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Effect of Nitrogen Fertilization and Some Foliar Applications on Growth, Yield and Quality of Two Garlic (*Allium sativum* L) Cultivars

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ABSTRACT

Improving garlic yield and enhancing bulb quality are essential aims for requirements of the market and the consumers. The field experiment was carried out during two winter successive seasons of 2015/2016 and 2016/2017, at the experimental farm of Ain Shams University, Faculty of Agriculture, Cairo, Egypt, to find out the influence of combination of nitrogen level and some foliar applications, i.e. tea compost, amino acids, yeast extract, seaweed extract and humic acids on plant growth, yield, and bulb chemical contents of two garlic plants cultivars "Balady and Sids-40". Results indicated that the combination of the recommended nitrogen level with foliar application of tea compost or yeast gave the highest values of plant growth, bulb weight and total yield for both cultivars.

***Keywords*:** Garlic- bio-Fertilization-growth-yield- chemical bulb contents.

Introduction

Garlic (*Allium sativum* L.) is one of the most important vegetable crops and is next to onion (*Allium cepa*) in importance (Shafeek *et al*., 2015b).

It is commonly cultivated for its flavor and 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). Abdel Razzak and El-Sharkawy (2013) reported that using chemical fertilizers alone for garlic can have negative effect on soil fertility and can lead to reducing yields, while, application of chemical fertilizers with organic manures and biofertilizers can maintain soil fertility and soil productivity (Zaghloul *et al*.,2016).

The increased amounts of inorganic fertilizers are applied to vegetables in order to achieve a higher yield. However, chemical fertilizers have negative effects to the environment and human health, the synthetic N, P and K fertilizers are quickly lost by either evaporation or by leaching in drainage water causing harmful environmental pollution (Ali *et al.,* 2007 and Dawa *et al.,* 2012).

Natural fertilizers are applied to decrease pollution sources in agriculture. One of the method to reduce soil pollution is the use of natural -stimulants, which have become commonly used as a safety plant growth regulators and vitamins. Such compounds can also reinforcement plant resistance and tolerance to environmental stresses. In addition, the increasing concern on the effect of chemical fertilizer on the environment makes organic fertilizer better alternatives to crop and safer. Therefore, integrated use of inorganic and organic fertilizers are preferred to get better growth, bulb characters, and increasing yields in garlic (Zaghloul *et al*., 2016). So the aim of this work was to study the effect of nitrogen with different natural foliar extract applications on growth, total bulb yield and its components as well as the contents of garlic cloves.

Material and Methods

This work was carried out at Horticulture Department, Agriculture Faculty, Ain Shams University during the two successive seasons 2015/2016 and 2016/2017 to study the effect of nitrogen fertilization and natural foliar extracts (tea compost, amino acids, yeast compost , seaweed extract and humic acids) on the two garlic cultivars " Balady and Sids-40" . The cloves were sown on 15th of September of both seasons at 10 cm apart on the two sides of each row. The plot area was 10.5 m2 (one row of 14 m length and 0.75m width). Garlic plants were harvested in April of both seasons. A spilt spilt plot design with three replicates was used. The main plots were for nitrogen, whereas the sub plots were for foliar

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treatments and the cultivars were placed in the sub – sub plots. The bulbs of both cultivars were obtained from the Horticulture Research Institute, Agricultural Research Center, Egypt.

Table 1: The physical and chemical properties of the experimental soil.

Physical properties					
Corase sand (%)	**Fine sand (%)**	**Silt (%)**	**Clay (%)**	**Organic matter (%)**	**Texture**
2.7	5.7	35.8	51.0	2.1	Clay loam

Chemical properties											
									Available mg/kg Soil		
EC dS/m	**CO^-_3**	**HCO^-_3**	**Cl^-**	**So^-_4**	**Ca^{++}**	**Mg^{++}**	**Na^+**	**K^+**	**N**	**P**	**K**
1.94	0.00	4.0	7.5	9.3	6.7	5.56	8.7	4.9	20.7	3.7	650.3

The experimental treatments

1- **Nitrogen fertilization**, the N fertilizer was added in the form of ammonium sulphate [$(NH4)_2$ SO_4:20.6%N)]. The recommended dose was added at the rate of 500 K N/fed and the half of recommended was added at 250 K N/fed. The given doses were divided into four equal parts, the first was with the preparation of the soil plus 20 m^3 the manure, the second was after sprouting, the third was after one month from the second and the final dose after three months from the third.

2- Foliar application with:

a- **Tea compost;** the stock nutrient solutions of tea compost was prepared by soaking 4 L from each compost in 20 L of water (1:5 by volume) as indicated by Ryan (2003) with addition of 200 ml from both *B. Circulans* and *B. megatheriu*. The brewing of the compost occurring after 48 hours to get the concentrated compost tea. The concentrated compost tea was filtrated to get the clear solution, and then used to prepare the organic nutrient solution by diluting this stock up to 100 L water in solution tank. The EC level was adjusted to 2.5 dS/m as mentioned by El-Shinawy *et al*. (1990). The chemical properties of the used tea compost was 24%moiture, 76.74% ash, N 0.78% total, P 0.48% total and 0.82% total K.

b- **Amino acid** is a commercial name for amino acids compound; it contains (W/V) 42/85% amino acids (85% total amino acids, 42%free amino acids, 10% organic nitrogen, 2.5% potassium oxide (Osman, 2015).

c- **Yeast compost:** backer's yeast was mixed with sugar at ratio of 1:1 and left for 3 hours at room temperature. Then it was frozen for disruption of yeast tissue and releasing their content, preparation of yeast extract was done according to El-Ghamriny *et al.* (1990) at the rates of 10 g/l.

d- **Seaweed extract:** A commercial seaweed extract product "Alga 600" (Techno green company) mixed of three seaweeds viz., *Ascophyllum nodosum, Laminaria* spp and *Sargassum* sp. Seaweed extract also contains 1% N, 18.5% K, 0.17% Ca, 0.42%Mg, 0.06% Fe, 2.2% S, 10-12% alganic acids and 600 ppm plant hormones (Shafeek *et al.,* 2015 a).

e- **Humic acid:** Black granules of potassium humate its origin from spain were mixed with tap water and sprayed on the growing garlic plants at the treatment rate 2 g L. Humic acid spraying numbers were started after one month from planting date and every 30 days for three times throughout the growing season. Composition: 80% humic acid, 5% Fulvic acid, 8% K_2O, 0.08% P_2O_5, 3.4% Ca, 0.32% Mg, 1.89%Fe, 0.24% Zn, 0.32% Cu, 0.05% B and 95 % soluble matter(Vallini *et al.,*1990).

Plants were sprayed with the used foliar application treatments three times during the growing seasons. The first spray was after 6 weeks from planting date, the second spray was after 3 weeks from the first spray and the third spray was after 3 weeks from the second spray.

Data Recorded:

Vegetative growth:

Leaf number, length and width (of the forth leaf) were measured at 4 months after the sowing.

Yield characteristics

After harvest, the fresh and dry weight of plant, bulb diameter, clove number, bulb weight, and total yield/fed. (6 months after the sowing) were recorded.

Chemical analysis: (6 months after the sowing).

a- Total soluble solids were measured in cloves using the handle refract meter.
b- Total nitrogen and phosphorus in tissue of produced cloves, were determined according to the methods which were described by Pregl (1945)

Statistical analysis

Data obtained in the two seasons of study was subjected to analysis using (Duncan.1995).

Results and Discussion

Vegetative growth

It could be, in general, concluded from (Table 2) that the higher plant length, leaf number, leaf width, plant fresh weight and dry weight, were obtained by the recommended nitrogen level, compared to the half recommended N level in both seasons. Betewulign and Solomon (2014) reported that leaf length of garlic increased with the increased rate of nitrogen fertilizer. Tadesse (2015) also reported that application of nitrogen significantly increased leaf width in compared to lower dosage and nil application of nitrogen fertilizer, the result indicated that leaf width increased with increased levels of fertilizers. This might be due to its role in in the enzyme activity photosynthesis, protein synthesis, cell division and expansion which are the basal steps of plant growth Hassan (2015). The increase in mean fresh weight of plant in response to nitrogen application could be refer to the increase in number of leaves produced, leaf length, and extended physiological maturity in response to the fertilization, all of which may have led to increased assimilate production and allocation to the bulbs (Kokobe *et al.,* 2013; Tadesse, 2015; Fikru and Fikreyohannes, 2018).

The yeast and tea compost extracts were, generally, the most effective in stimulating the plant growth, i.e. length, leaf number, leaf width, fresh and dry weight (Table 2) compared to other tested spray extracts. Spraying of tea compost extract gave the highest values of plant length, fresh and dry weights of plants. Yeast extract enhanced plant length, leaf number, leaf width and fresh weights of plants. Amino acid was also effective in increasing leaf width.

Balady cultivar plants showed, generally, narrower leaf width, higher fresh and lower dry weights compared to those of cv Sids-40 this may be due to the genetic differences between the two cultivars.

Concerning the interaction between The recommended N level combined with yeast or tea compost with cv Balady gave the highest values of length and fresh weight of plants, the recommended N level with cv Balady or cv Sids-40 combined with tea compost extract were the most effective treatments for plant dry weight, the recommended N level with cv Balady combined yeast extract or with cv sides combined with tea compost or yeast extract were the best for number of leaves and the recommended N level with cv Sids-40 combined with tea compost, amino acids or yeast extract were the most favorable treatments for leaf width . The positive effect of yeast extract may be referred to the promotion of plant hormones and the natural cytokinins content in yeast which stimulate cell division and enlargement (Spencer *et al.,* 1983).

Bulb characters and Yield

Data in Table 3 show that the plants which received the recommended nitrogen level produced higher bulb weight, diameter and total yield compared to those fertilized the half recommended level. This might be due to the stimulating effect of N on plant growth (table 2). As for spray treatments, tea compost followed in decreasing order by yeast were the most effective in increasing bulb weight, diameter and yield, the positive effects of tea compost and yeast on yield may be due to their encourage effect on plant growth (table 2). No significant difference was found between the yield of the tested

Table 2: Effects of nitrogen levels, cultivars and some foliar applications on growth of garlic (*Allium sativum* L.) plants.

Treatments			2015/2016 Plant height (cm)	No. of leaves/plant	Leaf width (cm)	Fresh weight (g/plant)	Dry weight (g/plant)	2016/2017 Plant height (cm)	No. of leaves/plant	Leaf width (cm)	Fresh weight (g/plant)	Dry weight (g/plant)
Nitrogen	**Recommended N level**		66.41 a	10.14 a	1.57 a	64.27a	20.53a	66.82a	9.37a	1.65a	60.47a	23.00a
	Half N level recommended		54.02 b	9.26 b	1.22b	51.08b	11.89b	61.99b	9.13a	1.25b	57.99a	20.30a
Cultivar	**Balady**		64.74a	9.61a	1.08 b	59.55a	13.39b	64.35a	9.41a	1.14 b	60.56a	20.79a
	Sids 40		55.69b	9.79a	1.71 a	55.80b	19.03a	64.45a	9.10a	1.77 a	57.89a	22.52a
Fertilizer	**Tea compost**		64.78 a	10.16 a	1.52 b	63.62 a	19.19a	71.99a	9.22b	1.68 a	66.95a	29.07a
	Amino acids		58.90 b	8.42b	1.64 ab	55.77b	17.85a	61.77b	9.22b	1.65 a	53.57b	18.93b
	Yeast extract		60.65ab	10.34a	1.84 a	65.85a	16.49ab	66.15ab	9.97a	1.82 a	67.74a	22.01b
	Seaweed extract		57.97 b	9.77a	0.93 c	55.78b	14.83bc	58.88b	9.08 b	1.00 b	53.94b	17.68b
	Humic acid		58.77b	9.81a	1.04 c	47.35c	12.69c	63.20b	8.77b	1.12 b	53.98b	20.60b
Recommended N level	**Balady**	**Tea c.**	77.89a	10.00bc	1.29d-g	78.04a	33.05a	82.66a	10.00ab	1.49c-f	74.46a	31.36a-c
		Amino	65.41c-f	9.19ce	1.44c-f	76.00a-d	11.84df	62.44b-e	10.00ab	1.51 c-f	57.31d-f	23.71a-d
		Yeast ex.	76.55ab	10.33a-c	1.55c-e	74.67ab	11.20df	71.44a-d	10.55a	1.67b-d	71.41ab	23.28bd
		Seaweed	67.71b-d	11.06ab	0.87eg	64.00b-e	17.08cd	57.66d-e	8.22d	0.94 f	50.51f-h	15.56 d
		Humic	71.88a-c	9.91bd	0.89fg	54.52e-h	13.41c-f	60.66be	9.00b-d	0.97 ef	65.54a-e	23.78a-d
	Sids 40	**Tea c.**	62.99c-h	10.77ab	2.49 a	64.76b-e	28.33ab	75.89ab	9.33a-d	2.67 a	73.36a	33.96 ab
		Amino	64.21c-g	8.00ef	2.30 ab	54.19e-i	28.75ab	59.95c-e	10.00ab	2.30 ab	56.94df	21.01cd
		Yeast ex.	65.81c-e	10.78ab	2.56 a	70.06a-c	18.07c	75.66a-c	9.88ac	2.56 a	71.41ab	24.38a-d
		Seaweed	59.81d-i	9.81bd	1.01 e-g	63.91b-e	24.93b	60.09b-e	8.55d	1.13 d-f	56.82d-f	16.14 d
		Humic	51.90i-k	11.55a	1.30 d-g	51.56f-i	18.67c	62.11b-e	8.22d	1.30 c-f	43.78h	16.93 d
Half N level recommended	**Balady**	**Tea c.**	62.55c-h	9.89bd	0.92e-g	55.87d-g	16.94c-e	70.99a-d	8.88b-d	0.92 f	61.01b-f	16.22 d
		Amino	56.73e-j	7.38f	0.95 eg	54.14e-i	16.55c-e	65.22b-e	8.33d	0.90 f	54.90e-g	14.72 d
		Yeast ex.	54.44h-k	10.09bc	1.25d-g	61.38c-f	10.81ef	52.13e	9.99ab	1.17d-f	64.14a-e	19.41 d
		Seaweed	53.82h-k	9.00ce	0.77 g	42.50ij	8.39f	59.64c-e	10.11ab	0.85 f	56.21d-f	19.02 d
		Humic	60.41d-i	9.22ce	0.87 fg	43.40h-j	9.63f	60.66b-e	9.00b-d	0.96 ef	50.24f-h	20.87 cd
	Sids 40	**Tea c.**	55.70f-k	10.00bc	1.38 d-g	55.83d-g	13.43c-f	58.44de	8.66cd	1.65 c-e	58.96c-f	34.74 a
		Amino	49.24jk	9.11ce	1.87b-d	47.77gj	14.27c-f	59.88be	8.55d	1.87 bc	56.94d-f	16.28 d
		Yeast ex.	45.82k	10.16bc	2.00 a-c	57.29d-g	10.91df	65.39be	9.44a-d	1.87 bc	68.96a-c	20.96 cd
		Seaweed	50.55ik	9.22ce	1.08 eg	52.72e-i	8.92f	58.13de	9.44a-d	1.08 d-f	52.21f-h	19.99 cd
		Humic	50.90i-k	8.55df	1.08 eg	39.93j	9.05f	69.39a-d	8.89b-d	1.24 c-f	56.21d-f	10.6 h

Values with the same letter(s) in the same column in each season are not significantly different at 0.05

Table 3: Effect of nitrogen fertilizer, foliar fertilization application and cultivars on bulb characters and yield of garlic (*Allium sativum* L.) plants during two seasons.

Season			2015/2016					2016/2017				
Treatments			Bulb weight (g)	Cloves number	Bulb diameter (cm)	Yield (ton\fed)	bulbing ratio	Bulb weight (g)	Cloves number	Bulb diameter (cm)	Yield (ton\fed)	Bulbing ratio
Nitrogen	Recommended N level		40.98 a	23 a	4.43 a	6.93 a	0.25 a	46.52 a	22.33 a	4.36 a	7.46 a	0.27 a
	Half N level recommended		37.74 b	22.20 a	3.81 b	4.80 b	0.27 a	40.53 b	23.07 a	4.33 a	6.07 b	0.23 b
Cultivar	Balady		39.85 a	34.63 a	3.99 a	5.73 a	0.25 a	42.69 a	34.27 a	4.29 a	6.85 a	0.25 a
	Sids 40		38.88 a	10.57 b	4.24 a	6.00 a	0.26 a	44.36 a	11.13 b	4.39 a	6.68 a	0.25a
Fertilizer	Tea compost		44.1a	22.66 a	4.49 a	7.79 a	0.24 a	45.47 ab	22.50 a	4.34 ab	7.20 a	0.28 a
	Amino acids		38.44 b	21.51a	3.97 b	5.11 c	0.24 a	46.83 a	22.53 a	4.31 ab	6.73b	0.26 ab
	Yeast extract		44.43 a	22.22a	4.48 a	6.03 b	0.24 a	47.78 a	23.82 a	4.62 a	7.02 ab	0.24 b
	Seaweed extract		34.83b	24.35 a	3.80 b	5.36 bc	0.28 a	38.58 b	22.26 a	4.34 ab	6.61 bc	0.24 b
	Humic acid		35.01b	22.26 a	3.85 b	5.03 c	0.28 a	38.96 b	22.38 a	4.11 b	6.27 c	0.24 b
Recommended N level	Balady	Tea c.	48.95 a	36.18 ab	4.62 a-c	8.75a	0.23 ab	43.63 a-c	31.01 b	4.36 b	8.90 a	0.30 a
		Amino	40.39 a-f	33.48 ab	3.84 b-e	5.83 c-g	0.22 ab	55.94 ab	32.14 ab	4.25 b	7.70 b-d	0.30 a
		Yeast ex.	48.05 a	35.74 ab	4.61 a-c	7.72 a-c	0.23 ab	49.76 a-c	38.73 a	4.61 ab	7.85 bc	0.28 ab
		Seaweed	32.42 ef	38.73 a	3.46 de	4.89 e-i	0.31 a	40.51 bc	33.63 ab	4.18 b	6.06 gh	0.25 bc
		Humic	37. 32b-f	33.63 ab	4.37 a-d	6.61 b-e	0.24 ab	37.71 c	32.85 ab	4.17 b	7.51b-e	0.28 ab
	Sids 40	Tea c.	43.72 a-c	10. 76 c	5.29 a	8.88 a	0.29 a	49.34 a-c	10.58 c	3.90 b	8.20 ab	0.31 a
		Amino	43.26 a-d	9.63 c	4.75 ab	6.63 b-e	0.21 ab	45.32 a-c	13.27 c	4.32 b	6.65 e-g	0.30 a
		Yeast ex.	46.20 ab	10. 69 c	5.31 a	8.12 ab	0.22 ab	57.76 a	8.92 c	5.15 a	8.24 ab	0.27 ab
		Seaweed	36.66 c-f	11.01 c	4.14 b-e	6.26 b-f	0.26 a	42.11 a-c	11.38 c	4.42 b	7.10 c-f	0.25 bc
		Humic	32.88 e-f	10.38 c	3.89 b-e	5.57 d-h	0.26 a	43.16 a-c	10.76 c	4.23 b	6.39 fg	0.25 bc
Half N level recommended	Balady	Tea c.	41.40 a-e	33.96 ab	3.65 c-e	6.33 b-f	0.24 ab	48.70 a-c	33.48 ab	4.37 b	6.34 f-h	0.24 bc
		Amino	35.79 c-f	30.35 b	3.73c-e	7.19 a-d	0.27 a	36.52 c	35.47 ab	4.37 b	4.59 i	0.25 bc
		Yeast ex.	41.25 a-e	22.14 ab	3.84 b-e	4.89 e-i	0.26 a	42.47 a-c	38.73 a	4.37 b	6.56 e-g	0.25 bc
		Seaweed	34.66 c-f	38.73 a	3.91 b-e	5.58 d-h	0.27 a	35.03 c	33.63 ab	4.50 ab	6.45 fg	0.25 bc
		Humic	38.27 b-f	33.63 ab	3.90 b-e	4.56 f-i	0.31 a	36.64 c	33.00 ab	4.10 b	6.57 e-g	0.25 bc
	Sids 40	Tea c.	42.32 a-d	9.76 c	4.41 a-d	4.89 e-i	0.14 b	40.22 bc	12.27 c	4.37 b	6.57 e-g	0.27 bc
		Amino	34.32 a-d	12.59 c	3.55 de	4.56 f-i	0.31 a	49.56 a-c	11.91 c	3.90 b	6.76 d-g	0.25 bc
		Yeast ex.	42.23 a-d	10.58 c	4.16 b-e	4.89 e-i	0.26 a	41.13 a-c	8.92 c	4.37 b	5.44 hi	0.24 b-d
		Seaweed	35.61 c-f	8.92 c	3.67 c-e	4.24 g-i	0.30 a	36.69 c	10.38 c	4.27 b	6.81 d-g	0.25 bc
		Humic	31.56 f	11.38 c	3.26 e	4.24 g-i	0.32 a	38.34 c	12.90 c	4.20 b	4.59 i	0.27 bc

Values with the same letter(s) in the same column in each season are not significantly different at 0.05

cultivars. The bulbing ratio was slightly affected by the tested factors. The high values of bulb diameter and weight were reflected on the total yield of garlic plants (Taha *et al.*, 2016). These results are in conformity with those obtained by Shrestha *et al.* (2011), Zaki *et al.* (2014), Marzauk *et al.* (2014) and Hassan (2015). According to Fikru and Fikreyohannes (2018) successive levels of fertilizers significantly increased the weight of bulb, number of cloves per bulb and total yield.

Concerning the interaction, spraying tea compost or yeast extracts were the most effective treatments for increasing the bulb fresh weight under both N levels for the two cultivars. Balady cultivar had the higher number of cloves compared to those of cv Sids-40, under both N level and all spray treatments. Applications of recommended N level and yeast extract on plants of cv sids-40 produced the highest values of bulb diameter (Table 3). The most effective treatments for producing the highest yield were the recommended N level combined with tea compost or yeast extracts for cvs Sids-40 and Balady.

These results are in conformity Abou El-Magd *et al.* (2014) and Hassan (2015) found that interactions between foliar applications treatments and nitrogen fertilizer levels and garlic cv increased the highest nitrogen ratio. Gouda and Gaheash (2015) found that the tea compost increased vegetative parameters, i.e. plant height, bulb diameter, fresh and dry weight/ plant and total yield. Hassan (2015) found that interactions between bio-enriched treatments and nitrogen fertilizer levels and garlic cv increased the highest average bulb weight and number of cloves per bulb. This increase in the growth parameters might also be due to the effect of auxins and nutrients which are utilized by foliar applications, According to Fikru and Fikreyohannes (2018) sequential levels of fertilizers significantly increased the weight of bulb, dry weight, number of cloves per bulb and Total yield.

The enhancing effect of seaweed extract on nitrogen in first season showed in table (8), of might be to major contain high levels of organic matter, micro elements, vitamins and fatty acids and also rich in growth regulators such as auxins, cytokinin and gibberellins. The positive effect of seaweed extract application is as a result of many components that may work together at different concentrations, although the mode of action still unknown (Shehata *et al.,* 2011 and shafeak *et al.,* 2015).

Chemical composition

As presented in table 4 the higher percentages of total soluble solids, nitrogen and phosphorus were obtained in cloves by the addition of the recommended nitrogen level, however the difference was insignificant between the N %. Cloves of cv Balady had lower N and higher P percentage compared to those of cv Sides in spite of insignificant difference for N in the first season but TSS values were insignificant.

Concerning the second order interactions, the most satisfactory treatments were the recommended N level combined with tea compost or humic acid on cvs Balady or Sides for TSS %, the recommended N level combined with seaweed on cv Balady for phosphors % and the recommended N level combined with tea compost, yeast or seaweed extracts on cv Sides for nitrogen %. These results are in conformity Abou El-Magd *et al.,* (2014) and Hassan (2015). Tea compost and humic acid extracts increased values of TSS in the first season also N% and P% in the second compared to the other tested spray treatments. The most effective treatments for increasing TSS were tea compost and humic acid in the first, for increasing N were tea compost, seaweed and humic acid in the second season, for raising P were tea compost, amino acid and humic acid in the second season.

Conclusion

The best recommended nitrogen level with foliar application of tea compost or yeast extracts gave the highest plant growth, bulb weight and total yield.

Table 4: Effect of nitrogen fertilizer, foliar fertilization application and cultivars on TSS, N and, p% of garlic cloves (*Allium sativum* L.) during two seasons.

Treatments			2015/2016			2016/2017		
			TSS (%)	N (%)	P (%)	TSS (%)	N (%)	P (%)
Nitrogen	**Recommended N level**		34.99 A	3.19 a	0.28 a	29.12 a	2.94 a	0.26 a
	Half N level recommended		28.84 B	3.02 a	0.24 b	28.10 a	2.69 a	0.24 b
Cultivar	**Balady**		32.42 a	3.10 a	0.27 a	29.63 a	2.58 b	0.26 a
	Sids 40		31.41 a	3.11 a	0.25 b	27.59 a	3.05 a	0.24 b
Fertilizer	**Tea compost**		35.10 ab	3.01 a	0.27 a	28.50 a	2.82 ab	0.25 ab
	Amino acids		28.72 c	3.16 a	0.27 a	29.98 a	2.72 bc	0.26 a
	Yeast extract		28.26 c	3.00 a	0.26 a	28.10 a	2.38 c	0.24 b
	Seaweed extract		31.20 bc	3.19 a	0.27 a	28.10 a	3.24 a	0.24 b
	Humic acid		36.31 a	3.15 a	0.25 a	28.36 a	2.93 ab	0.25 ab
Recommended N level	**Balady**	**Tea c.**	39.00 a-c	3.20 a-c	0.33 ab	31.30 a	2.47 b-d	0.33 ab
		Amino	32.33 b-e	3.43 a-c	0.29 bc	27.30 a	2.75 bc	0.29 bc
		Yeast ex.	28.06 c-e	3.63 a	0.33 ab	24.63 a	3.25 b	0.33 ab
		Seaweed	32.36 b-e	2.64 bc	0.36 a	31.10 a	2.75 bc	0.34 a
		Humic	42.31 ab	2.95a-c	0.23 ef	31.96 a	3.08 b	0.23 ef
	Sids 40	**Tea c.**	35.26 a-d	2.70 a-c	0.24 c-f	30.93 a	2.51 b-d	0.24 c-f
		Amino	31.30 c-e	3.50 a-c	0.27 c-e	26.93 a	2.94 b	0.27 c-e
		Yeast ex.	30.80 ce	2.73 a-c	0.24 c-f	26.13 a	3.25 b	0.23 c-f
		Seaweed	34.13 a-e	3.56 ab	0.26 c-f	29.40 a	4.60 a	0.23 c-f
		Humic	44.37 a	3.56 ab	0.28 b-e	31.66 a	2.93 b	0.28 b-e
Half N level recommended	**Balady**	**Tea c.**	34.16 a-e	3.36 a-c	0.26 c-f	27.53 a	2.93 bc	0.25 c-f
		Amino	27.16 d-e	2.56 c	0.24 c-f	27.73 a	1.93 cd	0.24 c-f
		Yeast ex.	28.23 c-e	3.08 a-c	0.23 ef	29.76 a	1.73 d	0.23 ef
		Seaweed	29.43 c-e	3.11a-c	0.26 c-f	25.80 a	2.76 bc	0.26 c-f
		Humic	31.16 c-e	3.08 a-c	0.24 c-f	29.76 a	2.98 b	0.24 c-f
	Sids 40	**Tea c.**	31.96 b-e	2.80 a-c	0.26 c-f	30.40 a	3.16 b	0.25 c-f
		Amino	24.10 e	3.16 a-c	0.29 bc	25.46 a	2.70 b c	0.29 bc
		Yeast ex.	25.96 d-e	2.58 c	0.25 c-f	26.70 a	2.60 b-d	0.25 c-f
		Seaweed	28.86 c-e	3.47 a-c	0.23 ef	24.63 a	2.86 bc	0.23 ef
		Humic	27.40 d-e	3.01 a-c	0.23 ef	26.26 a	2.72 bc	0.23 ef

Values with the same letter(s) in the same column in each season are not significantly different at 0.05

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