European Journal of Agricultural and Rural Education (EJARE)
Available Online at: https://www.scholarzest.com
Vol. 4 No. 10, October 2023
ISSN: 2660-5643

EFFECT OF FOLIAR APPLICATION OF SEAWEED EXTRACT, ZING, AND IRON NANOPARTICLES ON ZIZIPHUS MAURITIANA SEEDLING GROWTH

Diekan A. Saeed[1] and Jassim M. khalaf Al-Ecehagy[2]
[1,2]Department of Horticulture and Landscape, College of Agriculture, University of Kirkuk, Kirkuk, Iraq.
[1]E-mail: Dekanayub96@gmail.com

Article history:

Received: 6th August 2023
Accepted: 6th September 2023
Published: 08th October 2023

Abstract:

This study was carried out in the wooden canopy of the Department of Horticulture and Landscaping - College of Agriculture - University of Kirkuk during the growing season 2022 to study the effect of foliar spraying with seaweed extract at three levels (0,1,2 ml L^{-1}) sequentially and zinc nanoparticles at three levels (0, 10.20 mg L^{-1}) and nano-iron at three levels (0,20,40 mg L^{-1}) sequentially and the interaction between them in the characteristics of vegetative growth and the chemical content of leaves of Sidr seedlings of the local cultivar. The experiment was designed according to the randomized complete block design (RCBD), a factorial experiment that included three levels of seaweed extract, three levels of nano-zinc, three levels of nano-iron, and three repetitions of four seedlings per experimental unit, bringing the number of observations to 180 and the number of treatments in each sector to 60 treatments. The number of seedlings included in the experiment is 180, and the treatments were randomly distributed among the experimental units. It was noticed that spraying with marine extract at a concentration of 2 ml L^{-1} led to a significant superiority over the comparison treatment in the following characteristics (carbohydrates, nitrogen, phosphorous, potassium, iron). On the comparative treatment in the following characteristics (carbohydrates, nitrogen, phosphorus, potassium, iron). And the results of the interaction between that when spraying 40 mg L^{-1} of zinc and iron nanoparticles were significantly superior to the comparison treatment in the following characteristics (carbohydrates, nitrogen, phosphorus, potassium, iron).

Keywords: Bean, irrigated area, variety, ridge, return, selection, southern region, growing season, grain yield, leguminous crop.

INTRODUCTION

Sidr Ziziphus mauritiana Lam belongs to the genus Ziziphus and to the family Rhamnaceae, which includes 58 genera and more than 900 species and includes standing or climbing trees and shrubs, and rarely herbs. Plants that grow in the tropics, subtropics and warm temperate regions (Williams, 2006). It is believed that the original home of Sidr trees is the regions of southern Europe, the Himalayas, northern China, Sudan, the Arabian Peninsula, Iraq, and South America, and it may be North Africa (Hamid, 2017). Rancidity occurs as a result of exposure to atmospheric air containing oxygen, especially when there is light and heat. Sidr trees are used as fuel, and in some areas, they are grown as ornamental trees for their beauty or as windbreaks. The fruit has many medical benefits, as it is used in alternative medicine to purify the blood, protect the digestive system, stimulate appetite, and promote liver health. Its leaves are used to treat the skin from sunburn and reduce wrinkles and signs of aging in women (Chen et al., 2015, Cheng et al., 2012).

There are many fertilizers that contain more than one element that is added to the soil or sprayed on the vegetative system of plants, including Alga 300 seaweed extract. It stimulates plant growth, which leads to improving the physical and chemical characteristics of plants because it contains macro and microelements, amino and organic acids, and growth regulators such as auxins. Cytokinins, hormones, vitamins, and polysaccharides increase plant resistance to salinity and drought (Morales and Norrie, 2010). Algae extracts also contribute to increasing plant strength and increasing its ability to absorb nutrients, thus increasing its resistance to diseases. This leads to an increase in plant production and improvement of its quality (Spinelli et al., 2010) and increases the content of chlorophyll in the leaves and the process of division and elongation of cells, in addition to increasing the process of respiration and the process of photosynthesis and thus increase plant growth (Santana et al., 2006, Jensen, 2004).

In a number of countries in the world, agricultural systems face a large number of challenges, including the problem of deterioration of the nutrition of fruit orchards and agricultural soils as a result of pollution with chemical fertilizer residues, and improving growth and production depends on the availability of balanced quantities of the necessary nutrients that are consistent with the requirements of tree growth. Methods to increase the efficiency of fertilizer use and reduce waste and pollution. Nanotechnology has entered as a useful means for developing the agricultural side, especially in the fields of fertilization, because nano fertilizer is an alternative to traditional fertilizers due to reducing the number of chemical fertilizers used and increasing the speed of its absorption by the plant, and then increasing the ability to store it inside the plant. for a longer period of time, improving crop quality, ensuring its sustainability, and increasing productivity (Alrawi Alhchami 2020)

Nano-fertilization technology is an important method for providing nutritional supplements slowly and in a controlled manner, which is vital to mitigate fertilizer requirements challenges (Naderi M, Abedi A, 2012). This is due to the fact that micronutrients are transported in the form of nanoparticles, which changes their chemical and physical properties (Mazaherinia et al. 2010). Zinc is an essential micronutrient for plants. Zinc deficiency causes disruption in cell division, nitrogen metabolism, protein synthesis, photosynthesis, chlorophyll synthesis, root reduction, cutting, dry matter, carbonic anhydrase function, integrity of membrane structure and function (Zaidan and et al. 2010) Zinc is essential for the activity of various enzymes, including dehydrogenases, aldolases, isomerases, transphosphorylases, RNA and DNA poly-merases, and is involved in tryptophan synthesis and maintenance of membrane structure (Marchner, 2012). Zinc nanoparticles as nano fertilizer. Nano-fertilization enhances agricultural productivity and provides resistance against abiotic stresses. Nanofertilizers have encouraged great interest in increasing crop production. The profit margin of farmers is increased by using nano-fertilizers as it increases yield and product quality (Zulfiqar et al. 2019).

The fertilization process is one of the important factors affecting the growth of fruit trees in general, especially iron, which is considered a micronutrient and has a role in the growth and development of the plant as it plays an essential and important role in the system of many enzymes that enter into the respiration process, including Catalase, Cytochrome and Oxidase and Peroxidase, and the iron element is important in preserving green matter. Iron plays an essential role in the representation of nucleic acids and chloroplasts (lateef,2021).

MATERIAL AND METHODS

During the 2022–2023 growing season, Sidr seedlings were sprayed with varying concentrations of seaweed extract Alga 300 (0, 1, and 2 ml L^{-1}), zinc nanoparticles (0, 10, and 20) mg L^{-1} , and nano-iron (0, 20, and 40) mg L^{-1} in the wooden canopy of the College of Agriculture at the University of Kirkuk. Four-month-old Sidr seedlings were obtained from the Department of Agriculture's nursery in Kirkuk and planted in black plastic bags.

Experience Transactions

- The first variable is the result of spraying three different doses of seaweed extract (S1, S2, and S3).

The spraying of distilled water alone (the control treatment) is represented by S1.

- S2 = spraying with a seaweed extract concentration of 1 ml L^{-1}

; S3 = spraying with a seaweed

Extract concentration of 2 ml L^{-1}

- Spraying with only distilled water (coupler treatment) is represented by F1. Spraying with a

Concentration of 10 mg L^{-1}Of zinc nanoparticles is represented by F2. Spraying with a Concentration of 20 mg L^{-1}Of zinc nanoparticles is represented by F3. The second and third Factors: are the effect of spraying with two nanoparticles of zinc and iron at the following concentrations.

- Nano iron sprayed at a concentration of 20 mg L^{-1}(F4)
- Nano iron sprayed at a concentration of 40 mg L^{-1}(F5)

Studied traits:

Estimation of the total carbohydrate content in leaves (%):

The percentage of total carbohydrates in leaves was estimated in December of the year 2021 according to what was mentioned by (Joslyn 1970) according to the following:

1- (0.2 g) of the sample was taken and (8.8 ml) of ethyl alcohol with a concentration of 80% was added to it and the mixture was placed in a water bath at 60 °C for 30 minutes.

2- The filtered liquid was extracted by centrifugation at a speed of 3000 rpm for 15 minutes.

3- As for the precipitate, the process of adding (10 ml) of ethyl alcohol and sedimentation by centrifugation was repeated for two more times.

4- Collect the filtrate and complete the volume to (50 ml) with ethyl alcohol, from which (1 ml) was taken and placed in a test tube and (1 ml) of a 5% phenol solution was added to it and (5 ml) of concentrated sulfuric acid was added and after the mixture had cooled The optical absorption was read at a wavelength (490 nm) after filtering the device with ethyl alcohol with a concentration of 80%, and after recording the readings, it was projected onto the standard curve for glucose and multiplied by 50 to extract the total sugar concentration (%).

5- As for the precipitate, the carbohydrates were re-extracted from it by adding (10 ml) of perchloric acid (80%).

6- The mixture was placed in a water bath at 60 °C for 30 minutes, after which the filtrate was extracted using centrifugation at a speed of 3000 rpm for 15 minutes.

7- As for the precipitate, the process of adding (10 ml) of perchloric acid and sedimentation by centrifugation was repeated for two more times.
8- Collect the filtrate and complete the volume to (50 ml) perchloric acid, from which (1 ml) was taken and placed in a test tube and (1 ml) of 5% phenol solution was added to it and (5 ml) of concentrated sulfuric acid was added and after the mixture had cooled The optical absorption was measured at a wavelength of (490 nm).
9 - After filtering the device with 80% perchloric alcohol, and after recording the readings, they were projected onto the standard curve for glucose and multiplied by 50 to extract the concentration of total carbohydrates (%).
10- Prepare the standard curve for measuring glucose by preparing solutions with known concentrations of glucose, which are 0.05, 0.10, 0.15, and 0.20, by dissolving these weights of glucose in (100 ml) of distilled water, then adding (1 ml) of all these concentrations to a solution Phenol and concentrated sulfuric acid in the previously mentioned quantities, then its optical absorption to extract readings corresponding to these concentrations to draw a standard curve for glucose.
2- Determination of total nitrogen content in leaves (%):
The method of Semi – micro kjeldal A.O.A.C (1980) was used to estimate the nitrogen content by taking a sample of (0.2 g) and placing it in the digestion tube and adding 1 g of the catalyst $CuSO_4$, after which 5 ml of concentrated sulfuric acid (98%) was added, and the digestion tubes were placed on heater for the purpose of digesting the sample, after which the mixture became clear and the samples were cooled to which (25 ml) of distilled water and (10 ml of NaOH) were added, after which the distillation process took place for the product and ammonia gas was received in (25 ml) of a 2% solution of boric acid, then the samples were wiped with acid hydrochloric (0.01p) and the nitrogen percentage was estimated by applying the following equation: –
Nitrogen % = (100×0.014×(0.01)Nerm x HCl acid volume) / (((g)sample weight)
3- Determination of phosphorus content in leaves (%) :
The phosphorous content was estimated using the A.O.A.C method (1980) by taking 10 ml of the digested samples using the Kildall method into a beaker and adding (0.1 g) of ascorbic acid and (4 ml) of ammonium molybdate solution (10 gm of ammonium molybdate + 150 ml of concentrated sulfuric acid) and completes the volume to a liter of distilled water) and put the mixture on the heater for 60 seconds) until the color of the solution becomes blue, then the solution is cooled and the volume is completed to a liter of distilled water. The reading was taken on the standard curve of pure phosphorus, after which the percentage of phosphorus in the leaves was calculated according to the following equation:
% Ph = (10,000,000 x 10 x 10 (g) form weight concentration) / (100 x 100 x 100 x 50 x final phosphorus)
4- Determination of potassium content in leaves (%):
The method mentioned in Semi – micro kjeldal A.O.A.C (1980) was used to calculate the potassium content in the leaves by taking 1 gm of the sample and placing it in the digestion tube and adding 1 gm of the catalyst (CuSo4) to it, then adding (5 ml) concentrated sulfuric acid (98%) The heating was done for the purpose of digesting the sample, and after the mixture became clear and the samples cooled, distilled water was added to dilute the solutions to 100 (ml), and the potassium concentration was estimated by a flame photometer.
5- Determination of zinc content of leaves (mg.L^{-1}): Zinc was determined by atomic absorption spectrophotometry (Al-Wahaibi et al., 2006).
Results and discussion:
1- Percentage of carbohydrates in leaves (%):
The results shown in Table (1) confirm that the carbohydrate content in the leaves was significantly affected by the study treatments, as the F5 treatment recorded the highest carbohydrate content of 10.19%, which was significantly superior to the F2 treatment, which amounted to 9.56% and the comparison treatment, while it was the lowest value when the non-treatment spraying F1, which amounted to 8.59%. Spray treatments with seaweed extract showed a significant effect on the carbohydrate content of leaves, especially when treatment S3 reached 10.16%, which was superior to the other two treatments, followed by treatment S2 which amounted to 9.67%, and no-spray treatment which amounted to 9.05%.As for the interaction between the two factors of the study, it showed its significant impact in this capacity through the realization of the treatment.

Table (1) Effect of spraying with sea extract and spraying with zinc and iron nanoparticles and the interaction between them on the percentage of carbohydrates in the leaves (%) of Sidr plant

Alga 300 mL^{-1} / Zn and Fe Nano mg L^{-1}	S1 0	S2 1	S3 2	Zn and Fe nanoparticles (mg L^{-1})
F1 0	7.75 f	8.86 e	9.10 ed	8.57 c
F2 10	9.37 ed	9.53 ed	9.80 bdc	9.56 b

F3 20	9.10 ed	9.77 dc	10.82 a	9.90 ba
F4 20	9.31 ed	9.85 bdc	10.57 a	9.91 ba
F5 40	9.70 dc	10.36 bac	10.51 ba	10.19 a
Alga Seaweed Extract 300 (mL-1)	9.05 c	9.67 b	10.16 a	

* The averages of each of the factors or interactions followed by different letters indicate that there are significant differences between them at the 5% probability level according to Duncan's multiple range test.

2- Determination of total nitrogen content in leaves (%):

The results indicate in Table (2) the effect of foliar spraying with zinc and iron nanoparticles on the total nitrogen content in the leaves of Sidr seedlings, where the F5 treatment gave the highest rate of nitrogen in the leaves amounted to 1.53%, which was significantly superior to the F2, F3, F4 treatment, and the treatment recorded no spraying. F1 the lowest rate of nitrogen in the leaves, which reached 1.30%

As for spraying with seaweed extract, treatment S3 recorded the highest nitrogen rate of 1.66% and outperformed the other two treatments, followed by treatment S2 which amounted to 1.37%, while non-spray treatment S1 gave the lowest value of 1.21%. As for the effect of the interaction between the two study factors, it was significantly affected in this capacity, as the treatment F5S3 achieved the highest value of 1.85%, while the comparison treatment F1S1, which recorded the lowest nitrogen content, reached 1.10%.

Table (2) Effect of spraying with sea extract and spraying with zinc and iron nanoparticles and the interaction between them in estimating the nitrogen content in leaves (%) of Sidr plant

Alga 300 mL^{-1} / Zn and Fe Nano $mg L^{-1}$	S1 0	S2 1	S3 2	Zn and Fe nanoparticles ($mg L^{-1}$)
F1 0	1.10 l	1.32 hg	1.49 d	1.30 e
F2 10	1.19 k	1.33 hg	1.52 d	1.35 d
F3 20	1.21 jk	1.35 fg	1.66 c	1.41 c
F4 20	1.26 ji	1.40 fe	1.76 b	1.47 b
F5 40	1.29 hi	1.44 e	1.85 a	1.53 a
Alga Seaweed Extract 300 (mL^{-1})	1.21 c	1.37 b	1.66 a	

* The averages of each of the factors or interactions followed by different letters indicate that there are significant differences between them at the 5% probability level according to Duncan's multiple range test.

3- Determination of phosphorus content in leaves (%):

The results shown in Table (3) confirm the significant effect of foliar spraying with zinc and iron nanoparticles in increasing the percentage of phosphorus in the leaves, especially the F5 treatment, which achieved the highest rate of increase of 0.46%, which was significant superior to all treatments, while the lowest rate when the non-spraying treatment F1 reached 0.40. % As for spraying with seaweed extract, it resulted in a significant increase in this characteristic by increasing the levels of spraying, as level S3 achieved the highest rate of 0.49%, which was significantly superior to the other two treatments, followed by treatment S2, which amounted to 0.42%, while it was the lowest value when treatment of non-spraying S1, which amounted to 0. .37%. As for the interaction between the two factors of the study, it was significantly affected in this capacity, as the treatment F5S3 achieved the highest value of 0.54%, while the comparison treatment F1S1, which recorded the lowest content of phosphorus in the leaves, amounted to 0.34%.

Table (3) Effect of spraying with sea extract and spraying with zinc and iron nanoparticles and the interaction between them in estimating the phosphorus content in the leaves (%) of Sidr plant

Alga 300 mL^{-1} / Zn and Fe Nano $mg\ L^{-1}$	S1 0	S2 1	S3 2	Effect of Zn and Fe nanoparticles ($mg\ L^{-1}$)
F1 0	0.34 m	0.40 hi	0.46 d	0.40 e
F2 10	0.36 l	0.41 hg	0.48 c	0.42 d
F3 20	0.37 k	0.41 g	0.49 cb	0.43 c
F4 20	0.38 j	0.44 f	0.50 b	0.44 b
F5 40	0.39 ji	0.45 e	0.54 a	0.46 a
Alga Seaweed Extract 300 (mL^{-1})	0.37 c	0.42 b	0.49 a	

* The averages of each of the factors or interactions followed by different letters indicate that there are significant differences between them at the 5% probability level according to Duncan's multiple range test.

4- Determination of potassium content in leaves (%):

The results shown in Table (4) indicate that the potassium content in the leaves was significantly affected by the study treatments, as the F5 treatment recorded the highest potassium content in the leaves, amounting to 1.11%, significantly superior to the F2, F3, F4 treatment and the comparison treatment, while it was the lowest value when treating No spraying F1, which amounted to 1.01%. On the other hand, spraying with algae extract led to a significant difference in the potassium content, especially in treatment S3, which amounted to 1.16%, which also excelled over the other two treatments, followed by treatment S2, which amounted to 1.07%, while the non-spray treatment S1 gave the lowest potassium content in the leaves, amounting to 0.97%. On the other hand, the interaction between the two factors had a significant effect on this trait, especially the treatment F5S3, with the highest value of 1.21%, while the comparison treatment F1S1, which recorded the lowest potassium content in the leaves, reached 0.90%.

Table (4) Effect of spraying with sea extract and spraying with nanoparticles zinc and iron and the interaction between them on the determination of potassium content in the leaves (%) of Sidr plant

Alga 300 mL^{-1} / Zn and Fe Nano $mg\ L^{-1}$	S1 0	S2 1	S3 2	Effect of Zn and Fe nanoparticles ($mg\ L^{-1}$)
F1 0	0.90 j	1.01 gf	1.12 d	1.01 e
F2 10	0.96 i	1.03 f	1.14 c	1.04 d
F3 20	0.99 h	1.09 e	1.17 b	1.08 c
F4 20	0.10 gh	1.10 ed	1.18 b	1.09 b
F5 40	1.00 gh	1.11 d	1.21 a	1.11 a
Alga Seaweed Extract 300 (mL^{-1})	0.97 c	1.07 b	1.16 a	

* The averages of each of the factors or interactions followed by different letters indicate that there are significant differences between them at the 5% probability level according to Duncan's multiple range test.

5- Iron concentration in leaves (mg L^{-1}):

The data recorded in Table (5) show that the foliar spraying of zinc and iron nanoparticles had a significant effect on the percentage of iron, as treatment F5 was significantly superior to all treatments, as it gave 49.50 mg l-1, followed by treatment F4, which amounted to 43.80 mg l-1, which did not differ significantly. For F3, which amounted to 41.11 mg l-1, which in turn outperformed the F1 treatment, followed by the no-spray treatment F1, which recorded the lowest iron content in the leaves, amounting to 37.51 mg l-1.

As for spraying with algae extract, the table shows that treatment S3 also recorded a significant superiority in the percentage of iron in the leaves, amounting to 45.49 mg L-1, followed by treatment S2, which amounted to 41.37 mg L-1, while the non-spray treatment S1 recorded the lowest percentage of iron in the leaves, amounting to 39.26 mg L-1.

As for the interaction between the two study factors, it had a significant effect on this trait, as the treatment F5S3 achieved the highest value of iron in the leaves amounting to 55.03 mg L-1, while the comparison treatment F5S3 recorded the lowest percentage of iron in the leaves amounted to 33.04 mg L^{-1}.

Table (5) Effect of spraying with Bahri extract and spraying with zinc and iron nanoparticles and the interaction between them on the concentration of iron in the leaves (mg L-1) of Sidr plant

Alga 300 mL^{-1} / Zn and Fe Nano mg L^{-1}	S1 0	S2 1	S3 2	Effect of Zn and Fe nanoparticles (mg L^{-1})
F1 0	33.04 g	39.45 fed	42.33 ced	37.51 c
F2 10	37.22 feg	35.13 fg	40.17 fed	38.27 c
F3 20	39.19 fed	41.12 ed	43.02 cd	41.11 b
F4 20	42.25 ced	42.28 ced	46.87 cb	43.80 b
F5 40	44.58 cbd	48.89 b	55.03 a	49.50 a
Alga Seaweed Extract 300 (mL^{-1})	39.26 C	41.37 b	45.49 a	

* The averages of each of the factors or interactions followed by different letters indicate that there are significant differences between them at the 5% probability level according to Duncan's multiple range test.

REFERENCE:

1. Al-Wahaibi, Muhammad Hamad, Muhammad Omar Beslah, and Abd al-Salam Muhammad Meligy, (2006). Plant tissue analysis. Scientific publishing and printing presses - King Saud University. P.O. Box 68953, Riyadh 11537.
2. Williams, J. T. (2006). introdution, taxonomy and history. Fruits for the future, 2.
3. Hamid, A. G., and M. Qureshi. (2017). Extraction and separation of some secondary metabolic compounds of the Zizyphus lotus L wild seder plant. Master's degree, Faculty of Nature and Life Sciences, Martyr Hameh University for Khader al-Wadi, Algerian People's Democratic Republic.
4. Chen, Q., Bi, J., Wu, X., Yi, J., Zhou, L., and Zhou, Y. (2015). Drying kinetics and quality attributes of jujube (Zizyphus jujuba Miller) slices dried by hot-air and short-and medium-wave infrared radiation. LWT-Food Science and Technology, 64(2): 759-766.
5. Cheng, D., Zhu, C., Cao, J., and Jiang, W. (2012). The protective effects of polyphenols from jujube peel (Ziziphus Jujube Mill) on isoproterenol-induced myocardial ischemia and aluminum-induced oxidative damage in rats. Food and Chemical Toxicology, 50(5): 1302-1308.
6. Morales Payan, J. P., and J. Norrie. (2010). Accelerating the growth of Avocado (Persea Americana) in nursery using a soil applied, commercial extract of the brown alga Ascophyllum nodosum. International Seaweed Symposium, 189.
7. Spinelli, F., Fiori, G., Noferini, M., Sprocatti, M., and Costa, G. (2010). A novel type of seaweed extract as a natural alternative to the use of iron chelates in strawberry production. Scientia horticulturae, 125(3): 263-269.
8. Santana, L. M., R.Gabriel, J. P.Morales-Payan, C. H. Puello, J.Mancebo, and F. Rondon. 2006. Effects of biostimulants on nursery growth of orange budded on volkamer lemon and swingle citrumelo. In Proceedings of the 33rd Annual Meeting of the Plant Growth Regulation Society of America, Quebec City, Canada, 9-13 July, 2006 (pp. 217-219). Plant Growth Regulator Society of America.

9. Jensen, E. 2004. Seaweed; Fact or Fancy. From the Organic Broadcaster. Published by moses the Midwest Organic and Sustainable Education .From the broadcaster .12(3): 164-170.
10. Al-Hchami, Salah H. J. and T.K.Alrawi. (2020). Nano fertilizer, benefits and effects on fruit trees: a review, Plant Archives.20 (1): 1085-1088.
11. Naderi M, Abedi A. "Application of nanotechnology in agriculture and refinement of environmental pollut- ants," J Nanotechnol, 2012; 11 (1): 18-26.
12. Mazaherinia S, Astarael A R, Fotovat A, Monshi A. "Nano iron oxide particles efficiency on Fe, Mn, Zn 22. and Cu concentrations in wheat plant, "2010; World Appl Sci J; 7.
13. Zeidan M, Mohamed MF, Hamouda H. "Effect of foliar fertilization of Fe, Mn and Zn on wheat yield and quality in low sandy soils fertility," World J. Agric. Sci, 2010; 6(6): 696-699.
14. Marschner H (2012) Mineral nutrition of higher plants. Academic Press Limited Harcourt Brace and Company, Publishers, London, pp 347-364.
15. Zulfiqar F, Navarro M, Ashraf M, Akram N A, Munné-Bosch S. "Nanofertilizer use for sustainable agri- culture: Advantages and limitations," Plant Sci, 2019; 289: 110270. https://doi.org/10.1016/j.plantsci 2019.110270 PMID: 31623775.
16. Lateef, M. A. A., Saleh, Y. M., & Noori, A. M. (2021). Effect of Some Microelements on the Growth and Yield of Apricot *Prunus Armeniaca* L. *Journal of Global Scientific Research (ISSN: 2523-9376)*, *6*(11), 1843-1849.