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EFFECT OF BULB SIZE, PRE-PLANTING TREATMENTS AND MICROELEMENTS ON GROWTH, FLOWERING, BULB PRODUCTION AND STEM APEX DEVELOPMENT OF *Polianthes tuberosa* L.

BY

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ABSTRACT

This study was carried out to investigate the effect of bulb size (6, 8 or 10 cm circumference), some pre-planting treatments [cold storage of bulbs at 5° C for 15 days, soaking the bulbs in boiling water (100° C) for 10 second then in hot water (35° C) for 24 hours], and spraying the foliage with the following microelement treatments: (1) a mixture of Fe, Zn and Mn at concentrations of 0.15, 0.15 and 0.14%, respectively, (2) Zn at 0.15%, or (3) Mn at 0.14%, on growth, flowering, bulb production and stem apex development of *Polianthes tuberosa*. The most important results can be summarized as follows:

- Cold storage of the largest bulbs (10 cm circumference) prior to planting, and spraying the plants with a mixture of microelements (Fe+Zn+Mn) gave the tallest plants and the greatest number of florets/stalk (in both seasons).
- Hot water pre-treatment gave the earliest flowering in both seasons. Also, this treatment significantly increased flower stalk length in the first season, compared to the control.
- Hot water pre-treatment significantly reduced the number of florets/stalk.
- Soaking the largest bulbs (10 cm circumference) in hot water, and spraying the plants with microelements (Fe+Zn+Mn) gave the greatest number of bulbs/plant in both seasons.
- In both seasons, the greatest number of bulbelts /plant was obtained as a result of soaking the smallest size bulbs (6 cm circumference) in hot water, and spraying the plants with Mn alone.
- Cold storage of the bulbs and spraying the plants with Zn at the concentration of 0.15% resulted in maximum development of stem apex (in terms of initiation of leaf and flower primordia, and differentiation of flower parts) after 120 days from planting, compared to the other treatments.

INTRODUCTION

Tuberose (*Polianthes tuberosa*) is one of the most important flowering bulbs in Egypt. Studies conducted by a number of researchers have shown that cold storage of bulbs influences the vegetative growth, flowering characteristics

and flowering period of tuberose. For example, Dhua *et al.* (1987) reported that storage of tuberose bulbs at 10° C for 30 days increased the yield of spikes and flowers. In another study, Gomaa (2000) stated that storage of tuberose bulbs for 15 days at 5° C enhanced the flowering parameters and prolonged the flowering period. In contrast, the flowering of some ornamental bulbs can be promoted by pre-planting heat treatments. This was shown by Beijer (1961), who reported that iris bulbs that were stored for a week at 30° C, then treated with hot water (at 43.5° C) for 4 hours, followed by storage for one more week at 30° C gave earlier flowering, compared to the untreated bulbs.

Bulb size also has a great effect on growth and flowering of many bulb species. This was shown by Szlachetka *et al.* (1995), Sathyanarayana *et al.* (1994) and Reddy *et al.* (1994), who reported that using large-size tuberose bulbs significantly enhanced the sprouting time, number of leaves and flowering parameters, compared to small-size bulbs.

Application of microelements may also play a great role in the growth and flowering of many plant species. Manganese is an essential element in respiration and nitrogen metabolism; in both processes it functions as an enzyme activator. More than likely, manganese is involved in electron transfer from water to chlorophyll during the light reactions of photosynthesis. On the other hand, zinc may be involved in the biosynthesis of the plant auxin indole-3-acetic acid (Skoog, 1940).

Iron is incorporated directly into the cytochromes, into compounds necessary to the electron transport system in mitochondria, and into ferredaxin. Ferredaxin is indispensable to the light reactions of photosynthesis. Iron is essential for the synthesis of chlorophyll, and it plays an essential chemical role in both the synthesis and degradation of chlorophyll (Nason and McElory, 1963). Iron is required in the synthesis of chloroplast proteins. Protoporphyrinin-9 is one of the intermediates in chlorophyll biosynthesis, and may represent a branch point in the biosynthesis of either cytochromes or chlorophyll. The synthetic path is dependent on which metal, magnesium or iron, is incorporated into the porphyrin structure (Granick, 1950).

The anatomical development of various plant species passes through three stages, viz. the vegetative growth stage, the flower initiation stage and the flower differentiation stage. This was illustrated by Gomaa (2000) on *Ornithogalum thyrsoides*. Soliman (2002), on some ornamental bulbs, found that after three months from planting the flower primordia were initiated, besides the clear appearance of a protrusion on the capitalum.

The objective of this study was to investigate the effect of bulb size, pre-planting treatments (cold storage, hot water), and spraying with microelements on growth, flowering, bulb production and stem apex development of *Polianthes tuberosa*.

MATERIALS AND METHODS

This investigation was conducted in the open field at the Floriculture Nursery of the Horticulture Research Institute, and in the Ornamental Horticulture Department, Façulty of Agriculture, Cairo Univ., Giza, during the seasons of 2002 and 2003.

The objective of this study was to investigate the effect of bulb size, pre-planting treatments (cold storage, hot water), and spraying with microelements on growth, flowering, bulb production and stem apex development of *Polianthes tuberosa* plants.

Plant material:

Three sizes of tuberose bulbs (6, 8 or 10 cm circumference, with average weights of 18, 32 or 43 g, respectively) were used.

Pre-planting treatments:

The bulbs of each size received the following pre-planting treatments:

- Cold storage at 5° C for 15 days (from 15 to 30 of April, 2002 and 2003).
- Soaking the bulbs in boiling water (100° C) for 10 second followed by soaking in hot water (35° C) for 24 hours.
- Untreated bulbs (at room temperature 28 ± 3° C).

Planting procedures:

In both seasons, the bulbs were planted on the 1st of May in 120-cm long rows, with a distance of 50 cm between rows. Seven bulbs were planted in each row, at a spacing of 20 cm between bulbs, and at a depth of 7-8 cm. The soil in the experimental area was a clay loamy soil. The physical and chemical characteristics of the soil (Tables A and B) were determined at the Soil and Water Research Institute, Agriculture Research Center, Ministry of Agriculture, Giza.

After one month from palnting, the bulbs were supplied with NPK fertilization using ammonium sulfate (20.6% N), calcium superphosphate (15.5% P_2O_2) and potassium sulfate (48% K_2O). A mixture of the three fertilizers, with a ratio of 1:2:1 ($N : P_2O_5 : K_2O$), was prepared and applied to the experimental area at the rate of 50 g/m^2. Common agricultural practices (irrigation, manual weed control, ... etc.) were carried when needed.

Microelement treatments:

The following treatments were applied to the foliage:

1. Spraying with a mixture of Fe, Zn and Mn at concentrations of 0.15, 0.15 and 0.14%, respectively.
2. Spraying with Zn at the concentration of 0.15%.
3. Spraying with Mn at the concentration of 0.14%.

Table (A): The physical characteristics of the soil used for planting tuberose (*Polianthes tuberosa*) bulbs during the 2002 and 2003 seasons.

Physical characteristics %			
Sand fine	Sand caurse	Silt	clay
22.4	1.4	21.5	54.7

Table (B): The chemical characteristics of the soil used for planting tuberose (*Polianthes tuberosa*) bulbs during the 2002 and 2003 seasons.

EC (mmhos/cm)				pH					
3.40				7.40					
Soluble anions (meq/L)									
HCO_3^-			CL^-			SO_4^{--}			
3.50			27.30			51.60			
Soluble cations (meq/L)									
Ca^+	Mg^{++}	Na^{++}	K^+	Fe	Zn	Mn	Cu	B	Mo
28.00	12.10	34.30	7.90	7.48	5.66	20.92	17.18	3.77	11.31
Total macronutrient contents (ppm)									
N			P			K			
232.40			8.05			780.00			

In each season, the foliage was sprayed four times at monthly intervals during the growth period, starting one month after planting date (on the 1st of June, 1st of July, 1st of August and 1st of September).

Experiment layout:

The design of the experiment was a split-split plot design, with 27 treatments (3 bulb sizes X 3 pre-planting treatments X 3 microelement treatments), replicated 3 times (each replicate consisted of one row, with 7 bulbs/row). Pre-planting treatments were assigned to the main plots, the bulb sizes were assigned to the sub plot, while the microelements spray treatments were assigned to the sub-sub plots. The least significant differences (LSD) test was used for comparison among means (according to Snedecor and Cochran (1971).

Data recorded:

a- Morphological characteristics:

- Plant height (cm), measured from the surface of the soil to the top of the highest leaf.
- Number of days from planting till flowering (first floret opening on spike).
- Number of florets/stalk.
- Flower stalk length (cm), measured from the surface of the soil to the top of the highest floret.
- Number of bulbs and bulbelts /plant.

b- Anatomical study

Stem apex development (after 60 and 120 days from planting) was observed by microscopic examination of longitudinal sections in samples of the terminal buds, which were prepared using the method described by **Sass (1951)**, as follows: the buds were excised and fixed in F.A.A. solution (formalin, acetic acid and alcohol, at concentrations of 5% : 5% : 90%, respectively). The buds were transferred from F.A.A. and were dehydrated in a graded series of ethyl alcohol and cleared in xylol. Then, the buds were embedded in paraffin wax at 60° C for three days. A series of sections of 7-10 µm in thickness were prepared using a rotary microtome. Prior to staining, the mounted sections were deparaffinized in three changes of xylol for 15 minutes. The sections were later double stained with safranine and light green, and mounted by DPX. The sections were microscopically examined and photographed.

RESULTS AND DISCUSSION

1- Plant height (Table 1):

The data recorded in the two seasons indicated that a significant increase in plant height was obtained from the pre-treated bulbs, compared to the untreated control bulbs. In the first season, plant height ranged from 44.09 to 50.31 cm, with plants resulting from pre-treated bulbs (bulbs kept in cold storage, or soaked in hot water) being significantly taller than those resulting from untreated bulbs. However, in the second season only the cold storage of bulbs prior to planting caused a significant increase in plant height. Results recorded on the effect of bulb size revealed that increasing the bulb size from 6 to 8 or 10 cm caused steady significant increases in plant height (in both seasons). Accordingly, the tallest plants (53.27 and 51.29 cm in the first and second seasons, respectively) were those obtained from the largest bulb size (10 cm circumference). Also, foliar spray applications using a mixture of microelements (Fe+Zn+Mn) resulted in significantly taller plants (in both seasons), compared to those sprayed with Zn or Mn alone.

In general, one can observe that in both seasons, the tallest plants were those obtained when the largest bulbs (10 cm circumference) were pretreated with cold storage or hot water treatments, followed by spraying the plants with a mixture of microelements (Fe+Zn+Mn). The data recorded on the interaction between bulb size and bulb pretreatments revealed that combining the largest bulb size (10 cm circumference) with cold storage or hot water pretreatments gave the tallest plants.

Regarding the interaction between bulb size and microelement treatments, the data showed that combining the largest bulb size (10 cm circumference) with spray application of the microelement mixture (Fe+Zn+Mn) gave the tallest plants.

Also, the best combination of pre-treatments and microelement applications (in terms of plant height) was cold storage of bulbs, followed by spraying the resulting plants with a mixture of microelements (Fe+Zn+Mn).

Table (1): Effect of bulb size, pre-planting treatments, and microelements application on plant height (cm) of *Polianthes tuberosa* in the 2002 and 2003 seasons.

First season

*Micro-elements	Control			15 days cold (5°C)			Soaking in hot water.		
	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10
1	41.45	47.17	51.52	45.33	52.58	58.22	45.76	52.34	58.11
2	40.65	43.32	47.13	44.22	51.07	55.17	41.08	51.88	57.14
3	40.00	41.02	44.54	42.05	50.00	52.18	41.01	50.09	55.42
L.S.D 0.05	3.81								

Pre-planting treatments		Control			15 days cold storage (5° C)			Hot water			L.S.D. (0.05)
		44.09			50.09			50.31			5.64
Bulb size		Size 6			Size 8			Size 10			2.35
		42.39			48.83			53.27			
*Microelements		1			2			3			1.87
		50.39			47.96			46.26			
Interactions	Pre-treatments X bulb size	Control			15 days cold storage (5° C)			Hot water			
		Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	4.26
		40.70	43.84	47.73	43.87	51.22	55.19	42.62	51.44	56.89	
	Pre-treatments X *microelements	1	2	3	1	2	3	1	2	3	1.68
		46.71	43.70	41.85	52.04	50.15	48.08	52.07	50.03	48.84	
	Bulb size X *microelements	Size 6			Size 8			Size 10			1.68
		1	2	3	1	2	3	1	2	3	
		44.18	41.98	41.02	50.70	48.76	47.04	55.95	53.15	50.71	

Second season

*Micro-elements	Control			15 days cold storage (5° C)			Soaking in hot water		
	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10
1	45.16	50.05	50.74	50.11	53.47	56.23	46.76	52.15	55.11
2	44.03	45.78	46.22	47.53	51.78	54.12	45.05	47.62	51.07
3	41.76	43.15	42.53	44.55	47.66	49.99	43.17	45.33	50.63
L.S.D 0.05	4.52								

Pre-planting		Control			15 days cold storage (5° C)			Hot water			L.S.D. (0.05)
		46.05			50.60			48.54			4.41
Bulb size		Size 6			Size 8			Size 10			2.54
		45.35			48.55			51.29			
*Microelements		1			2			3			4.12
		51.64			48.13			45.42			
Interactions	Pre-treatments X bulb size	Control			15 days cold storage (5° C)			Hot water			
		Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	2.84
		43.65	46.33	48.16	47.40	50.97	53.45	44.99	48.37	52.27	
	Pre-treatments X *microelements	1	2	3	1	2	3	1	2	3	1.82
		50.32	45.34	42.48	53.27	51.14	47.40	51.34	47.91	46.38	
	Bulb size X *microelements	Size 6			Size 8			Size 10			1.82
		1	2	3	1	2	3	1	2	3	
		47.34	45.54	43.16	51.89	48.39	45.38	55.69	50.47	47.72	

* Microelement treatments: 1 : (Fe+Zn+Mn) 0.15, 0.15, 0.14%).
2 : Zn 0.15%.
3 : Mn 0.14%.

The best combination of the three studied factors (bulb pre-treatments, bulb size and microelement treatments) was pre-treatment of the large size bulbs (10 cm circumference) with hot water (in the first season) or cold storage (in the second season), and spraying the plants with the mixture of microelements (Fe+Zn+Mn).

These results were similar to those observed on *Polianthes tuberosa* by Mostafa *et al.* (1996), Chakraborti and Ghosh (1993) and Barman and Pal (1993).

2- Flowering characteristics:

a- Number of days to flowering (Table 2):

The data recorded in the two seasons revealed that the effects of pre-planting treatments, bulb size and microelements application on the number of days to flowering differed from one season to the other. For example, soaking the bulbs in hot water was the most effective treatment in enhancing early flowering in the first season (4 days earlier than bulbs stored for 15 days at 5° C), but in the second season the earliest flowering was obtained from untreated (control) bulbs. Also, the medium size bulbs (8 cm circumference) gave significantly earlier flowering than the large size bulbs (10 cm circumference) in the first season, but in the second season the earliest flowering was obtained from the largest bulbs (10 cm circumference). Application of Zn at 0.15% was the most effective treatment in promoting early flowering in the first season, whereas in the second season the earliest flowering was obtained from plants treated with the microelement mixture (Fe+Zn+Mn).

The interaction between pre-planting treatments and bulb size showed that in the first season, soaking the small size bulbs (6 cm circumference) in hot water prior to planting gave the earliest flowers, but in the second season the earliest flowering was obtained from medium size bulbs that received no treatment before planting. Also, the interaction between pre-planting treatments and microelements indicated that in both seasons, the earliest flowering was obtained from bulbs that received no pre-treatment, but were sprayed with the mixture of microelements (Fe+Zn+Mn). On the other hand the greatest delay in flowering was obtained from plants sprayed with Zn alone, combined with pre-treatment of the bulbs using cold storage (in the first season) or hot water (in the second season).

The interactions between the bulb size and microelements revealed that the mixture of microelements (Fe+Zn+Mn) gave the earliest flowering when applied to the medium size bulbs (in the first season) or the large size bulbs (in the second season, whereas the greatest delay in flowering was obtained when Zn was applied to the large size bulbs (in the first season) or the small size bulbs (in the second season).

b- Number of florets/stalk (Table 3):

Data in Table (3) revealed that the hot water treatment had a significant effect on reducing the number of florets/stalk. In both seasons, untreated bulbs and bulbs that were kept in cold storage gave significantly higher values than those that were soaked in hot water. No significant difference was detected between untreated bulbs and those kept in cold storage prior to planting

Table (2): Effect of pre-planting treatments, bulb size and microelements application on the number of days from planting till flowering of *Polianthes tuberosa* L. in the 2002 and 2003 seasons.

First season

*Micro-elements	Control			15 days cold storage (5° C)			Soaking in hot water.		
	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10
1	140.36	139.0	137.66	149.28	137.51	146.39	138.96	139.30	142.22
2	142.25	142.03	139.42	144.44	139.81	140.08	136.12	137.78	145.05
3	144.03	140.54	142.08	144.94	145.24	144.94	133.12	140.31	146.84
L.S.D 0.05	7.55								

Pre-planting treatments		Control			15 days cold storage (5° C)			Hot water			L.S.D. (0.05)
		141.15			143.58			139.97			3.33
Bulb size		Size 6			Size 8			Size 10			2.42
		141.45			140.17			142.74			
*Microelements		1			2			3			1.61
		141.19			140.78			142.40			
Interactions	Pre-treatments X bulb size	Control			15 days cold storage (5° C)			Hot water			
		Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	3.42
		142.21	140.52	139.72	146.07	140.85	143.80	136.07	139.13	144.70	
	Pre-treatments X *microelements	1	2	3	1	2	3	1	2	3	2.28
		139.01	141.23	142.22	144.39	141.44	144.89	140.16	139.65	140.09	
	Bulb size X *microelements	Size 6			Size 8			Size 10			2.28
		1	2	3	1	2	3	1	2	3	
		142.87	140.94	140.55	138.60	139.87	142.03	142.09	141.52	144.62	

Second season

*Micro-elements	Control			15 days cold storage (5° C)			Soaking in hot water		
	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10
1	139.87	137.11	138.33	140.22	138.98	138.42	141.43	139.32	137.31
2	140.52	139.54	139.15	142.18	140.96	139.44	143.71	143.07	138.12
3	143.66	139.88	139.78	143.41	145.67	140.90	147.11	144.42	142.85
L.S.D 0.05	5.58								

Pre-planting		Control			15 days cold storage (5° C)			Hot water			L.S.D. (0.05)
		139.76			141.13			141.93			3.25
Bulb size		Size 6			Size 8			Size 10			2.35
		142.46			140.99			139.37			
*Microelements		1			2			3			2.06
		139.00			140.74			141.29			
Interactions	Pre-treatments X bulb size	Control			15 days cold storage (5° C)			Soaking in hot water			
		Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	3.36
		141.35	138.84	139.09	141.94	141.87	139.59	144.08	142.27	139.43	
	Pre-treatments X *microelements	1	2	3	1	2	3	1	2	3	2.92
		138.44	139.74	141.11	139.21	140.86	143.33	139.35	141.63	144.79	
	Bulb size X *microelements	Size 6			Size 8			Size 10			2.92
		1	2	3	1	2	3	1	2	3	
		140.51	142.14	144.73	138.47	141.19	143.32	138.02	138.90	141.18	

* Microelement treatments: 1 : (Fe+Zn+Mn) 0.15, 0.15, 0.14%).
2 : Zn 0.15%.
3 : Mn 0.14%.

Table (3): Effect of pre-planting treatments, bulb size and microelements applications on the number of florets/stalk of *Polianthes tuberosa* L. in the 2002 and 2003 seasons.

First season									
* Micro elements	Control			15 days cold storage (5°C)			Soaking in hot water.		
	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10
1	24.13	28.05	28.22	23.50	27.73	28.73	21.67	20.13	21.10
2	24.00	26.41	28.03	21.29	23.42	24.69	20.55	23.73	20.42
3	21.76	23.55	27.86	20.11	27.00	23.93	17.57	23.36	19.39
L.S.D 0.05	3.85								

Pre-planting		Control			15 days cold storage (5°C)			Soaking in hot water.		L.S.D .05
		25.78			24.49			20.88		3.32
Bulb size		Size 6			Size 8			Size 10		1.26
		21.62			24.82			24.71		
* Micro elements		1			2			3		1.69
		24.81			23.62			22.73		
Interactions	Inter preX size	Control			15 days cold storage (5°C)			Soaking in hot water.		3.66
		Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10
		23.30	26.00	28.04	21.63	26.05	25.78	19.93	22.41	20.30
	Inter pre X microelements	Control			15 days cold storage (5°C)			Soaking in hot water.		2.40
		1	2	3	1	2	3	1	2	3
		26.80	26.15	24.39	26.65	23.13	23.68	20.97	21.57	20.11
	Inter size X microelements	Size 6			Size 8			Size 10		2.40
		1	2	3	1	2	3	1	2	3
		23.10	21.95	19.81	25.30	24.52	24.64	26.02	24.38	23.73

Second season									
* Micro elements	Control			15 days cold storage (5°C)			Soaking in hot water.		
	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10
1	28.22	29.05	33.12	29.14	32.64	34.81	26.89	21.59	22.70
2	25.16	27.76	28.05	27.32	32.43	32.40	25.10	22.28	21.62
3	23.33	25.87	28.02	25.68	32.45	30.73	24.69	21.27	20.36
L.S.D 0.05	0.142								

Pre-planting		Control			15 days cold storage (5°C)			Soaking in hot water.		L.S.D .05
		27.62			30.84			22.94		3.97
Bulb size		Size 6			Size 8			Size 10		3.36
		26.17			27.26			27.98		
* Micro elements		1			2			3		1.51
		28.68			26.90			25.82		
Interactions	Inter pre X size				15 days cold storage (5°C)			Soaking in hot water.		4.75
		Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10
		25.57	27.56	29.73	27.38	32.51	32.65	25.56	21.71	21.56
	Inter pre X microelements	Control			15 days cold storage (5°C)			Soaking in hot water.		5.42
		1	2	3	1	2	3	1	2	3
		30.13	26.99	25.74	32.20	30.72	29.62	32.73	23.00	22.11
	Inter size X microelements	Size 6			Size 8			Size 10		5.42
		1	2	3	1	2	3	1	2	3
		28.08	25.86	24.57	27.76	27.49	26.53	30.21	27.36	26.37

* Microelement treatments: 1 : (Fe+Zn+Mn) 0.15, 0.15, 0.14%).
2 : Zn 0.15%.
3 : Mn 0.14%.

Increasing the bulb size from 6 to 8 or 10 cm increased the number of florets/stalk. However, this effect was significant in the first season only. In the second season, the small size bulbs (6 cm) also gave the lowest number of florets/stalk, but no significant differences were recorded between values obtained from the three bulb sizes.

The results recorded on the effect of microelement treatments indicated that application of the microelement mixture (Fe+Zn+Mn) was the most effective treatment for increasing the number of florets/stalk.

The interaction between pre-planting treatments and bulb size indicated that the greatest number of florets/stalk were obtained from large size bulbs (10 cm) that received no pre-treatment (in the first season), or that were kept in cold storage (in the second season). Also spraying the plants with (Fe+Zn+Mn) gave the greatest number of florets/stalk when the bulbs received no pre-treatment (in the first season), or when they were soaked in hot water prior to planting (in the second season).

Regarding the interaction between bulb size and the microelement treatments, the data indicated that in both seasons, combining the large size bulbs (10 cm circumference) with application of the microelements mixture (Fe+Zn+Mn) gave the greatest number of florets/stalk.

Among the various combinations of the different bulb sizes, pre-treatments and microelement treatments, the best combination (i.e. giving the highest number of florets/stalk) was cold storage of the largest bulbs (10 cm circumference) prior to planting, and spraying the plants with a mixture of microelements (Fe+Zn+Mn).

c- Flower stalk length (Table 4):

The data showed that the pre-planting treatments had a significant effect on this character. Both cold storage and hot water treatments gave significantly longer stalk than those formed by untreated bulbs. In general increasing the bulb size caused steady increases in flower stalk length, with the large size bulbs (10 cm) giving significantly taller flower stalks than those produced by small or medium size (6 or 8 cm) bulbs.

The data on the microelement treatments indicated that the three treatments used in this study also had a significant effect on this character. In this respect, spraying the plants with the microelements mixture (Fe+Zn+Mn) gave significantly taller flower stalks (with lengths of 71.56 and 72.47 cm in the first and second seasons, respectively), compared to those produced by plants sprayed with Zn or Mn alone.

The results recorded on the interaction between pre-planting treatments and bulb size showed that the tallest flower stalks were produced by the largest bulbs (10 cm circumference) which were pre-treated by soaking in hot water (in the first season) or kept in cold storage (in the second season). Regarding the

Table (4): Effect of pre-planting treatments, bulb size and microelements application on flower stalk length (cm) of Polianthes tuberosa L. in the 2002 and 2003 seasons.

First season									
* Micro elements	Control			15 days cold storage (5°C)			Soaking in hot water.		
	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10
1	51.23	60.07	63.43	68.25	78.26	81.51	71.98	80.13	89.16
2	49.15	55.34	62.03	66.02	72.57	72.56	63.47	70.46	78.59
3	46.73	49.66	60.50	62.09	73.66	67.19	59.15	67.34	72.00
L.S.D. 0.05	2.21								

Pre-planting		Control			15 days cold storage (5°C)			Soaking in hot water.			L.S.D .05
		55.35			71.34			72.48			6.37
Bulb size		Size 6			Size 8			Size 10			4.11
		59.79			67.50			71.89			
* Micro elements		1			2			3			1.96
		71.56			65.58			62.04			
Interactions	Inter pre X size	Control			15 days cold storage (5°C)			Soaking in hot water.			
		Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	5.22
		49.04	55.02	61.99	65.45	74.83	73.75	64.87	72.64	79.92	
	Inter preX microelements	Control			15 days cold storage (5°C)			Soaking in hot water.			
		1	2	3	1	2	3	1	2	3	2.20
		58.24	55.51	52.30	76.01	70.38	67.65	80.42	70.84	66.16	
	Inter size X microelements	Size 6			Size 8			Size 10			
		1	2	3	1	2	3	1	2	3	2.20
		63.82	59.55	55.99	72.82	66.12	63.55	78.03	71.06	66.56	

Second season									
* Micro elements	Control			15 days cold storage (5°C)			Soaking in hot water.		
	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10
1	53.64	55.61	60.02	75.47	84.08	88.57	70.26	78.48	86.11
2	50.13	53.43	56.76	72.62	77.16	82.44	65.85	72.31	78.63
3	49.05	51.00	52.33	67.12	75.47	77.15	61.59	68.90	75.98
L.S.D. 0.05	4.19								

Pre-planting		Control			15 days cold storage (5°C)			Soaking in hot water.			L.S.D .05
		53.55			77.76			73.12			6.93
Bulb size		Size 6			Size 8			Size 10			4.35
		62.86			68.49			73.11			
* Micro elements		1			2			3			1.27
		72.47			67.70			64.29			
Interactions	Inter pre X size	Control			15 days cold storage (5°C)			Soaking in hot water.			
		Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	4.15
		50.94	53.35	56.37	71.74	78.90	82.72	65.90	73.23	80.24	
	Inter pre X microelements	Control			15 days cold (5°C)			Soaking in hot water.			
		1	2	3	1	2	3	1	2	3	1.80
		56.42	53.44	50.79	82.71	77.41	73.25	78.28	72.26	68.82	
	Inter size X microelements	Size 6			Size 8			Size 10			
		1	2	3	1	2	3	1	2	3	1.80
		66.64	62.87	59.25	72.72	67.63	65.12	78.23	72.61	68.49	

* Microelement treatments: 1 (Fe+Zn+Mn) 0.15, 0.15, 0.14%).
2 Zn 0.15%.
3 Mn 0.14%.

interaction between pre-planting treatments with the microelement treatments, the recorded data showed that the tallest flower stalks were obtained as a result of spraying the plants with the microelement mixture (Fe+Zn+Mn), in combination with pre-treatment by soaking the bulbs in hot water (in the first season) or by keeping them in cold storage (in the second season). Also, results recorded on the interaction between bulb size and microelement treatments showed that in both seasons, the tallest flower stalks (78.03 and 78.23 cm in the first and second seasons, respectively) were produced when plants formed by the large size bulbs (10 cm) were sprayed with the microelements mixture (Fe+Zn+Mn).

In conclusion, it can be stated that the longest flower stalk can be obtained by combining large size bulbs with application of a micronutrient mixture (Fe+Zn+Mn) and pre-treatment using hot water (in the first season) or cold storage (in the second season). These results were in agreement with the findings of Mahanta and Paswan (1995) on tuberose. They reported that large size bulbs gave more florets/stalk.

3- Bulb production

a- Number of bulbs/plant (Table 5):

The results presented in Table (5) indicated that pre-planting treatments, bulb size and microelement treatments had a significant effect on number of bulbs/plant. Among the pre-treatments that were tested, the hot water treatment gave the highest number of bulbs in both seasons (9.02 and 8.40 bulbs/plant in the first and second seasons, respectively). Also, bulb production was enhanced by the increase in bulb size, with the large size bulbs (10 cm) giving the highest number of bulbs (8.27 and 7.89 bulbs/plant in the first and second seasons, respectively). Eman (2004) obtained similar results using large rhizome size, which gave the best rhizome productivity of *Zantedeschia* and *Hedychium*. Also, spraying the plants with the microelements mixture (Fe+Zn+Mn) gave the highest number of bulbs/plant in the first season (8.32 bulb/plant), but in the second season, the highest value (7.33 bulbs/plant) were obtained from plants sprayed with Mn alone.

The data on the interactions revealed that in both seasons, soaking the large size of bulbs (10 cm) in hot water gave a significantly higher number of bulbs/plant, compared to other combinations of pre-treatments and bulb sizes. Also, the best combination of pre-treatments and microelements was soaking the bulbs in hot water, and spraying with Fe+Zn+Mn (in the first season) or Mn alone (in the second season). Regarding the interaction between bulb size and microelement treatments, the recorded results showed that the greatest number of bulbs/shoot (9.51 and 8.09 bulbs/plant in the first and second seasons, respectively) was obtained when the large size bulbs (10 cm) were used, and the plants were sprayed with Fe+Zn+Mn (in the first season) or Mn alone (in the second season).

Regarding the effect of the different combinations of the three factors (bulb size, pre-treatments and microelement treatments), the results recorded in the two seasons showed that soaking the largest bulbs (10 cm circumference) in hot water, and spraying the plants with microelements (Fe+Zn+Mn) gave the greatest number of bulbs/plant.

Table (5): Effect of pre-planting treatments, bulb size and microelements applications on the number of bulbelts/ of *Polianthus tuberosa* L., (2002 and 2003).

First season									
* Micro elements	Control			15 days cold storage (5°C)			Soaking in hot water.		
	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10
1	6.35	7.83	8.44	6.31	7.37	9.50	9.57	8.91	10.59
2	3.12	7.57	7.99	5.92	6.81	7.71	9.09	8.57	9.86
3	4.03	6.08	6.15	4.86	5.33	6.22	8.72	7.92	7.94
L.S.D. 0.05	1.48								

Pre-planting		Control			15 days cold storage (5°C)			Soaking in hot water.			L.S.D .05
		6.51			6.67			9.02			1.01
Bulb size		Size 6			Size 8			Size 10			0.43
		6.55			7.38			8.27			
* Micro elements		1			2			3			
		8.32			7.52			6.36			
Interactions	Inter pre X size	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	0.86
		4.83	7.16	7.53	5.70	6.50	7.81	9.13	8.47	9.46	
	Inter pre X microelements	1	2	3	1	2	3	1	2	3	0.61
		7.54	6.56	5.42	7.73	6.81	5.47	9.69	9.17	8.19	
	Inter size X microelements	Size 6			Size 8			Size 10			0.61
		1	2	3	1	2	3	1	2	3	
		7.41	6.38	5.87	8.04	7.65	6.44	9.51	8.52	6.77	

Second season									
Micro elements	Control			15 days cold storage (5°C)			Soaking in hot water.		
	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10
1	6.66	7.05	7.97	5.96	6.42	6.39	7.12	7.74	9.41
2	5.93	6.11	7.43	6.45	6.66	6.48	7.31	8.37	9.10
3	5.76	5.35	7.02	6.44	6.91	7.88	7.84	9.37	9.36
L.S.D. 0.05	1.07								

Pre-planting		Control			15 days cold storage (5°C)			Soaking in hot water.			L.S.D .05
		6.59			6.62			8.40			1.68
Bulb size		Size 6			Size 8			Size 10			1.18
		6.61			7.11			7.89			
* Micro elements		1			2			3			0.22
		7.19			7.09			7.33			
		Control			15 days cold storage (5°C)			Soaking in hot water.			
Interactions	Inter pre X size	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	0.63
		6.12	6.17	7.47	6.28	6.66	6.92	7.42	8.49	9.29	
	Inter pre X microelements	1	2	3	1	2	3	1	2	3	0.31
		7.23	6.49	6.04	6.26	6.53	7.08	8.09	8.26	8.86	
	Inter size X microelements	Size 6			Size 8			Size 10			0.31
		1	2	3	1	2	3	1	2	3	
		6.58	6.56	6.68	7.07	7.05	7.21	7.92	7.67	8.09	

* Microelement treatments: 1 : (Fe+Zn+Mn) 0.15, 0.15, 0.14%).
2 Zn 0.15%.
3 Mn 0.14%.

b- Number of bulbelts /plant Table (6):

The recorded data indicated that cold storage of the bulbs or soaking them in hot water prior to planting significantly increased the number of bulbelts /plant in the first season (giving values of 27.86 and 27.85, respectively), compared to the control (which gave 23.36 bulbelts /plant). However, in the second season the pre-treatment of bulbs had no significant effect on the number of bulbelts /plant.

In the first season, bulb size had a significant effect on the number of bulbelts /plant, with the large size bulbs (10 cm) giving a significantly higher value (27.47 bulbelts /plant) than the medium size bulbs (8 cm), which gave 25.27 bulbelts /plant. However, in the second season, bulb size had no significant effect on the number of bulbelts /plant. Regarding the effect of microelement treatments, the data presented in Table (6) show that in both seasons, plants sprayed with Fe+Zn+Mn gave the highest number of bulbelts /plant (27.42 and 28.77 bulbelts /plant in the first and second seasons, respectively), compared to plants sprayed with Zn or Mn alone. These results are supported by the views of Brown and Clark (1997), who reported that micronutrients are known to be important in carbon-dioxide assimilation and in nitrogen metabolism, suggesting that plants may have metabolic systems that predominately require microelements application

The data recorded on the interaction between bulb pre-treatments and bulb size showed that the smallest bulb size (6 cm) gave the greatest number of bulbelts /plants when they were pre-treated with hot water (in the first season) or cold storage (in the second season) prior to planting. Results obtained with different combinations of bulb pre-treatments and microelements application differed from one season to the other. In the first season, using hot water and spraying the plants with Mn alone produced the greatest number of bulbelts /plant (32.17), whereas in the second season, the highest value (29.56 bulbelts /plant) was obtained from bulbs that received no pre-treatment, but were sprayed with Fe+Zn+Mn. The interaction between bulb size and microelement treatments showed that using the smallest size bulbs (6 cm) and spraying with Mn alone gave the greatest number of bulbelts /plant in the first season, but in the second season, the highest value (29.01 bulbelts /plant) was obtained when large size bulbs (10 cm) were used, and the plants were sprayed with Fe+Zn+Mn.

Stem apex development:

Stem apex development of *Polianthes tuberosa* after planting passed through three stages, namely: vegetative growth, flower initiation and flower differentiation (Figures 1 to 5). The same stages were mentioned by Rees (1972).

With respect to the anatomical features of the stem apex of the bulb, it is clear from Fig. (1) that after 60 days from the planting date, a new growing point was formed (representing the vegetative growth stage), which was clearest in plants sprayed with (Fe+Zn+Mn), compared to plants receiving the other treatments. Also, the cell nuclei were dividing actively after 60 days from planting, and the active division of periclinal cells led to the initiation of leaf

Table (6): Effect of pre-planting treatments, bulb size and microelements applications on the number of bulbelts /sub of *Polianthus tuberosa* L. (2002 and 2003).

First season									
* Micro elements	Control			15 days cold storage (5°C)			Soaking in hot water .		
	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10
1	22.05	24.15	28.53	28.81	31.10	31.67	27.48	25.75	27.28
2	19.97	23.23	26.43	23.97	27.32	29.01	23.29	24.85	25.48
3	19.66	22.02	24.17	21.52	27.17	30.11	50.15	21.80	24.55
L.S.D. 0.05	2.69								

Pre-planting		Control			15 days cold storage (5°C)			Soaking in hot water .			L.S.D .05
		23.36			27.86			27.85			2.13
Bulb size		Size 6			Size 8			Size 10			2.15
		26.32			25.27			27.47			
* Micro elements		1			2			3			2.35
		27.42			24.84			26.79			
Interactions	Inter pre X size	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	0.56
		20.56	23.13	26.38	24.77	28.53	30.26	33.64	24.13	25.77	
	Inter pre X microelements	1	2	3	1	2	3	1	2	3	0.27
		24.91	23.21	21.95	30.53	26.77	26.27	26.84	24.54	32.17	
	Inter size X microelements	Size 6			Size 8			Size 10			0.27
		1	2	3	1	2	3	1	2	3	
		26.22	22.41	30.44	27.00	25.13	23.66	29.16	26.97	26.28	

Second season									
Micro elements	Control			15 days cold storage (5°C)			Soaking in hot water.		
	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10
1	28.34	29.89	30.44	30.11	29.79	27.39	27.61	26.12	29.20
2	27.15	27.99	29.23	28.07	26.74	22.68	25.63	24.62	25.63
3	23.55	25.05	27.07	28.76	26.56	20.38	30.99	22.86	19.38
L.S.D. 0.05	N.S								

Pre-planting		Control			15 days cold storage (5°C)			Soaking in hot water .			
		27.63			26.72			25.78			N.S.
Bulb size		Size 6			Size 8			Size 10			N.S.
		27.80			26.62			25.71			
* Micro elements		1			2			3			1.6
		28.77			26.42			24.96			
Interactions	Inter pre X size	Control			15 days cold storage (5°C)			Soaking in hot water .			
		Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	Size 6	Size 8	Size 10	4.06
		26.35	27.64	28.91	28.98	27.70	23.48	28.07	24.53	24.74	
	Inter pre X microelements	1	2	3	1	2	3	1	2	3	2.26
		29.56	28.12	25.22	29.10	25.83	25.23	27.64	25.29	24.41	
	Inter size X microelements	Size 6			Size 8			Size 10			2.26
		1	2	3	1	2	3	1	2	3	
		28.69	26.95	27.77	28.60	26.45	24.82	29.01	25.85	22.28	

* Microelement treatments: 1 : (Fe+Zn+Mn) 0.15, 0.15, 0.14%).
2 : Zn 0.15%.
3 : Mn 0.14%.

primordia (Fig 2). The initiation of leaf primordia was clearest after pre-treatment of bulbs with cold storage at 5°C for 15 days. These results indicate that the soil contents of both Fe and Mn (previously mentioned in Table B) were sufficient for active division of the nuclei, and for leaf primordia initiation. Moreover, in some cases, anticlinal cell division started in the first and second layers of tunica, and the division of the central mother cells and of the apical meristem resulted in the appearance of a dome shape, which was clearest after pre-treatment of the bulbs by soaking in hot water, and spraying the plants with Zn (Fig 3). The same observations were recorded by Banker (1991).

After 120 day from planting, the leaf primordia continued their growth. Also, the continued growth of the stem apex gave rise to more leaf primordia (Fig 4). These morphogenic changes were most evident after pre-treatment of the bulbs with cold storage for 15 days at 5°C, and spraying the plants with Zn. Figure (5) shows that after the formation of leaf primordia, the apical meristem begins to produce flower primordia as a result of vertical and horizontal cell division. The initially dome shaped stem apex starts to show a clear flattening at its top, and the various flower parts (sepals, petals, stamens and pistil) can be distinguished in the individual flower primordia as development proceeds. The same vision was observed by Rodrigues (1962) and John (1977).

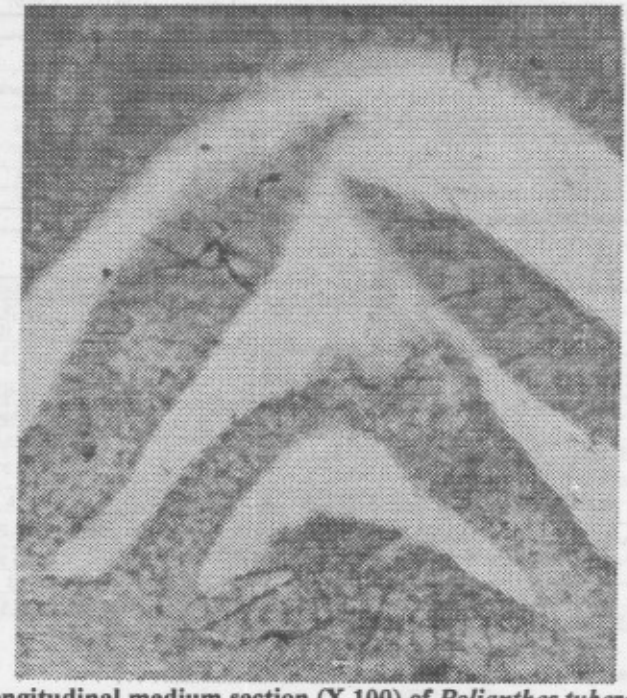

Fig. (1): Longitudinal medium section (X 100) of *Polianthes tuberosa* L. apex. after 60 days from planting. Bulbs received no preplanting treatment, and plants were sprayed with Fe+Zn+Mn. Vegetative apex (new growing point) is visible.

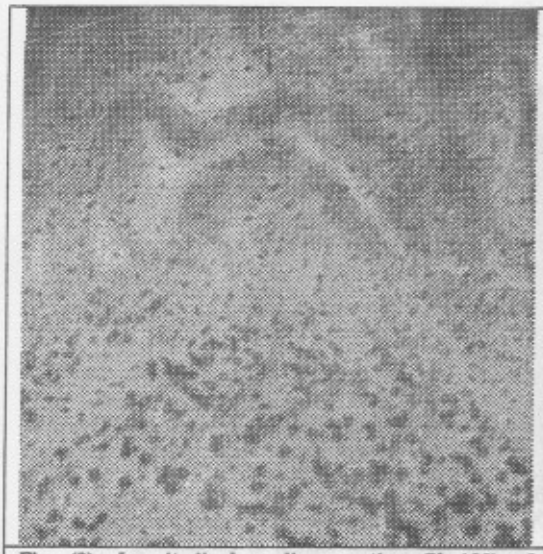

Fig. (2): Longitudinal medium section (X 100) of *Polianthes tuberosa* L. apex after 60 days from planting. Bulbs were pre-treated with cold storage (5° C), and plants sprayed with Zn. Bud is in growing vegetative stage, the nuclei are actively dividing and leaf primordia are initiated by periclinal cell division.

Fig. (3): Longitudinal medium section (X 100) of *Polianthes tuberosa* L. apex after 60 days from planting. Bulbs were pre-treated with hot water, and plants sprayed with Zn. Anticlinal cell division in the first and second layers of tunica, and the division of the central mother cells. The apical meristem turns to the dome shape.

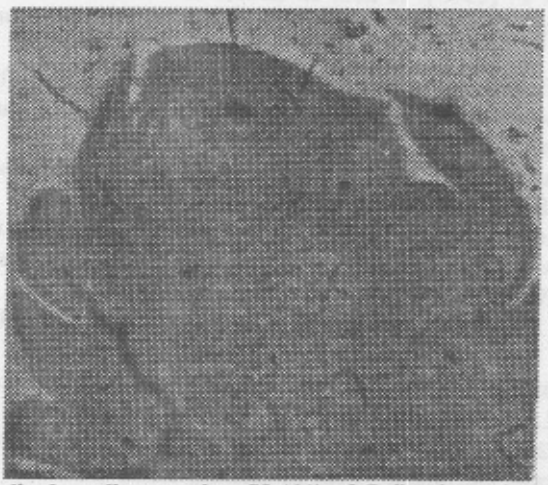

Fig. (4): Longitudinal medium section (X 100) of *Polianthes tuberosa* L. apex after 120 days from planting. Bulbs were pre-treated with cold storage (5° C), and plants sprayed with Zn. Leaf primordia continue their growth, stem apex gives rise to more leaf primordial.

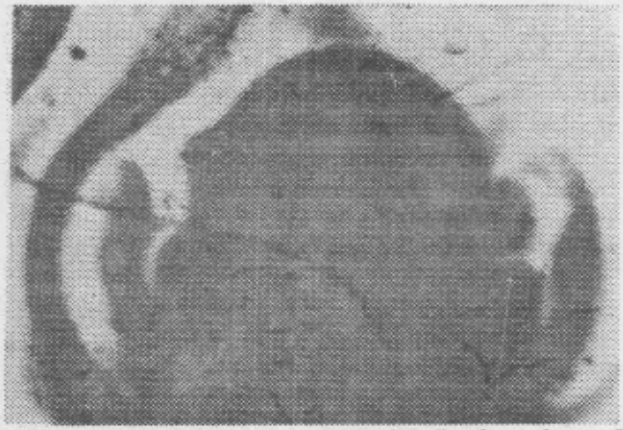

Fig. (5): Longitudinal medium section (X 100) of *Polianthes tuberosa* L. apex after 120 days from planting. The apical meristem, which is producing leaf primordia, begins to produce flower primordia, and its originally dome-shaped surface starts to flatten.

REFERENCES

Banker, G.J. (1991): Flower intiation study in tuberose (*Polianthes tuberosa*) cv. Double. Progressive Hort., Puble. 1993, 23:1-4, 119-121.

Barman, D.; and Pal. P. (1993): A note on effects of micronutrients on growth and yield of tuberose *Polianthes tuberosa* L. cv. Single. Hort. J. 6(1): 69-70.

Beijer. J. J. (1961): Excellent method of preparing wedgewood Irises for forcing. Good hot water treatment for all size. Weakble. Bloemboll-cult, 72:572 (Hort. Abst., 32: 6869).

Brown, J.C. and Clark R.B. (1997): Copper is essential to wheat reproduction. Plant and Soil, 48: 509-523.

Chakraborti, H.S. and Ghosh, S.C. (1993): Studies on the floral malady of *Polianthes tuberosa* L. in west Bengal. J. of Mycopathological Research 31(2): 109-115.

Dhua, R.S.; Ghosh, S.K; Mitra, S.K.; Yadav, L.P. and Bose, T.K. (1987): The effect of bulb size, temperature treatment of bulb and chemical fertilization on growth and flower production in tuberose (*Polianthes tuberosa* L.). Acta Hort. 205: 121-28 (Ornamental Hort., 13:1742).

Eman, A.A.M.A. (2004): Physiological Studies on Some Ornamental Bulbs. Ph.D. Thesis, Fac. Agric., Kafr El-Sheikh, Tanta Univ.

Granick, S. (1950): Iron metabolism in animals and plants. Harvey Lectures Ser. 44: 220.

Gomaa, S.A. (2000): Physiological studies on *Polianthes tuberosa* and *Ornithogalum thyrsoides* bulbs. Ph.D. Thesis, Fac. Agric., Kafr El-Sheikh Tanta Univ.

John, M.K. (1977): The greenhouse environment: The effect of environmental factors on the growth and development of flower crops. In: Development of Horticulture. The Pennsylvania State University. John Wiley & Sons. New York, Santa Barbara, London, Sydney, Toronto.

Mahanta, P. and Paswan, L. (1995): Effect of bulb size and spacing on growth, flowering and bulb production of tuberose *Polianthes tuberosa* L. cv. Single. Hort. J. 8:1, 75-83.

Mostafa, M.K.; El-Fadl, I.A.A. and Hussein, E.H. (1996): Effect of phosphorus and boron on the vegetative growth, flower and corm production and oil yield of tuberose plants. Alexandria J. of Agric. Research, 41(3): 93-107.

Nason, A., and McElory, W.D. (1963): Modes of action of the essential mineral elements. In: F.C. steward, ed., Plant Physiology. New York Academic Press.

Reddy, B.S.; Kartar, S.; Patil, R.V.; and Singh, K. (1994): Studies on effect of bulb size in tuberose. I: Influence of bulb sizes on vegetative growth. Advances in Agri. Res. in India, 2: 115-122.

Rees, A.R. (1972): The growth of bulbs. In: Applied Aspects of the Physiology of Ornamental Bulbous Crop Plants. 1st Ed., London Academic Press Inc., Ltd., pp. 228-231.

Rodrigues, P.A.S. (1962): Physiological experiments in connection with flower formation in wedgewood *Iris* (cv. *Wedgewood*). Act. Bot. Neerl., (11): 97-138.

Sass, J.E. (1951): Botanical Microtechnique. 2nd Ed., The Iowa State College Press.

Sathyanarayana T. ; Reddy, B; Singh, K. and Reddy, B.S. (1994): Studies on effect of bulb size in tuberose. II: Influence of bulb size on flowering, flower yield and quality of flower spikes. Advances in Agri. Res. in India, 2: 123-130.

Skoog, F. (1940): Relationships between zinc and auxin in the growth of higher plants. Am. J. Bot. 27:939.

Snedecor,G.W. and Cochran, W.G. (1971): Statistical methods. Iowa Stat. Univ. Press. U.S.A.

Soliman, M.A. (2002): Physiological and anatomical studies on some ornamental bulbs. Ph. D. Thesis, Fac. Agric., Kafr El-Sheikh, Tanta Univ.

Szlachetka, W.; Woznialowska, B. and Kucharska, R. (1995): Effect of tuber types and size on flowering and tuber yield of *Polianthes tuberosa*. Katedra Roslin Ozdobnych SGGW, Nowoursg nowska, 166, 02-787. Warszawa, Poland.

تأثير حجم الأبصال ومعاملات ما قبل الزراعة والعناصر الصغرى علي النمووالتزهير وإنتاج الأبصال وتطور البرعم الطرفي في التوبروز *Polianthes tuberosa L.*

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أجريت هذه الدراسة لبحث تأثير حجم الأبصال (محيط ٦ ، ٨ أو ١٠ سم) وبعض معاملات ما قبل الزراعة [التخزين البارد على درجة حرارة ٥° م لمدة ١٥ يوم، أونقع الأبصال فى ماء مغلى (١٠٠° م) لمدة ١٠ ثوانى ثم فى مـاء ساخن (٣٥ ° م) لمدة ٢٤ ساعة]، ورش الأوراق بمعاملات العناصر الصغرى التالية: (١) خليط من الحديد والزنك والمنجنيـز بتركيـزات ٠,١٥ و٠,١٥ و٠,١٤% على التوالى، أو(٢) الزنك منفرد بتركيز ٠,١٥%، أو(٣) المنجنيز منفرد بتركيز ٠,١٤% ، وذلك على النمووالتزهير وإنتاج الأبصال وتطور البرعم الطرفى لنبات التوبروز (*Polianthes tuberosa*) . ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلى:

- التخزين البارد للأبصال كبيرة الحجم (محيط ١٠ سم) قبل الزراعة، ثم رش النباتات بخليط من العناصر الصغرى (حديد+زنك+ منجنيز) أعطى أطول النباتات وأكبر عدد من الأزهار على الحامل النورى (فى الموسمين).
- أدت معاملة الأبصال قبل الزراعة بالماء الساخن إلى أقصى تبكير فى التزهير فى الموسمين. كذلك نتج عن هذه المعاملة زيادة معنوية فى طول الحامل النورى فى الموسم الأول، بالمقارنة بالنباتات غير المعاملة.
- أدت معاملة الأبصال قبل الزراعة بالماء الساخن إلى نقص معنوى فى عدد الأزهار على الحامل النورى.
- نقع الأبصال كبيرة الحجم (محيط ١٠ سم) فى الماء الساخن، ثم رش النباتات بمخلوط من العناصر الصغرى (حديد+زنك+ منجنيز) أعطى أكبر عدد من الأبصال/نبات فى الموسمين.
- فى كلا الموسمين تم الحصول على أكبر عدد من البصيلات/نبات عند نقع الأبصال صغيرة الحجم (محيط ٦ سم) فى الماء الساخن، ثم رش النباتات بعد ذلك بالمنجنيز منفردا.
- التخزين البارد للأبصال ورش النباتات بالزنك بتركيز ٠,١٥% أدى إلى الحصول على أقصى تطور للبرعم الطرفى (من حيث نشوء مبادئ الأوراق والأزهار، وكذلك تكشف الأجزاء الزهرية)، وهذا بعد مرور ١٢٠ يوم من الزراعة، مقارنة بالمعاملات الأخرى.