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RESPONSE OF YOUNG WASHINGTON NAVEL ORANGE TREES GROWN ON SLIGHTLY ALKALINE CLAYEY SOIL TO FOLIAR APPLICATION OF CHELATED MICRONUTRIENTS

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ABSTRACT

The present investigation was carried out during 1997/98 and 1998/99 seasons at the Experimental Farm of Sakha Agricultural Research Station on young Washington Navel orange trees (4-5-years old), where the soil is classified as alluvial clayey soil with slight alkalinity to study the response of young orange trees to EDTA micronutrients (Fe, Mn & Zn) foliar application alone or in combination.

The results showed a pronounced increase in leaf N, K, Fe, Mn and Zn content, while that of P was not significantly affected. Leaf chlorophyll content, plant growth (as indexed by TCSA, GR%, VI and LA) and reproductive growth (as indexed by flowering, fruit set %, fruiting %) have responded well, while preharvest drop and June drop had reduced. Remarkable increase of yield as kgs or fruit number was also observed, especially with (Zn + Mn) treatment. Fruit quality expressed as fruit weight, TSS %, total acidity % and juice volume had improved, while vit.C and peel thickness were not affected by micronutrients as foliar sprays. Zn + Mn treatment gave better results in both seasons.

INTRODUCTION

Egyptian soils, in common with most of the arid and semi-arid regions, are characterized by their low content of organic matter and high pH, which, affected nutrient elements balance and availability. Nutrients imbalance and deficiency of micronutrients, particularly Fe, Mn, and Zn form is one of the major limiting factors of plant growth and production in Egypt, (El-Fouly and Fawzi, 1982). Micronutrient deficiencies are one of the chief causes of low productivity of citrus, (Chadha *et al.*, 1970 and Raja, 1997). The most deficient micronutrients are Zn, Fe and Mn (El-Fouly, 1983).

Varies investigations have been carried out in order to correct these deficiencies in citrus trees. Foliar application of such elements may be equal or more effective for correcting the nutritional status of the trees, (Vinay, 1982; Mann *et al.*, 1985; Awad, 1988 and Swietlik and Laduke, 1991).

For evaluating the nutritional status of citrus orchards, leaf analysis was better than soil analysis for most nutrients, (Kohli and Srivastava, 1997). The application of Zn, Fe and Mn as foliar sprays increased leaf micronutrients, chlorophyll content and fruit yield of sathgrdi orange trees, (Devi *et al.*, 1997). Also, Omran *et al.* (1998) revealed that, Fe, Mn and Zn foliar application improved both physical and chemical properties of fruits, and enhanced the tree growth and nutrients uptake.

This work was carried out to study the effect of foliar sprays of Zn, Mn and Fe on yield, fruit quality, growth, reproductive growth and leaf mineral content of Washington Navel orange trees grown on slightly alkaline clayey soil under North Delta environmental conditions.

MATERIALS AND METHODS

1.Experimental site and trees:

Field experiment was conducted during two successive seasons (1997/98 and 1998/99), at the Experimental Farm of Sakha Agricultural Research Station. The experimental site (Table 1) was alluvial clay soil, poor in organic matter (less than 2%) and in alkaline range (pH 8.36). P concentration was fairly high, soluble and exchangeable K^+ and Ca^{++} were also high, and Zn concentration was low (0.59 ppm in the upper layer). The soil characteristics were determined according to Black (1965) and Lindsay and Norvell (1978).

Table (1): Some soil physical and chemical characteristics in the experimental site.

Analysis	Depth of layer (cm)		
	0-20	**20-40**	**40-60**
Mechanical analysis			
Clay %	45.6	42.0	47.2
Silt %	26.4	26.7	33.0
Sand %	28.0	31.3	19.8
Textural class	Clayey	Clayey	Clayey
pH (1: 2.5 Soil-Water ratio)	8.36	8.45	8.30
EC dS/m (Soil paste at 25°C)	2.28	2.53	2.40
$CaCO_3$ %	3.26	3.08	2.47
Organic matter %	1.23	0.87	0.54
Total N (ppm)	475	367	248
$NaHCO_3$-extractable-P (ppm)	14.5	6.4	3.7
NH_4OAC extractable-K (ppm)	535	377	271
Ca mg/100 g soil	483	474	452
Mg mg/100 g soil	182	203	185
Na mg/100 g soil	53	71	133
DTPA extractable			
Fe (ppm)	6.56	6.00	5.64
Mn (ppm)	6.90	6.20	7.10
Zn (ppm)	0.59	0.43	0.52
Cu (ppm)	1.30	1.00	1.20

As a result of soil analysis aforementioned in Table (1), the orchard trees were suffered from some leaf chlorosis. Also, leaf analysis showed a marginal leaf Zn, Mn & Fe specially leaf Zn content.

Thus, forty eight young Washington Navel orange trees (4-5 years old) on sour orange rootstock, planted at 5 x 5 meter were selected of uniform vigour as possible. The experiment compressed 7 micronutrient treatments plus the control trees. Each treatment was replicated by two trees plot three times in a randomized complete block design. All trees received the regular annual soil fertilization and cultivation practices as recommended by the Ministry of Agricultural.

2.Micronutrient treatments:

The treatments were applied in both experimental seasons of study as follows:

1) Control
2) Fe-EDTA, 50 ppm Fe
3) Mn-EDTA, 50 ppm Mn
4) Zn-EDTRA, 50 ppm Zn
5) Fe-EDTA, 50 ppm Fe + Mn EDTA, 50 ppm Mn
6) Fe-EDTA, 50 ppm Fe + Zn-EDTA, 50 ppm Mn
7) Mn-EDTA, 50 ppm Mn + Zn-EDTA, 50 ppm Zn
8) Fe-EDTA, 50 ppm Fe + Mn-EDTA, 50 ppm Mn + Zn-EDTA, 50 ppm Zn.

A neutral detergent was added to all the spraying solution as a wetting agent. The micronutrient were sprayed twice at the beginning of March and May. Spraying was done to full drenching of all leaves.

3.Leaf analysis:

Leaf samples were collected from non-fruiting terminals of spring and summer growth in the End of August and the End of November of each season, (Embleton *et al.*, 1983). The sample were cleaned with damp cloth, and washed three times with redistilled water. Then, leaf chlorophyll was determined using N, N-dimethyl formamide method, (Moran, 1982). The leaves were dried at 60ºC till constant weight, ground and wet-digested with H_2SO_4 and H_2O_2 (Cottenie, 1980). Leaf Zn, Mn and Fe were determined according to Carter, 1993 using atomic absorption spectrophotometer. N content was determined by kjeldahl method (Jackson, 1958), P content was colorimetrically determined and K content was photometrically estimated.

4.Vegetative growth:

Plant height, width and trunk diameter (cm) 15 cm above the bud union were measured on November (1998 and 1999) of each season. Volume index (VI) was calculated as indicated by Turrell, 1946. Leaf area was measured according to Singh and Snyder, 1984. Trunk diameter was measured 10 cm above the bud union then, trunk cross sectional area (TCSA) cm^2 was also calculated.

5.Reproductive growth:

Four uniform branches of about 2.5 cm thick and well distributed on tree were chosen for the following determination;

a) **Fruit set**: At full bloom, number of flowers on each chosen branch was recorded. During the first week of May, number of fruitlettes was counted and fruit set percentage was calculated using the formula:

$$\text{Fruit set (\%)} = \frac{\text{Total No of fruitlettes}}{\text{Total No of flowers}} \times 100$$

b) **June drop**: Fruit were counted again in the End of June and June fruit drop percentage was obtained as follow:

$$\text{June drop (\%)} = \frac{\text{Total No of fruitlettes - No of fruit in the late June}}{\text{Total No of flowers}}$$

c) **Preharvest fruit drop:** The number of preharvest fruit drop was weekly recorded from August to December and the percentage of fruit drop was calculated per season.

d) Fruiting (%): Mature fruits which remained on the tree at harvesting time wer counted and the yield percentage was counted as follows:

$$\text{Fruiting (\%)} = \frac{\text{Total No of fruits at harvst time}}{\text{No of flowers}} \times 100$$

6, Yield and fruit quality:

a) Fruit yield of Washington Navel orange was recorded at harvest time in both seasons (December, 1998 and 1999) on an individual tree basis and was expressed as total fruit number and kgs per tree.

b) A sample of 16 fruits were collected from each tree at harvest time for determination of fruit weight, total acidity %, TSS %, juice volume, peel thickness and vit. C according to A.O.A.C. (1975).

7. Statistical analysis:

All data were subjected to statistical analysis according to Steel and Torrie, 1982.

The aim of this study was to correct some leaf micronutrient deficiency for obtaining better plant growth, reproductive growth, yield and fruit quality.

RESULTS AND DISCUSSION

The effect of micronutrients spray on leaf mineral composition:

Nitrogen:

Concerning the effect of micronutrients spray on leaf nitrogen, data in Table 2 show that leaf N content significantly increased with micronutrients foliar application in comparison with control in both seasons. The highest value of leaf N content was obtained by using mixture of Fe + Zn. Whereas, the least value in this respect was obtained with Mn treatment, in both seasons. This may be due to the assimilation of N into organic molecules was dependent on the reduction of NO^-_{3} Nitrate reduction, which must occur before amino acids and other chemical combinations of N require electrons, which are products of photosynthesis. Iron is a constitute of the electron transport enzymes, (Gardner *et al.*, 1985). Amino acids have amino-N attached at the α-carbon position and may also have N in the ring as with tryptophan. Zinc was found to be essential for the enzymes in the synthesis tryptophan. Mohsen *et al.* (1990b) reported that mixture of Zn, Fe and Mn spray increased leaf N content.

Phosphorus:

With regard to the effect of micronutrients on leaf phosphorus, data in Table 2 revealed that spraying trees with Zn, Mn and Fe solely or in combinations had no significant effect on leaf P concentration of Washington Navel orange trees. The slight effect of micronutrients on leaf P content may be due to the fairly high level of the available P (14.5 ppm) in the experimental soil (Table 1). Mohsen *et al.* (1990a) obtained similar results. On the other hand, Firgany *et al.* (1983) and Ghoneim *et al.* (1983) revealed that Zn or Mn application decreased leaf P content than the control trees.

Table (2): Effect of micronutrients spray on some leaf mineral composition of Washington Navel orange trees in both seasons.

Treatments	Macronutrients (%)			Micronutrients (ppm)		
	N	P	K	Fe	Mn	Zn
			1998			
Control	2.36	0.142	0.962	108.9	23.82	21.24
Fe	2.51	0.149	0.979	137.4	27.81	24.96
Mn	2.34	0.169	1.043	119.7	34.53	23.36
Zn	2.55	0.158	1.025	123.3	27.43	33.19
Fe + Mn	2.48	0.168	1.032	128.8	33.64	25.42
Fe + Zn	2.60	0.166	1.017	133.0	31.12	26.27
Mn + Zn	2.53	0.174	1.144	132.3	32.28	30.53
Fe + Mn + Zn	2.53	0.159	1.118	133.6	33.50	29.19
L.S.D. at 5%	0.22	NS	0.019	6.52	3.31	2.54
			1999			
Control	2.38	0.136	1.021	112.6	22.83	20.69
Fe	2.53	0.141	1.042	142.4	26.94	25.55
Mn	2.37	0.163	1.111	123.3	33.58	24.02
Zn	2.61	0.154	1.094	128.1	26.49	34.15
Fe + Mn	2.50	0.162	1.105	133.6	32.43	26.18
Fe + Zn	2.64	0.159	1.083	138.1	30.02	27.21
Mn + Zn	2.58	0.167	1.216	136.9	31.13	31.35
Fe + Mn + Zn	2.56	0.153	1.183	138.2	32.27	29.87
L.S.D. at 5%	0.18	NS	0.020	7.26	3.56	2.77

Potassium:

As for potassium, from data of Table 2 it is obvious that spraying trees with Zn, Mn and Fe solely as well as in combinations significantly increased the leaf K content. Zn + Mn treatment had the highest value of leaf K while control trees had the lowest value. These results agreed fairly with those reported by Nasr (1982) and Awad (1988). In addition, Ghoniem *et al.* (1983) and Shawky *et al.* (1986) proved that the application of Zn, Mn and Fe solely or mixed together on citrus trees had no appreciable effect on leaf K content.

Zinc:

From the given data in Table 2 it is clear that, spraying trees with Zn, Mn and Fe single or in combinations significantly increased Zn content. Zinc treatment alone was more effective of leaf Zn content followed by Zn + Mn treatment in both seasons compared with control treatment. This may be because native available Zn (0.59 ppm) as shown in Table 1 was blew the critical level of available Zn (0.8 mg/kg) (Lindsay and Norvell, 1978). In addition, the high pH value (8.36) of the soil and the high content of calcium carbonate (3.26%) may also suppress Zn solubility (Saeed and Fox, 1977). It is interesting to mention that spraying Washington Navel orange trees with Zn was more effective than other treatment which correct Zn deficiency. However, Zn levels are negatively correlated with increasing soil pH than 7.2 (Thorne, 1957). Cu, Ca and P inhibit Zn uptake strongly, while Fe and Mn had no effect, (Chaudhry and Loneragan, 1972a, b and Olsen, 1972). Mohsen *et al.* (1990b) showed that spraying orange trees with solution containing Zn only or mixture of (Zn, Fe and Mn) resulted in significant increase in leaf Zn concentration.

Manganese:

Data concerning the effect of Mn foliar application (Table 2) revealed that, leaf Mn increased with Mn treatment. The highest value was obtained by Mn treatment followed by Fe + Mn, Fe + Zn and Fe + Mn + Zn, respectively. Control trees had the lowest value. Spraying trees with Mn significantly increased Mn level in leaves, in spite of the soil available Mn was sufficient (6.9 ppm, Table 1) and over the critical level of available Mn (1.0 mg/kg) (Lindsay and Norvell, 1978). This may be due to high soil pH (8.36) which, reduce Mn uptake (Halstead *et al.*, 1968). Mn may compete with other cations, particularly with NH^{+}_{4} and Fe^{2+} (Gardner *et al.*, 1985). Moreover, Barber (1995) reported that, the Mn concentration in the soil solution would theoretically decreased by a factor of 100 fold for every pH unit increase. These results were in agreement with those reported by Mohsen *et al.* (1990b).

Iron:

Data of Fe foliar spray show in Table 2 revealed that leaf Fe content was significantly affected with micronutrients foliar spray application in both seasons. The spraying with Fe alone gaves the highest leaf Fe value, which was 137.4 and 142.4 ppm) followed by (Fe + Mn + Zn), (Fe + Zn) and (Mn + Zn) treatment in 1998 and 1999 seasons, although, the available Fe of experimental site was 6.56 ppm, over the critical level of available Fe (4.5 mg/kg) (Lindsay and Norvell, 1978). This may be due to manganese and copper competitively, also, high calcium and high phosphorus (Table 1) inhibit iron uptake (Shim and Vose 1965). Also, the activity of Fe^{3+} mainted in soil solution decreases 1000 fold for unit increase in pH (Lindsay, 1979). These results are in accordance with those obtained by Patel *et al.* (1997).

From the present data in Table 2 it is obvious that micronutrient foliar spray applications caused a marked increase in leaf N, K, Fe, Mn and Zn concentration of Washington Navel orange trees, in both seasons. Similar results were reported by Swietlik and Laduke (1991), Hassan (1995a) and Omran *et al*. (1998).

Effect of micronutrients foliar spray on chlorophyll, plant growth and reproductive growth:

a)Leaf chlorophyll content:

The data in Table 3 revealed that, leaf chlorophyll a and b content significantly increased with micronutrients application in both seasons of study. The highest value of both chlorophyll a and b was obtained with Fe treatment followed by (Fe + Mn + Zn) treatment. This may be due to the precursor molecules for chlorophyll synthesis include iron, and if it is not present, chlorophyll cannot be synthesized (Gardner *et al*., 1985). It was observed that, foliar application of Fe, Zn and Mn increased leaf chlorophyll content (Mohsen *et al.*, 1992 and Devi *et al.*, 1997).

b) Plant growth:

As shown in Table 3 it is clear that plant growth as indexed by TCSA, GR %, VI and LA had significantly increased with micronutrients foliar spray application. The highest increases were obtained by Zn + Mn treatment. These results were true in both seasons. This may be due to micronutrients foliar spray application increased leaf chlorophyll (Table 3) and some nutrient elements particularly K which was found to serve a vital role in photosynthesis by directly increasing growth and leaf area index, and hence CO_2 assimilation and increasing the outward translocation of photosynthate. These results are in agreement with those reported by Omran *et al.* (1998).

Table (3): Effect of micronutrients spray on leaf chlorophyll and plant growth of Washington Navel orange trees in both seasons.

Treatments	Chlorophyll (ug/cm^2 FW)		Plant growth			
	(a)	(b)	TCSA (cm^2)	GR (%)	VI (m^3)	LA (cm^2)
1998						
Control	36.40	13.2	35.49	18.42	3.12	20.86
Fe	46.82	16.7	41.88	21.47	3.56	23.11
Mn	41.76	15.0	38.82	19.82	3.46	21.43
Zn	40.10	14.8	48.66	24.39	4.18	25.01
Fe + Mn	42.18	15.6	43.27	22.16	3.69	23.48
Fe + Zn	41.58	15.2	48.18	24.78	4.11	24.32
Mn + Zn	40.69	14.9	52.41	27.41	4.52	26.04
Fe + Mn + Zn	42.36	15.8	51.52	26.25	4.38	25.68
L.S.D. at 5%	2.28	1.16	3.14	1.32	0.32	0.56
1999						
Control	38.8	13.4	45.16	17.53	3.82	21.08
Fe	49.9	17.2	53.84	20.23	4.38	23.45
Mn	44.9	15.3	49.27	19.06	4.22	22.92
Zn	43.5	15.0	62.41	23.41	5.16	25.40
Fe + Mn	44.6	16.1	55.39	21.29	4.53	23.91
Fe + Zn	44.3	15.8	62.14	23.11	5.06	24.56
Mn + Zn	43.2	15.2	67.37	25.73	5.59	26.18
Fe + Mn + Zn	44.8	16.4	65.51	25.15	5.41	25.95
L.S.D. at 5%	2.48	1.22	3.62	1.48	0.39	1.08

TCSA = Trunk cross sectional area **GR = Growth rate**
VI = Volume index **LA = Leaf area**

c) Reproductive growth:

Regarding the effect of micronutrient elements foliar spray application, on Washington Navel orange tree reproductive growth, it was clear that (Table 4) fruit set % and fruiting % had significantly increased, meanwhile, June drop and preharvest fruit drop % significantly decreased as a result of micronutrients foliar spray in both seasons. The highest values of fruit set and fruiting % were obtained with (Zn + Mn) treatment which, gaves the lowest values of June drop and preharvest fruit drop %. This may be due to the enhancement of tree nutrition status (Table 2) and plant growth (Table 3). Similar observation were reported by Hassan (1993) and Omran *et al.* (1998).

Table (4): Effect of micronutrients spray on reproductive growth and yield of Washington Navel orange trees in both seasons.

Treatments	Reproductive growth				Yield	
	Fruit set (%)	June drop (%)	Preharvest drop (%)	Fruiting (%)	Kgs	No.
1998						
Control	64.42	57.34	6.67	0.406	14.72	72.36
Fe	65.89	55.89	6.21	0.508	17.43	83.16
Mn	65.46	54.39	6.38	0.497	15.99	79.41
Zn	67.12	53.26	5.77	0.614	19.84	92.12
Fe + Mn	66.66	53.87	5.93	0.607	18.06	79.93
Fe + Zn	66.91	53.48	5.86	0.633	20.12	89.24
Mn + Zn	67.23	52.83	5.32	0.687	21.18	96.54
Fe + Mn + Zn	66.99	53.98	5.56	0.617	21.29	92.67
L.S.D. at 5%	1.04	1.36	0.23	0.062	1.26	6.52
1999						
Control	65.38	58.16	7.22	0.412	20.34	107.69
Fe	66.84	56.73	6.72	0.521	26.50	125.26
Mn	66.54	55.39	6.98	0.486	24.11	114.32
Zn	67.83	53.96	6.20	0.588	30.42	134.89
Fe + Mn	67.62	54.67	6.49	0.543	27.23	122.63
Fe + Zn	67.84	54.24	6.36	0.624	31.01	132.18
Mn + Zn	68.07	52.58	5.71	0.669	33.14	139.68
Fe + Mn + Zn	67.88	54.66	5.96	0.629	33.20	136.52
L.S.D. at 5%	1.12	1.38	0.21	0.071	1.62	6.23

Effect of micronutrients foliar spray application on yield and fruit quality:

a) Yield:

As a result of nutrient elements enhancement and correction of some micronutrients deficiency aforementioned (Table 2), better plant growth (Table 3) and reproductive growth (Table 4) were obtained. Thus, the average fruit weight and number (Table 4) per tree were responded positively to micronutrients foliar spray application. The highest yield as fruit weight and number were obtained with (Zn + Mn) treatment. It was similar in both seasons of study. These results are supported by the findings of Rai and Tawari (1988), Devi, *et al.* (1997), Patel *et al.* (1997) and El-Safty (1998).

b) Fruit quality:

Concerning, fruit quality, data in Table 5 show that, fruit weight (gm), TSS %, acidity % and juice volume (cm^3) were significantly affected with micronutrients treatments. Whereas, Vit. C (mg/100 ml) and peel thickness did not significantly affect. The highest values of fruit weight, TSS%, acidity % and juice volume were with foliar spray of (Zn + Mn), (Zn + Fe) and Fe respectively, in both seasons. These results were in harmony with those obtained by El-Safty (1998) and Omran *et al.* (1998).

Table (5): Effect of micronutrients spray on some fruit quality of Washington Navel orange trees in both seasons.

Treatments	Fruit weight (g)	TSS (%)	Acidity (%)	Vit-C (mg/100 ml)	Juice volume (cm^3)	Peel thickness (mm)
1998						
Control	212	10.82	1.14	41.36	71.68	0.425
Fe	218	11.73	1.09	41.22	73.12	0.414
Mn	214	11.18	0.97	41.28	72.78	0.417
Zn	237	11.02	0.95	41.16	77.72	0.419
Fe + Mn	228	11.43	1.04	41.30	76.01	0.422
Fe + Zn	235	11.86	0.98	40.92	78.11	0.416
Mn + Zn	242	11.29	0.92	41.09	78.85	0.412
Fe + Mn + Zn	239	11.32	0.99	41.26	78.74	0.418
L.S.D. at 5%	19	0.15	0.12	NS	2.16	NS
1999						
Control	217	10.63	1.12	42.13	72.35	0.436
Fe	224	11.48	1.08	41.99	75.15	0.422
Mn	219	10.95	0.97	42.06	73.71	0.426
Zn	241	10.78	0.94	41.96	79.04	0.429
Fe + Mn	232	11.59	1.05	42.08	76.22	0.432
Fe + Zn	244	11.81	0.99	41.78	79.63	0.423
Mn + Zn	249	11.26	0.90	41.89	80.13	0.418
Fe + Mn + Zn	247	11.17	0.95	41.96	80.00	0.421
L.S.D. at 5%	17	0.21	0.11	NS	2.21	NS

Generally, it could be concluded that, micronutrients foliar spray application enhanced leaf nutrient status and corrected some micronutrient deficiency. Thus, plant growth, reproductive growth and yield increased and improved fruit quality of Washington Navel orange trees. The highest yield with best quality was obtained by Zn + Mn treatment.

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إستجابة أشجار البرتقال أبو سره الصغيرة النامية فى الاراضى الطينية خفيفة القلوية للرش بالعناصر الصغرى المخلوبه

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أجرى هذا البحث بمزرعة محطة البحوث الزراعية بسخا فى موسمى 98/97 ، 1999/98 على أشجار البرتقال أبو سره (5-4 سنوات) حيث التربة الطينية الرسوبية لدراسة استجابة أشجار البرتقال أبو سره الصغيرة للرش الورقى بالعناصر الصغرى المخلوبه (الحديد ، الزنك ، المنجنيز) منفردة أو مخلوطه.
وقد أظهرت النتائج المتحصل عليها أن الإضافة الورقية للعناصر الصغرى أدت إلى:

1- محتوى الاوراق المعدنى: زاد معنويا محتوى الاوراق من النيتروجين ، البوتاسيوم ، الحديد ، المنجنيز ، الزنك بينما لم يتأثير مستوى الفوسفور معنويا بالاضافة الورقية للعناصر الصغرى فى كلا الموسمين.
2- الكلوروفيل: زاد معنويا محتوى الاوراق من الكلوروفيل (a and b).
3- نمو النبات: تحسن معنويا نمو النبات معبرا عنه بمساحة مقطع جذع الشجرة ، معدل النمو % ، ودليل النمو % ومساحة الورقة.
4- الازهار والعقد: زاد معنويا عدد الازهار والنسبة المئوية للعقد والنسبة المئوية للاثمار بينما انخفض تساقط يونيو وتساقط قبل الجمع.
5- المحصول: زيادة واضحة فى وزن وعدد الثمار للشجرة فى كلا الموسمين.
6- صفات جودة الثمار: تحسنت معنويا صفات جودة الثمار (وزن الثمرة ، السكريات الكلية الذائبة % ، الحموضة الكلية % ، وحجم العصير) بينما لم تتأثر معنويا قشرة الثمرة ، فيتامين C.
7- أحسن معاملة: أظهرت النتائج أن المعاملة (Zn + Mn) هى أحسن معاملة حيث أعطت أحسن النتائج فى كلا موسمي الدراسة.