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Zn, Yeast and Naa Manipulation on Growth and Nutritional Status of Washington Navel Orange.

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Abstract

This investigation was carried out during two successive seasons, 2022 and 2023, on 7-year-old Washington navel orange trees that budded on sour orange rootstock and grown in clay loamy soil. The study aimed to improve the vegetative growth and nutritional status of the studied trees using foliar feeding with zinc in two forms (sulfate at 6.0g/l and Zn- Nps at 6.0cm/L), yeast extract at 2.0% and NAA at 100 ppm. The treatments (single or combined) were foliar sprayed 6 times, starting from mid-February, after the fruit set (mid-April) and every month till August. The results revealed that all studied treatments significantly improved the two studied parameters as compared with water-sprayed trees. It was clear that the studied vegetative growth parameters (shoot length and diameter; the number of leaves/shoot; the number of shoots/one-meter length limb and leaf area) were highly enhanced and their values were maximized when the trees were sprayed with ZnNPs at 6.0 cm/L + yeast extract at 2%. When $ZnSO_4$ replaced by ZnNPs the parameter reflected approach values. Leaf N, P, Fe, Zn, Mn, and chlorophyll contents increased with ZnNPs at 6.0 cm/L + yeast extract at 2%, but leaf K content was highly improved with $ZnSO_4$ alone. Meanwhile, the high concentrations of both Ca and Mg in the leaves were associated with $ZnSO_4$ at 6.0 g/L combined with NAA at 100 ppm.

Keywords: foliar application; Nutritional status, Vegetative growth Washington navel orange; Zinc sulfate-Nano Nps, Yeast and NAA

Introduction

Citrus fruits represent one of the most economically and nutritionally important horticultural crops worldwide. These fruits are valued not only for their refreshing taste and high vitamin C content but also for their significant contribution to international trade and national economies, especially in tropical and subtropical regions. In Egypt, citrus is the most important fruit crop in terms of both cultivated area and production(In Egypt, [529405 faddans) (more than 39% of total fruit area) are planted with citrus trees. The production of citrus in Egypt was increased to 5142829 tonnes in 2023 by the **Ministry of Agriculture and Reclamation, Egypt (2023).**

Egypt is considered to be one of the ten largest producers of citrus in the world. Therefore, strenuous efforts have always been exerted to increase the production of citrus through a better understanding of its reaction to the environment and mineral nutrition.

Zinc functions as a cofactor for over 300 enzymes and is essential for processes such as carbohydrate metabolism, hormone regulation (especially indole-3-acetic acid - IAA), and protection against oxidative stress. Inadequate zinc availability can lead to stunted growth, reduced leaf expansion, chlorosis, and poor fruit set **(Broadley et al., 2007; Alloway, 2008)**. In citrus, zinc deficiency is typically manifested as mottled leaves, rosetting, and small, hard fruits with low juice content.

Zinc (Zn) is an essential micronutrient for plants, playing vital roles in enzyme activation, auxin metabolism, photosynthesis, and cell membrane integrity. Zinc deficiency is particularly problematic in fruit orchards located in alkaline or calcareous soils, where zinc becomes less bioavailable. Conventional zinc fertilizers often suffer from poor solubility and mobility in soil. In contrast, zinc nanoparticles (ZnNPs) have demonstrated significantly higher bioavailability and mobility, leading to better absorption by plant tissues and improved physiological performance **(Dimkpa et al., 2012; Raliya et al., 2016).**

Numerous studies have reported the positive effects of foliar-applied ZnNPs on various fruit tree species, including citrus, mango, apple, and grapevine. ZnNPs have been shown to: Improve leaf chlorophyll content, photosynthetic rate, and nutrient translocation. Enhance fruit size, weight, and sugar-acid balance. Boost antioxidant enzyme activity, contributing to stress tolerance. Reduce premature fruit drop and increase yield **(El-Tohamy et al., 2021; Alsaeedi et al., 2019)**

Because foliar application delivers nutrients directly to the leaves, nano-zinc fertilizers provide a rapid and efficient method for correcting zinc deficiencies in fruit trees. Additionally, their low application rates reduce the risk of environmental contamination compared to traditional fertilizers.

Yeasts, particularly *Saccharomyces cerevisiae*, are rich in proteins, amino acids, vitamins (especially B-complex), enzymes, and phytohormones such as auxins, gibberellins, and cytokinins **(El-Tanany et al., 2011; El-Khawaga, 2013)**. They also contain nucleotides, carbohydrates, and various trace elements that enhance their bioactivity when applied to plants. Yeasts are known for their rapid multiplication, high metabolic activity, and ability to colonize plant surfaces or root zones, making them effective in promoting plant growth.

Naphthalene Acetic Acid (NAA) is a synthetic auxin, structurally analogous to the naturally occurring indole-3-acetic acid (IAA), and functions primarily by mimicking the action of endogenous auxins in plant systems. Naphthalene Acetic Acid (NAA) has received considerable attention due to its diverse roles in modulating plant growth and development. NAA is known for its efficacy in reducing pre-harvest fruit drop, enhancing fruit set, stimulating rooting, and regulating vegetative growth. Its application has been extensively studied in various fruit crops, with citrus being one of the most responsive genera **(Davies, 2010; Youssef & Roberto, 2020**).

The main goal of that study is to throw light on some foliar feeding amendments (Zinc, yeast and NAA), hopping enhancement in vegetative growth and leaf nutritional status of Washington navel orange trees grown in Qaliobia Governorate

Materials and Methods

Location and plant materials:

The present study was accomplished during two successive seasons (2022 and 2023) on 7-year-old Washington navel orange trees budded on sour orange and grown in the private orchard at Gezera Belee, Benha, Qalubiya Governorate, Egypt.

21 healthy fruitful trees were carefully selected to carry out the investigation.

The chosen trees were nearly as uniform as possible as we could in their size, and shape, grown in clay loamy soil, planted at 5 m apart, irrigated through a flood surface irrigation system and the trees were subjected to the annual regular horticulture management which was adopted in the area according to the Ministry of Agriculture recommendations.

Zinc in two forms (Zn-sulphate and Zn-Nano) and NAA besides bio-activator micro-organisms (yeast), were selected to build up the skeleton of such study.

The 7 Treatments involved in this study were as follows.

T1-Control (tap water spray).

T2 ZnSO4 (6.0 g/L)

T3- Zno-NPs(6.0cm /L

T4- ZnSO4 (6.0g/L) + yeast (0.2%).

T5- Zno-NPs (6.0cm /L)+ yeast (0.2%).

T6- ZnSO4(6.0g/L)+NAA(100 ppm).

T7-Zno-NPs(6.0cm/L)+NAA(100 ppm).

Those substances were arranged to form the six treatments, besides the control.

Experiments layout

The treatments were arranged in a complete randomized block design. Each treatment was replicated three times and each replicate was represented by one tree.

Application time

Taking into consideration that spray treatments were applied covering the whole foliage of each tree canopy, 5 liters were found to be sufficient in this concern. The trees were sprayed four times starting from the first week of February, after the fruit set (mid-April) and at one-month intervals till August.

The methodology has been reported in this study to evaluate the response of growth nutritional status and fruiting of

to the various investigated treatments being carried out determined changes in different measurements of the following examined characteristics :

2.1 Vegetative growth measurements:

In late March 2022 and early April 2023, four main branches (limbs/scaffolds) well distributed around each tree periphery were carefully selected and tagged. The following parameters were estimated in mid-October during both seasons of study.

2.1.1 Shoot length (cm)

2.1.2shoot diaameter (mm)

2.1.3- No. of leaves /shoot.

2.1.4 Average number of newly developed shoots per one meter of every tagged limb

2.1.5-average leaf area (cm2

Twenty mature leaves from the previously labeled shoots per limb were randomly collected then leaf area (cm2) was calculated according to the following equation of **Ahmed and Morsy (1999).**

Leaf area = 0.49 (Length x Width) + 19.09 = ... cm2.

2-Nutritional status measurements:

2.2.1 Total leaf chlorophyll content: (SPAD)

Total chlorophylls in fresh leaf samples were determined by using the chlorophyll meter model **SPAD 502**, according to **Netto *et al*., (2005).**

2.2.2 Leaf mineral content :

Representative samples of fourth and fifth leaves from the base of spring shoots were collected from each replicate in October during both seasons. The samples were thoroughly washed with tap water, rinsed twice with distilled water, and oven-dried at 80°C for 48 hours. The dried material was bags ready for analysis: till a constant weight and finely ground for .5g of each dried sample was ground and digested to be ready for the following determinations

1-Total Nitrogen: Total N in leaves was determined by the modified micro Kjeldahl method described by **(Pregl, 1945).**

2-Total phosphorus: Total P in leaves was determined by wet digestion of plant materials after the methods described by using sulphuric and perchloric acid, which has been strongly recommended by **(Piper, 1958).**

3. Total potassium: Total K in leaves was estimated by using a flame photometer as described by **Brown and Lillelland (1974).**

4-The percentage of Calcium, Magnesium, Iron and Zinc was determined using the Atomic absorption spectrophotometer "Perkin Elmer -3300" after **Chapman and Pratt (1961)**

Statistical analysis:

All the obtained data in the two seasons of the study were statistically analyzed using the analysis of variance method according to **Snedecor and Cochran (1990).** Meanwhile, differences among means were distinguished by Duncan`s multiple range tested at the probability of 5 % level **(Duncan, 1955).**

Results

3.1Vegetative growth

3.1.1.Shoot length and diameter(cm):

Regarding shoot length and diameter of Washington navel orange trees as impacted by foliar spray with either Zinc in both forms (sulfate and nano) or each form combined with either yeast or NAA, data presented in **Table (1)** declare that all investigated treatments improved both tested parameters as compared with control. Furthermore, spraying with Zno-NPs combined with yeast extract **(T5)**was more effective in enhancing the two studied parameters, as it maximized the values of such two parameters during both seasons of study. Meanwhile, Zn-sulphate + yeast (**T4**) came in the second rank during both seasons. On the other way around, the reverse was true with the control which exhibited the lowest values of the two studied parameters.

Table (1): shoot length, and shoot diameter and number of leaves per shoot of Washington navel orange trees as impacted by foliar spray with zinc (sulfate and Zno-NPs), yeast and NAA during the 2022 and 2023 experimental seasons.

Parameters / Treatments	Shoot length (cm)		Shoot diameter(mm)		No.of leaves/shoot	
	2022	2023	2022	2023	2022	2023
T_1-Control (tap waters pray).	25.1 E	27.2 E	2.20 F	2.15 E	9.33 D	10.33 D
T2 ZnSO4 (6 g/L)	26.3 E	31.1 D	2.43 E	2.23 E	11.33 C	13.66 C
T_3- Zno-NPs (.6cm /L	29.2 D	33.3 D	2.81 D	2.90 D	13.66 B	15.33 B
T_4- ZnSO4 (6g/L) + yeast (.4%).	34.1 B	39.4 B	3.61 B	3.61 B	15.66 A	17.00 A
T_5- Zno-NPs (.6cm /L)+ yeast (.4%).	38.1 A	43.1 A	3.82 A	4.05 A	16.33 A	18.00 A
T_6- ZnSO4(6g/L)+NAA(100 ppm).	32.2 C	36.2 C	3.11 C	3.22 C	15.33 A	17.33 A
T_7- Zno-NPs(.6cm/L)+NAA(100 ppm).	32.2 C	36.3 C	3.18 C	3.24 C	15.66 A	17.00 A

values followed by the same letters in the same column are not significantly different from the 0.5 level.

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3.1.2Number of leaves per shoot:

Concerning No. of leaves/shoots of Washington navel orange trees as affected by spraying with Zn-sulphate and Zn-nano besides combining each form with either yeast or NAA, data in **(T1)** cleared that the two Zn forms combined with either yeast extract or NAA (T4, T5, T6 and T7) were better than using Zn-sulphate or Zn-nano alone. Those four treatments maximized No. of leaves/shoot values during both seasons of study. Spraying Zn-nano alone(T3) was more effective than Zn-sulphate alone (T2)in such respect. Meanwhile, the lower value of such a parameter was associated with water-sprayed trees (control) during both seasons of study.

3.1.3Number of shoots per one-meter length limb:

Data presented in **Table (2)** cleared that trees that were sprayed with Zn-nano + yeast extract (T5) exhibited the highest values(20.39 and 18.41) of the studied parameter during the 1st and the 2nd seasons, respectively.

Meanwhile, values of(18.56 and 17.22) in the 1st and 2nd season, respectively)of that studied parameter came after the value of (T5) when the trees were sprayed with Zn-nano + NAA (T7). It was clear that Zn spraying in both forms alone (T2 and T3) was less effective in this respect. In contrast, control trees reflected the minimized values (10.0 and 11.22) during the 1st and the 2nd seasons, respectively.

Table 2. Number of shoots per one-meter length limb and average leaf area (cm^2) of Washington navel orange trees as impacted by foliar spray with zinc (sulfate and nano), yeast and NAA treatment T during the 2022 and 2023 experimental seasons.

Parameters / Treatments	Number of shoots per one-meter length limb		Average leaf area (cm2)	
	2022	2023	2022	2023
T_1-Control (tap waters pray).	10.0 E	11.22 E	14.46 E	13.20 E
T2 ZnSO4 (6 g/L)	13.56 D	12.22 D	16.23 D	15.98 D
T_3- Zno-NPs (.6cm /L	15.94 C	12.67 D	17.44 C	17.02 C
T_4- ZnSO4 (6g/L) + yeast (.4%).	18.06 B	18.0 A	18.00 B	17.90 B
T_5- Zno-NPs (.6cm /L)+ yeast (.4%).	20.39 A	18.41 A	18.96 A	19.03 A
T_6- ZnSO4(6g/L)+NAA(100 ppm).	17.78 B	15.44 C	17.11 C	16.89 C
T_7- Zno-NPs(.6cm/L)+NAA(100 ppm).	18.56 B	17.22 B	17.21 C	16.93 C

Values followed by the same letters in the same column are not significantly different from the 0.5 level.

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3.1.4Average leaf area (cm^2):

Referring to response of Washington Navel orange trees leaf area for spraying with Zn in two forms of Zn, as well as the combination between each form with either yeast extract or NAA, data tabulated in **Table (2)** indicate that spraying with Zn-nano + yeast (T5) was the promising treatment in this respect, as such treatment reflected the highest values (18.96 and 19.03**cm^2**) during the 1st and the 2nd season respectively.

Meanwhile, $ZnSo_4$ + yeast (T4) came later in such respect. The other tested treatments came in the third rank in such respect (Control). The only solitary treatment that was not able to achieve an acceptable value(14.46 and 13.20) of leaf area during both seasons of study.

2-Leaf nutritional status

3.2.1Leaf nitrogen and Phosphorus contents:

Regarding the effect of spraying with Zn in two forms (Nano and sulfate) either alone or combined with either yeast extract or NAA on leaf N and P contents of Washington navel orange trees data is recorded i**n Table (3).**

display that the response of both elements to the six investigated treatments was on images of each other.

Hence, Zn-Nano + yeast (T5) was the most promising treatment in enhancing leaf N and P contents, as such treatment raised both elements (N**,** P)in the leaves to the highest values (2.82 and 2.89%)

and (0.309 and 0.315%) as compared with the other tested treatments in the 1st and the 2nd season, respectively.

When NAA was replaced by yeast in (T7) or added to Zn. So4 (T6), both element concentrations in the leaves were improved to reach (2.75 and 2.79%) for N with (T7) and (2.76 and 2.80) with (T6) While P leaf content was (0.294 and 0.299%) with (T7) and (0.291 and 0.300%) with (T6) during the 1st and the 2nd season respectively.

It was clear that Zn.So4 (T2) was not able to improve leaf N and P contents, but the concentration of both elements was reflected as a little bit increment when yeast extract was combined with ZnSo4 (T4).

In contrast, the lowest values of both elements were detected with control trees during both seasons of study.

Table 3. leaf N, P, and K contents of Washington navel orange trees impacted by foliar spray with zinc (sulfate and nano), yeast and NAA treatment during the 2022 and 2023 experimental seasons.

Parameters / Treatments	N%		P%		K%	
	2022	**2023**	**2022**	**2023**	**2022**	**2023**
T_1-Control (tap waters pray).	1.99 F	1.93 F	0.209 F	0.212 F	0.92 E	0.89 E
T2 ZnSO4 (6 g/L)	2.10 E	2.09 E	0.225 E	0.240 E	1.50 A	1.45 A
T_3- Zno-NPs (.6cm /L	2.37 D	2.35 D	0.253 D	0.265 D	1.30 B	1.32 B
T_4- ZnSO4 (6g/L) + yeast (.4%).	2.50 C	2.52 C	0.280 C	0.285 C	1.34 B	1.35 B
T_5- Zno-NPs (.6cm /L)+ yeast (.4%).	2.82 A	2.89 A	0.309 A	0.315 A	1.19 C	1.18 C
T_6- ZnSO4(6g/L)+NAA(100 ppm).	2.76 B	2.80 B	0.291 B	0.300 B	1.07 D	1.08 D
T_7- Zno-NPs(.6cm/L)+NAA(100 ppm).	2.75 B	2.79 B	0.294 B	0.299 B	1.07 D	1.09 D

values followed by the same letters in the same column are not significantly different from the 0.5 level.

- ❖ Nps -Nanoparticles

3.2.2- Leaf potassium content

It was clear from the data presented in **Table (3)** that all tested treatments improved leaf K content as compared with control trees. Furthermore, the best and the highest values of leaf K content were associated with Zn So4 (T2), as those values reached (1.50 and 1.45%) in the 1st and the 2nd seasons, respectively. Meanwhile, Zn. Nano (T3) and ZnSo4 + yeast (T4) came later in such evaluation followed by Zn-Nano + yeast (T5), and ZnSo4 + NAA (T6) in descending order.

On the other hand, the minimum values of K leaf content were remarked With unsprayed trees with any of the tested compounds control trees

Table 4. Ca, Mg, and chlorophyll contents impacted by foliar spray with zinc (sulfate and nano), yeast and NAA treatment of Washington navel orange trees during 2022 & 2023 experimental seasons.

Parameters / Treatments	Ca%		Mg%		total chlorophyll	
	2022	2023	2022	2023	2022	2023
T_1-Control (tap waters pray).	2.61 F	2.80 D	.320 E	0.326 E	8.11 D	8.15 C
T2 ZnSO4 (6 g/L)	3.23 E	3.19 C	.363 E	0.372 E	8.25 C	8.23 C
T_3- Zno-NPs (.6cm /L	3.37 D	3.31 C	0.470 D	0.490 D	8.65 C	8.62 C
T_4- ZnSO4 (6g/L) + yeast (.4%).	3.80 B	3.79 A	0.645 B	0.640 B	9.88 B	9.56 B
T_5- Zno-NPs (.6cm /L)+ yeast (.4%).	3.35 D	3.32 C	0.475 D	0.482 D	10.89 A	10.77 A
T_6- ZnSO4(6g/L)+NAA(100 ppm).	3.93 A	3.83 A	0.822 A	0.794 A	9.25 B	8.77 C
T_7- Zno-NPs(.6cm/L)+NAA(100 ppm).	3.58 C	3.57 B	0.552 C	0.561 C	9.33 B	9.14 B

values followed by the same letters in the same column are not significantly different from 0.5 level.

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3.2.3 -Leaf Ca **and Mg content**

Concerning leaf Ca and Mg content of **Washington navel orange** as impacted by spraying with investigated treatments, data presented in **Table (4)** indicate that there are significant differences among the tested treatments, the most effective treatment in such respect was (T6) which resembled by ZnSO4 + NAA, as such treatment was able to promote leaf Ca and Mg contents to the best levels, it raised the values of Ca (3.93 and 3.83%) and Mg (0.822 and .794%) during the 1st and the 2nd seasons, respectively.

On the other way around, the reverse was true with control trees, as Ca levels were (2.61 and 2.80%) while Mg levels were (0.320 and 0.326%) during the 1st and the 2nd seasons respectively

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3.2.4 Leaf Fe, Zn and Mn content:

It was obvious from tabulated data in **Table (4)**, that sprayed trees with Zn nano combined with yeast (T5) reflected high leaf Fe, Zn and Mn contents, as such treatment maximized the concentration of the three minor investigated elements in the leaves. Leaf Fe values were (89.93 and 82.18 ppm), Zn values were (75.33 and 80.16 ppm) and Mn values were (102.0 and 104.0 ppm) during the 1st and the 2nd seasons respectively. Meanwhile, Zn Nano alone (T3) came in the second rank in such respect. The other investigated treatments were either shared (T3) in its effects or reflected less values than (T3). In contrast, the minimum values of the three minor elements were associated with water-sprayed trees (control) during both seasons of the study.

3.2.5Leaf total chlorophyll content (SPAD):

Concerning the impact of the investigated treatments on leaf chlorophyll content **of Washington navel orange trees**, data presented in **Table (4)** shows that leaf chlorophyll content was highly enhanced when the trees were sprayed with Zn-Nano + yeast (T5), the values were (10.89 and 10.77) in the 1st and the 2nd seasons, respectively. It was remarked that when NAA was replaced by yeast in (T7) or ZnSO4 was replaced by Zn Nano in (T4), the values were reduced. The least values. of such studied parameter was associated with control trees during both seasons of study."

Table 5. leaf Fe, Mn, and Zn, contents impacted by foliar spray with zinc (sulfate and nano), yeast and NAA treatment of Washington navel orange trees during the 2022 & 2023 experimental seasons.

Parameters / Treatments	Fe (ppm)		Zn (ppm)		Mn (ppm)	
	2022	2023	2022	2023	2022	2023
T_1-Control (tap waters pray).	68.11 C	66.11 D	45.16 D	48.00 B	48.30 D	53.10 C
T2 ZnSO4 (6 g/L)	77.11 B	78.13 B	50.36 C	56.00 B	61.43 C	62.00 C
T_3- Zno-NPs (.6cm /L	82.44 B	80.44 B	60.94 B	64.31 B	89.56 B	90.00 B
T_4- ZnSO4 (6g/L) + yeast (.4%).	79.13 B	76.16 C	55.60 C	57.21 B	64.33 C	63.00 C
T_5- Zno-NPs (.6cm /L)+ yeast (.4%).	89.93 A	82.18 A	75.33 A	80.16 A	102.0 A	104.00 A
T_6- ZnSO4(6g/L)+NAA(100 ppm).	76.08 B	73.18 C	51.43 C	56.18 B	61.16 C	64.14 C
T_7- Zno-NPs(.6cm/L)+NAA(100 ppm).	76.10 B	72.22 C	54.13 C	63.14 B	62.12 C	65.12 C

.values followed by the same letters in the same column are not significantly different of 0.5 level.

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Discussion

Zn is an important microelement for human beings, animals as well as crops. Zn is an important component of different enzymes catalyzing metabolic reactions in plants. Zn also plays a significant role in plant resistance against diseases, photosynthesis, and cell membrane integrity within plant tissues **(Azhdar, Hussain et al., 2015).**

Treated guava trees with ZnSO4 at 0.2% caused an increment in tree height, shoot length and diameter, leaf size and area. Such an increase might be due to the active involvement of Zn in the synthesis of tryptophan which is a precursor of IAA synthesis, subsequently, it increased tissue and development **(Haider et al. 2014).**

El-Gioushy et al. (2021) examined the effect of foliar application of ZnSO4 (300 and 600 mg/L) on Washington Navel orange trees. They reported that the level of ZnSO4 reflected the highest values of the various vegetative growth parameters including shoot length and diameter, number of leaves/shoot, leaf area and total assimilation area per shoot.

Our results are true to that reported by **Zekri, M. (2024),** who reported that foliar Zn is a key factor in stimulating the growth of citrus trees. Similar results were obtained by **Marcelo et al. (2021)** on orange, **Hussein et al. (2021)** on C. Limon, **Abed-Hak, et al., (2019)** on flame seedless grapes **and Singh et al. (2018)** on sweet orange cv. Mosambi.

Regarding leaf mineral content as affected by Zn foliar spray, the results are supported by which was mentioned by **Singh et al. (2023)** who mentioned that spraying Kinnow mandarin trees with Zn NPs led to an increase N, P, K and Z elements in the leaves, while **El-Gioushy et al. (2021)** mentioned that spraying Washington navel orange with ZnSO4 increased leaf chlorophyll and mineral contents. **Also, Awess et al. (2020)** on C. limon and **Basar and Gurel (2016)** on olive trees.

Yeast acts as a natural, safe bio-fertilizer and rich source of phytohormones, especially cytokinins, sugars, vitamins, enzymes, amino acids and minerals. It has stimulatory effects on cell division and enlargement, synthesis of protein and nucleic acid as well as chlorophyll formation and that may improve the growth and productivity of different plant species **(Abou El-Yazid and Mahdy Mady (2012))**

The results are confirmed by **AbdulKareem and Hussein (2022)** who reported that treatments of lemon with logic yeast gave the highest values **(1.57, 0.24, 1.48, 7.74 and 0.53%)** and (19.31, 114 .63 and 28.42 ppm)for N, P, K, Carbohydrates, Mg, Mn, Fe and Zn.

Also, Al-Mharib et al. (2022) reported that foliar spray with yeast improved all vegetative growth characteristics of spinach and lettuce respectively. and **Abd El-Galil et al. (2021)** and **Mady (2019).** Meanwhile, **Ahmed et al. (2023)** indicate that jujube-sprayed trees with yeast at 1 and 2% increased leaf total chlorophyll content.

Also, the result goes in line with **Faissal et al. (2018)** on Balady mandarin, **thana et al. (2015)** on olive, **Mustafa and El-Shazly (2013)** on Washington navel orange, and **Mohamed, Karima**

and Omaima Hafez (2004) on Valencia orange trees.

Many studies declared that sprayed fruit trees with NAA at pre or post-bloom decreases fruit drop, increases fruit set, and fruit retention, and improves fruit quality and yield as well as vegetative growth **(Abd-El-Rahman, 2005).**

Analogous results were obtained by **Singh et al. (2023)** reported that spraying Kinnow mandarin trees with NAA at 150 ppm and 250 ppm had a significant effect on various vegetative growth parameters (maximum height increment 31.7 cm, annual shoot growth 24.41cm, tree canopy 35.73cm). **Also, Das et al. (2021)** on Eureka lemon; **Abd-El-Naby et al. (2019)** on Canino apricot; **Hamady (2017) and** on Washington navel orange**; Hindy et al., (2017).**

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Effect of Foliar Application of Bio-Regulators (GA3 and NAA) on Vegetative Growth

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تاثير التغذية الورقية بالزنك والخميره ،NAA على النمو والحالة الغذائية لاشجار البرتقال ابو سرة .

اجريت هذة الدراسة خلال موسمى 2022، 2023 على اشجار البرتقال ابو سرة مطعومة على اصل النارنج وعمرها 7 سنوات ونامين فى ارض طينية بمحافظة القليوبية .

وتهدف هذة الدراسة الى تحسين النمو الخضرى والحالة الغذائية للاوراق وذلك باستخدام عنصر الزنك فى صورتين (سلفات الزنك بمعدل 6جم/لتر او الزنك فى صورة نانو بمعدل 6سم /لتر –مستخلص الخميرة بمعدل 2% و**NAA** بمعدل 100جزء فى المليون –كل على صورة حرة او متداخلة رشا على الاشجار 6دفعات (مرات) ابتداء من منتصف فبراير ،ومنتصف ابريل (بعد العقد) ثم كل شهر حتى شهر اغسطس .

وقد اوضحت النتائج ان جميع المعاملات ادت الى تحسين القياسات الخضرية والحالة الغذائية للاشجار البرتقال ابو سرة مقارنة بالكنترول .وقد تفوقت معاملة رش الاشجار بعنصر الزنك فى صورة نانو بمعدل 6سم/لتر مع مستخلص الخميرة بتركيز 2% فى تعظيم قيم كل ميقاسات النمو الخضرى (طول وسمك النمو الخضرى ،عدد الاوراق للنمو الخضرى ،عدد النموات الخضرية للمتر الطولى للفرع ومتوسط المساحة الورقية خلال موسمى الدراسة اما فيما يخص الحالة الغذائيه للاوراق فقد اظهرت النتائج تباين فى استجابة محتوى الاوراق من العناصر الغذائيه للمعاملات المختلفة حيث اظهرت معاملة رش الاشجار بعنصر الزنك فى صورة نانو بتركيز 6سم /لتر مع مستخلص الخميرة بتركيز 2% اعلى قيم محتوى الاوراق من الحديد والفسفور والنيتروجين والمنحنيز والزنك والكلورفيل الكلى بينما رش الاشجار بكبريتات الزنك بمعدل 6جم/لتر مع **NAA** بتركيز 100جزء فى المليون كان لها التاثير الاعظم فى محتوى الاوراق من عنصر الكالسيوم والمغنسيوم فى حين ان التركيز الاعلى لعنصر البوتاسيوم فى الاوراق كان مرتبطا برش الاشجار بسلفات الزنك منفردا بتركيز 6جم /لتر.

الكلمات الإسترشادية: النمو الخضرى الزنك الخميره نفثالين اسيتك اسيد