EFFECT OF SOIL-N APPLICATION AND FOLIAR NUTRITION WITH Zn AND Mn ON GROWTH, FLOWERING AND KEEPING QUALITY OF AMARYLLUS PLANTS (*HIPPEASTRUM VITTATUM,* HERB)

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ABSTRACT

Apot experiment was conducted to study the effect of soil-N fertilization rates (2 and 4 g of ammonium nitrate/plant) and foliar spray with Zn and Mn at 2 concentrations (100 and 150 ppm for each) on the vegetative growth, flowering and chemical composition of amaryllus (*Hippeastrum vittatum,* herb) plants. **The obtained data showed that,** fertilizing amaryllus plants with 4 g ammonium nitrate/plant significantly increased the vegetative growth characters i.e., plant height, number of leaves/plant, leaves area, fresh and dry weights of leaves, bulbs and the whole plant. Moreover, increased number of bulbs and bulblets/plant, bulb size and bulb dry weight. Flowering traits such as length of floral stalk, number of flowers on floral stalk, average dry weight of floral stalk and vase life of flowers were increased as well. The same rate (4 g) of N-fertilization also led to the increase in the concentration of chlorophylls (a and b), carotenoids, total carbohydrates, anthocyanin in flowers at picking time and five days later, and leaves content of N and P. The 2 g ammonium nitrate application/plant significantly increased both K and Zn contents in plant leaves. On the other side, leaf content of Mn and Fe was not affected with the 2 or 4 g ammonium nitrate rate. Foliar spray with the mixture of Zn and Mn at the rate 150 ppm of each significantly increased all the above mentioned vegetative growth characters and flowering traits. The tested treatments also caused insignificant increase in the leaves content of chlorophylls (a and b), carotenoids, total carbohydrates, flowers content of anthocyanin at picking time and 5 days later, and accumulation of N and K. The greatest accumulation of P occured when plants were sprayed with Mn at 150 ppm. On the contrary, the highest value of Fe was observed in plants sprayed with Zn and Mn at the concentrations of 150 and 100 ppm, respectively. Regarding the combined effect of soil N application and foliar spray with (Zn+Mn), the results revealed that, fertilizing the amaryllus plants with 4 g ammonium nitrate and foliar application with mixture of Zn and Mn at 150 ppm concentration for each significantly increased all vegetative growth characters, floral parameters, leaves content of chlorophylls (a and b), carotenoids, total carbohydrates, N, P and flowers content of anthocyanin at the time of picking or five days later. The greatest plant content of K was found when a plant recivied 2 g of N and sprayed with Zn and Mn at 150 ppm for each. Providing amaryllus plants with 2 g of ammonium nitrate and foliar spraying with only Zn at 150 ppm resulted in the greatest leaf content of Zn and Fe.

Key words: Amaryllus, *Hippeastrum vittatum,* Soil-N Application, Foliar Zn- and Mn-Nutrition, Vegetative growth, flowering, Chemical composition.

INTRODUCTION

Amaryllus (*Hippeastrum vittatum*, Herb), Family amaryllidaceae is an attractive flowering ornamental bulb, native to South America. It is grown in Egypt both outdoors, as flower bed impact and inborders, as well as, for cut flowers and indoors, as a foliage and flowering pot plant in a time where there is nearly a lack of other flowers. The inflorescences emerges under Egypt temperature in mid-April and lasts for a relatively short period (2-4 weeks). It consists of four large and colorific trumpet-like flowers, that last about two weeks with only one or two inflorescences for a vase. Fertilizing in general and with nitrogen in particular has been known as a vital step in steping up the growth and flowering of many ornamental plants. **Dahya *et al.* (1999), Chadha *et al.* (1999), Hameed and Sekar (1999), Ram *et al.* (1999)** and **Broschat and Moore (2001)** working on marigold plants and **El-Gendy *et al.* (2001)** working on *Ocimum bacilicum* declared that, increasing N-application up to a particular level, consistently increase vegetative growth parameters and flowering traits as well as the total carbohydrates and nitrogen content of plant.

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 and manganese were reported to stimulate the growth of various plants due to their 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 announced also that, high pH and low organic matter in the soil considerably reduce the availability of most microelements. 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 (**Selim and El-Tantawy, 1993)** on gerbera, (**El-Deeb, 1999)** on *Philodendron scandatum*, (**Refaat and Balbaa, 2001)** on lemongrass plants and (**Selim *et al.*, 2001)** on *Calendula officinalis*. They concluded that, spraying plants with Zn and Mn increase all vegetative growth characters and flowering. The effect of Zn or Mn on the chemical composition of plants was reported by many investigators (**El-Deeb, 1999)** on *Philodendron scandatum* and (**Selim *et al.*, 2001)** on *Calendula officinalis*. They found that, Zn and Mn foliar sprays increase the plant content of chlorophyll a or b and total carotenoids. **Refaat and Balbaa (2001)** on lemongrass plants indicated that Zn and Mn increase chlorophylls (a and b), carotenoids, macronutrients (N, P and K) and the micronutrient cations (Fe, Mn and Zn) while decrease total carbohydrates.

Objective of the present work is to investigate the effect of soil-N application and foliar spray with Zn and Mn and their interaction on the vegetative growth, flowering and chemical composition of amaryllus (*Hippeastrum vittatum*, Herb) plant.

MATERIALS AND METHODS

A pot experiment was conducted during the two successive seasons of 2003/2004 and 2004/2005 at the Experimental Farm of the Faculty of Agriculture, Fayoum, Cairo University, in order to study the effect of soil-N application and foliar spray with Zn and Mn and their interaction on the vegetative growth, flowering traits and bulbs yield of amaryllus (*Hippeastrum vittatum*, Herb) plants. Clay pots, 30 cm diameter, were filled with equal amounts of air dried clay soil mixed with sand at a ratio 1:1 by weight. Uniform sizes of amaryllus bulbs were utilized. One bulb was sown in each pot on August 25, 2003 and 2004. Samples of the used soil were analyzed according to **Black (1965**). Results of analysis are given in Table (1).

Table 1. **Some physical and chemical properties of the experimental soil.**

Properties	2003/2004	2004/2005
Particle size distribution:		
Sand%	**32.100**	**32.270**
Silt%	**32.070**	**31.410**
Clay%	**35.830**	**36.320**
Texture grade	**Sandy clay**	**Sandy clay**
Hydraulic conductivity (cm^3/hr)	**00.027**	**00.029**
Chemical properties:		
Calcium carbonate%	**4.800**	**4.600**
Organic matter%	**1.250**	**1.280**
Total nitrogen%	**0.062**	**0.066**
EC_e (dS/m)	**2.900**	**2.600**
PH of paste extract	**7.500**	**7.300**
Available nutrients (mg/kg soil):		
P	**23.00**	**22.00**
K	**96.80**	**99.26**
Zn	**00.81**	**00.80**
Fe	**03.64**	**03.71**
Mn	**08.03**	**07.89**

Fertilization treatments included the combinations of two N rates: 2 and 4 g ammonium nitrate (33.5% N)/plant, two concentrations of Zn (100 and 150 ppm) and two of Mn (100 and 150 ppm) applied as elemental zinc (65% Zn) and elemental manganese (65% Mn), respectively. Nitrogen fertilizer was added as a soil application in two equal portions; at November, 15^{th} and 15 days later. Zinc and manganese were applied as 3 foliar sprays at 2 weeks intervals starting from November 8, in both seasons, respectively. The experimental layout was a factorial experiment in a randomized complete blocks design with four replications for each experimental unit. Equal doses of potassium sulphate and calcium superphosphate; were added to each pot at the rate 3 g/pot. All other agromanagements for the production of amaryllus flowers were achieved whenever it was necessary. When the 1st flower of floal stalk, in each pot, seemed to be open, the following measurements were performed:

1. Vegetative growth characters in terms of plant height, number of leaves, leaves area/plant, dry weight of plant tops and whole plant (plant tops+bulbs), number of bulbs and bulblets, bulb fresh weight and bulb size.

2. Flowering traits expressed as length, number of flowers and fresh weight /floal stalk. Vase life of flowers as number of days starting from opening of the 1st flower till wilting the last one was considered.

3. Chemical composition of plant leaves: concentrations of chlorophylls (a and b) and carotenoids in fresh leaves at the beginning of flowering were determined according to the methods described by **Welburn and Lichtenthaler (1984)**. Total carbohydrates in leaves was colorimetrically estimated as outlined by **Herbert *et al.* (1971)**. Leaf N was determined using Orange G dye according to **Hafez and Mikkelsen (1981)**. For P,K, Mn, Zn and Fe determinaton, the wet digestion of 0.1 g of fine dry material of leaves of each treatment was done with sulphuric 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 Sommors (1982)**. Potassium was determined by Flame Photometer (Gallenkamp Co., England) as described by **Brown and Lilliand (1966)**. Leaf Mn, Zn and Fe 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 (LSD) at p=0.05 as illustrated by **Snedecor and Cochran (1980)**.

RESULTS AND DISCUSSION

I. Vegetative Growth Characters:

Data illustrated in Tables (2a, 2b and 2c) exhibit that, N-application to the growing *Hippeastrum vittatum* plants at the rate 4 g NH_4NO_3/pot was superior and associated significantly with higher mean magnitudes for plant height, number of leaves/ plant, leaves area/plant, dry weight for each of the plant tops, bulbs and whole plant (plant tops+bulbs), average number of bulbs and bulblets/pot, bulb size and bulb fresh weight than those grown with the lower level of N (2 g ammonium nitrate/plant). The obtained data matched well with the findings of **Dahya *et al.* (1999), Chadha *et al.* (1999), Hameed and Sakar (1999), Ram *et al.* (1999)** and **Broschat and Moore (2001)** on marigold plants and **El-Gendy *et al.* (2001)** on *Ocimum basilicum*. They reported that increased N-application up to a particular level, consistency increased vegetative growth parameters.

Foliar spray of amaryllus plants with the mixture of Zn and Mn at 150 ppm concentration, for each, significantly or unsignificantly increased all the studied vegetative growth parameters followed by the mixture of 150 ppm Zn and 100 ppm Mn (tables 2a, 2b and 2c). The favourable effect of Zn and Mn 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 **Abed *et al.* (1987)** on *Pisum* *sativum*, **Selim and El-Tantawy (1993)** on gerbera, **El-Deeb (1999)** on *Philodendron scandens*, **Refaat and Balbaa (2001)** on lemongrass plants and **Selim *et al.* (2001)** on *Calendula officinalis,* who retrieved that spraying the plants with Zn or Mn increased all vegetative characters.

Concerning the interaction between the different levels of ammonium nitrate fertilizer and foliar sprays of Zn or Mn and their mixture on vegetative growth varied between the two seasons. The significant response was obvious in one out of the two experimental seasons (tables 2a, 2b and 2c). Comparison among all treatments indicated that the combination of 4 g ammonium nitrate/plant with the mixture of Zn and Mn at the concentration of 150 ppm for each proved to be the best for all vegetative growth parameters.

Table 2a. Effect of soil N-application and foliar nutrition with Zn and Mn on vegetative growth characters of amaryllus plants during the two successive seasons 2003/2004 and 2004/2005.

Character	Plant height (cm)			No. of leaves/plant			Leaves area/plant (dm^2)		
Treatment	N_1	N_2	Mean (B)	N_1	N_2	Mean (B)	N_1	N_2	Mean (B)
				2003/2004					
Zn_0+Mn_0	42.67	43.67	**43.17**	6.33	6.67	**6.50**	6.86	7.36	**7.11**
Zn_0+Mn_1	44.67	46.00	**45.34**	6.67	7.33	**7.00**	7.30	8.00	**7.65**
Zn_0+Mn_2	47.33	48.33	**47.83**	7.00	7.67	**7.34**	7.70	8.24	**7.97**
Zn_1+Mn_0	45.67	47.33	**46.50**	7.00	7.33	**7.17**	7.55	8.10	**7.83**
Zn_1+Mn_1	49.33	50.67	**50.00**	7.33	7.67	**7.50**	8.10	8.24	**8.17**
Zn_1+Mn_2	52.33	53.33	**52.83**	7.67	7.67	**7.67**	8.40	8.44	**8.42**
Zn_2+Mn_0	50.67	52.00	**51.34**	7.67	7.67	**7.67**	8.24	8.30	**8.27**
Zn_2+Mn_1	53.67	54.33	**54.00**	8.00	8.00	**8.00**	8.66	8.85	**8.76**
Zn_2+Mn_2	55.67	56.67	**56.17**	8.00	8.33	**8.17**	8.78	9.26	**9.02**
Mean (A)	**49.11**	**50.26**		**7.30**	**7.59**		**7.95**	**8.31**	
$LSD_{(0.05)}$:									
(A)		**1.06**			**0.21**			**0.33**	
(B)		**1.59**			**0.32**			**0.42**	
(A)×(B)		**2.11**			**0.40**			**0.60**	
				2004/2005					
Zn_0+Mn_0	43.33	44.00	**43.67**	6.00	6.33	**6.17**	6.60	6.96	**6.78**
Zn_0+Mn_1	46.00	46.33	**46.17**	6.33	6.67	**6.50**	6.96	7.34	**7.15**
Zn_0+Mn_2	48.33	49.00	**48.67**	7.00	7.33	**7.17**	7.70	8.06	**7.88**
Zn_1+Mn_0	47.33	47.67	**47.50**	6.67	7.00	**6.84**	7.34	7.70	**7.52**
Zn_1+Mn_1	48.67	51.00	**49.84**	7.00	7.33	**7.17**	7.70	8.06	**7.88**
Zn_1+Mn_2	52.33	53.67	**53.00**	7.33	7.67	**7.50**	8.06	8.44	**8.25**
Zn_2+Mn_0	50.00	52.00	**51.00**	7.00	7.67	**7.34**	7.70	8.34	**8.02**
Zn_2+Mn_1	54.00	55.00	**54.50**	7.67	7.67	**7.67**	8.44	8.74	**8.59**
Zn_2+Mn_2	56.33	57.33	**56.83**	8.00	8.33	**8.17**	8.80	9.16	**8.98**
Mean (A)	**49.59**	**50.67**		**7.00**	**7.33**		**7.70**	**8.07**	
$LSD_{(0.05)}$:									
(A)		**1.01**			**0.19**			**0.31**	
(B)		**1.51**			**0.30**			**0.46**	
(A)×(B)		**2.00**			**0.37**			**0.61**	

Zn_0=water (control), Zn_1=100 ppm, and Zn_2=150 ppm.
Mn_0=water (control), Mn_1=100 ppm, and Mn_2=150 ppm.

Table 2b. Effect of soil N-application and foliar nutrition with Zn and Mn on vegetative growth characters of amaryllus plants during the two successive seasons 2003/2004 and 2004/2005.

Character / Treatment	Dry wt. of plant tops (%)			Dry wt. of bulbs (%)			Dry wt. of whole plant (%)		
	N_1	N_2	Mean (B)	N_1	N_2	Mean (B)	N_1	N_2	Mean (B)
				2003/2004					
Zn_0+Mn_0	6.24	6.40	**6.32**	17.90	18.60	**18.25**	12.07	12.50	**12.29**
Zn_0+Mn_1	6.65	6.87	**6.76**	18.99	19.76	**19.38**	12.82	13.32	**13.07**
Zn_0+Mn_2	6.85	7.08	**6.97**	20.48	21.24	**20.86**	13.67	14.16	**13.92**
Zn_1+Mn_0	6.80	6.99	**6.90**	19.65	20.60	**20.13**	13.23	13.80	**13.52**
Zn_1+Mn_1	6.94	7.20	**7.07**	21.00	21.98	**21.49**	13.97	14.59	**14.28**
Zn_1+Mn_2	7.10	7.66	**7.38**	22.39	23.54	**22.97**	14.75	15.60	**15.18**
Zn_2+Mn_0	6.98	7.36	**7.17**	21.86	22.75	**22.31**	14.42	15.06	**14.74**
Zn_2+Mn_1	7.24	7.80	**7.52**	23.05	24.26	**23.66**	15.15	16.03	**15.59**
Zn_2+Mn_2	7.43	7.95	**7.69**	23.96	25.00	**24.48**	15.70	16.48	**16.09**
Mean (A)	**6.91**	**7.26**		**21.03**	**21.97**		**13.98**	**14.62**	
$LSD_{(0.05)}$:									
(A)		**0.31**			**0.90**			**0.59**	
(B)		**0.45**			**1.35**			**0.90**	
(A)×(B)		**0.60**			**1.70**			**1.11**	
				2004/2005					
Zn_0+Mn_0	6.18	6.36	**6.27**	17.78	18.40	**18.09**	11.98	12.38	**12.18**
Zn_0+Mn_1	6.55	6.82	**6.69**	18.79	19.52	**19.16**	12.67	13.17	**12.92**
Zn_0+Mn_2	6.88	7.00	**6.94**	20.30	21.10	**20.70**	13.59	14.05	**13.82**
Zn_1+Mn_0	6.78	6.94	**6.86**	19.48	20.39	**19.94**	13.13	13.67	**13.40**
Zn_1+Mn_1	6.96	7.15	**7.06**	20.83	21.76	**21.30**	13.90	14.46	**14.18**
Zn_1+Mn_2	7.15	7.62	**7.39**	22.20	23.31	**22.76**	14.68	15.47	**15.08**
Zn_2+Mn_0	7.06	7.30	**7.18**	21.67	22.54	**22.11**	14.37	14.92	**14.65**
Zn_2+Mn_1	7.24	7.76	**7.50**	22.90	24.00	**23.45**	15.07	15.88	**15.48**
Zn_2+Mn_2	7.40	7.90	**7.65**	23.70	24.72	**24.21**	15.55	16.31	**15.93**
Mean (A)	**6.91**	**7.21**		**20.85**	**21.75**		**13.88**	**14.48**	
$LSD_{(0.05)}$:									
(A)		**0.28**			**0.85**			**0.51**	
(B)		**0.42**			**1.31**			**0.76**	
(A)×(B)		**0.55**			**1.60**			**0.92**	

Zn_0=water (control), Zn_1=100 ppm, and Zn_2=150 ppm.
Mn_0=water (control), Mn_1=100 ppm, and Mn_2=150 ppm.

Table 2c. Effect of soil N-application and foliar nutrition with Zn and Mn on vegetative growth characters of amaryllus plants during the two successive seasons 2003/2004 and 2004/2005.

Character	No. of bulbs+bulblets/pot			Bulb size (cm^3)			Fresh wt. of bulb (g)		
Treatment	N_1	N_2	Mean (B)	N_1	N_2	Mean (B)	N_1	N_2	Mean (B)
				2003/2004					
Zn_0+Mn_0	3.33	3.67	**3.50**	90.84	97.43	**94.14**	84.11	90.21	**87.16**
Zn_0+Mn_1	3.67	4.00	**3.84**	96.96	102.96	**99.96**	89.36	94.89	**92.13**
Zn_0+Mn_2	4.67	4.67	**4.67**	103.25	110.50	**106.88**	94.81	101.47	**98.14**
Zn_1+Mn_0	4.00	4.67	**4.34**	99.50	106.86	**103.18**	91.20	97.95	**94.58**
Zn_1+Mn_1	4.67	5.00	**4.84**	104.92	116.82	**110.87**	96.08	106.98	**101.53**
Zn_1+Mn_2	5.33	5.67	**5.50**	140.78	143.14	**141.96**	128.68	130.65	**129.67**
Zn_2+Mn_0	5.00	5.33	**5.17**	132.42	136.19	**134.31**	121.15	123.69	**122.42**
Zn_2+Mn_1	5.67	6.33	**6.00**	149.32	153.89	**151.61**	136.12	140.28	**138.20**
Zn_2+Mn_2	6.33	6.67	**6.50**	162.96	167.86	**165.41**	148.15	152.60	**150.38**
Mean (A)	**4.74**	**5.11**		**120.11**	**126.18**		**109.96**	**115.41**	
$LSD_{(0.05)}$:									
(A)		**0.20**			**5.40**			**5.11**	
(B)		**0.30**			**8.10**			**7.65**	
(A)×(B)		**0.38**			**9.80**			**9.21**	
				2004/2005					
Zn_0+Mn_0	3.00	3.33	**3.17**	85.42	91.45	**88.44**	79.09	84.68	**81.89**
Zn_0+Mn_1	3.33	3.67	**3.50**	91.81	97.41	**94.61**	84.62	89.78	**87.20**
Zn_0+Mn_2	4.00	4.33	**4.17**	108.50	112.62	**110.56**	99.82	103.61	**101.72**
Zn_1+Mn_0	3.67	4.00	**3.84**	101.12	105.48	**103.30**	93.20	97.16	**95.18**
Zn_1+Mn_1	4.67	4.67	**4.67**	119.92	125.48	**122.70**	110.02	115.12	**112.57**
Zn_1+Mn_2	4.67	5.33	**5.00**	136.49	141.80	**139.15**	124.65	129.50	**127.08**
Zn_2+Mn_0	4.67	5.00	**4.84**	127.12	132.80	**129.96**	116.30	121.50	**118.90**
Zn_2+Mn_1	5.33	5.67	**5.50**	145.59	150.44	**148.02**	132.72	137.14	**134.93**
Zn_2+Mn_2	6.00	6.33	**6.17**	157.56	161.66	**159.61**	143.24	146.96	**145.10**
Mean (A)	**4.37**	**4.70**		**119.28**	**124.35**		**109.30**	**113.94**	
$LSD_{(0.05)}$:									
(A)		**0.29**			**5.00**			**4.60**	
(B)		**0.43**			**7.45**			**6.90**	
(A)×(B)		**0.57**			**9.05**			**8.20**	

Zn_0=water (control), Zn_1=100 ppm, and Zn_2=150 ppm.
Mn_0=water (control), Mn_1=100 ppm, and Mn_2=150 ppm.

II. Flowering traits:

Data given in Tables (3a and 3b) indicate that, increasing N rate from 2 to 4 g NH_4NO_3/plant significantly promoted the number of flowers/floral stalk, floral stalk length, average of fresh weight/floral stalk and keeping quality. The obtained results are in harmony with those reported by **Dahya *et al.* (1998), Chadha *et al.* (1999), Hameed and Sakar (1999), Ram *et al.* (1999)** and **Broschat and Moore (2001)** on marigold plant and **El-Gendy *et al.* (2001)** on *Ocimum basilicum*. They concluded that nitrogen fertilization increases flowering traits.

Table 3a. Effect of soil N-application and foliar nutrition with Zn and Mn on flowering traits of amaryllus plants during the two successive seasons 2003/2004 and 2004/2005.

Character	Keeping quality from cutting time to						Mean of keeping quality (vase life) (day)		
	1^{st} flower death on floral stalk (day)			Last flower death on floral stalk (day)					
Treatment	N_1	N_2	Mean (B)	N_1	N_2	Mean (B)	N_1	N_2	Mean (B)
				2003/2004					
Zn_0+Mn_0	5.67	6.00	**5.84**	8.33	8.67	**8.50**	7.00	7.34	**7.17**
Zn_0+Mn_1	6.00	6.67	**6.34**	8.67	9.33	**9.00**	7.34	8.00	**7.67**
Zn_0+Mn_2	6.67	7.33	**7.00**	9.00	9.67	**9.34**	7.84	8.50	**8.17**
Zn_1+Mn_0	6.33	7.00	**6.67**	9.00	9.67	**9.34**	7.67	8.34	**8.01**
Zn_1+Mn_1	7.00	7.67	**7.34**	9.33	9.67	**9.50**	8.17	8.67	**8.42**
Zn_1+Mn_2	7.67	8.00	**7.84**	9.67	10.33	**10.00**	8.67	9.17	**8.92**
Zn_2+Mn_0	7.67	8.00	**7.84**	9.67	10.00	**9.84**	8.67	9.00	**8.84**
Zn_2+Mn_1	8.00	8.33	**8.17**	10.00	10.33	**10.17**	9.00	9.33	**9.17**
Zn_2+Mn_2	8.00	8.67	**8.34**	10.33	10.67	**10.50**	9.17	9.67	**9.42**
Mean (A)	**7.00**	**7.52**		**9.33**	**9.82**		**8.17**	**8.67**	
$LSD_{(0.05)}$:									
(A)		**0.45**			**0.43**			**0.36**	
(B)		**0.68**			**0.65**			**0.54**	
(A)×(B)		**0.89**			**0.84**			**0.71**	
				2004/2005					
Zn_0+Mn_0	5.33	5.67	**5.50**	8.67	9.33	**9.00**	7.00	7.50	**7.25**
Zn_0+Mn_1	5.67	6.00	**5.84**	9.33	9.67	**9.50**	7.50	7.84	**7.67**
Zn_0+Mn_2	6.00	6.67	**6.34**	9.67	10.00	**9.84**	7.84	8.34	**8.09**
Zn_1+Mn_0	6.00	6.33	**6.17**	9.67	10.00	**9.84**	7.84	8.17	**8.01**
Zn_1+Mn_1	6.33	6.67	**6.50**	9.67	10.33	**10.00**	8.00	8.50	**8.25**
Zn_1+Mn_2	6.67	7.00	**6.84**	9.67	10.67	**10.17**	8.17	8.84	**8.51**
Zn_2+Mn_0	6.67	7.00	**6.84**	9.67	10.67	**10.17**	8.17	8.84	**8.51**
Zn_2+Mn_1	7.00	7.33	**7.17**	10.33	11.00	**10.67**	8.67	9.17	**8.92**
Zn_2+Mn_2	7.67	7.67	**7.67**	10.33	11.00	**10.67**	9.00	9.34	**9.17**
Mean (A)	**6.37**	**6.70**		**9.67**	**10.30**		**8.02**	**8.50**	
$LSD_{(0.05)}$:									
(A)		**0.31**			**0.50**			**0.42**	
(B)		**0.46**			**0.74**			**0.63**	
(A)×(B)		**0.60**			**0.98**			**0.81**	

Zn_0=water (control), Zn_1=100 ppm, and Zn_2=150 ppm.
Mn_0=water (control), Mn_1=100 ppm, and Mn_2=150 ppm.

Regarding the infleunce of foliar spray of amaryllus plants with Zn and/or Mn, data indicate that the mixture of both Zn and Mn at a concentration of 150 ppm for each significantly increased all the studied flowering trait parameters in both seasons (tables 3a and 3b). In this respect, **Selim and Tantawy (1993)** on gerbera, **El-Deeb (1999)** on *Philodendron scandens*, **Refaat and Balbaa (2001)** on lemongrass plants and **Selim *et al.* (2001)** on *Calendula officinalis*, mentioned that spraying plants with Zn or Mn increase flowering traits.

Table 3b. Effect of soil N-application and foliar nutrition with Zn and Mn on flowering traits of amaryllus plants during the two successive seasons 2003/2004 and 2004/2005.

Character / Treatment	Length of floral stalk (cm) N_1	N_2	Mean (B)	No. of flowers/ floral stalk N_1	N_2	Mean (B)	Fresh wt. of flowers /floral stalk (g) N_1	N_2	Mean (B)
2003/2004									
Zn_0+Mn_0	23.67	26.33	**25.00**	2.00	2.33	**2.17**	19.20	22.37	**20.79**
Zn_0+Mn_1	26.33	30.00	**28.17**	2.33	2.67	**2.50**	22.34	25.63	**23.99**
Zn_0+Mn_2	30.67	35.33	**33.00**	2.67	3.00	**2.84**	25.77	28.95	**27.36**
Zn_1+Mn_0	29.33	33.67	**31.50**	2.67	3.00	**2.84**	25.75	28.90	**27.33**
Zn_1+Mn_1	32.67	38.00	**35.34**	2.67	3.33	**3.00**	25.90	32.30	**29.10**
Zn_1+Mn_2	37.33	43.33	**40.33**	3.00	3.67	**3.34**	29.10	35.60	**32.35**
Zn_2+Mn_0	36.67	41.67	**39.17**	3.00	3.67	**3.34**	29.25	35.78	**32.52**
Zn_2+Mn_1	41.67	46.67	**44.17**	3.67	3.67	**3.67**	35.96	36.00	**35.98**
Zn_2+Mn_2	44.33	50.00	**47.17**	4.00	4.00	**4.00**	39.20	39.36	**39.28**
Mean (A)	**33.63**	**38.33**		**2.89**	**3.26**		**28.05**	**31.65**	
$LSD_{(0.05)}$:									
(A)		**2.60**			**0.21**			**2.45**	
(B)		**3.88**			**0.31**			**3.60**	
(A)×(B)		**5.11**			**0.40**			**4.80**	
2004/2005									
Zn_0+Mn_0	25.00	27.33	**26.17**	2.00	2.00	**2.00**	19.04	19.36	**19.20**
Zn_0+Mn_1	28.33	30.67	**29.50**	2.33	2.33	**2.33**	22.25	22.72	**22.49**
Zn_0+Mn_2	32.00	34.67	**33.34**	2.33	2.67	**2.50**	22.31	26.04	**24.18**
Zn_1+Mn_0	30.67	33.67	**32.17**	2.33	2.67	**2.50**	22.31	25.96	**24.14**
Zn_1+Mn_1	34.00	36.00	**35.00**	2.67	3.00	**2.84**	25.63	29.40	**27.52**
Zn_1+Mn_2	39.00	39.67	**39.34**	3.00	3.67	**3.34**	28.95	36.15	**32.55**
Zn_2+Mn_0	37.33	39.00	**38.17**	3.00	3.33	**3.17**	28.80	32.64	**30.72**
Zn_2+Mn_1	41.67	43.00	**42.34**	3.33	3.67	**3.50**	32.30	36.26	**34.28**
Zn_2+Mn_2	43.67	46.33	**45.00**	3.67	4.00	**3.84**	35.96	39.20	**37.58**
Mean (A)	**34.63**	**36.70**		**2.74**	**3.04**		**26.39**	**29.75**	
$LSD_{(0.05)}$:									
(A)		**N.S.**			**0.20**			**2.70**	
(B)		**3.55**			**0.29**			**3.96**	
(A)×(B)		**4.70**			**0.39**			**5.30**	

Zn_0=water (control), Zn_1=100 ppm, and Zn_2=150 ppm.
Mn_0=water (control), Mn_1=100 ppm, and Mn_2=150 ppm.

The interacting effects of N levels with Zn or Mn and their mixtures at any concentration on flowering traits varied between the two seasons. Comparison among the different treatments clearly indicated that, fertilization with 4g ammonium nitrate/pot in combination with the mixture of Zn and Mn foliar spray at a concentration of 150 ppm for each resulted in the best mean values for all flowering parameters.

III. Chemical composition of plant tops and flowers:

1.Pigments and total carbohydrates:

Data presented in Tables (4 and 5) show that, increasing N rate from 2 to 4 g NH_4NO_3/plant significantly increased chlorophyll a and b, total carotenoids and total carbohydrates in leaves, and anthocyanin in flowers either at picking time or 5 days later. This trend was similar in both seasons. In this respect, **Yadav *et al.* (1999)** reported that, total leaf chlorophyll in African marigold increases consistently as a result of increasing N-application up to 180 ppm.

Regarding the effect of foliar spray with Zn or Mn and their mixtures, data in Tables (4 and 5) reveal that, Zn and Mn at 150 ppm concentration produced the highest values of chlorophylls (a and b), carotenoids and total carbohydrates in leaves and anthocyanin content of flowers.

Generally, spraying the plants with Zn alone at any concentration gave the best results compared with Mn. 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**). On the other hand, plants treated with the mixtures of Zn and Mn at different concentrations recorded the best values. These results may be attributed to their combined enhancing effect on most metabolic processes such as carbohydrates and chlorophyll formation (**Price *et al.*, 1972**, **Bidwell, 1980** and **Mohr and Schopfer, 1995**). The results are in harmony with findings of **El-Deeb (1999)** on *Philodendron scandens* and **Selim *et al.* (2001)** on *Calendula officinalis* who mentioned that, Zn and Mn increased chlorophylls (a and b) and carotenoids. While **Refaat and Balbaa (2001)** on lemongrass revealed that, Zn and Mn treated-plants showed lower values of total carbohydrates comparable to untreated plants.

The interaction between N-fertilization and Zn or Mn and their mixtures as tabulated in Tables (4 and 5) exhibit that, determinations fluctuated significantly or not. The highest values of chlorophylls a and b, total carotenoids, anthocyanin and total carbohydrates were associated with the treatment 4g ammonium nitrate/plant in combination with foliar spray of the mixture (Zn+Mn) at a concentreation of 150 ppm for each.

2. Nitrogen, phosphorus and potassium:

Data listed in Table (6) indicate that, the percentages of N and P in leaves significantly increased as a result of treating plants with 4 g ammonium nitrate/plant in both seasons. In this respect, **Yadav *et al.* (1999)** reported that, total nitrogen content of African marigold consistently increased with N-application up to 180 ppm. While for K, the highest value of K content was determined in plants treated with 2 g ammonium nitrate/plant.

Foliar spray with zinc and manganese at the concentration of 150 ppm for each increased total nitrogen and potassium concentrations in leaves followed by the mixtures of Zn (150 ppm) with Mn (100 ppm) then Zn (100 ppm) with Mn (150 ppm). Generally, all combinations of Zn and Mn concentrations increased the values of N and K concentrations. These results may be due to the role of Mn as essential in the final step of nitrate reduction to ammonia (**Amberger, 1978**). On the other side, the basic function of Zn in plant is related to its role in the metabolism of proteins (**Price *et al.*, 1972**). It is also necessary for RNA and protein synthesis (**Vallee and Walker, 1976**). The highest percentage of P was determined in plants treated with Mn at 150 or 100 ppm, respectively, followed by the combination of Zn (100 ppm) with Mn (150 ppm) then Zn with Mn at the concentration of 150 ppm for each.

Table 4. Effect of soil N-application and foliar nutrition with Zn and Mn on chlorophylls and carotenoids (in leaves) of amaryllus plants during the two successive seasons 2003/2004 and 2004/2005.

Character	Chlorophyll A (mg/g F. wt.)			Chlorophyll B (mg/g F. wt.)			Carotenoids (mg/g F. wt.)		
Treatment	N_1	N_2	**Mean (B)**	N_1	N_2	**Mean (B)**	N_1	N_2	**Mean (B)**
				2003/2004					
Zn_0+Mn_0	0.64	0.69	**0.67**	0.41	0.44	**0.43**	0.20	0.22	**0.21**
Zn_0+Mn_1	0.67	0.73	**0.70**	0.43	0.47	**0.45**	0.22	0.24	**0.23**
Zn_0+Mn_2	0.73	0.78	**0.76**	0.47	0.52	**0.50**	0.25	0.27	**0.26**
Zn_1+Mn_0	0.71	0.78	**0.75**	0.46	0.50	**0.48**	0.25	0.26	**0.26**
Zn_1+Mn_1	0.76	0.83	**0.80**	0.50	0.55	**0.53**	0.27	0.29	**0.28**
Zn_1+Mn_2	0.82	0.92	**0.87**	0.56	0.60	**0.58**	0.30	0.32	**0.31**
Zn_2+Mn_0	0.81	0.89	**0.85**	0.54	0.59	**0.57**	0.29	0.31	**0.30**
Zn_2+Mn_1	0.87	0.97	**0.92**	0.58	0.63	**0.61**	0.32	0.35	**0.34**
Zn_2+Mn_2	0.90	0.99	**0.95**	0.59	0.65	**0.62**	0.33	0.37	**0.35**
Mean (A)	**0.77**	**0.84**		**0.50**	**0.55**		**0.27**	**0.29**	
LSD$_{(0.05)}$:									
(A)		**0.07**			**0.04**			**0.02**	
(B)		**0.10**			**0.06**			**0.03**	
(A)×(B)		**0.13**			**0.07**			**0.03**	
				2004/2005					
Zn_0+Mn_0	0.60	0.64	**0.62**	0.39	0.42	**0.41**	0.19	0.20	**0.20**
Zn_0+Mn_1	0.63	0.68	**0.66**	0.42	0.45	**0.44**	0.20	0.21	**0.21**
Zn_0+Mn_2	0.70	0.74	**0.72**	0.46	0.50	**0.48**	0.22	0.24	**0.23**
Zn_1+Mn_0	0.67	0.72	**0.70**	0.45	0.48	**0.47**	0.22	0.23	**0.23**
Zn_1+Mn_1	0.75	0.78	**0.77**	0.49	0.53	**0.51**	0.24	0.26	**0.25**
Zn_1+Mn_2	0.81	0.85	**0.83**	0.54	0.58	**0.56**	0.27	0.30	**0.29**
Zn_2+Mn_0	0.79	0.83	**0.81**	0.52	0.57	**0.55**	0.26	0.29	**0.28**
Zn_2+Mn_1	0.86	0.90	**0.88**	0.58	0.62	**0.60**	0.30	0.33	**0.32**
Zn_2+Mn_2	0.88	0.94	**0.91**	0.60	0.65	**0.63**	0.32	0.35	**0.34**
Mean (A)	**0.74**	**0.79**		**0.49**	**0.53**		**0.25**	**0.27**	
LSD$_{(0.05)}$:									
(A)		**0.04**			**0.03**			**0.01**	
(B)		**0.06**			**0.05**			**0.02**	
(A)× (B)		**0.07**			**0.06**			**0.02**	

Zn_0=water (control), Zn_1=100 ppm, and Zn_2=150 ppm.
Mn_0=water (control), Mn_1=100 ppm, and Mn_2=150 ppm.

Table 5. Effect of soil N-application and foliar nutrition with Zn and Mn on anthocyanin (in flowers) and carbohydrates (in leaves) of amaryllus plants during the two successive seasons 2003/2004 and 2004/2005.

Character	Anthocyanin in flowers at cutting time (mg/g F. wt.)			Anthocyanin in flowers after 5 days from cutting time (mg/g F. wt.)			Total carbohydrates (D. wt.%)		
Treatment	N_1	N_2	Mean (B)	N_1	N_2	Mean (B)	N_1	N_2	Mean (B)
				2003/2004					
Zn_0+Mn_0	1.14	1.23	**1.19**	0.59	0.73	**0.66**	15.43	17.05	**16.24**
Zn_0+Mn_1	1.20	1.29	**1.25**	0.64	0.78	**0.71**	16.38	17.98	**17.18**
Zn_0+Mn_2	1.27	1.37	**1.32**	0.67	0.83	**0.75**	17.61	19.47	**18.54**
Zn_1+Mn_0	1.25	1.34	**1.30**	0.68	0.82	**0.75**	17.13	18.89	**18.01**
Zn_1+Mn_1	1.31	1.41	**1.36**	0.71	0.86	**0.79**	18.40	20.51	**19.46**
Zn_1+Mn_2	1.40	1.51	**1.46**	0.77	0.94	**0.86**	19.52	22.60	**21.06**
Zn_2+Mn_0	1.37	1.47	**1.42**	0.75	0.91	**0.83**	19.26	22.00	**20.63**
Zn_2+Mn_1	1.49	1.61	**1.55**	0.83	1.01	**0.92**	20.60	23.84	**22.22**
Zn_2+Mn_2	1.53	1.64	**1.59**	0.86	1.03	**0.95**	20.96	24.46	**22.71**
Mean (A)	**1.33**	**1.43**		**0.72**	**0.88**		**18.37**	**20.76**	
$LSD_{(0.05)}$:									
(A)		**0.06**			**0.11**			**1.10**	
(B)		**0.09**			**0.15**			**1.65**	
(A)×(B)		**0.11**			**0.21**			**2.00**	
				2004/2005					
Zn_0+Mn_0	1.12	1.19	**1.16**	0.58	0.70	**0.64**	14.83	15.89	**15.36**
Zn_0+Mn_1	1.20	1.28	**1.24**	0.64	0.77	**0.71**	15.78	16.68	**16.23**
Zn_0+Mn_2	1.28	1.34	**1.31**	0.68	0.80	**0.74**	17.20	18.20	**17.70**
Zn_1+Mn_0	1.27	1.34	**1.31**	0.69	0.81	**0.75**	16.59	17.79	**17.19**
Zn_1+Mn_1	1.35	1.39	**1.37**	0.73	0.84	**0.79**	18.10	19.19	**18.65**
Zn_1+Mn_2	1.43	1.47	**1.45**	0.79	0.90	**0.85**	19.76	20.60	**20.18**
Zn_2+Mn_0	1.40	1.44	**1.42**	0.77	0.89	**0.83**	19.21	20.26	**19.74**
Zn_2+Mn_1	1.47	1.53	**1.50**	0.82	0.95	**0.89**	20.80	21.72	**21.26**
Zn_2+Mn_2	1.50	1.58	**1.54**	0.84	0.98	**0.91**	21.40	22.46	**21.93**
Mean (A)	**1.34**	**1.40**		**0.73**	**0.85**		**18.19**	**19.20**	
$LSD_{(0.05)}$:									
(A)		**0.05**			**0.09**			**0.95**	
(B)		**0.08**			**0.14**			**1.40**	
(A)×(B)		**0.10**			**0.17**			**1.80**	

Zn_0=water (control), Zn_1=100 ppm, and Zn_2=150 ppm.
Mn_0=water (control), Mn_1=100 ppm, and Mn_2=150 ppm.

Concerning the combined effects of N levels with Zn and Mn on nitrogen accumulation in amaryllus leaves, data presented in Table (6) show that, fertilization with 4 g ammonium nitrate/plant in combination with Zn and Mn at the concentration of 150 ppm for each resulted in the highest accumulation of nitrogen, followed by 4g N-fertilizer/pot+Zn and Mn at the concentrations of 150 and 100 ppm, respectively. Phosphorus accumulation in amaryllus leaves was highest in plants were fertilized with 2 or 4 g ammonium nitrate combined with Mn at 150 ppm/plant, orderly.

Regarding the accumulation of K in leaves of amaryllus, the highest values were achieved when plants were fertilized with 2g NH_4NO_3/pot combined with the mixture of Zn and Mn at 150 ppm for each, followed by 2 g/plant ammonium nitrate plus Zn and Mn at 150 and 100 ppm, orderly. These results were true in both seasons.

3. Zinc, manganese and iron:

a. Zinc:

Data in Table (7) show that, fertilizing plants with the lower N rate (2 g/plant) significantly increased the concentration of Zn in amaryllus leaves than the higher rate (4 g/plant) in both seasons of study.

With regard to the combinal effect of Zn and Mn, data in Table (7) clearly show that, the highest values of the determined Zn in amaryllus plant were recorded in plants sprayed with Zn at the concentration of 150 ppm without Mn followed by the same concentration of Zn (150 ppm) mixed with Mn at the concentration of 100 ppm.

The interaction between N, Zn and Mn show significant effect on Zn concentration in amaryllus plants. Data show that, fertilization with 2 g NH_4NO_3/plant and Zn at the concentration of 150 ppm resulted in significant increase in Zn concentration in plant leaves followed by plants fertilized with 2 g NH_4NO_3/plant and sprayed with Zn and Mn at 150 and 100 ppm, orderly.

b. Manganese:

Data presented in Table (7) clarify that, neither the 2 g ammonium nitrate/plant nor 4 g/plant reflected any effect on Mn concentration in amaryllus leaves in both seasons.

Concerning the effect of Zn and Mn combinations, data clearly show that treating amaryllus plants with only Mn at the higher rate (150 ppm) or with the same concentration of Mn and Zn resulted in the highest concentrations of Mn in amaryllus leaves, orderly in the two seasons of study.

The combinations of N, Zn and Mn (Table, 7) clarify that, the highest Mn accumulation in amaryllus leaves was determined in plants fertilized with 2 or 4 g NH_4NO_3/plant and sprayed with the highest rate of Mn (150 ppm) in both seasons.

c. Iron:

Data presented in Table (7) show that, N-fertilization at 2 g or 4 g NH_4NO_3/plant had no significant effect on the concentration of Fe in amaryllus plant in the both seasons of study.

Foliar spray with Zn at the concentration of 150 ppm alone or mixed with Mn at the concentration of 100 ppm resulted in the highest accumulation of Fe in leaves of amaryllus. These results are in agreement with the findings of **Devlin and Witham (1985)** who mentioned that Zn participates in different physiological functions or processes inside the plant including the processes of mineral uptake by plant roots and translocation inside the plant.

Regarding the combined effect of N-fertilization, Zn and Mn foliar application, tabulated data in Table (7) clearly show that, the highest accumulation of Fe in amaryllus leaves were obtained when plants were fertilized with 2 or 4 g ammonium nitrate/plant and sprayed with Zn at the concentration of 150 ppm in both seasons.

From all the above mentioned results of the present study, it could be concluded that the application of Zn and Mn as foliar sprays at a concentration of 150 ppm for both in combination with soil-N application at the rate 4 g NH_4NO_3/plant produce a good keeping quality (long vase life) of flowering amaryllus plants.

Table 6. Effect of soil N-application and foliar nutrition with Zn and Mn on macroelements (N, P and K) in leaves of amaryllus plants during the two successive seasons 2003/2004 and 2004/2005.

Character		N			P (% D.wt.)			K	
Treatment	N_1	N_2	Mean (B)	N_1	N_2	Mean (B)	N_1	N_2	Mean (B)
2003/2004									
Zn_0+Mn_0	1.96	2.17	**2.07**	0.31	0.32	**0.32**	2.61	2.32	**2.47**
Zn_0+Mn_1	2.06	2.30	**2.18**	0.33	0.34	**0.34**	2.80	2.45	**2.63**
Zn_0+Mn_2	2.18	2.41	**2.30**	0.34	0.35	**0.35**	2.95	2.61	**2.78**
Zn_1+Mn_0	2.12	2.36	**2.24**	0.31	0.31	**0.31**	2.78	2.46	**2.62**
Zn_1+Mn_1	2.22	2.48	**2.35**	0.31	0.32	**0.32**	2.98	2.68	**2.83**
Zn_1+Mn_2	2.34	2.61	**2.48**	0.32	0.33	**0.33**	3.11	2.73	**2.92**
Zn_2+Mn_0	2.30	2.56	**2.43**	0.30	0.31	**0.31**	3.07	2.70	**2.89**
Zn_2+Mn_1	2.39	2.69	**2.54**	0.31	0.31	**0.31**	3.14	2.81	**2.98**
Zn_2+Mn_2	2.50	2.83	**2.67**	0.31	0.32	**0.32**	3.24	2.90	**3.07**
Mean (A)	**2.23**	**2.49**		**0.32**	**0.32**		**2.96**	**2.63**	
$LSD_{(0.05)}$:									
(A)		**0.21**			**N.S.**			**0.20**	
(B)		**0.30**			**0.01**			**0.30**	
(A)×(B)		**0.39**			**0.02**			**0.38**	
2004/2005									
Zn_0+Mn_0	2.01	2.15	**2.08**	0.33	0.34	**0.34**	2.53	2.27	**2.40**
Zn_0+Mn_1	2.12	2.26	**2.19**	0.35	0.36	**0.36**	2.66	2.41	**2.54**
Zn_0+Mn_2	2.25	2.40	**2.33**	0.36	0.37	**0.37**	2.78	2.54	**2.66**
Zn_1+Mn_0	2.18	2.34	**2.26**	0.31	0.32	**0.32**	2.68	2.42	**2.55**
Zn_1+Mn_1	2.29	2.44	**2.37**	0.33	0.34	**0.34**	2.90	2.65	**2.78**
Zn_1+Mn_2	2.41	2.56	**2.49**	0.34	0.35	**0.35**	2.99	2.75	**2.87**
Zn_2+Mn_0	2.35	2.54	**2.45**	0.31	0.32	**0.32**	2.91	2.65	**2.78**
Zn_2+Mn_1	2.47	2.66	**2.57**	0.32	0.33	**0.33**	3.05	2.81	**2.93**
Zn_2+Mn_2	2.60	2.82	**2.71**	0.33	0.34	**0.34**	3.19	2.94	**3.07**
Mean (A)	**2.30**	**2.46**		**0.33**	**0.34**		**2.85**	**2.60**	
$LSD_{(0.05)}$:									
(A)		**0.14**			**0.01**			**0.22**	
(B)		**0.21**			**0.01**			**0.33**	
(A)×(B)		**0.27**			**0.02**			**0.42**	

Zn_0=water (control), Zn_1=100 ppm, and Zn_2=150 ppm.
Mn_0=water (control), Mn_1=100 ppm, and Mn_2=150 ppm.

Table 7. Effect of soil N-application and foliar nutrition with Zn and Mn on microelements (Zn, Mn and Fe) in leaves of amaryllus plants during the two successive seasons 2003/2004 and 2004/2005.

Character	Zn			Mn (µg/g D. wt.)			Fe		
Treatment	N_1	N_2	**Mean (B)**	N_1	N_2	**Mean (B)**	N_1	N_2	**Mean (B)**
				2003/2004					
Zn_0+Mn_0	78.20	71.96	**75.08**	121.46	121.68	**121.57**	210.26	212.00	**211.13**
Zn_0+Mn_1	77.62	71.50	**74.56**	128.63	127.95	**128.29**	210.61	210.96	**210.79**
Zn_0+Mn_2	77.20	70.95	**74.08**	137.48	136.96	**137.22**	208.11	209.03	**208.57**
Zn_1+Mn_0	86.24	77.12	**81.68**	119.98	120.21	**120.10**	214.40	215.16	**214.78**
Zn_1+Mn_1	85.66	76.67	**81.17**	126.02	126.26	**126.14**	210.00	211.85	**210.93**
Zn_1+Mn_2	85.21	76.30	**80.76**	131.99	132.60	**132.30**	209.12	209.88	**209.50**
Zn_2+Mn_0	93.44	83.80	**88.62**	119.10	118.88	**118.99**	219.46	218.99	**219.23**
Zn_2+Mn_1	92.68	83.42	**88.05**	125.62	125.41	**125.52**	216.70	217.00	**216.85**
Zn_2+Mn_2	92.20	82.92	**87.56**	133.56	132.94	**133.25**	213.90	215.04	**214.47**
Mean (A)	**85.38**	**77.18**		**127.09**	**126.99**		**212.51**	**213.32**	
$LSD_{(0.05)}$:									
(A)		**4.20**			**N.S.**			**N.S.**	
(B)		**6.30**			**4.75**			**6.00**	
(A)×(B)		**7.40**			**6.00**			**7.00**	
				2004/2005					
Zn_0+Mn_0	84.98	79.00	**81.99**	118.35	119.00	**118.68**	206.17	203.31	**204.74**
Zn_0+Mn_1	84.10	78.19	**81.15**	126.40	126.69	**126.55**	205.94	201.92	**203.93**
Zn_0+Mn_2	83.72	77.80	**80.76**	135.63	135.18	**135.41**	202.68	200.14	**201.41**
Zn_1+Mn_0	92.18	86.40	**89.29**	117.49	117.81	**117.65**	210.15	206.68	**208.42**
Zn_1+Mn_1	91.89	85.72	**88.81**	124.13	124.69	**124.41**	206.80	203.10	**204.95**
Zn_1+Mn_2	91.28	85.24	**88.26**	130.88	131.28	**131.08**	203.98	201.69	**202.84**
Zn_2+Mn_0	98.60	91.18	**94.89**	116.90	117.24	**117.07**	213.67	210.00	**211.84**
Zn_2+Mn_1	97.89	90.69	**94.29**	125.00	125.43	**125.22**	211.94	207.94	**209.94**
Zn_2+Mn_2	97.14	90.04	**93.59**	132.12	133.00	**132.56**	210.00	206.48	**208.24**
Mean (A)	**91.31**	**84.92**		**125.21**	**125.59**		**207.93**	**204.58**	
$LSD_{(0.05)}$:									
(A)		**4.50**			**N.S.**			**N.S.**	
(B)		**6.70**			**6.15**			**5.70**	
(A)×(B)		**8.00**			**7.20**			**6.60**	

Zn_0=water (control), Zn_1=100 ppm, and Zn_2=150 ppm.
Mn_0=water (control), Mn_1=100 ppm, and Mn_2=150 ppm.

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تأثير التسميد الأرضي بالنيتروجين والرش بكل من الزنك والمنجنيز على نبات الأمريللس

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أجريت تجربة أصص لدراسة تأثير مستويان من النيتروجين (٢ و٤ جرام نترات أمونيوم/نبات) كإضافة أرضية مع ثلاث تركيزات لكل من الزنك والمنجنيز (صفر، ١٠٠، ١٥٠ جزء في المليون) رشاً على المجموع الخضري على النمو الخضري والإزهار والتركيب الكيماوي لنبات الأمريللس.

وقد أوضحت النتائج أن التسميد بنترات الأمونيوم بمعدل ٤ جرام/ نبات أدى إلى زيادة معنوية في كل صفات النمو الخضري حيث زاد كل من ارتفاع النبات، عدد الأوراق على النبات، الوزن الجاف للأوراق والأبصال والنبات الكامل، عدد الأبصال والبصيلات/ نبات، حجم البصلة والوزن الطازج للأبصال. كذلك أدى إلى زيادة معنوية في طول الشمراخ الزهري، عدد الأزهار على الشمراخ الزهري، متوسط الوزن الطازج للحامل الزهري وكذلك فترة بقاء الأزهار في آنية

التنسـيق. كـذلك أدى اسـتعمال ٤ جـرام نتـرات أمونيـوم إلــى زيـادة كـل مـن كلوروفيـل أ وب والكاروتنويدات الكلية والكربوهيدرات كذلك كمية الأنثوسيانين عند القطف وبعد القطف بخمسة أيام. كما أدى التسميد بمعدل ٤ جرام نترات أمونيوم إلى زيادة معنوية في محتوى النبات من النيتروجين والفوسفور بينما أدى التسميد بمعدل ٢ جرام إلى زيادة محتوى النبات من البوتاسيوم والزنك بينما لم يتأثر محتوى النبات من المنجنيز أو الحديد باي من إضافة ٢ أو ٤ جرام.

أدى الرش بمخلوط من الزنك والمنجنيز بتركيز ١٥٠ جزء في المليون لكل منهما إلى زيادة معنوية في كل قياسات الصفات الخضرية السابق ذكرها وكذلك كل الصفات الزهرية التي تم تقديرها. كذلك أدت هذه المعاملة إلى زيادة معنوية في محتوى الأوراق من كلوروفيل أ وب والكاروتنويدات وكذلك الكربوهيدرات الكلية وكذلك زاد محتوى الأزهار من الأنثوسيانين عند القطف وبعد القطف بخمسة أيام وكذلك أدى نفس التركيز (١٥٠ جزء في المليون لكل من الزنك والمنجنيز) إلى زيادة تراكم النيتروجين والبوتاسيوم في الأوراق بينما أدت المعاملة بالمنجنيز فقط بتركيز ١٥٠ جزء في المليون إلى أعلى تركيز للفوسفور بينما قدر أعلى تركيز للحديد في الأوراق من معاملة النباتات رشاً بمخلوط من الزنك والمنجنيز بتركيز ١٥٠ ، ١٠٠ جزء في المليون على الترتيب.

أما عن التأثير المشترك لكل من النيتروجين مع مخلوط الزنك والمنجنيز فقد أظهرت النتائج أن تسميد نبات الأمريللس بمعدل ٤ جرام من نترات الأمونيوم مع الرش بمخلوط الزنك والمنجنيز بتركيز ١٥٠ جزء في المليون لكل منهما أدى إلى أعلى زيادة في كل الصفات الخضرية والزهرية التي تم تقديرها وكذلك ازداد محتوى النباتات من الكلوروفيل أ وب والكاروتنويدات والكربوهيدرات والأنثوسيانين سواء عند القطف أو بعد القطف بخمسة أيام وكذلك زاد محتوى النباتات من النيتروجين والفوسفور بينما سجلت أعلى زيادة معنوية للبوتاسيوم عند استعمال النيتروجين بمعدل ٢ جرام مع الرش بمخلوط الزنك والمنجنيز بتركيز ١٥٠ جزء في المليون لكليهما. بينما قدرت أعلى نسبة مئوية لكل من الحديد والزنك في الأوراق عند تسميد النباتات بـ٢ جرام من نترات الأمونيوم ورشها بالزنك منفرداً بتركيز ١٥٠ جزء في المليون. ***وأخيراً***، لكي نحصل على نباتات أمريللس مزهرة ذات فترة حياة طويلة عند استخدامها كنباتات أصص يجب تسميدها بمعدل ٤جم نيتروجين/ نبات مع الرش الورقي بالزنك والمنجنيز بمعدل ١٥٠ جزء في المليون لكليهما.