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EFFECT OF ORGANIC FERTILIZER SOURCE AND FOLIAR SPRAY WITH SOME MICROELEMENTS ON GROWTH, YIELD, FRUIT QUALITY AND STORABILITY OF STRAWBERRY UNDER SANDY SOIL CONDITIONS

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ABSTRACT: A filed experiment was carried out during the two successive winter seasons of 2017/2018 and 2018/2019 at the Experimental Farm of El-Kassasein, Hort. Res. Station, Ismailia Governorate, Egypt, to investigate the effect of different organic manure sources, *i.e.* chicken manure (3.75 ton/fad.) vermicompost (4.44 ton/fad.) and compost (7.50 ton/fad.) (equal 120 kg N/fad., of each), and foliar spray with some microelements (B at 25 ppm, Zn at 100 ppm and Fe at 200 ppm) on vegetative growth, yield, fruit quality and storability of strawberry under sandy soil conditions. Fertilizing strawberry plants grown in sandy soil with 4.44 ton vermicompost /fad increased foliage dry weight, average fruit weight, yield/plant, early yield and total yield/fad, fruit firmness, TSS and Vit. C and gave the lowest values of deformed fruits (%) and fruit weight loss (%) as well as decay (%) during cold storage periods. Spraying with Fe at 200 ppm increased foliage dry weight, average fruit weight, yield/plant, early yield and total yield/fad. Spraying with B at 25ppm increased fruit firmness, TSS and Vit. C, whereas spraying with Zn at100 ppm gave the lowest values of deformed fruits (%) and fruit weight loss as well as decay (%) during cold storage periods The interaction between fertilizing with vermicompost at 4.44 ton/fad., and spraying with Fe at 200 ppm, significantly increased foliage dry weight, average fruit weight, yield/plant, early yield and total yield/fad., whereas the interaction between fertilizing with vermicompost at 4.44 ton/fad., and spraying with Zn at 100 ppm gave the lowest value for each of fruit weight loss (%) and fruit decay (%) during cold storage periods. The interaction between fertilizing with vermicompost at 4.44 ton/fad., and spraying with B at 25 at ppm increased fruit firmness, TSS and Vit. C in fruits and moreover it gave the lowest value of deformed fruits (%).

Key words: Strawberry, organic manure, vermicompost, compost, growth, yield, weight loss and decay.

INTRODUCTION

Strawberry (*Fragaria x ananassa* Duch.) is one of the most popular vegetable crops. In Egypt, it occupies an important position among the exportable vegetable crops due to its multifarious use as local fresh consumption, food processing and exportation. The crop is commonly grown in sandy soils for getting early yields and good fruit quality. Sandy soils have their own problems as single grain structure, susceptibility to erosion, and low levels of nutrients and organic matter as well as microorganisms **(Nour, 1999)**. Owing to their poverty in nutrients and organic matter, fertilizer requirements of strawberry plants grown in such soils, are quite high. The excessive use of inorganic fertilizers might cause ground water contamination and environmental hazards, in addition to their high costs **(Lee, 1992)**. Thus substitution of inorganic fertilizers with organic sources is needed.

Vermicomposts are finely-divided mature peat-like materials with a high porosity, aeration,

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drainage and water-holding capacity and microbial activity which are stabilized by interactions between earthworms and microorganisms in a non-thermophilic process (**Edwards and Burrows, 1988**). Vermicompost application at 10 ton/ha significantly increased leaf area, plant shoot biomass, number of flowers, number of runners and marketable fruit weight of strawberry (**Arancon *et al.,* 2004**). Vermicompost at 7.5 ton/ha. increased total fruit yield , firmness, total soluble solids and ascorbic acid content of strawberry (**Rajbir *et al*., 2008**).

Zinc is effective in plant nutrition for the synthesis of plant hormones and balancing intake of P and K inside the plant cells. Boron is essential for plant growth, new cell division in meristematic tissue, translocation of sugar, starch, nitrogen, phosphorus, certain hormones, synthesis of amino acids and protein, regulations of carbohydrate metabolism, development of phloem *etc*. Iron act as catalyst in synthesis of chlorophyll molecule and helps on the absorption of other elements. It is a key element in various redox reactions of respiration, photosynthesis and reduction of nitrates and sulphates (**Wallihan *et al*., 1958; Zende 1996**).

Boron has an effect on cell wall structure, cell elongation (pollen tube) and root growth **(Barker and Pilbeam, 2006)**. Zinc reduces pollen tube growth through functioning tryptophan as an auxin precursor biosynthesis **(Chaplin and Westwood, 1980).** Boron deficiency and poor pollination cause deformed berries. Micronutrients deficiencies such as boron may cause pollination problems.

Ekka *et al*. (2018) revealed that spraying with Fe at 0.4% recorded maximum values of plant height, number of leaves/plant, number of flowers per plant, number of fruits per plant, fruit yield per plant, TSS, total sugars, ascorbic acid and benefit cost ratio of strawberry cv. Chandler, whereas spraying with Zn at 0.2% recorded maximum values of fruit weight, fruit diameter, fruit length and specific gravity.

Therefore, the aim of this work was to obtained high yield and good quality of strawberry plants by using organic manure and foliar spray with microelements under sandy soil conditions.

MATERIALS AND METHODS

A filed experiment was carried out during the two successive winter seasons of 2017/2018 and 2018/2019 at the Experimental Farm of El-Kassasein, Hort. Res. Station, Ismailia Governorate, Egypt, to investigate the effect of organic manure sources (chicken manure, vermicompost and compost) and foliar spray with some microelements (B, Zn and Fe) on vegetative growth, yield, fruit quality and storability of strawberry under sandy soil conditions. The soil was sandy in texture 0.08 and 0.09% organic matter, 7.92 pH, 1.04 mmhos/cm EC.

Frigo transplants of strawberry (Festival cultivar) were transplanted on 25th and 27th September during the 1st and 2nd seasons, respectively. The experimental unit area was 12.6 m^2, It contains three dripper lines of 6m length and 0.7 distance between each two dripper lines. The distance between strawberry transplants was 25 cm.

This experiment included 12 treatments, which were the combinations between three sources of organic manure, *i.e.,* chicken manure (3.2% N) at 3.75 ton/fad., vermicompost (2.7% N) at 4.44 ton/fad., and compost (1.6 % N) at 7.50 ton/fad. (equal 120 kg N/fad.) and three microelements, *i.e.,* B at 25 ppm, Zn at 100 ppm and Fe at 200 ppm in the form of H_2BO_3, $ZnSO_4$ and $FeSO_4$, respectively, beside unsprayed plants. These treatments were arranged in a split plot design with three replicates. Organic manure sources were randomly arranged in the main plots, while foliar application with microelements were randomly arranged in the sub plots. Organic manure sources were placed pre transplanting and microelements (B, Zn and Fe) were sprayed four times at 70, 85, 100 and 115 days after transplanting. Untreated plants were left as a control treatment and sprayed with tap water. The agricultural practices concerning cultivation, irrigation, fertilization and insect control were conducted according to Ministry of Agriculture recommendation.

Data Recorded

Plant growth

Random samples each of five plants from each plot were randomly taken at 120 days after transplanting in the two growing seasons for measuring the vegetative growth, *i.e.,* plant height (cm), number of leaves/plant and shoot dry weight/plant (g) which measured using dried fresh shoot/plant at 70°C till constant weight.

N, P and K contents in shoots

Nitrogen, phosphorus and potassium percentages in shoots (leaves and branches) were determined in dry weight at 120 days after transplanting in the 2^{nd} season according to **AOAC (2005)**, and total protein percentage in dry shoots were determined by multiplying nitrogen content by 6.25.

Yield and its components

The early yield was determined as weights of all harvested fruits from each plot during February and March months, and then early yield per fad., was calculated. Total yield was recorded from each plot as weights of all harvested fruits during the season up to mid of May, then, yield per plant (g) and total yield per fad. (ton) were calculated, also average fruit weight as well as deformed fruits percent were determined. (fad.= 4200 m^2=0.42 ha.)

Fe and B contents in fruits

Iron and boron contents (ppm) in the fruits at harvest time were determined by atomic absorption spectrophotometer as described by **Evenhuis** and **De Waard (1980**).

Fruit quality at harvest

Fruit quality was measured in the mid of the harvesting season as follows: Firmness was determined by using a Chattilon pressure meter equipped with a plunger (N4, USA) a needle 3mm diameter. Total soluble solids contents (TSS) as brix°: Samples of ten ripe fruits were chosen randomly from each experimental plot at full ripe stage to measure the percentage of total soluble solids content using the hand refractometer. Samples of 100g fruits from each experimental plot at full ripe stage were randomly chosen to determine titratable acidity of juice by titration with 0.1 NaOH solution, according to the method described in **AOAC (2005).** Ascorbic acid content (Vit. C), was determined in juice as the method mentioned in **AOAC (2005).**

Storability

At ripe stage, 500g of strawberries fruits (uniform size and color) of each experimental unit were freshly harvested, surface-dried using blotting paper, divided into three lots (different cold storage periods, 5, 10, and 15 days) were stored at zero °C ±1°C and 90 -95 % relative humidity, to determine the following data:

Weight loss (%)

Weight loss percentage was measured at 5, 10 and 15 days from cold storage. Fruits of each treatment were weighed after 5 days by intervals, then weight loss percentage was calculated. The weight was measured by Digital Electrical Balance at zero day and was taken as reference weight then it was calculated by using the following equation:

Weight loss (%) = Initial weight - Weight of fruits at different sampling dates ÷ Initial weight of fruits × 100

Fruit decay (%)

Percentage of fruit decay was calculated after 5, 10 and 15 days from cold storage.

Statistical Analysis

Recorded data were subjected to the statistical analysis of variance according to **Snedecor and Cochran (1980)** and means separation was done according to least significant difference (LSD) at 0.05 levels of probability.

RESULTS AND DISCUSSION

Plant Growth

Fertilizing strawberry plants grown in sandy soil with 4.44 ton vermicompost/fad., recorded the tallest plants and gave the highest number of leaves/ plant and foliage dry weight/ plant at 120 days after transplanting followed by chicken manure at 3.75 ton/fad., (Table 1). These results agree with those reported by **Arancon *et al.* (2004).**

Foliar spray with B at 25 ppm, Zn at 100 ppm and Fe at 200 ppm increased plant height, number of leaves/plant and foliage dry weight/ plant compared to control (sprayed with tap water). Spraying with Fe at 200 ppm significantly

Table 1. Effect of organic manure and foliar spray with some microelements on growth parameters of strawberry plants at 120 days after transplanting during 2017/2018 and 2018/ 2019 seasons

Treatment	Plant height (cm)		Leaf number/plant		Foliage dry weight (g)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
			Organic manure source			
Chicken manure	15.78	14.95	25.83	26.53	31.55	32.53
Vermicompost	16.67	16.55	27.70	28.27	34.67	35.03
Compost	14.20	12.99	23.58	23.89	26.73	27.29
LSD at 0.05 level	**0.99**	**0.70**	**0.49**	**1.30**	**1.05**	**1.02**
			Microelement (ppm)			
Control	13.10	12.11	23.32	23.82	20.94	20.83
B at 25	15.11	14.68	26.27	26.62	32.00	32.66
Zn at 100	16.50	15.49	26.05	26.44	34.03	35.00
Fe at 200	17.49	17.05	27.16	28.05	36.98	37.99
LSD (0.05))	**0.86**	**0.61**	**0.42**	**1.14**	**0.91**	**0.89**

Quantity of chicken manure, vermicompost and compost were about 3.75, 4.44 and 7.50 ton/fad.

increased plant height, number of leaves/plant and foliage dry weight/ plant in both seasons (Table 1). Spraying strawberry plants with Fe at 0.4% was found the best treatment for growth **(Ekka *et al*., 2018)**.

The interaction between fertilizing with vermicompost at 4.44/fad., and foliar spray with Fe at 200 ppm significantly increased plant height, number of leaves/plant and foliage dry weight/plant without significant differences with the interaction between fertilizing with chicken manure at 3.75 ton/fad., and foliar spray with Fe at 200 ppm with respect to plant height in both seasons.

N, P, K and protein contents in shoots

Fertilizing with vermicompost at 4.44 ton/fad., increased N, P, K and total protein in shoots with no significant differences with fertilizing with chicken manure at 3.75 ton/fad., with respect N, P and total protein (Table 3).

Spraying plants with Fe at 200 ppm gave the highest values of N, P, K, total protein with no significant differences with Zn at 100 ppm (Table 3).

The interaction between fertilizing with vermicompost at 4.44 ton/fad., and foliar spray with Fe at 200 ppm increased N and total protein in shoots with no significant differences with the interaction between fertilizing with chicken manure at 3.75 ton/fad., and foliar spray with Fe at 200 ppm with respect to N content in shoots (Table 4) .

Yield and its Components

Results in Table 5 show that fertilizing strawberry plants grown in sandy soil with vermicompost at 4.44 ton/fad., gave the highest value for each of average fruit weight, yield/ plant and total yield/fad., followed by fertilizing with chicken manure at 3.75 ton/fad., in both seasons. As for early yield, fertilizing with vermicompost at 4.44 ton/fad., and chicken manure at 3.75 ton/fad., increased early yield (ton/fad.). These results agree with those reported by **Arancon *et al*. (2004) and Rajbir *et al*. (2008).**

The positive effects of fertilizing with vermicompost on plant growth and yield of strawberry may be due to that: Vermicompost contains most nutrients in plant- available forms

Table 2. Effect of interaction between organic manure and foliar spray with some microelements on growth parameters of strawberry plants at 120 days after transplanting in 2017/2018 and 2018/2019 seasons

Treatment		Plant height (cm)		Leaf number/plant		Foliage dry weight (g)	
Organic manure	Microelement	1st season	2nd season	1st season	2nd season	1st season	2nd season
Chicken manure	Control	13.66	12.00	22.16	23.66	20.16	20.83
	B at 25 ppm	15.00	14.16	27.66	28.00	33.27	34.60
	Zn at 100 ppm	16.83	15.66	26.50	26.66	35.85	36.60
	Fe at 200 ppm	17.66	18.00	27.00	27.83	36.94	38.12
Vermicompost	Control	14.00	14.33	25.66	25.16	25.51	24.83
	B at 25 ppm	16.00	16.22	27.66	28.45	34.41	34.60
	Zn at 100 ppm	18.03	17.66	28.00	28.83	36.94	38.11
	Fe at 200 ppm	18.66	18.00	29.50	30.66	41.85	42.60
Compost	Control	11.66	10.00	22.16	22.66	17.16	16.83
	B at 25 ppm	14.33	13.66	23.50	23.43	28.32	28.80
	Zn at 100 ppm	14.66	13.16	23.66	23.83	29.30	30.29
	Fe at 200 ppm	16.16	15.16	25.00	25.66	32.17	33.25
LSD 0.05		**1.50**	**1.06**	**0.74**	**1.98**	**1.59**	**1.54**

Quantity of chicken manure, vermicompost and compost were about 3.75, 4.44 and 7.50 ton/fad.

Table 3. Effect of organic manure and foliar spray with some microelements on chemical composition of strawberry shoots at 120 days after transplanting during 2018/2019 season

Treatment	N (%)	P (%)	K (%)	Total protein (%)	Fe (ppm)	B ppm
			Organic manure source			
Chicken manure	2.43	0.093	1.38	15.24	132.21	2.39
Vermicompost	2.53	0.090	1.87	15.81	110.51	1.61
Compost	2.06	0.088	1.32	12.92	121.33	6.79
LSD at 0.05 level	**0.15**	**0.002**	**0.10**	**0.94**	**6.54**	**0.32**
			Microelement (ppm)			
Control	2.10	0.096	1.39	13.17	98.83	3.10
B at 25	2.31	0.083	1.52	14.48	119.07	3.45
Zn at 100	2.42	0.091	1.55	15.12	123.96	5.39
Fe at 200	2.53	0.091	1.63	15.85	143.53	2.44
LSD 0.05	**0.13**	**0.004**	**0.08**	**0.82**	**5.71**	**0.28**

Quantity of chicken manure , vermicompost and compost were about 3.75, 4.44 and 7.50 ton/fad.

Table 4. Effect of the interaction between organic manure and foliar spray with some microelements on chemical composition of strawberry shoots at 120 days after transplanting during 2018/2019 season

Treatment		N (%)	P (%)	K (%)	Total protein (%)	Fe (ppm)	B ppm
Organic manure	Microelement						
	Control	2.14	0.101	1.31	13.38	121.42	1.55
	B at 25 ppm	2.46	0.080	1.32	15.39	138.05	3.47
Chicken manure	Zn at 100 ppm	2.52	0.103	1.43	15.75	129.34	2.00
	Fe at 200 ppm	2.63	0.090	1.46	16.44	140.04	2.57
	Control	2.28	0.097	1.67	14.25	101.20	1.70
	B at 25 ppm	2.48	0.085	1.88	15.50	98.51	2.96
Vermicompost	Zn at 100 ppm	2.62	0.089	1.88	16.38	112.58	1.05
	Fe at 200 ppm	2.74	0.090	2.07	17.13	129.74	0.73
	Control	1.90	0.090	1.21	11.88	73.88	6.05
	B at 25 ppm	2.01	0.086	1.37	12.56	120.65	9.76
Compost	Zn at 100 ppm	2.12	0.083	1.34	13.25	129.96	7.32
	Fe at 200 ppm	2.24	0.094	1.38	14.00	160.81	4.04
LSD 0.05		**0.22**	**0.007**	**0.15**	**1.42**	**9.90**	**0.49**

Quantity of chicken manure, vermicompost and compost were about 3.75, 4.44 and 7.50 ton/fad.

Table 5. Effect of organic manure and foliar spray with some microelements on yield and its components and deformed fruits of strawberry during 2017/2018 and 2018/2019 seasons

Treatment	Average fruit weight (g)		Yield / plant (g)		Early yield (ton/fad.)		Total yield (ton/fad.)		Deformed fruits (%)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
					Organic manure source					
Chicken manure	20.94	21.81	302.45	300.20	4.226	4.162	14.442	14.444	5.31	6.17
Vermicompost	22.62	22.53	323.76	318.48	4.446	4.362	15.473	15.111	3.83	4.69
Compost	17.59	16.63	211.13	190.23	2.836	2.628	9.779	8.752	4.67	5.69
LSD at 0.05 level	**1.07**	**0.73**	**7.52**	**9.81**	**0.392**	**0.425**	**0.654**	**0.981**	0.40	0.11
					Microelement (ppm)					
Control	18.19	18.26	209.75	199.81	2.929	2.847	10.025	9.591	6.33	7.42
B at 25	19.98	19.59	268.70	240.11	3.873	3.457	12.899	11.625	3.28	3.97
Zn at 100	20.59	21.09	293.27	298.13	4.084	4.047	13.933	13.922	4.17	5.08
Fe at 200	22.77	22.35	344.73	340.51	4.458	4.519	16.068	15.937	4.64	5.58
LSD at 0.05 level	**0.93**	**0.64**	**6.57**	**8.57**	**0.343**	**0.269**	**0.571**	**0.857**	0.33	0.29

Quantity of chicken manure, vermicompost and compost were about 3.75, 4.44 and 7.50 ton/fad.
Fad. = 4200 m2= 0.42 ha.

such as nitrates, phosphates and exchangeable calcium and soluble potassium (**Orozco *et al.*, 1996; Edwards, 1998**). Vermicompost have a large particulate surface areas that provide many microsites for microbial activity and for strong retention of nutrients (**Shi-wei and Fu-zhen, 1991**), vermicompost are rich in microbial population and diversity, particularly fungi, bacteria and actinomycetes (**Tomati *et al.* 1988, and Edwards, 1998**). Vermicompost contain plant growth regulators and other plant growth influencing material produced by microorganisms (**Grappelli *et al.*, 1987; Tomati *et al.*, 1988**) including humates (**Atiyeh *et al.*, 2002**).

Spraying strawberry plants with B at 25 ppm, Zn at 100 ppm and Fe at 200 ppm increased yield and its components compared to control (spraying with tap water) in both seasons. Foliar spray with Fe at 200 ppm increased average fruit weight, yield/plant, early yield and total yield /fad., followed by foliar spray with Zn at 100 ppm in both seasons (Table 5). Spraying plants with Fe at 0.4% was found the best treatment for yield of strawberry **(Ekka *et al.* 2018).**

Iron acts as catalyst in synthesis of chlorophyll molecule and helps the absorption of other elements. It is a key element in various redox reactions of respiration, photosynthesis and reduction of nitrates and sulphates (**Wallihan *et al.* 1958; Zende, 1996**).

The interaction between fertilizing with vermicompost at 4.44 ton/fad. and foliar spray with Fe at 200 ppm and the interaction between fertilizing with chicken manure at 3.75 ton/fad., and foliar spray with Fe at 200 ppm increased average fruit weight , yield per plant ,early yield and total yield/fad., in both seasons (Table 6).

As for deformed fruits percentage, fertilizing with vermicompost at 4.44 ton/fad. gave the lowest values of deformed fruits (%) compared to chicken manure and compost in both seasons. Spraying with B at 25 ppm, Zn at 100 ppm and Fe at 200 ppm decreased deformed fruits (%) compared to control (spraying with tap water. Boron at 25 ppm recorded minimum values of deformed fruits (%) followed by spraying plants with Zn at 100 ppm. The interaction between fertilizing with vermicompost at 4.44 ton/fad., and spraying with B at 25 ppm gave the lowest values of deformed fruits (%) in both seasons.

Boron has an effect on cell wall structure, cell elongation (pollen tube) and root growth **(Barker and Pilbeam, 2006).** Zinc reduces pollen tube growth through functioning tryptophan as an auxin precursor biosynthesis **(Chaplin and Westwood, 1980).**

Fruit Quality at Harvest

Fertilizing strawberry plants with vermicompost at 4.44 ton/fad. increased fruit firmness, TSS and Vit C in strawberry fruits, whereas fertilizing with compost at 7.50 ton/fad. increased total acidity in fruits at harvest in both seasons (Table 7). Fertilizing with vermicompost at 7.5 ton/ha. increased firmness, total soluble solids and ascorbic acid content of strawberry (**Rajbir *et al.*, 2008**).

Foliar spray with B at 25 ppm increased fruit firmness, TSS and Vit. C in fruits, at harvest in both seasons. Sprayed plants with tap water control increased total acidity in fruits (Table 7). Maximum ascorbic acid values were noticed with Fe at 0.04% compared to control (**Ekka *et al.*, 2018**)

Boron is essential for translocation of sugar, starch, nitrogen, phosphorus, certain hormone, synthesis of amino acids and protein, regulation of carbohydrate metabolism as well as development of phloem.

The interaction between fertilizing with vermicompost at 4.44 ton/fad. and foliar spray with B at 25 ppm increased fruit firmness, TSS and Vit. C in fruits at harvest in both seasons. Fertilizing with compost at 7.50 ton/fad. and spraying with tap water (control) increased total acidity in fruits (Table 8).

Fe and B Contents in Fruits at Harvest

The obtained results in Table 9 illustrate that fertilizing with chicken manure at 3.75 ton/fad., increased Fe content in strawberry fruits, whereas fertilizing with compost at 7.50 ton/ fad., increased B content in strawberry fruits. Spraying plants with Fe at 200 ppm gave the highest values of Fe in content strawberry fruits, whereas spraying with Zn at 100 ppm increased B content in strawberry fruits (Table 9).

Table 6. Effect of the interaction between organic manure and foliar spray with some microelements on yield and its components and deformed fruits of strawberry during 2017/2018 and 2018/2019 seasons

Treatment		Average fruit weight (g)		Yield/plant (g)		Early yield (ton/fad.)		Total yield (ton/fad.)		Deformed fruits (%)	
Organic manure	Microelement	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
	Control	18.27	19.31	223.81	230.33	3.101	3.220	10.473	11.056	**7.75**	**9.00**
	B at 25 ppm	20.74	20.44	298.14	275.14	4.299	3.866	14.316	13.206	**3.50**	**4.17**
	Zn at 100 ppm	21.46	23.09	309.21	325.11	4.454	4.385	14.833	15.600	**4.83**	**5.50**
Chicken manure	Fe at 200 ppm	23.30	24.41	378.62	370.23	5.050	5.180	18.147	17.915	**5.17**	**6.00**
	Control	20.38	20.18	235.32	220.57	3.334	3.180	11.436	10.589	**5.00**	**5.75**
	B at 25 ppm	22.13	22.27	317.14	295.41	4.571	4.356	15.222	14.507	**2.83**	**3.50**
	Zn at 100 ppm	23.17	23.40	350.45	365.78	4.753	4.828	16.827	16.410	**3.50**	**4.50**
Vermicompost	Fe at 200 ppm	24.82	24.29	392.14	392.17	5.128	5.087	18.407	18.937	**4.00**	**5.00**
	Control	15.93	15.31	170.13	148.52	2.352	2.141	8.166	7.128	**6.25**	**7.50**
	B at 25 ppm	17.07	16.08	190.81	149.79	2.750	2.151	9.159	7.163	**3.50**	**4.25**
	Zn at 100 ppm	17.15	16.79	220.15	203.49	3.045	2.929	10.140	9.755	**4.17**	**5.25**
Compost	Fe at 200 ppm	20.21	18.35	263.44	259.14	3.198	3.291	11.650	10.960	**4.75**	**5.75**
LSD at 0.05 level		**1.62**	**1.10**	**11.38**	**14.85**	**0.594**	**0.467**	**0.990**	**1.485**	**0.57**	**0.50**

Quantity of chicken manure, vermicompost and compost were about 3.75, 4.44 and 7.50 ton/fad.

Table 7. Effect of organic manure and foliar spray with some microelements on fruit quality of strawberry at harvest during 2017/2018 and 2018/2019 seasons

Treatment	Firmness (g/cm^2)		TSS ($brix^o$)		Total acidity (mg/100 ml juice)		Vitamin C (mg/100 ml juice)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
				Organic manure source				
Chicken manure	450.1	454.7	9.59	9.32	0.63	0.69	39.33	40.06
Vermicompost	473.4	501.9	9.96	10.00	0.60	0.61	45.79	45.54
Compost	436.4	455.2	8.47	8.61	0.75	0.78	28.67	30.04
LSD at 0.05 level	**16.36**	**10.14**	**0.52**	**0.39**	**0.06**	**0.09**	**1.41**	**2.29**
				Microelement (ppm)				
Control	342.8	356.9	7.98	8.01	0.80	0.80	33.42	35.03
B at 25	529.2	557.2	10.37	10.30	0.65	0.64	42.03	42.73
Zn at 100	459.2	467.0	9.31	9.39	0.65	0.73	37.53	37.67
Fe at 200	481.9	501.2	9.70	9.53	0.54	0.61	38.74	38.75
LSD at 0.05 level	**14.29**	**8.86**	**0.45**	**0.34**	**0.06**	**0.08**	**1.59**	**1.35**

Quantity of chicken manure, vermicompost and compost were about 3.75, 4.44 and 7.50 ton/fad.

Table 8. Effect of the interaction between organic manure and foliar spray with some microelements on fruit quality of strawberry at harvest during 2017/2018 and 2018/2019 seasons

Treatment		Firmness (g/cm^2)		TSS ($brix^o$)		Total acidity (mg/100 ml juice)		Vitamin C (mg/100 ml juice)	
Organic manure	Microelement	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
	Control	332.6	335.0	8.00	7.70	0.72	0.79	31.70	32.70
	B at 25 ppm	519.9	531.9	10.96	10.59	0.69	0.69	43.56	45.24
Chicken manure	Zn at 100 ppm	467.9	472.0	9.60	9.20	0.61	0.76	40.44	41.16
	Fe at 200 ppm	480.0	480.0	9.80	9.80	0.51	0.54	41.64	41.16
	Control	352.0	376.0	8.80	9.10	0.72	0.69	41.40	43.56
	B at 25 ppm	583.9	619.9	10.99	10.86	0.51	0.56	50.40	49.56
Vermicompost	Zn at 100 ppm	469.9	479.9	9.69	10.01	0.62	0.62	43.96	42.44
	Fe at 200 ppm	487.9	531.9	10.39	10.03	0.57	0.57	47.40	46.60
	Control	343.9	359.9	7.14	7.25	0.96	0.92	27.16	28.84
	B at 25 ppm	483.9	519.9	9.18	9.46	0.76	0.67	32.15	33.41
Compost	Zn at 100 ppm	439.9	449.3	8.64	8.97	0.74	0.81	28.19	29.42
	Fe at 200 ppm	477.9	491.8	8.92	8.77	0.56	0.72	27.18	28.49
LSD at 0.05 level		**24.76**	**15.35**	**0.79**	**0.59**	**0.09**	**0.14**	**2.75**	**2.34**

Quantity of chicken manure, vermicompost and compost were about 3.75, 4.44 and 7.50 ton/fad.

Table 9. Effect of organic manure and foliar spray with some microelements on iron and boron contents of strawberry fruits at harvest during 2018/2019 season

Treatment	Fe (ppm)	B (ppm)
	Organic manure source	
Chicken manure	132.21	2.39
Vermicompost	110.51	1.61
Compost	121.33	6.79
LSD at 0.05 level	**6.54**	**0.32**
	Microelement (ppm)	
Control	98.83	3.10
B at 25	119.07	3.45
Zn at 100	123.96	5.39
Fe at 200	143.53	2.44
LSD 0.05	**5.71**	**0.28**

Quantity of chicken manure, vermicompost and compost were about 3.75, 4.44 and 7.50 ton/fad.

The interaction between fertilizing with compost at 7.50 ton/fad., and foliar spray with Fe at 200 ppm increased Fe content in strawberry fruits, whereas the interaction between fertilizing with compost at 7.50 ton/ fad., and foliar spray with B at 25 ppm increased B content in strawberry fruits (Table 10).

Storability

Fruit weight loss (%) and Decay (%)

Fruit weight loss (%) and decay (%) increased with increasing cold storage periods. Fertilizing with vermicompost at 4.44 ton/fad., gave the lowest value for each of fruit weight loss (%) and decay (%), whereas fertilizing with compost at 7.5 ton/fad., gave the highest value for each of weight loss (%) and decay (%) during cold storage periods in both seasons (Tables 11 and 12).

Spraying strawberry plants with B at 25 ppm, Zn at 100 ppm and Fe at 200 ppm recorded the minimum value for each of fruit weight loss (%) and decay (%) compared to control (spraying with tap water). Spraying with Zn at 100 ppm and Fe at 200 ppm decreased weight loss (%) and decay (%) in fruits during cold storage periods (Tables 11 and 12).

The interaction between fertilizing with vermicompost at 4.44 ton/fad., and foliar spray with Zn at 100 ppm decreased weight loss (%) and decay (%) in fruits during cold storage periods, followed by the interaction between fertilizing with vermicompost at 4.44 ton/fad., and foliar spray with Fe at 200 ppm (Tables 13 and 14).

Table 10. Effect of the interaction between organic manure and foliar spray with some microelements on iron and boron contents of strawberry fruits at harvest during 2018/2019 season

Treatment		Fe (ppm)	B (ppm)
Organic manure	**Microelement**		
	Control	121.42	1.55
	B at 25 ppm	138.05	3.47
Chicken manure	**Zn at 100 ppm**	129.34	2.00
	Fe at 200 ppm	140.04	2.57
	Control	101.20	1.70
	B at 25 ppm	98.51	2.96
Vermicompost	**Zn at 100 ppm**	112.58	1.05
	Fe at 200 ppm	129.74	0.73
	Control	73.88	6.05
	B at 25 ppm	120.65	9.76
Compost	**Zn at 100 ppm**	129.96	7.32
	Fe at 200 ppm	160.81	4.04
LSD 0.05		**9.90**	**0.49**

Quantity of chicken manure, vermicompost and compost were about 3.75, 4.44 and 7.50 ton/fad.

Table 11. Effect of the interaction between organic manure and foliar spray with some microelements on fruit weight loss (%) of strawberry during storage period during 2017/2018 and 2018/2019 seasons

Treatment	Weigh loss (%)					
	Storage periods (day)					
	5 days		10 days		15 days	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
	Organic manure source					
Chicken manure	1.26	1.28	1.89	1.85	3.13	3.21
Vermicompost	0.99	0.95	1.40	1.22	2.20	2.33
Compost	1.56	1.59	2.48	2.44	3.51	3.60
LSD at 0.05 level	**0.16**	**0.24**	**0.17**	**0.25**	**0.32**	**0.42**
	Microelement (ppm)					
Control	1.59	1.62	2.61	2.42	3.84	3.98
B at 25	1.35	1.34	2.06	1.97	3.13	3.22
Zn at 100	1.03	1.06	1.44	1.46	2.34	2.35
Fe at 200	1.11	1.08	1.57	1.50	2.48	2.65
LSD at 0.05 level	**0.14**	**0.21**	**0.15**	**0.22**	**0.28**	**0.37**

Quantity of chicken manure, vermicompost and compost were about 3.75, 4.44 and 7.50 ton/fad.

Table 12. Effect of the interaction between organic manure and foliar spray with some microelements on fruit weight loss (%) of strawberry during storage periods in 2017/ 2018 and 2018/2019 seasons

Treatment		Weigh loss (%)					
		Storage periods (day)					
		5		10		15	
Organic manure	Microelement	1st season	2nd season	1st season	2nd season	1st season	2nd season
	Control	1.49	1.74	2.62	2.78	3.97	4.10
	B at 25 ppm	1.32	1.32	1.98	1.87	3.14	3.30
Chicken manure	**Zn at 100 ppm**	1.19	1.11	1.53	1.57	2.50	2.51
	Fe at 200 ppm	1.06	0.96	1.45	1.18	2.93	2.96
	Control	1.30	1.21	1.97	1.72	2.78	3.19
	B at 25 ppm	1.13	1.00	1.44	1.17	2.51	2.40
Vermicompost	**Zn at 100 ppm**	0.53	0.67	0.88	0.85	1.72	1.64
	Fe at 200 ppm	1.02	0.94	1.31	1.15	1.79	2.12
	Control	1.98	1.92	3.26	2.77	4.78	4.65
	B at 25 ppm	1.62	1.72	2.78	2.87	3.74	3.98
Compost	**Zn at 100 ppm**	1.39	1.41	1.93	1.97	2.80	2.91
	Fe at 200 ppm	1.26	1.34	1.95	2.18	2.73	2.88
LSD at 0.05 level		**0.24**	**0.37**	**0.26**	**0.39**	**0.49**	**0.64**

Quantity of chicken manure, vermicompost and compost were about 3.75, 4.44 and 7.50 ton/fad.

Table 13. Effect of organic manure and foliar spray with some microelements on decay (%) of strawberry fruits during storage periods in 2017/2018 and 2018/2019 seasons

Treatment	Decay (%)					
	Storage periods (day)					
	5		10		15	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
	Organic manure source					
Chicken manure	9.30	9.28	14.42	13.82	22.80	22.79
Vermicompost	7.96	7.64	11.20	9.78	17.60	18.70
Compost	12.50	12.78	19.84	19.91	28.10	28.84
LSD at 0.05 level	**0.68**	**2.35**	**2.65**	**1.93**	**1.67**	**2.07**
	Microelement (ppm)					
Control	11.63	11.68	19.94	18.52	27.71	31.37
B at 25	10.85	10.77	16.53	15.76	25.04	22.34
Zn at 100	8.29	8.50	11.57	11.70	18.72	18.82
Fe at 200	8.90	8.64	12.56	12.02	19.86	21.22
LSD at 0.05 level	**0.82**	**1.73**	**1.98**	**2.08**	**0.91**	**2.11**

Table 14. Effect of the interaction between organic manure and foliar spray with some microelements on decay (%) of strawberry fruits during storage periods in 2017/2018 and 2018/2019 seasons

Treatment		Decay (%)					
		Storage periods (day)					
		5		10		15	
Organic manure	**Microelement**	1st season	2nd season	1st season	2nd season	1st season	2nd season
	Control	8.66	10.00	18.00	18.33	22.66	31.40
	B at 25 ppm	10.56	10.56	15.84	14.96	25.12	16.00
Chicken manure	**Zn at 100 ppm**	9.52	8.88	12.24	12.56	20.00	20.08
	Fe at 200 ppm	8.48	7.68	11.60	9.44	23.44	23.68
	Control	10.40	9.68	15.76	13.76	22.24	25.52
	B at 25 ppm	9.04	8.00	11.52	9.36	20.08	19.20
Vermicompost	**Zn at 100 ppm**	4.24	5.36	7.04	6.80	13.76	13.12
	Fe at 200 ppm	8.16	7.52	10.48	9.20	14.32	16.96
	Control	15.84	15.36	26.08	23.49	38.24	37.20
	B at 25 ppm	12.96	13.76	22.24	22.96	29.92	31.84
Compost	**Zn at 100 ppm**	11.12	11.28	15.44	15.76	22.40	23.28
	Fe at 200 ppm	10.08	10.72	15.60	17.44	21.84	23.04
LSD at 0.05 level		**1.42**	**3.01**	**3.43**	**3.61**	**1.59**	**3.66**

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تأثير مصدر السماد العضوي والرش الورقى ببعض العناصر الصغرى على النمو و المحصول و جودة الثمار و القدرة التخزينية للفراولة تحت ظروف الأراضي الرملية

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أجريت تجربة حقلية خلال موسمين شتويين متتاليين لأعوام ٢٠١٨/٢٠١٧ و ٢٠١٩/٢٠١٨ فى مزرعة التجارب بمحطة بحوث البساتين بالقصاصين، محافظة الإسماعيلية، مصر لدراسة تاثير مصادر الأسمدة العضوية (سماد الدواجن بمعدل ٣,٧٥ طن/فدان، الفيرميكمبوست بمعدل ٤،٤٤ طن/فدان والكمبوست بمعدل ٧,٥٠ طن/فدان) والتى تعادل ١٢٠ كيلو جرام نيتروجين للفدان والرش الورقى ببعض العناصر الصغرى (البورون بتركيز ٢٥ جزء فى المليون والزنك بتركيز ١٠٠ جزء فى المليون والحديد بتركيز ٢٠٠ جزء فى المليون) على النمو والمحصول وجودة الثمار والقدرة التخزينية للفراولة تحت ظروف الأراضي الرملية. أدى تسميد نباتات الفراولة بالفيرميكمبوست بمعدل ٤,٤٤ طن/فدان إلى زيادة الوزن الجاف للمجموع الخضرى، متوسط وزن الثمرة، محصول النبات، المحصول المبكر، المحصول الكلى للفدان، صلابة الثمار، نسبة المواد الصلبة الذائبة الكلية، فيتامين ج فى الثمار واعطى اقل قيمة بالنسبة للثمار المشوهة ونسبة الفقد فى الوزن وعفن الثمار خلال فترة التخزين المبرد، ادى رش نباتات الفراولة بالحديد بتركيز ٢٠٠ جزء فى المليون إلى زيادة الوزن الجاف للمجموع الخضرى، متوسط وزن الثمرة، محصول النبات، المحصول المبكر، المحصول الكلى للفدان، أدى الرش بالبورون بتركيز ٢٥ جزء فى المليون الى زيادة صلابة الثمار، نسبة المواد الصلبة الذائبة الكلية وفيتامين ج بينما ادى الرش بالزنك بنركيز ١٠٠ جزء فى المليون الى انخفاض نسبة الثمار، المشوهة نسبة الفقد فى الوزن وعفن الثمار خلال فترات التخزين المبرد، أدى التفاعل بين التسميد بالفيرميكمبوست بمعدل ٤,٤٤ طن/فدان والرش بالحديد بتركيز ٢٠٠ جزء فى المليون فدان إلى زيادة الوزن الجاف للمجموع الخضرى، متوسط وزن الثمرة، محصول النبات، المحصول المبكر و المحصول الكلى للفدان، بينما أعطى التفاعل بين التسميد بالفيرميكمبوست بمعدل ٤,٤٤ طن/فدان والرش بالزنك بتركيز ١٠٠ جزء فى المليون فدان اقل نسبة فى الفقد فى الوزن وتلف الثمار خلال فترات التخزين المبرد، أدى التفاعل بين التسميد بالفيرميكمبوست بمعدل ٤,٤٤ طن/فدان والرش بالبورون بتركيز ٢٥ جزء فى المليون الى زيادة صلابة الثمار، نسبة المواد الصلبة الذائبة الكلية وفيتامين ج وأعطى اقل نسبة ثمار مشوهة.

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