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EFFECT OF SOME ORGANIC MANURES AND MICRONUTRIENTS ON THE GROWTH, SEED YIELD AND CHEMICAL CONSTITUENTS OF BORAGE (*BORAGO OFFICINALIS* L.) PLANTS UNDER SANDY SOIL CONDITIONS

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ABSTRACT: **The present study was carried out at the Experimental Farm of Horticultural Research Station, El-Quassasin, Ismailia Governorate, during the two seasons of 2000/2001 and 2001/2002 to study the effect of cattle manure (10 and 20 m^3/fed), chicken manure (5 and 10 m^3/fed) and Zn or Mn (both at 100 ppm) as foliar spraying as well as their interaction on growth, seed yield and some chemical constituents of borage (*Borago officinalis*) plants.**

The obtained data revealed that all levels of organic manures and Zn or Mn application as well as their interactions enhanced the vegetative growth characteristics and seed yield of borage plants. The treatments of chicken manure (10 m^3/fed), Mn (100 ppm) and their combination recorded the highest values with high significant differences in plant height, number of branches/plant, dry weight of aerial part, number of inflorescences/plant, yield of seeds per plant and feddan and percentages and contents of fixed oil, total carbohydrates, N, P and K/plant. The treatments of chicken manure (10 m^3/fed), Mn (100 ppm) and their combination gave highly increases in the content of manganese in plant, while treatments of chicken manure (10 m^3/fed), Zn (100 ppm) and their combination increased the content of zinc in plant during the two seasons.

Key words: Borage plant, cattle and chicken manures, micro-nutrients, seed yield, chemical constituents.

INTRODUCTION

Borage (*Borago officinalis*, L.) plant belongs to Family Boraginaceae. It is herbaceous annual native to the Mediterranean region, North America and Asia minor. Current interest exists in the commercial importance of borage which is a natural source of gamma linolenic acid (GLA), an unusual fatty acid and prostaglandin (Traitler *et al*, 1984 ; Cutting, 1985 and Jorgensen, 1988). Prostaglandin is involved in regulating many metabolic functions in mammalian systems (White *et al*, 1978 and Willis, 1981). It is also a good tonic. In herbal medicine it is used in infusions for urinary infections colds, bronchitis and rheumatic conditions. Externally, it is used in compresses for skin rashes (Stodola and Volak, 1992).

Organic fertilization by using cattle or chicken manure is a practice for providing plants with their nutritional requirements without having an undesirable impact on the environment. Also, organic fertilizers improve the chemical and physical characteristics of the soil. So organic fertilization plays an important role on growth, yield and quality of many crops. In this concern, El-Ghawwas *et al* (2002) on fennel found that, cattle manure caused a significant increase in the fruit yield, El-Sayed *et al* (2002) on spearmint and marjoram showed that, the application of cattle manure recorded a significant increase in fresh and dry weights of leaves, Kandeel and Abou Taleb (2002) on basil showed that, increasing the cattle manure rate led to positive increases in plant height and number of branches per plant as well as fresh and dry weights of herb, Abdou and Mahmoud (2003) found that, chicken and cattle manures produced the highest seed yield and total carbohydrate percentage as well as N, P and K contents of fennel. The differences between control and treatments were significant, Helmy and Zarad (2003) on borage (*Borago officinalis*) mentioned that, the rate of chicken manure at 30 m^3/fed. and cattle manure at 60 m^3/fed. significantly increased the number of inflorescences/plant, herb fresh and dry weights and N, P, K and fixed oil contents, Shaalan (2005) added chicken manure at the levels of 12, 18 and 24 m^3/fed. (before sowing) to *Nigella sativa* plants and found that, treating plants markedly increased plant height, number of branches/plant and number of fruits/plant.

The beneficial effect of Zn and Mn on plant growth is based on improving carbohydrates and

metabolism, enhancement of the plant resistance, improved photosynthesis and involvement in the controls of enzymes and vitamins, as was reported by Devlin (1975). Positive results on growth characters and yield quality were obtained by many researchers. Soliman (1997) showed that, the total carbohydrates content in herb of black cumin plants was increased by application of zinc at the concentration of 50 ppm. Also, the fixed oil content was increased in plants which received zinc if compared with control. He also revealed that, the application of Mn at 50 ppm. produced the highest seed yield per plant, the highest values of Zn and Mn contents/plant and the total carbohydrates content as well as fixed oil content. El-Fiky (1998) found that, spraying *Gerbera jamesonii* plants with Mn at the rates of 30 and 60 ppm increased the minerals content (N, P and K) in leaves. The concentration of 60 ppm gave the highest value if compared with the other level (30 ppm) or the control, Mohamed (1998) on *Nigella sativa* found that, number of capsules was positively affected with zinc application, and using Mn (25 ppm) increased N and K percentages and Abd El-Salam (1999) on fennel plants, found that Mn and Zn treatments (both at 50 and 100 ppm) caused a significant increase in plant height, number of branches and fresh and dry weight of plant organs as well as the heaviest fruits yield per plant.

Therefore, this investigation aimed to study the effect of different organic fertilizers (chicken and cattle manures) and microelements viz., zinc or manganese on the growth, seed yield and chemical composition of borage plants to reveal the suitable treatments for optimizing the seed and fixed oil yield.

MATERIALS AND METHODS

The present work was carried out at the Experimental Farm of El-Quassasian Research Station and the Laboratory of Horticulture Department, Faculty of Agriculture, Zagazig University during the two seasons of 2000/2001 and 2001/2002. This study was designed to study the effect of the interaction between different rates of some organic fertilizers (cattle and chicken manures) and some micronutrients (Zn and Mn) on growth, seed yield and some chemical constituents of *Borago officinalis* plants.

The seeds of borage were obtained from Agriculture Research Center, Medicinal and

Aromatic Plants Section, Dokki, Giza, Egypt. The physical and chemical characteristics of the soil were presented in Table A. The analysis of the soil was conducted using the methods described by Jackson (1967).

The seeds were sown on 21st September and 1st October in the first and second seasons, respectively. The experimental unit area (plot) was 3 X 3.5 meter, containing five rows. The distance between rows was 70 cm. and between plants was 50 cm., every plot contained 30 plants, under drip system irrigation. The experimental design was factorial experiment in split plot with three replicates. The rates of cattle manure and chicken manure represented the main plots, while the Zn and Mn considered as sub plot. There are 15 treatments which were the combinations between five organic manures treatments and three micro-nutrients treatments.

A. Organic manures treatments

1. Control,
2. Cattle manure (C.M.) at the rate of 10 m^3/fed.,
3. Cattle manure (C.M.) at the rate of 20 m^3/fed.,
4. Chicken manure (Ch.M.) at the rate of 5 m^3/fed., and
5. Chicken manure (Ch.M.) at the rate of 10 m^3/fed.

B. Zinc and manganese treatments

1. Control,
2. Zn (100 ppm), and
3. Mn (100 ppm).

Before planting, cattle manure and chicken manure as sources of organic fertilizers were uniformly broadcasted and incorporated into the soil. The chemical properties of the used manures were summarized in Table B.

The used sources of Zn and Mn were zinc sulphate and manganese sulphate, respectively. The plants were treated with the micronutrients as a foliar spray of an aqueous solution, four times at 21 days interval starting 30 days after sowing date. The normal agricultural practices were applied whenever required.

Data recorded

Plant Growth

Five plants were randomly chosen from every plot at two stages of growth (120 and 160 days) from sowing respectively in both seasons.

1. Plant height (cm.)
2. Number of branches per plant
3. Dry weight of the aerial part (gm.).

Table A. The physical and chemical properties of the experimental soil

Sand %	82.0	HCO_3^-	2.50
Silt %	14.0	CL^-	2.00
Clay %	4.0	SO_4^{++}	4.86
Soil texture	**Sandy**	**Macro elements (Mg/100 g soil)**	
Organic matter %	0.42	Nitrogen	1.05
pH	8.1	Phosphorus	1.95
E.C. (mmohs/cm 25 °C 1:5)	0.86	Potassium	4.29
Soluble ions (meq/L)		**Micro elements (ppm.)**	
Ca^{++}	3.74	Fe	2.0
Mg^{++}	1.62	Cu	--
Na^+	3.70	Zn	0.25
K^+	0.30	Mn	0.80

Table B. The physical and chemical analysis of used organic fertilizers.

Fertilizers characteristics	Cattle manure		Chicken manure	
	1st season	2nd season	1st season	2nd season
Weight of m^3/kg (density)	332	430	265	260
Humidity (%)	7.6	8.0	6.9	8.70
C/N ratio (%)	18.3 : 1	19.4 : 1	5.0 : 1	5.1 : 1
Organic matter (%)	45.19	39.46	74.34	36.76
Organic carbon (%)	27.95	22.89	43.12	21.32
Ammonia (mg/kg)	1.172	1.27	910.1	930.1
Nitrate (mg/kg)	917.0	930.1	71.3	75.9
Ash (%)	23.29	60.53	60.12	63.24
Macro elements				
Total nitrogen (%)	1.2	1.18	3.35	4.16
Total phosphorus (%)	0.29	0.68	0.4	0.73
Total potassium (%)	1.75	1.9	2.15	1.896
Micro elements (mg/kg)				
Iron	25346.0	26163.0	8342.3	8548.6
Manganese	349.9	327.8	196.8	212.5
Copper	42.9	43.0	50.1	41.2
Zinc	80.3	79.3	783.8	792.9

Seed Yield

At harvest date of May 15th in both seasons, the following data were recorded:

1. Number of inflorescences per plant
2. The weight of seeds per plant (gm) and feddan (kg)

Chemical Constituents

1. Determination of fixed oil percentage. Fixed oil percentage in dry seed was estimated using soxhlet apparatus according the methods described by A.O.A.C. (1980).
2. The fixed oil content (gm) in seeds of borage plant was calculated by multiplying fixed oil percentage by weight of seeds per plant .
3. Total carbohydrates percentage was carried in seeds out according to Dubois *et al* (1956).
4. Total carbohydrate content (gm) in seeds of borage plant was calculated by multiplying total carbohydrate percentage by weight of seeds per plant.
5. Total nitrogen percentage in seeds was determined according to the method described by Naguib (1969).
6. Total nitrogen content (gm) in seeds of borage plant was calculated by multiplying total nitrogen percentage by weight of seeds per plant .
7. Total Phosphorus percentage in seeds was determined according to the method described by Hucker and Catroux (1980).
8. Total Phosphorus content (gm) in seeds of borage plant was calculated by multiplying total phosphorus percentage by weight of seeds per plant .
9. Potassium percentage was determined in seeds by using flame photometer according to methods described by Brown and Lilleland (1964).
10. Potassium content (gm) in seeds of borage plant was calculated by multiplying potassium percentage by weight of seeds per plant .

The micronutrients Zn and Mn contents were determined in seeds by atomic absorption as described by Chapman and Pratt (1961).

Statistical analysis

The statistical analysis of the present data was carried out according to Snedecor and Cochran (1972), using new L.S.D. at 5 and 1% levels for comparison between means of the different treatments.

RESULTS AND DISCUSSION

Vegetative Growth

Data presented in Tables 1, 2 and 3 show that, vegetative

Table 1. Effect of some organic manures, micronutrients and their interactions on the plant height (cm) of *Borago officinalis* plants, during the two seasons of 2000/ 2001 and 2001/2002

Organic manures (A) \ Micronutrients (B)		Control	Zn (100 ppm)	Mn (100 ppm)	Mean (A)	Control	Zn (100 ppm)	Mn (100 ppm)	Mean (A)
		First season				Second season			
		Flowering stage							
Control		24.6	26.3	30.3	27.1	23.6	24.3	31.3	26.4
Cattle manure	10 m^3/fed	24.6	31.3	39.6	31.9	26.0	34.0	41.6	33.9
	20 m^3/fed	28.6	36.6	44.7	36.6	28.3	36.0	45.0	36.4
Chicken manure	5 m^3/fed	31.6	41.0	46.3	39.7	31.0	40.3	47.3	39.6
	10 m^3/fed	32.3	43.6	48.3	41.4	34.0	45.0	50.0	43.1
Mean (B)		28.4	35.8	41.9		28.6	35.9	43.1	
		A	B	AB		A	B	AB	
L.S.D. at 5%		2.80	5.92	4.85		4.05	9.45	7.02	
L.S.D. at 1%		3.79	9.82	6.57		5.49	15.67	9.51	
		Harvesting stage							
Control		32.3	37.0	39.6	36.3	37.0	39.0	44.6	40.2
Cattle manure	10 m^3/fed	41.0	43.0	45.0	43.2	45.0	47.3	49.3	47.2
	20 m^3/fed	43.6	47.3	49.0	46.7	47.0	51.6	53.6	50.8
Chicken manure	5 m^3/fed	45.3	49.3	53.6	49.4	48.0	52.6	56.0	52.3
	10 m^3/fed	46.3	50.6	57.0	51.3	50.3	54.0	54.0	52.8
Mean (B)		41.7	45.5	49.0		45.5	48.9	51.5	
		A	B	AB		A	B	AB	
L.S.D. at 5%		6.64	4.00	6.93		3.71	4.82	8.35	
L.S.D. at 1%		11.01	5.42	9.70		6.16	6.53	11.32	

growth parameters (plant height, number of branches and dry weight of plant) were increased as the levels of organic manures were increased. The differences between treatments and control were highly significant. The treatment of chicken manure at the rate of 10 m^3/fed. was the most effective treatment followed by 5 m^3/fed. chicken manure in the two stages of growth during both seasons.

Also, spraying borage plants with Zn or Mn at the level of (100 ppm) caused an increase in vegetative growth characters as shown in Tables 1, 2 and 3 . Mn (100ppm) recorded significant differences compared to control in

Table 2. Effect of some organic manures, micronutrients and their interactions on the number of branches/plant of *Borago officinalis* plants, during the two seasons of 2000/2001 and 2001/2002

Organic manures (A) \ Micronutrients (B)		Control	Zn (100 ppm)	Mn (100 ppm)	Mean (A)	Control	Zn (100 ppm)	Mn (100 ppm)	Mean (A)
		First season				Second season			
		Flowering stage							
Control		13.3	15.6	17.0	15.3	15.0	16.3	18.0	16.4
Cattle manure	10 m^3/fed	15.0	16.3	19.3	16.9	15.0	17.6	20.3	17.6
	20 m^3/fed	15.6	18.0	21.3	18.3	17.3	19.0	22.3	19.6
Chicken manure	5 m^3/fed	16.3	19.6	22.6	19.6	18.0	21.3	23.6	21.0
	10 m^3/fed	17.0	20.6	24.6	20.8	19.6	22.3	26.3	22.8
Mean (B)		15.5	18.1	21.0		17.0	19.3	22.1	
		A	B	AB		A	B	AB	
L.S.D. at 5%		4.62	2.93	5.07		4.17	3.03	5.24	
L.S.D. at 1%		7.66	3.97	6.88		6.92	4.10	7.11	
		Harvesting stage							
Control		20.3	20.6	21.6	20.9	21.0	21.6	22.0	21.6
Cattle manure	10 m^3/fed	21.3	22.6	23.6	22.6	22.6	24.0	24.6	23.8
	20 m^3/fed	22.3	24.0	26.3	24.2	23.6	26.3	28.3	26.1
Chicken manure	5 m^3/fed	23.6	24.6	27.3	25.2	25.6	27.0	29.6	27.4
	10 m^3/fed	24.0	25.6	30.3	26.7	26.3	27.6	31.3	28.4
Mean (B)		22.3	23.5	25.8		24.5	26.2	28.5	
		A	B	AB		A	B	AB	
L.S.D. at 5%		1.02	3.13	5.43		2.20	2.50	4.34	
L.S.D. at 1%		1.38	4.25	7.36		3.65	3.39	5.88	

this concern during the two stages in both seasons.

As for the interaction between organic fertilizers and micronutrients, data in the same Tables show a slight increase in vegetative growth parameters for treated plants compared with control. The combined treatment of 10 m^3/fed chicken manure +100 ppm Mn gave highly significant increase in vegetative growth followed by the treatment of 5 m^3/fed chicken manure with Mn at 100 ppm and 20 m^3/fed. cattle manure with Mn at 100 ppm.

Table 3. Effect of some organic manures, micronutrients and their interactions on the dry weight (gm) of *Borago officinalis* plant, during the two seasons of 2000/2001 and 2001/2002

Organic manures (A) \ Micronutrients (B)		Control	Zn (100 ppm)	Mn (100 ppm)	Mean (A)	Control	Zn (100 ppm)	Mn (100 ppm)	Mean (A)
		First season				Second season			
		Flowering stage							
Control		47.2	48.1	56.2	50.5	42.1	49.5	59.1	50.2
Cattle manure	10 m^3/fed	49.7	57.2	67.2	58.1	51.3	56.7	73.2	60.4
	20 m^3/fed	55.4	63.7	79.1	66.1	57.1	65.2	86.1	69.5
Chicken manure	5 m^3/fed	56.1	68.1	83.2	69.1	62.7	73.1	92.3	76.0
	10 m^3/fed	69.5	79.2	96.1	81.6	71.1	87.2	94.1	84.1
Mean (B)		55.6	63.3	76.4		56.9	66.3	80.9	
		A	B	AB		A	B	AB	
L.S.D. at 5%		3.53	3.30	5.72		2.61	1.25	2.17	
L.S.D. at 1%		5.86	4.48	7.76		4.33	1.70	2.94	
		Harvesting stage							
Control		72.1	78.9	91.1	80.7	82.1	91.7	93.2	89.0
Cattle manure	10 m^3/fed	79.2	89.2	97.4	88.6	86.2	94.1	95.1	91.8
	20 m^3/fed	86.1	94.6	119.2	99.9	91.1	98.2	125.2	105.9
Chicken manure	5 m^3/fed	89.3	101.3	123.1	104.6	93.2	114.1	131.7	113.0
	10 m^3/fed	100.2	111.2	141.2	117.5	110.1	119.2	139.1	122.8
Mean (B)		85.4	95.0	114.4		93.2	103.5	116.9	
		A	B	AB		A	B	AB	
L.S.D. at 5%		0.72	0.93	1.62		1.96	2.03	3.10	
L.S.D. at 1%		1.20	1.26	2.19		2.66	3.37	4.61	

These results are in line with those obtained by Abd El-Salam (1999) on fennel and Kandeel and Abou Taleb (2002) on basil.

Number of Inflorescences / Plant

Data dealing with the effect of levels of organic manures on number of inflorescences/plant in both seasons are shown in Table 4. It is evident that, the treatments of cattle manure (20 m^3/fed) and chicken manure (5 m^3/fed) caused highly significant increases if compared with control.

Results in Table 4 show that, Mn application recorded highly significant increase in the number of inflorescences / plant if compared with the control in both seasons. While Zn (100 ppm) treatment gave significant increase in this character compared to control in the first season. In the same time, the differences between Mn and Zn were significant in the two seasons.

The results presented in Table 4 show that, all levels of organic fertilizers combined with Mn at 100 ppm gave highly significant increases on number of inflorescences / plant compared with unfertilized plants in both seasons. In the same trend, all levels of chicken and cattle manure which interacted with Zn (100 ppm) recorded highly significant increases on the same character except for the treatment of 10 m^3/fed cattle manure with Zn (100 ppm) which recorded non-significant effect in the two seasons. The highest number of inflorescences / plant was noticed from the combined treatment of chicken manure (10 m^3/fed) with Mn (100 ppm) followed by chicken manure (5 m^3/fed) with Mn (100 ppm). These results are in agreement with those of Helmy and Zarad (2003) on borage plants.

Seed Yield

The obtained data in Table 5 show that in both seasons the maximum seed weight/plant was obtained from the treatment of chicken manure (10 m^3/fed) which gave highly significant increase when compared to control in both seasons. These increments were 49.0 and 39.4 % for the first and second season, respectively, over the control. The treatment of 20 m^3/fed. cattle manure caused significant and highly significant increases in the first and second seasons, respectively. It recorded increases by more than 30.3 and 34.3 %, respectively, over the control.

In the same Table, data indicate that, all organic manures levels used enhanced the seed yield/fed. in both seasons, always behave similar trend as in seed yield per plant.

Regarding the effect of Zn or Mn on the seed weight/plant, data in Table 5 clearly indicate that, all treatments had highly significant increases in the two seasons. The treatment of Mn (100 ppm) was the most effective one in both seasons. The increases in seed weight/plant affected by Mn (100 ppm) were 22.1 and 35.9 % over the control, in the first and second seasons, respectively. While, the increments from the treatment of

Table 4. Effect of some organic manures, micronutrients and their interactions on the number of inflorescences/plant of *Borago officinalis* plants, during the two seasons of 2000/2001 and 2001/2002

Organic manures (A) \ Micronutrients (B)		Control	Zn (100 ppm)	Mn (100 ppm)	Mean (A)	Control	Zn (100 ppm)	Mn (100 ppm)	Mean (A)
		First season				Second season			
Control		14.3	15.7	16.3	15.3	15.1	16.7	18.9	16.9
Cattle manure	10 m^3/fed	15.8	17.8	21.5	18.4	16.8	16.7	22.7	17.9
	20 m^3/fed	17.2	21.5	24.3	21.0	17.9	21.6	25.1	21.5
Chicken manure	5 m^3/fed	18.7	23.2	26.7	22.9	19.2	24.5	27.2	23.6
	10 m^3/fed	19.8	23.8	29.1	24.2	20.4	26.7	30.1	25.7
Mean (B)		17.2	20.4	23.6		17.9	21.2	24.8	
		A	B	AB		A	B	AB	
L.S.D. at 5%		3.62	2.65	4.60		2.10	2.52	4.38	
L.S.D. at 1%		4.58	3.59	6.23		3.49	3.42	5.93	

Zn (100 ppm) were 13.7 and 12.1 % over the untreated ones, in the 1st and 2nd seasons, respectively.

Results concerning the effect of micronutrients on seed yield/fed are shown in Table 5. The data reveal that, micronutrients treatments gave highly significant increases in seed yield/fed. compared with the control. The most pronounced effect was that of using Mn (100ppm) followed by Zn (100ppm). Both treatments increased seed yield/ fed. by more than 22.1 and 12.8 % respectively, in the first season, while in the second one they were 37.5 and 13.1 % respectively, over the control.

Data in Table 5 denote that, the interaction treatments led to an increase in the seed weight/plant. These increases were highly significant in both seasons. The highest results were obtained from the combined treatment of chicken manure (10 m^3/fed) with Mn (100 ppm) followed by chicken manure (5 m^3/fed) with Mn (100 ppm) in the two seasons. The increments in the seed weight /plant as affected by the treatments of chicken manure (10 m^3/fed) with Mn (100 ppm) and chicken manure (5 m^3/fed) with Mn (100 ppm)

Table 5. Effect of some organic manures, micronutrients and their interactions on seed yield/plant (gm) and per feddan (kg) of *Borago officinalis* plants, during the two seasons of 2000/2001 and 2001/2002

Organic manures (A) \ Micronutrients (B)		Control	Zn (100 ppm)	Mn (100 ppm)	Mean (A)	Control	Zn (100 ppm)	Mn (100 ppm)	Mean (A)
		First season				Second season			
		Seed yield (gm) / plant							
Control		16.2	20.2	22.1	19.8	18.7	20.1	26.1	21.6
Cattle manure	10 m^3/fed	21.6	22.1	26.1	23.3	22.6	24.2	29.2	25.3
	20 m^3/fed	23.7	27.1	28.1	25.8	24.1	28.1	34.1	28.8
Chicken manure	5 m^3/fed	25.2	28.9	31.1	28.1	24.9	28.1	34.1	29.0
	10 m^3/fed	26.7	30.1	31.7	29.5	25.1	29.9	35.2	30.1
Mean (B)		22.6	25.37	27.6		23.1	25.9	31.4	
		A	B	AB		A	B	AB	
L.S.D. at 5%		5.90	1.97	3.41		1.99	1.53	2.65	
L.S.D. at 1%		8.54	2.67	4.62		3.31	2.08	3.60	
		Seed yield (kg)/fed.							
Control		194.4	242.4	265.5	234.1	224.4	241.2	313.2	259.6
Cattle manure	10 m^3/fed	258.9	265.5	313.5	279.3	271.2	290.4	350.7	304.1
	20 m^3/fed	285.1	325.9	337.5	316.1	289.5	337.5	408.9	345.3
Chicken manure	5 m^3/fed	309.4	347.1	373.2	343.2	298.8	337.5	409.9	348.7
	10 m^3/fed	320.4	361.5	380.7	354.2	301.2	359.1	421.5	360.6
Mean (B)		273.6	308.5	334.1		277.0	313.2	380.8	
		A	B	AB		A	B	AB	
L.S.D. at 5%		4.81	2.42	5.41		0.68	0.59	1.32	
L.S.D. at 1%		7.98	3.30	7.38		0.99	0.80	1.80	

in the first season were 95.7 and 92.0 %. respectively over the control, while in the second one they were 88.2 and 82.4%, respectively over the untreated plants.

Similar findings were obtained by Abd El-Salam (1999) and El-Ghawwas *et al* (2002) on fennel plants.

As for seed yield/fed., the obtained data from Table 5

demonstrate that, all combined treatments had highly significant increases in both seasons. The superior treatment was 10 m^3/fed of chicken manure combined with Mn (100ppm) followed by chicken manure (5 m^3/fed) with Mn (100 ppm) during the two seasons. The seed yield/fed. in the first season was increased by more than 95.8 and 92.0 % for chicken manure (10 m^3/fed) with Mn (100 ppm) and (5 m^3/fed) of chicken manure with Mn (100 ppm) respectively as compared to untreated plants. While, the increases in the second season were 87.8 and 82.7 % for the same treatments, respectively if compared with control.

Chemical Constituents

Fixed oil

Data in Table 6 show that the percentage of fixed oil in dry seeds was increased with all used levels of organic manures. The largest value was obtained from the treatment of chicken manure (10 m^3/fed) during the two seasons. The data shown in Table 7 and illustrated in Fig. 1 indicate that, the chicken manure (10 m^3/fed) gave the highest yield of fixed oil in both seasons. This treatment gave 9.05 and 9.02 gm fixed oil/plant in the first and second seasons, respectively, while control gave 5.46 and 5.93 gm in 1st and 2nd seasons, respectively.

It is evident from Table 6 that, the percentage of fixed oil in borage seeds was slightly increased by using micronutrients (Zn or Mn) when compared to control. The highest percentage was obtained from the treatment of Mn (100 ppm). The obtained data in Table 6 and Fig. 1 show highly significant increases in the amount of fixed oil in seeds per plant in both seasons. Maximum values were obtained after spraying with Mn (100 ppm) followed by Zn (100 ppm) during the two seasons. There was significant difference between Mn and Zn in both seasons. The treatment of Mn (100 ppm) gave 8.92 and 9.96 gm fixed oil/plant in the 1st and 2nd seasons, respectively.

Regarding the interaction treatments, the data in Table 6 indicate that, all combined treatments markedly increased the percentage of fixed oil in seeds when compared to control in both seasons. In respect to fixed oil content per plant, the data in the same Table and Fig. 1 indicate that, all the interaction treatments induced highly significant increases if compared to the untreated plants in both seasons.

The highest fixed oil content per plant was produced from plants treated with chicken manure (10m^3/fed) combined with Mn

Table 6. Effect of some organic manures, micronutrients and their interactions on fixed oil percentage and content/plant of *Borago officinalis* plants, during the two seasons of 2000/2001 and 2001/2002

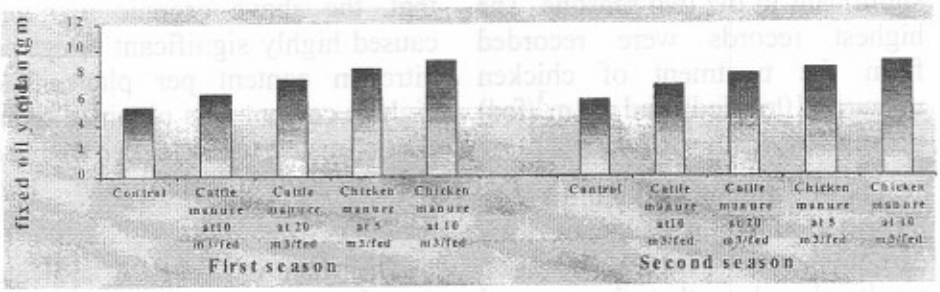
Organic manures (A) \ Micronutrients (B)		Control	Zn (100 ppm)	Mn (100 ppm)	Mean (A)	Control	Zn (100 ppm)	Mn (100 ppm)	Mean (A)
		First season				Second season			
		Fixed oil percentage							
Control		22.62	28.40	31.64	27.55	23.30	27.18	30.64	27.04
Cattle manure	10 m^3/fed	23.15	28.94	31.82	27.97	23.82	28.32	31.21	27.78
	20 m^3/fed	25.30	29.26	31.96	28.84	24.16	28.93	31.92	28.33
Chicken manure	5 m^3/fed	26.24	30.85	32.13	29.74	25.62	29.64	32.12	29.12
	10 m^3/fed	27.80	31.24	32.62	30.55	26.34	30.32	32.42	29.69
Mean (B)		25.02	29.73	32.03		24.64	28.87	31.66	
		Fixed oil content (gm)/plant							
Control		3.66	5.73	6.99	5.46	4.35	5.46	7.99	5.93
Cattle manure	10 m^3/fed	4.89	6.39	8.30	6.52	5.38	6.85	9.11	7.11
	20 m^3/fed	5.99	7.92	8.98	7.63	5.82	7.98	10.34	8.04
Chicken manure	5 m^3/fed	6.61	8.91	9.99	8.50	6.17	8.32	10.95	8.48
	10 m^3/fed	7.42	9.40	10.34	9.05	6.61	9.06	11.41	9.02
Mean (B)		5.71	7.67	8.92		5.66	7.57	9.96	
		A	B	AB		A	B	AB	
L.S.D. at 5%		0.923	0.715	1.599		0.876	0.678	1.519	
L.S.D. at 1%		1.210	0.938	2.097		1.149	0.889	1.990	

(100 ppm), which gave 10.34 and 11.41 gm fixed oil/plant in first and second seasons, respectively. There were non significant differences between chicken manure (10 m^3/fed) with Mn (100 ppm) and cattle manure (20 m^3/fed) with Mn (100 ppm) in both seasons.

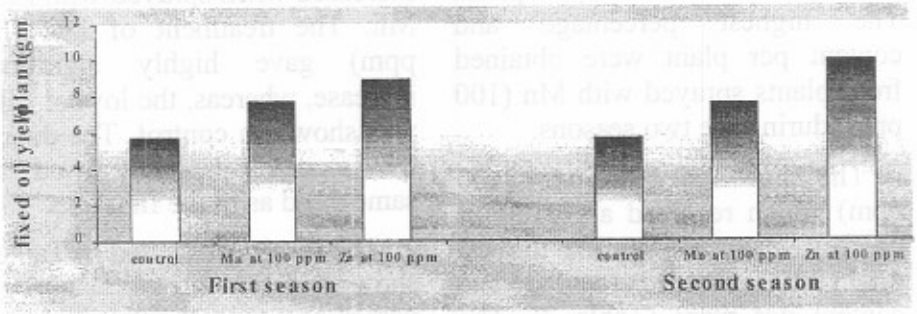
Similar findings were observed by Soliman (1997) on black cumin and Helmy and Zarad (2003) on borage plants.

Total carbohydrates

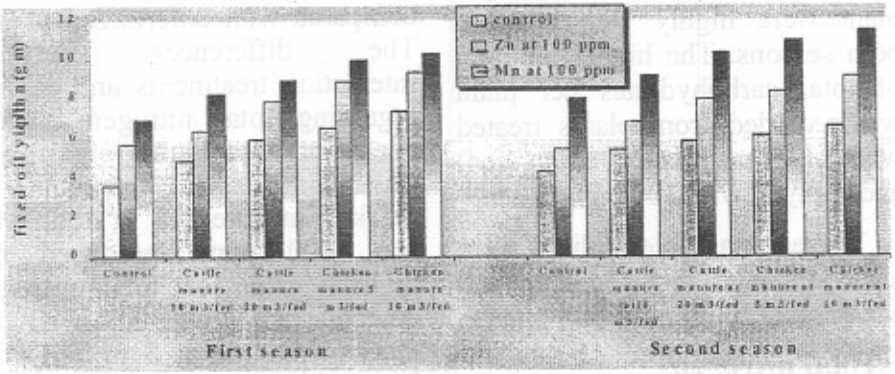
Regarding the total carbohydrates percentage and content in seeds per plant, the data in Table 7 show that, all treatments of organic manures caused increases over the control. The differences between the treatments and control in carbohydrates



Cattle and chicken manures



Micronutrients (Zn and Mn)



The interaction

Fig. 1. Effect of some organic manures, micronutrients and their interactions on fixed oil yield/plant (gm) of *Borago officinalis* plants, during the two seasons of 2000/2001 and 2001/2002

content per plant were highly significant in the two seasons. The highest records were recorded from the treatment of chicken manure ($10m^3$/fed) and (5 m^3/fed) in both seasons.

The treatments of Zn or Mn increased the percentage of total carbohydrates (Table 7). The results also show that, they caused highly significant effects on carbohydrates content per plant. The highest percentage and content per plant were obtained from plants sprayed with Mn (100 ppm) during the two seasons.

The treatments of Mn (100 ppm) which received all levels of chicken manure gave the highest total carbohydrates percentage and content per plant (Table 7). The effects of all interaction treatments on total carbohydrates content per plant were highly significant in both seasons. The highest content of total carbohydrates per plant was recorded from plants treated with chicken manure ($10m^3$/fed) and sprayed with 100 ppm of Mn.

These remarkable findings were also obtained by Abdou and Mahmoud (2003) on fennel plants

Total nitrogen

It is evident from Table 8 that, total nitrogen as percentage and content per plant were increased by using chicken or cattle manures. The results also show that, the above organic manures caused highly significant effect on nitrogen content per plant. The highest content was obtained from plants treated with chicken manure (10 m^3/fed) during the two seasons.

The data in Table 8 indicate that, the percentage and content of nitrogen in borage plants were increased when sprayed with Zn or Mn. The treatment of Mn (100 ppm) gave highly significant increase, whereas, the lowest value was shown in control. The data in the second season showed the same trend as in the first one.

The results presented in Table 8 show that, total nitrogen percentage was slightly increased in the treated plants with interaction treatments when compared with unfertilized plants. The differences between interaction treatments and control regarding total nitrogen content per plant were highly significant. The combination treatment of chicken manure (10 m^3/fed) with Mn (100 ppm) produced the highest value of total nitrogen content per plant followed by chicken manure at 5 m^3/fed with Mn (100 ppm) during the two seasons.

These results are in agreement with those of Abdou and Mahmoud (2003) on fennel.

Table 7. Effect some of organic manures, micronutrients and their interactions on total carbohydrates percentage and content (gm) / plant of *Borago officinalis* plants, during the two seasons of 2000/2001 and 2001/2002

Organic manures (A) \ Micronutrients (B)		Control	Zn (100 ppm)	Mn (100 ppm)	Mean (A)	Control	Zn (100 ppm)	Mn (100 ppm)	Mean (A)
		First season				Second season			
		Total carbohydrates percentage							
Control		18.03	18.92	20.33	18.96	18.12	19.44	21.05	19.53
Cattle manure	10 m^3/fed	18.52	20.72	23.44	20.89	18.74	20.63	22.91	20.76
	20 m^3/fed	19.91	21.42	23.84	21.72	20.25	22.07	24.35	22.22
Chicken manure	5 m^3/fed	21.62	23.49	24.33	23.14	22.22	23.56	25.19	23.65
	10 m^3/fed	23.26	24.70	26.15	24.70	23.74	24.12	27.63	25.16
Mean (B)		20.26	21.77	23.61		20.61	21.96	24.22	
		Total carbohydrates content (gm /plant)							
Control		2.92	3.74	4.49	3.72	3.38	3.90	5.49	4.26
Cattle manure	10 m^3/fed	4.00	4.57	6.11	4.89	4.23	4.99	6.68	5.30
	20 m^3/fed	4.71	5.80	6.69	5.73	4.88	6.09	7.88	6.28
Chicken manure	5 m^3/fed	5.44	6.78	7.56	6.59	5.53	6.62	8.58	6.91
	10 m^3/fed	6.21	7.43	8.28	7.31	5.95	7.21	9.72	7.63
Mean (B)		4.66	5.66	6.63		4.8	5.76	7.67	
		A	B	AB		A	B	AB	
L.S.D. at 5%		0.610	0.472	1.056		0.698	0.541	1.207	
L.S.D. at 1%		0.799	0.619	1.385		0.915	0.709	1.583	

Total phosphorus

The data given in Table 9 indicate that, total phosphorus content in seeds as percentage and amount per plant were increased due to using both chicken and cattle manure at all levels. The treatment of 10 m^3/fed. chicken manure gave the highest value, whereas, the lowest one was shown with the control. This treatment gave highly significant increase in total phosphorus content / plant comparing to control, in both seasons.

Table 8. Effect of some organic manures, micronutrients and their interactions on total nitrogen of *Borago officinalis* plants, during the two seasons of 2000/2001 and 2001/2002

Organic manures (A) \ Micronutrients (B)		Control	Zn (100 ppm)	Mn (100 ppm)	Mean (A)	Control	Zn (100 ppm)	Mn (100 ppm)	Mean (A)
		First season				Second season			
		Nitrogen percentage							
Control		1.95	2.25	2.58	2.26	2.18	2.31	2.81	2.43
Cattle manure	10 m^3/fed	2.50	3.00	3.30	2.93	2.66	2.88	3.40	2.98
	20 m^3/fed	2.96	3.22	3.50	3.22	3.12	3.31	3.66	3.36
Chicken manure	5 m^3/fed	3.03	3.43	3.37	3.27	3.22	3.50	4.12	3.61
	10 m^3/fed	3.30	3.75	3.75	3.60	3.32	3.72	4.25	3.67
Mean (B)		2.75	3.13	3.30		2.90	3.14	3.65	
		Nitrogen content (gm /plant)							
Control		0.312	0.454	0.570	0.445	0.407	0.563	0.733	0.367
Cattle manure	10 m^3/fed	0.540	0.663	0.861	0.688	0.601	0.696	0.992	0.763
	20 m^3/fed	0.701	0.872	0.983	0.852	0.751	0.913	1.180	0.948
Chicken manure	5 m^3/fed	0.763	0.991	1.160	0.971	0.801	1.040	1.400	1.080
	10 m^3/fed	0.881	1.120	1.380	1.120	0.833	1.040	1.490	1.120
Mean (B)		0.639	0.820	0.990		0.679	0.850	1.159	
		A	B	AB		A	B	AB	
L.S.D. at 5%		0.0725	0.0548	0.1234		0.0862	0.0666	0.1489	
L.S.D. at 1%		0.0950	0.0719	0.1619		0.1130	0.0873	0.1953	

The results presented in Table 9 revealed that, Zn and Mn spraying markedly increased phosphorus percentage and amount per plant. The highest content per plant of phosphorus was obtained from Mn (100 ppm). Statical analysis showed non significant differences between this treatment and control in the first season, while it recorded significant increase in the second one.

Data in Table 9 clearly indicate that, total phosphorus percentage and content in seeds per plant were increased due to both organic manures levels and when combined with Mn or Zn. In the same time, the highest rate of chicken manure with Mn (100 ppm) gave the highest value of total phosphorus content per plant. The differences between treatments and control were significant in the first season,

Table 9. Effect of some organic manures, micronutrients and their interactions on phosphorus content (gm)/plant of *Borago officinalis* plants, during the two seasons of 1999/2000 and 2000/2001

Organic manures (A) \ Micronutrients (B)		Control	Zn (100 ppm)	Mn (100 ppm)	Mean (A)	Control	Zn (100 ppm)	Mn (100 ppm)	Mean (A)
		First season				Second season			
		Phosphorus percentage							
Control		0.216	0.357	0.375	0.316	0.280	0.337	0.366	0.327
Cattle manure	0 m^3/fe	0.357	0.400	0.410	0.389	0.366	0.412	0.475	0.417
	0 m^3/fe	0.561	0.650	0.661	0.642	0.515	0.628	0.675	0.606
Chicken manure	5 m^3/fed	0.636	0.750	0.767	0.717	0.640	0.741	0.780	0.720
	0 m^3/fe	0.630	0.775	0.861	0.772	0.757	0.766	0.916	0.813
Mean (B)		0.499	0.586	0.612		0.511	0.576	0.642	
		Phosphorus content (gm)/plant							
Control		0.0349	0.0721	0.0828	0.0632	0.0523	0.0677	0.0955	0.0718
Cattle manure	0 m^3/fe	0.0771	0.0884	0.1070	0.0908	0.0827	0.0997	0.1387	0.1073
	0 m^3/fe	0.1329	0.1761	0.1857	0.1649	0.1241	0.1733	0.2187	0.1720
Chicken manure	5 m^3/fed	0.1602	0.2167	0.2385	0.2051	0.1593	0.2082	0.2659	0.2111
	0 m^3/fe	0.1915	0.2332	0.2729	0.2325	0.1900	0.2290	0.3220	0.2470
Mean (B)		0.1193	0.1573	0.1773		0.1215	0.1555	0.2080	
		A	B	AB		A	B	AB	
L.S.D. at 5%		0.1097	NS	0.1822		0.0921	0.0705	0.1626	
L.S.D. at 1%		0.1439	NS	------		0.1207	------	0.2133	

while in the second season, they were highly significant.

These results are in harmony with those obtained by Helmy and Zarad (2003) on borage plants.

Total potassium content per plant

The data given in Table 10 show that, all levels of chicken manure and cattle manure caused increases in potassium percentage and gave highly significant increases in potassium content in seeds per plant. The highest potassium percentage and content per plant were produced from plants treated with 10 m^3/fed chicken manure during both seasons.

It is evident from the results in Table 10 that, both Zn or Mn treatments gave the highest potassium percentage and content

Table 10. Effect of some organic manures, micronutrients and their interactions on potassium content (gm)/plant of *Borago officinalis* plants, during the two seasons of 2000/2001 and 2001/2002

Organic manures (A) \ Micronutrients (B)		Control	Zn (100 ppm)	Mn (100 ppm)	Mean (A)	Control	Zn (100 ppm)	Mn (100 ppm)	Mean (A)
		First season				Second season			
		Potassium percentage							
Control		2.02	2.15	2.64	2.21	2.25	2.31	2.54	2.37
Cattle manure	10 m^3/fed	2.38	2.51	2.75	2.54	2.44	2.63	2.90	2.65
	20 m^3/fed	2.64	3.10	3.25	2.99	2.75	3.00	3.44	3.06
Chicken manure	5 m^3/fed	2.80	3.17	3.37	3.11	2.90	3.24	3.51	3.22
	10 m^3/fed	3.10	3.24	3.68	3.34	3.17	3.44	3.64	3.42
Mean (B)		2.58	2.83	3.13		2.70	2.92	3.21	
		Potassium content (gm /plant)							
Control		0.327	0.494	0.583	0.468	0.420	0.464	0.662	0.515
Cattle manure	10 m^3/fed	0.514	0.554	0.717	0.595	0.551	0.636	0.846	0.677
	20 m^3/fed	0.625	0.840	0.913	0.792	0.662	0.828	1.110	0.866
Chicken manure	5 m^3/fed	0.705	0.916	1.040	0.887	0.722	0.910	1.190	0.940
	10 m^3/fed	0.827	0.975	1.160	0.987	0.795	1.020	1.280	1.031
Mean (B)		0.599	0.755	0.882		0.630	0.771	1.010	
		A	B	AB		A	B	AB	
L.S.D. at 5%		0.0196	0.0156	0.0333		0.0294	0.0235	0.0509	
L.S.D. at 1%		0.0257	0.0205	0.0436		0.0385	0.0308	0.0668	

per plant with highly significant differences if compared with control. In the same time, the treatment of Mn (100 ppm) recorded the highest results in this concern in both seasons.

The data obtained in Table 10 indicate that, potassium percentage was increased with all interaction treatments between both organic manures and Zn or Mn. All combination treatments caused highly significant increases in potassium content per plant in both seasons. The treatment of chicken manure (10 m^3/fed) with Mn (100 ppm) gave the highest result of potassium content per plant followed by chicken manure (5 m^3/fed) with Mn (100 ppm) and cattle manure (20 m^3/fed) with Mn

Table 11. Effect of some organic manures, micronutrients and their interactions on manganese and zinc contents (ppm) of *Borago officinalis* plants, during the two seasons of 2000/2001 and 2001/2002

Organic manures (A) \ Micronutrients (B)		Control	Zn (100 ppm)	Mn (100 ppm)	Mean (A)	Control	Zn (100 ppm)	Mn (100 ppm)	Mean (A)
		First season				Second season			
		Manganese (ppm.)							
Control		38.00	42.00	49.00	43.00	40.00	45.00	50.00	45.00
Cattle manure	10 m^3/fed	41.00	44.00	51.00	45.33	43.00	47.00	52.00	47.33
	20 m^3/fed	44.00	48.00	54.00	48.66	47.00	50.00	56.00	51.00
Chicken manure	5 m^3/fed	48.00	51.00	57.00	52.00	49.00	53.00	59.00	53.66
	10 m^3/fed	50.00	55.00	61.00	55.33	51.00	54.00	62.00	55.66
Mean (B)		44.20	48.00	54.40		46.00	49.80	55.80	
		Zinc (ppm.)							
Control		24.00	37.00	28.00	29.66	25.00	39.00	33.00	32.33
Cattle manure	10 m^3/fed	28.00	40.00	34.00	34.00	31.00	42.00	38.00	37.00
	20 m^3/fed	35.00	45.00	39.00	39.66	32.00	48.00	41.00	40.33
Chicken manure	5 m^3/fed	37.00	50.00	40.00	42.33	39.00	52.00	42.00	44.33
	10 m^3/fed	42.00	54.00	43.00	46.33	40.00	56.00	46.00	47.33
Mean (B)		33.20	45.20	36.80		33.40	47.40	40.00	

(100 ppm) during the two seasons. Similar results were attained by El-Fiky (1998) on gerbera plants.

Manganese and zinc contents

The results presented in Table 11 show the effect of both organic manures, Zn, Mn and their interactions on manganese content. The treatment of chicken manure (10 m^3/fed) gave the highest values in both seasons. On the other hand, Mn (100 ppm) treatment recorded high results in this respect. Concerning the interaction treatments, the data reveal that the highest content of manganese were obtained from the treatment of chicken manure (10 m^3/fed) with Mn (100 ppm.) followed by chicken manure (5 m^3/fed) with Mn (100 ppm) in both seasons.

The results of zinc content in leaves as affected by both organic manures, Zn, Mn and their combinations in both seasons are given in Table 11. It is evident that, the highest values were observed from the treatments of chicken manure (10 m^3/fed) and Zn (100 ppm). In the same time,

the highest percentage of zinc was produced from plants fertilized with chicken manure (10 m^3/fed) and sprayed with Zn (100 ppm) followed by chicken manure at 5 m^3/fed. with Zn at 100 ppm and cattle manure at 20 m^3/fed combined with Zn at 100 ppm. in both seasons.

These results are in agreement with those obtained by Abd El-Salam (1999) on fennel plants.

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تأثير بعض الأسمدة العضوية و العناصر الصغرى على النمو ومحصول البذور والمكونات الكيميائية فى نباتات خبز النحل تحت ظروف الأراضى الرملية

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هذه الدراسة أجريت فى المزرعة البحثية لمحطة بحوث البساتين بالقصاصين بمحافظة الإسماعيلية خلال موسمى ٢٠٠٠/٢٠٠١ و ٢٠٠١/٢٠٠٢ لدراسة تأثير سماد المواشى (١٠ ، ٢٠ م^3/ف) وسماد الدواجن (٥ ، ١٠ م^3/ف) والزنك والمنجنيز (كل منهما ١٠٠ جزء فى المليون) كرش ورقى ، والتفاعل بينهم على النمو، ومحصول البذور، وبعض المكونات الكيميائية فى نباتات خبز النحل.

وقد أفادت النتائج المتحصل عليها بأن كل مستويات الأسمدة العضوية واستعمال الزنك أو المنجنيز والتفاعل بينهم أدت إلى زيادة فى صفات النمو الخضرى، ومحصول البذور لنبات خبز النحل، وقد أعطت معاملات سماد الدواجن (١٠ م^3/ف) والمنجنيز (١٠٠ جزء فى المليون) والتفاعل بينهما أعلى القيم وبفروق معنوية جداً فى كل من طول النبات، وعدد الأفرع/نبات، والوزن الجاف للنبات ، وعدد النورات/نبات ، ومحصول البذور/نبات وللفدان ، ونسبة ومحتوى النبات لكل من الكربوهيدرات ، والزيت الثابت ، والنيتروجين ، والفوسفور، والبوتاسيوم/نبات .وقد تبين أن معاملات سماد الدواجن (١٠ م^3/ف) والمنجنيز (١٠٠ جزء فى المليون) والتفاعل بينهما أعطت زيادة عالية فى محتوى المنجنيز بالنبات، بينما أعطت معاملات سماد الدواجن (١٠ م^3/ف) والزنك (١٠٠ جزء فى المليون) والتفاعل بينهما كميات عالية فى محتوى الزنك بالنبات وذلك خلال الموسمين.