Response of Snapdragon plant (*Antirrhinum majus* L.) to foliar spraying with Tryptophan and zinc sulfate

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ABSTRACT

The experiment was conducted during the autumn season (2018-2019) in one of the greenhouses belonging to Research Station of Department of Horticulture and Landscape Gardening, College of Agriculture, University of Diyala. The research was conducted for the period from 8/11/2018 to 25/5/2019, to study the effect of foliar spray with Tryptophan at concentrations of (100, 150, and 200 mg.L-1), in addition to spraying with distilled water as a control treatment and foliar spraying with zinc sulfate at concentrations (0, 1, 2, and 4 $g.L^{-1}$) in the growth and flowering of Snapdragon plant (Antirrhinum majus L.) Monaco cultivar. Plants were sprayed with tryptophan and zinc sulfate twice after 30 and 45 days of seedling, with two days separator between spraying tryptophan and zinc sulfate. The research was conducted as a factorial experiment (4 × 4) according to Randomized Complete Block Design (RCBD), with three random replicates. The study showed that the treatments of foliar spraying with tryptophan led to improving all the traits of the vegetative and flowering growth for the Snapdragon plant, where the spraying treatment with tryptophan at a concentration of (200 $mg.L^{-1}$) has excelled by recording it the highest results compared to the control treatment. Foliar spraying of plants with zinc sulfate improved all the vegetative and flowering traits for the Snapdragon plant, where the spraying treatment with zinc sulfate at a concentration of (4 $g.L^{-1}$) was significantly excelled by recording it the best results compared to the control treatment. The result of the interaction between the foliar spraying with tryptophan and zinc sulfate showed a significant effect on all traits of the vegetative and flowering growth for the plant, where the interaction treatment between the spraying with tryptophan at a concentration of (200 $mg.L^{-1}$) and spraying with zinc sulfate at a concentration of (4 $g.L^{-1}$) was significantly excelled by recording it the best results for the studied vegetative and flowering traits.

Keywords: Snapdragon (*Antirrhinum majus* L.), Tryptophan, Zinc Sulfate.

إستجابة نبات حنك السبع (*Antirrhinum majus* L.)للرش الورقي بالتربتوفان وكبريتات الزنك

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المستخلص

نفذت التجربة خلال الموسم الخريفي 2018 - 2019 في أحد البيوت البلاستيكية التابعة لمحطة أبحاث قسم البستنة وهندسة الحدائق/كلية الزراعة/جامعة ديالى. اجري البحث للمدة من 2018/11/8 لغاية 2019/5/25، لدراسة تأثير الرش الورقي بالتربتوفان بالتراكيز 100، و150، و200 ملغم.لتر$^{-1}$، علاوة على الرش بالماء المقطر كمعاملة مقارنة، والرش الورقي بكبريتات الزنك بالتراكيز 0، و1، و2، و4 غم.لتر$^{-1}$ في نمو وتزهير نبات حنك السبع *Antirrhinum majus* L صنف 'Monaco'. تم رش النباتات بالتربتوفان وكبريتات الزنك مرتين بعد 30 و45 يوماً من الشتل وبفاصل يومين بين رش التربتوفان وكبريتات الزنك. نفذ البحث كتجربة عاملية (4 × 4) وفق تصميم القطاعات العشوائية الكاملة RCBD وبثلاث مكررات. بينت الدراسة أن معاملات الرش الورقي بالتربتوفان أدت الى تحسين جميع صفات النمو الخضري والزهري لنبات حنك السبع، وتفوقت معاملة الرش بالتركيز 200 ملغم.لتر$^{-1}$ في تسجيلها افضل النتائج قياساً بمعاملة المقارنة. أدى الرش الورقي للنباتات بكبريتات الزنك الى تحسين كافة صفات النمو الخضري والزهري لنبات حنك السبع، وتفوقت معاملة الرش بالتركيز 4 غم.لتر$^{-1}$ معنويا في تسجيلها افضل النتائج قياساً بمعاملة المقارنة.

أظهرت نتيجة التداخل بين الرش الورقي بالتربتوفان وكبريتات الزنك تاثيرا معنويا في جميع صفات النمو الخضري والزهري للنبات، وتفوقت المعاملة 4Trp200×Zn في تسجيلها افضل النتائج للصفات الخضرية والزهرية المدروسة.

الكلمات المفتاحية: حنك السبع *Antirrhinum majus* L.، التربتوفان، كبريتات الزنك.

1. INTRODUCTION

Snapdragon plant (*Antirrhinum majus* L.) is a special cut flower that can be cultivated in greenhouses and open fields (9). It is cultivated in Iraq as an annual winter plant and sometimes stays for two years if planted in a place protected from the summer heat. Its flowers are found in a simple multi-colored cluster inflorescence, and the florets are either single or multiple, and the inflorescence of florets open from bottom to the top gradually, and the demand for the snapdragon flowers increases, if it can be produced in the period in which the flowers of other plants reduce or in some stage between the flowering of plants. Flowers are suitable for cutting, Plants are also suitable for cultivation in flowerpots, ponds, or plots, and are also used for identification (2, 3, 6). Antirrhinum genus contains more than 30 species, including annuals, perennial herbs and sometimes small shrubs. The most popular species belongs to this genus is majus (43, 3). Amino acids represent the protein building unit. it is known as growth factors for higher plants and it is also known as components of the enzymatic protein fraction (18). Amino acids are involved in the formation of other organic compounds such as protein, amines, Purines, pyrimidine bases, alkaloids, vitamins, Terpenes, enzymes and others (16). Tryptophan (symbolized by Trp or W) is an α-type amino acid used in the biosynthesis for proteins. Tryptophan contains the α-amino group, the α-carboxylic acid group, and the side chains, which makes it a non-cyclic amino acid (40). Tryptophan or the first initiating compound (Indo-3-glycerol phosphate) are the first two precursors for the biosynthesis of IAA (30). Zinc is an important nutrient for the plant, where it is an essential component for plant growth and natural development because it is involved in the formation of many enzymes, proteins and living organisms (15). Zinc is the second most abundant transitional element after iron and participates in various biological processes in living organisms (11). It is considered one of the important elements for the plant because it is involved in the formation of many enzymes and its functional structural role, or as an organizational aid factor or its role in protein manufacture, photosynthesis, manufacture of auxin, cell division and maintains the function and structure of the cell membrane and fertilization (31). Zinc plays an important role in producing biomass (12). It may be a requirement for chlorophyll production, pollen function and fertilization (22). Due to the importance of amino acids, because they are starters or stimulants for plant hormones and growth materials, and the importance of the micronutrients in plant growth and development, as well as the importance of Snapdragon plant economically, this study aims to test the effect of foliar spraying with tryptophan and zinc sulfate and their interaction in improving the traits of the vegetative and flowering growth of Snapdragon plant.

2. MATERIALS AND METHODS

The experiment was conducted during the autumn season (2018-2019) in one of the greenhouses belonging to Research Station of Department of Horticulture and Landscape Gardening, College of Agriculture, University of Diyala. The experiment was conducted for the period from 8/11/2018 to 20/5/2019, and the research steps started by planting the seeds of Snapdragon plant in cork dishes containing peat moss on 8/11/2018. Three seeds were planted in each pit and left in the greenhouse. After the seeds were germinated, the seeds were thinned into one seed in each pit. The panicles were separated after reaching it the stage of 2-3 real leaves in plastic pots with a diameter of (22 cm), containing soil consisting of (3 loam: 1 peat moss). The pots soil was sterilized using Robin Systemic Fungicides (granularities)

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(Metalaxyl active substance 5% G) at a rate of (10 g.pot^{-1}) and the systemic insecticide Rivadan (nematode granules) (active substance) Carbofuran 10% G at a rate of (2 g.pot^{-1}) and mixed with the soil well. Random samples were taken from the soil of agriculture and analyzed in the Laboratory of Soil and Water Resources Department, College of Agriculture, University of Diyala. Table (1) shows some physical and chemical traits for the soil of agriculture. After the completion of planting, the plants were bound by placing plastic pots to keep the plants growing vertically. Plants were raised on five lateral stems in addition to the main stem by removing vegetative growths and lateral flower buds periodically whenever needed to provide food for the selected flower buds to obtain high-quality inflorescences. the process of fertilizing plants with neutral fertilizer NPK (20:20:20) with iron (Fe 0.05%), manganese (Mn 0.02%) and copper (Cu 0.03%), which was sprayed on the total vegetative for the plants at a rate of (1 g.L^{-1}) according to the recommendation of the manufactured company, with a rate of one spraying every two weeks for the duration of the study. The necessary service operations were conducted such as hoeing, weeding and controlling insect and pathological infections whenever needed.

Table 1: Some chemical and physical traits of cultivated soils.

Trait	Value	Units
EC (1: 1)	2.47	dS.m^{-1}
PH (1: 1)	7.11	----
Organic matter	2.899	%
$CaCO_3$	156.14	g.kg^{-1}
Elements availability		
Nitrogen	30.80	mg.kg^{-1}
Phosphorus	10.30	
Potassium	220.6	
Soil separates		
Clay	110.0	g.kg^{-1}
Silt	128.0	
Sand	762.0	
Texture	**Sandy silt loam**	

The experiment included a study of two factors, where the first factor represented the foliar spraying with tryptophan at different concentrations of (100, 150, and 200 mg.L^{-1}) which are symbolized by (Trp100, Trp150, and Trp200), respectively, in addition to spraying with distilled water as control treatment which is symbolized by (Trp0). The plants are sprayed with tryptophan twice after 30 and 45 days from the transplant. As for the second factor, it represented by foliar spraying with zinc sulfate at different concentrations of (0, 1, 2, and 4 g.L^{-1}) which are symbolized by (Zn0, Zn1, Zn2, and Zn4), respectively. The plants were sprayed with zinc sulfate twice, the first spray was conducted after two days of the first spraying with tryptophan, and the second spray was conducted after two days of the second spraying with tryptophan. Dishwashing liquid was added with the spray solution as a spreading material. The plants were sprayed with the used concentrations until completely wet with a hand sprayer. The research was conducted as a factorial experiment (4 × 4) according to the Randomized Complete Block Design (RCBD), with three replicates (5), to study the effect of two factors, the first factor is foliar spraying with tryptophan which is symbolized by (Trp) and the second factor is foliar spraying with zinc sulfate which is symbolized by (Zn). The experiment included 48 experimental units, in each experimental unit

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5 pots, plant in every single pot. Thus, the plants' number of the experiment is 240. The traits of vegetative growth represented by plant height, number of leaves, leaf area, the relative content of chlorophyll in the leaves, the dry weight of the leaves, the percentage of total carbohydrates in the leaves were measured, the traits of the flowering growth represented by the flowering date, the number of florets in the inflorescence, the length of the flower stalk, the dry weight of the flower, the duration of flowering, and the vase life. The data were analyzed according to the SAS statistical program (2003) and the arithmetic mean was compared using Duncan's new multiple tests at the probability level of 0.05.

3. RESULTS AND DISCUSSION

1- The effect of foliar spraying with tryptophan and zinc sulfate and their interaction on the traits of vegetative growth for Snapdragon plant (*Antirrhinum majus* L.)

Table (2) shows that all tryptophan concentrations led to a significant increase in plant height compared to the control treatment. The spraying treatment with tryptophan at a concentration of (200 $mg.L^{-1}$) has excelled by giving it the highest plant height amounted to (114.91 cm), which did not differ significantly from the spraying treatment with tryptophan at a concentration of (150 $mg.L^{-1}$) which amounted to (109.61 cm). The spraying treatment with tryptophan at a concentration of (200 $mg.L^{-1}$) has excelled by giving it the highest number of leaves amounted to (313.19 $leaves.plant^{-1}$) compared to the control treatment which gave the lowest number of leaves amounted to (165.80 $leaves.plant^{-1}$). The results showed that spraying with tryptophan led to a significant increase in the leaf area of the plant, where the spraying treatment with tryptophan at a concentration of (200 $mg.L^{-1}$) has excelled by recording it the highest leaf area amounted to (2245.64 cm^2) compared to the control treatment which recorded the lowest leaf area amounted to (1091.00 cm^2). The spraying treatment with tryptophan at a concentration of (200 $mg.L^{-1}$) has excelled by recording it the highest dry weight of the leaves amounted to (30.65 g) compared to the control treatment which recorded the lowest dry weight of the leaves amounted to (26.28 g). All tryptophan concentrations led to a significant increase in the percentage of carbohydrates in the leaves compared to the control treatment. The spraying treatment with tryptophan at a concentration of (200 $mg.L^{-1}$) has excelled by recording it the highest percentage of carbohydrates in the leaves amounted to (25.69%) compared to the control treatment which gave the lowest percentage of carbohydrates in the leaves amounted to (21.32%). As for zinc sulfate, Table (2) shows that all spraying treatments with zinc sulfate led to a significant increase in plant height compared to the control treatment. The spraying treatment with zinc sulfate at a concentration of (4 $g.L^{-1}$) has excelled by recording it the highest plant height amounted to (115.11 cm), but it did not differ significantly from the spraying treatment with zinc sulfate at concentrations of (1 and 2 $g.L^{-1}$), which recorded the plant height amounted to (109.25 and 108.61 cm), respectively. While the lowest plant height was at the control treatment which amounted to (97.28 cm). The spraying treatments with zinc sulfate showed a significant increase in the number of leaves compared to the control treatment. The spraying treatment with zinc sulfate at a concentration of (4 $g.L^{-1}$) has excelled by giving it the highest number of leaves amounted to (254.83 $leaves.plant^{-1}$). The spraying treatment with zinc sulfate at a concentration of (4 $g.L^{-1}$) has excelled by giving it the highest leaf area for the plant amounted to (1805.85 cm^2) compared to the control treatment. The spraying treatment with zinc sulfate at a concentration of (4 $g.L^{-1}$) has excelled by giving it the highest dry weight of the leaves amounted to (29.45 g) compared to the spraying treatments with other zinc sulfate and the control treatment that recorded the lowest dry weight of the leaves amounted to (26.68 g). The spraying treatments with zinc sulfate led to a significant increase in the percentage of carbohydrates in the leaves

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compared to the control treatment. The spraying treatment with zinc sulfate at a concentration of (4 $g.L^{-1}$) has excelled by giving it the highest percentage of carbohydrates in the leaves amounted to (24.50%), while the lowest percentage of carbohydrates in the leaves was at the control treatment which amounted to (21.82%). The result of the interaction between the foliar spraying with tryptophan and zinc sulfate in the table (2) showed a significant effect on all traits of the vegetative growth for the plant, where the interaction treatment between the spraying with tryptophan at a concentration of (200 $mg.L^{-1}$) and spraying with zinc sulfate at a concentration of (4 $g.L^{-1}$) was significantly excelled by recording it the best results for the traits of plant height (127.33 cm), and the number of leaves (384.55 $leaves.plant^{-1}$), the leaf area (2533.92 cm^2), the dry weight of the leaves (35.10 g), and the percentage of carbohydrates in the leaves (30.35%).

Table 2: The effect of foliar spray with tryptophan and zinc sulfate and their interaction on the traits of vegetative growth for Snapdragon plant (Antirrhinum majus L.)

Traits / Concentrations	Plant height (cm)	Number of leaves ($leaves.plant^{-1}$)	Leaf area (cm^2)	Dry weight of the leaves (g)	Percentage of carbohydrates in the leaves (%)	
Effect of Tryptophan						
Trp0	98.30 c	165.80 d	1091.00 c	26.28 d	21.32 d	
Trp100	107.41 b	195.75 c	1599.67 b	26.95 c	22.00 c	
Trp150	109.61 ab	233.58 b	1791.29 b	29.43 b	24.41 b	
Trp200	114.91 a	313.19 a	2245.64 a	30.65 a	25.69 a	
Effect of zinc sulfate						
Zn0	97.28 b	187.50 b	1416.94 b	26.68 c	21.82 c	
Zn1	109.25 a	232.86 a	1755.40 a	28.81 b	23.77 b	
Zn2	108.61 a	233.14 a	1749.42 a	28.36 b	23.33 b	
Zn4	115.11 a	254.83 a	1805.85 a	29.45 a	24.50 a	
Effect of interaction between Tryptophan and zinc sulfate						
Trp0	Zn0	77.55 d	146.33 g	828.22 f	23.89 f	19.18 e
	Zn1	101.55 c	166.55 fg	1054.25 ef	27.10 de	22.06 d
	Zn2	106.11 bc	170.77 fg	1371.56 de	27.43 de	22.39 d
	Zn4	108.00 bc	179.55 efg	1109.96def	26.70 de	21.66 d
Trp100	Zn0	103.66 c	189.00 efg	1318.05 de	26.25 e	21.54 d
	Zn1	104.00 bc	190.44 efg	1543.05 cd	27.38 de	22.36 d
	Zn2	109.33 bc	188.66 efg	1532.40 cd	27.31 de	22.28 d
	Zn4	112.66 bc	214.89 def	2005.19 bc	26.85 de	21.82 d
Trp150	Zn0	102.33 c	196.22 efg	1537.08 cd	27.68 d	22.68 d
	Zn1	118.44 ab	270.89 cd	2192.24 ab	31.22 b	26.18 b
	Zn2	105.22 bc	226.89 def	1861.53 bc	29.64 c	24.60 c
	Zn4	112.44 bc	240.33 de	1574.31 cd	29.15 c	24.16 c
Trp200	Zn0	105.55 bc	218.44 def	1984.41 bc	28.90 c	23.87 c
	Zn1	113.00 bc	303.55 bc	2232.05 ab	29.52 c	24.47 c
	Zn2	113.78 bc	346.22 ab	2232.20 ab	29.07 c	24.06 c
	Zn4	127.33 a	384.55 a	2533.92 a	35.10 a	30.35 a

The averages that share the same letter for each column do not differ significantly ($P \leq 0.05$) according to Duncan's new multiple tests.

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2- The effect of foliar spraying with tryptophan and zinc sulfate and their interaction on the traits of flowering growth for Snapdragon plant (*Antirrhinum majus* L.)

Table (3) shows that the foliar spraying treatments with tryptophan were significantly affected on the flowering date, where the spraying treatment with tryptophan at a concentration of (200 mg.L^{-1}) led to early the flowering date which amounted to (82.72 days), which did not differ significantly from the spraying treatment with tryptophan at a concentration of (150 mg.L^{-1}) where the flowering date amounted to (83.36 days) compared to the control treatment. Table results indicated that the number of florets in the inflorescence increased significantly when spraying the plant with tryptophan at a concentration of (200 mg.L^{-1}) where the number of florets in the inflorescence amounted to (39.72 florets.inflorescence^{-1}) compared to the control treatment that recorded the number of florets in the inflorescence amounted to (32.91 florets.Inflorescence^{-1}). All tryptophan concentrations led to a significant increase in the length of the flower stalk, where the spraying treatment with tryptophan at a concentration of (200 mg.L^{-1}) has excelled by giving it the highest length of the flower stalk amounted to (54.17 cm), while the lowest length of the flower stalk was at the control treatment which amounted to (42.66 cm). The results also showed that all foliar spraying treatments with tryptophan led to a significant increase in the dry weight of the inflorescence, where the spraying treatment with tryptophan at a concentration of (200 mg.L^{-1}) has excelled by giving it the highest dry weight of the inflorescence amounted to (29.44 g) while the lowest dry weight of the inflorescence was at the control treatment which amounted to (26.50 g). It was found that spraying plants with tryptophan had a significant effect on the duration of flowering, where the spraying treatment with tryptophan at a concentration of (200 mg.L^{-1}) has excelled by giving it the longest duration of flowering amounted to (32.27 days), while the shortest duration of flowering was at the control treatment which amounted to (27.97 days). It was observed from the results that spraying plants with tryptophan has significantly affected the vase life for cut flower inflorescences, where the spraying treatment with tryptophan at a concentration of (200 mg.L^{-1}) has excelled by giving it the longest vase life amounted to (12.17 days), Which did not differ significantly from the spraying treatment with tryptophan at a concentration of (150 mg.L^{-1}) which recorded the vase life amounted to (11.67 days). while the shortest vase life of inflorescences was at the control treatment which amounted to (9.75 days). As for the foliar spraying treatments with zinc sulfate, it affected significantly on the flowering date, where the spraying treatment with zinc sulfate at a concentration of (4 g.L^{-1}) led to early the flowering date which amounted to (83.36 days), which did not differ significantly from the spraying treatment with zinc sulfate at a concentration of (2 g.L^{-1}) where the flowering date amounted to (84.27 days) compared to the control treatment. It was noted from the results that spraying plants with zinc sulfate led to a significant increase in the number of florets in the inflorescence, where the spraying treatment with zinc sulfate at a concentration of (4 g.L^{-1}) has excelled by giving it the highest number of florets in the inflorescence amounted to (38.41 florets.inflorescence^{-1}) compared to the control treatment which gave the lowest number of florets in the inflorescence amounted to (34.33 florets.inflorescence^{-1}). All the spraying treatments with zinc sulfate led to a significant increase in the length of the flower stalk compared to the control treatment, where the spraying treatment with zinc sulfate at a concentration of (4 g.L^{-1}) has excelled by giving it the highest length of the flower stalk amounted to (52.17 cm), while the lowest length of the flower stalk was at the control treatment which amounted to (42.67 cm). The results showed that all the spraying treatments with zinc sulfate led to a significant increase in the dry weight of the inflorescence, where the spraying treatment with zinc sulfate at a

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concentration of (4 $g.L^{-1}$) has excelled by giving it the highest dry weight of the inflorescence amounted to (28.75 g), while the lowest dry weight of the inflorescence was at the control treatment which amounted to (26.83 g). The spraying treatment with zinc sulfate at a concentration of (4 $g.L^{-1}$) has excelled by giving it the longest duration of flowering amounted to (31.55 days), while the control treatment recorded the shortest duration of flowering amounted to (27.94 days). It was found that spraying plants with zinc sulfate significantly affected the vase life of the inflorescences, where the spraying treatment with zinc sulfate at a concentration of (4 $g.L^{-1}$)gave the longest vase life amounted to (12.42 days) compared to the comparison treatment that recorded the shortest vase life amounted to (9.42 days). The result of the interaction between the foliar spraying with tryptophan and zinc sulfate showed a significant effect on traits of the flowering growth for the plant, where the interaction treatment between the spraying with tryptophan at a concentration of (200 $mg.L^{-1}$) and spraying with zinc sulfate at a concentration of (4 $g.L^{-1}$) was significantly excelled by early the flowering date (73.55 days), increasing the number of florets in the inflorescence (42.55 $florets.inflorescence^{-1}$), the length of the flower stalk (57.89 cm), the dry weight of the inflorescence (31.00 g), and the duration of flowering (33.89 days), and vase life (13.67 days).

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Table 3: The effect of foliar spray with tryptophan and zinc sulfate and their interaction on the traits of flowering growth for Snapdragon plant (Antirrhinum majus L.)

Traits / Concentrations	Flowering date (day)	Number of florets in the inflorescence (florets.inflorescence^{-1})	Length of the flower stalk (cm)	The dry weight of the inflorescence (g)	Duration of flowering (day)	Vase life (day)	
Effect of Tryptophan							
Trp0	96.91 c	32.91 b	42.66 c	26.50 d	27.97 c	9.75 c	
Trp100	87.05 b	37.83 a	47.72 b	27.44 c	30.25 b	11.08 b	
Trp150	83.36 a	38.52 a	50.39 b	28.28 b	30.94 b	11.67 ab	
Trp200	82.72 a	39.72 a	54.17 a	29.44 a	32.27 a	12.17 a	
Effect of zinc sulfate							
Zn0	95.92 c	34.33 b	42.67 b	26.83 b	27.94 b	9.42 c	
Zn1	86.50 c	38.28 a	49.94 a	28.14 a	30.86 a	11.42 b	
Zn2	84.27 ab	37.97 a	50.16 a	27.94 a	31.08 a	11.42 b	
Zn4	83.36 a	38.41 a	52.17 a	28.75 a	31.55 a	12.42 a	
Effect of interaction between Tryptophan and zinc sulfate							
Trp0	Zn0	105.55 g	25.66 d	40.89 ef	24.55 e	24.33 f	8.00 h
	Zn1	94.22 f	35.55 bc	43.22 def	26.77 d	28.11 de	9.67 fg
	Zn2	93.89 f	35.22 c	44.33 cdef	27.11 d	30.33 bcd	10.33 efg
	Zn4	94.00 f	35.22 c	42.22 ef	27.55 cd	29.11 cde	11.00 cdef
Trp100	Zn0	93.55 f	36.44 bc	42.67 ef	27.67 cd	27.44 e	9.33 gh
	Zn1	84.44 bcd	38.00 abc	46.67 bcdef	26.89 d	30.55 bcd	10.67 defg
	Zn2	83.33 bcd	39.33 abc	50.22 abcd	27.11 d	30.78 bcd	11.33 cde
	Zn4	86.89 de	37.55 abc	51.33 abc	28.11 bcd	32.22 ab	13.00 ab
Trp150	Zn0	93.22 f	36.89 bc	39.11 f	27.33 cd	29.22	9.33

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						cde	gh
	Zn1	80.66 bc	40.89 ab	52.78 ab	29.78 ab	32.77 ab	13.66 a
	Zn2	80.55 bc	38.00 abc	52.44 ab	27.67 cd	30.77 bcd	11.67 bcde
	Zn4	79.00 ab	38.29 abc	57.22 a	28.33 bcd	30.99 bcd	12.00 bcd
Trp200	Zn0	91.33 ef	38.33 abc	48.00 bcde	27.77 cd	30.77 bcd	11.00 cdef
	Zn1	86.66 cde	38.66 abc	57.11 a	29.11 bc	32.00 abc	11.67 bcd
	Zn2	79.33 ab	39.33 abc	53.67 ab	29.89 ab	32.44 ab	12.33 abc
	Zn4	73.55 a	42.55 a	57.89 a	31.00 a	33.89 a	13.67 a

The averages that share the same letter for each column do not differ significantly ($P \leq 0.05$) according to Duncan's new multiple tests.

The results showed that spraying the Snapdragon plants with tryptophan positive effect on all studied traits of vegetative and flowering growth, The spraying treatment with Tryptophan at a concentration of (200 $mg.L^{-1}$) has significantly excelled by giving it the best results. The increase in the traits of vegetative growth as a result of spraying with the amino acid tryptophan may be due to being the initiator responsible for the biological construction of the hormone indole acetic acid (IAA), which has an important role with its initiator in the growth and development of the plant (26, 30). This was reflected in a significant effect on the traits of vegetative growth. Russell, (1982) has indicated that increasing vegetative growth attributes as a result of adding tryptophan may be due to its conversion to the IAA hormone. It may also be attributed to the role of the amino acid in regulating ions and modifying the movement of nutrients within plant tissues (45). The increase in plant height, number of leaves, and leaf area when treating with amino acids may be due to the bio-effect of these acids on stimulating cell division and its elongation (33). The increase in the dry weight of the leaves as a result of spraying with the amino acid

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(tryptophan) may be due to the fact that the amino acids have an important role in the continuity of the bio-processes leading to the production of organic materials, thus an increase in the accumulation of dry matter in the plant. The increase in the number of leaves and the leaf area as shown in table (2) leads to an increase in the effectiveness of photosynthesis and increasing the produced carbohydrates, thus the accumulation of dry matter in the plant. The results showed an increase in the percentage of carbohydrates in the leaves as a result of spraying with the amino acid (tryptophan). This increase may be attributed to the fact that the amino acids are not only used in building proteins but are also considered as primary starting agents for natural products including carbohydrates, plant pigments, alkaloids and hormones (28). increasing traits of vegetative growth as a result of spraying with the amino acid (tryptophan) closely agree with (8) in their study on Snapdragon plant (Antirrhinum majus L.), and Strawflower plant (Helichrysum bracteatum) (19), and eastern purple coneflower plant (Echinacea purpurea) (23), where They found that the amino acids led to a significant increase in the traits of vegetative growth. Improving the flowering traits as a result of adding the amino acid (tryptophan) may be due to the catalytic effects that associated with an increase in the content and levels of effectiveness for internal stimuli of origin, especially gibberellins and IAA indole which are known to stimulate the growth of plant organs (41, 44). The early flowering as a result of spraying with tryptophan may be due to the used amino acid can serve as a source of energy and promoting the manufacture of auxins, organic materials, and nitrogen, which are necessary to increase the rate of vegetative growth and accumulation of raw materials, thus the flowering can be early (37). The increase in the number of flowers in the inflorescence and the length of the flower stalks as a result of treating with tryptophan may be attributed to the bio-effect of these amino acids in stimulating the division and elongation of cells and the effectiveness of many enzymes, thus the possibility of increasing these flowering traits (33). The results also showed a significant increase in the duration of flowering when treating plants with tryptophan, It was attributed to the fact that using amino acids with appropriate concentrations works to eliminate free radicals, which helps prevent damage to cells and tissues and then delay the senescence of flowers as mentioned (32). The use of amino acids at certain concentrations increases the number of flowers in the inflorescence, so it can lead to an increase in the dry weight of the inflorescences (23). increasing the flowering traits as a result of spraying plants with amino acid agree with (8) in their study on Snapdragon plant (Antirrhinum majus L.), Gladiolus plant (Gladiolus grandiflorus) (23), and Barberton daisy plant (Gerbera jamesonii) (7). The results indicated that spraying the Snapdragon plants with zinc sulfate positively affected all traits of vegetative growth, and the spraying treatment at a concentration of (4 $g.L^{-1}$) has excelled by recording it the best results. The increase in the plant height, the number of leaves and the leaf area in the plant as a result of spraying plants with zinc sulfate may be attributed to the role of the main zinc in the manufacture of the amino acid (tryptophan), which is important in the formation of the hormone indole acetic acid (IAA), which affects the increase in cell division and stimulates the activity of the cells, division, and expansion of the Meristematic cells, and it participates in many functions of plant cells and the structure of the plasma membrane and it has a major role in protecting plant cells from oxidation (1), (38). The results showed a significant increase in the dry weight of the leaves when treating plants with zinc sulfate, this increase is due to the role of zinc in plant growth and its effective contribution to the main bio-processes represented by the bio-processes for the Meristematic cells that lead to the formation of the biomass in the plant (42), where it was found that it contributes to the manufacturing and production of proteins

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through chemical stimulation, or it works to maintain protein building and stability as well as improving the physical and biological properties for the leaves (25). This result agrees with (4) in their study on the Calotropis proccera plant, where all the traits of vegetative growth increased, in addition to the dry weight of the total vegetative for the plant. Through the results, it was found that treating with zinc sulfate led to a significant increase in the percentage of carbohydrates in the leaves. This increase may be due to the role of zinc in increasing vegetative growth and its participation in photosynthesis and the content of ribosomes in the plant cell, which leads to stimulating the formation of carbohydrates, proteins, and nucleic acids, It also helps to manufacture tryptophan as a substance to improve growth (20). The results showed that treating Snapdragon plants with zinc sulfate improved the traits of flowering growth. Early flowering when spraying plants with zinc sulfate at a concentration of (4 g.L-1), It may be due to the growth and development of the plant, where zinc promotes the storage of more carbohydrates through photosynthesis, and this may be the factor that causes the positive effects for the optimal concentration of zinc in reducing the stage of modernity in the plant and then the early flowering (14). Similar results were obtained by (27) in their study on gladiolus plant, (10) in the African marigold, and (24) in the Gerbera plant. The increase in the number of flowers in the inflorescence and the length of the flower stalk as a result of spraying plants with zinc sulfate may be due to the zinc activate many enzymes including catalase and tryptophan synthase and others, and the participation of zinc in the manufacture of chlorophyll and various physiological activities through which the growth and development of the plant are encouraged, which increases these traits. These results agree with (20) in their study on the African marigold plant, and (39) on the gladiolus plant. The results showed a significant increase in the dry weight of the inflorescence and the duration of flowering as a result of spraying plants with zinc sulfate. This increase may be attributed to the fact that zinc is necessary for the growth and development of plants. Zinc is also effective in nourishing the plant to manufacture plant hormones and achieving balanced absorption for phosphorus and potassium into plant cells. This leads to the accumulation of dry matter and increasing the duration of flowering on the plant with better nutrition (39). These results agree with (21, 17) in their study on gladiolus plants. The results showed a significant increase in the vase life for the cut flowers as a result of spraying with zinc sulfate. This increase may be due to the participation of micronutrients, including zinc, in maintaining a great balance and absorption of water, which prolongs the vase life of the cut flowers as mentioned in (29) in their study on rose tree plant. These results agree with (34) in their study on the rose tree, and (14) on the gladiolus plant.

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