water treatment Foliar spray	MW	NMW	$\bar{X}$	MW	NMW	$\bar{X}$	MW	NMW	$\bar{X}$
Sea algae 1g/l	24.7	24.0	24.3	4.00	3.71	3.86	9.46	8.46	8.96
Sea algae 1.5g/l	23.7	25.3	24.5	4.86	3.96	4.41	10.29	9.17	9.73
Yeast extract 5g/l	22.0	25.0	23.5	4.83	3.80	4.31	10.46	9.73	10.10
Yeast extract 7.5g/l	20.7	26.0	23.3	4.79	3.52	4.16	11.97	10.37	11.17
Compost tea 100g/l	22.3	21.7	22.0	4.45	4.33	4.39	11.31	10.45	10.88
Compost tea 150g/l	20.7	20.3	20.5	5.81	4.94	5.37	11.83	10.89	11.36
Control	15.0	18.3	16.7	3.37	3.07	3.22	9.23	8.76	8.99
$\bar{X}$	21.29	22.95		4.59	3.90		10.65	9.69	
2nd season									
Sea algae 1g/l	25.0	23.3	24.2	4.72	4.30	4.51	9.66	9.12	9.39
Sea algae 1.5g/l	25.3	25.3	25.3	4.46	3.87	4.17	11.69	10.30	10.99
Yeast extract 5g/l	22.3	22.0	22.2	4.69	4.21	4.45	10.31	9.48	9.89
Yeast extract 7.5g/l	22.7	24.3	23.5	5.16	4.37	4.76	11.72	10.79	11.26
Compost tea 100g/l	20.7	22.3	21.5	5.26	4.70	4.98	10.47	10.35	10.41
Compost tea 150g/l	19.0	19.3	19.2	6.54	5.85	6.19	12.31	10.72	11.52
Control	16.7	22.0	19.3	5.53	3.34	4.43	9.75	8.89	9.32
$\bar{X}$	21.29	22.95		5.19	4.38		10.85	9.95	
L. S. D. (0.05) for:	Sea. 1	Sea. 2		Sea. 1	Sea. 2		Sea. 1	Sea. 2	
Water treatment	NS	NS		0.67	0.75		0.26	0.74	
foliar spray	3.25	4.05		1.02	0.80		0.76	0.57	
Interaction	NS	NS		NS	NS		NS	NS	

*Magnetized water = (MW) *Nonmagnetized water = (NMW)

cost, LE) for fresh yield and pickle production following Rana *et al.,* (1996).

Experimental design and statistical analysis

The experimental treatments were arranged in split plot design with three replicates, the main plots were assigned for magnetized water, whereas, spray treatments rates were randomly arranged in the sub plots. Statistical analyses of obtained data were analyzed according to Thomas and Hills (1975).

Results and Discussion

Plant Growth and yield Parameters

Growth and yield parameters results, *i.e.*, plant height and weight, No. of leaves/plant shoot and head weight, leaves and bulb dry matter percent, neck and head diameters, blubing ratio, number of cloves, average of cloves weight and total yield presented in tables 3-6 indicated that there were significant positive effects for both magnetized water and foliar application on all investigated growth parameters. From the data, it could remark the following:

1- Magnetized water treatment superior significantly than non magnetized water on plant height and weight, No. of leaves/plant, head fresh weight, head diameters, average of cloves weight and total yield in both seasons and in blubbing ratio in first season only.The impact of magnetic fields on plant growth and development may be due to the role of magnetized water on stimulation synthesis and transport of hormones and enzymes metabolism and increase the final plant yield, Esitken (2003). These results in the same line with several studies reported by (Carbonell, 2011 and Ahmed, 2013) they fiend that the irrigation by magnetized water increased significantly plant height, no. of leaves / plant, fresh and dry weight, as well as survival rate than those irrigated by non- magnetized water on tomato and Abdel Nabi *et al.,* (2019) on garlic plant. On the other hand no significant differences appeared between magnetized and non-magnetized water on shoot fresh weight, shoot and bulb dry matter percentage, neck diameter and number of cloves/ head in both seasons. These results in the same line with those obtained by Negin *et al.,* (2015) reported that magnetic field has no positive effects on garlic growth.

1- In generally foliar spray treatments showed improvement on values in all growth and yield parameters when compared with control treatment (foliar spray by water). But the highest values were recorded with

Table 7: Effect of Magnetized water and foliar spray on T.S.S. and N, K and Ca (%) of garlic plants during 2018/2019 and 2019/2020 growing seasons.

Seasons	1st season											
CharactersTreatments	T.S.S			N (%)			K (%)			Ca (%)		
Water treatment Foliar spray	MW	NMW	$\bar{X}$	MW	NMW	$\bar{X}$	MW	NMW	$\bar{X}$	MW	NMW	$\bar{X}$
Sea algae 1g/l	33.2	28.4	30.8	0.85	0.76	0.80	1.16	1.05	1.10	1.00	0.92	0.96
Sea algae 1.5g/l	34.7	29.6	32.1	0.95	0.80	0.87	1.37	1.34	1.36	1.06	0.98	1.02
Yeast extract 5g/l	29.8	28.7	29.2	0.98	0.80	0.89	1.24	1.36	1.30	1.12	0.97	1.05
Yeast extract 7.5g/l	30.0	29.1	29.6	1.00	0.78	0.89	1.29	1.36	1.33	1.29	1.12	1.21
Compost tea 100g/l	30.0	28.6	29.3	0.99	0.87	0.93	1.21	1.29	1.25	1.02	1.07	1.04
Compost tea 150g/l	29.3	27.0	28.2	1.03	0.90	0.96	1.13	1.31	1.22	1.13	1.13	1.13
Control	29.0	28.6	28.8	0.91	0.83	0.87	1.18	1.14	1.16	0.95	0.84	0.90
$\bar{X}$	30.9	28.6		0.96	0.82		1.23	1.26		1.08	1.00	
	2nd season											
Sea algae 1g/l	30.6	32.2	31.4	0.85	0.79	0.82	1.15	1.32	1.23	0.95	0.94	0.95
Sea algae 1.5g/l	33.1	31.5	32.3	0.88	0.87	0.87	1.47	1.41	1.44	1.25	1.21	1.23
Yeast extract 5g/l	32.2	30.1	31.2	0.91	0.88	0.90	1.30	1.33	1.31	1.15	1.27	1.21
Yeast extract 7.5g/l	31.0	31.2	31.1	0.91	0.91	0.91	1.34	1.29	1.31	1.31	1.37	1.34
Compost tea 100g/l	30.7	29.7	30.2	0.94	0.87	0.91	1.25	1.33	1.29	1.28	1.28	1.28
Compost tea 150g/l	30.1	28.4	29.3	0.96	0.92	0.94	1.29	1.26	1.27	1.26	1.28	1.27
Control	29.8	30.1	30.0	0.84	0.77	0.81	1.28	1.22	1.25	1.17	1.10	1.13
$\bar{X}$	31.1	30.5		0.90	0.86		1.29	1.31		1.19	1.21	
L. S. D. (0.05) for:	Sea. 1	Sea. 2		Sea. 1	Sea. 2		Sea. 1	Sea. 2		Sea. 1	Sea. 2	
Water treatment	NS	NS		0.05	0.02		NS	NS		0.06	NS	
foliar spray	2.29	1.45		0.05	0.09		0.16	0.11		0.17	0.08	
Interaction	NS	NS		NS	NS		NS	NS		NS	NS	

*Magnetized water = (MW) *Nonmagnetized water = (NMW)

compost tea at the rate of 150g/L which was superior significantly in plant weight, shoot and head fresh weight, neck and head diameters, average of cloves weight and total yield ton/fed. in both seasons. Moreover, no significant differences appeared between compost tea at the rate of 150g/L and 100g/L on some growth characters. These results agree with those reported by Biocycle, 2004, compost tea stimulate the microorganisms that have a direct or indirect beneficial effect on plant rhizosphere, improves soil physical and chemical properties which were reveled on plant growth and suppress some plant diseases pathogen. In the same line with those reported by Bayoumi and Hafez (2006) and Abou-El-Hassan *et al.,* (2014) they found that compost tea significant increased growth characters and final yield of plants. Moreover, sea algae at the rate of 1.5g/L showed significant increases in number of leaves/plant, shoot and bulb dry matter percent and number of cloves/plant in both seasons, but no significant differences appeared between sea algae at the rate of 1.5g/L and 1g/l in shoot and bulb dry matter percent in both seasons. These results agree with numerous studies which were revealed a wide range of beneficial effects of seaweed extract applications on plants, such as early seed germination, improved crop growth and yield, elevated resistance to biotic and abiotic stress and enhanced postharvest shelf-life of products (Beckett and Staden 1989; Blunden, 1991 and Norrie and Keathley, 2006). Also, yeast extract at the rate of 7.5g/l increased in plant height significantly in both seasons. This improvement in plant height may be due to that yeast extract richest sources of high quality protein, especially the essential amino acids which were reveled on plant growth and cells elongation these results agree with those reported by Abou El-yazied and Mady (2012) on broad bean; Mahmoud *et al.,* (2013) on pea and Tarek and Hassan (2014) on garlic.

Chemical composition

Obtained results in table 7 indicated significant positive effect for both studied factors, *i.e.*, magnetized water and foliar spray application on chemical components. The data could remark the following:

1- Magnetized water treatment superior significantly when compared with non-magnetized water treatment in nitrogen % in both seasons and highest values of calcium % content in the first season. These results are agree with those reported by Selim (2008) who found that

Table 8: Fixed input cost and output for fresh garlic production (LE./fed.).

Fixed cost/fed.									
Items	**Unit**	**Counts**	**Unit cost L.E.**	**Total L.E.**	**Labor cost**	**Unit**	**Counts**	**Unit cost L.E.**	**Total L.E.**
Land preparation	Hour	6	100	600	Fertilizer add	Worker	4	100	400
Organic fertilizer	M3	30	100	3000	Planting seeds		10	100	1000
Chemical fertilizer				3500	Seasonal labor		10	100	1000
Seeds (Cloves)	KG	300	20	6000	Harvest labor		5	100	500
Pesticides	Liter	7	100	700	Total	17000			
Foliar fertilizer	Liter	3	100	300					
Variable cost									
Magnetic device	Season cost		300	300	Outputfresh garlic yield	Ton	3000		
Compost tea	3 time		100	300					
Sea algae	3 time		100	300					
Yeast extract	3 time		100	300					

magnetically water has induced changes in the mobility of nutrient elements in root zone. There are differences from one element to another according to the element magnetic susceptibility. In addition, the magnetized water increased the chemical constituents and inorganic minerals K+, Ca+2 and P+3 contents) in all plant parts of broad bean (Elayed, 2015) and in pepper plants Rawabdeh *et al.*, (2014).

2- Compost tea at the rate of 150g/l superior significantly in N(%) followed by compost tea at the rate of 100g/l in both seasons. This result is agreed with those reported by Abbasi *et al.,* 2002 and Diver, 2002. Compost tea is a good source of organic matter and soil amendment that provide plants with mineral nutrients. Moreover, yeast extract at the rate of 7.5g/l treatment had the highest and significant values in Ca (%) in both seasons. This result is agreed with those reported by Fathy and Farid, 1996 and Amer 2004 they indicated that yeast is one of the richest sources of high quality protein, especially the essential amino acids, essential minerals as calcium and trace elements as cobalt and iron. Yeast is the best source of the B-complex vitamins and a valuable source of bio-constituents. But, sea algae at the rate of 1.5g/l showed significant increase in K (%) content and T.S.S in both seasons. In the same line the results reported by Masny *et al.,* 2004 cleared that application of seaweed extract, as foliar spray increased, total soluble solid and vitamin C of two strawberry cultivars, also on pepper plant (Mohammed, 2013).

Table 9: Effect of magnetized water and foliar spray on total output (L.E/fed.) and Investment ratio of garlic plants during both growing seasons.

Seasons	**1st season**					
Characters Treatments	**Total output (L.E/fed.)**			**Investment ratio**		
Water treatment Foliar spray	**MW**	**NMW**	**$\bar{X}$**	**MW**	**NMW**	**$\bar{X}$**
Sea algae 1g/l	28374	25390	26882	1.61	1.47	1.54
Sea algae 1.5g/l	30866	27500	29183	1.75	1.59	1.67
Yeast extract 5g/l	31380	29200	30290	1.78	1.69	1.74
Yeast extract 7.5g/l	35920	31100	33510	2.04	1.80	1.92
Compost tea 100g/l	33920	31340	32630	1.93	1.81	1.87
Compost tea 150g/l	35500	32660	34080	2.02	1.89	1.95
Control	27680	26280	26980	1.60	1.55	1.57
$\bar{X}$	31949	29067		1.82	1.68	
2nd season						
Sea algae 1g/l	28970	27358	28164	1.65	1.58	1.61
Sea algae 1.5g/l	30930	28426	29678	1.76	1.64	1.70
Yeast extract 5g/l	31420	31038	31229	1.79	1.79	1.79
Yeast extract 7.5g/l	35080	30890	32985	1.99	1.79	1.89
Compost tea 100g/l	35150	32380	33765	2.00	1.87	1.93
Compost tea 150g/l	36940	32160	34550	2.10	1.86	1.98
Control	29260	26670	27965	1.68	1.57	1.63
$\bar{X}$	32536	29846		1.85	1.73	
L. S. D. (0.05) for:	Sea. 1	Sea. 2		Sea. 1	Sea. 2	
Water treatment	781.8	2222.6		0.05	0.12	
foliar spray	2265.5	1709.2		0.13	0.10	
Interaction	NS	NS		NS	NS	

Investment ratio

The final goal of any agricultural application is to get profitable yield as gain from the invested cost. The agricultural process is mainly economic so the net gain of each pound from the input is important to get the highest rate of revenue. Table 8 showed the calculation of fixed input for all fresh production treatments and the total output of one unit of production, we must note that magnetic device available used for ten seasons, so we calculated magnetic treatment for one season, while table 9 gave the total output for all treatments and investment

ratio.

Obtained results in table 9 indicate significant positive effect for both studied factors, *i.e.*, magnetized water and foliar spray application on total output for all treatments and investment ratio. The data could remark the following:

- Magnetized water treatment superior significantly when compared with non-magnetized water treatment, total output for all treatments and investment ratio in both seasons.

- Compost tea at the rate of 150g/l superior significantly total output for all treatments and investment ratio in both seasons followed by foliar spray by yeast extract at the rate of 7.5g/l in the first season and compost tea at the rate of 100g/l in second season.

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