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Effect of Nano fertilizers and amino acid of tryptophan on some physiological characteristics of saffron plant *Crocus sativus* L.

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Abstract

study was carried out in the Lathhouse , agricultural research station belonging to the College of Agriculture, University of Kirkuk - Iraq for for the period 15/9/2021 to 20/4/2022, to study the effect of spraying with different concentrations(0, 1.5, 3.0) $g.L^{-1}$ of nano-fertilizers (NPK, N, P), and soaking the corms with the amino acid tryptophan at concentrations (0,150,300) $mg.L^{-1}$ before planting for 24 hours affected the growth, flowers and yield of the corms of saffron plant(*Crocus sativu* L.) Kormat saffron was obtained from the Islamic Republic of Iran،the factorial experiment was designed according to the(R.C.B.D) Randomized Completely Block Design, the results were analyzed according to the statistical program(SAS, 2005) The Statistical Analysis, and Duncan's Multiple Range Test was used to compare averages at the level of probability 5%، NPK Nano fertilizer resulted in a significant increase in the number of flowers when the plants were sprayed with a concentration of 3.0$g.L^{-1}$ and reached 2.5 $flowers.plant^{-1}$, while the highest average weight of corms was 24.02g when sprayed with a concentration of 1.5 $g.L^{-1}$.Nano-nitrogen fertilizer at a concentration of 3.0 $mL.L^{-1}$had a significant positive effect on increasing the average number of leaves at the second stage and reached 30.27 leaves, and the highest dry weight of the stigmas was 0.090 g .The number of branches for the first stage amounted to 4.53 $buds.plant^{-1}$,while spraying with a concentration of 1.5 $gm.L^{-1}$ increased the

average number of branches in the second stage and reached 6.06 buds.plant^{-1}،Soaking the corms with a concentration of 150 mg.L^{-1} of the amino before planting led to a significant increase in the average number of leaves in the first stage, which amounted to 14.60 leaves.Plant^{-1}, the fresh weight of the corms was 19.08 g, and the least number of flowers was 1.3 flowers. Plant^{-1} As for the soaking at a concentration of 300 mg.L^{-1}, the highest number of branches were (4.74 and 5.62) bud.plant^{-1} for both stages, respectively, and the highest number of leaves after flowering was 28.66 leaves.plant^{-1} ، number of flowers 1.5 flower.plant^{-1}, and the dry weight of the stigmas was 0.082 g, while the control plants had the lowest average number of branches (3.60and5.08) bud.plant^{-1} for both stages،The interaction between spraying with Nana-fertilizer and soaking with the amino acid tryptophan had a significant effect on physiological characteristics, the response was different according to the Nana-fertilizer and its concentration، average number of leaves and flowers increased (15.40 leaves, plant^{-1} and 3.0 flowers), wet weight of corms 31.08 g , Nano fertilizer at a concentration of 3.0 ml L^{-1} increased at the same concentration above the acid increased the average number of leaves to 32.60 leaves.Plant^{-1}, nano-phosphorus fertilizer at a concentration of 3.0 g.L^{-1} at the same concentration of the above acid led to an increase in the average number of branches for both stages (5.20 and 8.40) bud.Plant^{-1} .

Key words: saffron plant, Nano fertilizers, amino acid of tryptophan

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Introduction

The saffron plant (L. sativus Crocus) belongs to the Iris family (Iridaceae), and the genus of saffron contains 80 species and about (30) species of which are cultivated as ornamental plants only [1], and some of it is used as a seasoning, and to dye food yellow. Al-Faqe, and it was cultivated in Persia and Greece, and its cultivation moved from the East to Europe, then to America, and the global production volume of saffron is 300 tons annually, a hectare produces about 25 kilograms of dried stigmas, and it gives a quantity of flowers of 60 thousand A flower of about 0.5 kilograms of stigmas [2] ,Iran and Spain are among the most important producing countries [3], And saffron occupies an advanced rank among medicinal and aromatic crops in terms of the most expensive spice in the world, and it is called red gold [4]. It has a special flavor and has multiple uses in industry. It is used in dyeing textiles and perfumes. It has been used since ancient times in the treatment of many diseases [5]. Saffron stigmas contain (crocin, picrocrocin, and safranal aldehyde). Crocin is: (Crocin (C44H64O), a colored substance that dissolves in water and alcohol giving a strong amber-yellow color. As for Picrocrocin (C16H26O): it is a glycoside that breaks down into sugar and volatile oil and is responsible for the taste and smell of saffron. Safranal (C10H14O safranal) also shares): With picrocrocin in giving saffron its distinctive aroma, and saffron stigmas contain proteins, sugars, vitamins and amino acids, and nanotechnology is one of the modern technologies that has the ability to bring about a new scientific revolution, due to its ability to produce tiny particles of various elements and be able to provide More benefits than regular particles, and they are added to the soil to improve its properties

and increase its fertility, or by spraying it on the plant [6]. Nano fertilizers are characterized by unique characteristics due to their small size and large surface area, which lead to an increase in the absorption surface, and then increase the process of photosynthesis and thus increase production in the plant. Growth and flowering In many plants [7], [8], nitrogen is the main component of proteins and protoplasm, which plays an important role in increasing plant biomass and reproduction [9], and is considered a nutrient It determines the growth of crops in agricultural systems, it is involved in the formation of chlorophyll, it increases the efficiency of photosynthesis, it is involved in the representation of proteins, and it helps in the manufacture of vitamins. Phosphorus plays its role in many physiological processes in plants, such as energy metabolism, synthesis of nucleic acids and biofilms, photosynthesis, respiration, nitrogen fixation, and enzymatic regulation [10]. Proteins, photosynthesis, osmosis, regulation of stomata movement, energy transfer, phloem, cation and anion balance, in addition to a cycle in plant stress resistance [9]. The amino acid tryptophan is an essential amino acid that contains an amino group, a carboxylic group, and an indole side chain, making it a monopolar aromatic amino acid. And tryptophan helps in the formation of indole acetic acid (IAA) because it represents the raw material for the formation of auxins that are found naturally in root secretions [11] as well as it plays an important role in encouraging early growth, as well as multiple physiological roles [12], and this study came to find out And demonstrate the effect of spraying with different levels of nano-fertilizers (NPK, N, P) and soaking with the amino acid tryptophan, and finding the best combination in improving the growth, flowering and yield of corms of the saffron plant.

Materials and methods

The experiment was conducted in the wooden canopy, the Agricultural Research Station of the College of Agriculture, University of Kirkuk - Iraq, for the period from 9/15/2021 to 4/20/2022, for the saffron plant *Crocus sativus* L., the land that was allocated for conducting the experiment was prepared, plastic pots were placed under the pots, It had a diameter of 20 cm and a capacity of 6.5 kg of the soil mixture, as the pots were filled with a medium mixture consisting of (2 soil: 1 peat moss), and a sample of this mixture was taken after mixing, and before planting for the purpose of laboratory analysis. Table (1) shows the chemical and physical properties of the mixture, and it was soaked Saffron corms with a fungicide (1 gm Taisam + 1 gm of the fungicide Finish) That is, with a concentration of 2 $g.L^{-1}$ for half an hour before planting, then the corms were soaked with three concentrations of the amino acid tryptophan (0,150,300) $mg.L^{-1}$, and after preparing it in the form of an aqueous solution, by dissolving it with drops of ethyl alcohol. Until complete dissolution, and bringing the volume to a liter of distilled water, the leaves were sprayed with two sprays, the first at the start of the third leaf formation stage, and the second two weeks after the first spray, and the plants were sprayed with nano fertilizers (K P, N, N P) at two levels (1.5, 3.0). $gm.l^{-1}$ in addition to the control treatment at a concentration of (0), and to the degree of complete wetness, and follow a weekly preventive program consisting of the insecticide Solde Of Indian origin, the active substances in it are (+ Bifenthrin 2% + Acetamiprid 2%

Alphacypermethrin 5%) in an amount of (2 ml. liter^{-1} water) spraying on the leaves and the week following spraying with 1 gm each of the fungicide Taisam that contains the active substance Thiophanate- methyl 70% WP and 1 gm of the fungicide Finish contains 35% of the active substance: Metalaxyl, i.e. in an amount of (2 gm.L^{-1} water), as it was added to the soil and repeated spraying with the two fungicides every week, respectively, until the end of the growing season. Follow-up the growth of the bushes and its weeding whenever needed, and the corms were planted in plastic pots, with one corm in each pot, with a depth of 7 cm [13] and the plants were watered regularly whenever needed. The factorial experiment was carried out according to the randomized complete block design (R.C.B.D.), with three replications, and it included spraying with different levels of nano-fertilizers (NPK N, P) which are (1.5, 3.0) gm.l^{-1} for each of them, in addition to the comparison treatment that included spraying With distilled water only, and it represents the secondary plots (Sub plots) and spraying with different levels of the amino acid tryptophan, which are (150, 300) mg.L^{-1}, in addition to the comparison treatment and it represents the main plots (Main plots), so the number of experimental units in each sector is (105). experimental unit, Each experimental unit included (5) anvils per treatment, each planted with one plant, and thus the number of experimental units in the experiment is (105 x 3 replicates = 305), and the studied factors are distributed randomly, and the statistical program SAS (2005)[14] is used. To analyze the data, Duncan's Multiple Range Test was used to compare averages at a probability level of 0.05 [15].

Table: (1): Some physical and chemical properties of the soil mixture transported before planting.

Analysis type	Standard unit	Analysis result
N ready	mg.kg^{-1}	0.175
P ready	mg.kg^{-1}	27.55
K ready	mg.kg-1	49.60
Ca	Milleq.L^{-1}	48.60
Mg	Milleq.L^{-1}	19.80
PH The degree of reaction		7.11
electrical conductivity EC	Decisimens.m^{-1}	0.12
TDS	Milleq.L^{-1}	140
Sand	gm.kg-1	90
Clay	gm.kg-1	4
Green	gm.kg-1	6
organic matter	gm.kg-1	4.86
Tissue	Sandy loam	

* The soil was analyzed in the soil laboratory of the Directorate of Agriculture of Kirkuk.

The following characteristics were studied and included:

Readings were taken for the characteristics of vegetative and flowering growth when the color appeared in the flowers, and the vegetative characteristics were taken in two stages, the first stage when the color began to appear in the flower, and the second after flowering, and it included:

1- Number of developing buds (bud. plant^{-1}) .
2 - The number of leaves (leaf. plant $^{-1}$).
3- The number of flowers (flower. plant^{-1}).
4-The dry weight of the stalks (g.plant^{-1}).
5- The wet weight of the corms (g).

Results and discussion

1- The number of developing buds (bud. plant^{-1}):

The results in Table (2,3) for the first and second stages indicate that there are significant differences in the effect of nano-fertilizers. The effect of nano-phosphorous was lost in increasing the number of buds at a concentration of 3.0 g.l^{-1} and 1.5 (4.53 and 6.06) bud.plant^{-1}, respectively, and this is due to The importance of nano-fertilizers and their physiological role in the processes within the plant, which was reflected positively in improving the characteristics of the plant, and this was confirmed by [16], and what is characterized by nano-fertilizers from their small size and large surface area, which leads to an increase in the absorption surface and raising the efficiency of the construction process photosynthesis and increased plant growth as well as its role in he distribution of nutrients and converting them to the ready form, so the plant absorbs them easily and quickly. L^{-1}, while the lowest average number of buds in the control plants was (3.60 and 5.08) bud.plant-1, respectively, and this may be due to the role of the amino acid tryptophan in increasing the production of auxin, which has an effective role in regulating growth and development in the plant. [17], and that the amino acid tryptophan leads to an increase in photosynthesis products and an increase in the level of amino and nucleic acids [18], Manufacture of basic and stimulating proteins for the process of cell division and growth and its effective role in increasing the nitrogen in the leaves through the compositions of the porphyrins aggregates included in the synthesis of chlorophyll and its availability in large quantities of the element nitrogen, which is the main component of chlorophyll, and its role in increasing the activity of many enzymes, especially the enzymes responsible for building and forming a molecule Chlorophyll [19], increasing the plant's ability to photosynthesize and thus increasing the content of chlorophyll in the leaves. As for the interaction between the two factors, spraying with nano-phosphorous fertilizer (for both stages) at a concentration of 3 g.l^{-1} and soaking at a concentration of 300 mg.l^{-1} of The amino acid tryptophan increased the number of developing buds, reaching 5.20 bud plant^{-1} in the first stage and 8.40 bud plant^{-1} in the second stage.

Table (2): The effect of nanofertilizers and the amino acid tryptophan and the interaction between them on the number of developing buds (bud. plant-1) of the saffron plant Crocus sativus L. (first stage - when the color begins to appear).

The effect of nanofertilizers		The amino acid tryptophan mg.L^{-1}			Effect rate of nano-fertilizers
		0	150	300	
Comparison	0	3.40 h	4.20 e	4.20 e	3.93 f
NPK gm.l^{-1}	1.5	3.60 g	4.40 d	4.60 c	4.20 d
	3	3.80 f	4.20 e	5.20 a	4.40 b
N ml^{-1}	1.5	3.40 h	4.60 c	4.60 c	4.20 d
	3	3.60 g	4.40 d	4.80 b	4.26 c
P gm.l^{-1}	1.5	3.60 g	4.20 e	4.60 c	4.13 e
	3	3.80 f	4.60 c	5.20 a	4.53 a
Rate of effect of the amino acid tryptophan		3.60 c	4.37 b	4.74 a	

***** Coefficients with similar letters are not significantly different among themselves at the 5% probability level according to Dunkin's multiple test

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Table: (3): The effect of nanofertilizers and the amino acid tryptophan and the interaction between them on the number of developing buds (bud^{-1}) of saffron plant. *Crocus sativus* L (second stage - after flowering)

The effect of nanofertilizers		The amino acid tryptophan mg.L^{-1}			Effect rate of nano-fertilizers
		0	150	300	
Comparison	0	4.60 I	4.40 j	4.80 h	4.60 f
NPK gm.l^{-1}	1.5	5.40 E	5.60 d	5.00 g	5.33 d
	3	5.20 F	4.80 h	4.80 h	4.93 e
N ml^{-1}	1.5	5.60 D	5.60 d	5.40 e	5.53 c
	3	4.60 I	4.40 j	4.80 h	4.60 f
P gm.l^{-1}	1.5	5.80 C	6.20 b	6.20 b	6.06 a
	3	4.40 J	5.20 f	8.40 a	6.00 b
Rate of effect of the amino acid tryptophan		5. 08 C	5.17 b	5.62 a	

* Coefficients with similar letters are not significantly different among themselves at the 5% probability level according to Dunkin's multiple test.

2- Number of leaves (leaf. plant^{-1}):

The results in Table (4,5) indicate that there are significant differences for the effect of nano-fertilizers (nano-nitrogen) for both phases at two concentrations of N (1.5 and 3) ml.L-1 in increasing the number of leaves, which amounted to (14.80 and 30.27) leaves on plant-1. Respectively, and this was confirmed by [16] , which may be due to the importance of nano-fertilizers and their physiological role in influencing the processes within the plant, which were positively reflected in improving the characteristics of the plant. The nano-fertilizers are characterized by their small size and large surface area, which lead to an increase in the absorption surface and raising the efficiency. The process of photosynthesis and increasing plant growth, as well as its role in distributing nutrients and converting them into a ready-made form, so the plant absorbs them easily and quickly. What is unique about nitrogen and its effective role in the above-mentioned processes is: As for the effect of soaking with the amino acid tryptophan, the concentration of 150 mg.l-1 was superior in increasing the number of leaves in the first stage, and it was higher than the concentration of 300 mg.l-1 in the second stage, and it reached (14.66 and 28.66) leaf. plant-1, respectively, and it differed significantly with the comparison treatment plants [20]. In giving the lowest number of leaves, which amounted to (13.73 and 26.54) leaf.plant-1, respectively, and that this positive effect of the amino acid is due to the effective role in increasing the growth regulator auxin, which has an effective role in regulating the growth and development of the plant [17], and adding The acid leads to an increase in plant hormones, which lead to an increase in the process of cell division, elongation, and increase in size, which has a positive role in increasing and improving most traits. The amino acid leads to an increase in photosynthesis products and an increase in the level of amino and nucleic acids. Manufacture of basic and stimulating proteins for the process of cell division and growth, and for its effective role in increasing nitrogen in the leaves through the composition of porphyrins groups included in the composition of chlorophyll and its availability in large quantities in the element nitrogen, which is the main component of chlorophyll and that amino acids are a source of major and minor elements necessary for plant growth, as well as Increasing the vital activity of microorganisms, which increases the indicators of vegetative growth, and this was confirmed by the results [21]. For calendula plants for lemongrass plants, as for the effect of the interaction between the two factors, spraying with nano fertilizers (NPK) at a concentration of 1.5 g.l-1 in the first stage and N at a concentration of 3 ml.l-1 in the second stage) and soaking at a concentration of 300 mg.l -1For both stages in giving the highest average number of leaves, which amounted to (15.40 and 32.60) leaves. Plant-1.

Table (4): The effect of nanofertilizers and the amino acid tryptophan and the interaction between them on the number of leaves (leaf^{-1}) of saffron plant *Crocus*

The effect of nanofertilizers		The amino acid tryptophan mg.L^{-1} 0	150	300	Effect rate of nano-fertilizers
Comparison	0	12.60 k	14.20 h	14.20 h	13.67 e
NPK gm.l^{-1}	1.5	12.40 l	14.80 d	15.40 a	14.20 d
	3	12.80 J	15.20 b	15.20 b	14.40 c
N ml^{-1}	1.5	14.80 d	15.00 c	14.60 f	14.80 a
	3	14.70 e	14.80 d	13.80 i	14.43 b
P gm.l^{-1}	1.5	14.60 f	14.40 g	14.20 h	14.40 c
	3	14.20 h	14.20 h	14.80 d	14.40 c
Rate of effect of the amino acid tryptophan		13.73 c	14.66 a	14.60 b	

* Coefficients with similar letters are not significantly different among themselves at the 5% probability level according to Dunkin's multiple test.

Table (5): The effect of nanofertilizers and the amino acid tryptophan and the interactions between them on the number of leaves (leaf. plant-1) of saffron plant *Crocus sativus* L. (after flowering - second stage)

The amino acid The rate of effect of nanofertilizers		tryptophan mg.L^{-1} 0	150	300	The effect of nanofertilizers
Comparison	0	24.60 o	22.60 s	31.40 C	26.40 f
NPK gm.l^{-1}	1.5	27.80 g	22.60 s	30.60 D	27.00 e
	3	25.80 n	28.80 e	27.20 I	27.27 c
N ml^{-1}	1.5	24.20 p	25.00 n	24.00 Q	24.40 g
	3	26.00 l	32.20 b	32.60 A	30.27 a
P gm.l^{-1}	1.5	28.80 e	26.60 j	26.20 K	27.20 d
	3	28.60 f	27.60 h	28.60 F	28.27 b
Rate of effect of the amino acid tryptophan		26.54 c	26.57 b	28.66 A	

* Coefficients with similar letters are not significantly different among themselves at the 5% probability level according to Dunkin's multiple test.

3- Number of flowers / plant: The results in Table (7) indicate that spraying with nanocomplex fertilizer at a concentration of 3 gm.L^{-1} gave the highest average number of flowers, 2.5 flowers. $Plant^{-1}$. The positive role of nano-fertilizers is due to its physiological role. Effective in improving the characteristics of vegetative growth of the plant, which reflected positively on the characteristics of flowering, that spraying with nano-fertilizers, including nano-compound fertilizer, had a significant effect on all flowering characteristics of saffron plants compared to the control treatment, and a significant increase in yield, number of flowers and dry weight of stigmas. In addition to the significant effect of the amino acid tryptophan, the concentration exceeded 300 $mg.l^{-1}$ and reached 1.5 $flowers.plant^{-1}$. As for the effect of the interaction between the two factors, the spraying of the compound nanofertilizer at a concentration of 1.5$g.l^{-1}$ reached 3.00 flowers.plant. 1- The effective role of soaking with the amino acid tryptophan, which led to the improvement of most of the vegetative and flowering characteristics, and these results referred to are due to the fact that the amino acid tryptophan represents the initial expression of the plant hormone auxin, which has an effective role in regulating growth and development in plants [17]. Adding it leads to an increase in the production of auxin in plant tissues, so this acid is the main substance in the process of biosynthesis of auxin (IAA), And that the increase in plant hormones leads to an increase in the process of cell division, elongation, and an increase in their size, and these results are consistent with what, and others mentioned, and may be due to an increase in the components of vegetative growth, including plant height, leafy area of the plant, and the number of side buds, and this was confirmed by the results of Mustafa And Alsaad [21], when spraying caladiolus varieties with different concentrations of the amino acid tryptophan, and the concentration exceeded 300 $mg.l^{-1}$, significantly improved growth and flowering characteristics, if the number of leaves, plant height, leafy area of the plant, and early flowering date increased significantly, as well as the results of [20] of the lemongrass plant. It is worth noting that some overlapping treatments did not flower but rather grew vegetative, and this may indicate

that flowering was affected by all factors, including high temperatures during the cultivation period and its indirect effect in reducing the size of the corms and depleting the nutrients in them, which is directly related to flowering, which was reflected in the lack of flowering. Plants and their growth only vegetatively, as well as other influencing factors, which are results indicated by [23] for the saffron plant.

Table (6): The effect of nanofertilizers and the amino acid tryptophan and the interaction between them on the number of flowers of the saffron plant *Crocus sativus* L.

The amino acid The rate of effect of nanofertilizers		tryptophan mg.L^{-1} 0	150	300	The effect of nanofertilizers
Comparison	0	1.00 c	**	**	1.00 d
NPK gm.l^{-1}	1.5	1.00 c	**	3.00 a	2 b
	3	3.00 a	2.00 b	**	2.5 a
N ml^{-1}	1.5	**	1.00 c	1.00 c	1.5 c
	3	**	**	1.00 c	1. 00 d
P gm.l^{-1}	1.5	**	**	1.00 c	1.00 d
	3	1.00 c	1.00 c	**	1. 5 c
Rate of effect of the amino acid tryptophan		1.5 a	1.3 b	1.5 a	

* Coefficients with similar letters are not significantly different among themselves at the 5% probability level according to Dunkin's multiple test.

** Missing pilens represent non-flowering and vegetatively developing plants only.

4- Dry weight of the stigmas (g): The results appear in Table (7) superiority of spraying with nano-nitrogen fertilizer at a concentration of 3 ml.L $^{-1}$ The weight of the stigmas is 0.090 g. flowering qualities,. And the positive role of the amino acid tryptophan when soaking at a concentration of 300 g. L^{-1} in increasing the weight of the stigmas due to 0.082 g. As for the effect of the interaction between spraying with nano fertilizers, the concentration was superior to the concentration of 1.5 g. tryptophan, tryptophan, tryptophan, tryptophan, to improve most of the qualities of the plant being, tryptophan, tryptophan, tryptophan, tryptophan, tryptophan, of the plant being It represents the initial expression of the plant hormone auxin, which has an effective role in regulating growth and development in plants [14], and adding it leads to an increase in auxin production in plant tissues, so this acid is considered the basic material in the process of biosynthesis of auxin (IAA) and that the increase in hormones Vegetarianism leads to an increase in the process of cell division, elongation, and an increase in their size[22]. These results agree with what was mentioned, and this was confirmed by the results of Mustafa and ALsaad [19] when spraying cladiols varieties with different concentrations of the amino acid tryptophan, with a concentration exceeding 300 mg.l $^{-1}$ Significantly in improving the characteristics of growth and flowering, if the average number of leaves, plant height, leafy area of the plant, and early flowering increased significantly.

Table No. (7): The effect of nanofertilizers and the amino acid tryptophan and the interaction between them on the dry weight of the stigmas (gm) of saffron plant *Crocus sativus* L

The amino acid The rate of effect of nanofertilizers		tryptophan mg.L^{-1} 0	150	300	The effect of nanofertilizers
Comparison	0	0.070 c	**	**	0.070 D
NPK gm.l^{-1}	1.5	0.050 e	**	0.090 a	0.07 D
	3	0.080 b	0.070 c	**	0.075 C
N ml^{-1}	1.5	**	0.060 d	0.090 a	0.075 C
	3	**	**	0.090 a	0.090 A
P gm.l^{-1}	1.5	**	**	0.080 b	0.080 B
	3	0.090 A	0.090 a	0.060 d	0.080 B
Rate of effect of the amino acid tryptophan		0.072 c	0.073 b	0.082 a	

* Coefficients with similar letters are not significantly different among themselves at the 5% probability level according to Dunkin's multiple test.

** Missing pilens represent non-flowering and vegetatively developing plants only

5- Fresh weight of the turmeric (gm): The results presented in Table (8) showed a significant increase in the fresh weight of the turmeric of the NPK nano-compound fertilizer at a concentration of 1.5 g.l^{-1}, while the amino acid tryptophan had a significant effect at a concentration of 300 mg.l^{-1} in The fresh weight of the chromate decreased by 18.20 g, while the highest increase in the fresh weight was 19.08 g at a concentration of 150 mg.L^{-1}. This is due to the physiological role of nano-fertilizers in improving the vegetative, flowering and yield growth characteristics[24], as well as the effective role of soaking with the amino acid tryptophan, which It led to the improvement of most of the vegetative and flowering characteristics and the yield of corms. This was confirmed by many researchers who referred to the role of the amino acid tryptophan in increasing the outputs of photosynthesis, increasing the level of amino and nucleic acids, and manufacturing basic proteins that stimulate the process of cell division and growth [25]. The main component of chlorophyll, as well as an increase in the activity of many enzymes, especially the enzymes responsible for building and forming the chlorophyll molecule, and the increase in the plant's ability to photosynthesize and thus increase the content of chlorophyll in the leaves Mustafa and ALsaad [21], If they show that increasing the concentration of amino acid has increased the concentration of nutrients in leaves, and that amino acids are a source of macro and microelements necessary for plant growth and increase its ability to absorb water and nutrients and transfer them to the vegetative system, especially the leaves, as well as increase the vital activity of microorganisms, which It increased the components of vegetative growth and improved all growth indicators. As for the effect of interaction between the two factors, the spraying with nano-compound fertilizer

at a concentration of 1.5 gm.l^{-1} and soaking with the amino acid tryptophan at a concentration of 300 gm.l^{-1} was superior, and the fresh weight of the corms reached 31.08 gm.

Table. (8): The effect of nanofertilizers and the amino acid tryptophan and the interaction between them on the fresh weight of corms (g) of saffron plant *Crocus sativus* L.

The amino acid The rate of effect of nanofertilizers		tryptophan mg.L^{-1} 0	150	300	The effect of nanofertilizers
Comparison	0	15.78 L	19.37 e	14.93 n	16.69 E
NPK gm.l^{-1}	1.5	21.09 c	19.37 e	31.08 a	24.02 A
	3	15.68 n	17.50 i	13.61 r	15.59 F
N ml^{-1}	1.5	19.06 e	18.91 h	16.60 k	18.19 B
	3	14.04 q	14.46 o	14.33 p	14.27 G
P gm.l^{-1}	1.5	12.52 s	25.04 b	16.81 i	18.12 C
	3	14.45 o	18.95 g	20.09 d	17.83 C
Rate of effect of the amino acid tryptophan		16.16 c	19.08 a	18.20 b	

* Coefficients with similar letters are not significantly different among themselves at the 5% probability level according to Dunkin's multiple test.

conclusions

1- Spraying with nano-fertilizers gave the best significant increase in vegetative and flowering traits, and the best results were when spraying with nano-compound fertilizer and nano-nitrogen fertilizer with a concentration of (3.0) gm.l-1.

2- Soaking with the amino acid tryptophan in both concentrations had a significant effect on increasing the number of developing buds, the average number of leaves and flowers, and the dry weight of flowers.

3- The two-way interaction had a significant effect on the physiological characteristics represented in increasing the number of developing buds, the number of leaves, the number of flowers and the dry weight of the stigmas for some overlapping treatments, as the other treatments only grew vegetatively.

References

[1] Davies, D. D. 1982. Physiological aspects of protein turnover. In *Nucleic acids and proteins in plants I* (pp. 189-228). Springer, Berlin, Heidelberg.

[2] Tajik, S. and Niknam, V. 2015. Effects of salicylic acid on carotenoids and antioxidant activity of saffron (*Crocus sativus* L.). *Applied food biotechnology*, 2 (4): 33-37. Davies, P. J. (1998(. Gibberellins. In plant Physiology By : Tiaz, L. and Zeiger, E. eds. Sinaur Associates Inc. USA

[3] Hosseini, M., & M, Abdollah. 2017. Increasing Water Use Efficiency in Saffron *(Crocus sativus* L.) Cultivation . Tropentag, September 20 - 22, 2017 in Bonn "Future Agriculture: Social-ecological transitions and bio-cultural shifts"

[4] Poggi, L. M., Portela, A. J., Pontin, M. A. and Molina, R. V. 2009. Corm size and incubation effects on time to flowering and threads yield and quality in saffron production in Argentina. In *III International Symposium on Saffron:*

Forthcoming Challenges in Cultivation, Research and Economics 850: 193-198.

[5] Al-Shihabi, Prince Mustafa. (1988). Al-Shihabi Dictionary of Agricultural Science Terminology.

[6] Singh, A.; Singh, N.B.; Hussain, I.; Singh, H. and Singh, S.C. (2015). Plantnanoparticle interaction: an approach to improve agricultural practices and plant productivity. Int. J. Pharm. Sci. Invent., 4(8): 25- 40.

[7] Nair, R.; Varghese, S.H.; Nair, B.G.; Maekawa, T.; Yoshida, Y. and Kumar, D.S. (2010). Nanoparticulate material delivery to plants. Plant Sci., 179(3): 154-166.

[8] Naderi, M. R. and Danesh-Shahraki, A. 2013. Nanofertilizers and their roles in sustainable agriculture. *International Journal of Agriculture and Crop Sciences (IJACS)*, 5 (19): 2229-2232.

[9] Marschner, H. (2011). Marschner's Mineral Nutrition of Higher Plants. 3rd ed., Academic Press: London, UK, pp: 178-189. Manikandan, A. and Subramanian, K.S. (2014). Fabrication and characterisation of nanoporous zeolite based N fertilizer. Afric. J. Agric. Res., 9(2): 276-284.

[10] Raghothama, K.G. (1999). Phosphate acquisition. Ann. Rev. Plant Biol., 50(1): 665-693

[11] Villarreal, S.Q., N. Hernandez, L. Romero, E. Lazcano and A. Dorantes.)2012(. Assessment of plant growth promotion by rhizobacteria supplied with tryptophan as phytohormone production elicitor on Axon opus affinis.Agri.Sci.Res.J. 2(11)

[12] Khattab, M., Shehata, A., El-Saadate, A. and Al-Hasni, K. 2016. Effect of Glycine, Methionine and Tryptophan on the vegetative growth, flowering and corms production of Gladiolus plant. *Alexandria Science Exchange Journal*, 37: 647-659.

[13]Al-Zubaidi, Marwa Muhammad Omar. (2019). The effect of benzyl adenine and gibberellic acid on the growth and productivity of some saffron cultivars Crocus sativus L.. Master's thesis_Kirkuk_College of Agriculture. Al-Shihabi, Prince Mustafa. (1988). Al-Shihabi Dictionary of Agricultural Science Terminology.

[14] SAS. (2005). Statistical analysis system User'S guide for personal computer release, 9 SAS Institute Inc., Cary, NC. USA.

[15]Al-Rawi, Khasha'a Mahmoud and Abdel-Aziz Khalafallah. (2000). Design and analysis of agricultural experiments. Dar Al-Kutub for printing and publishing, University of Mosul, Iraq.

[16] Amırnıa, R., Bayat, M. and Tajbakhsh, M. 2014. Effects of Nano Fertilizer Application and Maternal Corm Weight on Flowering at Some Saffron (*Crocus sativus* L.) Ecotypes. Turkish Journal of Field Crops, 19 (2): 158-168. DOI: 10.17557/tjfc.46269.\

[17] Abbas, S. H., Sohail, M., Saleem, M., Mahmood, T., Aziz, I., Qamar, M., Majeed, A. and Arif, M.**(**2013**)**. Effect of L-tryptophan on plant weight and pod weight in chickpea under rain fed conditions. Sci Tech. Dev. 32: 277–280.

[18] Raouf, Sheelan Khaled Raouf. (2020). Effect of the amino acid tryptophan and date sap on some physiological characteristics, oil yield and its specific characteristics of lemongrass plant Cymbopogon citratus L. . Master's thesis _ Kirkuk _ College of Agriculture.

[19] Mahdi, S. A. and Saeed, A. K. A. M. 2019. Effect of tryptophan and phenylaianime on some Biochemical components and floral traits of *gerbera (Gerbera gamesouii* L.) cv. 'Great Smoky Mountains'. *Plant Archives*, 19 (1) 1051-1056.

[20] Al-Obeidi, Muhannad Kamal Mustafa. (2019). Effect of the amino acid tryptophan and Acadian organic fertilizer on the growth and yield of three varieties of Gladiolas hybrida. Master Thesis - Kirkuk - College of Agriculture.

[21] Mustafa, M. K. and AL-Saad, K. G. 2020. Response of three Gladiolus cultivars spraying with different concentration of amino acid of Tryptophan and growth and yield *(Gladiolus hybrida*). Plant Archive, 20 (2).

[22] Khaled, R. S., AL-Saad, K. G. S. and ALhammedi, A. N. A. 2021. Influence of two cutting dates and foliar spray of tryptophan on some physiological traits and active substance of lemon grass *cymbopogon citratus* L. *Plant Archives*, 21 (1): 1419-1429.

[23] Al-Barzanji, Berri Latif Hussain (2020). The effect of salicylic acid (CPPU) on the growth, flowering and yield of corms and corms of three saffron cultivars Crocus sativus L.. Master's thesis - Kirkuk - College of Agriculture. **(**In Arabic).

[24] Subbarao, C. V., Kartheek, G. and Sirisha, D. 2013. Slow release of potash fertilizer through polymer coating. *International Journal of Applied science and engineering*, 11 (1): 25-30.

[25] Abdel-Kader, H. H., Elbanna, H. Y. and A. K. Aljammali. 2015. Studies on production of thymus plant (*Thymus Vulgaris* L.). Part one: effect of Foliar spray with NPK, mico nutrients and amino acid on the vegtative growth and volatile oil percentage in the dry Herb. *Journal of Plant Production*, 6 (6): 1025-1036.

بعض قياسات العناصر الثقيلة وصفات الماء لسد دربنديخان ونهري سيروان وتانجرو

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- البحث مستل من رسالة ماجستير للباحث الاول .

المستخلص

نفذت الدراسة في الظلة الخشبية، محطة البحوث الزراعية العائدة لكلية الزراعة جامعة كركوك – العراق للفتره من 2021/9/15 ولغاية 2022/4/20 ، لغرض دراسة تأثيرالرش بتراكيز مختلفة (3.0،1.5) غم.لتر$^{-1}$ من الأسمدة النانوية(P،N،NPK) إضافة إلى معاملة المقارنة بتركيز(0)، و نقع الكورمات بالحامض الأميني التربتوفان بالتراكيز (300،150) ملغم.لتر$^{-1}$ إضافة إلى معاملة المقارنة بتركيز(0)، قبل الزراعة لمدة 24ساعة في نمووأزهاروحاصل الكورمات لنبات الزعفران . *Crocus sativus* L، تم الحصول على كورمات الزعفران من الجمهورية الأسلامية الأيرانية، وتم قلع الابصال بعد أسبوعين من الجفاف التام للمجموع الخضري وبعد سبعة أشهر من الزراعة وبتأريخ 2022/4/20 ، صممت التجربة العاملية وفق تصميم القطاعات العشوائية الكاملة (R.C.B.D Randomized Completely Block Design، وحللت النتائج وفق البرنامج الاحصائي(SAS، 2005)The Statistical Analysis واعتمد إختبار دنكن متعدد الحدود Duncan's Multiple Range Test لمقارنة المتوسطات عند مستوى الإحتمالية 5% ، أدى السماد المركب النانوي عند التركيز 3.0 غم .لتر$^{-1}$الى زيادة عدد الأزهار وبلغ 2.5 زهرة.نبات$^{-1}$ في حين أعلى معدل لوزن الكورمات24.02غم عند الرش بالتركيز 1.5غم.لتر$^{-1}$ و للرش بالسماد النتروجين النانوي بالتركيز3.0 مل.لتر$^{-1}$ الأثرالأيجابي في زيادة معدل عدد الأوراق عند المرحلة الثانية وبلغ 30.27 ورقة ، وأعلى وزن جاف للمياسم 0.090غم، و للرش بالسماد الفسفورالنانوي التأثير المعنوي الأيجابي في زيادة معدل عدد البراعم النامية للمرحلة الأولى 4.53 برعم.نبات$^{-1}$، في حين زاد الرش بالتركيز 1.5 غم.لتر$^{-1}$ من معدل عدد البراعم النامية في المرحلة الثانية 6.06

برعم.نبات$^{-1}$ ، وأدى التركيز 150 ملغم.لتر$^{-1}$ للحامض الأميني الى زيادة معدل عدد الأوراق للمرحلة الأولى وبلغت 14.60ورقة.نبات$^{-1}$ ، ووزن الكورمات الطري 19.08غم وأقل معدل لعدد الأزهار 1.3 زهرة.نبات$^{-1}$ ، أما التركيز 300 ملغم.لتر$^{-1}$بلغ فيه أعلى معدل لعدد البراعم النامية(4.74و5.62) برعم.نبات$^{-1}$لكلا المرحلتين على التوالي، وأعلى عدد أوراق بعدالتزهير 28.66ورقة.نبات$^{-1}$ وعددالأزهار 1.5زهرة.نبات$^{-1}$ ، والوزن الجاف للمياسم 0.082غم في حين نباتات معاملة المقارنة بلغ أقل معدل لعدد البراعم النامية (3.60 و5.08) برعم.نبات$^{-1}$ لكلا المرحلتين، وللتداخل الثنائي بين الأسمدة النانوية والحامض الأميني التربتوفان أثره المعنوي في الصفات الفسلجية، ، اذ أدى السماد المركب النانوي عند التركيز 1.5 غم.لتر$^{-1}$ والتركيز 300 ملغم.لتر$^{-1}$ الى زيادة عدد الأوراق والأزهار (15.40 ورقة.نبات$^{-1}$ و3.0 زهرة) والوزن الطري للكورمات31.08غم ، في حين أدى السماد النتروجين النانوي بالتركيز 3.0 مل. لتر$^{-1}$ عند نفس التركيز للحامض الى زيادة عدد الأوراق 32.60 ورقة.نبات$^{-1}$، أما السماد الفسفورالنانوي عند التركيز 3.0 غم.لتر $^{-1}$ عند نفس التركيز للحامض أدى الى زيادة عدد البراعم لكلا المرحلتين(5.20 و8.40) برعم.نبات $^{-1}$على التوالي .

الكلمات المفتاحية: نبات الزعفران ، الأسمدة النانوية، الحامض الأميني التربتوفان