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Effect of some Natural Material Additives on Growth and Flowering of Tuberose *(Polianthes tuberosa,* L.) Bulbs

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ABSTRACT

Tuberose (*Polianthes tuberosa*, L.) has a good economic potential for cut flower trade and essential oil industry. A field experiment was conducted at Sakha Horticulture Research Station, Kafr El-Sheikh Governorate, Egypt, during the two successive seasons of 2013/2014 and 2014/2015 to study the effect of some natural materials, i.e. humic acid, yeast and garlic extracts, using two application methods, i.e. soil drench and foliar spray, on some vegetative growth traits, flowering, bulbs and bulblets productivity. The investigation aimed to improve plant quality and raise new formed bulbs and bulblets under local conditions. Results indicated that humic acid treatment followed by yeast then garlic extract significantly increased all traits under study. Soil drench method was superior for vegetative growth, flowering traits, bulbs productivity and chemical constituents compared to the foliar spray one. Application of humic acid as soil drench increased leaf length, number of leaves. Furthermore, it induced precocity in flowering, increased spike and rachis length, number of florets per spike, fresh weight of florets, fresh and dry weights of spike. Also, it significantly increased number of bulblets, fresh weight of clump, fresh weight of new formed bulb and its diameter. Besides, it increased chlorophyll (a) and (b), carbohydrates content, nitrogen, phosphorus and potassium percentage in the leaves compared to untreated plants in both seasons. Therefore, application of humic acid by soil drench method, at the rate of 9 ml/l after three weeks of planting tuberose bulbs, three times with three weeks' interval is important for improving plant quality and raising new formed bulbs and bulblets under local conditions.

Keywords: Natural extracts, Ornamental bulbs and Tuberose (*Polianthes tuberosa. L.).*

INTRODUCTION

Polianthes tuberosa L. belongs to the ornamental flowering bulbs (Fam. Agavaceae). It has a good economic potential for cut flower trade and essential oil industry (Alan *et al*., 2007). Intensive ornamental bulbs production demands suitable agricultural practices. With the rapid increase in population and limited area of cultivation, there is a need to improve productivity with less formative effect on the environment. This is only possible with the integration of conventional and non-conventional approaches (Zafar, 2007). Recently, among the fertilization strategies, the application of different molecules as humic acid has been introduced.

Humic acid (HA), called humin materials widely consist of a part of soil organic matter (65- 70%) (Stott and Martin, 1990). It is a potential natural resource that can be utilized to increase growth, nutrient availability and yield (Sharif *et al*., 2002). Its function is to buffer the hydrogen ion (pH) concentration of the soil. Humic acid makes important contributions to improve soil stability, fertility, improves flower quality that leads to enhance plant growth and micronutrient uptake. Recent investigations revealed that the application of organic fertilizers to the soils can promote nutrients availability and plant uptake, increase crop yield, reduce inputs of chemical fertilizers and minimize environmental risks (Koreish, 2003; Koreish *et al.,* 2004). In addition, humic acid can stimulate shoot and root growth, and improve resistance to environmental stress in plants (Goatley and Schmidt, 1990). There are direct and indirect effects on plant growth because of the multiple roles of humic (Pal and Biswas, 2005). Humic acid treatments improve soil aggregation, structure, water permeability, air conditioning, fertility, moisture holding capacity, and increase microbial activity of microbial population and cation exchange capacity (Mohamed, 2012).

Few research works have been carried out on the application of humic acid on some ornamental flowering bulbs.

Hanel and Muller (2006) observed that *Gladiolus imbricatus* grew well in a moderately and strongly acidic humic acid. Eliwa *et al*., (2009), on *Iris tingitana* cv. Wedgewood, stated that supplying the plant with actosol [containing 2.9% humic acid (ElSeginy 2006)] as a foliar spray at the rate of 2.5 ml/l significantly increased plant height, number of leaves/plant, flower stalk length, fresh weight of spike and bulbs fresh weight. Actosol at 20 ml/l as a soil drench induced early flowering compared with control plants. Meanwhile, applying actosol at 10 ml/l as a soil drench revealed its superiority for increasing fresh weight and yield of bulblets. El-Sayed *et al*., (2010) on two *Gladiolus* cvs. (White and Rose Prosperity), concluded that soaking the corms before planting in actosol solution at the rate of 20 ml/l for 12 and 24 hours increased significantly vegetative growth, flowering traits and corms production of both cultivars. There was a progressive increase with elongating soaking period of humic acid solution. Ahmad *et al*., (2013) on *Gladiolus grandiflorus* L. found that humic acid treatment gave more foliage growth per plant, reduce the days from planting to flowering, increased spike length, vase life, gave higher number of cormels per clump, greater corm weight and its diameter, and total leaf chlorophyll contents.

Ali *et al.,* (2014) on *Tulipa gesneriana* indicated that the treatment of 1.25 ml/l of 8% humic acid + 10 g/m2 NPK (17:17:17) was the most effective, compared with the other treatments, concerning earliest flowering, higher records of stalk length, stem diameter, vase life, fresh and dry weight of flower, plant height, and the maximum leaf chlorophyll contents. Khodakhah *et al.*, (2014) showed that application of 1000 ppm humic acid increased *Tuberose* number of leaves per plant, number of florets, spike length, vase life and chlorophyll (a and b) contents.

Pradeep *et al.,* (2014) on *Gladiolus grandiflours* revealed that plant height, number of leaves and leaf length were significantly influenced by the application of organic fertilizers.

Ahmed *et al*., (2015) mentioned that application of humic acid combined with NPK resulted in significant increases in stalk length of *Tulipa gesneriana.* This may be due to an improvement of plant growth in terms of stem elongation by hormone - like activity of humic acid (HA).

Ibrahim *et al.*, (2016) on *Limonium sinuatum* stated that applying 5 cm foliar spray of humic acid at 30 day intervals gave an increment in plant height. Plants which received 15 cm humic acid at 30 days' interval, gave the highest significant values of leaf number per plant, fresh and dry weights of leaves compared with the control. The significant highest values of number of florets and dry weight of florets were observed after treatment with 10 cm humic acid at 30 days' interval in both seasons. Moreover, the highest significant values of stem fresh and dry weights, leaf chlorophyll content and leaf N, P and K percentage were observed after treatment with 15 cm humic at 15 day intervals.

Khattab *et al*., 2016 indicated that using actosol alone at 2.5 or 5.0 ml/l gave the significant highest values of chlorophyll (a + b) in the *Gladiolus* leaves.

Effect of active dry yeast and garlic extracts:

The use of extracts of certain plants referred to as bio stimulants, botanical activators, such as garlic and yeast (fungi) extracts in improving the growth of agriculture crops especially ornamental plants, is highly recommended as an environment friendly and safe approach to get better plants without being forced to use more chemical nutrients or synthetic growth regulators that may harm the environment. This procedure improves nutrients utilization and lower environmental pollution through reducing the amount of added fertilizers to the soil.

A- Effect of active dry yeast:

The positive effects of applying active dry yeast (*Saccharomyces cervisiae*) to plant can be attributed to its high nutrient contents, high protein, large amount of vitamin B and natural plant growth regulators such as cytokinins (Ahmed, 2002). Cytokinins stimulate cell division and enlargement as well as the synthesis of protein, nucleic acid and vitamin B, (Kutzman and Fell, 2005). Yeast nutrition is considered as a potent, safe and costless natural stimulator.

The effect of yeast extract on different plant characters could be interpreted in the light of the following findings: Desouky (2004) on *Strelitizia reginae* plant, reported that a combination of NPK at the rate of 100:60:20g/plant + active dry yeast at 2g/plant greatly increased plant height, leaf number/plant, fresh and dry weights of plant, number of flowers /plant, stalk length, as well as flower fresh and dry weights and total carbohydrate in vegetative parts. Mohamed *et al*., (2005), on *Lilium longiflorum*, mentioned that a spray solution with 3g dry yeast/l significantly increased leaf number/plant, flower dry weight and carbohydrates content compared to the control plants. Abass (2008), subjected *Narcissus tazetta* plants a foliar spray of active dry yeast solution at the rate of 6 g/l. They found that using the yeast solution led to a significant increase in most studied characters and a significant reduction in time required to flowering stage. Moreover, nitrogen, phosphorus and chlorophyll contents in leaves significantly increase compared to the control treatment. On *Dahlia pinnata* Manoly 2008 found that active dry yeast, was effective an enhancing different vegetative growth characters, flowering aspects and chemical constituents. Emam (2010) on *Polianthes tuberosa* stated that a significant increment in rachis length compared with control was detected due to treating plants with yeast at the rate of 7ml/l, whereas using yeast at the lowest level (1ml/l) caused an obvious increment in time required from planting to flowering. Abd El-Kafie *et a*l., (2010) showed that treating tuberose plants with 2 and 3g/l yeast extract significantly increased number of florets, spike length and leaf dry weight more than using 1g/l yeast extract.

EL-Sayed *et al*., 2015 on *Fressia refracta* noticed that using yeast extract at 2.5 m/l, improved vegetative growth, most of flower parameters and corms and cormlets productivity. Also chlorophyll (a) and (b), total carbohydrates, nitrogen, phosphorus and potassium contents in the leaves were increased as compared to the untreated plants.

El-Naggar *et al*., (2016) indicated that treating *Anthurium andreanum*, L. with 10g/pot of mineral N, P and K monthly combined with active dry yeast at 6 g/l, enhanced vegetative growth, flowering parameters and N, P and K% and total chlorophyll in leaves.

On Gladiolus plants Khattab *et al*., (2016) reported that using yeast extract at 10 g/l combined with kristalon at 2 g/l gave the highest significant increases of plant height, leaf number and the content of the produced corms of phosphorus, potassium and total carbohydrates, compared with the control treatment. Using yeast extract at 10 g/l combined with actosol at 2.5 ml/l achieved the largest circumference of the produced corms (grade number), corms dry weight and the number of cormels/plant, compared with the control treatment.

B- Effect of garlic extract:

The garlic extract is the sap of garlic bulb *Allium satvium*. L. It is distinguished by containing high amount of amino acids, which contain sulfur element, such as: cysteine and methionine (Synge 1971). Garlic contains the following materials: volatile oil, allicin, alliin, sugars, iodine and vitamins (Al Rawi & Chakravarty 1964). Abou Hussein *et al*., (1975 a and b), mentioned that garlic extract has many effects due to its hormonal (auxin–like) nature, which has an important role in lateral extension and elongation of cells.

The effect of garlic extract on different plant characters could be noticed in the following findings. On *Narcissus tazetta* cv. Geranium, Gommaa *et al*., (2005) found that garlic extract at the rate of 25, 50 and 100% as a foliar spray significantly increased plant height, flower stalk length, fresh weight of flowers, bulbs and bulblets.

Emam (2010), on *Polianthes tuberosa* reported that garlic extract at 1 and 5ml/l improved flowers traits, increased clump fresh weight, clump dry weight, number of bulbs/plant and number of bulblets/plant. Atowa (2012) on *Freesia refracta* found that application of garlic extract at 500 ml/l increased number and fresh weight of cormlets and chlorophyll (a), whereas using garlic extract at 250 ml/l significantly increased total carbohydrates, N, P and K contents in the leaves.

Hanafy *et al*., (2012) on *Schefflera arboricola* plants stated that the highest values of plant height, dry weight of leaves/plant, total carbohydrates and nitrogen contents were obtained when using garlic extract as a soil drench compared with foliar spray method.

On *Fressia refracta EL*-Sayed *et al*., (2015) reported that using garlic extract at 500 ml/l increased number of cormlets/plot, fresh weight of cormlets and

chlorophyll (a) in the leaves. Great influence was detected on carbohydrates content due to applying garlic extract at 250 ml/l.

The suitable agricultural practices are necessary for the best growth, flowering, bulbs productivity because the application of natural materials (humic acid, yeast and garlic extracts) and application of methods (soil drench and foliar spray) are paramount factors that affect the physiological behavior and morphological traits of tuberose plant, besides getting a safe and clean product.

MATERIALS AND METHODS

A field experiment was carried out at Sakha Horticulture Research Station, Kafr El-Sheikh Governorate, Egypt, during the two successive seasons of 2013/2014 and 2014/2015 to study the effect of three natural material treatments, i.e. humic acid, yeast and garlic extract under two methods of application, i.e. soil drench and foliar spray on growth, flowering, bulbs productivity and some chemical constituents of Polianthes tuberosa.

The treatments were as follows:

1. Control plants under soil drench.
2. Humic acid under soil drench
3. Active dry yeast under soil drench
4. Garlic under soil drench
5. Control plants under foliar spray.
6. Humic acid under foliar spray
7. Active dry yeast under foliar spray.
8. Garlic under foliar spray.

In this experiment, the used bulbs were a local cultivar, and the weight of bulbs ranged from 85 to 95 g. Bulbs were planted on March 26th in both seasons at a depth of 10-12 cm. The application rate of natural materials under soil drench and foliar spray was 9 ml/l three weeks after planting bulbs, applied three times at three weeks' interval. Irrigation and agricultural practices were done whenever plants needed. Kristalon fertilizer (19-19-19) was applied three times for all plants.

Factorial experiment in randomized complete blocks design was used Eight treatments (4 natural materials × 2 methods) were replicated three times and distributed within each block. Duncan multiple range test was used for the comparison between means of treatments according to Snedecor and Cochran (1972). Soil samples were taken for physical and chemical analysis before planting in the two seasons. The obtained data are presented in Table (A).

Table A. Physical and chemical analysis of soil before planting

Physical analysis									
Clay		**Silt**		**Fine sand**		**Coarse sand**		**Texture**	
54.4%		23.3 %		11.4%		10.9%		clay loam	
Chemical analysis									
pH	EC dSm^{-1}	Na^{+}	K^{+}	Ca^{++}	Mg^{++}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}
8.3	2.1	9.2	0.7	5.1	6.2	-	11.7	6.6	1.8

Chemical composition of humic acid and its concentration is presented in Table (B)

Table B. Chemical analysis of humic acid (rich humic) product of Sakha Agriculture Research Station, Branch of Plant Nutrition.

Composition	Concentration	Composition	Concentration
Humic acid	40%	Citric acid	3%
Nitrogen	5%	Potassium	3%
Magnesium	0.5%	Boron	0.2%
Copper	0.2%	Iron	4000 ppm
Zinc	600 ppm	Manganese	1200 ppm

Extracts of yeast and garlic, were prepared according to Hnanfy *et al.,* (2012) as follows:

1- **Yeast (*Saccharomyces cerevisiae*):** Relatively newly produced active dry yeast was obtained and 10 g of yeast was weighed and put with 100 cm of water in a glass beaker. A teaspoon full of sugar was added. The beaker was kept in a dark warm place for 20 minutes. Contents of the beaker were then filtered into a one liter measuring flask and water was added to 1-liter final volume. Chemical composition of the active dry yeast and the nutritional value per 100 g according to USDA nutrient database is presented in Table (C).

2- **Garlic (*Allium sativum*):** Newly produced garlic cloves were brought and 250 g of these cloves were put in a glass beaker containing 250 ml of tap water. The beaker was put in a freezer for one day, after which, the frozen beaker was left to thaw. Freezing and thawing were repeated three. Water was added to a final volume of 1 liter before filtering. The final size of the filtrate was adjusted to 1: l, before being used. The natural materials were sprayed three times at three weeks' interval three weeks after planting. The most and important chemical components of garlic extract are shown in Table (D).

Table C. Chemical composition of the active dry yeast nutritional value per 100 g

Chemical composition	Concentration	Chemical composition	Concentration
Proteins	40.24 m/g	Zinc	7.94 m/g
Carbohydrates	41.22 m/g	Iron	2.17 m/g
Niacin	40.2 m/g	Manganese	0.312 m/g
Pantathenate	13.3 m/g	Calcum	30 m/g
Cholin	32.0 m/g	Phosphorus	637 m/g
Folic acid	2340 ug	Potassium	955 m/g
Fiber	26.9 m/g	Vit.B 12	0.001 m/g
Fat	7.61 m/g	Vit.B 6	0.3 m/g
Riboflavin	4.0 m/g	Thiamine(B1)	10.99 m/g
Water	5.08 g	Vitamin C	1.5 m/g

Table D. Important chemicals and minerals per 100 g of garlic.

Chemical composition	Concentration	Chemical composition	Concentration
Lysine	0.273 g	Aspartic acid	0.489 g
Carbohydrates	33.07 g	Leucine	0.308 g
Lipids	0.50 g	Manganese	1672.00 mg
Sodium	17.00 mg	Calcum	181.00 mg
Magnesium	32.0 m/g	Phosphorus	153.00 mg
Calories	149.00 Kcal	Potassium	401.00 mg
Fiber	2.10 g	Sulphur	70.00 mg
Glutamic acid	0.805 g	Vit.B 6	1235.00 mg
Argenine	0.634 g	Vitamin C	31.00 mg
Water	59 g	Fiber	2.10 g

Source
http://www.botanical-online.com/medicinalsalliumsativumang les.htm

Data recorded were:

1. Leaf length in cm.
2. Fresh and dry weights of leaves/plant in g.

3. Leaf number/plant at flowering time.
4. Flowering date (days).
4. Length of spike in cm.
5. Rachis length in cm.
6. Floret number/flowering spike
7. Fresh and dry weights of flowering spike in g.
8. Fresh weights of florets in g.
9. Vase-life in days: Three similar stalks from each replicate were chosen at the stage of the open of the first florets and put vertically in a vase containing distilled water.
10. Number of new formed bulblets
11. Fresh and dry weights of clump in g.
12. Fresh weights of new formed bulb in g.
13. Diameter of new formed bulb in cm.
14. Length of the longest root in cm.
15. Fresh weight of roots in g.

Data on vegetative growth and flowering were recorded at flowering time on July and August months, while those of bulbs productivity were estimated after the end of flowering duration when the plants began to wilt on September month.

Chemical analyses:

Chlorophylls (a) and (b) contents were determined according to Moran (1982). Total carbohydrates concentration was determined using colorimetric method given by Herbert *et al.*, (1971). Percentages of N, P and K of dried leaves were determined according to the following methods: Nitrogen% was determined using micro-kjeldahle method according to Piper (1947), phosphorus% was colorimetrically determined according to Troug and Meyer (1939), while potassium% was determined using the flame photometer according to the method described by Brown and Lilliland (1946).

RESULTS AND DISCUSSION

Data presented in Table (1) showed that leaf length was affected by all natural materials than control treatment in both seasons regardless methods of application. The highest record resulted from humic acid treatment as gave 41.75 and 54.35 cm against 35.5 and 38.0 cm for the control treatment in both seasons, respectively, non-significant difference was observed between humic acid and yeast extracts in leaf length trait in the first seasons only. Similar results were observed by El-Sayed *et al*., (2010), Hanafy *et al*., (2012) Pradeep *et al*., (2014), Ali *et al*., (2014), Ibrahim *et al*., (2016) and Khattab *et al*., (2016).

Concerning the method of application, data in the same table showed that both methods increased leaf length trait, with non-significant difference between the two methods in the first season only. Referring to the interaction between the two factors, data in the same table revealed that plants treated with humic acid under soil drench recorded 53.5 and 59.0 cm in the first and second seasons respectively. However untreated plants gave the lowest values of leaf length under both methods.

Data presented in Table (1) indicated that humic acid, yeast and garlic extracts had a significant effect on increasing number of leaves as compared with untreated plants. The highest number of leaves wasobserved on plants treated with humic acid to be 61.7 and 69.2 in both seasons respectively, while the lowest number of leaves resulted from the control treatment to be 45.0 and 44.3 in the first and second seasons respectively. These findings are in harmony with those obtained by Ahmed *et al*., (2013) Pradeep *et al*., (2014), Khodakhah *et al*., (2014), Ibrahim *et al*., (2016) and Khattab *et al*., (2016).

Table 1. Effect of some natural materials and method of application on leaf length and number of leaves/plant of *Polianthes tuberosa*, during the two seasons of 2013/2014 and 2014/2015.

Traits	Leaf length (cm)			Number of Leaves / plant		
Natural materials	Soil drench	Foliar spray	Mean	Soil drench	Foliar spray	Mean
First season						
Control	36.5 d	34.5 d	35.5 B	46.0 f	44.0 f	45.0 D
Garlic	39.5 cd	38.0 d	38.8 B	51.0 d	48.0 e	49.5 C
Yeast	42.0 c	39.5 cd	40.8 A	60.4 b	50.3 d	55.4 B
Humic acid	53.5 a	48.0 b	41.8 A	66.4 a	57.0 c	61.7 A
Mean	42.9 A	40.0 A		56.0 A	49.8 B	
Second season						
Control	38.0d	38.0d	38.0 C	44.6 e	44.0 e	44.3 D
Garlic	41.4 c	39.8 cd	40.6 C	55.3 c	50.2 d	52.8 C
Yeast	50.6 b	41.3 c	45.9 B	66.4 b	55.2 c	60.8 B
Humic acid	59.0 a	49.7 b	54.4 A	71.8 a	66.6 b	69.2 A
Mean	47.3 A	42.2 B		59.5 A	54.0 B	

Means within a column having the same letters are not significantly different according to Duncan's multiple range test.

Regarding method of application regardless natural materials treatments, it is evident from Table (1) that the soil drench technique led to more number of leaves. The recorded values were 55.9 and 59.5 the first and second seasons, respectively compared with foliar spray method as gave 49.8 and 54.0 in the first and second seasons, respectively. As for the interaction between natural materials treatments and method of application, data presented in the same table indicated that applying humic acid as a soil drench resulted in more leaves as gave 66.4 and 71.8 the first and second seasons, respectively.

Data presented in Table (2) pointed out the humic acid, yeast and garlic extras had a significant effect on increasing leaves fresh weights as compared with the control treatment in both seasons. The highest recorded values resulted from humic acid treatment to be 285.9 and 308.9 g in the first and second seasons, respectively, whereas the lowest fresh weights of leaves were 161.0 and 195.0 g for control treatment in the first and second seasons, respectively. These results are in line with those of the other researchers on some ornamental bulbs such as Pradeep *et al*., (2014) and Ibrahim *et al*., (2016). Results concerning the effect of both methods application on fresh weight of leaves in Table (2) indicated that either soil drench or foliar spray methods were effective in increasing fresh weight of leaves, with superiority of soil drench method as gave 252.1 and 265.2g over foliar spray method which recorded 227.8 and 243.4g. The interaction between natural materials and methods of application on fresh weight of leaves, clear that applying humic acid under soil drench method resulted in the heaviest fresh leaves to be 291.7 and 317.7g in the two seasons, respectively.

Table 2. Effect of some natural materials and method of application on fresh and dry weights of leaves of *Polianthes tuberosa*, during the two seasons of 2013/2014 and 2014/2015.

Ttraits	Leaves (f.w g)			Leaves (d.w g)		
Natural materials	Soil drench	Foliar spray	Mean	Soil drench	Foliar spray	Mean
First season						
Control	162.0 f	160.0 f	161.0 D	49.0 e	47.0 e	48.0 C
Garlic	275.6 c	220.0 e	247.8 C	75.0 c	52.7 d	63.9 B
Yeast	280.0 b	250.0 d	265.0 B	80.2 b	57.3 d	68.8 B
Humic acid	291.7 a	280.2 b	285.9 A	93.7 a	83.8 b	88.8 A
Mean	252.1 A	227.8 B		74.5 A	60.2 B	
Second season						
Control	195.0e	195.0 e	195.0 D	31.2 d	31.0 d	31.1C
Garlic	270.0bc	230.4 d	250.2 C	41.8 b	36.6 c	39.2B
Yeast	268.0 b	248.1c	263.1 B	44.0 b	37.3 c	40.7B
Humic acid	317.7a	300.0 ab	308.9 A	51.8 a	50.0 a	50.9A
Mean	265.2A	243.4 B		42.2 A	38.7 B	

Means within a column having the same letters are not significantly different according to Duncan's multiple range test.

It is evident from presented data in Table (2) that the trend of the results of dry weight of leaves similar to the trend of the results of fresh weight of leaves in both seasons. These results are in agreement with those obtained by Abd El-Kafie *et al*., (2010), Pradeep *et al*., (2014) and Ibrahim *et al*., (2016). The increment of vegetative growth may be due to the absorption of humic acid through plant roots, and translocation to shoots and other plant parts, and eventually enhancing plant growth responses (Lulakis and Petsas,1995). Baldotto and Baldotto (2013), on gladiolus plants cv. 'White Friendship', stated that the stimulating effect of humic acid on vegetative growth might be due to improvement of micro and macro nutrients uptake and reduction in water evaporation from soil.

With respect to the effect of natural materials on flowering date regardless of method application, data in Table (3) revealed that, humic acid, yeast and garlic extracts treatments tended to a steady and significant precocity in flowering compared with untreated plants. The earliest flowering resulted significantly from applying humic acid treatment as occurred after 96.1 and 95.7 days followed by yeast extract treatment after 100 and 102.4 days then garlic extract treatment which occurred after 108.3 and 107.8 days. However, in the control treatment flowering occurred after 125.5 and 127.1 days from planting in the two respectively. Similar results were obtained by Abass (2008), Eliwa *et al*., (2009), Ahmed *et al*., (2013) and Ali *et al.,* (2014). Concerning method application irrespective of natural materials treatments, data in Table (3) revealed that both methods of application induced earlier flowering after 107.0 days under soil drench method and 107.9 days under foliar spray method in the first season with non-significant differences between both methods in the first season. However, in the second season, the corresponding values were 105.8 and 110.7 days with significant differences. In accordance with these results were those reported by Hanafy *et al*., (2012). The interaction indicated that applying humic acid as soil drench caused flowering after 95 and 93 days. whereas the flowering in the control treatments occurred after 126.1 and 128.0 days from planting under soil drench. However, flowering under foliar spray occurred after 124.9 and 126.2 days in the two seasons respectively.

Table 3. Effect of some natural materials and method application on flowering date and number of florets/spike of *Polianthes tuberosa*, during the two seasons of 2013/2014 and 2014/2015.

Traits	Flowering date (days)			Number of florets/spike		
Natural materials	Soil drench	Foliar spray	Mean	Soil drench	Foliar spray	Mean
First season						
Control	126.1 a	124.9 a	125.5 C	22.7 d	22.9 d	22.8 C
Garlic	108 b	108.5 b	108.2 B	39.3bc	34.0 c	36.7 B
Yeast	98.9 bc	101.1bc	100.0 A	41.6 b	34.5 c	38.1 B
Humic acid	95 c	97.1 c	96.1 A	46.7 a	41.4 b	44.1 A
Mean	107.0 A	107.9 A		37.5 A	33.2 B	
Second season						
Control	128.0 a	126.2 a	127.1 D	25.0 c	25.0 c	25.0 C
Garlic	104.5 bc	111.0 b	107.8 C	38.0bc	35.0bc	36.5 B
Yeast	97.5 c	107.2 bc	102.4 B	41.1 ab	35.5 bc	38.5 B
Humic acid	93.0 d	98.3 d	95.7 A	44.4 a	41.2 ab	42.8 A
Mean	105.8 A	110.7 B		37.1 A	34.2 B	

Means within a column having the same letters are not significantly different according to Duncan's multiple range test.

Data obtained on the effect of natural materials treatments on number of florets per spike through two seasons are presented in Table (3). A gradual and significant increment in number of florets was observed due to treating plants with humic acid as gave 44.1 and 42.8, followed by yeast extract as recorded 38.1 and 38.3 then garlic extract as gave 36.7 and 36.5 against 22.8 and 25.0 florets/spike for control in both seasons, respectively. Non-significant differences were obtained between yeast extract and garlic extract treatments. Similar results were obtained by Abd El-Kafie *et al.*, (2010), Ahmad *et al*., (2013) Khodakhah *et al*., (2014) and Ibrahim *et al*., (2016). Regarding application method regardless natural materials, it is evident from Table (3) that the soil drench technique resulted in more number of florets/spike as 37.6 and 37.1 compared with foliar spray method (33.2 and 34.2) in the first and second seasons, respectively. For the interaction between the two factors it is evident from Table (3) that humic acid under soil drench treatment pronouncedly affected floret number per spike, when compared with other treatments and resulted a significant increment in number of florets during both seasons. The treatment of humic acid under soil drench method recorded 46.7 and 44.4 florets/spike in the two seasons, respectively. However, the control treatment gave the lowest number florets/spike in the two seasons either soil drench or as foliar spray method. as

From the presentation in Table (4) data revealed that, all natural materials treatments significantly increased spike length over the control plants in an ascending order from the garlic extract treatment followed by yeast treatment then humic acid treatment in both seasons. The highest increment was obtained from the treatment of humic acid as gave 92.9 and 85.4 cm against 58.5 and 60.2 cm for the control treatment in both seasons, respectively. A similar trend of results was found by Abd El-Kafie *et al.*, (2010) Ahmad *et al*., (2013), Baldotto and Baldotto (2013), Ali *et al.*, (2014), Khodakhah *et al.*, (2014) and Ahmed *et al*., (2015). Regarding the effect of method application, it is clear from

data also, that, the soil drench method significantly increased the spike length in comparison to foliar spray method as recorded 80.6 and 75.9 cm, while foliar spray method recorded 74.1 and 70.3 cm, respectively in the two seasons. Referring to the interaction between the application of method and natural materials, it is obvious from Table (4) that the longest spikes resulted from applying humic acid under soil drench method as gave 95.0 and 89.8 cm in the two seasons, respectively. However, the control treatment under both methods gave the shortest spike length in the first and second seasons. Data presented in Table (4) pointed out that a similar trend as that in case of spike length was obtained for rachis length. Data cleared that the significantly highest value in two seasons resulted from applying humic acid as gave 31.3 and 29.9 cm against 18.2 and 16.9 cm, in the first and second seasons, respectively. Non-significant difference was observed between yeast and garlic extract treatments in both seasons. The findings are in harmony with those obtained by Emam (2010) Ahmad *et al*., (2013), Baldotto and Baldotto (2013), Khodakhah *et al*., (2014) and Ahmed *et al*., (2015). Concerning the effect of application method on rachis length regardless the other factor data presented in Table (4) revealed that the soil drench treatment gave longer rachis than the foliar spray treatment in two seasons. The recorded values were 26.6 and 26.9 cm, while the foliar spray method recorded 23.5 and 21.5 cm in both seasons, respectively.

Table 4. Effect of some natural materials and method application on spike length and rachis length of *Polianthes tuberosa*, during the two seasons of 2013/2014 and 2014/2015.

Traits	Spike length (cm)			Rachis length (cm)		
Natural materials	Soil drench	Foliar spray	Mean	Soil drench	Foliar spray	Mean
First season						
Control	59.0 d	58.0 d	58.5 D	18.3 c	18.1 c	18.2 C
Garlic	80.0bc	70.7 c	75.4 C	25.7 b	23.0 bc	24.4 B
Yeast	88.4 b	77.0 bc	82.7 B	29.6 ab	23.2 bc	26.4 B
Humic acid	95.0 a	90.7 ab	92.9 A	32.9 a	29.7 ab	31.3 A
Mean	80.6 A	74.1 B		26.6 A	23.5 B	
Second season						
Control	60.3 d	60.0 d	60.1 D	17.1 d	16.8 d	16.9 C
Garlic	72.5 c	70.0 c	71.3 C	28.1 b	20.0 c	24.3 B
Yeast	81.0 b	70.2 c	75.6 B	30.3 ab	21.4 c	25.9 B
Humic acid	89.8a	81.0 b	85.4 A	32.0 a	27.7 b	29.9 A
Mean	75.9 A	70.3 B		26.9 A	21.5 B	

Means within a column having the same letters are not significantly different according to Duncan's multiple range test.

As regards the interaction between the two studied factors, it is obvious from the results presented in Table (4) that, the highest records of rachis length resulted from treating plants with humic acid as a soil drench as recorded 32.9 and 32.0 cm, while the control temperature gave the least values under both methods in this concern, Baldotto and Baldotto (2013) reported that application of humic acid increased flowering and yield of gladiolus. This may be due to the role of humic acid in improving nutrients uptake and hence increase the spike length.

Data listed in Table (5) indicated that, the fresh weight of spike was gradually and significantly increased by using all natural materials in both seasons. The significantly heaviest fresh weight of spike was obtained from the treatment of humic acid as recorded 137.6 and 142.2 g against 75.5 and 63.0 g for the control treatment in the first and second seasons, respectively. Non-significant differences were observed between yeast and garlic extract treatments in the first season only. These results agree with those reported by Ali *et al*., (2014) and Ibrahim *et al*., (2016). Concerning the effect of method application on fresh weight of spike, it was clear that the highest value resulted from drench soil method to be 122.8 and 117.9g in both seasons, respectively. Using foliar spray method recorded 106.5 and 101.1 g, in the first and second seasons, respectively. Thus the drench method was better than the spray one on increasing fresh weight of spike. The interaction between application method and natural martials, data in Table (5) showed that, applying humic acid as soil drench recorded the heaviest weight of 145.0 and 151.3 g in both seasons, respectively.

Data presented in Table (5) show that the trend of the results of dry weight of spike was similar to the trend of the results of fresh weight of spike. These results agree with those reported by Ibrahim *et al*., (2016).

Table 5. Effect of some natural materials and method of application on fresh and dry weights of spike of *Polianthes tuberosa*, during the two seasons of 2013/2014 and 2014/2015.

Traits	Fresh weight of spike (g)			Dry weight of spike (g)		
Natural materials	Soil drench	Foliar spray	Mean	Soil drench	Foliar spray	Mean
First season						
Control	75.5 d	75.6 d	75.5 C	10.5 d	10.5 d	10.5 C
Garlic	130.4 b	110.0c	120.2B	28.2 a	16.9 c	22.6 B
Yeast	140.3 ab	110.3c	125.3B	29.0 a	17.0 c	23.0 B
Humic acid	145.0 a	130.2b	137.6A	29.1 a	21.4 b	25.3A
Mean	122.8 A	106.5B		24.2 A	16.5 B	
Second season						
Control	63.0 e	63.0 e	63.0 D	11.0 d	11.0 d	11.0D
Garlic	120.0 c	96.0 d	108.0C	18.0 bc	15.0 c	16.5 C
Yeast	137.4 b	109.2cd	123.3B	25.6 b	16.8 c	21.2 B
Humic acid	151.3 a	136.0b	142.2A	29.0 a	25.7 b	27.4A
Mean	117.9 A	101.1B		20.9 A	17.3 B	

Means within a column having the same letters are not significantly different according to Duncan's multiple range test.

From the data presented in Table (6) it can be noticed that humic acid had a significant effect on increasing fresh weight of florets/ spike as compared to the control treatment in both seasons. The highest fresh weight of florets as 50.3 and 41.5 g resulted from humic acid treatment in the first and second seasons, respectively, whereas the lowest fresh weight of florets was 21.2 and 22.3g resulted from control treatment in two seasons, respectively. Similar results were observed by Ali *et al.*, (2014) and Ibrahim *et al*., (2016). Regarding method of application, it was clear that the soil drench technique resulted in heavier fresh florets to be 37.8 and 34.3 g in the first and second seasons, respectively. Thus, the drench method was better than the spray one on increasing fresh weights of floret.

Concerning the interaction between the two studied factors, data presented in Table (6) proved that, the treatment of humic acid followed by the treatment of yeast extract then garlic extract as soil drench gave the heaviest fresh weight of florets, whereas the lowest values were obtained with the interaction between control treatment and the two methods of application in the two seasons.

Table 6. Effect of some natural materials and method of application on fresh and dry weights of florets of *Polianthes tuberosa*, during the two seasons of 2013/2014 and 2014/2015.

Traits	Fresh weight of florets (g/spike)			Vase life		
Natural materials	Soil drench	Foliar spray	Mean	Soil drench	Foliar spray	Mean
		First season				
Control	21.4 f	21.0 f	21.2 D	5.1 d	5.0 d	5.0 C
Garlic	35.2 cd	26.0 e	30.6 C	8.4 ab	6.8 c	7.6 B
Yeast	40.0 c	30.0 d	35.0 B	8.4 ab	7.0 bc	7.7 B
Humic acid	54.4 a	46.2 b	50.3 A	8.8 a	7.3 b	8.1 A
Mean	37.8 A	30.8 B		7.7 A	6.5 B	
		Second season				
Control	22.7 d	21.8 d	22.25C	5.0 d	5.0 d	5.0 C
Garlic	31.5 b	26.8 c	24.15C	8.7 ab	6.8 c	7.7 B
Yeast	40.0 ab	26.5 c	33.25B	8.8 ab	6.8 c	7.8 B
Humic acid	43.1 a	40.0 ab	41.50A	9.1 a	7.1 b	8.1 A
Mean	34.3 A	26.3 B		7.9 A	6.4 B	

Means within a column having the same letters are not significantly different according to Duncan's multiple range test.

From the presentation in Table (6), data showed that, the longest vase-life was obtained from treated plants with humic acid as recorded 8.1 days for each season, while the control treatment gave the shortest vase-life of 5.0 days for each season. These results are in harmony with those of Ahmad *et al*., (2013), Ali *et al*., (2014) and Khodakhah *et al.*, (2014).

With regard to the application method, data listed in Table (6) indicated, superiority of soil drench method over foliar spray method in both seasons. Concerning the interaction between natural materials and application of method treatments, data presented in Table (6) indicated that, vase life increased with using humic acid as soil drench method. This treatment gave the highest record of 8.8 and 9.1 day in the two seasons, respectively. However, the control treatment gave the least values under both methods in the two seasons.

The stimulatory effect of humic acid application on flowering characteristics could be attributed to that humic acid have auxin-like activity that enhanced the nutrient uptake which may be responsible for the good floral growth (Kulikova *et al*., 2005). Moreover, the presence of humic molecules raised the effect on plants of the fertilization based on nitrogen, phosphorus and potassium (Pollhamer, 1993). In addition, the enhancement in flower yield and quality could be attributed to the greatly improved biometric characteristics such as photosynthetic activity, nitrogen metabolism and protein synthesis besides, the increase, which in turn supplied more photosynthates leading to produce more flowers as with high quality (Baldotto and Baldotto, 2013).

The great results in this concern may be due to the excess of nitrogen and other elements as well as growth regulators from yeast extract, which had positive effects on the rate of photosynthesis and cell division, consequent the number of leaves per plant could be increased.

Table 7. Effect of some natural materials and method of application on number of bulblets and fresh weight of clump of *Polianthes tuberosa*, during the two seasons of 2013/2014 and 2014/2015.

Traits	Number of bulblets			Fresh weight of clump (g)		
Natural materials	Soil drench	Foliar spray	Mean	Soil drench	Foliar spray	Mean
		First season				
Control	9.3 d	9.1 d	9.2 C	292.0 f	288.0 f	290.0 D
Garlic	11.5 c	11.0 c	11.3 B	626.4 d	447.2 e	536.8 C
Yeast	13.8 bc	11.2 c	12.5 B	775.0 c	455.4 e	615.2 B
Humic acid	18.3 a	14.6 b	16.5 A	920.0 a	864.3 b	892.2 A
Mean	13.2 A	11.5 B		653.4 A	513.7 B	
		Second season				
Control	8.3 f	8.3 f	8.3 C	298.0 f	300.0 f	299.0 D
Garlic	15.2 c	10.1 d	12.7 B	775.7 c	593.4 e	684.6 C
Yeast	16.1 bc	10.1 d	13.1 B	901.5 b	611.9 d	756.7 B
Humic acid	22.4 a	20.4 a	21.4 A	950.0 a	753.0 c	851.5 A
Mean	15.5 A	12.2 B		731.3 A	564.6 B	

Means within a column having the same letters are not significantly different according to Duncan's multiple range test.

With regard to natural materials effect on number of bulblets, data presented in Table (7) revealed that, all treatments significantly and gradually increased number bulblets over the control treatment in both seasons. The highest numbers were observed on plants treated with humic acid to be 6.5 and 21.4 in the first and second seasons respectively, while the lowest number of bulblets resulted from the control treatment to be 9.2 and 8.5 in both seasons respectively. On gladiolus, Baldotto and Baldotto (2013) mentioned that the increased number of cormels per plant might be due the effect of humic acid to make more mineral nutrients available to plants. Furthermore, it caused a greater number of cormels/clump. The obtained findings are in agreement with those mentioned by many workers such as Saleem *et al*., (2013) and Ahmad *et al*., (2013). Regarding the application methods, it was clear that the highest number of bulblets was produced from soil drench treatment to be 13.22 and 15.5 respectively, whereas the lowest number of bulblets resulted from foliar spray method to be 11.5 and 12.2 in the first and second seasons, respectively. For the interaction between the two studied factors, data presented in Table (7) proved that, the treatment of humic acid under soil drench gave the highest number of bulblets to be 18.3 and 22.4 in the first and second seasons respectively. The control treatment gave the least number of bulblets under the two methods in both seasons.

It is obvious from data presented in Table (7) that application of natural materials increased fresh weight of clump compared to the control treatment, with significant and gradual differences. The significantly heaviest fresh weights were obtained from humic acid treatment as recorded 892.2 and 851.5 g followed by yeast extract to be 615.2 and 756.7 g then garlic extract treatment which gave 536.8 and 684.6 g in the first and second seasons respectively, while the least recorded values of fresh weight of clump resulted from the treatment of control which was 209 and 299 g, in the first and second seasons respectively. The increased weight of cormels may be due

to the greater effect of humic acid for uptake of mineral nutrients (Ahmad *et al*., 2013; Baldotto and Baldotto, 2013 and Saleem *et al*., 2013). Concerning the effect of application method on fresh weight of clump, it is obvious that drench soil method was better than foliar spray method for increasing fresh weight of clump in the two seasons. Drench soil method gave 635.4 and 731.3 g in the first and second seasons, respectively, while the foliar spray method gave513.7 and 564.6 g in the first and second seasons respectively. As for the interaction between two studied factors, it was clear that all natural materials with soil drench or foliar spray increased fresh weight of clump in the two seasons, thus the highest fresh weights of clump were produced with interaction between humic acid added under soil drench method which were 864.3 and 753.0 g in the first and second seasons, respectively. Similar results were obtained by Atowa (2012) and Saeed *et al*., (2014), who mentioned that either organic fertilization (actosol) or biostimulants such as garlic and yeast slightly improved Gladiolus cormels fresh and dry weights.

From the presentation in Table (8), data revealed that, all natural materials treatments significantly increased fresh weight of new formed bulb over the control treatment in a descending order from the humic acid, yeast extract, and garlic extract to be 158.6, 119.5 and 99.4g in the first season respectively. The corresponding values were 158.9, 126 and 108.1g for second seasons, respectively. A similar trend of results was found by Atowa (2012) and Saeed *et al*., (2014), who mentioned that either organic fertilization (actosol) or biostimulants such as garlic and yeast slightly improved Gladiolus cormels fresh and dry weights.

Regarding method of application, it was clear that the highest values were produced from soil drench technique to be 98.7 and 130.2g in the first and second season, respectively. whereas the lowest values were 82.75 and 107.28 g resulted from foliar spray method in the first and second season, respectively. The interaction between natural materials and method of application had a clear effect on increasing fresh weight of new formed bulb as compared with the control and the two methods of application.

Table 8. Effect of some natural materials and method of application on fresh weight and diameter of new formed bulb of *Polianthes tuberosa*, during the two seasons of 2013/2014 and 2014/2015.

Traits	Fresh weight of new formed bulb (g)			Diameter of new formed bulb (cm)		
Natural materials	Soil drench	Foliar spray	Mean	Soil drench	Foliar spray	Mean
			First season			
Control	75.8 e	75.6 e	75.7 D	3.55 c	3.55 c	3.55 D
Garlic	110.6 c	88.1d	99.4 C	4.25 b	4.12 b	4.19 C
Yeast	140.4 bc	98.5 cd	119.5 B	5.05 ab	4.18 b	4.62 B
Humic acid	168.4 a	148.8 b	158.6 A	5.98 a	5.41 ab	5.69 A
Mean	98.7 A	82.8 B		4.71 A	4.31 A	
			Second season			
Control	83.0 f	81.0 f	82.0	3.77 d	3.55 d	3.66 D
Garlic	120.6 c	95.5 d	108.1	5.04 b	4.14 c	4.59 C
Yeast	141.2 b	110.8 cd	126	5.73 ab	4.57 bc	5.15 B
Humic acid	176.0 a	141.8 b	158.9	6.88 a	5.04 ab	5.96 A
Mean	130.2	107.3		5.36 A	4.33 B	

Means within a column having the same letters are not significantly different according to Duncan's multiple range test.

It was evident that the heaviest fresh weight of new formed were obtained from humic acid treatment under soil drench as gave 168.4 and 176.0g as compared with the control in the two methods of application.

From the presentation in Table (8), data proved that diameter of new formed bulb was gradually and significantly increased by treated plants with all natural materials, the significantly widest bulbs resulted from the treatment of humic acid as gave 5.69 and 5.96 cm against 3.55 and 3.66 cm for control in both seasons, respectively. Plants provided with three applications of humic acid produced larger diameter of a cormel and higher number of cormels per clump, which may be due to healthy soil conditions (Ahmad *et al*,.2013).

For the effect of application of method irrespective of the other factor, data presented in Table (8) showed that the soil drench and foliar spray methods significantly increased the bulb diameter in both seasons, with no significant differences between the methods of application in the first season only. The increase in corm diameter may be due to their higher contents of total carbohydrates that produce stronger plants. Hence, more metabolites would be produced in plant leaves and accumulate in the new formed bulbs.

With respect to the interaction between natural materials and application method, data presented in Table (8) indicate that the widest bulbs resulted from using humic acid with soil drench method as gave 59.8 and 6.88 cm in the first and second seasons, respectively.

Data presented in Table (9) indicated that all natural materials treatments resulted in a significantly longer roots than control in both seasons regardless application method. The highest record resulted from the treatment of humic acid as gave 68.9 and 70.4 cm against 39.7 and 43.0 cm for the control treatment in the first and second seasons, respectively. It is evident also, that there was a significant and gradual increase in root length by treating plants with yeast extract followed by garlic extracts in both seasons. The previous results are in agreement with those attained by Goatley and Schmidt (1990).

Concerning the application method, data presented in the same Table showed clearly that soil drench method significantly increased the root length compered to foliar spray method. The tallest root under soil drench method was 60.8 and 60.3 cm, while under foliar spray method recorded 51.0 and 51.2 cm in the two seasons, respectively.

Referring to the interaction between the two factors, data in the same Table showed the superiority of application of humic acid as soil drench giving the tallest root over the other treatments in the two seasons. This treatment gave 77.4 and 80.0 cm in two seasons, respectively. Humic acid as soil drench plays an important role in increasing cell membrane permeability, oxygen uptake, respiration and photosynthesis, phosphate uptake, and root elongation (Russo and Berlyn, 1990).

Table 9. Effect of some natural materials and method of application on length of the longest roots and fresh weight of roots of *Polianthes tuberosa*, during the two seasons of 2013/2014 and 2014/2015.

Traits	Length of the longest roots(cm).			Fresh weight of roots(g).		
Natural materials	Soil drench	Foliar spray	Mean	Soil drench	Foliar spray	Mean
		First season				
Control	39.9 e	39.6 e	39.7 D	95.0 e	95.0 e	95.0 D
Garlic	57.3 bc	49.4 d	53.4 C	223.3 c	120.0 de	171.7 C
Yeast	68.5 ab	54.7 c	61.6 B	240.4 b	160.3 d	200.4 B
Humic acid	77.4 a	60.3 b	68.9 A	288.0 a	230.0bc	259.0 A
Mean	60.8 A	51.0 B		211.7 A	151.3 B	
		Second season				
Control	44.0 e	42.0 e	43.0	107.0 f	104.0 f	105.5 D
Garlic	55.5 c	51.0 d	53.3	245.5 c	177.3 e	211.4 C
Yeast	61.8 b	51.0 cd	56.0	269.4 b	201.3 d	235.4 B
Humic acid	80.0 a	60.7 b	70.4	294.7 a	238.4 cd	266.4 A
Mean	60.3 A	51.2 B		229.2 A	180.3 B	

Means within a column having the same letters are not significantly different according to Duncan's multiple range test.

It is evident from data presented in Table (9) that all natural materials treatments significantly increased the fresh weight of roots over control during the two seasons in an ascending order from garlic extract, yeast extract and humic acid. The significant highest value of fresh weight was obtained from the treatment of humic acid as gave 259.0 and 266.4g against 95.0 and 105.5g for control treatment in the first and second seasons respectively.

As for the effect of application method, data presented in the same Table indicated that, soil drench method significantly increased the fresh weight of roots over the foliar spray method. It could be mentioned in this concern that, the soil drench method recorded 211.7 and 229.2 g, while the foliar spray method recorded 151.3 and 180.3 g in the first and second seasons, respectively. Regarding the interaction between natural materials and application method, throughout the two experimental seasons, data presented in Table (9) revealed that, significant highest value of fresh weight was obtained from using humic acid with soil drench as gave 288.0 and 294.7 g in the two seasons, respectively.

Table 10. Effect of some natural materials and method of application on chlorophyll (a), chlorophyll (b) and total carbohydrates of *Polianthes tuberosa*, during the two seasons of 2013/2014 and 2014/2015.

Traits	Chlorophyll (a) (mg/g f.w.)			Chlorophyll (b) (mg/g f.w.)			Total carbohydrates (mg/g d.w.)		
Natural materials	Soil drench	Foliar spray	Mean	Soil drench	Foliar spray	Mean	Soil drench	Foliar spray	Mean
				First season					
Control	0.848 c	0.849 c	0.848D	0.601 c	0.603 c	0.602 D	19.22 c	19.05 c	19.13D
Garlic	0.907 b	0.909 b	0.908C	0.701 b	0.686 b	0.693 C	25.36 b	22.30 bc	23.83C
Yeast	0.972 ab	0.919 b	0.945B	0.733 ab	0.708 b	0.720 B	28.44 a	22.44 bc	25.44B
Humic acid	1.055 a	0.958 ab	1.007A	0.773 a	0.748 ab	0.760A	29.65 a	29.38 a	29.52A
Mean	0.946 A	0.909 B		0.702 A	0.686 B		25.66 A	23.29 B	
				Second season					
Control	0.828 c	0.823 c	0.825D	0.622 d	0.620 d	0.621D	21.47 c	21.40 c	21.44 B
Garlic	0.888 b	0.871 b	0.879C	0.747 b	0.708 c	0.727C	24.39 b	23.11bc	23.75 B
Yeast	0.995 ab	0.875 b	0.935B	0.846 ab	0.733 b	0.789B	26.66 b	23.17	24.92 B
Humic acid	1.103 a	1.00 a	1.052A	0.876 a	0.867 a	0.871A	29.44 a	28.65 a	29.05 A
Mean	0.954 A	0.893 B		0.772 A	0.732 B		25.49A	24.08A	

Means within a column having the same letters are not significantly different according to Duncan's multiple range test.

From the presentation in Table (10), data indicated that a significant increment was observed on chlorophyll (a) and chlorophyll (b) content in both seasons as a result of applying natural materials with superiority of humic acid as compared to using yeast or garlic extracts.

The significant highest increase in leaf chlorophyll content as a result of applying humic acid application could be due to increasing the availability of nitrogen, consequently increasing its absorption by the plant which refracted on the acceleration of N uptake, enhancing N metabolism and production of protein that ultimately increase chlorophyll contents (Haghighi *et al*., 2012). Humic acid plays an important role in increasing cell membrane permeability, oxygen uptake, respiration and photosynthesis, phosphate uptake, and root elongation (Russo and Berlyn, 1990). Similar results were observed by Ahmad *et al*., (2013), Ali *et al*., (2014), Khodakhah *et al*., (2014) El-Naggar *et al*., (2016) and Khattab *et al*., (2016).

Regarding application method in the same table, data indicated that application of soil drench method exhibit significant effects on increasing chlorophyll (a) and chlorophyll (b) content in both seasons.

With respect to the interaction between natural materials treatments and application method, data presented in the same table, revealed that the highest chlorophyll (a) and chlorophyll (b) content resulted from treating plants with humic acid, yeast extract and garlic extract with the two methods, there were non-significant differences were observed among them in the first and second seasons.

From the recorded data in Table (10), it can be concluded that the highest total carbohydrates values resulted from the treatment of humic acid followed by yeast then garlic extract in both seasons as gave 29.52, 25.44 and 23.83mg/g d.w. in the first season and, the corresponding values were 29.05, 24.92 and 23.75 mg/g d.w in the second one, respectively. However, the control treatment gave the least values in the two seasons.

The increase in total carbohydrates content resulted from the application of natural materials may be directly or indirectly due to the activation of the anabolic processes of carbohydrates metabolism, leading to more chlorophyll contents, which participate directly in carbohydrate metabolism. These results are in harmony with those of

Desouky (2004), Mohamed *et al*., (2005) Hanafy *et al*., (2012), Saeed *et al*., (2014) and EL-Sayed *et al*., (2015).

As for effect of application method on total carbohydrates data presented in Table (10), indicated that, either soil drench or foliar spray treatments increased total carbohydrates values in the leaves over control treatment during both seasons with superiority was for soil drench method. The highest values were obtained from soil drench to be 25.66 and 25.49 mg/g d.w. in the first and second seasons while under foliar spray method the corresponding values were 23.29 and 24.08 mg/g d.w in both seasons, respectively.

These results are in line with those reported by Hanafy *et al*., (2012). Regarding the interaction between natural materials treatments and application method, throughout the two experimental seasons, data revealed that, the highest total carbohydrates values resulted from humic acid with soil drench and foliar spray methods where there were non-significant differences between the two methods.

It is evident from data presented in Table (11) that a considerable increase in nitrogen percentage resulted from humic acid treatment followed by yeast then garlic extracts as compared to the control treatment during the two seasons. The significant highest value of nitrogen percentage was obtained from the treatment of humic acid as gave 2.072 and 1.723% against 1.404 and 1.288% for the control treatment in the first and second seasons, respectively. Similar results were obtained by Manoly (2008), Emam (2010), Atowa (2012) and Ibrahim *et al*., (2016).

Table 11. Effect of some natural materials and method of application on N, P and K% of *Polianthes tuberosa*, during the two seasons of 2013/2014 and 2014/2015.

Traits	N%			P%			K%		
Natural materials	Soil drench	Foliar spray	Mean	Soil drench	Foliar spray	Mean	Soil drench	Foliar spray	Mean
First season									
Control	1.406 c	1.402 c	1.404C	0.366 c	0.362 c	0.364 C	1.90 c	1.70 c	1.80 D
Garlic	2.036 a	1.811b	1.924B	0.524 a	0.470 b	0.497 B	2.29 b	2.22 b	2.25C
Yeast	2.091 a	1.885 b	1.988B	0.526 a	0.470 b	0.498 B	2.46 ab	2.29 b	2.37B
Humic acid	2.112 a	2.031 a	2.072A	0.547 a	0.530 a	0.538 A	2.84 a	2.53 ab	2.68A
Mean	1.911 A	1.782 B		0.490 A	0.458 B		2.37 A	2.18 A	
Second season									
Control	1.289 c	1.286 c	1.288D	0.386 c	0.386 c	0.386 C	1.87 c	1.78 c	1.82D
Garlic	1.565 b	1.373 bc	1.469C	0.486 ab	0.460 b	0.473 B	2.33 b	2.23 b	2.28C
Yeast	1.712 a	1.414 bc	1.067B	0.515 a	0.460 b	0.487 B	2.51 ab	2.27 b	2.39B
Humic acid	1.727 a	1.719 a	1.723A	0.526 a	0.495	0.510 A	2.63 a	2.61 a	2.62A
Mean	1.573 A	1.448 B		0.478 A	0.450 B		2.34A	2.22 A	

Means within a column having the same letters are not significantly different according to Duncan's multiple range test.

Concerning the method of application irrespective of natural materials, data in the same Table indicated that soil drench method significantly increased nitrogen percentage in the leaves over foliar spry method as recorded 1.911 and 1.573 %, while using foliar spray treatment gave 1.782 and 1.448 % for both seasons, respectively. In this concern Abass (2008) on Narcissus tazetta pointed out that spray of the active dry yeast solution at the rate 6 g/l led to significant increase nitrogen percentage in leaves. As regards the interaction between the two studied factors, it is obvious from the results presented in Table (11) that, the highest recorded values of nitrogen percentage resulted from application of humic acid as soil drench as gave 2.112 and 1.727% in the first and second season, respectively.

All natural materials treatments gradually increased phosphorus percentage in the leaves over the control plants as show in Table (11), the highest values of phosphorus percentage in polianthes tuberosa leaves resulted in the first and second seasons from the treatment of humic acid as gave 0.538 and 0.510% against 0.364 and 0.386% for the control treatment, respectively. Data in the same Table pointed out non- significant differences between application of yeast and garlic extract on phosphorus percentage in both seasons. The previous results are in conformity with those of many researchers as Emam (2010), Atowa (2012), EL-Sayed *et al*., (2015) and Ibrahim *et al.,* (2016). Concerning the application method, data presented in the same Table showed clearly that soil drench method significantly increased the phosphorus percentage in the leaves compared to the foliar spray one. The soil drench treatment recorded 0.490 and 0.478%, while the foliar spray treatment recorded 0.458 and 0.450% in the first and second seasons, respectively. These results are in line with those reported by Hanafy *et al.,* (2012).

Regarding the interaction between natural materials treatments and application method, throughout the two experimental seasons, data revealed that, non- significant difference were observed between the two methods and natural materials.

Data presented in Table (11) indicated that, all natural materials treatments significantly and gradually increased potassium percentage in the leaves over the control treatment in both seasons. The highest values were obtained from humic acid treatment as gave 2.68 and 2.67%, while the control treatment gave the lowest values to be 1.80 and 1.82% in the first and second seasons, respectively.

As for the effect of application method regardless natural materials treatments, it appears from data in the same table, that the two methods significantly increased potassium percentage in the leaves.

Referring to the interaction between the two factors, data presented in Table (11), showed that application of humic acid by the two methods give the highest values of potassium percentage in the leaves in the two seasons.

The obtained results of leaf N, P, and K percent can be explained by that application of humic substances may interact with the phospholipids structures of cell membranes and react as carriers of nutrients through them (Ulukan, 2008). Humic acid affect the solubility of many nutrient elements by building complex forms or chelating agents of humic matter with metallic cations (Lobartini *et al*., 1997). Either organic fertilization (actosol) or bio stimulants i.e. yeast and garlic extract, appreciably affected N, P, K and total carbohydrates percentage, with superiority of actosol. Meanwhile, applying yeast extract occupied the second rank

in improving the same traits then garlic extract, with significant effect comparing to control treatment (Saeed *et al*., 2014 on gladiolus cv. Novalux).

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تأثير بعض إضافات المواد الطبيعية علي نمو وتزهير أبصال التيوبروز

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يحتل التيوبروز مكانة اقتصادية هامة كزهرة قطف تجارية بالإضافة إلي استخدامه فى صناعة الزيوت العطرية .تم تنفيذ التجربة الحقلية في محطة بحوث البساتين – سخا بمحافظة كفر الشيخ - مصر خلال موسمين متعاقبين 2014/2013-2015/2014 لدراسة تأثير إستخدام بعض المواد الطبيعية مثل حمض الهيومك ومستخلص الخميرة ومستخلص الثوم، من خلال استخدام طريقتين للإضافة وهما الاضافة الأرضية و الرش الورقي، علي بعض صفات النمو الخضري والتزهير وإنتاجية الأبصال والبصيلات. يهدف البحث إلي تحسين جودة نبات التيوبروز بالإضافة إلى زيادة إنتاجية البصيلات والأبصال الجديدة المتكونة تحت الظروف المحلية .أوضحت النتائج مايلي: كان لإستخدام حمض الهيومك التأثير الاكثر معنوية على الصفات تحت الدراسة ثم تبعه مستخلص الخميرة ثم مستخلص الثوم .طريقة الإضافة الأرضية كانت هي الأفضل لزيادة النمو الخضري والصفات الزهرية وإنتاجية الأبصال والمكونات الكيمائية مقارنة بطريقة الاضافة عن طريق الرش الورقى. الاضافة الأرضية لحمض الهيوميك الي حدوث زيادة في طول الأوراق وعددها. مع حدوث تبكير في التزهير. كما أدت الى حدوث زياده في طول الساق الزهرية والجزء المزهر وعدد الزهيرات علي الساق الزهرية. علاوة علي ذلك فقد حدثت زيادة معنوية في عدد البصيلات والوزن الطازج للجورة والوزن الطازج للبصلة الجديدة المتكونة وكذا قطرها .أيضا أدت الى زيادة محتوى الأوراق من كلورفيل (أ) و(ب) و الكربوهيدرات الكلية والنسبة المئوية للنتروجين والفوسفور والبوتاسيوم في الاوراق، وذلك مقارنة بالنباتات الغير معاملة على مدى الموسمين. ولهذا فإن طريقة الإضافة الأرضية لحمض الهيوميك بمعدل 9 سم في اللتر بعد ثلاثة أسابيع من زراعة أبصال التيوبروز ، ثلاث مرات بفاصل ثلاثة أسابيع، ضروري لتحسين جودة النبات وزيادة عدد البصيلات والأبصال الجديدة المتكونة تحت الظروف المحلية.