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EFFECTS OF SOME NUTRIENTS AND GROWTH SUBSTANCES APPLICATION ON FRUITING, YIELD AND FRUIT QUALITY OF NAVEL ORANGE TREES

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ABSTRACT

This experiment was carried out during two successive seasons 1998 and1999 on 25- year –old navel orange (*Citrus sinensis* osbeck) trees budded on sour orange rootstock in a private orchard at El-Monofia Governorate. The effects of zinc, calcium , gibbrellic acid and biozem on fruiting, yield , fruit quality and mineral contents were recorded.

Spraying zinc sulfate alone or as a combination with calcium chelates, biozem and gibbrillic acid treatments increased fruit- set , tree efficiency (as a number of fruits per 1 m^3 tree canopy), reduced June and pre-harvest fruit drop when compared with the control treatment. Whereas, zinc sulfate plus calcium chelated and biozem treatment had more effect in this respect . Furthermore , the above mentioned treatments markedly increased fruit weight , fruit size, fruit firmness and fruit height (which causes a change in fruit shape). Moreover, they had a slight effect on peel thickness. Zinc sulfate alone or combined with calcium chelated significantly increased fruit juice weight, TSS, TSS/ acid ratio and reduced acidity.

Moreover, combination of zinc sulfate with calcium chelated and biozem or gibbrellic acid increased N, Ca (macro elements) and Fe, Zn, Mn (micro elements) in navel orange leaves. On the other hand, these, treatments had no effect on P and K contents .

Key words *: calcium, citrus, zinc.*

1. INTRODUCTION

In citrus, the majority of the produced orange abscise within two months after anthesis . Certain cultivars require pollination and seed development for fruit set , while others can be set without pollination (seedless cultivars) whereas , a pollen stimulates fruit setting only (Erickson and Brannaman 1960) .

Washington navel orange tree is practically more sensitive to environmental stresses , particularly water stress and microclimate stability to a degree that they may suffer in many years from excessive drop during May and June, which is reflected on reducing fruit – set and yield (Azab 1979) .

Zinc is known to stimulate growth and its deficiency leads to shortening of internodes in plants .This led to the discovery that this element is closely related to auxin level in the affected plants .In addition, it was thought that Zn deficiency causes the destruction of IAA by an increase in oxidation due to the promotion of peroxides activity. Moreover , it was clearly shown that a lower auxin level in the plant due to Zn deficiency is an account of reduced synthesis of tryptophan , a precursor of I AA (Nason and Mc Elroy , 1963).

Spraying of $ZnSO_4$ at 0.5% significantly increased the number of flowers formed on bearing shoots , fruit set and reduced fruit drop (Nasr 1982 and Sharaf 1990) . Moreover , $ZnSO_4$ application improved leaf chlorophyll content (Patel and Patel 1985)and fruit quality (Sharaf 1990 and Desai *et al.,*1991) .

It is well known that GA_3 and IAA significantly affect tree yield (Giffillan *et al.,* 1974 and Smit 1990) and fruit quality (Didda 1971, Lima & Davis 1984 and Ibrahim *et al.,*1994) .

Application of calcium inhibited fruit abscission and delayed its senescence development (Poovaiah and Leopold, 1973) , protected the middle lamella from normal breakdown (Poovaiah 1988), increased fruit pull force and firmness (Faust 1975) , reduced acid concentration and enhanced sugar accumulation (Xie *et al.,* 1992) .

The aim of this investigation was to study the effect of foliar application of some growth substances ($ZnSO_4$, GA_3 , Biozeme and Ca – EDTA) on Navel orange trees fruit set, fruit drop, tree productivity and fruit quality .

2. MATERIAL AND METHODS

The present work was carried out during two successive seasons (1998 and 1999) on 25 – year –old Navel orange trees *(Citrus sinensis* osbeck) grafted on sour orange rootstock in a private orchard at El – Menofia Governorate and planted 5 m apart in a clay loamy soil. The trees were selected at random and as uniform as possible in their growth vigour and yield. All the experimental trees were treated alike in their cultural practices(60-80 kgm. animal manure plus 1.5 kgm super phosphate 15.5 % phosphoric acid in December, 2 kgm amonum sulfate 20.6% N plus 1 kgm potasum sulfate 48% ko H in March and August and 1 kgm amonium nitrate 33% N in May per tree) except for the purpose of this experiment .

2.1.The treatments were as follows

1. Control (sprayed with water) .
2. $ZnSO_4$ at 5 gm / l . (at 15th Feb. , 1st May and 15th July).
3. $ZnSO_4$ at 5 gm /l + *Ca – EDTA at 0.5 gm /l (at 15th Feb. 1st. May and 15th July .
4. $ZnSO_4$ at 5 gm /l at 15th Feb, 1st May and 15th July) ** Biozem at 1.5 m /l. Which were sprayed at 30% and 70% of blooming.
5. $ZnSO_4$ at 5 gm/ l (at 15th Feb., 1st May and 15th July) and gibberellic acid at 15ppm which were sprayed at 30% and 70% of blooming .
6. $ZnSO_4$ at 5 gm /L+ Ca- EDTA at 0.5 gm/l (at 15th Feb., 1st May and 15th July) and Biozem at 1.5 ml . which were sprayed at 30% and 70% of blooming .
7. $ZnSO_4$ at 5gm/ l. + Ca –EDTA at 0.5 gm/l. (at 15th Feb., 1st May and 15th July) and gibbrilLic acid at 15ppm which were sprayed at 30% and 70% of blooming .

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*Ca- EDTA (10% Sequestered calcium chelated by ethyl- di- amine tetra – a cetec acid .

**Biozem { Micro elements eq. 19.34 gm /L. (1.86 %) (Fe 0.49 % , Zn 0.34%, Mn 0.12% , Mg 0.14 % , B 0.30% and S 0.44%) , biological hormones (78.87 %) (GA 32.2ppm, IAA 32.2 ppm and Zeatin 83.2 ppm). Ingredients inertnes (19.27 %) }

Each treatment was replicated three times with two trees in each replicate in a complete randomized block design .Each tree was individually sprayed with 8 litres of the solution which was sufficient for a thorough coverage of the canopy .

Effects of treatments on fruit-set, June drop and pre-harvest fruit-drop percentage were weasured as follows :

1. Fruit-set percentage was calculated at fruit–setting stage (after petals fall at1st May) as formula :

$$\text{Fruit set\%} = \frac{\text{Number of fruits/ Shoot X100,}}{\text{Total number of flowers /shoot}}$$

2. June drop percentage was recorded at 1st July as follows:

$$\text{J.D.(\%)} = \frac{\text{Number of fruits which dropped x 100}}{\text{Total number of fruits}}$$

3. Pre-harvest fruit-drop percentage was calculated at15th December as follows:

$$\text{Pre-H.F.D(\%)} = \frac{\text{Number of dropped fruitsunder tree x100}}{\text{Total number of fruits on tree}}$$

A sample of mature leaves from non fruiting spring flushes were collected in September in both seasons , oven dried at 70 °C and analyzed for their contents of N,P, K, Ca , Fe , Zn and Mn using the standard procedures (Anderson *et al.,* 1968) .

Fruit yield was recorded annually. Yield in relation to tree volume was used as a measure of tree efficiency (Tree efficiency equals number of fruits /m^3 *canopy of tree (Castle and Phillips, 1980).

2.2.Fruit chemical and physical properties at harvest

A sample of 20 fruits per each replicate was collected at random at the 1st week of January to determine fruit weight, fruit volume, fruit dimensions, fruit firmness, peel thickness, juice weight,

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*Was calculated by the formula: 0.5236 × height × diameter square (Turrell , 1946) .

total soluble solids (%), acidity percentage and T.S.S/ acid ratio (A. O. A. C.,1960).

A complete randomized design was used. The obtained data were subjected to the analysis of variance according to Snedecor and Cochran (1972) . Means between treatments were compared using the LSD values at 0.05 and 0.01 level.

3. RESULTS AND DISCUSSION

3.1.Fruit set and tree yield efficiency

The obtained data in (Table 1) indicate that, fruit-set ,June fruit-drop, pre-harvest fruit drop as a percentage and tree yield efficiency respectively were significantly increased by spraying $ZnSO_4$ alone or in combination with Ca-EDTA, gibbrellic acid and biozem treatments. Whereas ,these treatments clearly increased fruit–set and tree yield efficiency and reduced June fruit drop and pre-harvest fruit drop compared with the control treatment in both seasons . Similar findings were reported by, Nasr (1982) & Sharaf (1990) who mentioned that ,$ZnSO_4$ foliar application increased the number of flowers formed on bearing shoots and fruit–set. Smit (1990) concluded that GA_3 and IAA improved fruit set and tree yield Our findings were in line with Poovaiah & Leopold (1973) and El –Hammady *et al.* (2000) who concluded that calcium application inhibited fruit abscission and reduced fruit–drop .On the other hand , Embleton *et at.*(1973b) found that fruit yield was not affected by the application of gibbrellic acid.

Table(1): Effect of some nutrient and growth substance treatments on fruit set %, June drop %, Pre-harvest fruit drop % and Tree yield efficiency of Navel orange trees in two seasons (1998 and 1999).

Treatment		Fruit Set %		June drop %		Pre-harvest fruit drop %		Tree efficiency number / 1m3	
		1998	1999	1998	1999	1998	1999	1998	1999
T_1	Control	33.60	33.99	92.75	92.66	3.35	3.67	4.44	4.80
T_2	Zn So_4 at 5 gm /L.	36.08	34.57	91.01	90.44	1.79	1.81	6.69	6.43
T_3	Zn So_4 + Ca –EDTA at 0.5gm/L.	34.67	35.11	91.80	91.46	1.61	1.73	5.61	7.01
T_4	Zn So_4 + biozem at 1.5 ml/L.	37.01	37.36	90.93	90.11	2.36	2.98	6.79	8.70
T_5	Zn So_4 + GA_3 at 15 ppm.	35.74	36.83	91.75	90.95	2.86	3.01	5.62	7.03
T_6	Zn So_4 + Ca- EDTA +biozem	37.58	37.86	90.33	90.20	1.12	1.14	8.02	10.43
T_7	Zn So_4 + Ca – EDTA + GA_3	36.63	37.01	91.37	90.83	0.93	0.99	6.44	8.18
	L.S.D 5%	1.14	1.22	1.18	1.30	0.30	0.40	0.11	0.15
	1%	2.19	2.20	2.19	2.03	0.92	2.27	2.14	3.02

3.2. Fruit quality

It is clearly observed that, fruit weight , fruit size , fruit dimensions, fruit firminess and peel thickness were significantly affected by $ZnSO_4$ and their combination (Ca-EDTA,GA_3 and biozem) treatments. In this respect as shown in (Table 2), $ZnSO_4$, plus Ca-EDTA, $ZnSo_4$ plus (Ca-EDTA and biozem) and $ZnSO_4$, combined with (Ca-EDTA and GA_3) treatments tended to increase navel orange fruit weight and size compared with the control in both seasons . These results are in line with Kojima (1999) who indicated that, there is a positive relationship between IAA and GA_3 and the growth of plant organs and the development of natural growth regulators in plants , especially in citrus fruits. Hield *et al* ., (1965) found that the application of GA_3 had no effect on navel orange fruit size . Our results also revealed that foliar applications of $ZnSo_4$ and their combinations of Ca- EDTA,GA_3 and biozem significantly increased navel orange dimensions and changed fruit shape to "oval shape" compared to the control "spherical shape " in both seasons. However, no significant differences were found between the treatments except $ZnSO_4$ plus GA_3 which was of a highest effect in this respect. A similar conclusion was reported by Ibrahim *et al* ., (1994) .

The results also indicated that fruit firmness and rind thickness were significantly increased by foliar applications of $ZnSO_4$ and their combinations . The highest values for fruit firmness were obtained by applying $ZnSO_4$ plus GA_3 , $ZnSO_4$ plus Ca–EDTA and $ZnSo_4$ plus Ca-EDTA and biozem treatments respectively in both seasons . This conclusion is in agreement with those of Poovaiah (1986) who pointed out that calcium had an important role in maintaining the cell wall structure and membrane integrity , by the inter action of calcium with pectic acid in cell wall to form calcium pectate . Moreover , GA_3 , biozem and Zn (considered precursores of endogenous IAA) caused a reduction in maturity and ripening. This effect delayed fruit softening associated with polygalacturanase enzyme activity. Regarding the effect of these treatments on fruit rind thickness , the same observation was reported by Coggins *et al.,* (1960) who mentioned that GA_3 induced more thick–peeled fruits.Generally, it can be noticed that there is a positive relationship betweer. fruit peel thickness and its firmness .

Table(2): Effect of some nutrient and growth substances treatments on some physical and chemical of navel orange at harvest in two seasons (1998 and 1999).

Treatment		Fruit weight (gm)		Fruit volume (ml.)		Fruit shape		Firmeness		Fruit rind thickness (cm)		Juice weight gm		T.S.S %		Total Acidity %		T.S.S / Acid Ratio	
		1998	1999	1998	1999	1998	1999	1998	1999	1998	1999	1998	1999	1998	1999	1998	1999	1998	1999
T_1	Control	215.17	210.08	225.47	221.84	0.95	0.98	14.10	13.86	0.41	0.42	177.31	179.19	10.73	10.87	1.327	1.402	8.086	7.718
T_2	Zn So_4 at 5 gm /L.	242.48	238.97	242.48	238.82	1.06	1.05	22.50	22.93	0.44	0.46	198.08	199.87	11.00	11.10	0.930	0.952	11.828	11.659
T_3	Zn So_4 + Ca –EDTA at 0.5gm/L.	241.71	236.32	269.50	266.66	1.06	1.07	20.40	21.07	0.46	0.48	188.50	191.34	11.00	11.31	0.990	0.995	11.111	11.367
T_4	Zn So_4 + biozem at 1.5ml/L.	219.78	214.96	247.42	241.37	1.08	1.11	23.17	22.99	0.47	0.45	185.00	187.90	10.86	10.99	1.060	1.084	10.245	10.138
T_5	Zn So_4 + GA_3 at 15 ppm.	217.47	214.88	231.99	225.93	1.12	1.15	23.50	24.00	0.44	0.42	180.74	185.01	10.06	10.17	1.077	1.093	9.340	9.305
T_6	Zn So_4+Ca- EDTA +biozem	231.27	230.11	253.38	250.13	1.02	1.01	22.72	22.91	0.48	0.46	194.43	196.62	10.93	11.20	1.110	1.120	9.847	10.000
T_7	Zn So_4 + Ca – EDTA + GA_3	230.37	227.01	250.73	245.79	1.05	1.08	17.75	18.01	0.47	0.46	203.44	206.10	10.46	10.70	1.107	1.115	9.449	9.596
	L.S.D 5%	1.53	1.70	1.66	1.81	0.03	0.02	2.92	3.99	0.03	0.03	3.52	3.70	0.41	0.42	0.028	0.039	1.008	1.125
	1%	8.15	10.80	9.33	11.47	0.10	0.12	4.87	6.01	0.04	0.04	5.79	5.92	N.S	1.12	0.31	0.400	2.311	3.118

Table(3): Effect of some nutrient and growth substances treatments on Navel orange leaf mineral contents of Navel orange in two seasons (1998 and 1999).

Treatment		N %		P %		K %		Ca %		Fe (ppm)		Zn (ppm)		Mn (ppm)	
		1998	1999	1998	1999	1998	1999	1998	1999	1998	1999	1998	1999	1998	1999
T_1	Control	2.46	2.47	0.13	0.12	0.78	0.80	1.98	1.96	68	66	51	55	32	30
T_2	Zn So_4 at 5 gm /L.	2.44	2.46	0.11	0.13	0.80	0.81	2.48	2.52	79	78	80	82	36	38
T_3	Zn So_4 + Ca –EDTA at 0.5gm/L.	2.56	2.58	0.12	0.11	0.79	0.78	3.91	4.00	82	81	70	68	36	35
T_4	Zn So_4 + biozem at 1.5 ml/L.	2.58	2.40	0.14	0.15	0.83	0.81	2.85	2.82	96	94	78	80	52	54
T_5	Zn So_4 + GA_3 at 15 ppm.	2.36	2.38	0.10	0.11	0.84	0.82	2.78	2.80	78	80	76	78	34	32
T_6	Zn So_4 + Ca- EDTA +biozem	2.52	2.50	0.13	0.14	0.82	0.84	3.82	3.90	95	96	72	75	48	50
T_7	Zn So_4 + Ca – EDTA + GA_3	2.61	2.58	0.11	0.10	0.78	0.79	3.78	3.77	85	84	68	70	32	30
	L.S.D 5%	0.035	0.031	N.S	N.S	N.S	N.S	0.043	0.387	3.495	4.808	3.302	3.235	3.026	3.167
	1%	0.049	0.042	N.S	N.S	N.S	N.S	0.060	0.538	4.866	6.695	4.598	4.505	4.216	4.411

Regarding $ZnSo_4$ and its combination sprays , the results demonstrated that a significant increase was noticed in fruit juice weight when compared with the control in both seasons. The highest value was resulted from $Znso_4$ plus Ca-EDTA and GA_3 . These findings are in agreement with those obtained by Babu *et al* ., (1984) who mentioned that the percentage of fruit juice was the highest in fruit treated with GA_3 at 20-40 ppm. Concerning total soluble solids , acidity and T.S.S/Acid ratio, the results revealed that $ZnSo_4$ and $ZnSo_4$ plus Ca–EDTA treatments significantly increased T.S.S% and reduced acidity . The results showed an increase in T.S.S /acid ratio in navel orange fruit juice when compared with other treatments . These finding are in line with those obtained by Xie *et al.,* (1992) who noticed that , IAA stimulated the transport of Ca^{2+} to the interior parts of the fruit, which enhanced sugar accumulation, increased total soluble solids and reduced acid concentration in the fruits .

3.3.Leaf mineral contents

Data in (Table 3) show the effect of Zn SO_4 and its combination (Ca-EDTA , GA_3 and biozem) treatments on navel orange leaf N,P,K and Ca (percentage) and Fe, Zn and Mn (ppm) contents . Results indicated that , $ZnSo_4$ plus (Ca-EDTA and GA_3), $ZnSO_4$ plus biozem , $ZnSO_4$ plus Ca-EDTA and $ZnSO_4$ plus (Ca – EDTA and biozem) treatments significantly increased leaf N percentage respectively in both seasons. On the other hand , $ZnSO_4$ alone or plus GA_3 had no effect on N content . From the results , it can be concluded that there is a positive effect of Ca-EDTA on nitrogen absorption. This conclusion is in agreement with those obtained by Heweihua *et al.,*(1999) who mentioned that calcium applied as foliar spray to apple trees enhanced N absorption which caused an increase of nitrogen content .

Furthermore, results clearly indicated that $ZnSO_4$ and its combination treatments insignificantly affect P% and K% contents in navel orange leaves. These results are in line with those found by Bacha (1977) , who stated that with foliar spray of Zn to Balady orange, P % and K% were generally not affective.

Data in (Table 3) indicated that $ZnSO_4$ and its combination treatments significantly increased Ca % in leaves of navel orange trees when compared with the control in both seasons. The highest increments were in calcium application treatments. These results are in agreement with those obtained by Meyer *et al* . (1966) who indicated that Zinc is necessary in the synthesis of indol acetic acid (IAA) which causes an increase in plant growth rate and subsequently an increase in the leaf constituent of some major nutrients .

It is clear from the data presented in (Table 3) that , $ZnSO_4$ and its combination (Ca-EDTA , GA_3 and biozem) treatments statistically increased Fe ,Zn and Mn of navel orange leaves content when compared with control treatment in both seasons . The highest effect may be due to biozem compound which consists of GA ,IAA and some micro elements . These results are in line with those obtained by Meyer *et al.,* (1966) and Ranvir & Missra (1980) who indicated that foliar application of micronutrients on Kinnow mandarin caused an increase of Fe , Zn and Mn contents . Moreover, $ZnSO_4$ at 0.5% plus borax at 0.2% gave the best results in improving general tree condition .

According to leaf standards guide of Embleton *et al.,* (1973b), the results in (Table 3) showed that there was no nutrient deficiency in navel orange trees under control and no excess symptoms in trees under treatments. This means that the improvement in yield , fruit quality and tree growth conditions will be due to $ZnSO_4$ and its combination applications under this study .

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تأثير إضافة بعض المغذيات ومنشطات النمو على إثمار ومحصول وصفات الجودة للبرتقال أبو سرة

عبد الرحمن محمد عبد الرحمن

معهد بحوث البساتين– مركز البحوث الزراعية–الجيزة

ملخص

أجريــت هذه التجربة خلال موسمى ١٩٩٨ و ١٩٩٩ على اشجار برتقال بســرة عمر ٢٥ سنة مطعومة على أصل النارنج ونامية فى احد البساتين الخاصة بمحافظة المنوفية وذلك لدراسة مدى تأثير الرش بسلفات الزنك بمعدل ٥ جم / لتر منفردا او خلطــا مع الكالسيوم المخلبى بمعدل ٠,٥ جم / لتر ثلاث مرات خلال موســم النمو (منتصف فبراير قبل بدء النمو، اول مايو عقب انتهاء التزهير

و ١٥ يولـــيو اثناء نمو الثمار) مع رش حمض الجبريللين بتركيز ١٥ جزء فى المـلـــيون او مركب البايوزيم بمعدل ١,٥ سم٣ / لتر مرتين : عند ٣٠% و ٧٠% مـــن التزهـــير الكامل للبرتقال ابو سرة على النسبة المئوية للعقد عند تمام العقد ، النســـبة المئوية لتساقط يونيو ، نسبة تساقط الثمار قبل الحصاد وكذلك كفاءة اثمار الاشجار من خلال عدد الثمار لكل ١م٣ من حجم الشجرة . وكانت نتائج التجربة كالاتى :-

ادت هذه المعاملات الى زيادة نسبة العقد وتقليل تساقط يونيو وكذلك تساقط ما قبل الحصاد مما ادى الى زيادة واضحة فى كفاءة إثمار الأشجار . الا ان رش ســـلفات الـــزنك خلطا مع شيلات الكالسيوم مع إضافة مركب البايوزيم كان اكثر تأثيرا .

كان لاضافه هذه المعاملات اثرا واضحا على صفات الثمار حيث ادت الى زيادة وزن الثمرة ، حجم الثمرة ، صلابة الثمرة عند الحصاد وكذلك زيادة ارتفاع الـــثمرة ممـــا ادى الـــى تغير شكلها حيث اصبحت شبة بيضاوية حيث كانت شبه مســـتديرة فـــى معاملـــة المقارنة. ويرجع هذا التأثيرإلى عنصر الزنك او مركب الانـــدول اســـتيك اســـيد (ضـــمن محتوى البايوزيم) . الا ان تأثير اضافة هذه المعاملات كان غير واضح على سمك القشرة فى اغلب المعاملات ما عدا معاملتى الزنك مع الكالسيوم المخلبى او مركب البايوزيم .

ادى الـــرش بسلفات الزنك منفردا او خلطا مع شيلات الكالسيوم إلى زيادة محتوى عصير الثمرة من المواد الصلبة الكلية الذائبة وخفض نسبة الحموضة مما ادى الى زيادة النسبة بينهما .

كـــان لاضافة هذه المعاملات اثر واضح فى زيادة محتوى اوراق البرتقال ابو سرة من عنصرى الازوت والكالسيوم (عناصر كبرى) وكذلك زيادة تركيز الحديد والزنك والمنجنيز (عناصر صغرى) فى حين انه لم يكن لها تأثير واضح على عنصرى الفوسفور والبوتاسيوم .

مما سبق نستخلص ان :

عنصـــرى الزنك والكالسيوم من العناصر المؤثرة فى تحسن حالة الاشجار ممـــا ينعكس على المحصول وصفات الجودة و مع استخدام اى منشط للنمو يمكن زيادة انتاجية وتحسين صفات الجودة للبرتقال ابو سرة مع الوضع فى الاعتبار أن هـــذه المركبات متوفرة محليا ولن تؤثر كثيرا فى تكاليف الانتاج لانخفاض سعرها مقارنة بالمواد الاخرى التى تستخدم لهذا الغرض .