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Effect of some Bio-stimulants on Growth, Yield and Bulb Quality of Garlic Grown in Newly Reclaimed Soil, New Valley-Egypt

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ABSTRACT

This work was performed during the two consecutive winter seasons of 2015/2016 and 2016/2017 at the Farm of the Faculty of Agriculture, Assiut University (New Valley Branch), to investigate the effect of foliar spray with bio-stimulant namely yeast extract (0, 1, 2 and 3 %), and two antioxidants; i.e., salicylic acid and ascorbic acid at 200 ppm of each, beside control treatment on plant growth, yield and its components as well as bulb quality of garlic cv. Sids-40 under newly reclaimed soil of New Valley-Egypt. Results showed that the interaction between foliar spray with yeast extract at 3 % and sprayed plants with salicylic acid at 200 ppm was the best interaction treatment for increasing plant growth traits, i.e., plant height, leaf area/plant both fresh and dry weight/plant, bulbing ratio, mineral contents (N, P, K and S in leaves and bulb) and biochemical concentration in leaves (total carbohydrates and salicylic acid) after 135 days from planting time, total yield/fed. and bulb parameters as well as bulb quality (total carbohydrates and salicylic acid contents) at harvesting time, while the interaction between yeast extract at 3 % and sprayed plants with ascorbic acid at 200 ppm gave the highest values of ascorbic acid content in leaves and bulb at 135 days after planting and harvesting time respectively in both seasons. The increases in total yield were about 166.9 and 165.1 % for the interaction treatment between the plants which sprayed with yeast extract at 3 % and salicylic acid at 200 ppm; 148.9 and 151.3 % for the interaction treatment between the same rate of yeast extract and sprayed plants with ascorbic acid at 200 ppm over control treatment in the 1st and 2nd seasons, respectively.

Keywords: Garlic, yeast extract, salicylic acid, ascorbic acid, yield, bulb quality.

INTRODUCTION

Garlic is one of the most important bulb crops in Egypt which is cultivated for both local consumption and export. It is often used as a spice or condiment as well as for medical purposes. In Egypt in 2014 season, the total area devoted for production was 10997 ha, which produced (263167 ton) and by average 23.93 ton/ha of garlic plants (FAOSTAT, 2017).

It was reported that the yeast extract had a stimulatory effects on several process in plant such as cell division, chlorophyll formation, synthesis of protein and nucleic acid beside its content of protective agents, i.e., sugars, amino acids, protein and several vitamins (Wanas, 2006). Treated garlic plants with yeast extract as foliar spray had significant effect on vegetative growth, yield and its components as well as bulb quality (El-Morsy *et al*., 2011; Dawa *et al.,* 2012; Mansour, 2012; Abou El-Khair and Khalil, 2014; Shalaby and El-Ramady, 2014 and Ahmed, 2015) on garlic plants and (Fawzy *et al.,* 2012 and Shafeek *et al*., 2015) on onion plants. Other effects of yeast on plant growth and yield of some vegetable crops (El-Tohamy and El-Greadly, 2007 and Fawzy *et al*., 2010) on beans, (El-Tohamy *et al*., 2008) on eggplant, (Fathy *et al*., 2000) on tomato, (El-Desuki and El-Greadly, 2006) on pea, (Ghoname *et al*., 2010) on sweet pepper, (Ahmed *et al.,* 2011 and Ahmed *et al*., 2013) on potato and Shehata *et al*. (2012) on cucumber.

Salicylic acid an organic signal molecule has been reported to play a key part in regulating many physiological processes in plants. Its external application has encouraged plant productivity under biotic and abiotic stress conditions (Senaratna *et al.,* 2000). Foliar spray of salicylic acid has been shown to increase vegetative growth, yield and bulb quality of garlic (Bardisi, 2004 a & b), Amin *et al*. (2007) on onion, El-Zohiri (2009) on globe artichoke and Bideshki *et al*. (2013), Khadr (2015) on garlic, Pradhan *et al*. (2016) and Prajapati *et al.* (2016) on onion, Shama *et al*. (2016) and Meena *et al.* (2017) on garlic.

Ascorbic acid has a wide range of important roles in plant such as photoprotection, regulation of photosynthesis, affects nutritional cycle's activity, electron transport system, as antioxidant defense and a cofactor for a large number of key enzymes in plants, developmental senescence, programmed cell death and responses to pathogens (Blokhina *et al*., 2003). Foliar application of ascorbic acid previously increased plant height, leaves number, dry weight of plant and total yield (El-Sayed, 1991) on potato, (El-Morsy *et al*., 2010) on garlic and (Gouda *et al*., 2015) on potato, and increased bulbing ratio as well as average bulb weight and diameter and clove weight (El-Morsy *et al*., 2010) on garlic.

The main purpose of the current study was to evaluate the effect of foliar spray with bio-stimulant treatments namely yeast extract either single and/or in combination with two antioxidants; i.e., salicylic acid and ascorbic acid on plant growth, yield and its components, bulb quality as well as some chemical constituents of garlic plants cv. Sids-40 under newly reclaimed soil, New Valley-Egypt.

MATERIALS AND METHODS

This work was performed during the two consecutive winter seasons of 2015/2016 and 2016/2017 at the Farm of the Faculty of Agriculture, Assiut University (New Valley Branch), to investigate the effect of foliar spray with bio-stimulant namely yeast extract (1, 2 and 3 %) in addition to control treatment (0 %), and two antioxidants; i.e., salicylic acid (SA) and ascorbic acid (AA) at 200 ppm of each, plus 0 ppm as control treatment (control treatments were sprayed with tap water) on growth, yield and its components as well as bulb quality of garlic cv. Sids-40 under newly reclaimed soil of New Valley-Egypt.

Randomized samples at 30 cm depth were collected from the experimental soil before plantation to determine some of its physical and chemical properties in accordance to Page *et al*. (1982), as shown in Table (1).

This experiment included 12 treatments, which were the interactions between four rates of yeast extract (YE) and three concentrations of antioxidants (SA and AA). The experimental layout was split plot system in a complete randomized block design with three replicates. Yeast extract rates were randomly arranged in the main plots while antioxidants concentrations were randomly distributed in the sub plots.

Table 1. Some physical and chemical properties of the experimental soil.

Soil properties	Value
Particle size distribution (%)	
Coarse sand	4.93
Fine sand	77.41
Silt	10.38
Clay	7.28
Texture class	Sandy
Chemical properties	
E.C. dsm^{-1} (1:5 ex.)	1.04
pH (1:2.5 w/v)	8.17
Organic matter (%)	0.53
$CaCO_3$ (%)	5.27
Water soluble ions meq/100g soil	
Ca^{+2}	0.99
Mg^{+2}	0.65
Na^{+}	3.41
K^{+}	0.27
CO_3^{-2}	0.00
HCO_3^{-}	1.19
Cl^{-}	3.02
SO_4^{-2}	1.11
Available nutrients (mg kg^{-1})	
N	29.8
P	4.93
K	121.2

The values are the average of the two growing seasons.

The experimental unit area was 12.6 m^2. It contained three dripper lines with 7 m length and 60 cm in width. Plants of one dripper line were used as samples for measuring vegetative growth characteristics, N, P, K and S contents in leaves and bulb as well as total carbohydrates, salicylic acid and ascorbic acid contents in leaves. While plants of the two other dripper lines were used for yield determinations.

Cloves of garlic cv. Sids-40 were used in this study and these cloves were selected for its uniformity in shape and size. Then, they were sown on both line dripper sides at distance of 10 cm apart. Sowing was done on October 4th, 2nd in 2015 and 2016 seasons, respectively.

Yeast extract was prepared from active dry yeast (*Saccharomyces cerevisiae*) according to the method of Morsi *et al*. (2008) by dissolving amount of dry yeast in water followed by adding sugar at a ratio of 1:1 and kept 24 hours in a warm place for reproduction. Chemical analysis of yeast extract is shown in Table (2) according to Mahmoued (2001).

Yeast extract rates, salicylic acid and ascorbic acid concentration were sprayed four times beginning 60 days from planting time and 15 days intervals in both growing seasons. Each plot received 1.5 - 2 litre solution of each concentration according to the age of the plant using spreading agent in all treatments (yeast extract, salicylic acid and ascorbic acid) to improve adherence of the spray to the plant foliage for increasing yeast extract, salicylic acid and ascorbic acid absorption by the plants. The untreated plants (control) were sprayed with tap water and spreading agent. One dripper line was left between each two experimental plots without spraying as a guard row to avoid the overlapping of spraying solution. Yeast, salicylic acid and ascorbic acid were obtained from El-Gomhoria Company for Chemicals, Egypt.

Table 2. Chemical analysis of yeast extract.

Amino acids mg/100g dry weight		Vitamins and Carbohydrates mg/100g dry weight	
Arginine	1.99	Vit. B1	2.23
Histidine	2.63	Vit. B2	1.33
Isoleucine	2.31	Vit. B6	1.25
Leucine	3.09	Vit. B12	0.15
Lysine	2.95	Thiamin	2.71
Methionine	0.72	Riboflavin	4.96
Phenyl alanine	2.01	Insitol	0.26
Thronine	2.09	Biotin	0.09
Tryptophan	0.45	Nicotinic acid	39.88
Valine	2.19	Panthothenic acid	19.56
Glutamic acid	2.00	P-amino benzoic acid	9.23
Serine	1.59	Folic acid	4.36
Aspartic acid	1.33	Pyridoxine	2.90
Cystine	0.23	Total carbohydrates	23.20
Proline	1.53	Glucose	13.33
Tyrosine	1.49		

All experimental units were received equal amounts of chemical fertilizers; i.e., ammonium sulfate (20.5 % N), calcium superphosphate (15.5 % P_2O_5) and potassium sulfate (48 % K_2O) at the recommended doses (120, 90 and 120 kg/fed. for N, P and K respectively). Farmyard manure at 30 m^3/fed., one third of both ammonium sulfate and potassium sulfate as well as all amount calcium superphosphate fertilizers were added in the center of rows and covered by sand during soil preparation. The rest of amounts of N and K fertilizers were added through irrigation water (fertigation) at 7 days intervals beginning one month after planting. The plants also were received sulphuer at the recommended dose (150 kg/fed.) which was added with farmyard manure. All normal agricultural practices were carried out when ever needed as commonly followed in district.

Data recorded:

Vegetative growth characters:

Representative samples, ten plants were randomly taken from each plot at 135 days after planting time to estimate the following characters.

a. Plant height (cm), plant leaf area (cm^2) was calculated according to the formula described by Koller (1972), fresh weight/plant (bulb + leaves) and dry weight/plant (g) were recorded.

b. Bulbing ratio: It was measured as reported by Mann (1952).

$$\text{Bulbing ratio} = \frac{\text{Neck diameter}}{\text{Bulb diameter}}$$

Chemical and biochemical contents:

Dried samples of bulb and leaves of the all tested plots at 135 days after planting time in both seasons were finely ground and wet digested. Then, N, P, K and S contents were determined according to the methods described by Bremner and Mulvaney (1982), Olsen and Sommers (1982), Jackson (1970) and Jonson and Hideo (1952) respectively. Total carbohydrates, salicylic acid and ascorbic acid contents were also determined in leaves at the same time and described by the same methods in the bulb quality.

Yield and its components:

At harvesting time (the first week in April in both seasons), the plants of each plot were harvested and cured for 15 days after harvest, weighted in kg and converted to record the following data:

a. Average yield/plant (kg) and total yield (ton/fed.).

$$\text{b. Relative total yield (\%)} = \frac{\text{Total yield of treatment}}{\text{Total yield of control}} \times 100$$

Bulb traits:

A random sample (10 bulbs) was randomly taken from each plot at harvesting time to determine average bulb length (cm), bulb fresh weight (g), bulb dry weight (g) and bulb dry matter (%).

Bulb quality at harvesting time:

Total carbohydrates content was determined in cloves dry matter according to the method described by Dubois *et al*. (1956). Ascorbic acid content in fresh bulbs juice was determined according to A.O.A.C. (1990). Salicylic acid content was determined by using spectro photometrically (Backman OU.50) at wave length 248 nm as described by Salinas *et al*. (1990).

Statistical analysis:

Data were subjected to the statistical analysis of variance according to the method mentioned by Snedecor and Cochran (1980). The treatment means were compared using Duncan's multiple range test at probability of 5 % level according to Duncan (1958).

RESULTS AND DISCUSSION

1. Vegetative growth characters:

Effect of yeast extract rates:

The obtained results in Table (3) showed that plant height, leaf area/plant, both fresh and dry weight/plant as well as bulbing ratio were significantly increased with increasing yeast extract concentration up to 3 % in both seasons.

The increases in total dry weight/plant were about 52.7 and 63.9 % for yeast extract at 3 %; 36.9 and 31.7 % for yeast extract at 2 % over control treatment (sprayed plants with tap water) in the 1st and 2nd seasons, respectively.

The positive effect of increasing yeast extract concentration attributed to the great role of yeast in stimulate the cell division, elongation, enlargement, chlorophyll formation, protein and nucleic acid synthesis (Spencer *et al*., 1983).

Similar results were obtained by (Mansour, 2012; Abou El-Khair and Khalil, 2014). They found that spraying garlic plants with yeast extract recorded higher values of plant growth parameters than untreated plants.

Table 3. Vegetative growth characters of garlic plants at 135 days after planting time as affected by yeast extract rates, antioxidants and their interactions during 2015/2016 (S1) and 2016/2017 (S2) growing seasons.

Treatments		Characters									
		Plant height (cm)		Leaf area/plant (cm^2)		Fresh weight (bulb+ leaves)/plant (g)		Dry weight (bulb+ leaves)/plant (g)		Bulbing ratio	
		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
YE rates											
Control		33.69 d	32.69 d	449.46 d	356.18 d	37.16 d	33.07 d	8.54 d	7.54 d	0.21 d	0.18 d
1 % YE		36.22 c	34.93 c	522.27 c	444.96 c	39.22 c	35.43 c	10.12 c	8.28 c	0.22 c	0.20 c
2 % YE		37.56 b	36.61 b	576.83 b	515.67 b	41.05 b	37.47 b	11.69 b	9.93 b	0.24 b	0.22 b
3 % YE		40.00 a	39.20 a	669.13 a	600.41 a	42.79 a	40.13 a	13.04 a	12.36 a	0.27 a	0.25 a
Antioxidants											
Control		31.49 c	30.83 c	390.40 c	296.24 c	36.14 c	31.52 c	7.13 c	6.10 c	0.19 c	0.16 c
SA at 200 ppm		40.13 a	39.05 a	652.46 a	596.84 a	42.71 a	39.83 a	13.11 a	11.69 a	0.26 a	0.25 a
AA at 200 ppm		38.98 b	37.70 b	620.39 b	544.83 b	41.32 b	38.22 b	12.30 b	10.79 b	0.25 b	0.23 b
Interaction											
YE rates	Antioxidants										
Control	Control	28.14 i	26.99 f	331.16 l	246.07 l	32.85 g	29.20 h	4.90 i	4.49 i	0.17 j	0.14 h
	SA at 200 ppm	37.08 e	35.60 d	527.95 g	433.12 g	39.42 de	35.50 ef	10.65 e	9.31 ef	0.23 fg	0.21 e
	AA at 200 ppm	35.87 ef	35.50 d	489.27 h	389.37 h	39.23 de	34.52 f	10.07 ef	8.81 f	0.22 gh	0.20 f
1 % YE	Control	30.65 h	30.00 e	373.34 k	280.23 k	35.33 f	30.07 h	6.16 h	5.23 i	0.18 ij	0.16 g
	SA at 200 ppm	39.17 cd	38.30 bc	615.53 e	565.12 e	41.95 bc	39.01 cd	12.40 d	10.06 e	0.25 de	0.23 d
	AA at 200 ppm	38.85 d	36.50 cd	577.94 f	489.54 f	40.37 cd	37.20 de	11.79 d	9.55 ef	0.24 ef	0.22 de
2 % YE	Control	32.27 g	31.64 e	405.78 j	314.28 j	37.47 e	32.61 g	8.00 g	6.79 h	0.19 i	0.17 g
	SA at 200 ppm	40.60 bc	39.50 b	672.21 c	627.34 c	43.51 b	40.31 bc	14.00 b	12.00 c	0.27 c	0.26 bc
	AA at 200 ppm	39.82 bcd	38.70 b	652.50 d	605.39 d	42.18 bc	39.50 c	13.06 c	11.01 d	0.26 cd	0.25 c
3 % YE	Control	34.92 f	34.70 d	451.34 i	344.40 i	38.92 de	34.20 fg	9.44 f	7.90 g	0.21 h	0.19 f
	SA at 200 ppm	43.70 a	42.80 a	794.18 a	761.81 a	45.94 a	44.51 a	15.42 a	15.39 a	0.31 a	0.30 a
	AA at 200 ppm	41.40 b	40.10 b	761.87 b	695.02 b	43.52 b	41.67 b	14.27 b	13.81 b	0.29 b	0.27 b

Values followed by the same letters within a column are not significantly differed at 5% according to Duncan's multiple range test.
YE: Yeast extract, SA: Salicylic acid, AA: Ascorbic acid.

Effect of antioxidants:

Such data in Table (3) show that sprayed plants with salicylic acid (SA) or ascorbic acid (AA) exerted significant increases on all parameters of vegetative growth such as plant height, leaf area/plant, both fresh and dry weight/plant and bulbing ratio than untreated plants. However, sprayed garlic plants with salicylic acid recorded the maximum values of all plant growth parameters in both seasons.

The increases in total dry weight/plant were about 83.9 and 91.6 % for SA; 72.5 and 76.9 % for AA over control treatment (sprayed plants with tap water) in the 1st and 2nd seasons, respectively.

The simulative effect of SA and AA on fresh and dry weight of eggplant shoots may be due to that they involved as antioxidant defense, regulation of photosynthesis and growth (Blokhina *et al*., 2003).

These results are harmony with those reported with Bardisi (2004 a) on garlic, Amin *et al.* (2007) on onion and Shama *et al.* (2016) on garlic.

Effect of the interaction between yeast extract rates and antioxidants:

It is obvious from data in Table (3) that the interaction between yeast extract and antioxidant foliar applications had significant effect on different plant growth parameters than control treatment in both seasons.

The interaction between sprayed plants with yeast extracts at 3 % and SA at 200 ppm gave the highest values of plant height, leaf area/plant, both fresh and dry weight/plant as well as bulbing ratio, followed by the same rate of yeast extract and AA at 200 ppm in both seasons.

The increases in total dry weight/plant were about 214.7 and 242.8 % for the interaction between yeast extract at 3 % and sprayed plants with SA at 200 ppm and 191.2 and 207.6 % for the interaction between 3 % yeast extract and sprayed plants with AA at 200 ppm over control treatment (sprayed plants with tap water) in the first and second seasons, respectively.

These results could be due to the individual and/or the combined effects of the two studied factors in improving growth aspects and enhancing tolerance against adverse conditional stresses. In this respect, El-Tohamy *et al.* (2008) reported that foliar application of yeast and ascorbic acid resulted in higher growth and yield of eggplant.

2. Chemical and biochemical contents:

Effect of yeast extract rates:

From data in Tables (4 and 5) it is evident that yeast extract at different rates had significant effect on all chemical constituents of leaves and bulb such as N, P, K and S contents as well as total carbohydrates, ascorbic acid and salicylic acid contents in leaves than control treatment at 135 days after planting time in both seasons.

Sprayed garlic plants with yeast extract at 3 % significantly increased N, P, K and S contents in leaves and bulb as well as total carbohydrates, ascorbic acid and salicylic acid contents in leaves in both seasons, followed by sprayed plants with 2 % yeast extract, while untreated plants recorded the lowest values in these respect in both seasons.

Table 4. Chemical constituents in leaves and bulb of garlic plants at 135 days after planting time as affected by yeast extract rates, antioxidants and their interactions during 2015/2016 (S1) and 2016/2017 (S2) growing seasons.

Treatments		Characters															
		N (%)				P (%)				K (%)				S (%)			
		Leaves		Bulb		Leaves		Bulb		Leaves		Bulb		Leaves		Bulb	
		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
YE rates																	
Control		1.33 d	1.28 d	1.14 d	1.07 d	0.17 d	0.15 d	0.14 d	0.12 d	1.74 d	1.71 d	1.53 d	1.51 d	2.36 d	2.26 d	2.31 d	2.31 d
1 % YE		1.84 c	1.83 c	1.61 c	1.56 c	0.22 c	0.21 c	0.19 c	0.17 c	2.26 c	2.15 c	2.01 c	2.00 c	2.83 c	2.74 c	2.82 c	2.80 c
2 % YE		1.95 b	1.95 b	1.67 b	1.64 b	0.23 b	0.22 b	0.20 b	0.19 b	2.31 b	2.28 b	2.11 b	2.09 b	2.94 b	2.81 b	2.88 b	2.85 b
3 % YE		2.05 a	2.05 a	1.79 a	1.75 a	0.24 a	0.23 a	0.21 a	0.20 a	2.42 a	2.38 a	2.22 a	2.19 a	3.03 a	2.87 a	3.04 a	3.02 a
Antioxidants																	
Control		1.56 c	1.53 c	1.31 c	1.26 c	0.19 c	0.17 c	0.16 c	0.14 c	1.96 c	1.87 c	1.72 c	1.70 c	2.56 c	2.46 c	2.54 c	2.52 c
SA at 200 ppm		2.03 a	2.02 a	1.79 a	1.75 a	0.24 a	0.23 a	0.21 a	0.20 a	2.41 a	2.39 a	2.21 a	2.20 a	3.01 a	2.93 a	2.98 a	2.96 a
AA at 200 ppm		1.79 b	1.78 b	1.55 b	1.50 b	0.21 b	0.20 b	0.18 b	0.17 b	2.17 b	2.13 b	1.96 b	1.95 b	2.79 b	2.63 b	2.77 b	2.76 b
Interaction																	
YE rates	Antioxidants																
Control	Control	1.25 l	1.16 l	1.05 k	0.98 l	0.16 l	0.14 l	0.13 l	0.11 l	1.65 j	1.61 l	1.42 l	1.42 l	2.30 l	2.19 l	2.20 j	2.22 j
	SA at 200 ppm	1.44 j	1.40 j	1.21 i	1.14 j	0.18 j	0.16 j	0.15 j	0.13 j	1.84 h	1.81 j	1.61 j	1.60 j	2.42 j	2.34 j	2.44 h	2.42 h
	AA at 200 ppm	1.32 k	1.29 k	1.16 j	1.09 k	0.17 k	0.15 k	0.14 k	0.12 k	1.74 i	1.71 k	1.56 k	1.53 k	2.36 k	2.27 k	2.29 i	2.28 i
1 % YE	Control	1.52 i	1.51 i	1.33 h	1.28 i	0.19 i	0.18 i	0.16 i	0.14 i	2.03 g	1.85 i	1.73 i	1.71 i	2.54 i	2.46 i	2.52 g	2.51 g
	SA at 200 ppm	2.12 c	2.11 c	1.92 c	1.88 c	0.25 c	0.25 c	0.22 c	0.21 c	2.47 c	2.46 c	2.26 c	2.26 c	3.14 c	3.08 c	3.06 c	3.03 c
	AA at 200 ppm	1.87 f	1.86 f	1.59 f	1.54 f	0.22 f	0.21 f	0.19 f	0.18 f	2.28 e	2.14 f	2.03 f	2.02 f	2.82 f	2.69 f	2.88 d	2.87 d
2 % YE	Control	1.69 h	1.67 h	1.37 h	1.35 h	0.20 h	0.19 h	0.17 h	0.15 h	2.05 g	1.98 h	1.81 h	1.79 h	2.65 h	2.57 h	2.62 f	2.57 f
	SA at 200 ppm	2.25 b	2.25 b	1.97 b	1.94 b	0.26 b	0.26 b	0.23 b	0.23 b	2.60 b	2.59 b	2.42 b	2.42 b	3.21 b	3.12 b	3.14 b	3.12 b
	AA at 200 ppm	1.93 e	1.93 e	1.67 e	1.63 e	0.23 e	0.23 e	0.20 e	0.19 e	2.28 e	2.28 e	2.10 e	2.08 e	2.95 e	2.73 e	2.89 d	2.87 d
3 % YE	Control	1.77 g	1.79 g	1.50 g	1.43 g	0.21 g	0.20 g	0.18 g	0.16 g	2.12 f	2.06 g	1.94 g	1.91 g	2.78 g	2.62 g	2.81 e	2.80 e
	SA at 200 ppm	2.31 a	2.34 a	2.08 a	2.06 a	0.27 a	0.27 a	0.24 a	0.24 a	2.74 a	2.71 a	2.54 a	2.52 a	3.27 a	3.18 a	3.29 a	3.26 a
	AA at 200 ppm	2.07 d	2.04 d	1.81 d	1.76 d	0.24 d	0.24 d	0.21 d	0.20 d	2.40 d	2.38 d	2.18 d	2.16 d	3.04 d	2.83 d	3.03 c	3.01 c

Values followed by the same letters within a column are not significantly differed at 5% according to Duncan's multiple range test.
YE: Yeast extract, SA: Salicylic acid, AA: Ascorbic acid.

The beneficial effect of dry yeast is may be attributed to its high contents of carbohydrates, amino acids, sugars, fatty acids, proteins, hormones, macro and micro-nutrients (Khedr and Farid, 2002).

These results are in accordance with those obtained by El-Tohamy *et al*. (2008), they found that yeast foliar treatment resulted in a significant increment in cytokinins, N, P and K contents in leaves especially at the high level of yeast on eggplant compared to untreated plants in both seasons. In addition, Ahmed (2015) came the similar results on garlic.

Effect of antioxidants:

Data in Tables (4 and 5) show that all chemical constituents i.e., N, P, K and S contents in leaves and bulb at 135 days after planting time were affected by sprayed plants with both antioxidants than control treatment in both seasons. However sprayed garlic plants with salicylic acid gave the highest values of all chemical constituents in leaves and bulb of garlic plants in both seasons.

Regarding total carbohydrates, ascorbic acid and salicylic acid contents in leaves, data in Table (5) show that sprayed plants with SA at 200 ppm recorded the highest values of total carbohydrates and salicylic acid in both seasons, while the highest values of ascorbic acid were recorded with the plants which treated with AA at 200 ppm in both seasons.

These results agreed with those reported with Bardisi (2004 a) who found that spraying garlic plants with SA recorded maximum values of N, P and K uptake by leaves and bulb and N, P and K total uptake by plant.

Effect of the interaction between yeast extract rates and antioxidants:

It is obvious from data presented in Tables (4 and 5) that the interaction between yeast extract and antioxidants had a significant effect on all concentrations of chemical constituents. In this respect, the plants which sprayed with yeast extract at 3 % and salicylic acid at 200 ppm achieved the highest concentrations of N, P, K and S in leaves and bulb as well as total carbohydrates and salicylic acid contents in leaves at 135 days after planting time, while the interaction between the plants which sprayed with yeast extract at 3 % and ascorbic acid at 200 ppm gave the highest values of ascorbic acid content in leaves at 135 days after planting time in both seasons.

Table 5. Total carbohydrates, ascorbic acid and salicylic acid contents in leaves of garlic plants at 135 days after planting time as affected by yeast extract rates, antioxidants and their interactions during 2015/2016 (S1) and 2016/2017 (S2) growing seasons.

Treatments		Characters					
		Total carbohydrates (%)		Ascorbic acid (mg/100g fresh weight)		Salicylic acid (ppm)	
		S1	S2	S1	S2	S1	S2
YE rates							
Control		33.42 d	32.72 d	31.53 d	31.02 d	74.64 d	71.98 d
1 % YE		34.58 c	33.90 c	31.72 c	31.20 c	74.83 c	72.19 c
2 % YE		34.77 b	34.08 b	31.94 b	31.42 b	75.04 b	72.39 b
3 % YE		35.15 a	34.38 a	32.17 a	31.64 a	75.23 a	72.58 a
Antioxidants							
Control		33.93 c	33.16 c	31.05 c	30.54 c	74.14 c	71.48 c
SA at 200 ppm		34.99 a	34.32 a	31.84 b	31.33 b	75.72 a	73.07 a
AA at 200 ppm		34.52 b	33.83 b	32.63 a	32.09 a	74.95 b	72.31 b
Interaction							
YE rates	Antioxidants						
Control	Control	33.22 l	32.49 l	30.72 l	30.24 l	73.81 l	71.18 l
	SA at 200 ppm	33.59 j	32.94 j	31.58 h	31.08 h	75.43 d	72.74 d
	AA at 200 ppm	33.45 k	32.73 k	32.29 d	31.74 d	74.69 h	72.01 h
1 % YE	Control	33.82 i	33.18 I	30.91 k	30.40 k	74.01 k	71.38 k
	SA at 200 ppm	35.19 c	34.45 c	31.76 g	31.25 g	75.64 c	72.96 c
	AA at 200 ppm	34.73 f	34.09 f	32.49 c	31.95 c	74.85 g	72.22 g
2 % YE	Control	34.13 h	33.47 h	31.15 j	30.65 j	74.29 j	71.60 j
	SA at 200 ppm	35.36 b	34.65 b	31.94 f	31.40 f	75.81 b	73.18 b
	AA at 200 ppm	34.84 e	34.12 e	32.73 b	32.23 b	75.03 f	72.40 f
3 % YE	Control	34.56 g	33.51 g	31.41 i	30.87 i	74.44 i	71.76 i
	SA at 200 ppm	35.81 a	35.23 a	32.09 e	31.60 e	76.03 a	73.40 a
	AA at 200 ppm	35.07 d	34.39 d	33.03 a	32.47 a	75.23 e	72.60 e

Values followed by the same letters within a column are not significantly differed at 5% according to Duncan's multiple range test.
YE: Yeast extract, SA: Salicylic acid, AA: Ascorbic acid.

3. Yield and its components:

Effect of yeast extract rates:

Data in Table (6) illustrate that spraying the plants with yeast extract at the high concentration (3 %) was generally beneficial comparing with the untreated plants. Moreover, this treatment significantly increased average yield/plant and total yield/fed. than all studied yeast extract rates or control treatment in both seasons.

The increases in total yield/fed. were about 55 and 63 % for yeast extract at 3 %; 33 and 40 % for yeast extract at 2 % higher than control treatment (sprayed plants with tap water) in the 1st and 2nd seasons, respectively.

It can be concluded that the heaviest bulbs yield which resulted may be attributed to the best vigor of

plant growth characters which obtained by foliar application of yeast extract (Table 3).

The obtained results are in accordance with those of Abou El-Khair and Khalil (2014), Shalaby and El-Ramady (2014) and Ahmed (2015) on garlic and Shafeek *et al*. (2015) on onion.

Effect of antioxidants:

Data in Table (6) indicate that yield/plant and total yield/fed. were significant affected by both antioxidants (salicylic acid or ascorbic acid) than control treatment (sprayed plants with tap water) in both seasons. However, sprayed plants with salicylic acid gave the highest values of yield/plant and total yield/fed. than ascorbic acid in both seasons.

The increases in total yield/fed. were about 77 and 80 % for SA; 64 and 65 % for AA over control treatment (sprayed plants with tap water) in the 1st and 2nd seasons, respectively.

These increments may be explained on the bases that all used antioxidants had favorable stimulatory effects on vegetative growth characters and then increased total yield/fed. (Table 3).

Results are harmony with those reported with Bardisi (2004 b) on garlic, Amin *et al*. (2007) on onion, Abd El-Mageed *et al*. (2009), Bideshki *et al*. (2013) and Khadr (2015) on garlic, Pradhan *et al*. (2016) and Prajapati *et al*. (2016) on onion, Shama *et al*. (2016) and Meena *et al*. (2017) on garlic.

Effect of the interaction between yeast extract rates and antioxidants:

Data in Table (6) show that the interaction between foliar spray with yeast extract and antioxidants had significant effect on yield/plant and total yield/fed. in both seasons. The plants which sprayed with yeast extract at 3 % and SA at 200 ppm resulted in the highest values of yield/plant and total yield/fed. in both seasons, followed by the interaction treatment between that plants which sprayed with yeast extract at 3 % and AA at 200 ppm.

The increases in total yield/fed. were about 166.9 and 165.1 % for the interaction between yeast extract at 3 % and sprayed plants with SA at 200 ppm; 148.9 and 151.3 % for the interaction between 3 % yeast extract and sprayed plants with AA at 200 ppm over control treatment (sprayed plants with tap water) in the 1st and 2nd seasons, respectively.

These results are in harmony with those reported with Abou El-Khair and Khalil (2014) on garlic.

Table 6. Yield and its components of garlic plants as affected by yeast extract rates, antioxidants and their interactions during 2015/2016 (S1) and 2016/2017 (S2) growing seasons.

Treatments		Characters					
		Average yield/plant (kg)		Total yield (ton/fed.)		Relative total yield (%)	
		S1	S2	S1	S2	S1	S2
YE rates							
Control		0.117 d	0.108 d	4.501 d	4.140 d	100	100
1 % YE		0.128 c	0.114 c	5.200 c	5.044 c	116	122
2 % YE		0.132 b	0.122 b	5.993 b	5.809 b	133	140
3 % YE		0.140 a	0.129 a	6.995 a	6.747 a	155	163
Antioxidants							
Control		0.115 c	0.103 c	3.863 c	3.660 c	100	100
SA at 200 ppm		0.139 a	0.127 a	6.838 a	6.603 a	177	180
AA at 200 ppm		0.134 b	0.125 b	6.317 b	6.043 b	164	165
Interaction							
YE rates	Antioxidants						
Control	Control	0.101 i	0.095 j	3.177 k	3.119 l	100.0	100.0
	SA at 200 ppm	0.129 e	0.115 f	5.317 g	4.880 g	167.4	156.5
	AA at 200 ppm	0.122 f	0.115 f	5.009 h	4.422 h	157.7	141.8
1 % YE	Control	0.118 h	0.100 i	3.802 j	3.527 k	119.7	113.1
	SA at 200 ppm	0.134 d	0.121 e	6.126 e	6.067 e	192.8	194.5
	AA at 200 ppm	0.132 d	0.121 e	5.672 f	5.539 f	178.5	177.6
2 % YE	Control	0.120 g	0.107 h	3.870 j	3.859 j	121.8	123.7
	SA at 200 ppm	0.142 c	0.131 c	7.430 c	7.197 c	233.9	230.8
	AA at 200 ppm	0.134 d	0.128 d	6.680 d	6.372 d	210.3	204.3
3 % YE	Control	0.121 g	0.112 g	4.602 i	4.135 i	144.9	132.6
	SA at 200 ppm	0.150 a	0.139 a	8.478 a	8.267 a	266.9	265.1
	AA at 200 ppm	0.148 b	0.135 b	7.906 b	7.838 b	248.9	251.3

Values followed by the same letters within a column are not significantly differed at 5% according to Duncan's multiple range test.
YE: Yeast extract, SA: Salicylic acid, AA: Ascorbic acid.

4. Bulb traits:

Effect of yeast extract rates:

Data in Table (7) illustrate that all yeast extract rates had significantly affected on all bulb parameters than untreated plants, except bulb dry matter in both seasons. Spraying plants with the highest rates of yeast extract gave the highest values of bulb length, both fresh and dry weight of bulb and lowest dry matter (%) in bulb in both seasons. The positive effect of yeast extract in improving yield/plant and total yield may be imputed to the fact that yeast contains sugar, proteins and amino acids, as well as several vitamins (Eata, 2001).

The obtained results are in accordance with those reported by Tartoura and El-Saei (2006), Abd El-

Mageed *et al*. (2009), El-Morsy *et al*. (2011) and Dawa *et al*. (2012) on garlic.

Effect of antioxidants:

Data presented in Table (7) indicate that bulb length, both bulb fresh and dry weight were better with foliar application of antioxidants comparing with the untreated ones in both seasons, except bulb dry matter (%) in both seasons. Moreover, application of salicylic acid at 200 ppm was more beneficial treatment to increase and improve bulb length, both bulb fresh and dry weight than that plants which sprayed with ascorbic acid in both seasons. These increments in bulb parameters may be explained on the bases that all used antioxidants had favorable stimulatory effects on vegetative growth characters and increased mineral contents in leaves and bulbs and then increased bulb quality.

These results were in agreements with El-Morsy *et al*. (2010), Bideshki *et al*. (2013) and Shama *et al*. (2016). They found that SA increased bulb weight, diameter and length, clove number and its weight of garlic plants.

Effect of the interaction between yeast extract rates and antioxidants:

Data in Table (7) show that the interaction between foliar spray of yeast extract and antioxidants had a significant effect on bulb length, both bulb fresh and dry weight in both seasons. The interaction between the highest rate of yeast extract and sprayed plant with SA at 200 ppm gave the highest values of bulb length, both bulb fresh and dry weight and lowest values of dry matter (%) in bulb at harvesting time.

Table 7. Bulb traits of garlic plants as affected by yeast extract rates, antioxidants and their interactions during 2015/2016 (S1) and 2016/2017 (S2) growing seasons.

Treatments		Characters							
		Bulb length (cm)		Bulb fresh weight (g)		Bulb dry weight (g)		Bulb dry matter (%)	
		S1	S2	S1	S2	S1	S2	S1	S2
YE rates									
Control		2.88 d	2.50 d	46.45 d	40.43 d	5.78 d	4.92 d	12.48 a	12.20 a
1 % YE		2.99 c	2.65 c	51.39 c	43.23 c	6.27 c	5.16 c	12.23 b	11.97 b
2 % YE		3.09 b	2.81 b	53.69 b	47.80 b	6.44 b	5.63 b	12.03 c	11.82 c
3 % YE		3.22 a	2.93 a	61.10 a	53.06 a	7.15 a	6.09 a	11.78 d	11.54 d
Antioxidants									
Control		2.71 c	2.40 c	44.63 c	38.46 c	5.61 c	4.74 c	12.59 a	12.34 a
SA at 200 ppm		3.26 a	2.93 a	58.86 a	50.80 a	6.92 a	5.87 a	11.80 c	11.60 c
AA at 200 ppm		3.16 b	2.84 b	55.98 b	49.13 b	6.70 b	5.74 b	12.00 b	11.71 b
Interaction									
YE rates	Antioxidants								
	Control	2.57 g	2.28 i	38.67 l	34.91 l	4.94 l	4.36 j	12.78 a	12.49 a
Control	SA at 200 ppm	3.11 d	2.65 f	52.16 g	43.31 g	6.40 g	5.21 f	12.28 f	12.03 f
	AA at 200 ppm	2.96 e	2.58 fg	48.53 h	43.06 h	6.00 h	5.20 f	12.37 e	12.08 e
	Control	2.59 g	2.34 i	45.75 k	36.83 k	5.78 k	4.56 i	12.64 b	12.39 b
1 % YE	SA at 200 ppm	3.23 bc	2.86 d	54.63 e	46.55 e	6.53 e	5.46 e	11.95 h	11.73 h
	AA at 200 ppm	3.16 cd	2.77 e	53.79 f	46.30 f	6.51 f	5.45 e	12.10 g	11.78 g
	Control	2.80 f	2.47 h	46.80 j	39.87 j	5.85 j	4.90 h	12.50 c	12.30 c
2 % YE	SA at 200 ppm	3.25 bc	3.03 b	59.23 c	52.78 c	6.93 c	6.06 c	11.70 j	11.48 j
	AA at 200 ppm	3.24 bc	2.94 c	55.03 d	50.76 d	6.55 d	5.93 d	11.91 i	11.68 i
	Control	2.91 e	2.51 gh	47.30 i	42.22 i	5.87 i	5.15 g	12.42 d	12.19 d
3 % YE	SA at 200 ppm	3.46 a	3.20 a	69.42 a	60.57 a	7.84 a	6.75 a	11.29 l	11.14 l
	AA at 200 ppm	3.30 b	3.09 b	66.58 b	56.40 b	7.73 b	6.37 b	11.62 k	11.30 k

Values followed by the same letters within a column are not significantly differed at 5% according to Duncan's multiple range test.
YE: Yeast extract, SA: Salicylic acid, AA: Ascorbic acid.

5. Bulb quality at harvesting time:

Effect of yeast extract rates:

It is clear from previous data in Table (8) that the yeast extract rates had a significant effect on biochemical contents in bulbs at harvest time such as total carbohydrates, ascorbic acid and salicylic acid contents of garlic plants. All tested biochemical contents were significantly increased with increasing yeast extract rate up to 3 % compared with the other rates or untreated plants. While control treatment recorded the lowest values of these parameters in both seasons.

The beneficial effect of dry yeast is may be attributed to its high contents of carbohydrates, amino acids, sugars, fatty acids, proteins, hormones, macro and micro-nutrients (Khedr and Farid, 2002).

The results are harmony with those reported by El-Morsy *et al*. (2011) and Ahmed (2015) on garlic and Shafeek *et al*. (2015) on onion.

Effect of antioxidants:

Data in Table (8) show that total carbohydrates, ascorbic acid and salicylic acid contents in cloves of garlic plants were significantly increased as a result of spraying garlic plants with antioxidants compared with the untreated plants. Foliar spray with salicylic acid gave the highest values of total carbohydrates and salicylic acid contents in cloves of garlic plants, while sprayed garlic plants with ascorbic acid at 200 ppm gave the highest values of ascorbic acid content in cloves of garlic plants in both seasons.

The obtained results concerted with those reported by El-Morsy *et al*. (2010) and Meena *et al*. (2017) on garlic.

Effect of the interaction between yeast extract rates and antioxidants:

It is obvious from results in Table (8) that the interaction between yeast extract and antioxidants had significant effects on total carbohydrates, ascorbic acid and salicylic acid contents in bulb in both seasons. The interaction between the plants treated with foliar spray of yeast extract at 3 % and sprayed with salicylic acid at 200 ppm achieved the highest concentrations of total carbohydrates and salicylic acid in cloves of garlic plants in both seasons, while the interaction between foliar spray of yeast extract at 3 % and sprayed with ascorbic acid at 200 ppm gave the highest concentration of ascorbic acid in cloves of garlic plants in both seasons of the study.

It could be concluded that spraying garlic plants with yeast extract at 3 % and salicylic acid at 200 ppm was the best treatment for enhancing growth, productivity and bulb quality of garlic plants cv. Sids-40 under newly reclaimed soil of New Valley-Egypt and the same conditions.

Table 8. Total carbohydrates, ascorbic acid and salicylic acid contents in bulb of garlic plants at harvesting time as affected by yeast extract rates, antioxidants and their interactions during 2015/2016 (S1) and 2016/2017 (S2) growing seasons.

Treatments		Characters					
		Total carbohydrates (%)		Ascorbic acid (mg/100g fresh weight)		Salicylic acid (ppm)	
		S1	S2	S1	S2	S1	S2
YE rates							
Control		24.93 d	24.06 d	28.51 d	27.55 d	60.39 d	58.17 d
1 % YE		26.24 c	25.28 c	28.69 c	27.85 c	60.65 c	58.42 c
2 % YE		26.37 b	25.49 b	28.91 b	28.12 b	60.85 b	58.64 b
3 % YE		26.72 a	25.88 a	29.11 a	28.35 a	61.07 a	58.86 a
Antioxidants							
Control		25.50 c	24.65 c	28.00 c	26.98 c	59.93 c	57.60 c
SA at 200 ppm		26.61 a	25.69 a	28.82 b	28.02 b	61.61 a	59.46 a
AA at 200 ppm		26.08 b	25.19 b	29.61 a	28.90 a	60.68 b	58.51 b
Interaction							
YE rates	Antioxidants						
Control	Control	24.71 l	23.86 l	27.66 l	26.35 l	59.57 l	57.23 l
	SA at 200 ppm	25.14 j	24.29 j	28.53 h	27.62 h	61.24 d	59.11 d
	AA at 200 ppm	24.93 k	24.02 k	29.34 d	28.68 d	60.36 h	58.17 h
1 % YE	Control	25.43 i	24.57 i	27.89 k	26.98 k	59.87 k	57.47 k
	SA at 200 ppm	26.95 c	25.86 c	28.71 g	27.80 g	61.52 c	59.34 c
	AA at 200 ppm	26.34 f	25.41 f	29.48 c	28.77 c	60.58 g	58.45 g
2 % YE	Control	25.70 h	24.85 h	28.15 j	27.16 j	60.05 j	57.74 j
	SA at 200 ppm	26.99 b	26.06 b	28.90 f	28.24 f	61.75 b	59.59 b
	AA at 200 ppm	26.43 e	25.55 e	29.69 b	28.97 b	60.76 f	58.59 f
3 % YE	Control	26.16 g	25.31 g	28.28 i	27.45 i	60.25 i	57.94 i
	SA at 200 ppm	27.38 a	26.54 a	29.13 e	28.41 e	61.92 a	59.80 a
	AA at 200 ppm	26.63 d	25.80 d	29.92 a	29.20 a	61.04 e	58.85 e

Values followed by the same letters within a column are not significantly differed at 5% according to Duncan's multiple range test.
YE: Yeast extract, SA: Salicylic acid, AA: Ascorbic acid.

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تـأثير بعض المستحثات الحيوية على النمو والمحصول وجودة الأبصال للثوم المنزرع فى أرض مستصلحة حديثاً ، الوادى الجديد-مصر

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أجريت تجربتين حقليتين متتاليتين خلال موسمى الزراعة 2016/2015 و 2017/2016 م فى مزرعة كلية الزراعة - جامعة أسيوط - فرع الوادى الجديد لدراسة تأثير الرش الورقى بتركيزات مختلفة من مستخلص الخميرة (صفر ، 1 ، 2 ، 3 %) كلاً منها منفرداً أو مع الرش الورقى بتركيزات مختلفة من بعض مضادات الأكسدة (صفر ، حامض الساليسيليك ، حامض الأسكوربيك بمعدل 200 جزء فى المليون لكل منهما) على نمو النباتات والمحصول ومكوناته وصفات الأبصال وكذلك جودة الأبصال للثوم (صنف سدس-40) المنزرع فى أرض مستصلحة حديثاً بالوادى الجديد-مصر ، ويمكن تلخيص النتائج المتحصل عليها فيما يلى: كانت معاملة التفاعل بين الرش الورقى بمستخلص الخميرة بمعدل 3 % وحامض الساليسيليك بمعدل 200 جزء فى المليون أفضل المعاملات لزيادة صفات النمو مثل أرتفاع النبات ، المساحة الورقية للنبات ، الوزن الطازج والجاف للنبات ونسبة التبصيل ، محتوى كلاً من الأوراق والأبصال من النيتروجين والفوسفور والبوتاسيوم والكبريت بعد 135 يوم من الزراعة وكذلك محتوى الأوراق من الكربوهيدرات الكلية وحامض الساليسيليك عند نفس التاريخ ، المحصول الكلى للفدان ، صفات البصلة وكذلك جودة الأبصال (المحتوى من الكربوهيدرات الكلية وحامض الساليسيليك) عند الحصاد ، بينما سجلت معاملة التفاعل بين الرش الورقى بمستخلص الخميرة بمعدل 3 % وحامض الأسكوربيك بمعدل 200 جزء فى المليون أعلى القيم لمحتوى الأوراق من حامض الأسكوربيك بعد 135 يوم من الزراعة وكذلك محتوى البصلة عند الحصاد فى كلا الموسمين. سجلت معاملة التفاعل بين الرش الورقى بمستخلص الخميرة بمعدل 3 % وحامض الساليسيليك بمعدل 200 جزء فى المليون زيادة نسبية فى المحصول الكلى للفدان مقدارها 166.9 ، 165.1 % ، كما سجلت معاملة التفاعل بين الرش الورقى بمستخلص الخميرة بمعدل 3 % وحامض الأسكوربيك بمعدل 200 جزء فى المليون زيادة نسبية فى المحصول الكلى للفدان مقدارها 148.9 ، 151.3 % مقارنة بمعاملة المقارنة (الرش الورقى بالماء فقط) خلال الموسم الأول والثانى على التوالى.