European Journal of Agricultural and Rural Education (EJARE)
Available Online at: https://www.scholarzest.com
Vol. 6 No. 01 January 2025
ISSN: 2660-5643

EFFECT OF NANO AND CHEMICAL NPK FERTIGATION ON THE GROWTH OF WAZIRI FIG SEEDLINGS

Faiza Khadim Dawood Al-Rumaidh
Faiza-khadim@utq.edu.iq
Department of Horticulture and Landscape Architecture, College of Agriculture and Marshlands, University of Thi-Qar, Iraq

Article history:

Received: 20th October 2024
Accepted: 14th November 2024

Abstract:

The study was conducted during the 2023-2024 growing season in the College of Agriculture and Marshlands field. The goal of this study was to find out how Nano and chemical NPK fertilisers will help Waziri fig seedlings grow in Thi-Qar Governorate. The experiment included two factors: the first factor is the normal compound fertilizer 20:20:20, added soil at four levels (0, 1000, 1500, 2000) mg.L-1, and the second factor is the compound Nano NPK fertilizer 20:20:20, also added soil at three levels (0, 75, 150) mg.L-1. The experiment was implemented as a factorial experiment according to the randomized block design (RCBD) with three replicates, with three seedlings per experimental unit. The results of the statistical analysis showed that the N2 treatment with a concentration of 75 mg.L-1 of nano-fertilizer was superior in the characteristics of main stem height, stem diameter, number of fruits, and percentage of phosphorus. The results were (45.88 cm, 5.011 mm, 3.599 fruits. plant-1, 0.436%), respectively. Similarly, the T3 treatment at a dosage of 1500 mg.L-1 of normal fertiliser outperformed the other treatments regarding "stem length, stem diameter, fruit quantity, and phosphorus". The results were (48.64 cm, 4.037 mm, 5.630 fruits. plant-1, 0.440%). The N3 treatment of nano fertiliser at a dose of 150 mg pertains to the traits of leaf count and branch count. L-1 yielded the greatest averages, specifically "34.90 leaves.4.847 branches per plant". In addition, the concentration of 150 mg.L-1 of Nano fertilizer was superior in the percentage of nitrogen, recording 2.404%, while the regular NPK fertilizer did not record any significance for this trait. Also, the N3 treatment of nano fertilizer was superior in the percentage of potassium over the rest of the treatments by 1.765%, and the concentration of 1500 mg.L-1 of regular fertilizer recorded the highest percentage of potassium, 1.716%. The results of the statistical analysis also showed that the interaction coefficients were significant for all the studied traits at varying rates according to the concentrations of the study factors

Keywords: NPK fertilizer chemical; Nano NPK; fig seedlings

INTRODUCTION

The fig (Ficus carica L.) is a deciduous shrub that belongs to the Moraceae species. The genus Ficus has 400 species and 700 variants. Botanical researchers differed about determining the original homeland, as it is believed that Western Asia is the original homeland of figs and its cultivation spread in the Mediterranean basin (Mango, 2006). There are many different kinds of it that are grown extensively in Iraq. The Black Diyala variety is considered one of the most important, and the Waziri variety comes in second place. These two varieties are widespread in the central and southern regions of the country. The best yield is at an average of 37 degrees Celsius, and figs tolerate high temperatures up to 50 degrees Celsius (Al-Khafaji and Al-Mukhtar 1989: Herre et al., 2008). The number of fruit trees in Iraq reached 412,859 trees, and the average production per tree was 22.58 kg and the total production was 9,322 tons (Central Bureau of Agricultural Statistics 2020). Their milky liquid with a distinctive smell characterizes fig trees, while their leaves are palm-shaped, complete or segmented, and their shape varies according to the variety (Ronsted et al., 2005). In this respect, Figs are cultivated for their fruits, which can be eaten fresh or dried, and possess significant nutritional value due to their content of carbohydrates, proteins, and several vitamins and minerals, including "iron, sodium, calcium, and vitamins C and A" (Isaac, 2000). The fruit of the fig is false, is botanically called

(Syconium), and is a fleshy flower stalk (Receptacle) that encloses a cavity, and this cavity is connected to the outside by a small opening called the eye (Ostiolum) (Machado et al., 2005 and Haine et al., 2006).

Adding fertilizers is necessary to provide the soil with the necessary fertility. The soil is the basic medium to support plant growth and one of the most basic natural mediums. The NPK compound fertilizer is one of the important nutrients used to feed plants and increase their production. Nitrogen is a crucial macronutrient required by plants in substantial amounts, playing a vital role in various physiological processes, including the synthesis of protoplasm, proteins, nucleic acids, and the creation of chlorophyll. Since, phosphorus is a fundamental the nutrients essential for plant life. It is one of the components of the cell and is involved in the composition of organic materials in plant tissues such as phytin and phosphorylated sugars. Potassium also plays an important role in increasing the efficiency of photosynthesis. It is also responsible for the activation of certain enzymes in the plant's vital processes, as well as the regulation of osmotic potential, the opening and closing of stomata, and the regulation of water content through the process of transpiration, as noted by Mengel et al., (2001); Taiz and Zeiger, (2006).

Although chemical fertilizers are efficient in improving plant growth, excessive use of these fertilizers leads to soil salinization and environmental degradation. Therefore, researchers have worked to find ways to increase the efficiency of fertilizer use and reduce loss and pollution by introducing nanotechnology in the field of fertilization. Consequently, the nano nutrient system has extremely small diameters that are readily absorbed by the walls of plant cells, allowing them to be kept within the growth system for a lengthy duration. In addition to releasing nutrients such as nitrogen, phosphorus and potassium. This increases the efficiency of fertilizer use, which is reflected in improving crop quality and increasing productivity (Tarafdar et al., 2012; Al-Hchami and Alrawi, 2020; DeRosa et al., 2010).

The research aims to:

- Lower the environmental and economic repercussions stemming from the overuse of chemical fertilisers.
- Explore the potential for enhancing vegetative growth and establishing robust seedling structures of the Waziri fig cultivar through a balanced application of nano and conventional NPK fertilisers.
- Identify the optimal levels of nano and conventional fertilisation or their combination.

MATERIALS AND METHODS

1- Research preparation:

The research was carried out in the valley of the College of Agriculture and Marshlands - University of Thi-Qar, for the agricultural season 2023-2024. The current study was conducted on two-year-old Waziri fig seedlings of almost uniform length and size. The seedlings were brought from the Najaf Specialized Nursery - Department of Horticulture - Ministry of Agriculture at the beginning of February. The seedlings were subsequently relocated to appropriately sized anvils (holding 10 kg), utilising a planting medium composed of compost and peat moss. Samples were taken from the medium to conduct laboratory tests on them before starting the experiment. The experiment was carried out in Dhi-Qar Governorate, Nasiriyah City.

Table (1) Soil components used in the growing medium

attribute	value	unit
PH	7.9	
EC	2.66	ds.m^{-1}
attribute		
Sand	78	%
Clay	10	%
Silt	12	%
Soil texture - Loary sand		
Nitrogen	23.18	mg kg-1
Phosphorus	9.94	
Potassium	162.01	

2- Study factors:

The experiment included two factors. The first factor is the normal balanced compound fertilizer 20:20:20, added to the ground at four concentrations (0, 1000, 1500, 2000) mg.L-1 and at a rate of three additions on 01.04 - 01.05 - 01.06 at four levels (T1-T2-T3-T4). The second factor is the balanced compound nano NPK fertilizer 20:20:20. Additionally, incorporated into the soil at three quantities (0, 75, 150 mg). L-1 at the following dates 05.04, 05.05, 05.06 at three levels (N1, N2, N3).

Table (2) Coefficients symbols in the experiment

No.	Treatments	symbols
1	Comparison treatment	T1N1
2	75 mg nano fertilizer	N2
3	150 mg nano fertilizer	N3
4	1000 mg chemical fertilizer	T2
5	150 mg chemical fertilizer	T3
6	200 mg chemical fertilizer	T4
7	1000 mg chemical fertilizer + 75 mg nano fertilizer	T2N2

8	1000 mg chemical fertilizer + 150 mg nano fertilizer	T2N3
9	150 mg chemical fertilizer + 75 mg nano fertilizer	T3N2
10	150 mg chemical fertilizer + 150 mg nano fertilizer	T3N3
11	200 mg chemical fertilizer + 75 mg nano fertilizer	T4N2
12	200 mg chemical fertilizer + 150 mg nano fertilizer	T4N3

3- The studied characteristics:

3.1 The rate of increase in growth height (cm per plant)

The height of the seedlings was recorded at the commencement of the experiment using a measuring instrument, tape, from the soil layer to the summit of the primary stem, at a rate of three plants per experimental unit. At the conclusion of the experiment, the procedure was reiterated, and by combining the two numbers, the growth rate of the seedlings' height was determined.

3-2- Rate of expansion in the diameter of the primary stem: (mm per seedling).

The diameters of the seedlings were measured at both the commencement and conclusion of the experiment, and the difference in measurements was determined using the Vernia meter for each experimental unit.

3-3-The rate of growth in leaf quantity (leaves per seedling).

The leaf count was determined using three replicates for each treatment at the experiment's conclusion, and the rate of leaf growth was estimated.

3-4-The rate of increase in the number of primary branches (branch. seedling-1).

The overall number of major branches for each seedling within each of the experimental units was assessed at the completion of the experiment. Subsequently, the growth rate of the number of major branches for each experimental unit was determined.

3.5 The rate of rise in the total number of fruits for each plant (fruit per seedling-1).

The experiment was made for each treatment to determine the number of plants at the completion of the experiment.

3-6 Percentage of nitrogen in leaves:

The method of Haynes (1980) was adopted in estimating total nitrogen using the Micro-kejdahl device.

3-7 Leaves' phosphorus content: The phosphorus percentage was determined using the ammonium molybdate and ascorbic acid method with a Spectrophotomeyer at a wavelength of 620 nm, in accordance with the approved procedure (Olsen and Sommers, 1982).

3-8 Percentage of potassium in leaves.

Potassium was estimated by flame photometer after dilutions of the digested sample according to the method of (Haynes, 1980).

4- Experimental design:

The current research implemented a factorial experiment within the randomized complete block design (R.C.B.D). The experiment included two factors, the first factor is the regular compound NPK fertilizer, added to the ground at four concentrations, and the second factor is the compound nano NPK fertilizer, also added to the ground at three concentrations. The treatments were distributed into three replicates and the results were analyzed statistically using the Genstat program. The differences between the arithmetic means were compared according to the least significant difference (LSD) test and under the probability level of 0.05 (Al-Rawi and Khalaf Allah, 2000).

s. Thus increasing the representation of carbohydrates within the plant leads to an increase in the manufactured nutrients in the leaves and accordingly increases the production of cells, tissues and plant organs such as leaves and branches, as most of the materials are transferred at the end of the season from the leaves to other parts of the plant. This can explain the formation of fruits. This is consistent with Al-Hamidawi (2012) on fig trees. The increase may be due to the entry of phosphorus into the formation of energy compounds ATP, which are necessary in the process of nutrient absorption and transport, as well as carbohydrates and phospholipids that enter into the construction of cell membranes. The efficiency of the roots in absorbing major and minor elements increases. This is consistent with the increase in the percentage of phosphorus and potassium in the leaves. This is consistent with what was found by Hamdan (2019) on pomegranate seedlings, Al-Imam (2016) on almond seedlings, Al-Maamouri (2018) on Waziri fig seedlings, and Al-Abbasi (2019) on pomegranate seedlings.

Results and discussion

1- Rate of increase in plant height (cm):

The results of Table No. (3) showed that the effect of the compound nano fertilizer was significant in the plant height trait and the N2 treatment at a concentration of 75 mg. L-1 recorded the highest values of 45.88 cm, followed by the N3 treatment at a concentration of 150 mg. L-1, which gave 42.57 cm compared to the comparison treatment, which recorded the lowest values of 39.11 cm.

Also, the regular compound fertilizer had a significant effect on this trait, as T3 at a concentration of 1500 mg.L-1 gave the highest value of 48.46 cm, followed by treatment T4, which gave 41.85 cm, while treatment T2 recorded the lowest values of 39.75 cm, without a significant difference from the comparison treatment T1, which gave 40.03 cm. Also, the interaction between the two study factors recorded a significant effect, and treatment T3N3 recorded the highest value of 53.60 cm, compared to the comparison treatment, which recorded the lowest value of 34.81 cm.

Table 3: Effect of nano and chemical NPK fertilizer on the rate of increase in plant height (cm).

NPK Nano Fertilizer	NPK chemical fertilizer				Nano fertilizer rate
	T1	T2	T3	T4	
N1	34.81	35.88	38.37	47.39	39.11
N2	46.36	44.73	53.42	39.01	45.88
N3	38.91	38.64	53.60	39.14	42.57
Chemical fertilizer rate	40.03	39.75	48.46	41.85	
L.S.D 0.05	T=0.91		N=0.79	TN=1.583	

2-Rate of increase in stem diameter (mm).

Table 4 shows that nano fertilizer had a significant effect on the stem diameter trait and the N2 treatment at a concentration of 75 mg.L-1 gave the highest average of 5.011 mm compared to the comparison treatment, which gave the lowest average of 3.923 mm.

As for the compound chemical fertilizer, it had a significant effect on this trait and the T3 treatment recorded the highest average of 4.690 mm compared to the comparison treatment which recorded the lowest values of 4.037 mm. Also, the interaction between nano fertilizer and balanced chemical fertilizer had a significant effect and the T3N2 treatment outperformed with the highest values of 5.290 mm compared to the comparison treatment which recorded the lowest average of 3.400 mm.

Table 4: Effect of nano and chemical NPK fertilizer on rate of increase in stem diameter (mm).

NPK Nano Fertilizer	NPK chemical fertilizer				Nano fertilizer rate
	T1	T2	T3	T4	
N1	3.400	4.233	4.580	3.480	3.923
N2	4.963	4.520	5.290	5.270	5.011
N3	3.747	3.690	4.200	4.180	3.954
Chemical fertilizer rate	4.037	4.148	4.690	4.310	
L.S.D 0.05	T=0.25		N=0.22	TN=0.44	

3- Rate of increase in the number of leaves (leaf. plant-1)

The results of Table 5 showed that the compound nano fertilizer had a significant effect on the number of leaves trait, and the N3 treatment at a concentration of 150 mg. L-1 gave the highest average of 34.90 (leaf. plant-1) compared to the control treatment which recorded the lowest average of 26.34 (leaf. plant-1). Also, for the conventional compound fertilizer, it had a significant effect on the number of leaves trait, and the T2 treatment at a concentration of 1000 mg. L-1 outperformed the rest of the treatments with the highest average of 39.07 leaf. plant-1, and the comparison treatment T1 recorded the lowest values of 20.70 leaf. plant-1. The interaction coefficients between the two study factors showed a significant superiority, and the T2N3 treatment outperformed the rest of the treatments, while the comparison treatment recorded the lowest average of 16.67 (leaf. plant-1).

Table 5: Effect of nano and chemical NPK fertilizer on Rate of increase in the number of leaves (leaf. plant-1)

NPK Nano Fertilizer	NPK chemical fertilizer				Nano fertilizer rate
	T1	T2	T3	T4	
N1	16.67	27.95	18.49	42.26	26.34
N2	26.67	28.36	25.07	36.19	29.07
N3	18.76	48.03	34.05	38.77	34.90
Chemical fertilizer rate	20.70	34.78	25.87	39.07	
L.S.D 0.05	T=0.85		N=0.74	TN=1.48	

4- Number of main branches (branch. plant-1):

Table 6 demonstrated that the N3 treatment with a dosage of 150 mg and the balanced nano fertiliser had a substantial impact on the number of branches characteristic.L-1 significantly outperformed the maximum values of 4.847 (branch. plant-1). The comparison treatment N1 resulted in the lowest average of 3.399 (branch. plant-1). The T2 treatment superior to the other treatments, recording an average of 5.604 (branch. plant-1), and the effect of the added compound fertiliser was also significant. The treatment without providing fertiliser recorded the smallest mean of 2.439 (branch. plant-1). This trait was also significantly influenced by the interactions of the study factors. The T2N3 treatment achieved the maximum average, while the other treatment had a modest average, which was 1.263 (branch. plant-1).

Table 6: Effect of nano and chemical NPK fertilizer on number of main branches (branch. plant-1):

NPK Nano Fertilizer	NPK chemical fertilizer				Nano fertilizer rate
	T1	T2	T3	T4	
N1	1.263	4.660	2.510	5.163	3.399
N2	1.770	4.307	4.477	5.623	4.044
N3	4.283	7.847	2.260	5.000	4.847
Chemical fertilizer	2.439	5.604	3.082	5.262	

rate					
L.S.D 0.05	T=0.25		N=0.22	TN=1.44	

5 - Average number of fruits (fruit. plant-1):

The results of Table 7 indicated that the number of fruit characteristics was significantly influenced by the compound nano fertiliser, particularly the treatment with a concentration of 75 mg. The comparison treatment recorded the lowest average of 2.152 (fruit. plant-1), while L-1 reported the most significant value of 3.599 (fruit. plant-1). The typical complex fertiliser also exhibited a substantial impact on this trait. Treatment T3 achieved the greatest average of 5.630 (fruit. plant-1) among the treatments, which was significantly higher than the other treatments. Treatment T4 achieved the lowest average of 0.943 (fruit. plant-1). In terms of the connection between nano and typical fertiliser, treatment T3N2 performed better than the other treatments by 7.883 (fruit. plant-1), while treatment T4N produced the lowest average of 0.943 (fruit. plant-1).

Table 7: Effect of nano and chemical NPK fertilizer on Average number of fruits (fruit. plant-1)

NPK Nano Fertilizer	NPK chemical fertilizer				Nano fertilizer rate
	T1	T2	T3	T4	
N1	1.660	1.477	4.403	1.067	2.152
N2	1.590	4.227	7.883	0.697	3.599
N3	3.477	2.550	4.603	1.067	2.924
Chemical fertilizer rate	2.242	2.751	5.630	0.943	
L.S.D 0.05	T=0.30		N=0.26	TN=0.52	

6- Percentage of nitrogen in leaves %:

The substance used as nano fertiliser had a substantial impact on the percentage of nitrogen and treatment (N3) at a concentration of 150 mg, as demonstrated in Table No. 8.The control treatment recorded the lowest percentage of 1.851%, while L-1 recorded the highest percentage of 2.404%. In terms of the interaction between the two study factors, it demonstrated a substantial impact on this trait. The treatment T1N3 provided the highest percentage of 2.678%, while the opposite treatment T1N1 provided the smallest percentage of 1.515%.

Table 8: Effect of nano and chemical NPK fertilizer on a percentage of nitrogen in leaves %:

NPK Nano Fertilizer	NPK chemical fertilizer				Nano fertilizer rate
	T1	T2	T3	T4	
N1	1.515	**2.087**	1.895	1.905	1.851
N2	2.011	2.191	2.634	2.673	2.377
N3	2.678	2.531	2.197	2.210	2.404
Chemical fertilizer rate	2.068	2.270	2.242	2.263	
L.S.D 0.05	T=n.s		N=0.22	TN=0.45	

7- The percentage of phosphorus %:

The results of Table 9 showed that the neutral nano fertilizer had a significant effect on this trait. Treatment (N2) at a dosage of 75 mg.The maximum percentage was obtained by L-1 at 0.436%, while the smallest value was recorded by N1 at 0.360%. The results of the table also demonstrated that the normal fertilisation treatments had a substantial impact on this trait. The maximum percentage of phosphorus (0.440%) was obtained in Treatment T3, which was significantly different from the rest of the treatments. The average of 0.367% was the lowest in the comparison (N1). The interaction interventions between nano and chemical fertiliser had a substantial impact on this trait. The comparison revealed that the treatment T1N1 reported the smallest percentage of 0.288%, while the treatment T4N2 observed the most significant percentage of 0.477%.

Table 9: Effect of nano and chemical NPK fertilizer on the percentage of phosphorus %:

NPK Nano Fertilizer	NPK chemical fertilizer				Nano fertilizer rate
	T1	T2	T3	T4	
N1	0.288	0.317	0.422	0.414	0.360
N2	0.385	0.431	0.451	0.477	0.436
N3	0.428	0.417	0.446	0.413	0.426
Chemical fertilizer rate	0.367	0.389	0.440	0.434	
L.S.D 0.05	T=0.035		N=0.030	TN=0.6	

8- Percentage of potassium %:

Table 10 revealed that the nano fertiliser significantly increased the potassium percentage. The N3 treatment reported the highest possible percentage of 1.765%, while the other treatment recorded the smallest percentage of 1.306%. Similar to the typical fertiliser, the T3 treatment is administered at a dosage of 1500 mg.The difference between the two treatment reported the lowest value of 1.256%, while L-1 recorded the highest value of 1.716%.

Additionally, the interaction between the two study factors revealed substantial disparities between the treatments. The T4N3 treatment exhibited the greatest potassium concentration of 1.931%, while the compared treatment showed the lowest potassium dosage of 0.883%.

Table 10: Effect of nano and chemical NPK fertilizer on Percentage of potassium %

NPK Nano Fertilizer	NPK chemical fertilizer				Nano fertilizer rate
	T1	T2	T3	T4	
N1	0.883	1.398	1.699	1.244	1.306
N2	1.324	1.512	1.666	1.868	1.593
N3	1.588	1.761	1.782	1.931	1.765
Chemical fertilizer rate	1.265	1.557	1.716	1.681	
L.S.D 0.05	T=0.10		N=0.09	TN=0.18	

DISCUSSION:

Nano fertilizers

The stem diameter expanded as a result of the plant's overall increase (see Table 3 Table 4, the quantity of leaves has increased. Table 5 and an increased number of major branches The fact that fertilisers constructed at the nanoscale have a high surface area and delayed release is the reason for Table 6, which aids in the speed of nutrient release and penetration. This, in turn, results in the increase in the pace that growth occurs and the subsequent increase in the size of the roots. This, in turn, benefits to the efficiency of nutrient absorption, which in turn increases the growth of the vegetative group and, as a result, the aforementioned characteristics. This rise may be attributed to the nitrogen element's involvement in the synthesis of protein and nucleic acids that are crucial for cell division and elongation. Additionally, the nitrogen element is involved in the development of amino acids, including Tryptophan, which is the initial enhance in the synthesis of auxins. This process in turn promotes cell division and elongation, thereby increasing plant growth and establishing a robust structure. Alternatively, the increase may be attributed to the phosphorus element's role in promoting growth and the formation of a robust root system that can absorb nutrients. Consequently, the material produced by the photosynthesis process increases, and its products are transferred to other parts of the plant (Barad et al. 2010).

This is in accordance with the findings of Al-Jalehawi (2019) on citrus seedlings, Karam (2020) on pear seedlings, and Hagagg (2018) on olive seedlings. The rise in the number of fruits can be attributed to the direct effect of nano fertilisers on the areas of leaf formation and the increase in the number of their divisions, as well as the effect on the hormones responsible for the leaf (cystokinins). The green cells are stimulated to divide and elongate. The efficiency of nano fertilisers in transporting proteins and amino acids from the stem and foliage of the plant to the targeted areas is evident in the formation of fruits. This finding is consistent with Masir's (2020) findings on fig trees.

The three elements' critical roles in the fertiliser are the explanation for the rise in the percentage of nitrogen, phosphorus, and potassium in the argument (8, 9 and 10). Potassium is involved in a variety of physiological processes, including respiration, photosynthesis, and chlorophyll formation. Its role in metabolic processes lies in activating enzymes, thus encouraging cell division and tissue growth. The exchangeable potassium ion is released into the soil solution to maintain the balance between the soil solution and the plant. It is necessary to produce ATP, which is important in chemical processes during the vegetative growth of the plant. Accordingly, the percentage of nitrogen, potassium and phosphorus increases, or the reason may be due to the repeated preparation of small amounts of nutrients with irrigation water to increase the availability of NPK in the root zone with much higher results reaching 90% according to other methods.

Or perhaps the reason is attributed to the fact that when nanonutrients enter the cell, they can be transported apoplastically or symplastically and can be transported through the plasma membrane from one cell to another. In the cytoplasm, nanonutrients approach the various cytoplasmic organelles and enter into the various metabolic processes of the cell. This leads to an increase in the ability to absorb and fix elements inside the plant. This can explain the increase in the percentage of nitrogen, phosphorus and potassium in the leaves. This is consistent with what Al-Rumaidh (2020) found on pomegranate seedlings and Karam (2020) on pear seedlings.

Chemical fertilizers

The increase in tables (3, 4, 5, 6, 7, 9 and 10) may be attributed to the presence of this fertilizer combination (NPK) in plant tissues in its ready form necessary to carry out vital processes within the plant and which meet the needs of the vegetative group. This led to its activity and increased ability to absorb elements and enter the process of photosynthesis and division of meristematic cells and their elongation through plant growth hormones such as auxins and gibberellins, which results in a strong vegetative group. The increase may be attributed to the fact that the potassium element present in the combination stimulated the enzymes necessary for physiological activities such as photosynthesis, respiration and transport of sugars to their disposal site

REFERENCES

1. Al-Abbasi, G B, K M Abdullah, Z A Hussein. 2019. Effect of spraying with Tecamin Algae and NPK fertilizer on the growth of pomegranate *Punica granatum* L. seedlings cv. California wonderful IOP Conf. Ser.: Earth Environ. Sci. 388. 012078.

2. 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.
3. Al-Imam, N. M. Amin A. 2016. Effect of Chemical Fertilizer (NPK) on the Growth and Production of Grafted Almond Seedlings Prunus amygdalus Batsch. Journal of the University of Babylon. Pure and Applied Sciences. 24(1).
4. Al-Jalihawi, I. A. A. 2019. Response of Bitter Orange Seedlings to Spraying with Growth Stimulant and Chelated NPK Fertilizer Produced by Nanotechnology. Master's Thesis. Department of Horticulture and Landscape Engineering. College of Agriculture. University of Kufa. Ministry of Higher Education and Scientific Research. Iraq.
5. Al-Khafaji, M. A., and Faisal A. H. A. 1989. Fruit and Vegetable Production. Bayt Al-Hikma, University of Baghdad. Iraq.
6. Al-Maamouri, S. M. T. 2018. Effect of foliar nutrition on the growth of Waziri variety seedlings. Master's thesis. College of Agricultural Engineering Sciences. University of Baghdad. Iraq.
7. Al-Rawi, K. M., and Abdul Aziz, M. Khalaf A. 2000. Design and Analysis of Agricultural Experiments. Ministry of Higher Education and Scientific Research. University of Mosul. Dar Al-Kutub for Printing and Publishing. Iraq.
8. Al-Rumaidh, F. K. D. 2020. Response of pomegranate seedlings Wonderful variety to balanced nano-NPK fertilization and spraying of salicylic acid and their effect on the growth and phenolic content of leaves. Master's thesis. College of Agriculture and Marshlands. University of Thi Qar. Iraq.
9. Baiea M. H. M., M. A. Abdel Gawad-Nehad and A. Abedelkhalek .2017. Influence of Natural Alternative NPK and Biofertilizations on Vegetative Growth and Nutritional Status of Young Wonderful Pomegranate Trees. Asian Journal of Soil Science and Plant Nutrition 2(3): 1-8.
10. Central Organization for Agricultural Statistics of Iraq. 2020. Summer Fruit Production Report. Ministry of Planning. Baghdad. Iraq.
11. DeRosa, M.R; C.Monreal; M.Schnitzer; R.Walsh; Y.Sultan .2010. Nanotechnology in fertilizers. Nat. Nanotechnol. J 5, 91-96.
12. Hagagg, L.F.; N. S. Mustafa; E.A.E. Genaidy and El-Hady, E. S. 2018a. Effect of spraying Nano-NPK on growth performance and nutrients status for (Kalamat cv.) olive seedling. Bioscience Research, 15(2): 1297-1303.
13. Haine , E. R., Martin, J., and Cook J. M. 2006. Deep Midna divergences indicate cryptic species in a Fig pollinating Wasp BMC Evolution any Biology 6 : 83 .
14. Hamdan, A. Q. 2019. Effect of fertilization and spraying of gibberellic acid on the growth of pomegranate seedlings. Master's thesis. College of Agricultural Engineering Sciences. University of Baghdad. Iraq.
15. Haynes, R.J. 1980. A comparison of two modified Kjeldal digestion techniques for multi elements plant analysis with conventional wet and dry ashing methods. Commune cation Soil Sci. Plant Analysis. 11 (5): 459-467.
16. Herre, E. A, Jan eler Kc., Machado, C. A. 2008. Evolutionary Ecology of Fig leaves extra; Recent pro grass and out staneling puzzles. Ann. Per. Ecol. Evol. Syst. 37: 438 – 456.
17. Karm, B. N. I. 2020. Effect of nano- and non-nano-NPK fertilizer on the growth of pear seedlings. Doctoral thesis. College of Agricultural Engineering Sciences. University of Baghdad. Iraq.
18. Mango, N. 2006. Fig mltorticlture in Japan. The Japanese Society for Horticultural Science (cds). Shonkadoh publication, Dept. of Publishing of Nakanishi Printing CO. Ltel., P. 106 – 110.
19. Masir, S. A. 2020. NPK and gibberellin GA3 on physical, chemical, physiological characteristics and fruit yield of black fig trees, *Ficus carica*.L.
20. Mengel, K., E. A. Kirkby., H. Kosegarten and T. Appel. 2001. Principles Plant Nutrition. Kluwer Academic Publishers.
21. Olsen, S.R. and L.M. Sommers. 1982. Phosphorus in A.L Page, (Ed). Methods of Soil Analysis. Part2. Chemical and Microbiological Properties 2nd edition, Amer. Soc. of Agron. Inc. Soil Scs. Sco. Am. Inc. Madision. Wis. U.S.A.
22. Taiz. L. and E. Zeiger.2006. Plant Physiology. 4th ed, Sinauer Associates, Inc . Publishers Sunderland, Massachusetts - AHS. U.S.A.
23. Tarafdar, J. C., Xiang, Y., Wang, W. N., Dong, Q. and Biswas, P., (2012c). Standardization of size, shape and concentration of nanoparticles for plant application. Applied Biological Res., 14: 138-144.
24. Zuoping Zhao, D. Min, Y. Sha, L. Zhifeng,W. Qi3, F. Jing, and T. Yan’an .2017. Effects of different fertilizations on fruit quality, yield and soil fertility in field-grown kiwi fruit orchard. Int J Agric & Biol Eng. 10(2): 162–171.