Middle East Journal of Agriculture Research
ISSN 2077-4605
Volume : 04 | Issue : 02 | April-June | 2015
Pages: 332-346

Improving Growth and Productivity of two Garlic Cultivars (*Allium sativum* L.) Grown under Sandy Soil Conditions.

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ABSTRACT

Two field experiments were conducted at Sadat City, Menoufia governorate, Egypt. The aim of these experiments is to study the response of two garlic cultivars namely Balady and clone Sids-40 to nitrogen fertilizer levels (50, 75 and 100 % + 10 ton fed $^{-1}$) in the form of organic sources as compost in addition to inorganic fertilizer (NPK) 100 % of the recommended does (120, 80, 70 kg fed $^{-1}$ of NPK fertilizers respectively) + (20 m^3) cattle manure as control treatment and some bio-enriched treatments (yeast plus bio-fertilizer, compost extract plus bio-fertilizer were used in a combination of 24 treatments to study their effect on the vegetative plant growth expressed as plant height, number of leaves per plant and fresh as well as dry weight of whole plant , chemical composition and total garlic bulb yield, its components and bulb characteristics. A split-split plot design with three replicates was used. The main plots were the two garlic cultivars, Balady and Sids-40 whereas the sub plots were assigned for N levels and the bio-enriched treatments were placed in the sub-sub plots. Results show that using bio-enriched treatments increased vegetative growth of garlic plants expressed as plant height, number of leaves per plant and fresh as well as dry weight of whole plant, chemical composition and yield of garlic plants. Compost extract plus bio-fertilizer recorded the highest values of the plant height, number of leaves per plant and fresh as well as dry weight of whole plant, chemical composition and yield of garlic plants. Increasing nitrogen fertilizer levels increased all the above mentioned measures. Obtained results indicated that the highest values of number of leaves / plant and fresh and dry weight of whole plant as well as total garlic bulb yield, its components and bulb characteristics were obtained in case of cv. Sids-40 while the highest values of plant height and number of cloves/ bulb were recorded in case of cv. Balady. The interactions between bio-enriched treatments and nitrogen fertilizer levels and garlic cv., gave positive results with respect to the above mentioned parameters. To obtain high maximum bulb weight clove weight and total fresh yield, it could be recommended to use compost extract plus bio-fertilizer and 100% nitrogen fertilizer levels of inorganic fertilizer per feddan under such condition planting cv. Sids-40.

Key words: Garlic cultivars, bio-enriched, nitrogen levels, organic, inorganic, compost, yeast, compost extract, vegetative growth, chemical content, bulb weight clove, fresh yield.

Introduction

Garlic (*Allium sativum* L.) is one of the most important bulb vegetable crops and is next to onion (*Allium cepa)* in importance Hamma *et al.,* (2013). It is commonly used as a spice or in the medicinal purposes. In Egypt, it has been generally cultivated for both local consumption and export. Egypt ranks the fourth leading country in the world for garlic production (244.626 MT) after China, India and Korea (FAO, 2011 and Abou El-Magd *et al*., 2012). The economic importance of the garlic crop has increased considerably in the entire world in recent years. Therefore, increasing garlic yield and improving bulb quality are essential aim for both growers and consumers, but it usually depends on many factors especially that influence the plant growth throughout the growth period. Vegetable workers must carry out extensive trials for evaluating these garlic cvs for ensuring the success of these cvs under different locations of Egypt. The great variation on the growth and production of different garlic cultivars according to the different locations in Egypt was a wide field for many workers (Hassan, 2002, El-Sayed, 2004, Gowda *et al.,* 2007; Moustafa *et al.,* 2009 , Aly, 2010, Dawood *et al.,* 2011 and Youssef and Tony 2014). Date of sowing, fertilization and irrigation requirement are among the most important agricultural practices that judging the yield and quality of the garlic. Growing garlic in the newly reclaimed soils is faced by various problems, such as low amounts of available nutrients and poor organic matter content as well as poor hydrophsic, chemical and biological properties. The best means of maintaining soil fertility and productivity could be through periodic addition of organic materials either alone or in addition to mineral fertilizers. Many investigators studied the effect of organic fertilization on growth of garlic plant (Stewart *et al*., 2005, Gaviola and Lipinski, 2008, El-Hifny,2010, Abou El-Magd *et al*., 2012, Ahmed *et al.,* 2012 ,Nori *et al*., 2012 , Patel and Patel *et al*., 2012, Abou El-Magd *et al*., 2014, Diriba-Shiferaw, 2014 and Zaki *et al*., 2014). Other investigators reported that, bio-enriched increased the yield of garlic plant (Abou El-Magd *et al*., 2012,

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Ahmed *et al.,* 2012, Abdel-Razzak and EI-Sharkawy, 2013, Abou El-Magd *et al*., 2014 and Zaki *et al*., 2014). There is an increasing in global interest in the use of liquid organic fertilizers and inoculums of beneficial microbes in support of biological farming and sustainable agriculture (Naidu *et al.,* 2010). A primary reason for producing compost extract is to transfer microbial biomass, fine particulate organic matter and soluble chemical components of compost into an aqueous phase that can be applied to plant surfaces and soils in ways not possible or economically feasible with solid compost (Hargreaves *et al.,* 2009). To promote plant growth with compost extract the extract must be derived from compost that also promotes plant growth (Shrestha *et al.,* 2011). The diverse microbial profile in compost extract help the plant's leaves absorb nutrients from the air, and as they find their way into the soil, they help the plant's root system extract nutrients from the soil (Pane *et al.,* 2012).

Dry yeast is a natural bio-substance suggested to have stimulating, nutritional and protective functions when used on vegetables. Foliar application of yeast was found to increase growth, yield and quality of many vegetable crops (Abou El-Nasr *et al.,* 2001, Fawzy, 2007 and Ahmed *et al.,* 2010). In the same respect, foliar application of yeast extract increased vegetative growth of eggplant (El-Tohamy *et al.,* 2008). Also, Abou El-yazied and Mady (2012) found that yeast extract stimulated growth and total yield. However, Marzauk, *et al.,* (2014) found that the highest values of broad bean plant growth criteria expressed as plant length, number of leaves and branches as well as fresh and dry weight of leaves, branches and whole plant and the highest values of total pods yield and different organs and the content of nitrogen and protein % in seeds tissues were recorded when sprayed by high level of yeast extract (6 ml/L).

Microbial fertilizer is one way that organic farmers are able to increase yield and quality of crops without a large investment of money and labor (Pham, 2004) .Several reports indicated that the inoculation of some plants with bio-fertilizer singly or in combination with mineral fertilizers improved plant growth, yield and chemical composition (Osman, 2007).

The aim of this study was to investigate the effect of bio-enriched treatments under fertigation and nitrogen fertilizer levels in the form of organic and inorganic applications on vegetative growth characters and bulb growth, yield and its components and chemical composition of cloves of two garlic cvs.

Materials and Methods

This study was carried out in private farm at Sadat city, Minofia Governorate during two successive winter seasons of 2010/2011 and 2011/2012. The experimental trails were conducted in sandy soil using drip irrigation. to investigate the response of two garlic cultivars namely Balady and clone Sids-40 to some bio-enriched treatments (Yeast, compost extract and without) and three NPK fertilizer levels (50, 75 and 100 % + 10 ton fed $^{-1}$) in the form of organic sources as compost in addition to inorganic nitrogen fertilizer 100 % of the recommended does (120, 80, 70 kg fed $^{-1}$ of NPK fertilizers respectively) + (20 m^3) cattle manure as a control treatment, according to the recommendations given by ministry of agriculture (1998). Compost rates were calculated as NPK unit/ fed $^{-1}$ were given to each row of plots before planting. Chemical analysis of organic fertilizers is given in Table (1).The soil of experimental field was clay loam in texture with Ec. 0.88 dS /m and PH 8.20 , N was 6.8 mg/kg soil , P 12.1 mg/kg soil and exchangeable K was 85.4 mg/kg soil .

Table 1: Average chemical analysis of different sources of organic manures during the two seasons of study.

Organic materials	sources of compost	PH	Ec dS /m	O.M %	N %	P %	K %	C/N	Humidity %	Weight of m3 (kg)
Botanical waste compost	AL wadi compost	6.6	1.6	58	1.4	0.65	0.79	18: 1	24	730
Cattle manure		7.3	1.2	25	1.2	0.72	0.98	20 : 1	19.8	750

Treatments were as follows:-

1) ***Cultivars:***
   - A- Balady
   - B- Clone Sids-40

2) ***Nitrogen levels treatments:***

Three nitrogen levels, i.e. 50, 75 and 100 N unit fed $^{-1}$ in the form of organic sources as compost in addition to one nitrogen levels 100 N unit fed $^{-1}$ in the form of inorganic fertilizer of the recommended does by Ministry of Agriculture (120, 80, 70 kg fed $^{-1}$ of NPK fertilizers respectively) + (20 m^3) cattle manure as control treatment.

A- Three compost levels were used at (50, 75 and 100 kg N unit fed $^{-1}$, which were about (5.9, 7.725 and 10.630 ton compost/fed.) in both seasons. Rock phosphate (P_2O_5 22.8%) at 19.724 kg p_2o_5 unit fed $^{-1}$ which were

about (86.500 kg) and feldspar (K_2O 10.6%) at 53.031 kg k_2o unit fed $^{-1}$ which were about (500.292 kg) were used as a source of P and K, respectively and were added during soil preparation mixture with compost before agriculture. In each treatment the content of compost, potassium and phosphorus account calculated and completed to the required concentration by adding feldspar and rock phosphate.

B- Control (mineral NPK at rate of 120 N-75 P_2O_5-96K_2O/fed.). Regarding mineral fertilization application, all amounts of nitrogen, phosphorus and potassium were broadcasted manually during soil preparation in the form of ammonium sulfate (20.5%), superphosphate (15%), and potassium sulfate (48%), the amounts of NPK fertilizers, were added at three equal portions. The first portion was applied with organic fertilizer during the soil preparing, while the second portion was applied two months after planting and third one was applied two months later.

3) Bio-enriched treatments:

The experiment included three fertigation treatments.

A- With bio-enriched (compost extract + bio-fertilizers). To prepare the bio enriched compost extract, 6 kg of mature compost blended with 1 kg molass, in a 120 liter plastic barrel (1:5 by volume) as indicated by Ryan (2003) with addition 200 ml from both *B. circulans* and *B. megatherium*., the brewing of the compost occurring after 48 hours to get the concentrated compost extract. The concentrated compost extract was filtrated to get the clear solution, and then used to prepare the organic nutrient solution by diluting this stock up to 100 liters of water in solution tank. The EC level adjusted to 2.5 dS/m as mentioned by Mohamed (2005) and Abou-El-Hassan *et al.*, (2008). After elapsing of incubation time, the liquid mixture was filtered on a 100 mesh screen, then fertigation with 1L bio-fertilizers that contain bacteria *Azotobcter* spp., *Azospirillum* spp., *Bacillus* spp., and *Pseudomonas* spp. Biofertilizers were obtained from the existing isolate samples in the Laboratory of Microbiology, Faculty of Agriculture, Cairo University.

B- With bio-enriched (Yeast extract + bio-fertilizers).Yeast extract was prepared from200g brewer's yeast (*Saccharomyces cerevisiae*), dissolved in10 liters of water , blended with 1 kg molass for 4-6 hours and then dilute the solution to 100 liters of water and then fertigation with 1L bio-fertilizers that contain bacteria *Azotobcter* spp., *Azospirillum* spp., *Bacillus* spp., and *Pseudomonas* spp. for reproduction according to the methods of Morsi *et al.,* (2008).

C- Without bio-enriched (control).

Soil application:

The amounts of liquid bio-enriched (600L/fed.) were divided into equal portions and were added through the irrigation water (fertigation) one times per week starting 21days after planting and ended 21days before the end of harvest season. All treatments of organic manures were added at soil preparation, meanwhile, the amounts of NPK fertilizers, were added at three equal portions. The first portion was applied with organic fertilizer during the soil preparing, while the second portion was applied two months after planting and third one was applied two months later. Drip irrigation lines were spread over the ditches. Soil was irrigated continuously three days before planting. Cloves were planted on the first third of October 2010 and 2011 using homogeneous size cloves. The cloves were planted at 10 cm apart on the two sides of each row. The plot area was 10.5 m^2 (one row of 14 m length and 0.75m width).

Garlic plants were harvested on 15th of April in 2011 and on the 19th of April in 2012. Garlic plants were cured for fifteen days and weight of cured plants/plot was detected then the total yields as ton/ fed., was accounted, also the average cloves weight and cloves number/ bulb were determined.

Experimental design:

A split-split plot design with three replicates was used. The main plots were cultivars, whereas the sub plots were assigned for the NPK levels and bio-fertilizer treatments were placed in the sub-sub plots. were used in a combination of 24 treatments, the recommendations given by ministry of agriculture (1998).

Data recorded: -

A random sample of ten plants was taken from each experimental plot at 150 days after planting in both seasons and the following vegetative growth characters were measured (plant height, number of leaves, fresh and dry weight of whole plant as mentioned by Mann, 1952).

Total nitrogen, phosphorus and potassium content in tissue of produced cloves, were determined according to the methods which were described by Pregl (1945), Murphy and Riley (1962) and Brown and Lilleland (1946) for N,P and K respectively.

Statistical analysis:-

The data of the experiment was tabulated and subjected to statistical analysis according to Snedecor and Cochran (1980).

Results and Discussion

1- Vegetative growth:

a) Effect of cultivars

Data on vegetative growth parameters, i.e. plant height, number of leaves, fresh and dry weight per plant for the studied cultivars under different nitrogen levels and bio-enriched were presented in Table 2. Such data reveal that there were significant differences in most studied plant growth characteristics among cv. Balady and Sids-40 In this respect, cv. Balady recorded the highest values in plant height. But cv. Clone Sids-40 significantly produced more leaves than cv. Balady. Obtained results may be attributed to the genetically variance that showed vegetative growth differences among the studied cultivars. Similar results were reported by El-Zohery(2004), Mohamed(2004), Moustafa *et al.,* (2009) and Aly (2010) on Balady and clone Sids-40 garlic cultivars.

b) Effect of nitrogen levels

Data in Table 2 show the linear relationship between nitrogen levels and garlic plant growth. As nitrogen level increased vegetative growth (plant height, number of leaves, fresh and dry weight per plant) increased up to the highest nitrogen level, i.e.100 kg N/fed. The results were nearly similar in the two seasons of the experiment. Some investigators showed the same trend (Stewart *et al*., 2005, Gaviola and Lipinski, 2008, El-Hifny,2010, Abou El-Magd *et al*., 2012, Ahmed *et al.,* 2012 ,Nori *et al*., 2012 , Patel and Patel *et al*., 2012, Diriba-Shiferaw, 2014 and Abou El-Magd *et al*., 2014). The increase of plant growth by increasing nitrogen level might be due to its role in photosynthesis, protein synthesis, cell division and enlargement which are the basal steps of plant growth. In addition, nitrogen plays an important role in the enzyme activity which reflects more products needed in plant growth**.**

c) Effect of bio- enriched

Bio-enriched increased the vegetative growth of garlic plants expressed as plant height, number of leaves, fresh and dry weight per plant as shown in Table 2. These increases were statistically significant and similar in the two seasons of the experiment.Many investigators reported that bio-enriched increased growth of garlic plants (Abou El-Nasr *et al.,* 2001, Pham, 2004, Fawzy, 2007**,**Osman, 2007, Hargreaves *et al.,* 2009, Naidu *et al.,* 2010, Shrestha *et al.,* 2011 and Marzauk, *et al.,* 2014).The increase in the vegetative growth of garlic plants by bio-enriched might be due to its effect in dissolving soil nutrients which offers more available nutrients for absorption by the root system (Abou El-Magd *et al*., 2012, Ahmed *et al.,* 2012,Abdel-Razzak and EI-Sharkawy, 2013 ,Abou El-Magd *et al*., 2014 and Zaki *et al*., 2014). This increase in the vegetative growth might also be due to the effect of auxins and nutrients which are exerted by bio-enriched (Gomaa, 1995).

Table 2: Effect of cultivars, nitrogen fertilizer levels in the form of organic and inorganic and bio- enriched applications on vegetative growth of garlic *(Allium sativum L.)* plants during two seasons.

Treatments			Seasons 1				Seasons 2			
Cultivars (A)	Nitrogen levels (B)	Bio – enriched (C)	Plant height (cm)	No. of leaves/plant	Leaves fresh weight (g)	leaves dry weight (g)	Plant height (cm)	No. of leaves/plant	Leaves fresh weight (g)	leaves dry weight (g)
Balady			37.89	6.3	18.04	3.81	41.00	6.6	18.53	4.27
Clone Sids-40			25.06	7.9	26.28	4.80	29.22	8.6	28.06	5.34
L.S.D. at 5% cultivars (A)			02.44	0.4	00.31	0.23	01.86	0.5	00.89	0.09
	50% Compost		29.39	6.7	21.45	3.75	33.00	7.1	22.30	4.25
	75% Compost		30.78	7.0	21.86	4.10	34.00	7.4	22.84	4.51
	100% Compost		32.00	7.2	22.43	4.46	34.94	7.7	23.48	4.96
	100% Mineral (Control)		33.72	7.5	22.91	4.91	38.50	8.4	24.56	5.51
L.S.D. at 5% nitrogen levels (B)			00.77	0.3	00.10	0.06	00.65	0.1	00.08	0.06
		Without	29.83	6.7	21.59	3.93	33.21	7.2	22.64	4.35
		Yeast	31.63	7.1	22.20	4.30	35.08	7.6	23.24	4.84
		Compost extract	32.96	7.5	22.70	4.68	37.04	8.0	24.00	5.23
L.S.D. at 5% bio – fertilizers (C)			00.63	0.1	00.10	0.07	00.60	0.6	00.14	0.07

d) Effect of the interactions

The combined effect of cultivars and nitrogen levels increased in the vegetative growth of garlic plant (Table3). The highest plant height, number of leaves, fresh and dry weight per plant was obtained by Sids-40 cv. and the highest nitrogen level, i. e. 100 kg N/fed., mineral or organic fertilizers compared with the control. The other interactions recorded the low values.

Table 3: Effect of the combination between cultivars and nitrogen fertilizer levels in the form of organic and inorganic applications on vegetative growth of garlic (*Allium sativum L.*) plants during two seasons.

Treatments		Seasons 1				Seasons 2			
Cultivars (A)	Nitrogen levels (B)	Plant height (cm)	No. of leaves/plant	Leaves fresh weight (g)	leaves dry weight (g)	Plant height (cm)	No. of leaves/plant	Leaves fresh weight (g)	leaves dry weight (g)
Balady	50% Compost	35.56	5.9	17.38	3.23	39.44	6.1	17.78	3.63
	75% Compost	37.00	6.2	17.68	3.63	40.00	6.4	18.27	3.95
	100% Compost	38.78	6.4	18.23	4.06	41.22	6.6	18.57	4.44
	100% Mineral (Control)	40.22	6.8	18.88	4.34	43.33	7.6	19.51	5.06
Clone Sids-40	50% Compost	23.22	7.5	25.52	4.26	26.56	8.2	26.82	4.86
	75% Compost	24.56	7.7	26.03	4.57	28.00	8.5	27.42	5.06
	100% Compost	25.22	8.0	26.62	4.86	28.67	8.7	28.40	5.47
	100% Mineral (Control)	27.22	8.3	26.93	5.48	33.67	9.2	29.60	5.96
L.S.D. At 5% interaction AXB		0.73	0.1	0.21	0.11	00.63	0.2	00.23	0.09

The combined effect of cultivars and bio-enriched recorded linear increases in plant growth (Table 4). It could be reported that the highest plant height, number of leaves, fresh and dry weight per plant were obtained by the combined effect of bio-enriched (compost extract + bio-fertilizers**)** and cv.Sids-40 compared with the other interactions.

Table 4: Effect of the combination between cultivars and bio- enriched applications on vegetative growth of garlic (*Allium sativum* L.) plants during two seasons.

Treatments		Seasons 1				Seasons 2			
Cultivars (A)	Bio – enriched (C)	Plant height (cm)	No. of leaves/plant	Leaves fresh weight (g)	leaves dry weight (g)	Plant height (cm)	No. of leaves/plant	Leaves fresh weight (g)	leaves dry weight (g)
Balady	Without	36.17	5.8	17.42	3.49	38.92	6.2	17.99	3.85
	Yeast	38.00	6.2	18.07	3.81	41.08	6.7	18.44	4.30
	Compost extract	39.50	6.9	18.63	4.15	43.00	7.1	19.16	4.65
Clone Sids-40	Without	23.50	7.6	25.75	4.37	27.50	8.3	27.29	4.84
	Yeast	25.25	7.9	26.33	4.80	29.08	8.6	28.04	5.38
	Compost extract	26.42	8.2	26.76	5.22	31.08	9.0	28.85	5.80
L.S.D. At 5% AXC		0.86	0.17	0.25	0.13	00.74	0.2	00.27	0.11

The combined effect of the highest level of nitrogen (100 kg N/fed.) mineral and or organic fertilizers and bio-enriched (compost extract + bio-fertilizers**)** (Table5). In addition, the lowest vegetative growth was obtained by the combined effect of 50% organic nitrogen fertilizers and without bio-enriched.

Table 5: Effect of the combination between nitrogen fertilizer levels in the form of organic and inorganic and bio- enriched applications on vegetative growth of garlic (*Allium sativum* L.) plants during two seasons.

Treatments		Seasons 1				Seasons 2			
Nitrogen levels (B)	Bio – enriched (C)	Plant height (cm)	No. of leaves/plant	Leaves fresh weight (g)	leaves dry weight (g)	Plant height (cm)	No. of leaves/plant	Leaves fresh weight (g)	leaves dry weight (g)
50% Compost	Without	28.33	6.4	21.13	3.48	31.33	6.9	21.93	3.91
	Yeast	29.33	6.6	21.45	3.71	33.17	7.1	22.18	4.30
	Compost extract	30.50	7.0	21.77	4.05	34.50	7.4	22.78	4.53
75% Compost	Without	29.00	6.7	21.32	3.76	32.33	7.1	22.22	4.15
	Yeast	30.83	6.9	21.97	4.10	34.00	7.4	22.82	4.55
	Compost extract	32.50	7.3	22.28	4.45	35.67	7.7	23.50	4.83
100% Compost	Without	30.33	6.9	21.80	4.05	33.17	7.3	22.82	4.45
	Yeast	32.33	7.2	22.45	4.50	34.67	7.7	23.45	4.95
	Compost extract	33.33	7.6	23.03	4.85	37.00	8.1	24.18	5.48
100% Mineral (Control)	Without	31.67	7.0	22.10	4.43	36.00	7.7	23.60	4.88
	Yeast	34.00	7.6	22.92	4.91	38.50	8.5	24.52	5.58
	Compost extract	35.50	8.0	23.70	5.40	41.00	9.0	25.55	6.08
L.S.D. At 5% B XC		0.69	0.1	0.20	0.10	00.59	0.2	0.23	0.09

Interactions of cultivars, nitrogen levels and bio-enriched, 100% NPK mineral and organic fertilizers and Sids-40 cv. statistically affected plant height, number of leaves, fresh and dry weight per plant (Table 6). In general, the highest values of vegetative growth of garlic were obtained by the combined effect of cultivars and nitrogen levels reflected statistical increases in the vegetative growth of garlic plant. The highest vegetative

growth of garlic plant was obtained by bio-enriched (compost extract + bio-fertilizers), the highest level of nitrogen (100 kg N/fed.) mineral or organic fertilizers and cv.Sids-40. Lower values of vegetative growth were obtained by without bio- enriched, lower level of compost and cv. Balady. These results are in agreement with those obtained by (Abou El-Magd *et al*., 2012, Ahmed *et al.,* 2012, Abdel-Razzak and EI-Sharkawy, 2013, Abou El-Magd *et al*., 2014 and Zaki *et al*., 2014) on garlic.

Table 6: Interaction effects among cultivars, nitrogen fertilizer levels in the form of organic and inorganic and bio- enriched applications on vegetative growth of garlic (*Allium sativum L.*) plants during two seasons.

Treatments			Seasons 1				Seasons 2			
Cultivars (A)	Nitrogen levels (B)	Bio – enriched (C)	Plant height (cm)	No. of leaves/plant	Leaves fresh weight (g)	leaves dry weight (g)	Plant height (cm)	No. of leaves/plant	Leaves fresh weight (g)	leaves dry weight (g)
Balady	50% Compost	Without	34.67	5.6	17.03	3.06	37.33	5.8	17.47	3.26
		Yeast	35.33	5.8	17.43	3.16	39.67	5.9	17.63	3.70
		Compost extract	36.67	6.3	17.67	3.46	41.33	6.5	18.23	3.93
	75% Compost	Without	35.00	5.8	17.23	3.30	38.00	6.0	17.73	3.63
		Yeast	37.00	6.0	17.63	3.63	40.33	6.3	18.23	4.03
		Compost extract	39.00	6.7	18.17	3.96	41.67	6.8	18.83	4.20
	100% Compost	Without	37.00	5.9	17.53	3.66	39.33	6.1	18.03	3.96
		Yeast	39.00	6.4	18.33	4.06	41.00	6.7	18.53	4.43
		Compost extract	40.33	7.1	18.83	4.46	43.33	7.0	19.13	4.93
	100% Mineral (Control)	Without	38.00	6.1	17.90	3.93	41.00	6.7	18.73	4.56
		Yeast	40.67	6.8	18.87	4.40	43.33	7.8	19.37	5.06
		Compost extract	42.00	7.4	19.87	4.70	45.67	8.1	20.43	5.56
Clone Sids-40	50% Compost	Without	22.00	7.3	21.23	3.90	25.33	8.0	26.40	4.56
		Yeast	23.33	7.5	22.47	4.26	26.67	8.2	26.73	4.90
		Compost extract	24.33	7.8	23.87	4.63	27.67	8.3	27.33	5.13
	75% Compost	Without	23.00	7.5	22.87	4.23	26.67	8.2	26.70	4.66
		Yeast	24.67	7.8	25.40	4.56	27.67	8.5	27.40	5.06
		Compost extract	26.00	7.9	26.30	4.93	29.67	8.7	28.17	5.46
	100% Compost	Without	23.67	7.9	26.40	4.43	27.00	8.4	27.60	4.93
		Yeast	25.67	8.1	26.07	4.93	28.33	8.7	28.37	5.46
		Compost extract	26.33	8.2	26.57	5.23	30.67	9.1	29.23	6.03
	100% Mineral (Control)	Without	25.33	7.9	26.30	4.93	31.00	8.6	28.47	5.20
		Yeast	27.33	8.4	26.97	5.43	33.67	9.1	29.67	6.10
		Compost extract	29.00	8.7	27.23	6.10	36.33	9.9	30.67	6.60
L.S.D. at 5% interaction AXBXC			0.98	0.2	0.28	0.15	00.84	0.3	00.35	0.12

2- Total garlic bulb yield, its components and bulb characteristics.

a) Effect of cultivars

Data in Table 7 reveal that there were varietals differences in yield and its components. In this concern. Balady cv. showed the highest average bulb weight and number of cloves per bulb, whereas, sids-40 cv. being the lowest in these characters. However, sids-40 cv. recorded higher average clove weight and total yield than cv. Balady during both seasons of study. Similar results were reported by El-Sayed (2004), Gowda *et al.,* (2007) and Dawood *et al.,* (2011).

b) Effect of nitrogen levels

The results reported in Table 7 indicate that average bulb weight, number of cloves per bulb, average clove weight and fresh yield of garlic plants were significantly affected by all the studied treatments, i.e. level of nitrogen (100 kg N/fed.) mineral and organic fertilizers.On the other hand. The lowest average bulb weight, number of cloves per bulb, average clove weight and total yield of garlic plants were resulted from the plants fertilized by level of nitrogen (50 kg N/fed.) organic fertilizers during both season. In this respect, the highest average bulb weight, number of cloves per bulb, average clove weight and fresh bulb yield were resulted by fertilizing the plants with inorganic nitrogen fertilizers 100 % of the recommended does in the two seasons. These results are in agreement with those obtained by Abou El-Magd *et al*., 2012, Ahmed *et al.,* 2012, Nori *et al*., 2012, Patel and Patel *et al*., 2012, Abou El-Magd *et al*., 2014 and Diriba-Shiferaw, 2014.

c) Effect of bio-enriched

Data (Table,7) show that fertigation with (compost extract + bio-fertilizers) gave higher average bulb weight, number of cloves per bulb, average clove weight and fresh yield of garlic plants per feddan than when without bio-enriched was added, as shown in both seasons. The enhancing effect of biofertilizer application could be referred to the role of free living bacteria on N-fixation in the soil and the role of PDB on increasing the available-P in the soil (Rai, 2006). Moreover, the mechanism of microorganisms on plant

growth and fruit yield depends on producing growth promoting substances (El-Hadad *et al.,* 1986) and enhancing nutrients uptake (Sarig *et al.,* 1984).Results on the favorable effect of biofertilizer application on number of cloves per bulb, average clove weight and fresh yield of garlic plants per feddan have been mentioned by (Abou El-Nasr *et al.,* 2001, Pham, 2004, Fawzy, 2007**,**Osman, 2007, Hargreaves *et al.,* 2009, Naidu *et al.,* 2010, Shrestha *et al.,* 2011 and Marzauk, *et al.,* 2014).working on garlic plants using fertigation with compost extract and yeast extract + bio-fertilizers.

Table 7: Effect of cultivars, nitrogen fertilizer levels in the form of organic and inorganic and bio- enriched applications on the yield and its components of garlic *(Allium sativum L.)* plants during two seasons.

Treatments			Seasons 1				Seasons 2			
Cultivars (A)	Nitrogen levels (B)	Bio – enriched (C)	Average bulb weight (g)	No. cloves / bulb	Average clove weight (g)	Total yield (t/fed)	Average bulb weight (g)	No. cloves / bulb	Average clove weight (g)	Total yield (t/fed)
Balady			46.83	22.37	3.05	6.653	53.61	23.24	3.45	7.044
Clone Sids-40			73.11	9.88	4.34	9.378	79.86	10.19	4.53	9.947
L.S.D. at 5% cultivars (A)			0.93	0.61	0.09	0.473	2.66	0.37	0.09	0.576
	50% Compost		53.56	15.31	3.31	7.444	58.83	15.98	3.61	7.783
	75% Compost		57.72	15.70	3.62	7.833	63.89	16.41	3.81	8.328
	100% Compost		61.61	16.42	3.78	8.222	68.33	16.87	4.02	8.733
	100% Mineral (Control)		67.00	17.07	4.06	8.561	75.89	17.60	4.52	9.139
L.S.D. at 5% nitrogen levels (B)			0.25	0.13	0.12	0.106	0.68	0.09	0.10	0.0821
		Without	55.17	15.48	3.26	7.554	61.08	16.05	3.63	8.142
		Yeast	59.83	16.17	3.71	8.050	66.83	16.76	4.00	8.500
		Compost extract	64.92	16.72	4.11	8.442	72.29	17.34	4.35	8.846
L.S.D. at 5% bio – fertilizers (C)			0.27	0.25	0.14	0.130	0.28	0.26	0.11	0.111

d) Effect of the interactions

The combined effect of cultivars and nitrogen levels increased average bulb weight, number of cloves per bulb, average clove weight and fresh yield of garlic plants per feddan (Table 8). The highest number of cloves per bulb, average clove weight and fresh yield was obtained by Sids-40 cv. and the highest nitrogen level, i. e. 100 kg N/fed., mineral or organic fertilizers compared with the control. The other interactions recorded the lowest values.

Table 8: Effect of the combination between cultivars and nitrogen fertilizer levels in the form of organic and inorganic applications on the yield and its components of garlic (*Allium sativum* L.) plants during two seasons.

Treatments		Seasons 1				Seasons 2			
Cultivars (A)	Nitrogen levels (B)	Average bulb weight (g)	No. cloves / bulb	Average clove weight (g)	Total yield (t/fed)	Average bulb weight (g)	No. cloves / bulb	Average clove weight (g)	Total yield (t/fed)
Balady	50% Compost	39.89	21.51	2.64	6.211	44.78	22.34	3.11	6.444
	75% Compost	43.33	21.83	2.98	6.522	49.56	22.88	3.32	6.933
	100% Compost	49.78	22.77	3.13	6.789	55.00	23.47	3.47	7.267
	100% Mineral (Control)	54.33	23.37	3.44	7.089	65.11	24.29	3.92	7.533
Clone Sids-40	50% Compost	67.22	9.10	3.98	8.678	72.89	9.622	4.12	9.122
	75% Compost	72.11	9.56	4.26	9.144	78.22	9.944	4.30	9.722
	100% Compost	73.44	10.08	4.44	9.656	81.67	10.27	4.56	10.200
	100% Mineral (Control)	79.67	10.78	4.67	10.030	86.67	10.91	5.13	10.740
L.S.D. at 5% interaction AXB		0.41	0.24	0.16	0.142	1.02	0.22	0.09	0.114

The combined effect of cultivars with bio-enriched increased average bulb weight, number of cloves per bulb, average clove weight and fresh yield of garlic plants per feddan (Table 9). These increases were similar in the two seasons. The highest number of cloves per bulb, average clove weight and fresh yield was obtained by the combined effect of Sids-40 cv. and (compost extract + bio-fertilizers). Whereas, lower average bulb weight, number of cloves per bulb, average clove weight and fresh yield was obtained by the other interactions. While by using nitrogen level and bio-enriched significantly increased average bulb weight, number of cloves per bulb, average clove weight and fresh yield in both seasons (Table10). The highest number of cloves per bulb, average clove weight and fresh yield was obtained by the combined effect of nitrogen level, i. e. 100 kg N/fed., mineral or organic fertilizers and (compost extract + bio-fertilizers). Whereas, lower average bulb weight, number of cloves per bulb, average clove weight and fresh yield was obtained by the other interactions.

Data presented in Table (11) show that, fertigation with compost extract + bio-fertilizers and fertilized with (100 kg N/fed.) mineral or organic fertilizers and Sids-40 cv. gave the highest average bulb weight, number of cloves per bulb, average clove weight and fresh yield with a significant increase in comparing

Table 9: Effect of the combination between cultivars and bio- enriched applications on the yield and its components of garlic (*Allium sativum* L.) plants during two seasons.

Treatments		Seasons 1				Seasons 2			
Cultivars (A)	Bio – enriched (C)	Average bulb weight (g)	No. cloves / bulb	Average clove weight (g)	Total yield (t/fed)	Average bulb weight (g)	No. cloves / bulb	Average clove weight (g)	Total yield (t/fed)
Balady	Without	42.08	21.62	2.54	6.200	48.08	22.48	3.09	6.708
	Yeast	46.42	22.45	3.11	6.708	53.58	23.25	3.47	7.067
	Compost extract	52.00	23.04	3.50	7.050	59.17	24.01	3.80	7.358
Clone Sids-40	Without	68.25	9.35	3.98	8.908	74.08	9.62	4.17	9.575
	Yeast	73.25	9.90	4.31	9.392	80.08	10.27	4.52	9.933
	Compost extract	77.83	10.39	4.73	9.833	85.42	10.67	4.89	10.33
L.S.D. at 5% AXC		0.49	0.28	0.19	0.166	1.19	0.26	0.11	0.136

Table10: Effect of the combination between nitrogen fertilizer levels in the form of organic and inorganic and bio- enriched applications on the yield and its components of garlic (*Allium sativum L.*) plants during two seasons.

Treatments		Seasons 1				Seasons 2			
Nitrogen levels (B)	Bio – enriched (C)	Average bulb weight (g)	No. cloves / bulb	Average clove weight (g)	Total yield (t/fed)	Average bulb weight (g)	No. cloves / bulb	Average clove weight (g)	Total yield (t/fed)
50% Compost	Without	51.67	14.82	3.00	7.117	55.00	15.55	3.31	7.533
	Yeast	53.00	15.25	3.38	7.517	58.67	15.93	3.63	7.717
	Compost extract	56.00	15.85	3.56	7.700	62.83	16.47	3.90	8.100
75% Compost	Without	53.17	15.17	3.16	7.317	59.33	15.85	3.45	7.883
	Yeast	58.00	15.70	3.68	7.883	64.33	16.52	3.83	8.367
	Compost extract	62.00	16.23	4.03	8.300	68.00	16.87	4.15	8.733
100% Compost	Without	56.00	15.68	3.36	7.683	62.00	16.10	3.71	8.367
	Yeast	61.67	16.65	3.80	8.250	67.83	16.97	4.01	8.800
	Compost extract	67.17	16.93	4.20	8.733	75.17	17.53	4.33	9.033
100% Mineral (Control)	Without	59.83	16.27	3.51	8.100	68.00	16.70	4.05	8.783
	Yeast	66.67	17.10	4.00	8.550	76.50	17.62	4.51	9.117
	Compost extract	74.50	17.85	4.66	9.033	83.17	18.48	5.01	9.517
L.S.D. at 5% B XC		00.39	00.22	0.15	0.134	0.95	0.21	0.08	0.109

Table11: Interaction effects among cultivars, nitrogen fertilizer levels in the form of organic and inorganic and bio- enriched applications on the yield and its components of garlic (*Allium sativum L.*) plants during two seasons.

Treatments			Seasons 1				Seasons 2			
Cultivars (A)	Nitrogen levels (B)	Bio – enriched (C)	Average bulb weight (g)	No. cloves / bulb	Average clove weight (g)	Total yield (t/fed)	Average bulb weight (g)	No. cloves / bulb	Average clove weight (g)	Total yield (t/fed)
Balady	50% Compost	Without	37.67	20.93	2.30	5.933	41.00	21.87	2.83	6.200
		Yeast	39.00	21.43	2.76	6.367	44.67	22.33	3.16	6.433
		Compost extract	43.00	22.17	2.86	6.333	48.67	22.83	3.33	6.700
	75% Compost	Without	39.33	21.27	2.46	6.000	44.67	22.30	2.93	6.533
		Yeast	43.33	21.90	3.10	6.533	50.00	22.90	3.36	7.000
		Compost extract	47.33	22.33	3.40	7.033	54.00	23.43	3.66	7.267
	100% Compost	Without	43.67	21.83	2.63	6.200	48.67	22.63	3.10	6.867
		Yeast	50.00	23.10	3.20	6.867	54.33	23.57	3.50	7.367
		Compost extract	55.67	23.37	3.56	7.300	62.00	24.20	3.83	7.567
	100% Mineral (Control)	Without	47.67	22.43	2.76	6.667	58.00	23.10	3.50	7.233
		Yeast	53.33	23.37	3.40	7.067	65.33	24.20	3.86	7.467
		Compost extract	62.00	24.30	4.16	7.533	72.00	25.57	4.40	7.900
Clone Sids-40	50% Compost	Without	65.67	8.70	3.70	8.300	69.00	9.23	3.80	9.000
		Yeast	67.00	9.06	4.00	8.667	72.67	9.53	4.10	9.500
		Compost extract	69.00	9.53	4.26	9.067	77.00	10.10	4.46	9.233
	75% Compost	Without	67.00	9.06	3.86	8.633	74.00	9.40	3.96	9.733
		Yeast	72.67	9.50	4.26	9.233	78.67	10.13	4.30	10.20
		Compost extract	76.67	10.13	4.66	9.567	82.00	10.30	4.63	9.867
	100% Compost	Without	68.33	9.53	4.10	9.167	75.33	9.56	4.33	10.23
		Yeast	73.33	10.20	4.40	9.633	81.33	10.37	4.53	10.50
		Compost extract	78.67	10.50	4.83	10.17	88.33	10.87	4.83	10.33
	100% Mineral (Control)	Without	72.00	10.10	4.26	9.533	78.00	10.30	4.60	10.77
		Yeast	80.00	10.83	4.60	10.030	87.67	11.03	5.16	11.13
		Compost extract	87.00	11.40	5.16	10.530	94.33	11.40	5.63	9.000
L.S.D. at 5% interaction AXBXC			00.55	00.32	0.21	0.189	1.36	0.30	0.12	0.154

without bio-enriched, 50% NPK organic fertilizers and cv.Balady came in both seasons. Similar results were reported by Naruka and Dhaka (2001), Hassan (2002), Tiwari *et al.,* (2002), Pardo and Marin (2003), Patil *et al.,* (2003), El-Sayed (2004), Costa *et al.,* (2004), Mohamed(2004),Pham (2004), Baghalian *et al.,* (2005), Gowda *et al.,* (2007), Fawzy (2007)**,**Osman (2007), Moustafa *et al.,* (2009) , Aly(2010), Abou El-Magd *et al*., (2014) and Zaki *et al*., (2014).

3- Bulb characteristics

a) Effect of cultivars

Data on bulb characteristics, i.e. neck diameter, bulb diameter and bulbing ratio for the studied cultivars under different nitrogen levels were presented in Table 12. Such data reveal that there were significant differences in most studied bulb characteristics among cv. Balady and Sids-40 In this respect, cv. Balady recorded the highest values in neck diameter, bulb diameter and bulbing ratio than cv.Sids-40. Obtained results may be attributed to the genetically variance that showed bulb characteristics, i.e. neck diameter, bulb diameter and bulbing ratio differences among the studied cultivars. Similar results were reported by El-Moustafa *et al.,* (2009) and Aly (2010) on Balady and clone Sids-40 garlic cultivars.

b) Effect of nitrogen levels

Linear and statistical increase was obtained in the bulb characteristics, i.e. neck diameter, bulb diameter and bulbing ratio by increasing nitrogen levels up to its highest level, i.e. (100 kg N/fed.) mineral or organic fertilizers .the lowest neck diameter, bulb diameter and bulbing ratio was obtained by (50 kg N/fed.) organic fertilizers (control treatments). The results were nearly similar in the two seasons of the experiment. Some investigators showed the same trend (Abou El-Magd *et al*., 2012, Ahmed *et al.,* 2012, Nori *et al*., 2012, Patel and Patel *et al*., 2012, Abou El-Magd *et al*., 2014 and Diriba-Shiferaw, 2014). The increase of bulb characteristics, i.e. neck diameter, bulb diameter and bulbing ratio by increasing nitrogen level might be due to its role in photosynthesis, protein synthesis, cell division and enlargement which are the basal steps of plant growth. In addition, nitrogen plays an important role in the enzyme activity which reflects more products needed in plant growth

c) Effect of bio-enriched

Bio-enriched increased the bulb characteristics, i.e. neck diameter, bulb diameter and bulbing ratio as shown in Table 12. These increases were statistically significant and similar in the two seasons of the experiment.Many investigators reported that bio-enriched increased bulb characteristics (Naidu *et al.,* 2010, Shrestha *et al.,* 2011 and Marzauk, *et al.,* 2014).The increase in the bulb characteristics, i.e. neck diameter, bulb diameter and bulbing ratio by bio-enriched might be due to its effect in dissolving soil nutrients which offers more available nutrients for absorption by the root system (Abdel-Razzak and EI-Sharkawy, 2013 ,Abou El-Magd *et al*., 2014 and Zaki *et al*., 2014). This increase in the bulb characteristics might also be due to the effect of auxins and nutrients which are exerted by bio-enriched (Gomaa, 1995).

Table 12: Effect of cultivars, nitrogen fertilizer levels in the form of organic and inorganic and bio-enriched applications on Bulb Characteristics of garlic *(Allium sativum L.)* plants during two seasons.

Treatments			Seasons 1			Seasons 2		
Cultivars (A)	Nitrogen levels (B)	Bio – enriched (C)	Neck diameter (cm)	Bulb diameter (cm)	Bulbing ratio %	Neck diameter (cm)	Bulb diameter (cm)	Bulbing ratio %
Balady			1.18	4.44	26.6	1.21	4.53	26.6
Clone Sids-40			1.47	5.24	27.9	1.56	5.41	28.8
L.S.D. at 5% cultivars (A)			0.09	0.21	01.4	0.09	0.29	01.7
	50% Compost		1.25	4.66	26.7	1.31	4.77	27.3
	75% Compost		1.30	4.78	27.1	1.36	4.93	27.5
	100% Compost		1.36	4.90	27.7	1.40	5.00	27.9
	100% Mineral (Control)		1.40	5.03	27.7	1.46	5.18	28.0
L.S.D. at 5% nitrogen levels (B)			0.03	0.04	00.4	0.03	0.03	00.2
		Without	1.27	4.71	26.9	1.33	4.86	27.2
		Yeast	1.33	4.85	27.3	1.38	4.97	27.7
		Compost extract	1.37	4.97	27.6	1.44	5.08	28.1
L.S.D. at 5% bio – fertilizers (C)			0.04	0.05	00.4	0.04	0.04	00.3

d) Effect of the interactions

The combined effect of cultivars and nitrogen levels increased the bulb characteristics, i.e. neck diameter, bulb diameter and bulbing ratio (Table13). The highest neck diameter, bulb diameter and bulbing ratio was obtained by Sids-40 cv. and the highest nitrogen level, i. e. 100 kg N/fed., mineral or organic fertilizers compared with the control. The other interactions recorded the lowest values.

Table13: Effect of the combination between cultivars and nitrogen fertilizer levels in the form of organic and inorganic applications on Bulb Characteristics of garlic (*Allium sativum* L.) plants during two seasons.

Treatments		Seasons 1			Seasons 2		
Cultivars (A)	Nitrogen levels (B)	Neck diameter (cm)	Bulb diameter (cm)	Bulbing ratio **%**	Neck diameter (cm)	Bulb diameter (cm)	Bulbing ratio **%**
Balady	50% Compost	1.11	4.33	25.6	1.13	4.40	25.8
	75% Compost	1.16	4.41	26.2	1.18	4.47	26.3
	100% Compost	1.23	4.46	27.5	1.24	4.57	27.1
	100% Mineral (Control)	1.24	4.57	27.1	1.28	4.68	27.2
Clone Sids-40	50% Compost	1.39	5.00	27.8	1.48	5.14	28.8
	75% Compost	1.44	5.15	27.9	1.55	5.38	28.7
	100% Compost	1.49	5.34	27.8	1.56	5.44	28.7
	100% Mineral (Control)	1.56	5.50	28.3	1.64	5.68	28.8
L.S.D. at 5% interaction AXB		0.04	0.05	00.5	0.04	0.05	0.3

The combined effect of cultivars and bio-enriched recorded linear increases in bulb characteristics, i.e. neck diameter, bulb diameter and bulbing ratio (Table 14). It could be reported that the highest neck diameter, bulb diameter and bulbing ratio were obtained by the combined effect of bio-enriched (compost extract + bio-fertilizers**)** and cv.Sids-40 compared with the other interactions.

Table 14: Effect of the combination between cultivars and bio-enriched applications on Bulb Characteristics of garlic (*Allium sativum* L.) plants during two seasons.

Treatments		Seasons 1			Seasons 2		
Cultivars (A)	Bio – enriched (C)	Neck diameter (cm)	Bulb diameter (cm)	Bulbing ratio **%**	Neck diameter (cm)	Bulb diameter (cm)	Bulbing ratio **%**
Balady	Without	1.12	4.32	26.0	1.15	4.44	25.8
	Yeast	1.19	4.45	26.7	1.21	4.52	26.8
	Compost extract	1.24	4.55	27.2	1.26	4.63	27.2
Clone Sids-40	Without	1.42	5.11	27.8	1.51	5.27	28.5
	Yeast	1.47	5.24	28.0	1.56	5.42	28.7
	Compost extract	1.51	5.38	28.0	1.61	5.53	29.1
L.S.D. at 5% AXC		0.05	0.06	00.6	0.05	0.05	0.6

The combined effect of the highest level of nitrogen (100 kg N/fed.) mineral and or organic fertilizers and bio-enriched (compost extract + bio-fertilizers**)** (Table15). In addition, the lowest bulb characteristic was obtained by the combined effect of 50% N organic fertilizers and without bio-enriched.

Table 15: Effect of the combination between nitrogen fertilizer levels in the form of organic and inorganic and bio-enriched applications on bulb Characteristics of garlic (*Allium sativum* L.) plants during two seasons.

Treatments		Seasons 1			Seasons 2		
Nitrogen levels (B)	Bio – enriched (C)	Neck diameter (cm)	Bulb diameter (cm)	Bulbing ratio **%**	Neck diameter (cm)	Bulb diameter (cm)	Bulbing ratio **%**
50% Compost	Without	1.20	4.55	26.3	1.25	4.65	26.8
	Yeast	1.25	4.65	26.8	1.32	4.75	27.7
	Compost extract	1.29	4.79	26.9	1.35	4.90	27.5
75% Compost	Without	1.24	4.62	26.8	1.30	4.81	26.9
	Yeast	1.30	4.81	26.9	1.36	4.93	27.4
	Compost extract	1.35	4.90	27.6	1.43	5.04	28.2
100% Compost	Without	1.31	4.76	27.5	1.35	4.90	27.5
	Yeast	1.36	4.89	27.8	1.40	5.00	27.9
	Compost extract	1.39	5.05	27.6	1.45	5.11	28.3
100% Mineral (Control)	Without	1.33	4.92	27.0	1.40	5.07	27.5
	Yeast	1.40	5.04	27.9	1.46	5.20	27.9
	Compost extract	1.46	5.15	28.3	1.51	5.27	28.6
L.S.D. at 5% B X C		0.04	0.05	00.5	0.04	0.04	0.4

Interactions of cultivars, nitrogen levels and bio-enriched, 100% NPK mineral and organic fertilizers and Sids-40 cv. statistically affected neck diameter, bulb diameter and bulbing ratio (Table 16). In general, the highest values of bulb characteristics were obtained by the combined effect of cultivars and nitrogen levels reflected statistical increases in the vegetative growth of garlic plant. The highest bulb characteristics was obtained by bio-enriched (compost extract + bio-fertilizers**)**, the highest level of nitrogen (100 kg N/fed.) mineral or organic fertilizers and cv.Sids-40. Lower values of bulb characteristics were obtained by without bio-enriched, lower level of compost and cv. Balady. These results are in agreement with those obtained by (Abou

El-Magd *et al*., 2012, Ahmed *et al.,* 2012, Abdel-Razzak and EI-Sharkawy, 2013, Abou El-Magd *et al*., 2014 and Zaki *et al*., 2014) on garlic.

Table 16: Interaction effects among cultivars, nitrogen fertilizer levels in the form of organic and inorganic and bio-enriched applications on Bulb Characteristics of garlic (*Allium sativum* L.) plants during two seasons.

Treatments			Seasons 1			Seasons 2		
Cultivars (A)	Nitrogen levels (B)	Bio – enriched (C)	Neck diameter (cm)	Bulb diameter (cm)	Bulbing ratio %	Neck diameter (cm)	Bulb diameter (cm)	Bulbing ratio %
Balady	50% Compost	Without	1.05	4.20	25.0	1.07	4.30	24.8
		Yeast	1.11	4.33	25.6	1.16	4.36	26.6
		Compost extract	1.17	4.46	26.1	1.18	4.53	26.0
	75% Compost	Without	1.09	4.25	25.7	1.12	4.38	25.5
		Yeast	1.15	4.45	25.9	1.17	4.48	26.2
		Compost extract	1.23	4.53	27.1	1.24	4.56	27.2
	100% Compost	Without	1.17	4.35	27.0	1.18	4.50	26.2
		Yeast	1.24	4.46	27.7	1.25	4.56	27.3
		Compost extract	1.27	4.56	27.9	1.29	4.65	27.7
	100% Mineral (Control)	Without	1.17	4.48	26.2	1.23	4.58	26.8
		Yeast	1.26	4.58	27.5	1.27	4.70	27.1
		Compost extract	1.29	4.66	27.7	1.33	4.78	28.8
Clone Sids-40	50% Compost	Without	1.35	4.90	27.6	1.44	5.00	28.8
		Yeast	1.39	4.98	27.9	1.48	5.15	28.9
		Compost extract	1.42	5.11	27.7	1.53	5.28	28.3
	75% Compost	Without	1.39	5.00	27.8	1.49	5.25	28.7
		Yeast	1.44	5.18	27.8	1.55	5.38	29.3
		Compost extract	1.48	5.26	28.1	1.62	5.51	28.8
	100% Compost	Without	1.46	5.18	28.1	1.53	5.30	28.6
		Yeast	1.49	5.31	28.0	1.56	5.45	28.8
		Compost extract	1.52	5.53	27.4	1.61	5.58	28.2
	100% Mineral (Control)	Without	1.49	5.36	27.8	1.57	5.56	28.8
		Yeast	1.55	5.50	28.2	1.64	5.70	29.4
		Compost extract	1.63	5.63	28.9	1.70	5.77	28.8
L.S.D. At 5% interaction		A X B X C	0.06	0.08	00.7	0.06	0.06	0.5

4- Chemical constituents of garlic bulb:

a) Effect of cultivar

Data recorded in Table 17 show clearly that there were significant differences among the tested cultivars in the percentage of total nitrogen, phosphorus and potassium for the produced cloves during both seasons of growth. In this regard, the highest values for the percentage of all assayed macro-elements (N, P and k) were noticed in case of cv. (clone Sids-40) gloves compared with cv. Balady. Obtained results may be due to the difference in genotype potential which affects the absorption and accumulation of N, P and K in cloves of garlic plant. Similar results were reported by Mohamed (*2004*), Baghalian *et al.,* (2005), Gowda *et al.,* (2007), Moustafa *et al.,* (2009), Aly (2010) and Dawood *et al.,* (2011).

b) Effect of nitrogen levels

Results recorded in Table 17 indicate that total nitrogen, phosphorus and potassium percentages in garlic cloves were statistically increased by increasing nitrogen level up to 100 kg N/fed., during both seasons of study. In this respect, garlic plants fertilized with inorganic or organic nitrogen fertilizers 100 % of the recommended nitrogen fertilizer reflected the highest values of nitrogen, phosphorus and potassium percentage during both seasons of growth. Obtained results as in agreement with those reported by Suthar (2009), Yassen and Khalid (2009), Aly (2010) and Dawood *et al.,* (2011).

c) Effect of bio-enriched

The highest percentage of total nitrogen, phosphorus and potassium in garlic cloves were obtained by (compost extract + bio-fertilizers). Lower values were obtained by without bio-fertilizers. The results were true and similar in the two seasons. The other treatments ranged between these two limits without clear trend (Table 17). Results of the chemical garlic cloves were similar in the two seasons. Obtained results are in agreement with those reported by Fawzy (2007)**,** Osman (2007), Moustafa *et al.,* (2009), Aly (2010) and Dawood *et al.,* (2011).

Table 17: Effect of cultivars, nitrogen fertilizer levels in the form of organic and inorganic and bio-enriched applications on chemical constituents of garlic *(Allium sativum* L.) plants during two seasons.

Treatments			Seasons 1			Seasons 2		
Cultivars (A)	Nitrogen levels (B)	Bio – enriched (C)	Nitrogen %	Phosphorus %	Potassium %	Nitrogen %	Phosphorus %	Potassium %
Balady			1.96	0.392	2.36	2.28	0.491	2.88
Clone Sids-40			2.44	0.508	3.02	2.55	0.552	3.26
L.S.D. at 5% cultivars (A)			0.40	0.094	0.21	0.09	0.094	0.09
	50% Compost		1.91	0.394	2.26	2.15	0.448	2.61
	75% Compost		2.11	0.428	2.48	2.28	0.496	2.88
	100% Compost		2.30	0.467	2.81	2.52	0.551	3.22
	100% Mineral (Control)		2.48	0.511	3.22	2.70	0.592	3.56
L.S.D. at 5% nitrogen levels (B)			0.033	0.033	0.04	0.06	0.067	0.03
		Without	2.00	0.415	2.39	2.16	0.470	2.74
		Yeast	2.20	0.451	2.71	2.45	0.526	3.06
		Compost extract	2.40	0.485	2.97	2.63	0.570	3.40
L.S.D. at 5% bio – fertilizers (C)			0.08	0.039	0.03	0.05	0.068	0.07

d) Effect of the interactions

The combined effect of cultivars and nitrogen levels increased total nitrogen, phosphorus and potassium percentages in garlic cloves during both seasons of study (Table 18). The highest percentage of total nitrogen, phosphorus and potassium for the produced cloves was obtained by cv. Sids-40 combined with the highest nitrogen level, i. e. 100 kg N/fed., mineral or organic fertilizers compared with the control. The other interactions recorded the low values.

Table 18: Effect of the combination between cultivars and nitrogen fertilizer levels in the form of organic and inorganic applications on chemical constituents of garlic (*Allium sativum L.*) plants during two seasons.

Treatments		Seasons 1			Seasons 2		
Cultivars (A)	Nitrogen levels (B)	Nitrogen %	Phosphorus %	Potassium %	Nitrogen %	Phosphorus %	Potassium %
Balady	50% Compost	1.68	0.351	1.96	2.02	0.414	2.50
	75% Compost	1.85	0.375	2.20	2.15	0.467	2.66
	100% Compost	2.05	0.401	2.44	2.43	0.524	2.95
	100% Mineral (Control)	2.24	0.442	2.83	2.53	0.561	3.40
Clone Sids-40	50% Compost	2.14	0.437	2.55	2.28	0.482	2.72
	75% Compost	2.37	0.481	2.76	2.42	0.525	3.11
	100% Compost	2.54	0.534	3.17	2.61	0.578	3.48
	100% Mineral (Control)	2.72	0.580	3.61	2.87	0.624	3.73
L.S.D. at 5% interaction A X B		0.08	0.047	0.19	0.08	0.047	0.06

The combined effect of cultivars with bio-enriched increased total nitrogen, phosphorus and potassium percentages in garlic cloves. These increases were similar in the two seasons (Table 19). The highest percentage of total nitrogen, phosphorus and potassium for the produced cloves was obtained by the combined effect of Sids-40 cv. and (compost extract +bio-fertilizers). Whereas, the lower percentage of total nitrogen, phosphorus and potassium for the produced cloves was obtained by the other interactions.

Table 19: Effect of the combination between cultivars and bio-enriched applications on chemical constituents of garlic (*Allium sativum L.*) plants during two seasons.

Treatments		Seasons 1			Seasons 2		
Cultivars (A)	Bio – enriched (C)	Nitrogen %	Phosphorus %	Potassium %	Nitrogen %	Phosphorus %	Potassium %
Balady	Without	1.75	0.367	2.10	2.01	0.449	2.55
	Yeast	1.98	0.395	2.37	2.31	0.491	2.88
	Compost extract	2.14	0.415	2.60	2.52	0.535	3.20
Clone Sids-40	Without	2.24	0.462	2.67	2.31	0.491	2.94
	Yeast	2.42	0.507	3.05	2.58	0.561	3.24
	Compost extract	2.67	0.555	3.35	2.75	0.605	3.60
L.S.D. at 5% A X C		0.09	0.055	0.22	0.09	0.055	0.07

Also, it is noticed that in most cases nitrogen level and bio-enriched significantly increased percentage of total nitrogen, phosphorus and potassium for the produced cloves in both seasons (Table 20). The highest percentage of total nitrogen, phosphorus and potassium for the produced cloves was obtained by the combined effect of nitrogen level, i. e. 100 kg N/fed., mineral or organic fertilizers and (compost extract + bio-fertilizers).

Whereas, lower percentage of total nitrogen, phosphorus and potassium for the produced cloves was obtained by the other interactions.

Table 20: Effect of the combination between nitrogen fertilizer levels in the form of organic and inorganic and bio-enriched applications on chemical constituents of garlic (*Allium sativum L.*) plants during two seasons.

Treatments		Seasons 1			Seasons 2		
Nitrogen levels (B)	Bio – enriched (C)	Nitrogen %	Phosphorus %	Potassium %	Nitrogen %	Phosphorus %	Potassium %
50% Compost	Without	1.73	0.370	2.06	1.93	0.063	2.40
	Yeast	1.90	0.393	2.28	2.16	0.063	2.60
	Compost extract	2.11	0.420	2.43	2.36	0.063	2.83
75% Compost	Without	1.91	0.395	2.13	2.06	0.063	2.58
	Yeast	2.08	0.423	2.51	2.33	0.063	2.90
	Compost extract	2.35	0.466	2.80	2.46	0.063	3.18
100% Compost	Without	2.11	0.428	2.51	2.25	0.063	2.85
	Yeast	2.31	0.480	2.81	2.56	0.063	3.20
	Compost extract	2.46	0.495	3.10	2.75	0.063	3.61
100% Mineral (Control)	Without	2.23	0.466	2.85	2.41	0.063	3.15
	Yeast	2.51	0.508	3.23	2.73	0.063	3.55
	Compost extract	2.70	0.558	3.58	2.96	0.063	4.00
L.S.D. At 5% B X C		0.07	0.044	0.18	0.07	0.044	0.06

As for the affect of the interaction between the used cultivars, nitrogen levels and bio-enriched , the same date in Table 21 show that the highest percentage of nitrogen, phosphorus and potassium was recorded in case of fertigation with compost extract + bio-fertilizers and fertilized with (100 kg N/fed.) mineral or organic fertilizers and Sids-40 cv., during both seasons of study. These results are in conformity with those obtained by Baghalian *et al.,* (2005), Shaheen *et al.,* (2005), Gowda *et al.,* (2007), Fawzy (2007)**,**Osman (2007), Moustafa *et al.,* (2009), Yassen and Khalid (2009), Aly (2010) ,Dawood *et al.,* (2011) Abou El-Magd *et al*., (2014) and Zaki *et al*., (2014).

Table 21: Interaction effects among cultivars, nitrogen fertilizer levels in the form of organic and inorganic and bio-fertilizer applications on chemical constituents of garlic (*Allium sativum L.*) plants during two seasons.

Treatments			Seasons 1			Seasons 2		
Cultivars (A)	Nitrogen levels (B)	Bio – enriched (C)	Nitrogen %	Phosphorus %	Potassium %	Nitrogen %	Phosphorus %	Potassium %
Balady	50% Compost	Without	1.56	0.333	1.80	1.80	0.393	2.30
		Yeast	1.66	0.350	2.00	2.03	0.406	2.50
		Compost extract	1.83	0.370	2.10	2.23	0.443	2.70
	75% Compost	Without	1.66	0.350	1.93	1.93	0.426	2.40
		Yeast	1.86	0.370	2.20	2.20	0.470	2.70
		Compost extract	2.03	0.406	2.46	2.33	0.506	2.90
	100% Compost	Without	1.83	0.376	2.20	2.10	0.470	2.60
		Yeast	2.06	0.420	2.46	2.46	0.530	2.93
		Compost extract	2.26	0.406	2.66	2.73	0.573	3.33
	100% Mineral (Control)	Without	1.96	0.410	2.50	2.23	0.506	2.90
		Yeast	2.33	0.440	2.83	2.56	0.560	3.40
		Compost extract	2.43	0.476	3.16	2.80	0.616	3.90
Clone Sids-40	50% Compost	Without	1.90	0.406	2.33	2.06	0.423	2.50
		Yeast	2.13	0.436	2.56	2.30	0.486	2.70
		Compost extract	2.40	0.470	2.76	2.50	0.536	2.96
	75% Compost	Without	2.16	0.440	2.33	2.20	0.470	2.76
		Yeast	2.30	0.476	2.83	2.46	0.526	3.10
		Compost extract	2.66	0.526	3.13	2.60	0.580	3.46
	100% Compost	Without	2.40	0.480	2.83	2.40	0.523	3.10
		Yeast	2.56	0.540	3.16	2.66	0.590	3.46
		Compost extract	2.66	0.583	3.53	2.76	0.623	3.90
	100% Mineral (Control)	Without	2.50	0.523	3.20	2.60	0.550	3.40
		Yeast	2.70	0.576	3.63	2.90	0.643	3.70
		Compost extract	2.96	0.640	4.00	3.13	0.680	4.10
L.S.D. At 5% interaction A X B X C			0.11	0.063	0.26	0.10	0.063	0.08

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