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The response of okra plants *Abelmoschus esculentus* (L) Moenth. Cultivated in greenhouses for foliar spraying with nano fertilizer NPK

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Abstract

The study was carried out during the winter season 2018-2019 under the conditions of unheated greenhouses of the Agricultural Research Station of the College of Agriculture - University of Muthanna, to study the effect of foliar application with nano NPK fertigation and the number of sprays on the chemical properties of the leaves and fruits of okra plants Hasinawi variety. The study included four concentrations of nano NPK fertilizer (0, 0.5, 1.0, 1.5) ml L^{-1} with number of sprays (once and twice) and interaction between them. Randomized Complete Block Design (RCBD) was used with three replicates per treatment. The means of treatment were compared by Least Significant Difference (L.S.D) at 0.05 probability. The aforementioned treatments and their interactions in the chemical properties of leaves and fruits were studied, which included leaf content of chlorophyll, carbohydrates, the percentage of total soluble solids (TSS) of fruits, the percentage of fibres, phenols, polyphenol oxidase (PPO) and the percentage of total protein, Results indicated that spray treatment with a concentration of 1.5 ml L^{-1} was superior in increasing the chlorophyll content, TSS and the percentage of fibers. Spraying twice treatment with nano NPK fertilizer outperformed all the chemical properties of the leaves and fruits under study. In the case of overlap between both factors, as the treatment of spraying with a concentration of 1.5 ml L^{-1} times was superior, with significant differences in most of the characteristics studied.

Keywords: nano NPK fertilizer, Hasinawi, phenols, polyphenol oxidase (PPO).

1. Introduction

Okra, *Abelmoschus esculentus* (L).Monenth, is one of the important summer vegetable crops in Iraq, which belongs to the Malvaceae family, and the previous scientific name of the crop is *Hibiscus esculentus* L. okra is called by other names such as bride's finger the bride. The area cultivated with okra crop in Iraq for the year 2016 was about 8770 hectares, with a total productivity of 4.6071 tons and a low production rate of 5.253 tons hectare^{-1} compared to some Arab countries such as Saudi Arabia is 14.371 tons, Egypt 11.468 tons, Kuwait 23.293 tons, Bahrain 25.681 tons, and the average production of Arab countries is 9.591 tons [1]. A positive effect on plant growth and productivity increase and the current production is much less compared to the neighbouring Arab countries. The continuous addition of traditional chemical fertilizers and their overuse to compensate for the lack of soil nutrients leads to environmental pollution as well as the high costs of these fertilizers [2], and as a result of the negative effects of the excessive use of chemical fertilizers in the southern region, including the problem of soil pollution Moreover, it increases the salinity of the soils of the region, all of these reasons were sufficient To research and think about using alternatives to traditional fertilizers to provide all the necessary nutrients the plant needed to increase growth and yield while preserving the quality and quality of agricultural land, so most researchers have resorted to experimenting with the use of fertilizers with modern, environmentally friendly and very effective techniques called Nano fertilizer. Al-Juthery [3] , the positive effect of it compared with traditional fertilizers in improving the growth and yield of vegetable plants and on this basis it was done application of the use of integrated nano composite in this study. Nanotechnology means studying the basic principles of molecules and compounds whose size does not exceed 100 nm [4], and this technique depends on reducing the part to a size equal to one billionth of a meter (10^{-9} m) and then using the new material, and the use of Nano fertilizer is one of the most widely used molecules for its positive effect on improving plant growth [5]. In recent years, a lot of studies and research have appeared that dealt with the introduction of nanotechnology in the agricultural field, which is called Agro-Nanotechnology, which made it have a great impact on the world economy, and agriculture occupies the second place in the list of using nanotechnology after energy storage, production and conversion, which It is considered the most important field of nanotechnology in the coming years [6]. This technique provided the

exploration of nanomaterial's or Nano composites as carriers of fertilizers or materials that are controlled by their release towards smart fertilizers to enhance the efficiency of nutrient use and reduce agricultural inputs and environmental pollution [7]. Sharma [8], stated that the importance of nanotechnology lies in the fact that tiny objects with Nano scale dimensions have properties when they differ in size. About their properties when they combine to form larger bodies. Peddis [9], showed that there are some unique properties of nanoparticles such as very high specific surface area and high surface energy. This leads to a big difference in their behaviour and environmental fate compared to their larger-molecular counterparts. Prasad [10] showed that the use of nanomaterial's particles is a modern technology whose use has become in a wide range of life sciences, including adding them to the soil to improve their properties or vital components or adding them to plants to increase their growth and improve their productivity and nanoparticles have unique and distinctive behavior and characteristics such as their smallness. And having a high effective surface area with a high ability to dissolve and penetrate inside the plant, stability and stability within the treated area. Drostkar [5], said that treating *Cicer arietinum* L. chickpea plants with NPK Nano fertilizer improved the morphology and chemical components of the fruits. Al-juthery and Al-Shami [11], noticed that the treatment plant potato *Solanum tuberosum* L. with nano NPK fertilizers may significantly improve the content of chlorophyll in the stock by 28% compared with non-treatment plants, Merghany [12], said that treated *Cucumis sativus* L. with nano and chemical fertilizers improved the chlorophyll content of leaves compared to untreated plants at (37.3 and 32.9)%, respectively, noticed that the plants treated with nano fertilizer outperformed the plants treated with chemical fertilizers by 3.3%. Mahmoud and Swaefy [2], found that treated *Salvai offcinalis* L. with chemical and Nano fertilizers improved plant growth, but with the outperformance of plants treated with Nano fertilizers, the leaf content of chlorophyll and carbohydrates was (40.05, 40.70%) and (12.60, 35.16%).) respectively and for both growing seasons (2018-2019).

2. Materials and methods

The experiment was carried out in an unheated greenhouse with dimensions (9 x 51) m in Al-Muthanna Governorate at the second agricultural research station on the Euphrates River affiliated to the College of Agriculture - Al-Muthanna University, which is located within the coordinates of longitude 45.283333 and latitude 31.316667 and for the 2018-2019 agricultural season, Random samples of greenhouse soil was taken before planting to estimate some of the chemical and physical properties of it table 1 shows some of the physical and chemical properties of house soil. The house was prepared by plowing the land twice, perpendicularly to a depth of 30 cm, using a tipping plow and smoothing it using the harrows The disc was divided into three experimental units and left the soil for solar sterilization in the summer for a period of thirty days, after which the soil was settled and divided into eight lines with a width of 45 cm and a length of 9.00 m. Each line was divided into three experimental units, leaving a distance of 75 cm between the lines and 40 cm between one plant and another on the same line Thus, each experimental unit contains 8 hole, and in each hole there were two plants, and the number of plants was in the experimental unit 16 plants, the plants were irrigated in the greenhouse using a drip irrigation system consisting of a 5,000-liter tank and a 3-inch main tube, from which tubes were distributed to grow vegetables 0.5 inches on both sides of the main tube inside the house containing drips 40 cm apart, and the tank was filled with a pump from a river Euphrates, samples of water were taken and analyzed, as indicated in Table 1.

Table 1. Chemical and physical properties of field soil samples and irrigation water.

Method used	Type of analysis	measuring unit	Season 2019
Page et al. (1982)	ECe	ds m-1	3.5
	TDS	g L-1	1.7
	NaCl	%	4.2
	pH	-----	7.2
	Ready nitrogen	mg kg-1	35
	Ready phosphorous	mg kg-1	3.7
	Ready Potassium	mg kg-1	252
	Organic matter	%	0.84
	clay ratio	%	32
	Silt ratio	%	63
	Sand ratio	%	5
	Soil tissue	----	Silty clay
	Irrigation water properties		
Page et al. (1982)	ECe	ds m-1	2.8
	TDS	g L-1	1.4
	NaCl	%	4.2
	pH	-----	7.1

Laboratories of the Department of Soil Sciences and Water Resources in the College of Agriculture - Al-Muthanna University The experimental units were fertilized with fully decomposed organic fertilizer (cow manure) at the rate of one ton per greenhouse. Choose the local variety (Hasinawi) desired by the consumer, and it is a variety known for its abundance of production. It does not contain thorns and its texture is soft [13]. The seeds were purchased from one of the approved agriculture offices in Al-Muthanna Governorate, and the planting was directly in the plastic house after removing the damaged, irregular seeds. The seeds were soaked in warm water for 12 hours before planting, planting The seeds are in a hole at a depth of 3-4 cm, and the distance between the sockets is 40 cm in the center of the line, and the sowing was on 1/12/2018.

The greenhouse was irrigated by the drip irrigation system two days before planting the seeds to moisten the soil. 3-4 seeds were planted in one hole, two plants were reduced in one hole and the number of plants in the experimental unit was 18, two plants were left at the beginning and end of the experimental unit as Protective plants, the lines were covered with Soil Mulching before planting. To get rid of diseases Fungicide Use the Bio content biocide (1 gm^{-1}) spread on the lines in the form of a line at the top of the lines, and to get rid of the cutworm, use Toxan pesticide (1 ml L^{-1}) for infected plants only, as preventive sprays of Toxan pesticide were carried out on both sides of the house to avoid insects Toxan was used to control aphids on the infested plants. The study included the effect of spraying with Nano NPK fertilizer from the Iranian company Sepehr Parmis which contains (5% K, 4% P, 8% N) and the number of sprays with this fertilizer on the chemical properties of the leaves and fruits of okra plants, and the treatments were as follows: -

1- Spraying with nano NPK fertilizer : spraying plants with nano NPK fertilizer in four concentrations (0, 0.5, 1.0, 1.5) ml

2- The number of sprays: The experimental units were divided into two parts, the first was sprayed once three weeks after planting the seeds, the second part was sprayed twice between the spray and the other two weeks and the first spray was three weeks after planting as well.

Randomized Complete Block Design (R.C.B.D.) was used with three replications. Thus, the number of transactions reached eight parameters, which are the number of experimental units of one repeat (4 × 2) and with three replications, and the total number reached 24 experimental units. The total chlorophyll pigment in green leaves was determined according to [14] method using a Visible spectrophotometer to measure the optical absorption of the pigment at wavelengths of 645 and 663 nm. The carbohydrate content of the leaves was estimated by the method of Modification of Phenol - Sulfuric Acid Colorimetric Method described by [15], and the percentage was calculated. For total dissolved solids by taking (5) g of fruits with 20 ml of distilled water and placed in an electric mixer. It was filtered and a drop was taken from it and put on a hand refrectometer to read the percentage of total dissolved solids as described [16], The percentage of fibers in the fruits was estimated as shown in [16], and the phenolic substances were estimated according to the Folin-Denis method mentioned in [17]. Oxidase in fruits by the method reported by [18], the percentage of protein in fruits was estimated based on the percentage of nitrogen in the dry and milled sample of fruits and was calculated as shown in [16]. The results were analyzed statistically according to the used design using the Genstat 2008 statistical program. The averages were tested using the lowest significant difference and a probability level of 0.05.

3. Results and discussion

Table 2 shows the main effects of spraying with nano NPK fertilizer, the number of sprays and their interactions in the content of chlorophyll and carbohydrates in the leaves, the percentage of total dissolved solids (TSS) and the percentage of fibers in the fruits of okra plants. 79.81 mg 100 gm^{-1} wet weight, 51.41 mg 100 gm^{-1} dry weight, 6.94% and 10.18% respectively, while the lowest content in control treatment was 67.76 mg100 gm^{-1} wet weight, 36.51 mg 100 gm^{-1} dry weight, 5.12% and 8.21% respectively, and it is noted that the plants treated by spraying twice and for all the previous characteristics reached 76.87 mg 100 g^{-1} wet weight, 49.58 mg 100 g^{-1} dry weight, 6.44% and 9.47%, respectively, compared to plants treated with one spray, it was 72.20 mg 100 g^{-1} wet weight , 42.83 mg 100 g^{-1} wet weight, 5.65% and 8.94% respectively, as it is noted in the table the superiority of plants treated by spraying with a concentration of 1.5 ml l^{-1} times the highest content of chlorophyll and carbohydrates in the leaves and the percentage of total soluble solids and fibers was 81.54 mg 100 g^{-1} wet weight, 58.13 mg 100 g^{-1} dry weight, 8.05% and 10.80% compared with the lowest content for both traits in plants. The treatment by spraying with distilled water (zero concentration) once was 67.53 mg 100 g^{-1} wet weight, 33.38 mg 100 g^{-1} dry weight, 4.95% and 8.05% respectively. Table 2 show the main effects of spraying with nano NPK fertilizer and the number of sprays and their interactions in the percentage of phenols and the PPO enzyme in the fruits, as the spray treatment with the concentration of 0.5 ml l^{-1} surpassed the highest percentage of phenols and the enzyme content in the fruits reached 1.86% and 80.92 enzyme units ml^{-1} compared with the lowest percentage of phenols and the enzyme content in the control treatment was 1.44% and 76.15 enzyme units ml^{-1} respectively, and the plants treated by spraying twice with nano NPK fertilizer outperformed in the ratio, The percentage of phenols and the content of the enzyme polyphenol oxidase was 1.85% and 84.05 enzyme units ml^{-1} compared with the lowest values when spraying plants once was 1.61% and 74.16 enzyme units ml^{-1} respectively, but in the case of overlap between both factors, we notice the superiority of the treated plants, at a concentration of 1.5 ml l^{-1} twice The highest percentage of phenols was 1.95%, compared to the lowest percentage when spraying plants

with distilled water once, which was 1.24%, while the highest PPO content when spraying plants with a concentration of 1.0 ml l^{-1} twice compared to the lowest content of the enzyme in plants was the treatment sprayed with water. Once distilled only reached 72.02 ml^{-1} enzymatic units.

It is noted from Table 2 that there were no significant differences when spraying okra plants with nano NPK fertilizer in the percentage of protein in the fruits, while the sprayed plants outperformed twice with the highest percentage of protein amounting to 2.88% compared with plants treated with a once spray of 2.10%. In the case of interaction between both factors, the plants treated with a concentration of 1.0 ml^{-1} times outperformed the highest percentage of protein compared to the lowest percentage when spraying plants with distilled water once, reaching 1.97%.

It is noted from the table that there is a significant effect of the nano NPK fertilizer for the experimental characteristics in study, and the reason might be due to the major elements it contains (NPK) essential for the plant, which have an important role in the vital activities that take place inside the plant, including the carbon representation and the increase of the manufactured substances accumulated in the plant such as starch and sugars then It is reflected in the improvement of the quality characteristics of the fruits [19]. The reason might also be attributed to the role of the elements nitrogen and phosphorous, which are included in the synthesis of nucleic acids DNA, RNA, and proteins and their role in increasing cell growth and division, and potassium also have an important role as it works to activate the enzymes responsible for building proteins [20]. It also notes the important role of nano NPK fertilizer in the moral effect on all characteristics through the unique characteristics of this type of fertilizer, including the small size of its minutes, which made it possible to better efficiently absorb it by the plant and also increase its surface area increased the surface of absorption and direct entry For plant cells [21]. The reason might also be attributed to the important effect of nanotechnology that worked on controlling the release of various nutrients and reduced their loss through decomposition or washing from the soil, as well as avoiding their interaction with the soil, increasing its efficiency and reducing its potential toxicity when increasing the concentration or repetition when treating [22].

Table 2. The effect of concentration and number of sprays of NPK on the content of leaves and fruits of some chemicals.

Nano NPK ml L^{-1}	Sprays	Chlorophyll mg $100g^{-1}$ FW	Carbohydrate mg $100g^{-1}$ WD	TSS %	Fiber %	Phenols %	Poly phenols Oxidase Unit ml^{-1}	Protein of Fruits %
0	Once time	67.53	33.38	4.95	8.05	1.24	72.02	1.97
	Twice time	67.99	39.64	5.29	8.38	1.63	80.28	3.22
0.5	Once time	68.47	44.59	5.52	8.83	1.83	80.35	2.61
	Twice time	78.03	49.23	5.85	9.13	1.89	81.48	2.25
1.0	Once time	74.73	48.66	6.29	9.33	1.70	71.60	1.96
	Twice time	79.92	51.32	6.59	9.56	1.93	88.71	3.64
1.5	Once time	78.07	44.70	5.84	9.56	1.66	72.66	1.87
	Twice time	81.54	58.13	8.05	10.80	1.95	85.74	2.42
L. S. D. 0.05		3.44	5.27	0.53	0.53	0.13	4.00	1.01
Effect Nano NPK	0	67.76	36.51	5.12	8.21	1.44	76.15	2.60
	0.5	73.25	46.91	5.69	8.98	1.86	80.92	2.43
	1.0	77.32	49.99	6.44	9.45	1.82	80.15	2.80
	1.5	79.81	51.41	6.94	10.18	1.81	79.20	2.14

L. S. D. 0.05		2.43	3.72	0.37	0.37	0.09	2.83	NS
Effect Sprays	Once time	72.20	42.83	5.65	8.94	1.61	74.16	2.10
	Twice time	76.87	49.58	6.44	9.47	1.85	84.05	2.88
L. S. D. 0.05		1.72	2.63	0.26	0.26	0.07	2.00	0.51

Recommendations

In order to obtain a significant increase in the okra yield and fruits of good quality, we recommend the use of nano NPK fertilizer at a concentration of 1.5 ml l^{-1} spray on the leaves, at a rate of two sprays.

References

[1] Arab Organization for Agricultural Development (2017), The League of Arab States, The Yearbook of Arab Agricultural Statistics, Vol. (7) The League of Arab States, Khartoum.
[2] Mahmoud, A. M. and Swaefy, H. M. (2020). Comparison between commercial and nano NPK in presence of nano zeolite on sage plant yield and it is components under water stress. Agriculture (Pol'nohospodárstvo) . 66(1): 24-39.
[3] Al-juthery, H. W. and Al-Maamouri, E. H. O. (2020). Effect of Urea and Nano-Nitrogen Fertigation and Foliar Application of Nano-Boron and Molybdenum on some Growth and Yield Parameters of Potato. Al-Qadisiyah Journal for Agriculture Sciences. 10(1), 253-263.
[4] Solomon, S. ; Bahadory, M. ; Jeyarajasingam, A. ; Rutkowsky, S. and Boritz, C. 2007. Synthesis and study of silver nanoparticles. of Chem. Edu. , 2(84) :322-325.
[5] Drostkar , E. ; Talebi, R. and Kanouni, H. (2016). Foliar application of Fe, Zn and NPK nano-fertilizers on seed yield and morphological traits in chickpea under rainfed condition. J. of Res. in Ecology. 4(2): 221-228.
[6] Ousrir, Munawar and Quraino Hussain (2011). The feasibility of using nanotechnology in developing the Arab industrial technological base. Damascus University Journal of Economic and Legal Sciences. 27 (1): 93-113.
[7] Chinnamuthu, C. R. and Boopathi, P. M. (2009). Nanotechnology and agroccosystem. Madras Agric. J. , 96(1-6): 17-31.
[8] Sharma, P.D. (2008). Nutrient Management–challenges and options. J. Ind. Soc. Soil Sci. 55(4):395-403.
[9] Peddis, D. ; Cannas, C. ; Musinu, A. and Piccaluga, G. (2009). Magnetism in nanoparticles: beyond the effect of particle size. Chem. Eur. J., 15:7822-7829.
[10] Prasad, R.; Kumar, V. and Prasad, K. (2014). Nanotechnology in sustainable agriculture: Present concerns and future aspects. African J. of Biotechnology. 13(6): 705-713.
[11] Wanted, Adnan Nasser; Izz al-Din Sultan Muhammad and Karim Saleh Abdol (1989). Vegetable Production Part Two, Revised Version. University of Mosul, Higher Education Press in Mosul, second edition. 337.
[12] Al-juthery,H. W. and Al-Shami, Q. M. N. (2019). The Effect of Fertigation with Nano NPK Fertilizers on Some Parameters of Growth and yield of potato (Solanum tuberosum L.) . Al-Qadisiyah Journal for Agriculture Sciences, 9(2), 225-232.
[13] Merghany, M. M. ; Shahein, M. M. ; Sliem, M. A. ; Abdelgawad, K. F. and Radwan, A. F. (2019). Effect of Nano-fertilizers on cucumber plant growth, fruit yield and it is quality. Plant Archives 19(2): 165-172.
[14] Matlob, A. N., E. Sultan, and K. S. Abdul (1989). Vegetable Production Part one . Dar Al-Kutub Publication. Mosul Univ., Iraq. (In Arabic).
[15] Goodwin, T. W. (1976). Chemistry and biochemistry of plant pigments. Academic Press 2ndEd., London. P: 373.
[16] Dubois, M., Gilles, K. A., Hamilton, J. K., Rebers, P. T., and Smith, F. (1956). Colorimetric method for determination of sugars and related substances. Analytical chemistry, 28(3): 350-356.
[17] A.O.A.C. (1970). Association of Official Analytical Chemists. Official Method of Analysis, 12th. Ed. Washington D.C. USA.
[18] Dalali, Bassem Kamel and Sadiq Hussain Al-Hakim (1987). Food Analysis, Dar Al Kutub for Printing and Publishing, University of Mosul - Iraq. 563.
[19] Mohammed, M.A., Abdulridha, W.M., Abd, A.N. (2018). Thickness effect on some physical properties of the Ag thin films prepared by thermal evaporation technique. Journal of Global Pharma Technology, 10(3), 613-619.
[20] Yildirim, E. (2007). Foliar and soil fertilization of humic acid affect productivity and quality of tomato. Acta Agriculturae Scandinavica Section B-Soil and Plant Science. 57(2): 182-186.
[21] Al-Sahhaf, Fadel Hussain 1989. Feed the application system. Al-Hikma Press, Ministry of Higher Education and Scientific Research. Iraq.
[22] Sabir, S. ; Arshad M. and Chaudhar, S. K. (2014). Zinc oxide nanoparticles for revolutionizing agriculture: synthesis and applications. The Scientific World Journal. 1-8.
[23] Al-Amin-Sadek, M. D. and Jayasuriya, H. P. (2007): Nanotechnology prospects in agricultural context An overview. In Processing of the International Agricultural Engineering Conference., Bangkok :548pp.