RESEARCH ARTICLE

SABRAO Journal of Breeding and Genetics
56 (4) 1728-1737, 2024
http://doi.org/10.54910/sabrao2024.56.4.38
http://sabraojournal.org/
pISSN 1029-7073; eISSN 2224-8978

ORGANIC MANURE AND NANO-ZINC EFFECTS ON THE PEACH SEEDLINGS GROWTH

T.J.M. ALI[1*], O.H. MAHMOOD[2], and F.K. GOUDA[1]

[1]College of Agriculture, Al-Qasim Green University, Al-Qasim, Iraq
[2]College of Agriculture, University of Kerbala, Kerbala, Iraq
*Corresponding author's emails: sabraoassociateeditors@gmail.com, dr.tah@agre.uoqasim.edu.iq
Email addresses of co-authors: ola.h@uokerbala.edu.iq, fatima.kadum@agre.uoqasim.edu.iq

SUMMARY

The latest study aimed to identify the effects of organic manure (sheep manure) with four concentrations (0, 5, 10, and 15 g seedling^{-1}) and nano-zinc four levels (0, 1, 2, and 3 g L^{-1}) on the growth of peach cultivar Hollywood seedlings. The experiment began in 2022 at private nurseries in Babylon province, Iraq. The nano-zinc application with three foliar sprays transpired at 30-day intervals. The experiment continued in a randomized complete block design (RCBD) with three replications. The addition of organic manure treatment (15 g seedling^{-1}) excelled in traits of seedling length, stem diameter, number of leaves, chlorophyll content, shoot dry weight, leaves area, and zinc in the leaves, with highest averages of 62.03 cm, 8.08 mm, 51.20 leaf seedling^{-1}, 43.8 SPAD, 57.35 g seedling^{-1}, 1322.3 cm^2, and 56.40 mg kg^{-1}, respectively, compared with the control treatment. The addition of nano-zinc (3 g L^{-1}) was significantly superior in performance and excelled other treatments by revealing the highest values for the above growth traits, i.e., 60.45 cm, 7.83 mm, 50.90 leaves seedling^{-1}, 42.35 SPAD, 54.85 g seedling^{-1}, 1251.90 cm^2, and 53.63 mg kg^{-1}, respectively.

Keywords: Peach (*Prunus persica* L.), organic matter, nano-zinc, foliar nutrition, growth traits, physiological parameters

Key findings: Organic manure (15 g seedling^{-1}) produced the highest averages of 62.03 cm, 8.08 mm, 51.20 leaf seedling^{-1}, 43.8 SPAD, 57.35 g seedling^{-1}, 1322.3 cm^2, and 56.40 mg kg^{-1} for the seedling's length, stem diameter, number of leaves, chlorophyll content, dry matter of the seedling shoot, leaf area, and zinc content in the leaves, compared with the control treatment.

Communicating Editor: Dr. A.N. Farhood

Manuscript received: December 29, 2023; Accepted: February 27, 2024.

Citation: Ali TJM, Mahmood OH, Gouda FK (2024). Organic manure and nano-zinc effects on the peach seedlings growth. *SABRAO J. Breed. Genet.* 56(4): 1728-1737. http://doi.org/10.54910/sabrao2024.56.4.38.

INTRODUCTION

The peach tree (*Prunus persica* L.), belonging to the family Rosaceae, is one of the stone fruit trees bearing fruits of high value with many uses. Peaches can serve as fresh fruit and for making jams, jellies, and juices. It is a belief that it originally came from China. Its estimated fruit production is 15,846,000 tons, with several cultivars in Iraq grown in the Northern regions, especially the cultivar Hollywood, which is very prominent (Al-Araji and Al-Hamdani, 2009).

Utilizing organic waste to create organic acids, particularly humic acid, and adding them to the soil and foliar application to vegetative parts is one of the strategies to combat the drawbacks in agriculture. Since these roasts contain two different types of substances, one is water-loving, and the other is hydrophobic, which collaborate and develop surfaces amenable to absorption on the surfaces of plant membranes. It activates some of the enzymes while inhibiting others; the acid also affects the processes of photosynthesis and respiration. The said processes also enhance the permeability of cellular membranes and activate a cultivar of critical processes, as reflected in the plant's growth traits (Fathy *et al.*, 2010).

The available nutrients and signs of plants' vegetative growth, especially citrus plants, can accept enhancement by adding organic fertilizers and their byproducts to the soil and foliar application using humic acid as their carrier. Agricultural crop remnants, animal waste, fermented (compost) fertilizers, green manuring, and cities and industrial waste are sources (Abbas *et al.,* 2013; Al-Abbasi *et al.,* 2016). Fertilizing orange seedlings with compost manure improved their vegetative growth traits, such as their height, leaf area, stem diameter, chlorophyll content, and the proportion of nitrogen, phosphorus, and potassium elements in their leaves (Barakat *et al.*, 2012).

Adding organic waste extracts—wheat straw waste extract, mushroom cultivation waste, and rice husk extracts—to orange seedlings significantly improved their growth, number of total branches, leaf area, chlorophyll content, and total soluble carbohydrate content compared with the non-addition transaction (Al-Taie *et al.*, 2014). Al-Hayani *et al.* (2016) sprayed the humic acid on seedlings of some citrus roots (citrus orange, orange, and lemon). They discovered that applying the acid to the seedlings significantly boosted their ability to withstand more saline irrigation water, with their height, main stem diameter, and content of soluble sugars improved. Additionally, the proline content of the leaves rose, and their average features decreased by using salt water individually.

Zinc is one of the primary micronutrients required by all plants and crucial in synthesizing chlorophyll and fundamental parts of the plant cell, such as cytochromes and phytochromes. It participates in the synthesis and activity of various considerable enzymes involved in constructing, demolishing, oxidizing, and reducing reactions in several enzymes, such as catalase, peroxidase, and cytochrome oxidase. Zinc also significantly influences how DNA operates and contributes to forming chlorophyll molecules, activates many enzymes necessary for plants, and has an influential role in building proteins (Saini *et al.,* 2021). Additionally, it aids in the production of tryptophan, an amino acid converted into the plant hormone indole acetic acid (IAA), which is essential for cell division and elongation.

Zinc deficiency in plants leads to severe stunting of the plant, as the stem becomes thin, with the leaflets bent upward, and irregular spots occur on the leaves (Abu-Dahi and Al-Younis, 1988). In the central region of Iraq, most soils tend to be basic, depending on their lime content, which makes some nutrients unavailable and difficult to absorb by crop plant roots (Arshad and Ali, 2016). Crop plants cannot cover their needs for these macro and microelements, including zinc. Past findings also revealed that 83% of soil samples taken from different regions of Iraq lacked ready-made zinc (Esfandiari *et al.,* 2016). The presented study sought to ascertain the impact of adding organic manure and the foliar application of nano-zinc on the peach cultivar Hollywood seedlings' vegetative growth indicators.

MATERIALS AND METHODS

The experiment commenced in 2022 at the Alhindia Horticulture Station, Kerbala province, Iraq, to study the effects of organic manure (sheep manure) with four concentrations (0, 5, 10, and 15 g seedling^{-1}) and nano-zinc four levels (0, 1, 2, and 3 g L^{-1}). The nano-zinc application with three foliar sprays ensued at 30-day intervals. The first spraying occurred after one month of planting the seedlings in pots to grow the peach cultivar Hollywood seedlings. The six-month-old seedlings planted in plastic pots had a capacity of 15 kg of soil and an average distance of 30–35 cm. A random sampling of the potting soil continued their analysis for physicochemical traits (Table 1). Organic manure and irrigation water compositions also bore analysis by following the methodology of Bottomley *et al.* (2020) (Tables 2 and 3).

All treatments followed a random distribution, with the organic manure (representing the sheep manure) added at the required levels on January 3, 2023. The potassium fertilizer was in the form of potassium sulfate when added. Urea fertilizer addition had a rate of 10 g seedling^{-1} in two batches. The first was at the beginning of the experiment, and the second after 30 days of the first batch. The phosphate fertilizer addition had a rate of 15 g seedling^{-1} before transferring the seedlings to the pots. Potassium fertilizer addition continued at 10 g seedling^{-1} a week after adding urea and carrying out irrigation afterward. A factorial experiment proceeded in a completely randomized design with three replications. The total number of seedlings was 240 (five seedlings per treatment).

Table 1. Characteristics of the soil used in the growth medium and the organic matter used in the peach study.

Adjective Soil Texture	Measuring Unit	The Soil Mixture
Degree of soil reaction (pH)		7.6
Electrical conductivity (Ece)	dS m^{-1}	3.08
Organic matter	g kg^{-1}	14.8
Bulk density	g cm^{-3}	1.51
Calcium carbonate	g kg^{-1}	236.7
(Clay)		270
(Silt)		359
(Sand)		371
Total nitrogen	mg kg^{-1}	13.1
Ready phosphorus		6.7
Ready potassium		23.8
Ready zinc		1.6

Table 2. Laboratory analysis of organic waste used in the peach experiment.

Degree of interaction	Salinity	Organic matter	Organic carbon	C:N	Total nitrogen	Total phosphorus	Total potassium
	dS m^{-1}	g kg^{-1}	G kg^{-1}		G kg^{-1}	g kg^{-1}	g kg^{-1}
6.51	5.46	438.6	295.2	16.96	17.4	0.32	1.8

Table 3. Chemical analysis of irrigation water used in the peach study.

Ec (dS m^{-1})	pH	Positive ions m l^{-1}				Negative ions m l^{-1}			SAR
		$Ca^{=}$	$Mg^{=}$	Na^{-}	K^{-}	$SO_4^{=}$	CL^{-}	HCO_3^{-}	
5.2	7.1	33	17	15.5	1.8	25	35	1.2	3.1

Data recorded

The end of the growing season had measurements of vegetative growth traits as follows. Each seedling's primary vegetative branch height measurement used a metric tape from the graft connection site on the rootstock to the branch top. For the primary branch diameter (mm) in each seedling, the Vernier Caliper measured the diameter at the plant height of 2 to 3 cm. The leaves per seedling counting in each experimental unit transpired and then averaged. The digital planimeter helped measure leaf area (in cm^2) in peach seedlings. For chlorophyll content in the leaves, the study used the Chlorophyll meter CCM-200 Plus device, calculating the average chlorophyll content of 20 leaves in each experimental unit, with the values measured in SPAD units. The shoot dry weight calculation occurred by taking the vegetative parts of three seedlings from each treatment and measuring the fresh weight. Later, drying the samples continued in an electric oven at 70 °C for 48 hours to measure the dry weight. Measuring the zinc in peach leaves (mg kg^{-1}) applied the methodology of Bottomley *et al.* (2020). The fresh peach leaves dried at 70 °C, bore grinding and digesting in 4 ml of sulfuric acid solution and 2 ml of concentrated perchloric acid. Obtaining the amount of zinc used an atomic absorption device.

Statistical analysis

All the recorded data analysis proceeded per the required analysis of variance (ANOVA) (Al-Sahuki and Waheeb, 1990). The means' further comparison and separation used the least significant difference ($LSD_{0.05}$) tests.

RESULTS AND DISCUSSION

Plant height

Table 4 showed significant differences between the organic fertilization treatments for peach seedling height. The organic manure fertilization (15 g $seedling^{-1}$) excelled by providing the highest average seedling height (62.03 cm) compared with the control treatment, with the lowest average for the said trait (44.55 cm). The two other levels of organic fertilization (5 and 10 g $seedling^{-1}$) revealed an average seedling height of 49.08 and 54.53 cm, respectively.

The discrepancy in the peach seedlings' height may be due to the positive role of organic fertilizer, which improves the plant's vegetative growth by enriching soil fertility resulting from an acidic environment by modifying the soil pH. The said process also enhanced the readiness and absorption of nutrients, including nitrogen and its importance in base formation. Nitrogen and protein primarily increase cell size and division, leading to a considerable rise in shoots, reflecting plant height (Saeed and Hamad, 2021).

The results showed significant differences among nano-zinc treatments for peach seedling height (Table 4). The zinc concentration (3 g L^{-1}) excelled by giving the highest average (60.45 cm) compared with the control treatment, which gave the lowest average plant height (46.18 cm). The nano-zinc concentration (1 and 2 g L^{-1}) displayed the average seedling height of 49.35 and 54.20 cm, respectively. The nano-zinc is likely to affect the plant height in several ways in the early stages, including activating many enzymes in plants. These enzymes have an influential role in the growth process and development of the plant's vegetative system, including the formation of hormones, proteins, and chlorophyll. These physiological substances proved necessary for forming dry matter through biological processes and worked to enhance plant growth (Almeekh *et al.,* 2020).

The results also enunciated a significant interaction by adding the organic manure (15 g) with nano-zinc (3 g L^{-1}), revealing the highest peach seedling height (72.4 cm) compared with the control treatment, with the lowest average for the said trait (39.7 cm).

Stem diameter

For stem diameter in peach seedlings, the organic fertilization treatments showed

Table 4. Effect of organic fertilizer and foliar application of nano-Zn on the seedling height in peach.

Organic matter ($g\ seedling^{-1}$)	Nano zinc ($g\ L^{-1}$) 0	1	2	3	Means (cm)
0	39.7	42.5	45.8	50.2	44.55
5	43.7	46.1	49.8	56.7	49.08
10	47.5	50.2	57.9	62.5	54.53
15	53.8	58.6	63.3	72.4	62.03
Means (cm)	46.18	49.35	54.20	60.45	
$LSD_{0.05}$ Organic matter: 3.72, Nano-zinc: 3.72, OM × NZ interaction: 7.11					

Table 5. Effect of organic fertilizer and foliar application of nano-Zn on the stem diameter in peach.

Organic matter ($g\ seedling^{-1}$)	Nano zinc ($g\ L^{-1}$) 0	1	2	3	Means (mm)
0	5.2	5.6	6.1	6.6	5.88
5	5.7	6.3	6.7	7.2	6.48
10	6.5	6.9	7.4	8.1	7.23
15	7.1	7.5	8.3	9.4	8.08
Means (mm)	6.13	6.58	7.13	7.83	
$LSD_{0.05}$ Organic matter: 0.52 , Nano-zinc: 0.52 , OM × NZ interaction: 0.97					

significant differences (Table 5). The organic fertilization (15 g $seedling^{-1}$) excelled by giving the highest average stem diameter (8.08 mm) versus the control treatment with the lowest average (5.88 mm). The organic fertilization of two other levels (5 and 10 g $seedling^{-1}$) provided average values of 6.48 and 7.23 mm, respectively. It might be due to the positive role of organic fertilizers in increasing the readiness of nutrients through acidifying the soil from a reduced soil basicity. It facilitates the readiness of essential elements critical for plant growth and development and boosts the accumulation of dry matter, which reflects positively in stem diameter and other growth traits (Melo *et al.,* 2016).

The nano-zinc treatments also showed significant differences in peach seedlings' stem diameter (Table 5). The nano-zinc concentration (3 g L^{-1}) exhibited the best performance by giving the highest average of the stem diameter (7.83 mm) compared to the control treatment, providing the lowest average (6.13 mm) for the said trait. The two other doses of nano-zinc (1 and 2 g L^{-1}) displayed average values of 6.58 and 7.13 mm, respectively. It may refer to the positive role of nano-zinc in activating enzymes as a cofactor for other various enzymes in plants. These enzymes play an essential role in metabolic processes, such as respiration, glycolysis, protein and amino acid synthesis, and regulating cellular structure, including cell growth, development, and division. Thus, zinc contributes indirectly to increasing the representation of dry matter and reflects positively in raising the stem diameter and other growth traits (Ajboory and Al-Douri, 2023).

The interaction effects of organic manure doses and nano-sinc levels were also substantial for the stem diameter (Table 5). The highest stem diameter (9.4 mm) came through the interaction of organic fertilization (15 g $seedling^{-1}$) and nano-zinc concentration (3 g L^{-1}), and the lowest value for the said trait resulted in the interaction control treatments (5.2 mm) for the said trait in peach seedlings.

Leaves per seedling

The organic fertilization treatments significantly affected the number of leaves in peach seedlings (Table 6). The organic fertilization treatment (15 g $seedling^{-1}$) revealed the highest average of leaves per seedling (51.20) compared with the control treatment, with an average of 37.25 leaves per seedling. The two other organic fertilization treatments (5 and 10 g seedling^{-1}) gave average values of 42.53 and 46.60 leaves seedling^{-1}, respectively. It may be due to the remarkable role of organic matter in increasing the production of organic acids and decomposing them, which, in turn, dissolves nutrient minerals and releases them into the soil solution, increasing their absorption by the plants, boosting plant growth and development (Al-Hadethi *et al.,* 2017). Organic fertilizers provided most of the nutrients extensively throughout the plant's growth stage, especially the macronutrients (NPK), which reflected positively in peach seedlings' increased number of leaves (Eissa *et al.,* 2007).

For leaves per seedling, the nano-zinc treatments also exhibited significant differences (Table 6). The nano-zinc treatment (3 g L^{-1}) showed the highest number of leaves per seedling (50.90) compared with the control treatment (38.28). The two other nano-zinc treatments (1 and 2 g L^{-1}) also provided averages of 42.35 and 46.05 leaves seedling^{-1}, respectively. The reason for this was that the nano-zinc fertilization leads to supplying the plant with nutrients, increasing the ability to assimilate carbon, which supports the processes of manufacturing proteins and carbohydrates, ultimately leading to efficient growth and differentiation processes, contributing to the increased number of leaves in the peach seedlings (Saini *et al.,* 2021).

The interaction between the organic manure and nano-zinc fertilization levels revealed a noteworthy impact on the leaves per seedling in peach (Table 6). As for the interaction treatments, the 15 g seedling^{-1} organic matter + 3 g L^{-1} nano-zinc was significantly superior and gave the highest average number of leaves per seedling (60.2), versus the control treatment, which gave the lowest average for the said trait (31.5).

Chlorophyll content

The outcomes showed a significant effect of the organic fertilization treatments on the chlorophyll content in peach seedlings (Table 7). The organic fertilization treatment (15 g seedlings^{-1}) was leading by giving the maximum rate of chlorophyll content (43.80 SPAD) compared with the control treatment that showed the lowest average (32.35 SPAD).

Table 6. Effect of organic fertilizer and foliar application of nano-Zn on the leaves per seedling in peach.

Organic matter (g seedling^{-1})	Nano zinc (g L^{-1})				Means (#)
	0	1	2	3	
0	31.5	34.6	39.8	43.1	37.25
5	36.8	40.5	44.1	48.7	42.53
10	41.6	45.4	47.8	51.6	46.60
15	43.2	48.9	52.5	60.2	51.20
Means (#)	38.28	42.35	46.05	50.90	
$LSD_{0.05}$ Organic matter: 3.11, Nano-zinc: 3.11, OM × NZ interaction: 6.08					

Table 7. Effect of organic fertilizer and foliar application of nano-Zn on the leaf chlorophyll content in peach.

Organic matter (g seedling^{-1})	Nano zinc (g L^{-1})				Means (SPAD)
	0	1	2	3	
0	28.7	31.6	33.4	35.7	32.35
5	32.6	34.4	37.8	39.7	36.13
10	36.2	38.5	40.3	43.8	39.70
15	39.2	41.7	44.1	50.2	43.80
Means (SPAD)	34.18	36.55	38.90	42.35	
$LSD_{0.05}$ Organic matter: 3.27, Nano-zinc: 3.27, OM × NZ interaction: 6.38					

The two other organic manure treatments (5 and 10 g seedlings^{-1}) gave average values of 36.13 and 39.70 SPAD, respectively. The reason was the positive role of organic acids in organic fertilizers contributing to the activation of macro- and micro-nutrients, including nitrogen and iron. In addition, 70% of the leaf nitrogen is part of the composition of this pigment, and 80% of the total iron occurs in chloroplasts, which are very crucial in the process of photosynthesis and building chlorophyll (Abu-Dahi and Al-Younis, 1988). It may also refer to the organic fertilizer's content of organic acids, such as humic and fulvic acid, which contain the highest concentrations of nitrogen, through which the leaves' chlorophyll content rises because most of the nitrogen concentration rests in the leaves, explaining about the effect of humic acid on the chlorophyll content of leaves (Sharma *et al.,* 2022).

The nano-zinc treatments also implied significant differences in the chlorophyll content in peach seedlings (Table 7). The nano-zinc treatment (3 g L^{-1}) showed the best performance by giving the optimum average of chlorophyll content (42.35 SPAD) compared with the control treatment, showing the lowest average for the said trait (34.18 SPAD). The two other nano-zinc treatments (1 and 2 g L^{-1}) also gave average chlorophyll contents of 36.55 and 38.90 SPAD, respectively. The increased rate in chlorophyll content after foliar application of the nano-zinc could be due to the activation of the enzymes associated with the chlorophyll pigment synthesis and its considerable role in stimulating cell division and differentiation, which increased chlorophyll content (Mosa *et al.,* 2021).

The results further revealed the significant interaction effects of both study factors (Table 7). The interaction of organic fertilizer (15 g seedlings^{-1}) with nano-zinc concentration (3 g L^{-1}) exhibited the highest average of chlorophyll content (50.2 SPAD), with the lowest interaction effects for the said trait observed in control treatments (28.7 SPAD).

Vegetative dry weight

For vegetative dry weight, the organic fertilization treatments showed noteworthy differences (Table 8). The organic fertilization treatment (15 g seedlings^{-1}) was superior by giving the highest vegetative dry weight (57.35 g seedling^{-1}) compared with the control treatment, which gave the lowest average for the said trait (37.05 g seedling^{-1}). The two other organic fertilization treatments (5 and 10 g seedlings^{-1}) provided average values of the vegetative dry weight (44.95 and 51.03 g seedling^{-1}, respectively). The fertilization process contributes to increasing the plant height, leaf area, and the number of leaves, leading to an increase in plant biomass and, thus, an increased dry weight. Raising the availability of nutrients would contribute to elevated activity of vital processes within the plant, the most important of which is the process of photosynthesis, eventually enhancing the accumulation of dry matter (Frąc *et al.,* 2023).

The nano-zinc treatments remarkably affected the vegetative dry weight (Table 8). The nano-zinc concentration (3 g L^{-1}) was best in giving the highest average of vegetative dry weight (54.85 g seedling^{-1}) compared to the control treatment, with the lowest average for the said trait (40.23 g seedling^{-1}). The two other nano-zinc doses (1 and 2 g L^{-1}) also gave average values of the vegetative dry weight, i.e., 45.20 and 50.10 g seedling^{-1}, respectively. Foliar application of zinc can lead to increased activity of the enzymes that help activate the vital processes within the plant, such as photosynthesis, leading to increased growth and development in the plant, as reflected in an increased dry weight (Almeekh *et al.,* 2020).

The results revealed significant interaction effects between the organic fertilization and nano-zinc treatments (Table 8). The interaction of organic fertilizer (15 g seedlings^{-1}) with a nano-zinc concentration of 3 g L^{-1} showed the maximum average of vegetative dry weight (65.1 g seedling^{-1}), with the lowest value for the said trait obtained in the interaction of the comparison treatments (30.5 g seedling^{-1}).

Table 8. Effect of organic fertilizer and foliar application of nano-Zn on the vegetative dry weight in peach.

Organic matter (g seedling^{-1})	Nano zinc (g L^{-1}) 0	1	2	3	Means (g)
0	30.5	33.1	39.4	45.2	37.05
5	35.7	43.7	47.8	52.6	44.95
10	45.1	48.6	53.9	56.5	51.03
15	49.6	55.4	59.3	65.1	57.35
Means (g)	40.23	45.20	50.10	54.85	

$LSD_{0.05}$ Organic matter: 3.71, Nano-zinc: 3.71, OM × NZ interaction: 7.08

Table 9. Effect of organic fertilizer and foliar application of nano-Zn on the leaf area in peach.

Organic matter (g seedling^{-1})	Nano zinc (g L^{-1}) 0	1	2	3	Means (cm^2)
0	507.2	581.3	744.3	840.5	668.33
5	636.6	761.4	890.8	1090.9	844.93
10	815.4	967.0	1089.8	1264.2	1034.10
15	963.4	1154.0	1359.8	1812.0	1322.30
Means (cm^2)	730.65	865.93	1021.18	1251.90	

$LSD_{0.05}$ Organic matter: 175.4, Nano-zinc: 175.4, OM × NZ interaction: 340.2

Leaf area

For leaf area in peach seedlings, the organic fertilizer treatments enunciated significant differences (Table 9). The organic fertilizer treatment (15 g seedlings^{-1}) provided the highest leaf area (1322.30 cm^2), excelling all other treatments compared with the control treatment, which showed the lowest leaf area average (668.33 cm^2). The two other organic fertilizer treatments (5 and 10 g seedlings^{-1}) gave an average of 844.93 and 1034.10 cm^2, respectively. Organic fertilizers can contribute to stimulating the progress of leaves by providing the macro- and micro-elements necessary for their expansion, which helps in enhancing their growth and, thus, increases the leaf surface available for photosynthesis and the absorption of nutrients from the surrounding environment, with all these activities reflected in the leaf area (Saeed and Hamad, 2021).

The nano-zinc treatments also expressed meaningful differences for leaf area (Table 9). The nano-zinc treatment (3 g L^{-1}) showed the best performance by providing the highest average leaf area (1251.90 cm^2) compared with the control treatment with the lowest average (730.65 cm^2). The two other nano-zinc treatments (1 and 2 g L^{-1}) gave average leaf areas of 865.93 and 1021.18 cm^2, respectively. The reason for this increase may be due to a rise in nano-zinc concentrations activating enzymes and their inclusion in forming the amino acid tryptophan, which is vital in cell elongation, energy compounds, and RNA and DNA necessary for cell division, and, in turn, boosts the activity of water absorption. These nutrients positively increase the leaf area of plants. In addition to the distinction of nanotechnology, it effectively influences plant growth and development. Given the tiny nanoparticles, zinc can move more through cellular membranes in crop plants (Mosa *et al.,* 2021).

For leaf area in peach seedlings, the interaction effects of the organic fertilizer and nano-zinc treatment were significant (Table 9). The organic fertilizer (15 g seedlings^{-1}) reacting with nano-zinc treatment (3 g L^{-1}) revealed the maximum average of leaf area (1812.0 cm^2), and the lowest interaction effects (507.2 cm^2) were evident in the interaction of control treatments for leaf area.

Table 10. Effect of organic fertilizer and foliar application of nano-Zn on the leaf zinc content in peach.

Organic matter (g seedling^{-1})	Nano zinc (g L^{-1})				Means (mg kg^{-1})
	0	1	2	3	
0	28.4	31.1	35.7	42.2	34.35
5	32.9	37.1	43.8	49.2	40.75
10	39.3	45.6	53.7	57.4	49.00
15	47.1	54.6	58.2	65.7	56.40
Means (mg kg^{-1})	36.93	42.10	47.85	53.63	

$LSD_{0.05}$ Organic matter: 0.11, Nano-zinc: 0.11, OM × NZ interaction: 0.19

Leaf zinc concentration

The results showed the notable effect of organic fertilization treatments on the zinc content of peach leaves (Table 10). The organic fertilization treatment (15 g seedlings^{-1}) was supreme by giving the utmost average for leaf zinc content (56.40 mg kg^{-1}) compared with the control treatment, which gave an average of 34.35 mg kg^{-1}. The two other organic fertilization treatments (5 and 10 g seedlings^{-1}) revealed leaf zinc average values of 40.75 and 49.00 mg kg^{-1}, respectively. The reason for this may be that fertilizing peach seedlings with zinc in response to vegetative growth indicators will increase photosynthesis rates, enhance plant growth, and enrich bud development, which contributes to raising the efficiency of absorption of nutrients critical for plant growth and development, including zinc (Frąc *et al.,* 2023).

The results further revealed that nano-zinc treatments significantly differed for leaf zinc content (Table 10). The nano-zinc treatment (3 g L^{-1}) was leading in the highest average of leaf zinc content (53.63 mg kg^{-1}) compared with the control treatment, giving the lowest rate (36.93 mg kg^{-1}), and the two treatments (1 and 2 g L^{-1}) with average values of 42.10 and 47.85 mg kg^{-1}, respectively. Spraying with nano-zinc and improving its availability can enhance the ability of plants to use more nutrients optimally. Therefore, zinc is considerably a part of that group of elements regulating and stimulating the absorption of nutrients available in the soil. It can ultimately lead to enhanced growth and development of plant parts. Therefore, the increased attraction of nutrients, including zinc, can appear in elevated leaf zinc content (Motyleva *et al*., 2021; Saini *et al.,* 2021; Kareem *et al*., 2022).

The interaction between organic fertilizers and nano-zinc treatments had remarkable effects (Table 10). The organic fertilizer (15 g seedlings^{-1}) in interaction with nano-zinc concentration (3 g L^{-1}) revealed the maximum average of leaf zinc content (65.7 mg kg^{-1}) compared with the lowest average obtained in the control treatments of both factors (28.4 mg kg^{-1}).

CONCLUSIONS

The results concluded that organic material and some secondary nutrients, such as zinc, had a tangible role in the growth and development of peach seedlings.

REFERENCES

Abbas T, Ahmed S, Ashraf M, Shahid MA (2013). Effect of humic and application at different growth stages of kinnow. *J. Bot.* 45(6): 212-218.

Abu-Dahi YM, Al-Younis MA (1988). Plant Nutrition Manual. Dar Al-Kutub Printing and Publishing Directorate, University of Mosul. pp: 300.

Ajboory A, Al-Douri E (2023). Effect of some iron and zinc sources on the vegetative growth characteristics of lemon seedlings (*Citrus lemon* L.). *Tikrit J. Agric. Sci*. 23(1): 120-129.

Al-Abbasi GB, Nehme SS, Mahmoud BS, Majeed MH (2016). The effect of ground addition to organic residues infusion and spraying of the vegetative system of lemon seedlings with salicylic acid on their vegetative growth. *Kufa J. Agric. Sci*. 8(2): 62-76.

Al-Araji JMA, Al-Hamdani RIA (2009). Study of the response of peach seedlings of the coronette cultivar to foliar spraying with zinc and ascorbic acid. *J. Mesop. Agric.* 37(2): 1-11.

Al-Hadethi ME, Ali SAD, BMK A (2017). Influence of biofertilizers on growth and leaf mineral content in peach transplants. *IOSR J. Agric. Vet. Sci*. 10(9): 90-93.

Al-Hayani AMA, Al-Tamimi DAM, Hathal NM (2016). The effect of spraying with humic acid on the tolerance of some citrus origins to the salinity of irrigation water. *Diyala J. Agric. Sci*. 8(1): 244-258.

Almeekh MTA, Assi SL, Ameer HKA (2020). Effect of spraying with zinc nanoparticles, humic acid, and adding the mineral fertilizer on the growth of pear seedlings (Hollywood cultivar). *In IOP Conf. Ser: Earth Environ. Sci*. 553(1): 3-11.

Al-Sahuki M, Waheeb KM (1990). Applications in Design and Analysis of Experiments. Dar Al-Hekma for Printing and Publishing. University of Mosul. Iraq. pp: 380.

Al-Taie ZTI, Hassan AI, Salman AM (2014). Response of citrus orange seedlings to spraying with decomposed organic extracts. *Kufa J. Agric. Sci.* 6(2): 1-15.

Arshad I, Ali W (2016). Effect of foliar application of zinc on growth and yield of guava (*Psidium guajava* L.). *Adv. Sci. Tech. Eng. Syst. J.* 1(1): 19-22.

Barakat MR, Yehia TA, Sayed BM (2012). Response of new hall naval orange to bio-organic fertilization under newly reclaimed area conditions I: Vegetative growth and nutritional. *J. Hortic. Sci. Ornam. Plants* 4(1): 18-25.

Bottomley PJ, Angle JS, Weaver RW (2020). Methods of soil analysis, Part 2: Microbiological and biochemical properties. John Wiley and Sons. *Soil Sci. Soc. Am. Inc*. pp: 802.

Eissa FM, Fathi MA, El-Shall SA (2007). Response of peach and apricot seedlings to humic acid treatments under salinity condition*. J. Plant Prod.* 32(5): 3605-3620.

Esfandiari E, Abdoli M, Mousavi S (2016). Impact of foliar zinc application on agronomic traits and grain quality parameters of wheat grown in zinc deficient soil. *Ind. J. Plant Physiol.* 21(3): 263-270.

Fathy MA, Gabr MA, El Shall SA (2010). Effect of humic acid treatments on 'Canino' apricot growth, yield and fruit quality. *New York Sci. J.* 3(12): 109-115.

Frąc M, Sas-Paszt L, Sitarek M (2023). Macro and microelements in leaves of 'Meredith' peach cultivar supplied with biochar, organic and beneficial biofertilizer combinations. *Agriculture* 13(5): 933.

Kareem KhA, Alojany ZOO, Al-Janabi ASA (2022). Marine algae extracts, and nano fertilizer with zinc and copper effects on growth, and macro- and micronutrients composition of apple trees. *SABRAO J. Breed. Genet*. 54(2): 389-396. http://doi.org/10.54910/sabrao2022.54.2.143

Melo GWBD, Sete PB, Ambrosini VG, Freitas RF, Basso A, Brunetto G (2016). Nutritional status, yield and composition of peach fruit subjected to the application of organic compost. *Acta Sci. Agron*. 38: 103-109.

Mosa WF, El-Shehawi AM, Mackled MI, Salem MZ, Ghareeb RY, Hafez EE, Abdelsalam NR (2021). Productivity performance of peach trees, insecticidal and antibacterial bioactivities of leaf extracts as affected by nanofertilizers foliar application. *Sci. Rep*. 11(1): 10191-10205.

Motyleva SM, Medvedev SM, Morozova NG, Kulikov IM (2021). Leaf micromorphological and biochemical features of scab disease in immune and moderately resistant columnar apple (*Malus domestica*) cultivars. *SABRAO J. Breed. Genet.* 53(3): 352-366.

Saeed SS, Hamad AH (2021). Effect of spraying with nutrition solution and organic fertilizer in some vegetative growth characteristics of peach seedlings cv. Red June. *In IOP Conf. Ser: Earth and Environ. Sci.* 761(1): 1-8.

Saini S, Kumar P, Sharma NC, Sharma N, Balachandar D (2021). Nano-enabled Zn fertilization against conventional Zn analogues in strawberry (*Fragaria* × *ananassa* Duch.). *Sci. Horti*. 282: 11002-110016.

Sharma S, Rana VS, Rana N, Sharma U, Gudeta K, Alharbi K, Bhat SA (2022). Effect of organic manures on growth, yield, leaf nutrient uptake and soil properties of Kiwi fruit (*Actinidia deliciosa* Chev.) cv. Allison. *Plants* 11(23): 3354.