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PHYSIOLOGICAL EFFECTS OF N- SOIL APPLICATION AND ZN FOLIAR SPRAY AND THEIR INTERACTION ON GROWTH, FLOWERING, BULBS AND CHEMICAL COMPOSITION OF *Polianthes tuberosa* L. c.v. "Double"

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ABSTRACT

Two field experiments were carried out in the experimental farm of Faculty of Agriculture, Fayoum University during the two successive seasons 2001/2002 and 2002/2003 to explore the response of *Polianthes tuberosa* L. c.v. "Double" plants to the effect of soil- N fertilization (0.0, 5, 10 and 20 g ammonium nitrate/plant) and foliar spray with Zn at two concentrations (1000 and 2000 ppm) on vegetative growth, summer and autumn flowering, bulbs and bulblets and chemical composition. The obtained data showed that, fertilizing tuberose plants with the highest rate of nitrogen (20 g ammonium nitrate/plant) increased all vegetative growth characters, i.e., plant height, leaf length and fresh weight of leaves/clumb. Moreover, increased flowering traits of summer and autumn flowering such as length of floral stalk, fresh weight of spike, number of florets/spike, and flowering yield/ plot, as well as, number of days to flowering at summer flowering. Bulbs and bulblets production such as number of bulbs + bulblets/plant, fresh weight of bulbs + bulblets/plant and bulbs diameter were also increased . The same rate (20 g) of N- fertilization also led to the increase in the concentration of chlorophyll (a + b), carotenoids, and the percentage of N but decreased P and K in leaves and also led to increase the percentage of N, P, and K and the concentrations of Zn and Mn in bulbs. Foliar spray with Zn at 2000 ppm significantly or not significantly increased all abovementioned vegetative growth characters and flowering traits as well as bulbs production, while delayed bulbs diameter. The tested treatments also caused significant increase in the leaves content of chlorophyll (a + b), carotenoids and the percentage of N, P, and K. Moreover, increased, significantly, the bulbs content of N, P, K, Zn and Mn. Regarding the combined effect of soil N- application with Zn varied between the different above-mentioned parameters of vegetative growth, flowering, bulbs production and chemical composition, as well as, between the two successive seasons. Generally, the combined effect of N fertilizer at 20 g ammonium nitrate/plant with Zn at 2000 ppm promoted the highest effect of the most of the above-mentioned characters.

So it is advisable to use ammonium nitrate at the rate 20 gm/plant as soil application in combination with foliar application of Zn at the rate of 200 ppm to achieve a higher yield of tuberose and to improve the flower quality parameters.

INTRODUCTION

Tuberoses are among the most fragrant of all garden plants. They are members of the Agavaceae. *P. tuberosa,* commonly known as "Rajnigandha", is an important bulbous ornamental high-value crop. Waxy white flowering spikes of tuberose with sweet and pleasant fragrance are in great demand for indoor decoration, garlands, bouquets, cut flower trade and extraction of essential oil.

Fertilization in general and with nitrogen in particular has been known as a vital step in stepping up the growth and flowering of many ornamental plants. For instance, Singh *et al.* (1996), Sita *et al.* (1997), Balak *et al.* (1999) Amarjeet *et al.* (2000), Dahiya *et al.* (2001), Ramesh *et al.* (2002), Ydav *et al.* (2002 & 2003), Bawedja and (2003), Hardeep *et al.* (2003 & 2004), Singh and Singh and Pal and Biswas (2005) on P. tuberosa declared that increasing N application, up to a particular level, consistently increased vegetative growth parameters, flowering traits and bulbs and bulblets production as well as chemical composition.

Although micronutrients are needed in relatively very small quantities for good plant growth, their deficiencies cause great disorders in the physiological and metabolic processes of plant (Kanwer and Dhingra, 1962). Zinc was reported to stimulate the growth of various plants due to its enhancing effect on most metabolic processes such as carbohydrates, protein, phosphate RNA and ribosome formation (Price *et al.*, 1972 and Bidwell, 1980), in chlorophyll formation and nucleic acid metabolism (Mohr and Schopfer, 1995) and in oxidation-reduction processes (Mengel and Kirkby, 1982). They also announced that, high pH and low organic matter in the soil considerably reduce the availability of most micronutrients. The intensive cropping without adequate conservation of soil fertility through balanced fertilization may be responsible for deficiencies of most nutrients, especially microelements in plants grown in Egypt (Sillanpaa, 1982). It was found by several investigators that, micronutrients play an important role in improving the vegetative growth and flowering of several ornamental plants Barman and Pal (1993), Mukesh *et al.* (2001), Munikrishnappa *et al.* (2002), Yadav *et al.* (2002 & 2003), Hardeep *et al.*(2003 & 2004) on tuberose and Selim *et al.* (2001) on Calendula officinalis. They concluded that, spraying plants with Zn increase all vegetative growth characters and flowering. The effect of Zn on the chemical composition of plants were reported by many investigators (El- Deeb, 1999) on Philodendron scandatum. (Selim *et al.*, 2001) on Calendula officinalis and (Hardeep *et al.*, 2003) on tuberose. They found that, Zn foliar spray increase the plant content of chlorophyll a or b and total carotenoids. Yadav *et al.* (2002) on tuberose found that, leaf N and Zn contents increased with increasing Zn rates while leaf P and K contents were not affected. Hardeep *et al.* (2004) on tuberose plants indicated that leaf N and Zn content increased with increasing Zn rates while leaf P content decreased and K remained unaffected.

MATERIALS AND METHODS

The present work was conducted in two successive seasons 2001/2002 and 2002/2003 at the Experimental farm, Faculty of Agriculture, Fayoum University to investigate the effect of N fertilization and some micro-nutrients application on tuberose (*Polianthes tuberosa* L. c.v. Double).

The bulbs (corms) of tuberose were obtained from the local market at the average diameter 2-4 cm and were sown on 1st of April in 2001 and 2002 seasons. The experimental area was divided into 4 m2 (2x 2 m) containing three rows at a distance 65 cm, the bulbs were planted in each row at 30 cm apart and 5 cm depth,(15 bulbs/ experimental plot), each treatment occupied three replicates. All agro managements required for bulbs production were followed. Samples of the used soil were analyzed according to Balack (1965). Results of analysis are given in Table (1).

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

Properties	2001/2002	2002/2003	Properties	2001/2002	2002/2003
Particle size distribution			**Chemical properties**		
Sand %	32.100	32.270	**Calcium carbonate %**	4.800	4.600
Silt %	32.070	31.410	**Organic matter %**	1.250	1.280
Clay %	35.830	36.320	**Total nitrogen %**	0.062	0.066
Texture grade	Sandy clay	Sandy clay	**ECe (ds/m)**	2.900	2.600
Hydrolyic conductivity (cm3/hr)	00.027	00.029	**PH of paste extract**	7.500	7.300
Available nutrients					
P	23.00	22.00	**Fe**	03.64	03.71
K	96.80	99.26	**Mn**	08.03	07.89
Zn	00.81	00.80			

Treatments comprised four different N rates, 0, 5, 10 and 20 g ammonium nitrate/ plant and two various concentrations of both of Zn (as Edita form 13%) 1000 and 2000 ppm. Such quantities of ammonium nitrates were applied as a soil dressing and divided into three equal portions for each plant. Addition of these portions began at 5th week of planting the bulbs followed by the second addition after one month, while, the last one was applied after the first harvest of flowers. Foliar application of Zn treatments were performed three times at a week interval each dose of N fertilizer.

Either calcium super phosphate at 200 ppm kg/ fed or potassium sulphate (48% K_2O) at 50 kg/ fed were added to the soil before planting or after one month from planting, respectively.

The experimental layout was a split block design. The following measurements were determined at the end of each seasons:

1- Vegetative growth characters in terms of plant height (cm), leaf length (cm) and fresh weight of leaves (g).
2- First flowering (summer flowering) traits expressed as length of floral stalk (cm), fresh weight of spike (g), number of florets/spike, number of days to flowering and flowering yield/plot.
3- Second flowering (autumn flowering) traits expressed as length of floral

stalk (cm), fresh weight of spike (g), number of florets/spike, number of days to flowering and flowering yield/plot.

4- Bulbs and bulblets production expressed as, number of bulbs and bulblets/ plant, bulbs diameter (cm) and fresh weight of bulbs and bulblets/ plant (g).

5- Chemical composition; concentrations of chlorophylls (a + b) and total carotenoids in the fresh leaves at the beginning of flowering, were determined according to the methods described by Welburn and Lichtenthaler (1984). Total N in the dry leaves and bulbs was determined using orange G dye colorimetric method according to Hafez and Hikkelsem (1981). For P, K in leaves and bulbs or Mn and Zn in bulbs determined, the wet digestion of 0.1 g of fine dry material of leaves or bulbs of each treatment was done with sulphoric and perchloric acids as described by Piper (1947). Phosphorus was estimated colorimetrically by the method as outlined by King (1951) after extraction according to Olsen and Sommers (1982). Potassium was determined by Flame Photometer (Gallenkamp Co., England) as described by Brown and Lilliand (1966). Bulbs Mn and Zn were determined using atomic absorption spectrophotometer as outlined by Parkinson and Allen (1975). All the obtained results were statistically analyzed and comparisons among means of the different treatments were achieved using the least significant differences (L.S.D.) at p=0.05 as illustrated by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

1-Vegetative growth characters:

Data arranged in Table (2) exhibited that N application to growing tuberose plants at the highest rate 20 g ammonium nitrate/plant was superior and associated either insignificantly or significantly with higher mean magnitudes for plant height and leaf length or fresh weight of leaves/ clumb, respectively, than those grown with the other levels of N, in both seasons of study. The obtained results matched well with those reported by Sita *et al.* (1997), Ramesh *et al.* (2002) and Bawedja, Hardeep *et al.* (2003)and Yadav *et al.* (2003) working on tuberose. They concluded that, the response of vegetative growth to N application was positive at the highest rate compared with the other rates as well as untreated plants.

In both seasons, spraying the foliage of tuberose plants with Zn at 2000 ppm concentration, significantly or insignificantly, resulted in taller plants and leaves, as well as, fresh weight of leaves/clumb than those of the other concentration. The favorable effect of Zn may be due to the role of Zn in promotion of enzymes activity and the internal growth regulators which may be associated with plant growth. The obtained results are in harmony with the findings of Mukesh *et al.* (2001), Munikrishnappa *et al.* (2002), Hardeep *et. al* (2003). and Yadav *et al.* (2003) who retrived that spraying tuberose plants with Zn increased vegetative growth characters.

Concerning the interaction between the different levels of ammonium nitrate fertilizer and foliar sprays of Zn on vegetative growth varied between the two successive seasons. The significant response, in general, was obvious in one out of the two experimental seasons Table (2). Comparison among all treatments indicated that

the comparison of 20 g ammonium nitrate/plant with Zn at 2000 ppm proved to be the best for plant height and fresh weight of leaves/clumb, in both seasons, whereas, the tallest plant was obtained as a result FROM the combination of 10 or 20 g ammonium nitrates/plant with Zn at 1000 ppm in first or second seasons, respectively, Table (2). The stimulating effects of N by Zn interaction are in agreement with those of Hardeep *et al.* (2003), who mentioned that interaction effects of N and Zn were synergistic and significant in influencing the growth of tuberose.

Table (2): Effect of N as soil application and foliar application of Zn on vegetative growth characters of *Polianthus tuberosa* L. plants during the two successive seasons 2001/2002 and 2002/2003.

Character		Plant height (cm)			Leaf length (cm)			Fresh weight of leaves/clumb		
Treatment		Zn 1	Zn 2	Mean	Zn 1	Zn 2	Mean	Zn 1	Zn 2	Mean
2001/2002										
N	0.0	83.42	87.41	85.42	47.21	49.77	48.49	139.96	168.00	153.98
	5	85.03	89.70	87.37	49.36	49.50	49.43	168.92	142.23	155.58
	10	91.28	82.85	87.07	49.26	50.08	49.67	204.83	172.16	188.50
	20	86.07	90.85	88.46	49.99	53.42	51.71	157.87	230.83	194.35
Mean		86.45	87.71		8.96	50.69		167.89	178.31	
L.S.D. 5%										
N		N.S.			N.S.			18.03		
Zn		N.S.			N.S.			7.57		
N+Zn		5.94			N.S.			15.15		
2002/2003										
N	0.0	87.94	85.34	86.64	3.22	4.92	.07	116.00	83.89	99.95
	5	84.32	89.33	86.83	42.63	49.47	6.05	152.08	133.06	142.57
	10	8.07	90.32	87.20	46.53	46.33	46.43	161.53	192.93	177.23
	20	92.22	85.50	88.86	4.37	50.17	47.27	170.24	204.59	187.2
Mean		87.14	87.63		44.19	7.72		149.96	153.62	
L.S.D. 5%										
N		N.S.			N.S.			12.79		
Zn		N.S.			N.S.			N.S.		
N+Zn		N.S.			N.S.			17.97		

2-First flowering traits (summer flowering):

Data tabulated in Table (3) indicated that, in both seasons, the gradual increase of N application caused a significant gradual increase in all flowering traits (i.e. length of floral stalk, fresh weight of spike, number of florets/spike and flowering yield/ plot). Whereas, the gradual increase of N application led to significant or not significant gradual decrease in number of days to flowering at the respective seasons. The obtained results are in harmony with those reported by Sita *et al.* (1997), Ramesh *et al.* and Yadav *et al.* (2002), Bawedja and Yadav *et al.* (2003), Hardeep *et al.* (2003 & 2004) and Singh and Singh (2005) and Pal and Biswas (2005). They concluded that treating tuberose plants with nitrogen fertilizer at any rate increased flowering traits compared with untreated plants.

Regarding the effect of foliar spray of tuberose plants with Zn, data in the same table indicated that the highest concentration of Zn (2000 ppm), insignificantly increased length of floral stalk, fresh weight of spike, number of florets/spike, number of days to flowering and flowering yield/plot, in both seasons of study. In this respect, Selim *et al.* (2001) on *Calendula officinalis*, Mukesh *et al.* (2001), Munikrishnappa (2002), Yadav *et al.* (2002 & 2003) and Hardeep *et al.* (2003 & 2004) on tuberose, they mentioned that spraying plants with Zn increased flowering traits.

The interaction effect of N levels with Zn at any concentration used in the study on flowering traits varied between the two seasons of study. Comparison among the different treatments clearly indicated that, in the first season the combination of 20 g ammonium nitrate/plant with Zn at 2000 or 1000 ppm concentration led to insignificant increase in fresh weight of spike, number of florets/ spike and flowering yield/plot or length of floral stalk, respectively. On the other hand, in the second season the highest values of length of floral stalk and fresh weight of spike or number of florets/ spike and flowering yield/ plot were promoted resulting from in the combination of 20 g ammonium nitrate/ plant with Zn at 2000 or 1000 ppm, respectively. On the other side, the interaction effects of N application at 20 g ammonium nitrate/ plant with Zn at 1000 or 2000 ppm in the first or second seasons, respectively, decreased number of days to flowering. The obtained results are in harmony with those reported by Hardeep *et al.* (2003), who reported that interaction of N and Zn was synergistic and significant in influencing of the growth of tuberose.

3- Second flowering traits (autumn flowering):

Data illustrated in Table (4) exhibited that, N- application to the growing tuberose plants at the highest rate 20 g ammonium nitrate/ plant was superior and associated significantly or not significantly with higher mean magnitudes for fresh weight of spike and number of florets/ spike or length of floral stalk and flowering yield/ plot, respectively, in both seasons.

Foliar spray of tuberose plants with Zn at 2000 ppm insignificantly increased all the above mentioned studied of flowering traits, compared with the other concentration (1000 ppm).

Concerning the interaction between the different levels of ammonium nitrate fertilizer and foliar spray with Zn on autumn flowering varied between the two seasons. Comparison among all treatments indicated that the combination of 20 g ammonium nitrates/ plant with foliar spray of Zn at 2000 or 1000 ppm promoted the highest values of fresh weight of spike, number of florets/ spike and flowering yield/ plot or length of floral stalk, respectively, in both seasons of study.

Table (3): Effect of N as soil application and foliar application of Zn on bulbs production of *Polianthus tuberosa* L. plants during the two successive seasons 2001/2002 and 2002/2003.

Character	Length of floral stalk (cm)			Fresh weight of spike (gm)			No. of florets/spike			No. of days to flowering			Flower yield/plot		
Treat-ments	Zn 1	Zn 2	Mean	Zn 1	Zn 2	Mean	Zn 1	Zn 2	Mean	Zn 1	Zn 2	Mean	Zn 1	Zn 2	Mean
Nitrogen level	2001/2002														
0.0	23.08	23.25	23.17	84.57	92.2	88.50	26.20	26.60	26.69	120.00	12.00	122.00	10.67	12.30	11.50
5	23.68	23.9	23.81	83.24	95.13	89.19	25.79	27.59	26.69	116.67	126.67	121.67	11.33	13.30	12.33
10	24.49	25.55	25.02	113.68	94.98	104.33	26.64	27.28	26.96	114.33	124.00	119.17	14.67	13.30	14.00
20	27.00	26.02	26.51	101.90	107.59	104.75	26.08	28.8	27.6	110.67	117.67	114.17	14.33	16.30	15.33
Mean	2.52	24.69		95.85	97.53		26.18	27.58		115.2	123.08		12.75	13.80	
L.S.D.5%															
N	2.38			2.20			8.18			N.S.			N.S.		
Zn	N.S.			N.S.			N.S.			7.41			N.S.		
N x Zn	N.S.			N.S.			21.10			N.S.			5.08		
	2002/2003														
0.0	24.29	23.53	23.91	89.00	93.53	91.27	23.39	24.27	23.83	128.67	130.67	129.67	8.67	12.30	10.50
5	24.12	25.26	2.69	84.79	100.30	92.55	22.58	25.40	23.99	118.67	128.67	123.67	8.33	14.00	11.17
10	25.76	2.89	25.33	108.80	92.65	100.73	23.87	25.38	24.63	125.00	121.33	123.17	10.33	17.30	13.83
20	25.94	26.59	26.27	97.03	109.90	103.47	28.30	27.14	27.73	125.33	118.00	121.67	17.67	12.60	15.17
Mean	25.03	25.07		94.91	99.10		24.5	25.55		12.42	124.67		11.2	14.00	
L.S.D.5%															
N	2.10			2.46			1.64			4.66			N.S.		
Zn	N.S.			N.S.			N.S.			N.S.			2.82		
N x Zn	N.S			2.08			N.S.			7.89			5.64		

N: Nitrogen Zn 1: 1000 ppm Zn 2: 2000 ppm

Table (4): Effect of N as soil application and foliar application of Zn on second flowering of *Polianthus tuberosa* L. plants during the two successive seasons 2001/2002 and 2002/2003.

Character	Length of floral stalk (cm)			Fresh weight of spike (gm)			No. of florets/ spike			Flower yield/plot		
Treat-ments	Zn 1	Zn 2	Mean	Zn 1	Zn 2	Mean	Zn 1	Zn 2	Mean	Zn 1	Zn 2	Mean
Nitrogen level	2001/2002											
0.0	29.59	33.85	31.72	35.96	40.01	37.99	39.47	48.96	44.22	4.33	5.67	4.67
5	32.00	33.56	32.78	41.43	37.25	39.3	44.91	49.28	47.10	5.00	4.67	4.83
10	31.51	35.21	33.36	39.73	0.80	40.27	50.55	45.85	48.20	4.33	5.33	4.83
20	37.30	33.38	35.34	44.91	50.25	47.58	49.81	52.01	50.91	4.33	5.67	5.00
Mean	32.60	3.00		40.51	42.08		46.18	49.02		4.33	5.33	
L.S.D.5%												
N	N.S.			6.0			2.97			N.S.		
Zn	N.S.			N.S.			N.S.			0.79		
N x Zn	N.S.			1.20			5.85			N.S.		
	2002/2003											
0.0	28.50	33.02	30.76	37.90	35.78	36.84	45.67	40.57	43.12	4.00	4.33	5.67
5	31.32	35.82	33.57	38.00	42.57	0.29	51.50	39.67	45.59	4.67	5.67	5.17
10	32.74	35.84	34.29	42.29	0.50	41.0	55.00	45.46	50.23	4.33	6.00	5.17
20	3.29	36.31	35.30	43.42	4.88	.15	44.00	82.57	68.79	5.00	6.33	5.67
Mean	31.71	35.26		40.40	40.93		51.79	52.07		4.50	5.58	
L.S.D.5%												
N	N.,S.			6.17			10.38			N.S.		
Zn	N.S.			N.S.			N.S.			1.00		
N x Zn	N.S.			6.43			19.96			N.S.		

N: Nitrogen Zn 1: 1000 ppm Zn 2: 2000 ppm

4-Bulbs and bulblets production:

Data presented in Table (5) show that, in both seasons, treating tuberose plants with the highest rate of nitrogen fertilizer (20 g ammonium nitrate/ plant), compared with the other nitrogen rates and control plants, promoted the highest values of fresh weight and number of bulbs+ bulblets/plant and bulbs diameter. This results are in harmony with the findings of Singh *et al.* (1996), Ramesh *et al.* and Yadav *et al.* (2002) and Singh and Singh (2005) who indicated that, tuberose bulbs and bulblets production increased as a resulted of nitrogen level increased.

Concerning the influence of foliar spray of tuberose plants with Zn, data in table (5) indicated that in both seasons, the highest records of fresh weight and number of bulbs+ bulblets/ plant were recorded at the higher rat of Zn (2000 ppm). While, the highest diameter of bulbs was obtained at the low concentration of Zn (1000 ppm). These results are in agreement with Yadav *et al.* (2002), who reported that tuberose bulbs production was not affected by increasing Zn levels .

Regarding to the interaction effect of nitrogen fertilizer with Zn at any concentration used in the study on bulbs and bulblets production varied greatly between the two seasons of the study. In the first season, either the highest values

of fresh weight of bulbs+ bulblets/plant or bulbs diameter and number of bulbs+ bulblets/ plant were obtained at the combination of 20 g ammonium nitrate/ plant with Zn at 1000 or 2000 ppm, respectively. On the other side, in the second season the highest values of fresh weight of bulbs+ bulblets/ plant or number of bulbs + bulblets/ plant and bulbs diameter were obtained at the combination of 20 or 10 g ammonium nitrate with Zn at 2000 ppm, respectively.

Table (5): Effect of N as soil application and foliar application of Zn on bulbs production of *Polianthus tuberosa* L. plants during the two successive seasons 2001/2002 and 2002/2003.

Character		Plant height (cm)			Leaf length (cm)			Fresh weight of leaves/clumb		
Treatment		Zn 1	Zn 2	Mean	Zn 1	Zn 2	Mean	Zn 1	Zn 2	Mean
2001/2002										
N	0.0	29.22	32.06	32.64	406.44	556.22	81.33	3.59	3.63	3.61
	5	44.83	41.3	43.08	433.34	546.67	90.01	3.61	3.68	3.65
	10	42.71	43.50	43.11	555.56	487.78	521.67	3.98	3.60	3.79
	20	40.33	48.00	44.17	675.55	58.56	612.06	3.95	4.00	3.98
Mean		39.28	1.22		517.72	53.81		3.78	3.73	
L.S.D. 5%										
N		N.S.			119.46			0.23		
Zn		N.S.			50.46			N.S.		
N+Zn		6.50			N.S.			0.30		
2002/2003										
N	0.0	.67	34.00	39.34	357.50	308.33	332.92	3.52	3.14	3.33
	5	39.42	45.50	42.46	342.50	447.50	395.00	3.97	3.25	3.61
	10	34.84	55.92	5.36	417.09	81.67	449.38	3.85	3.97	3.76
	20	4.17	8.17	46.17	402.50	496.25	449.38	3.80	4.19	4.00
Mean		0.77	45.90		379.90	433.44		3.78	3.56	
L.S.D. 5%										
N		N.S.			109.02			0.25		
Zn		4.14			53.46			0.20		
N+Zn		8.29			N.S.			0.51		

5- Chemical Composition:

Leaf plastid pigments:

Data presented in Table (6) show that, increasing N rate from 5 to 20 g ammonium nitrate/ plant significantly increased chlorophyll (a+ b) and total carotenoids in leaves compared with untreated plants. This trend is similar in both seasons. In this respect, Hardeep *et al.* (2003) reported that tuberose leaf chlorophyll content significantly increased with N application at any rate compared with untreated plants.

Regarding the effect of foliar spray with Zn data in Table (6) revealed that, Zn at 2000 ppm concentration produced the highest values of chlorophyll (a+ b) and total carotenoids in leaves, in both seasons. These results may be due

to the basic function of zinc in plant which is related to its role in the metabolism of carbohydrates (Price *et al.*, 1972). These results are in harmony with findings of El-Deeb (1999) on Philodendron scandens, Selim *et al.* (2001) on Calendula officinalis and Hardeeb *et al.* (2003) on tuberose, they mentioned that, Zn increased chlorophylls (a & b) and total carotenoides.

The interaction between N- fertilization with Zn as tabulated in Table (6) showed that, the highest values of chlorophyll (a+ b) and total carotenoids were associated with the treatment 20 g ammonium nitrate/ plant in combination with foliar spray of Zn at a concentration of 2000 ppm.

Nitrogen, phosphorus and potassium percentages:

a- In leaves:

Data presented in Table (6) showed that leaves N or P and k percentages insignificantly increased or decreased, respectively, with each increase in the applied nitrogen level, in both seasons. Similar findings were recorded by Sita *et al.* (1997), Amarjeet *et al.* (2000), Yadav *et al.* (2002), Mohanasundram *et al.* (2003) and Hardeeb *et al.* (2004) on tuberose. They mentioned that nitrogen fertilization increased leaf N content, but leaf P and K contents decreased.

Regarding to the effects of foliar spray with Zn, the results of Table (6) illustrated that spraying Zn at 2000 ppm concentration affected positively and significantly the N, P and K percentages in leaves, in both seasons. Yadav *et al.* (2002) mentioned that leaf N content increased with increasing Zn concentration, while, leaf P and K contents were not affected.

The interaction effects of N levels by Zn concentrations in the same Table (6) showed that recorded determinations fluctuated insignificantly, however, observation of the highest ones differed as the season and parameter. The highest values of P and K were observed in association with 20.0 g ammonium nitrate/ plant combined with 2000 ppm Zn, in both seasons.

b- In bulbs:

As shown in Table (7), increasing N application up to the highest rate correspondingly, significantly, increased bulbs N, P and K contents, in both seasons of study. This results are in harmony with Amarjeet *et al.* (2000) on tuberose, who reported that bulbs N, P and K contents increased with increasing rates of nitrogen fertilizer.

In both seasons, spraying the foliage of tuberose plants with Zn at 2000 ppm concentration, significantly resulted in the higher percentages of N, P and K in bulbs.

Concerning the interaction between the different rates of ammonium nitrate and the various concentrations of Zn on N, P and K contents in bulbs, data in Table (7) show that, the significant response was obvious in one out the two experimental seasons. Comparison among the eight interaction treatments clearly indicated that the combination treatment of 20 g ammonium nitrate/ plant with 2000 ppm Zn recorded the highest percentages of N, P and K in bulbs.

Table (6): Effect of N as soil application and foliar application of Zn on leaves chemical composition of *Polianthus tuberosa* L. plants during the two successive seasons 2001/2002 and 2002/2003.

Character	Chlorophyll (a+b) (mg/g)			Total carbohydrates (mg/g)			N %			P %			K %		
Treat-ments	Zn 1	Zn 2	Mean	Zn 1	Zn 2	Mean	Zn 1	Zn 2	Mean	Zn 1	Zn 2	Mean	Zn 1	Zn 2	Mean
Nitrogen level	2001/2002														
0.0	7.02	8.05	7.5	0.82	0.97	0.90	2.51	2.85	2.68	0.6	0.65	0.56	1.03	1.07	1.05
5	7.92	8.90	8.41	1.11	1.23	1.17	2.69	3.05	2.87	0.46	0.64	0.55	0.98	1.0	1.01
10	9.15	9.45	9.30	1.38	1.30	1.3	2.85	3.09	2.97	0.45	0.63	0.54	0.95	1.03	0.99
20	9.90	10.7	10.19	1.39	1.39	1.39	2.90	3.10	3.00	0.44	0.61	0.53	0.91	1.01	0.96
Mean	8.50	9.22		1.18	1.22		2.74	3.02		0.45	0.63		0.97	1.0	
L.S.D.5%															
N	0.63			0.08			0.08			N.S.			N.S.		
Zn	0.27			0.04			N.S.			0.02			0.03		
N x Zn	0.53			0.07			N.S.			N.S.			N.S.		
	2002/2003														
0.0	4.49	5.24	4.87	0.61	0.63	0.62	2.52	2.90	2.71	0.46	0.63	0.55	1.04	1.21	1.13
5	5.67	6.24	5.96	0.72	0.92	0.82	2.70	2.98	2.84	0.4	0.63	0.54	1.01	1.18	1.10
10	6.53	7.44	6.99	0.9	1.06	1.00	2.91	3.11	3.01	0.43	0.61	0.52	0.99	1.17	1.08
20	7.69	9.26	8.65	1.05	1.24	1.15	2.93	3.15	3.04	0.41	0.60	0.51	0.97	1.14	1.06
Mean	6.10	7.05		0.83	0.96		2.77	3.04		0.	0.62		1.00	1.18	
L.S.D.5%															
N	0.47			0.06			0.12			N.S.			N.S.		
Zn	0.19			0.03			0.08			0.02			0.04		
N x Zn	0.37			0.05			N.S.			N.S.			N.S.		

N: Nitrogen Zn 1: 1000 ppm Zn 2: 2000 ppm

Table (7): Effect of N as soil application and foliar application of Zn on bulbs chemical composition of *Polianthus tuberosa* L. plants during the two successive seasons 2001/2002 and 2002/2003.

Character	N %			P %			K %			Zn (ppm)			Mn (ppm)		
Treat-ments	Zn 1	Zn 2	Mean	Zn 1	Zn 2	Mean	Zn 1	Zn 2	Mean	Zn 1	Zn 2	Mean	Zn 1	Zn 2	Mean
Nitrogen level	2001/2002														
0.0	1.03	1.13	1.08	0.24	0.25	0.25	0.31	0.35	0.33	40.70	56.0	8.55	53.50	55.60	54.55
5	1.11	1.71	1.41	0.25	0.29	0.27	0.33	0.36	0.35	49.60	57.30	53.45	67.50	75.60	71.55
10	1.37	1.83	1.60	0.31	0.37	0.34	0.34	0.38	0.36	51.30	59.60	55.45	79.60	81.30	80.45
20	1.59	1.93	1.76	0.35	0.40	0.38	0.38	0.40	0.39	59.30	60.60	59.95	81.60	88.60	85.10
Mean	1.28	1.65		0.29	0.33		0.34	0.37		50.23	58.48		70.55	75.28	
L.S.D.5%															
N	0.02			0.02			0.03			3.84			5.04		
Zn	0.04			0.01			0.01			1.69			2.25		
N x Zn	0.04			0.02			0.02			3.37			4.50		
	2002/2003														
0.0	1.00	1.06	1.03	0.20	0.21	0.21	0.37	0.43	0.0	40.60	51.00	5.80	61.60	65.50	63.55
5	1.20	1.24	1.22	0.28	0.29	0.29	0.44	0.45	0.45	44.30	53.30	48.80	70.00	79.00	74.50
10	1.38	1.62	1.50	0.30	0.34	0.32	0.48	0.48	0.48	50.10	55.00	52.55	80.00	88.00	84.00
20	1.65	1.95	1.80	0.35	0.37	0.36	0.51	0.53	0.52	55.60	59.30	57.45	87.30	95.00	91.15
Mean	1.31	1.47		0.28	0.30		0.45	0.47		47.65	54.65		74.73	81.88	
L.S.D.5%															
N	0.03			0.02			0.03			3.65			5.55		
Zn	0.03			0.01			0.01			1.54			2.36		
N x Zn	0.04			0.02			0.03			3.08			.72		

N: Nitrogen Zn 1: 1000 ppm Zn 2: 2000 ppm

Zink and Manganese contents in bulbs:

The results listed in Table (7) clarified that, increasing the amount of N fertilizer from 0.0 to 20 g ammonium nitrate/ plant significantly promoted Zn and Mn contents in bulbs in 2001/2002 and 2002/2003 seasons.

Regarding the effect of foliar spray with Zn data presented in Table (7) clearly indicated that treated the plants with Zn at 2000 ppm increased significantly each of Zn and Mn contents in bulbs compared with the other concentration (1000 ppm), in both seasons.

The comparisons presented in Table (7) illustrated the presence of some interaction effect between the different levels of N and the two concentrations of Zn on Zn and Mn contents in bulbs, in both seasons. The comparison among the eight combination treatments indicated that the combinations of 20 g ammonium nitrate/ plant with Zn at 2000 ppm were the most beneficial treatments which gave significantly the highest means values for bulbs Zn and Mn contents.

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تأثير التسميد الأرضي بالنيتروجين والرش بالزنك والتفاعل بينهمـــا على النمو والتزهير ومحصول الأبصال والمحتوى الكيمـــاوى لنباتات التيبوروز

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أجريت هذه الدراسة في مزرعة التجارب بكلية الزراعة بـــالفيوم -جامعـــة الفيوم لدراسة تأثير مستويات مختلفة من النيتروجين صفر، ٥، ١٠ ،٢٠ جرام نتـــرات امونيوم/ نبات مع الرش بالزنك بتركيزات ١٠٠٠ ،٢٠٠٠ جزء في المليون علي النمو الخضري والازهار والأبصال والتركيب الكيمـــاوي لنبـــات التيبـــوروز *Polianthes tuberosa* خلال موسمين متتاليين ٢٠٠١ /٢٠٠٢، ٢٠٠٢ /٢٠٠٣ وقد تم التوصل الي النتائج التالية:-

١- باستبعاد تأثير الزنك ففي كلا الموسمين أدت المعاملة بالنيتروجين عند التركيـــزات المختلفة (خاصة ٢٠ جرام نترات أمونيوم /نبات) الـــي الحصـــول علـــي أعـــلا القياسات للنمو الخضرى (ارتفاع النبات، طول الأوراق، الوزن الطازج للأوراق/ نبات) وكذلك قياسات النمو الزهري (طول الحامل الزهـــري، الـــوزن الطـــازج للنورة، عدد الأزهار علي النورة، كما أدي الي زيادة محصول الأزهـــار وزيـــادة

الأبصال والبصيلات ووزنها الطازج وزيادة قطرها. كما أدت المعاملة بأعلي معدل للنيتروجين الي زيادة كل من الكلوروفيل والكاروتينات والنسبة المئوية للنيتروجين في الأوراق والأبصال وكذلك زيادة النسبة المئوية لكل من البوتاسيوم والفوسفور وتركيز الزنك والمنجنيز في الأبصال -ولكن أدي الي نقص تركيز كل من البوتاسيوم والفسفور في الأوراق.

٢- بالنسبة للرش بالزنك وجد أن الرش بالزنك بتركيز ٢٠٠٠ جزء في المليون الي زيادة معنوية أو غير معنوية في كل قياسات النمو الخضري والزهري السابقة وكذلك نمو الأبصال ولك أدي الي نقص قطر الأبصال في كلا الموسمين- كما أدي الي زيادة محتوي الأوراق معنويا من الكلوروفيل (أ+ب) والكاروتينات والنيتروجين والفوسفور والبوتاسيوم وكذلك زيادة محتوى الأبصال من النيتروجين والفوسفور والبوتاسيوم بالاضافة الي الزنك والمنجنيز.

٣- وبالنسبة للتداخل بين النيتروجين والزنك فقد أوضحت النتائج أن تأثير هذا التداخل اختلف بين قياسات النمو الخضرى والزهرى وانتاج الأبصال والتركيب الكيماوى وكذلك بين الموسمين. ولكن بصفة عامة أدت المعاملة بالتسميد النيتروجينى بمعدل ٢٠ جرام نترات أمونيوم /نبات متداخلاً مع الزنك بمعدل ٢٠٠٠ جزء فى المليون الي زيادة أغلب القياسات السابقة.

٤- وعلى ذلك فانة يمكن التوصية باستخدام ٢٠ جم نترات الأمونيوم/للنبات إضافة أرضية مع رش النباتات بالزنك بتركيز ٢٠٠ جزء فى المليون للحصول على أعلى محصول لنباتات التيبروز وأيضا لتحسين صفات الأزهار.