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Growth, Yield, Bulb Quality and Storability of Garlic (*Allium sativum* L.) as Affected by Using Poultry Manure, Sulphur and Different Levels of Phosphorus Fertilizer

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ABSTRACT

An important bulb vegetable is garlic with several nutritional and medicinal benefits (Anti-infective properties such as anti-cancer). Poultry manure is an ecofriendly, economically viable and considered a suitable solution for overcoming environmental pollution and to improve soil fertility and also increase the qualitative and quantitative of garlic (*Allium sativum* L.). So, this work was conducted at Mallawi Agriculture Research Station, Minia governorate, Egypt, as well as Laboratories of Horticulture and Food Science Departments, Faculty of Agriculture, New Valley Branch, Assuit University during two winter seasons of 2015/2016 and 2016/2017 to study the influence of poultry manure, sulphur and different levels of phosphorus fertilizer on growth, yield and its components, bulb quality as well as bulb storability of garlic cv. Egaseed 1. The obtained results revealed that there were a significant effect for poultry manure, sulphur and different levels of phosphorus fertilizer on the remaining nutrients such as N, P, K (ppm) and organic matter percentage (OM %) in the soil postharvest, growth, yield and its components, bulb quality, plant nutrient status and uptake of N, P, K and S kg fed.$^{-1}$ and storability (weight loss %) of garlic blub. The study revealed that application of 5 ton fed.$^{-1}$ of poultry manure and 100 kg fed.$^{-1}$ of sulphur and 60 kg P_2O_5 fed.$^{-1}$ was the best treatment, because it recorded the higher values of the remaining nutrients, i.e., N, P (ppm) and OM % in the soil postharvest, the highest values of fresh total yield (6.45 and 6.75 ton fed.$^{-1}$) and bulb yield (5.62 and 5.78 ton fed.$^{-1}$), highest values of blub quality (dry matter, total soluble solids, carbohydrates, protein, lipids and ash) percentages, the lowest values of nitrite and nitrate contents (mg kg^{-1} FW) as well as the lowest values of weight loss percentage of garlic blub during the storage period for 8 months in the 1st and 2nd seasons, respectively, would be suitable economical, productivity, quality, storability and health for garlic production in Egypt under experimental conditions.

Keywords: Garlic blub, poultry manure, phosphorus, sulphur, quality, nitrite and nitrate.

INTRODUCTION

Reducing environmental pollution and saving health foods are the basic goals and optimal using for the integration of organic fertilizers. Garlic (*Allium sativum* L.), was cultivated for thousands of years and a member of the onion family, is widely applied for culinary and medicinal uses (Hahn, 1996). Popularity of this crop has recently increased, in part because of the many health and nutritional benefits attributed to garlic consumption.

In Egyptian market, garlic is one of the most highest-value cash crops. Garlic has multifarious use in local consumption, food, processing and exportation. An important cash crop for smallholder farmers is garlic. Marketability for this crop is bulb quality. There is an urgent need to reduce pollution in food products, especially in sensitive agricultural practices. One of the solutions necessary to reduce soil pollution is using of organic fertilizers. The positive effect of organic fertilizers on plant growth and measurements might be due to the presence of many nutrients that affect plant growth and crop yield (Kloos, 1986). The basic impact of organic fertilizers on plant growth is attributed to improve soil physiochemical and increasing soil humus content as well as by supplying macro and micronutrients (Zebrath *et al*., 1999). There are a several factors had high effect on bulb quality among which imbalanced and low availability of nutrients in the soil is prominent (Baghalian *et al*., 2005 and Petropoulos *et al.,* 2018).

Sulfur is an essential macro-element for plant nutrition and can play a key role in increasing the yield of garlic (Ahmed *et al.*, 1988). Adequate nutrient uptake by garlic culture is important for improving growth, yield and marketable proportions as well as crop quality (Nai-hua *et al.,* 1998). Sulphur concentration in plants is the lowest of all macronutrients (Bakry *et al.,* 2015). The increase in total yield under sulphur application may be due to sulfuric acid, a very important factor in lowering the pH of the soil and increasing the solubility of calcium phosphate (Kumar *et al.,* 1998 and Piri *et al*., 2012). There are a significant increase in bulb yield and dry matter of garlic with increasing doses of S and P (Chandel *et al.,* 2012). Where, application of 80 kg P_2O_5 ha^{-1} and 40 kg S ha^{-1} had significant positive on yield and its components. Uptake of phosphorus and sulfur increased with increasing application rates of P and S individually and in various combinations were reported by Dhage *et al.* (2014).

Increasing crop yield per unit area is need to large amount of chemical fertilizers are added. Environmental pollution is resulted in excessive use of chemical fertilizers, which caused destroy the balance of the ecosystem that is one of the major problems in the agriculture production (Zaller, 2007). Poultry manure is an economically viable, ecofriendly and sound of ecologically that also played a significant role in soil biology, chemistry and physics.

The aim of this work was to study the effect of poultry manure, sulphur and different levels of phosphorus fertilizer on growth, yield and its components, bulb quality as well as bulb storability of garlic cv. Egaseed 1 to improve the qualitative and quantitative of garlic plants under experimental conditions.

MATERIALS AND METHODS

Two field experiments were conducted at Station of Mallawi Agric. Res., Minia governorate, as well as Laboratories of Horticulture and Food Science Departments, Faculty of Agriculture, New Valley Branch, Assuit University during two winter seasons of 2015/2016 and 2016/2017. The experiments were allocated in a spilt plot system in a complete randomized block design with three replicates. The main plots were allocated for levels of poultry manure and sulphur as following:

1- zero kg fed.$^{-1}$ of sulphur (S1).
2- 100 kg fed.$^{-1}$ of sulphur (S2).

3- 5 ton fed.$^{-1}$ of poultry manure and zero kg fed.$^{-1}$ of sulphur (S3).

4- 5 ton fed.$^{-1}$ of poultry manure and 100 kg fed.$^{-1}$ of sulphur (S4).

As well as the sub plots were devoted for four levels of phosphorus fertilizer, i.e., 30, 45 and 60 kg P_2O_5 fed.$^{-1}$ in addition to zero kg P_2O_5 fed.$^{-1}$. The experimental unit area was 10.5 m^2 (1/400 fed.).

Prior to planting, garlic bulbs cv. Egaseed 1 were split into the individual cloves. Poultry manure at 5 ton fed.$^{-1}$ was collected from private fattening poultry farm in Mallawy district, Minia governorate. All treatments was treated with ammonium nitrate (33.5 % N) and potassium sulphate (48 % K_2O) according to the recommendations of the Ministry of Agriculture, Egypt.

The largest size of bulbs was chosen, free of any defects and the cloves were sorted to select the largest cloves. Plots were pre-irrigated one day before planting and cloves were sown on October 15th and 18th in 2015 and 2016 seasons, respectively on the west side of the row, with the distance between the plants being 10.0 cm for both study seasons. Ammonium nitrate (33.5 % N), calcium super phosphate (15.5 % P_2O_5), and potassium sulphate (48 % K_2O), fertilizers used as sources of N, P and K respectively. While, poultry manur amount and sulphur were added at preparation of soil directly before ridging. Samples of soils were analyzed using methods cited by Black (1965). Sampling dates were two weeks before planting and after harvesting. Some main physiochemical and fertility characteristics of the experimental soil before plantation are presented in Table (1).

Table 1. Some physiochemical analysis of the experimental soil at depth (0-30 cm) before plantation in 2015/2016 and 2016/2017 seasons.

Properties	Value 2015/2016	Value 2016/2017
Physical analysis		
Sand (%)	8.47	10.11
Clay (%)	55.71	50.32
Silt (%)	35.82	39.57
Soil texture	Silty clay loam	
Mechanical analysis		
Organic matter (%)	1.60	1.72
EC (ds m^{-1}) soil:water extract (1:5)	1.14	1.21
pH soil–water suspension ratio (1:2.5)	8.09	8.00
Soluble cations (meq/L)		
Ca^{++}	7.25	7.45
Mg^{++}	2.10	2.15
K^+	0.18	0.20
Na^+	3.20	3.22
Soluble anions (meq/L)		
CO_3^-	0.00	0.00
HCO_3^-	3.18	3.20
SO_4^{--}	5.40	5.72
Cl^-	4.15	4.10
Available nutrients (ppm)		
N	17	19
K	250	260
P	6	9

The chemical properties of the poultry manure as average of 2015/2016 and 2016/2017 seasons were determined at the laboratory of the Soil, Water, Environment, Res. Ins., Giza, Egypt and listed in Table (2_a).

Table 2_a. Chemical analysis of poultry manure as average of two seasons.

Properties	Value
Total macronutrients (%)	
N	3.00
P	0.21
K	0.68
Organic matter (%)	51.6
Total micronutrients (mg/kg)	
Fe	11
Mn	388.3
Zn	319.5
Cu	112

Sample of 10 plants from each plot was taken at random after 135 days from sowing to measured plant height (cm). Garlic plants were harvested when 70 % of the plant leaves turned yellow, harvesting was done at 15th and 20th of April in the 1st and 2nd seasons, respectively. The plants of each plot were harvested, then translocated to a shady place in the same day for curing (15 days) and the studied traits were:

a) Fresh total yield (ton fed.$^{-1}$).

b) Bulb yield (ton fed.$^{-1}$), determined after separating leaves from bulb for each plant.

c) Bulb dry matter percentage (DM %).

d) Plant nutrient status:

Ten clean sample of matured bulbs from each plot were collected randomly at harvesting date. The cloves were ground and over dried at 65 °C for 48 h. The finely ground and dried tissues were wet digested using sulphuric-perchloric acid mixture (1:1) as described by A.O.A.C. (2000). Total N % was determined by Kjeldahl method, total P % was estimated calorimetrically and total K % was determined using the flame photometer according to Jackson (1967). Sulphur percentage was estimated by turbidometric method (Tabatabai and Bremner, 1970).

Bulb quality parameters such as total soluble solids (TSS), carbohydrates, protein, lipids and ash percentages of garlic bulb samples were determined according to A.O.A.C. (2000). As well as Nitrite (NO_2^{-1}) and Nitrate (NO_3^{-1}) contents were extracted from garlic cloves by 1% K_2SO_4 solution and determined as mentioned by Venhuis and Dewarg (1980).

e) Storability of garlic bulb:

After curing, a random samples, each of 3 kg of cured garlic bulbs were taken from every treatment, stored at normal room conditions and weight loss percentage of garlic bulbs was estimated after 2, 4, 6 and 8 months of storage period according to the formula of Wills *et al.* (1982). The average of normal room temperature and relative humidity during storage period for 8 months are shown in Table (2_b).

Table 2_b. The average of normal room temperature and relative humidity during storage period of garlic bulbs.

Month	Temperature (ºC) 2016	Temperature (ºC) 2017	Relative humidity (%) 2016	Relative humidity (%) 2017
May	33.7	34.2	37.5	37.9
June	37.2	37.5	38.1	41.2
July	38.6	38.8	55.4	52.3
August	37.2	38.2	62.5	61.9
September	33.2	35.1	62.2	63.6
October	30.4	31.0	70.9	66.3
November	25.2	27.4	77.1	74.8
December	22.6	23.7	82.6	80.0

Statistical analysis:

Data collected were subjected to Analysis of Variance (ANOVA) for obtained data in each season was performed. The measured variables were analyzed using MSTATC. Differences among treatments were evaluated by LSD test at 5% according to procedure out lined by Elias and Karim (1984) and Gomez and Gomez (1984).

RESULTS AND DISCUSSION

1. Remaining nutrients in the soil postharvest:

Data tabulated in Table (3) indicated that poultry manure and sulphur had a significant effect on the remaining nutrients in the soil postharvest. Application of 100 kg fed.$^{-1}$ of sulphur, irrespective of phosphorus fertilizer, had the higher values of the remaining nutrients, i.e., N, P, K (ppm) and organic matter percentage (OM %) in the soil postharvest than application of zero kg fed.$^{-1}$ of sulphur. Also, application of 5 ton fed.$^{-1}$ of poultry manure + 100 kg fed.$^{-1}$ of sulphur had the higher values of the remaining nutrients, i.e., N, P, K (ppm) and OM % in the soil postharvest than application of 5 ton fed.$^{-1}$ of poultry manure and zero kg fed.$^{-1}$ of sulphur. Soil analysis values showed that the experimental field had nutrient deficiencies, particularly N, P and S. The application of N, P as a cover and S fertilizer could help maintain soil fertility and provide a favorable response to the absorption of nutrients by plants that reflect greater garlic yield. Poultry manure is played a significant role in soil physiochemistry and biology. Consequently, biological fertilizers can be considered a suitable application for overcoming this problem, further by adding beneficial organisms to improve soil fertility and also increase the qualitative and quantitative products. In fact, using organic fertilizers like poultry manure can be used in a sustainable agricultural system (Jones *et al.,* 2004 and Nasreen and Huq, 2005). In this subject, Chen (2006) pointed out that some of soil nutritional elements are mostly in an un-accessible form to plants and need long time period to release part of them through biological activity and chemical processes.

Table 3. Effect of poultry manure, sulphur and different levels of phosphorus fertilizer and their interactions on remaining nutrients in the soil postharvest in 2015/2016 and 2016/2017 growing seasons.

Treatments		Remaining nutrients							
		N (ppm)	P (ppm)	K (ppm)	OM %	N (ppm)	P (ppm)	K (ppm)	OM %
		Season 2015/2016				Season 2016/2017			
Levels of poultry manure and sulphur									
S1		18.46	9.41	262	1.64	18.58	9.43	269	1.64
S2		18.54	9.80	267	1.66	18.83	9.81	274	1.65
S3		19.02	9.69	266	1.74	19.21	9.76	272	1.73
S4		19.45	10.30	275	1.78	19.62	10.34	278	1.78
LSD at 5%		0.019	0.131	8.701	0.005	0.052	0.085	6.669	0.007
Levels of phosphorus (P) fertilizer (kg P_2O_5 fed.$^{-1}$)									
0 (P1)		18.38	9.52	263	1.68	18.75	9.53	270	1.67
30 (P2)		18.74	9.71	266	1.70	18.95	9.74	273	1.69
45 (P3)		19.06	9.90	269	1.72	19.10	9.95	274	1.70
60 (P4)		19.29	10.08	273	1.73	19.44	10.11	277	1.73
LSD at 5%		0.027	0.048	3.483	0.005	0.039	0.064	3.210	0.004
Interaction (SXP)									
S1	(P1)	18.14	9.18	258	1.62	18.24	9.18	264	1.62
	(P2)	18.31	9.34	258	1.63	18.48	9.33	267	1.63
	(P3)	18.67	9.43	263	1.65	18.72	9.46	271	1.64
	(P4)	18.73	9.71	269	1.67	18.90	9.74	273	1.66
S2	(P1)	18.21	9.49	262	1.62	18.58	9.36	268	1.61
	(P2)	18.43	9.75	266	1.65	18.74	9.69	274	1.64
	(P3)	18.69	9.96	268	1.68	18.81	10.04	275	1.65
	(P4)	19.84	10.11	272	1.70	19.20	10.13	279	1.70
S3	(P1)	18.35	9.42	262	1.72	18.94	9.44	273	1.71
	(P2)	19.03	9.54	265	1.73	19.23	9.66	273	1.73
	(P3)	19.23	9.78	267	1.75	19.25	9.84	270	1.73
	(P4)	19.45	10.04	271	1.77	19.41	10.08	272	1.74
S4	(P1)	18.81	10.11	270	1.78	19.25	10.15	274	1.75
	(P2)	19.22	10.20	274	1.78	19.36	10.27	276	1.78
	(P3)	19.65	10.42	277	1.79	19.61	10.44	279	1.80
	(P4)	20.13	10.46	280	1.79	20.25	10.51	283	1.81
LSD at 5%		0.042	0.095	Ns	0.011	0.079	0.128	Ns	0.009

OM %: organic matter percentage, S1: zero kg fed.$^{-1}$ of sulphur, S2: 100 kg fed.$^{-1}$ of sulphur, S3: 5 ton fed.$^{-1}$ of poultry manure and zero kg fed.$^{-1}$ of sulphur, S4: 5 ton fed.$^{-1}$ of poultry manure and 100 kg fed.$^{-1}$ of sulphur.

Data for the effect of phosphorus fertilizer levels on the remaining nutrients, i.e., N, P, K (ppm) and OM % in the soil postharvest are shown in Table (3). Results cleared that phosphorus fertilizer had a significant effect on all previous traits. The present results indicated that increasing phosphorus fertilizer level from zero to 30, 45 and 60 kg P_2O_5 fed.$^{-1}$ led to an gradually increase in the remaining nutrients, i.e., N, P, K (ppm) and OM % in the soil postharvest. These results are in the same line with that reported by Nasreen and Huq (2005).

A significant interactions between levels of poultry manure, sulphur and levels of phosphorus fertilizer with regard to the remaining nutrients in the soil postharvest in both seasons are recorded in Table (3). It could be revealed from the data that use of 5 ton fed.$^{-1}$ of poultry manure and 100 kg fed.$^{-1}$ of sulphur and 60 kg P_2O_5 fed.$^{-1}$ contained the highest values of the remaining nutrients, i.e., N (20.13 and 20.25 ppm), P (10.46 and 10.51 ppm) and OM % (1.79 and 1.81 %) in the soil postharvest in the 1st and 2nd seasons, respectively. In general, it is demonstrated that such data are related to the status of the previous nutrients in the soil and its adsorption by the plant. But, it is pointed out that poultry manure contains a high content of different nutrients, which is applied before sowing and has been able to provide a lot of nutrients in the soil. Murphy (2015) pointed out that organic matter of soil can contribute to soil quality through aggregate stability and soil porosity, water retention capacity, especially available water, and exchange capacity action. Such data confirmed the previous reports of (Stewart *et al.*, 2005; Naeem *et al.,* 2006 and Kuldeep *et al*., 2012).

2. Growth, yield and its components:

Data given in Table (4) showed that poultry manure and sulphur, irrespective of phosphorus fertilizer, had a significant effect on plant height, fresh total yield and blub yield of garlic plants in the two growing seasons. The lowest plant height, fresh total yield and blub yield were recorded with application of zero kg fed.$^{-1}$ of sulphur. Using of 100 kg fed.$^{-1}$ of sulphur scored the higher values of plant height (cm), fresh total yield (ton fed.$^{-1}$) and blub yield (ton fed.$^{-1}$) of garlic plants compared with zero kg fed.$^{-1}$ of sulphur in the two growing seasons. Also, application of 5 ton fed.$^{-1}$ of poultry manure and 100 kg fed.$^{-1}$ of sulphur contained the higher values of plant height (cm), fresh total yield (ton fed.$^{-1}$) and blub yield (ton fed.$^{-1}$) of garlic plants than application of 5 ton fed.$^{-1}$ of poultry manure and zero kg fed.$^{-1}$ of sulphur in the two growing seasons. This result might be due to better growth and development of garlic plants. Thus higher photosynthate accumulation in the cloves from higher leaves/plant would ensure higher cloves/bulb, large bulb diameter, and higher bulb fresh weight. Kuldeep *et al*. (2012) reported that farmers increase the dose of organic fertilizer led to significantly improve the state of soil fertility and derive economic benefits. Organic fertilizers improve the chemical, physical and physicochemical properties of the soil (Stewart *et al.,* 2005) and maximum growth rate (Dauda *et al.,* 2008) resulting in increased root development and activity of soil microflora and fauna which may affect micronutrients available to plants (Zeidan, 2007).

Data for the effect of phosphorus fertilizer levels on plant height, fresh total yield and blub yield of garlic plants in the two growing seasons are shown in Table (4). Results cleared that phosphorus fertilizer had a significant effect on all previous traits. The present results indicated that increasing phosphorus fertilizer level from zero to 30, 45 and 60 kg P_2O_5 fed.$^{-1}$ led to an gradually increase in plant height (cm), fresh total yield (ton fed.$^{-1}$) and blub yield (ton fed.$^{-1}$) of garlic plants. The rate of inappropriate application of phosphorus has affected in growth and development of garlic plants. The weak application of phosphorus eclipses garlic plants. These results confirm the role of phosphorus in increasing the growth, yield and NPK content of garlic bulbs when combined with organic fertilizer treatments. The results of this survey are in close agreement with those obtained by many researchers have studied the effect of organic fertilization on the growth of garlic plants (Kuldeep *et al.,* 2012; Umrao *et al.*, 2013; Adem and Tadesse, 2014; Zaki *et al.,* 2014 and Hassan, 2015).

A significant interactions between levels of poultry manure, sulphur and phosphorus fertilizer levels with regard to plant height (cm), fresh total yield (ton fed.$^{-1}$) and blub yield (ton fed.$^{-1}$) of garlic plants in both seasons are scored in Table (4). It could be demonstrated from the results that application of 5 ton fed.$^{-1}$ of poultry manure and 100 kg fed.$^{-1}$ of sulphur and 60 kg P_2O_5 fed.$^{-1}$ recorded the highest values of plant height (78.87 and 79.77 cm), fresh total yield (6.45 and 6.75 ton fed.$^{-1}$) and bulb yield (5.62 and 5.78 ton fed.$^{-1}$) of garlic in the 1st and 2nd seasons, respectively. Reasons for the low yield of garlic plants are mainly due to depletion of macro and micro-nutrients from the soil, use of low yielding varieties with low or no inputs and poor management practices (Umrao *et al.,* 2013 and Damse *et al.*, 2014). Hassan (2015) clarified that treatment of organic manure had the highest values of plant height, fresh and dry weight of whole plant, chemical composition and yield of garlic plants. In addition, they indicated that maximum clove yield and fresh total yield may be recommended for use of organic manure at a high level.

3. Bulb quality:

Results from Figs., 1, 2, 7, 8, 13 and 14 indicated that poultry manure and sulphur, irrespective of phosphorus fertilizer, had a significant effect on dry matter (DM), total soluble solids (TSS), carbohydrates, protein, lipids, ash percentages, nitrite and nitrate contents (mg kg^{-1} fresh weight) in garlic bulb in the two growing seasons. Application of 100 kg fed.$^{-1}$ of sulphur had the higher values of DM, TSS, carbohydrates, protein, lipids and ash percentages as well as the lowest values of nitrite and nitrate contents (mg kg^{-1} FW) in garlic bulb compared with application of zero kg fed.$^{-1}$ of sulphur in the two growing seasons. Also, application of 5 ton fed.$^{-1}$ of poultry manure and 100 kg fed.$^{-1}$ of sulphur had the higher values of the all previous traits compared with application of 5 ton fed.$^{-1}$ of poultry manure and zero kg fed.$^{-1}$ of sulphur. This indicates that the availability of S along with N influenced the uptake and utilization by garlic plants to synthesis more protein and strong building amino acids that are used to increase the bulbs quality. Yassen and Khalid (2009) showed that, the mix of farm manure and chicken manure overcame the control treatment (inorganic NPK recommended), enhanced vegetative growth traits. Organic fertilizers would give a higher quality of garlic plants with a higher spiciness than the widely used NPK fertilizer and no fertilizer application (Babatunde *et al.,* 2009). The findings are in general acceptance with those obtained by Van-Der-Schee (1998) who pointed out that the average of nitrate content in plants (leafy vegetables) is 35 mg kg^{-1}. Plants fertilized by zero kg $fed.^{-1}$ of sulphur contained the highest values (2.674 and 2.712 mg kg^{-1} FW) of nitrite and (44.32 and 46.15 mg kg^{-1} FW) of nitrate contents in its bulbs in both seasons, respectively. While, garlic plants fertilized by 5 ton $fed.^{-1}$ of poultry manure and 100 kg $fed.^{-1}$ of sulphur scored the lowest values (1.113 and 1.126 mg kg^{-1} FW) of nitrite and (2.45 and 2.10 mg kg^{-1} FW) of nitrate contents in its bulbs in both seasons, respectively. Despite the nutritional benefit of eating vegetables, they also contain substances that adversely affect human health such as nitrates and nitrites. NO_3^{-1} content in vegetable crops was different from 1 to 1000 mg kg^{-1} of fresh weight. Level of applied poultry manure fertilizer was in the safe extent (10 mg kg^{-1} FW) and do not cause any toxic effects (MAFF, 1987). The best known health effect of nitrite or nitrate reduced into nitrite is methemoglobinemia in new born babies, due to the fact that nitrite can prevent hemoglobin from being able to transport oxygen (FAO/WHO, 2002). Nitrite itself is relatively non-toxic but as precursor material of nitrosamines poses a threat to human health. Nitrite in the acidic environment can form a strong carcinogenic nitrosamine. Nitrosamines have a strong carcinogenic effect, which can cause esophageal cancer, stomach cancer, liver cancer and colorectal cancer (Yingzhen, 2009). The different nitrite contents in vegetables are resulted from the type of vegetables, and environmental factors such as use of nitrogen fertilizer (Cui *et al.*, 2017).

Table 4. Effect of poultry manure, sulphur and different levels of phosphorus fertilizer and their interactions on growth, yield and its components of garlic plants in 2015/2016 and 2016/2017 growing seasons.

Treatments		Plant height (cm)	Fresh total yield (ton $fed.^{-1}$)	Bulb yield (ton $fed.^{-1}$)	Plant height (cm)	Fresh total yield (ton $fed.^{-1}$)	Bulb yield (ton $fed.^{-1}$)
		Season 2015/2016			**Season 2016/2017**		
Levels of poultry manure and sulphur							
S1		67.67	5.08	4.08	68.40	5.36	4.32
S2		73.55	5.60	4.46	73.69	5.68	4.41
S3		75.14	5.81	4.81	75.21	6.03	4.90
S4		76.68	6.14	4.99	76.98	6.31	5.08
LSD at 5 %		0.396	0.214	0.089	0.175	0.061	0.072
Levels of phosphorus (P) fertilizer (kg P_2O_5 $fed.^{-1}$)							
0 (P1)		69.52	5.15	4.08	70.03	5.41	4.13
30 (P2)		72.03	5.53	4.41	72.53	5.75	4.53
45 (P3)		75.14	5.83	4.66	74.94	5.98	4.82
60 (P4)		76.35	6.11	5.19	76.78	6.24	5.21
LSD at 5 %		0.410	0.073	0.085	0.367	0.052	0.052
Interaction (SXP)							
S1	(P1)	62.57	4.30	3.67	63.73	4.65	3.78
	(P2)	66.47	4.97	3.76	66.47	5.35	4.12
	(P3)	69.93	5.37	4.19	70.63	5.65	4.41
	(P4)	71.70	5.70	4.69	72.77	5.80	4.95
S2	(P1)	70.10	5.17	3.88	70.47	5.35	3.99
	(P2)	72.03	5.47	4.41	72.93	5.55	4.35
	(P3)	75.50	5.67	4.59	74.57	5.70	4.79
	(P4)	76.57	6.10	4.94	76.80	6.10	4.51
S3	(P1)	71.97	5.30	4.20	72.50	5.65	4.23
	(P2)	73.60	5.70	4.68	74.17	6.00	4.78
	(P3)	76.73	6.05	4.86	76.37	6.15	4.96
	(P4)	78.27	6.20	5.51	77.80	6.30	5.61
S4	(P1)	73.43	5.85	4.57	73.40	6.00	4.53
	(P2)	76.00	6.00	4.79	76.57	6.10	4.89
	(P3)	78.40	6.25	4.99	78.20	6.40	5.11
	(P4)	78.87	6.45	5.62	79.77	6.75	5.78
LSD at 5 %		0.821	0.146	0.170	0.717	0.104	0.104

S1: zero kg $fed.^{-1}$ of sulphur, S2: 100 kg $fed.^{-1}$ of sulphur, S3: 5 ton $fed.^{-1}$ of poultry manure and zero kg $fed.^{-1}$ of sulphur, S4: 5 ton $fed.^{-1}$ of poultry manure and 100 kg $fed.^{-1}$ of sulphur.

Data for the effect of phosphorus fertilizer levels on of DM, TSS, carbohydrates, protein, lipids, ash percentages, nitrite and nitrate contents (mg kg^{-1} FW) in garlic bulb in the two growing seasons are shown in Figs., 3, 4, 9, 10, 15 and 16. Results cleared that phosphorus fertilizer had a significant effect on the all previous traits. The present results indicated that increasing phosphorus fertilizer level from zero to 30, 45 and 60 kg P_2O_5 fed.$^{-1}$ led to an gradually increase in DM, TSS, carbohydrates, protein, lipids, ash percentages, nitrite and nitrate contents (mg kg^{-1} FW) in garlic bulb. Bulb quality is constrained by several factors among which imbalanced and low availability of nutrients in the soil is prominent. These findings are in harmony with those mentioned by Petropoulos *et al*. (2018).

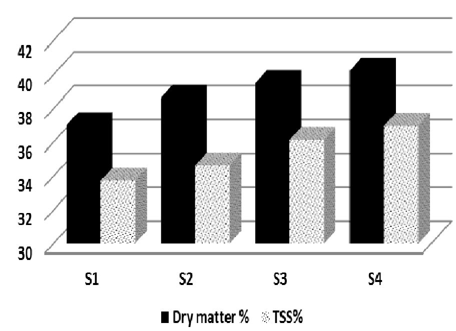

Fig.1. Levels of poultry manure and sulphur (S). 2015/2016

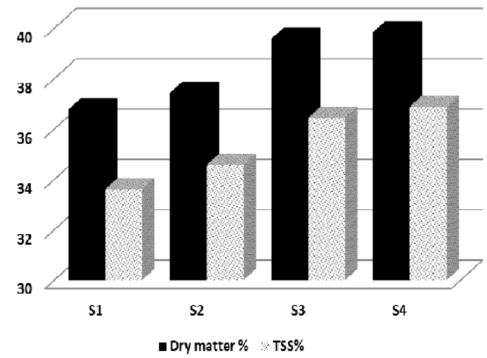

Fig.2. Levels of poultry manure and sulphur (S). 2016/2017

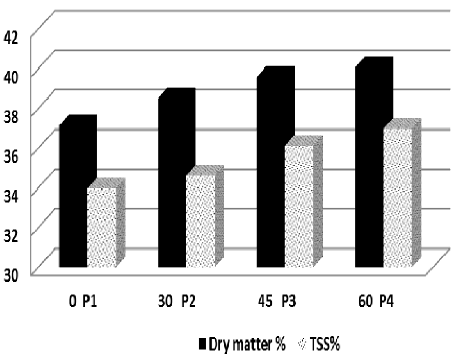

Fig.3. Levels of phosphorus (P) fertilizer (Kg P_2O_5/fed) 2015/2016

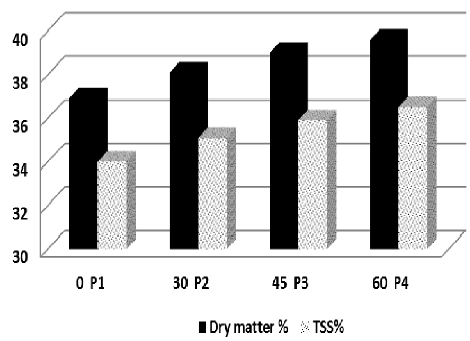

Fig.4. Levels of phosphorus (P) fertilizer (Kg P_2O_5/fed) 2016/2017

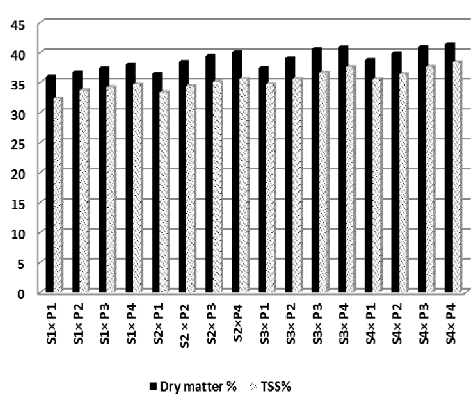

Fig.5. Interaction (S X P) 2015/2016

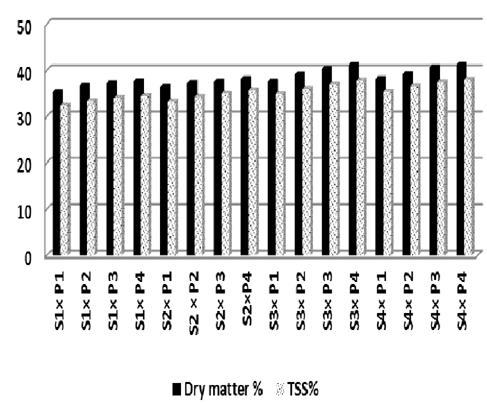

Fig.6. Interaction (S X P) 2016/ 2017

Figs. 1-6. Effect of poultry manure, sulphur (S) and different levels of phosphorus (P) fertilizer and their interactions on DM and TSS percentages in bulb of garlic plants in 2015/2016 and 2016/2017 growing seasons.

A significant interactions between levels of poultry manure, sulphur and levels of phosphorus fertilizer with regard to DM, TSS, carbohydrates, protein, lipids, ash percentages, nitrite and nitrate contents (mg kg^{-1} FW) in garlic bulb in both seasons were recorded in Figs., 5, 6, 11, 12, 17 and 18. It could be revealed from the results that application of 5 ton fed.$^{-1}$ of poultry manure with 100 kg fed.$^{-1}$ of sulphur and 60 kg P_2O_5 fed.$^{-1}$ recorded the highest values of DM (41.35 and 41.25 %), TSS (38.40 and 38.03 %), carbohydrates (32.52 and 32.61 %), protein (6.95 and 7.07 %), lipids (0.32 and 0.33 %) and ash (1.65 and 1.62 %) as well as lowest values of nitrite (1.521 and 1.612 mg kg^{-1} FW) and nitrate (2.43 and 2.90 mg kg^{-1} FW) contents in garlic bulb among the studied treatments in the 1st and 2nd seasons, respectively. These data are in harmony with those obtained by Singh *et al*. (2012). They showed that dry matter percentage of garlic bulb increased significantly with application of 80 kg P_2O_5 and 40 kg S ha^{-1} individually as well as in combination over control. These data are in a good accordance with those scored by Chandel *et al*. (2012).

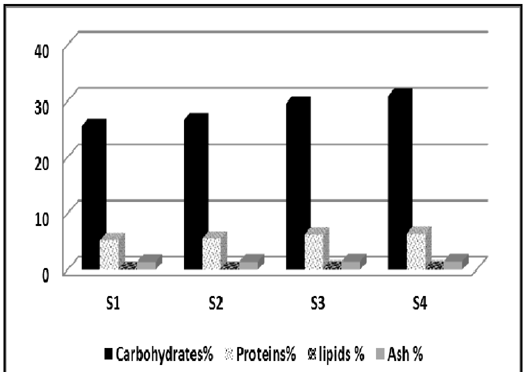

Fig.7. Levels of poultry manure and sulphur (S). 2015/2016

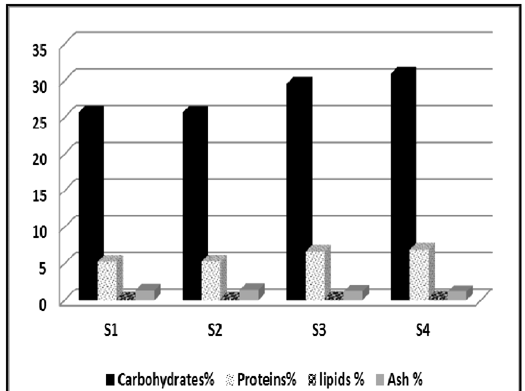

Fig.8. Levels of poultry manure and sulphur (S). 2016/2017

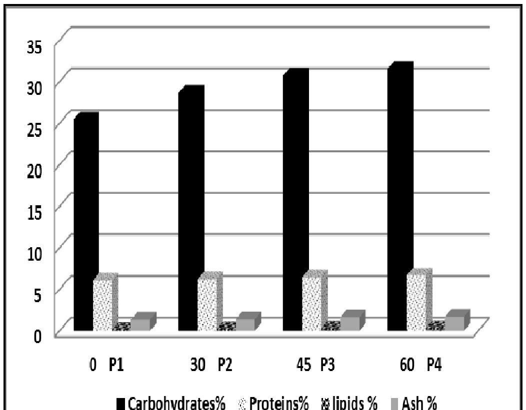

Fig.9.Levels of phosphorus (P) fertilizer (Kg P_2O_5/fed) 2015/2016

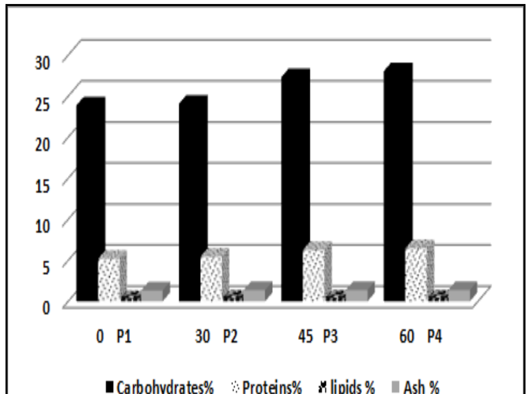

Fig.10. Levels of phpsphorus (P) fertilizer (kg P_2O_5/fed.) 2016/2017

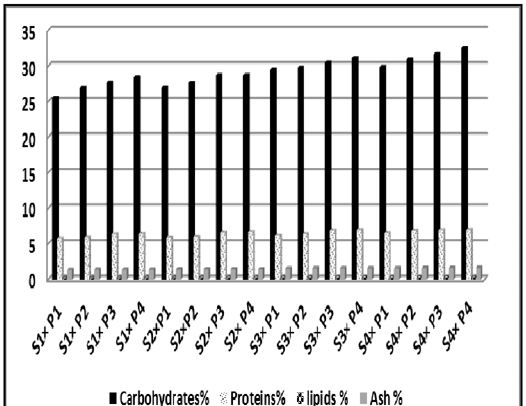

Fig.11. Interaction (S X P) 2015/2016

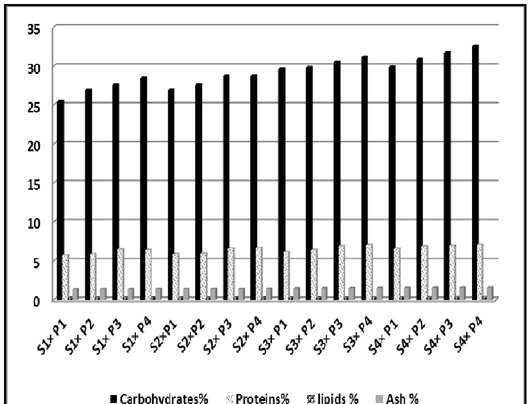

Fig.12. Interaction (S X P) 2016/2017

Figs. 7-12. Effect of poultry manure, sulphur (S) and different levels of phosphorus (P) fertilizer and their interactions on carbohydrates, protein, lipids and ash percentages of garlic plants in 2015/2016 and 2016/2017 growing seasons.

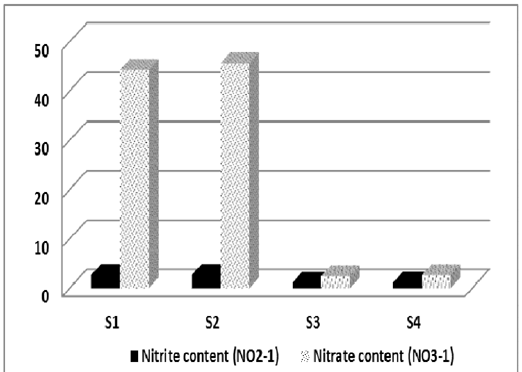

Fig.13. Levels of poultry manure and sulphur (S). 2015/2016

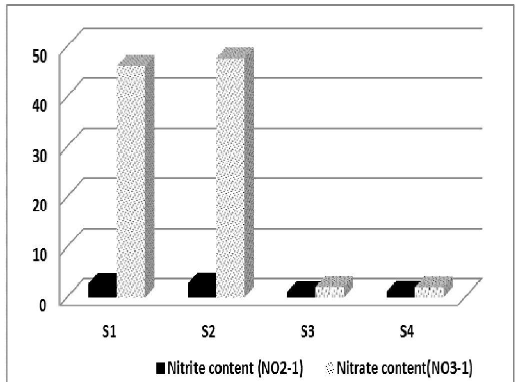

Fig.14. Levels of poultry manures and sulphur (S). 2016/2017

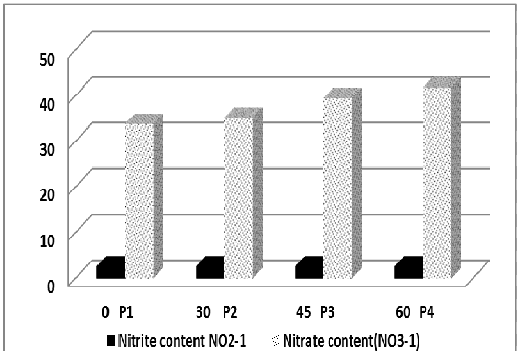

Fig.15. Levels of phosphorus (P) fertilizer (Kg P_2O_5 /fed) 2015/2016

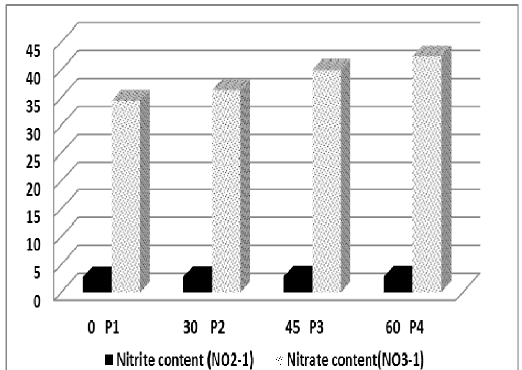

Fig.16. Levels of phosphorus (P) fertilizer (Kg P_2O_5 / fed) 2016/2017

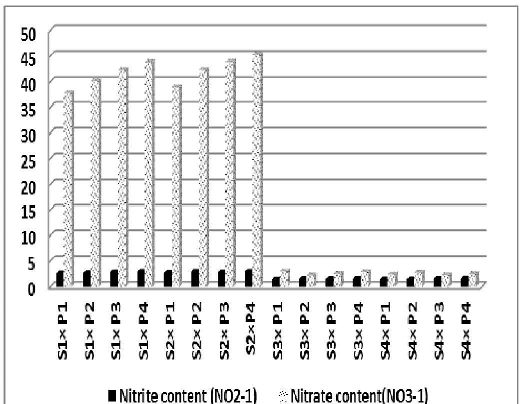

Fig.17. Interaction (S X P) 2015/2016

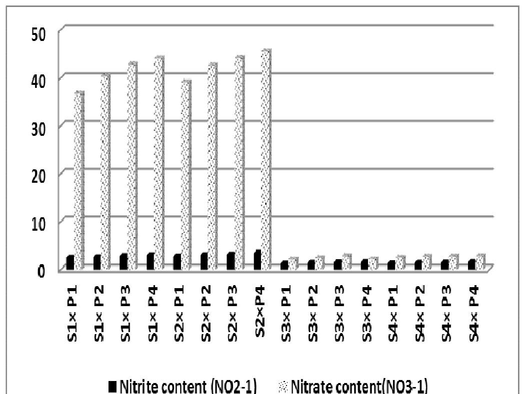

Fig.18. Interaction (S X P) 2016/2017

Figs. 13-18. Effect of poultry manure, sulphur (S) and different levels of phosphorus (P) fertilizer and their interactions on nitrite and nitrate contents (mg/kg FW) in bulb of garlic plants in 2015/2016 and 2016/2017 growing seasons.

4. Plant nutrient status:

Results in Tables (5 and 6) showed that poultry manure and sulphur, irrespective of phosphorus fertilizer, had a significant effect on N, P, K and S contents in garlic blub and uptake of N, P, K and S kg fed.$^{-1}$ by garlic blub in the two growing seasons. Application of 100 kg fed.$^{-1}$ of sulphur had the higher values of N, P, K and S percentages in garlic blub and uptake of N, P, K and S kg fed.$^{-1}$ by garlic blub compared with application of zero kg fed.$^{-1}$ of sulphur in the two growing seasons. Also, application of 5 ton fed.$^{-1}$ of poultry manure and 100 kg fed.$^{-1}$ of sulphur had the higher values of the all previous traits compared with application of 5 ton fed.$^{-1}$ of poultry manure and zero kg fed.$^{-1}$ of sulphur in both growing seasons. This result might be due to poultry manure which contain a broader range of nutrients than most commercial fertilizers (Mousa and Mohamed, 2009) and (Oyewole and

Oyewole, 2011). In this respect, Hassaneen (1992) found that sulphur element reduced pH and conversed the unavailable phosphorus to available form. Also, reducing the pH values and improves the availability of micro elements (Hetter, 1985) and improves the chemical properties (Kineber *et al*., 2004).

Data for the effect of phosphorus fertilizer levels on N, P, K and S contents in garlic blub and uptake of N, P, K and S kg fed.$^{-1}$ by garlic blub in the two seasons are shown in Tables (5 and 6). Results cleared that phosphorus fertilizer had a significant effect on the all previous traits, irrespective of poultry manure fertilizer level with or without sulphur. The present results indicated that increasing phosphorus fertilizer level from zero to 30, 45 and 60 kg P_2O_5 fed.$^{-1}$ led to an gradually increase in N, P, K and S percentages in garlic blub and uptake of N, P, K and S kg fed.$^{-1}$ by garlic blub in the 1st and 2nd seasons. These findings are in acceptance with that mentioned by (Almadini *et al.,* 2000; Alkaff *et al.,* 2002 and Shaheen *et al*., 2007).

Table 5. Effect of poultry manure, sulphur and different levels of phosphorus fertilizer and their interactions on nutrients content in blub of garlic plants in 2015/2016 and 2016/2017 growing seasons.

Treatments		N %	P %	K %	S %	N %	P %	K %	S %
		Season 2015/2016				**Season 2016/2017**			
		Levels of poultry manure and sulphur							
S1		0.926	0.403	0.782	0.271	0.930	0.392	0.817	0.256
S2		0.975	0.412	0.827	0.362	0.935	0.410	0.825	0.264
S3		1.100	0.424	0.842	0.268	1.175	0.412	0.872	0.307
S3		1.126	0.431	0.904	0.312	1.221	0.421	0.939	0.361
LSD at 5%		0.021	0.003	0.005	0.008	0.010	0.009	0.020	0.010
		Levels of phosphorus (P) fertilizer (kg P_2O_5 fed.$^{-1}$)							
0 (P1)		1.065	0.399	0.782	0.328	0.904	0.388	0.828	0.276
30 (P2)		1.089	0.417	0.827	0.310	0.951	0.403	0.862	0.287
45 (P3)		1.133	0.424	0.852	0.298	1.096	0.419	0.874	0.300
60 (P4)		1.177	0.430	0.879	0.276	1.126	0.426	0.889	0.324
LSD at 5%		0.005	0.003	0.004	0.004	0.004	0.004	0.007	0.007
		Interaction (SXP)							
S1	(P1)	1.004	0.387	0.760	0.243	1.012	0.376	0.767	0.231
	(P2)	1.030	0.396	0.777	0.265	1.035	0.384	0.800	0.253
	(P3)	1.112	0.411	0.787	0.284	1.140	0.402	0.847	0.260
	(P4)	1.121	0.420	0.807	0.290	1.128	0.406	0.887	0.281
S2	(P1)	1.028	0.398	0.777	0.341	1.037	0.378	0.787	0.335
	(P2)	1.047	0.414	0.817	0.350	1.053	0.406	0.810	0.363
	(P3)	1.156	0.417	0.837	0.362	1.161	0.425	0.830	0.366
	(P4)	1.168	0.421	0.877	0.394	1.175	0.434	0.840	0.379
S3	(P1)	1.077	0.406	0.810	0.235	1.084	0.390	0.860	0.231
	(P2)	1.118	0.426	0.837	0.265	1.126	0.405	0.900	0.258
	(P3)	1.207	0.430	0.847	0.273	1.218	0.422	0.860	0.266
	(P4)	1.218	0.434	0.877	0.286	1.237	0.430	0.870	0.299
S4	(P1)	1.142	0.407	0.847	0.321	1.158	0.407	0.900	0.277
	(P2)	1.200	0.432	0.877	0.313	1.212	0.417	0.937	0.304
	(P3)	1.216	0.438	0.937	0.330	1.221	0.427	0.960	0.312
	(P4)	1.219	0.446	0.957	0.399	1.240	0.434	0.960	0.335
LSD at 5%		0.010	0.006	0.008	0.008	0.008	0.007	0.015	0.014

S1: zero kg fed.$^{-1}$ of sulphur, S2: 100 kg fed.$^{-1}$ of sulphur, S3: 5 ton fed.$^{-1}$ of poultry manure and zero kg fed.$^{-1}$ of sulphur, S4: 5 ton fed.$^{-1}$ of poultry manure and 100 kg fed.$^{-1}$ of sulphur.

A significant interactions between levels of poultry manure, sulphur and levels of phosphorus fertilizer with regard to N, P, K and S contents in garlic blub and uptake of N, P, K and S kg fed.$^{-1}$ by garlic blub in the two growing seasons, except P uptake in first season, are shown in Tables (5 and 6). It could be revealed from the results that application of 5 ton fed.$^{-1}$ of poultry manure and 100 kg fed.$^{-1}$ of sulphur and 60 kg P_2O_5 fed.$^{-1}$ recorded the highest values of N % (1.219 and 1.240 %), P % (0.446 and 0.434 %), K % (0.957 and 0.960 %) and S % (0.399 and 0.335 %) in garlic blub and uptake of N (68.51 and 71.67 kg fed.$^{-1}$), K (53.80 and 55.48 kg fed.$^{-1}$) and S (16.05 and 15.99 kg fed.$^{-1}$) by garlic blub among the studied treatments in the 1st and 2nd seasons, respectively. Many investigators showed that with increasing the levels of phosphorus in root zone, the increase in its absorption by plants was increased and consequently increased the ability of plant root to uptake more elements in plant tissues (Almadini *et al.,* 2000; Alkaff *et al.,* 2002 and Shaheen *et al*., 2007).

Table 6. Effect of poultry manure, sulphur and different levels of phosphorus fertilizer and their interactions on uptake of N, P, K and S by garlic bulb in 2015/2016 and 2016/2017 growing seasons.

Treatments		Nutrients uptake (kg $fed.^{-1}$)							
		N	P	K	S	N	P	K	S
		Season 2015/2016				Season 2016/2017			
Levels of poultry manure and sulphur									
S1		37.78	16.49	31.95	10.94	40.18	16.97	32.79	10.98
S2		43.49	18.32	36.95	16.02	41.23	18.17	36.10	15.85
S3		52.91	20.45	40.66	12.78	57.58	20.23	42.73	12.78
S4		56.19	20.90	45.30	15.52	62.03	21.38	47.43	15.45
LSD at 5%		1.901	1.286	0.672	0.084	1.879	0.779	1.675	0.093
Levels of phosphorus (P) fertilizer (kg P_2O_5 $fed.^{-1}$)									
0 (P1)		43.45	15.58	32.68	13.38	37.34	16.04	34.32	13.37
30 (P2)		48.02	18.44	36.59	13.68	43.08	18.30	39.00	13.61
45 (P3)		52.80	19.76	39.79	13.90	52.83	20.20	42.19	13.86
60 (P4)		61.09	22.37	45.80	14.30	58.66	22.21	46.54	14.20
LSD at 5%		1.152	1.093	0.496	0.031	1.977	0.451	0.885	0.036
Interaction (SXP)									
S1	(P1)	36.85	14.19	27.87	10.62	38.25	14.23	28.89	10.64
	(P2)	38.73	14.78	29.19	10.68	42.64	15.82	32.96	10.70
	(P3)	46.59	17.20	32.92	11.08	50.27	17.43	37.34	11.14
	(P4)	52.57	19.67	37.81	11.40	55.84	20.08	43.86	11.43
S2	(P1)	39.89	15.12	30.15	15.28	41.38	15.10	31.43	15.16
	(P2)	46.17	18.24	36.00	15.92	45.81	17.64	35.19	15.78
	(P3)	53.06	19.13	38.38	16.05	55.61	20.36	39.80	16.03
	(P4)	57.70	20.79	43.29	16.83	52.99	19.59	37.97	16.42
S3	(P1)	45.23	17.05	34.03	12.57	45.85	16.51	36.36	12.63
	(P2)	52.32	19.94	39.18	12.76	53.82	19.37	43.06	12.71
	(P3)	58.66	20.88	41.13	12.87	60.41	20.93	42.67	12.80
	(P4)	67.11	23.92	48.30	12.94	69.40	24.10	48.86	12.97
S4	(P1)	52.19	15.94	38.67	15.07	52.46	18.32	40.50	15.06
	(P2)	57.48	20.71	42.01	15.37	59.27	20.37	44.80	15.27
	(P3)	60.68	21.85	46.72	15.61	62.39	21.77	48.96	15.49
	(P4)	68.51	25.07	53.80	16.05	71.67	25.06	55.48	15.99
LSD at 5%		2.303	Ns	0.992	0.062	1.035	0.903	1.770	0.073

S1: zero kg $fed.^{-1}$ of sulphur, S2: 100 kg $fed.^{-1}$ of sulphur, S3: 5 ton $fed.^{-1}$ of poultry manure and zero kg $fed.^{-1}$ of sulphur, S4: 5 ton $fed.^{-1}$ of poultry manure and 100 kg $fed.^{-1}$ of sulphur.

5. Storability of garlic bulb:

Results in Table (7) showed that poultry manure and sulphur, irrespective of phosphorus fertilizer, had a significant effect on weight loss % of garlic bulb during the storage period for 8 months in the two growing seasons. Application of 100 kg $fed.^{-1}$ of sulphur had the lower values of weight loss % of garlic bulb during the storage period for 8 months compared with application of zero kg $fed.^{1}$ of sulphur in the two growing seasons. Also, application of 5 ton $fed.^{-1}$ of poultry manure and 100 kg $fed.^{-1}$ of sulphur had the lower values of weight loss % of garlic bulb during the storage period for 8 months compared with application of 5 ton $fed.^{-1}$ of poultry manure and zero kg $fed.^{-1}$ of sulphur in both seasons. These results agreeing with those mentioned by Bloem *et al.* (2011), they stated that water loss of garlic bulb were lower at higher sulphur levels, and this relationship is proved to be significant in the absence of N application. Zaki *et al.* (2014) referred that there was a decrease in bulb weight loss during storage might be due to improve the uptake of both macro and micro-elements, which positively influenced by organic fertilizer (poultry manure) with/without sulphur.

Data for the effect of phosphorus fertilizer levels on weight loss % of garlic bulb during the storage period for 8 months in the two seasons are shown in Table (7). Results cleared that phosphorus fertilizer levels had a significant effect on weight loss % of garlic bulb during the storage period for 8 months in both seasons. The present results indicated that increasing phosphorus fertilizer level from zero to 30, 45 and 60 kg P_2O_5 $fed.^{-1}$ led to an gradually decrease in weight loss % of garlic bulb during the storage period for 8 months in both seasons. This might be due to the role of phosphors in garlic plants which play a key role in balance nutrition of the crop (Dhage *et al*., 2014).

A significant interactions between levels of poultry manure, sulphur and levels of phosphorus fertilizer with regard to weight loss % of garlic bulb during the storage period for 8 months in the two seasons are shown in Table (7). It could be revealed from the results that application of 5 ton $fed.^{-1}$ of poultry manure and 100 kg $fed.^{-1}$ of sulphur and 60 kg P_2O_5 $fed.^{-1}$ recorded the lowest values of weight loss % of garlic bulb during the storage period for two months (2.30 and 2.05 %), four months (7.12 and 6.71 %), six months (8.05 and 8.90 %) and eight months (12.10 and 11.90 %) among the other studied treatments in the 1st and 2nd seasons respectively. Many investigators showed that with increasing the levels of phosphorus in root zone, the increase in its absorption by plants was increased and consequently increased the ability of plant root to uptake more elements in plant tissues (Almadini *et al.,* 2000; Alkaff *et al.,* 2002 and Shaheen *et al*., 2007).

Table 7. Effect of poultry manure, sulphur and different levels of phosphorus fertilizer and their interactions on weight loss percentage of garlic bulb during storage period for 8 months in 2015/2016 and 2016/2017 growing seasons.

Treatments		Weight loss %							
		2 months	4 months	6 months	8 months	2 months	4 months	6 months	8 months
		Season 2015/2016				Season 2016/2017			
Levels of poultry manure and sulphur									
S1		3.42	11.19	16.54	27.89	2.92	11.00	15.39	26.12
S2		3.17	9.49	14.40	24.70	2.56	9.08	13.14	22.79
S3		3.03	8.24	11.04	19.15	2.39	8.17	10.79	18.87
S4		2.45	7.28	9.42	13.01	2.17	7.25	9.66	13.00
LSD at 5%		0.151	0.013	0.082	0.204	0.145	0.044	0.165	0.058
Levels of phosphorus (P) fertilizer (kg P_2O_5 fed.$^{-1}$)									
0 (P1)		3.14	9.84	13.76	23.18	2.56	9.85	13.22	21.79
30 (P2)		3.10	9.29	13.46	21.83	2.59	8.89	12.50	20.76
45 (P3)		2.95	8.24	12.60	20.66	2.50	8.52	11.82	19.92
60 (P4)		2.88	7.28	11.60	19.08	2.38	8.25	11.44	18.32
LSD at 5%		0.132	0.043	0.038	0.110	0.123	0.028	0.141	0.097
Interaction (SXP)									
S1	(P1)	3.66	12.87	17.17	29.53	3.15	13.76	16.43	28.06
	(P2)	3.43	11.83	17.05	28.23	2.92	10.35	15.23	27.14
	(P3)	3.37	10.12	16.10	27.06	2.92	10.18	15.06	25.24
	(P4)	3.24	9.96	15.84	26.75	2.70	9.76	14.85	24.05
S2	(P1)	3.20	9.83	15.76	26.06	2.62	9.44	14.75	23.85
	(P2)	3.17	9.65	15.45	25.25	2.57	9.25	14.05	22.65
	(P3)	3.17	9.33	14.26	24.15	2.53	9.07	12.03	22.46
	(P4)	3.12	9.15	12.15	23.35	2.51	8.57	11.75	22.22
S3	(P1)	3.05	9.15	11.86	23.10	2.48	8.43	11.60	21.05
	(P2)	3.31	8.34	11.60	20.75	2.43	8.23	10.82	20.10
	(P3)	2.91	7.82	10.36	18.65	2.39	8.06	10.48	19.25
	(P4)	2.86	7.67	10.35	14.10	2.27	7.96	10.27	15.10
S4	(P1)	2.64	7.53	10.24	14.05	2.25	7.77	10.10	14.20
	(P2)	2.48	7.34	9.73	13.10	2.22	7.75	9.90	13.15
	(P3)	2.36	7.15	9.68	12.80	2.15	6.78	9.74	12.75
	(P4)	2.30	7.12	8.05	12.10	2.05	6.71	8.90	11.90
LSD at 5%		Ns	0.085	0.076	0.220	0.045	0.055	0.289	0.195

S1: zero kg fed.$^{-1}$ of sulphur, S2: 100 kg fed.$^{-1}$ of sulphur, S3: 5 ton fed.$^{-1}$ of poultry manure and zero kg fed.$^{-1}$ of sulphur, S4: 5 ton fed.$^{-1}$ of poultry manure and 100 kg fed.$^{-1}$ of sulphur.

CONCLUSION

This study revealed that application of 5 ton fed.$^{-1}$ of poultry manure and 100 kg fed.$^{-1}$ of sulphur and 60 kg P_2O_5 fed.$^{-1}$ was the best treatment, because it recorded the higher values of the remaining nutrients, i.e., N, P (ppm) and OM % in the soil postharvest, the highest values of fresh total yield (6.45 and 6.75 ton fed.$^{-1}$) and bulb yield (5.62 and 5.78 ton fed.$^{-1}$), highest values of blub quality (DM, TSS, carbohydrates, protein, lipids and ash) percentages, the lowest values of nitrite and nitrate contents (mg kg^{-1} FW) as well as the lowest values of weight loss percentage of garlic blub during the storage period for 8 months in the 1st and 2nd seasons, respectively, would be suitable economical, productivity, quality, storability and health for garlic production cv. Egaseed 1 in Egypt under experimental conditions.

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النمو والمحصول وجودة الابصال والقدرة التخزينية للثوم المتاثر باستخدام زرق الدواجن والكبريت ومستويات مختلفة من السماد الفوسفاتى

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يعتبر الثوم من أهم الخضروات البصلية ذات العديد من الفوائد الغذائية والطبية (له خصائص مضادة للعدوي مثل مكافحة السرطان). زرق الدواجن صديق للبيئة واقتصادي ويعتبر حلاً مناسباً للتغلب على التلوث البيئي وتحسين خصوبة التربة وأيضاً الزيادة النوعية والكمية للثوم. لذلك تم أجراء هذا العمل فى محطة البحوث الزراعية بملوى ، محافظة المنيا وكذلك معامل قسمى البساتين وعلوم الاغذية ، كلية الزراعة بالوادى الجديد ، جامعة اسيوط ، مصر خلال موسمى الشتاء ٢٠١٦/٢٠١٥ و ٢٠١٧/٢٠١٦م لدراسة تأثير زرق الدواجن والكبريت ومستويات مختلفة من السماد الفوسفاتى على النمو ، والمحصول ومكوناته ، وجودة الأبصال وكذلك القدرة التخزينية للثوم (صنف ايجاسيد ١). أوضحت النتائج التي تم الحصول عليها أن هناك تأثيراً معنوياً لزرق الدواجن والكبريت والمستويات المختلفة من السماد الفوسفاتى على المغذيات المتبقية فى التربة بعد الحصاد مثل النيتروجين والفوسفور والبوتاسيوم والمادة العضوية ، والنمو ، والمحصول ومكوناته ، وجودة الأبصال ، وحالة المغذيات النباتية ، والممتص من النيتروجين والفوسفور والبوتاسيوم والكبريت ، وكذلك القدرة التخزينية (نسبة الفقد فى الوزن) لأبصال الثوم. أوضحت الدراسة أن استخدام زرق الدواجن بمعدل ٥ طن/فدان مع ١٠٠ كجم/فدان كبريت و٦٠ كجم/فدان خامس اكسيد الفوسفور كانت أفضل المعاملات ، لأنها سجلت أعلى القيم للمغذيات المتبقية فى التربة بعد الحصاد مثل النيتروجين والفوسفور والمادة العضوية ، وأعلى القيم للمحصول الكلى الطازج (٦.٤٥ و ٦.٧٥ طن/فدان) ومحصول الأبصال (٥.٦٢ و ٥.٧٨ طن/فدان) ، وأعلى القيم لجودة الأبصال (نسب كلاً من المادة الجافة والمواد الصلبة الذائبة الكلية والكربوهيدرات والبروتين والليبيدات والرماد) ، وأقل القيم للمحتوى من النتريت والنترات (ملليجم/كجم وزن طازج) ، وكذلك أقل القيم لنسبة الفقد فى الوزن لأبصال الثوم أثناء فترة التخزين لمدة ٨ أشهر فى الموسم الأول والثاني على التوالى ، وستكون مناسبة اقتصادياً وإنتاجياً وعلي الجودة والقدرة التخزينة والصحية لإنتاج الثوم في مصر تحت ظروف التجربة.