

The response of *Gerbera (Gerbera jamesonii)* to spraying with Moringa leaves extract, Fenugreek seed, and Zinc in the traits of vegetative and flowering growth

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ABSTRACT

The experiment was conducted during the 2017-2018 agricultural season in the greenhouse covered with saran cover belonging to the Agricultural Research and Experimental Station, College of Agriculture, University of Basra, in order to study the response of *Gerbera (Gerbera jamesonii)* to spraying with Moringa leaves extract at a concentration of (0, 5, 10 g.L⁻¹), Fenugreek seed soak at a concentration of (0, 3, 6 g.L⁻¹), and zinc at a concentration of (0, 60 mg.L⁻¹) in the traits of vegetative and flowering growth, with rate of three sprayings between one spraying and another (21 days). The results showed that treating with Moringa leaves extract at concentration of (5 g.L⁻¹) led to a significant increase in the number of leaves, flowering period, diameter of flower stalk, number of flowers, diameter of flower and number of petals which amounted to (35.11 leaves.plant⁻¹, 156.56 days, 4.21 mm, 30.50 flowers.plant⁻¹, 11.84 cm, 52.28 petals.flower⁻¹), respectively. The results also showed that spraying with the same extract but with a concentration of (10 g.L⁻¹) led to a significant increase in all studied traits, while spraying the plants with fenugreek seed soak at a concentration of (3 g.L⁻¹) led to a significant increase in the length of the flower stalk, the diameter of the flower stalk and the number of petals (40.27 cm, 4.16 mm, 52.67 petals.flower⁻¹), respectively. The results showed that spraying with fenugreek seeds soak at a concentration of (6 g.L⁻¹) led to a significant increase in all studied vegetative and flowering traits. while spraying with zinc led to a significant increase in flowering period, length of the flower stalk, the diameter of the flower stalk, number of flowers and number of petals (159.19 days, 42.27 cm, 4.22 mm, 29.59 flowers.plant⁻¹, 53.56 petals.plant⁻¹). The triple and bi-interactions between the factors of the experiment showed a significant effect on most of the studied traits.

Keywords: *Gerbera*, Moringa, Fenugreek seeds.

*Research paper from thesis for the first author.

استجابة نبات الجربيرا *Gerbera Jamesoni* للرش بمستخلص أوراق المورنجا ومنقوع بذور الحلبة والخاصين في صفات النمو الخضري والزهرى

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الخلاصة:

نفذت التجربة خلال الموسم الزراعي 2017 – 2018 في البيت المحمي المغطى بغطاء الساران التابع لمحطة البحوث والتجارب الزراعية في كلية الزراعة/جامعة البصرة، لدراسة استجابة نبات الجربيرا *Gerbera Jamesoni* للرش بمستخلص أوراق المورنجا بتركيز (10,5,0) غم.لتر⁻¹ ومنقوع بذور الحلبة بتركيز (6,3,0) غم.لتر⁻¹ والخاصين بتركيز (60,0) ملغم.لتر⁻¹ في صفات النمو الخضري والزهرى ، بواقع ثلاث رشات بين رشة وأخرى 21 يوم . بينت النتائج أن المعاملة بمستخلص أوراق المورنجا تركيز 5 غم.لتر⁻¹ أدى الى زيادة معنوية في عدد الأوراق ، فترة التزهير ، قطر الحامل الزهرى ، عدد الازهار ، قطر الزهرة و عدد البتلات (35.11 ورقة.نبات⁻¹ ، 156.56 يوم ، 4.21 ملم ، 30.50 زهرة.نبات⁻¹ ، 11.84 سم ، 52.28 بتلة.زهرة⁻¹) على التوالي. كما أظهرت النتائج أن الرش بذات المستخلص لكن بتركيز 10 غم.لتر⁻¹ أدى الى زيادة معنوية في جميع الصفات المدروسة. بينما رش النباتات بمنقوع بذور الحلبة تركيز 3 غم.لتر⁻¹ أدى الى زيادة معنوية في طول الحامل الزهرى وقطر الحامل الزهرى وعدد البتلات (40.27 سم ، 4.16 ملم ، 52.67 بتلة.زهرة⁻¹) على التوالي. وتبين من النتائج أن الرش بتركيز 6 غم.لتر⁻¹ من منقوع بذور الحلبة أدى الى زيادة معنوية في جميع الصفات الخضريّة والزهرية المدروسة . في حين أدى الرش بالخاصين الى زيادة معنوية في فترة التزهير ، طول الحامل الزهرى ، قطر الحامل

الزهري ، عدد الأزهار و عدد البتلات (159.19 يوم ، 42.27 سم ، 4.22 ملم ، 29.59 زهرة نبات¹، 53.56 بتلة نبات¹). أظهرت التداخلات الثنائية والثلاثية بين عوامل التجربة تأثيراً معنوياً في أغلب الصفات المدروسة.

الكلمات مفتاحية: جريبيرا , مورنجا , بذور الحلبة .
*مستل من رسالة الباحث الأول .

1. INTRODUCTION

Gerbera (Gerbera jamesonii L.) is considered a short perennial herbaceous plant with a rhizome stem underground with a height of approximately (15-25 cm). The leaves are similar to the *Arugula* leaves and the plant forms many offsets, and *Gerbera* plants belong to the *Asteraceae* family (17). *Gerbera* is considered one of the main cut flowers, it is a very popular ornamental plant that is used as picking and it is cultivated in most countries of the world for its attractive flowers, multiplying of their colors and the length of the vase life (23). The demand for them has increased in the local and international markets (18). It can also be cultivated in ponds as cover plants, but they must be protected from high temperatures in the hot summer (28). The origin-country for *Gerbera* is South Africa and Asia, which is one of the very beautiful arrangements, *Gerbera* flowers are multicolored (single or double), with a long neck, it appears throughout the year, suitable for picking and it has a large commercial demand and from the flowers that continue and live for a long time after the harvest (7). Studies have shown that there are many plant extracts that have the effect in increasing the traits of vegetative and flowering growth for many plants, due to the fact that these plants contain many natural chemical compounds that differ according to the plant parts, growth phases, and environmental conditions to which plants are exposed (10). Mengel, (26) showed that most plants have the ability to absorb nutrients through the leaves, and this is done through leaf surfaces, or through stomata, or both. Joly, (22) explained that the primary goal for foliar nutrition is allowing absorption and rapid benefiting of sprayed nutrients on the plant. Among these plant extracts *Moringa* leaves extract, it has

multiple roles in the physiological and bioactivities for the plant where it works to accelerate the growth of young plants, strengthening plants, and increasing growth indicators such as the total number of leaves for the plant, the leaf area, the fresh and dry weight for the plant, the number of branches, and the length of roots when adding *Moringa* leaves extract at several levels (27). As well as extract of fenugreek seeds and the importance of fenugreek is due to its seeds containing many chemical and nutritionally important medicinal compounds (19). Fenugreek seeds contain many nutrients, including iron, copper, zinc, manganese, potassium, and others (15). Studies indicated that micronutrients are no less important than macronutrients in increasing production and improving quality (2). The zinc element is one of the important micronutrients in plant growth (13), where it activates enzymatic processes within the plant and adversely affects the growth and development of chloroplast and chlorophyll content (24). Because of the importance of the *Gerbera* plant in landscaping gardens and presenting it on occasions as cut flowers, this study aims to:

- 1- Improving the traits of vegetative and flowering growth to produce cut flowers with desirable marketing traits.
- 2- Determining the best type and concentration for some plant extracts (*Moringa* leaves extract and extract of fenugreek seed soak).
- 3- Studying the effect of foliar spraying with a zinc element on vegetative and flowering growth.
- 4- Studying the effect of triple and bi-interactions between the study factors on the vegetative and flowering growth for this plant.

2. MATERIALS AND METHODS

The experiment was conducted in the greenhouse covered with saran cover belonging to the Agricultural Research and Experimental Station, College of Agriculture, University of Basra, Karmah Ali location for the period 1/10/2017 until 15/6/2018. The Gerbera seedlings were brought from one of the Baghdad nurseries on 9/28/2017 at the age of one and a half months, where the Gerbera seeds were cultivated on 8/13/2017 and the seedlings were transported on 1/10/2017 to the flowerpots, with diameter of (20 cm) and filled with an agricultural media consisting of riverine mixture and peat moss with a ratio of 1 : 3, respectively, as shown in Table (1). The plants were sprayed with extract of Moringa leaves soak at three concentrations of (0, 5, 10 g.L⁻¹) as shown in Table (2) and fenugreek seeds extract with three concentrations of (0, 3, 6 g.L⁻¹) as shown in Table (3) and sprayed with zinc at two concentrations of (0, 60 mg.L⁻¹), with rate of three sprayings during the growing season. Moringa leaves extract was prepared by drying the vegetative leaves for a plant well and then

grinding and taking the fine powder with a weight of (0, 5, 10 g) which it was dissolved separately in 1 L of warm distilled water at a temperature of 50 °C and for 24 hours and the solution was filtered, the plants were then sprayed with a hand sprayer until complete wetness. As for the extract of fenugreek seed soak, it was prepared by dissolving (0, 3, 6 g) of dry powder in a liter of warm distilled water at a temperature of 50 °C, left for 24 hours, it was then filtered with Gauze cloth, the plants were then sprayed with a hand sprayer until complete wetness. A few drops of diffusion matter (Tween-20) were added to all solutions before spraying (11). As for zinc (0, 60 mg), it was prepared by dissolving 0.240 mg of zinc sulfate in a liter of distilled water plus a few drops of diffusion matter (Tween-20). The experiment was conducted according to the design of the Randomized Complete Block Design (RCBD), with a factorial experiment at three replicates. The averages were compared using the Least Significant Difference (LSD) test at the probability level (0.05) (4).

Table 1: Some of the chemical and physical traits for the soil used in the experiment.

Traits	Value	Units
Electrical conductivity (EC)	1.30	dS.m ⁻¹
pH	7.71	——
Total nitrogen (N)	175.00	Ppm
Phosphorus availability (P)	2.71	
Dissolved potassium (K)	56.00	
Zinc (Zn)	1.39	
Organic matter (OM)	1.06	g.kg ⁻¹
Soil separates	——	——
Sand	865.9	g.kg ⁻¹
Silt	63.7	
Clay	70.4	
Soil texture	Loamy sand	

Table 2: The content of 100 grams of fresh Moringa leaves from mineral and organic ingredients, vitamins and various materials (30).

Matter	Value	Matter	Value
Water	78.1 g	Phosphorus	112 mg
protein	9.4 g	Calcium	185 mg
Fats	1.4 g	Magnesium	147 mg
carbohydrate	8.2 g	potassium	337 mg
Fibers	2 g	sodium	9 mg
Vitamin C.	51.7 g	iron	4 mg
Folic acid	40 μ g	zinc	0.6 mg
Vitamin B6	1.2 mg	copper	0.51 mg
Vitamin A	378 μ g	Calories	64 kcal

Table 3: Some nutritional components and mineral elements for fenugreek seeds based on dry weight (15).

Ingredients	%	Element	μ g.g ⁻¹
Dissolved extract in water	34.96	Copper	0.17
Gel	26.20	zinc	1.58
Protein	22.80	Iron	1.07
Humidity	9.82	Manganese	2.76
Reducing sugar	7.76	Magnesium	3.19
Fixed oils	6.25	Sodium	68.02
Total ash	5.58	Potassium	240.19
Fibers	5.19		
Ash dissolved in water	2.51		
Ash dissolved in acid	2.10		
Volatile oils	1.04		

The studied traits

Vegetative growth indicators

The measurements of the vegetative growth indicators for all plants were taken after reaching it the flowering phase as follows:

- 1- The total number of leaves (leaf.plant⁻¹).
- 2- Leaf area per plant (cm²).

The leaf area was measured by the weighing method according to (14). Three leaves were taken from each plant representing the plant for each experimental unit. The weight of each leaf was recorded separately and an area of 4 cm² (2 cm x 2 cm) was cut from each of the three leaves and the fresh weight of these pieces was

then recorded. The area of one leaf was calculated by the following equation:

$$\text{Leaf area (cm}^2\text{)} = \frac{\text{The average weight of leaf (g) x the area of the cut square (4 cm}^2\text{)}}{\text{The average weight of the cut square (g)}}$$

The total leaf area for the plant was calculated according to the following formula:

The leaf area for the plant (cm²) = the area of one leaf (cm²) x the total number of leaves

Flowering growth indicators

1- Flowering period (day)

The number of days required for opening the first flower bud on the plant to the last flower for each plant was calculated.

2- Number of flowers (flower.plant⁻¹)

The number of flowers per plant was calculated from the beginning of flowering to the end of the plant, then record its average.

3- The length of the flower stalk (cm)

The length of the flower stalk was measured from its contact point with soil to the base of the flower.

4- The diameter of the flower stalk (mm)

The diameter of the flower stalk was measured for each plant at a distance of 5 cm from the base of the flower by the vernier.

5- The diameter of the flower (cm)

The diameter of the flower for each plant was measured when fully blooming at the farthest two distant points between the petals by a ruler, and the average was then calculated.

6- Number of petals (petal.flower⁻¹)

The number of petals was calculated for five flowers were randomly chosen for each plant, and the average was then calculated.

3. RESULTS AND DISCUSSION

The traits of vegetative growth

The plants treated with Moringa leaves extract at a concentration of (5 or 10 g.L⁻¹) have excelled in the total number of leaves for plants which amounted to (35.11, 39.89 leaves.plant⁻¹), respectively, compared to the control plants that gave the lowest total number of leaves amounted to (31.22 leaves.plant⁻¹). As for spraying with the extract of fenugreek seed soak at a concentration of (6 g.L⁻¹), it had a significant effect on increasing the average number of total leaves per plant, which

amounted to (37.44 leaves.plant⁻¹) compared the control plants that sprayed with the same extract at a concentration of (3 g.L⁻¹), which did not differ significantly between them in the number of total leaves per plant which the number of their leaves amounted to (34.44, 34.33 leaves.plant⁻¹), respectively. The results of the same table showed that spraying plants with zinc had no significant effect. The interaction between spraying with moringa leaves extract and spraying with the extract of fenugreek seed soak had a significant effect, where the plants formed the highest number of leaves when spraying them with moringa leaves extract at a concentration of (10 g.L⁻¹) only amounted to (44.00 leaves.plant⁻¹) compared to the control plants that gave the lowest total number of leaves amounted to (19.00 leaves.plant⁻¹). As for the interaction between the spraying with Moringa leaves extract and zinc, plants treated with Moringa leaves extract at a concentration of (10 g.L⁻¹) have excelled amounted to (43.67 leaves.plant⁻¹) only compared to the control plants that gave the lowest total number of leaves amounted to (27.89 leaves.plant⁻¹). The bi-interaction between spraying with the extract of fenugreek seeds soak and zinc had a significant effect, where the plants that were sprayed with the extract of fenugreek seeds soak at a concentration of (6 g.L⁻¹) only were distinguished by giving them the highest number of leaves amounted to (41.33 leaves.plant⁻¹) compared to the control plants that gave the lowest number of leaves amounted to (31.33 leaves.plant⁻¹). Triple interaction had a significant effect, where the plants that sprayed with the extract of fenugreek seed soak at a concentration of (6 g.L⁻¹) only were distinguished by giving them the highest average number of leaves amounted to (50.67 leaves.plant⁻¹) compared to the control plants that gave the lowest number of leaves amounted to (11.00 leaves.plant⁻¹). There was a significant increase in the leaf area for the plants sprayed with Moringa leaves extract at a concentration of (10 g.L⁻¹) which amounted to (3863 cm²)

compared to the leaf area of the control plants that amounted to (3001 cm^2). The plants were significantly excelled when spraying them with the extract of the fenugreek seed soak at a concentration of (6 g.L^{-1}) by giving them the highest leaf area amounted to (3992 cm^2) compared to the leaf area of the control plants which amounted to (3031 cm^2). The same table showed that spraying plants with zinc had no significant effect on the trait of the leaf area. The bi-interaction between spraying with Moringa leaves extract and the extract of fenugreek seed soak had a significant effect, where the plants treated with the extract of fenugreek seed soak at a concentration of (6 g.L^{-1}) only gave the highest leaf area amounted to (4142 cm^2) compared to the control plant that gave the lowest leaf area amounted to (1520 cm^2). As for the interaction between the spraying with Moringa leaves extract and Zinc had a significant effect, where the plants treated Moringa leaves extract at a concentration of (10 g.L^{-1}) and zinc at a concentration of (60 mg.L^{-1}) gave the highest leaf area amounted to (4095 cm^2) compared to the control plants that gave the lowest leaf area amounted to (2489 cm^2). As for the bi-interaction between spraying with the extract of fenugreek seeds soak and zinc, the plants treated with the extract of fenugreek seeds soak at a concentration of (6 g.L^{-1}) and zinc at a concentration of (60 mg.L^{-1}) have excelled by giving them the highest leaf area amounted to (4322 cm^2) compared to the plant treated with zinc at a concentration of (60 mg.L^{-1}) that gave the lowest leaf area amounted to (3019 cm^2). Triple interaction had a significant effect in this trait, where the plants that sprayed with Moringa leaves extract at a concentration of (10 g.L^{-1}) and fenugreek seed soak at a concentration of (6 g.L^{-1}) and zinc at a concentration of (60 mg.L^{-1}) have excelled by giving them the highest leaf area amounted to (4778 cm^2) compared to the control plants that gave the lowest leaf area amounted to (892 cm^2).

The traits of flowering growth

Table (5) shows that spraying plants with Moringa leaves extract has a significant effect on prolonging the flowering period of plants, where the plants treated with Moringa leaves extract at a concentration of (5 or 10 g.L^{-1}) have excelled by giving them the longest flowering period which amounted to (165.39 , 156.56 days), respectively, compared to the control plants that gave the lowest flowering period amounted to (151.57 days). The plants that sprayed with the extract of fenugreek seed soak at a concentration of (6 g.L^{-1}) were significantly excelled in the flowering period which amounted to (160.28 days) compared to the plants that sprayed at a concentration of (3 g.L^{-1}) which gave the lowest flowering period amounted to (154.61 days). The plants that sprayed with zinc at a concentration of (60 mg.L^{-1}) were significantly excelled in the prolong flowering period, which amounted to (159.19 days) compared to the control plants that gave the lowest flowering period amounted to (156.59 days). As for spraying with Moringa leaves extract and the extract of the fenugreek seed soak had a significant effect, where the plants that sprayed with Moringa leaves extract at a concentration of (10 g.L^{-1}) only have excelled by giving them the longest flowering period which amounted to (168.17 days) compared to the control plants whose flowering period amounted to (144.50 days). As for spraying with Moringa leaves extract and Zinc, where the plants that sprayed with Moringa leaves extract at a concentration of (10 g.L^{-1}) only have excelled by giving them the longest flowering period amounted to (166.33 days) compared to the lowest flowering period amounted to (150.44 days) for the control plants. The table also showed that spraying with the extract of fenugreek seeds soak and zinc had a significant effect on the flowering period, where the plants that were sprayed with extract of fenugreek seed soak at a concentration of (6 g.L^{-1}) and zinc of (60 mg.L^{-1}) were characterized by giving them the longest

flowering period amounted to (160.44 days) compared to the plants that sprayed with the extract of fenugreek seeds soak at a concentration of (3 g.L^{-1}) gave the lowest flowering period for plants amounted to (149.44 days). As for the effect of triple interaction, it has a significant superiority, where the plants that sprayed Moringa leaves extract at a concentration of (10 g.L^{-1}) were characterized by giving them the longest flowering period amounted to (175.67 days) compared to the lowest flowering period amounted to (134.33 days) for plants that sprayed Moringa leaves extract at a concentration of (5 g.L^{-1}) and the extract of fenugreek seeds soak at a concentration of (3 g.L^{-1}) and did not spray with zinc. Table (5) also shows that the plants that sprayed with Moringa leaves extract at a concentration of (5 or 10 g.L^{-1}) were significantly excelled in increasing the number of flowers, which amounted to (30.50, 28.83 flowers.plant⁻¹) respectively, compared to the control plants whose number of flowers amounted to (26.94 flowers.plant⁻¹). The plants that sprayed with the extract of the fenugreek seeds soak at a concentration of (6 g.L^{-1}) were characterized by giving them the highest number of flowers, which amounted to (30.28 flowers.plant⁻¹) compared to the control plants that gave the lowest number of flowers and plants that sprayed with the same extract but with a concentration of (3 g.L^{-1}) which amounted to (28.22, 27.78 flowers.plant⁻¹), respectively. The plants that sprayed with zinc at a concentration of (60 mg.L^{-1}) were significantly excelled in increasing the number of flowers, which amounted to (29.59 flowers.plant⁻¹) compared to the control plants which amounted to (27.93 flowers.plant⁻¹). As

for the bi-interaction between the two spraying factors with Moringa leaves extract and the extract of fenugreek seed soak had a significant effect on the number of flowers, where the plants that sprayed with Moringa leaves extract at a concentration of (5 g.L^{-1}) only had the highest number of flowers amounted to (32.83 flowers.plant⁻¹) compared to the control plants which gave the lowest number of flowers amounted to (21.33 flowers.plant⁻¹). As for spraying with Moringa leaves extract and Zinc, the plants that were sprayed with Moringa leaves extract at a concentration of (5 g.L^{-1}) and zinc at a concentration of (60 mg.L^{-1}) were characterized by giving them the highest number of flowers amounted to (31.89 flowers.plant⁻¹) compared to the lowest number of flowers amounted to (26.00 flowers.plant⁻¹) for the control plants. The bi-interaction between spraying with the extract of the fenugreek seeds soak and zinc was significantly excelled, where the plants sprayed with the extract of the fenugreek seeds soak at a concentration of (6 g.L^{-1}) and zinc extract at a concentration of (60 mg.L^{-1}) were significantly excelled by giving them the highest number of flowers amounted to (31.89 flowers.plant⁻¹) compared to the lowest number of flowers for plants that were sprayed with the extract of the fenugreek seeds soak only at a concentration of (3 g.L^{-1}) amounted to (27.22 flowers.plant⁻¹). As for the effect of triple interaction, the plants that sprayed with Moringa leaves extract a concentration of (5 g.L^{-1}) was characterized by giving them the highest number of flowers amounted to (35.00 flowers.plant⁻¹) compared to the lowest number of flowers amounted to (17.67 flowers.plant⁻¹) for the control plants.

Table 4: Effect of spraying with Moringa leaves extract, Fenugreek seed, and Zinc, and their interactions on the total number of leaves (leaves.plant⁻¹) and the leaf area (cm²) for Gerbera plant.

Moringa leaves extract (g.L ⁻¹)	Fenugreek seed extract (g.L ⁻¹)	The total number of leaves (leaves.plant ⁻¹)			The leaf area (cm ²)		
		Zinc (mg.L ⁻¹)		Moringa × Fenugreek seed	Zinc (mg.L ⁻¹)		Moringa × Fenugreek seed
		0	60		0	60	
0	0	11.00	27.00	19.00	892	2147	1520
	3	22.00	44.33	33.17	2270	4414	3342
	6	50.67	32.33	41.50	4304	3981	4142
5	0	33.00	47.00	40.00	3875	3262	3568
	3	34.33	29.33	31.83	3957	2692	3324
	6	35.00	32.00	33.50	3444	4206	3825
10	0	50.00	38.00	44.00	4359	3649	4004
	3	42.67	34.00	38.33	3288	3859	3573
	6	38.33	36.33	37.33	3242	4778	4010
				The average effect of Moringa			The average effect of Moringa
Moringa × Zinc	0	27.89	34.56	31.22	2489	3514	3001
	5	34.11	36.11	35.11	3759	3387	3573
	10	43.67	36.11	39.89	3630	4095	3863
				The average effect of Fenugreek seed			The average effect of Fenugreek seed
Fenugreek seed × Zinc	0	31.33	37.33	34.33	3042	3019	3031
	3	33.00	35.89	34.44	3172	3655	3413
	6	41.33	33.56	37.44	3663	4322	3992
The average effect of zinc		35.22	35.59		3292	3665	
L.S.D. 0.05							
Trait	Moringa	Fenugreek seed	Zinc	Moringa × Fenugreek seed	Moringa × Zinc	Fenugreek seed × Zinc	Moringa × Fenugreek seed × Zinc
Number of leaves	1.37	1.37	NS	2.37	1.93	1.93	3.35
leaf area	743.8	743.8	NS	1288.3	1051.9	1051.9	1821.9

Table 5: Effect of spraying with Moringa leaves extract, Fenugreek seed, and Zinc, and their interactions on the flowering period of plants (day) and the number of flowers (flowers.plant⁻¹) for Gerbera plant.

Moringa leaves extract (g.L ⁻¹)	Fenugreek seed extract (g.L ⁻¹)	The flowering period of plants (day)			The number of flowers (flowers.plant ⁻¹)		
		Zinc (mg.L ⁻¹)		Moringa × Fenugreek seed	Zinc (mg.L ⁻¹)		Moringa × Fenugreek seed
		0	60		0	60	
0	0	140.00	149.00	144.50	17.67	25.00	21.33
	3	156.67	154.33	155.50	31.33	27.00	29.17
	6	154.67	155.67	155.17	29.00	31.67	30.33
5	0	165.00	162.33	163.67	35.00	30.67	32.83
	3	134.33	158.33	146.33	21.33	31.00	26.17
	6	159.67	159.67	159.67	31.00	34.00	32.50
10	0	175.67	160.67	168.17	31.00	30.00	30.50
	3	157.33	166.67	162.00	29.00	27.00	28.00
	6	166.00	166.00	166.00	26.00	30.00	28.00
				The average effect of Moringa			The average effect of Moringa
Moringa × Zinc	0	150.44	153.00	151.72	26.00	27.89	26.94
	5	153.00	160.11	156.56	29.11	31.89	30.50
	10	166.33	164.44	165.39	28.67	29.00	28.83
				The average effect of Fenugreek seed			The average effect of Fenugreek seed
Fenugreek seed × Zinc	0	160.22	157.33	158.78	27.89	28.56	28.22
	3	149.44	159.78	154.61	27.22	28.33	27.78
	6	160.11	160.44	160.28	28.67	31.89	30.28
The average effect of zinc		35.22	156.59	159.19		27.93	29.59
L.S.D. 0.05							
Trait	Moringa	Fenugreek seed	Zinc	Moringa × Fenugreek seed	Moringa × Zinc	Fenugreek seed × Zinc	Moringa × Fenugreek seed × Zinc
Number of leaves	2.70	2.70	2.21	4.68	3.82	3.82	6.62
leaf area	0.67	0.67	0.55	1.16	0.95	0.95	1.64

Table (6) shows that spraying plants with Moringa leaves extract has a significant effect on the length of flower stalk, where the plants treated with Moringa leaves extract at a

concentration of (10 g.L⁻¹) have excelled by giving them the highest length of flower stalk which amounted to (42.53 cm), respectively, compared to the control plants that gave the

lowest length of flower stalk amounted to (36.67 cm). As for spraying with the extract of fenugreek seeds soak, the results showed that the plants that were sprayed with the extract of fenugreek seeds soak at a concentration of (3 or 6 g.L⁻¹) differed significantly between them in the length of the flower stalk, which amounted to (40.27, 41.64 cm), respectively. However, they together excelled on the control plants in the length of the flower stalk, which amounted to (35.58 cm). The plants that sprayed with zinc at a concentration of (60 mg.L⁻¹) were significantly excelled in the lengths of their flower stalk, which amounted to (42.27 cm), compared to the control plants, which the average length of their flower stalk amounted to (36.06 cm). As for the effect of bi-interaction between the spraying with Moringa leaves extract and the extract of the fenugreek seed soak had a significant effect, where the plants that sprayed with Moringa leaves extract at a concentration of (10 g.L⁻¹) and the extract of fenugreek seeds soak at a concentration of (6 g.L⁻¹) gave the highest length of flower stalk amounted to (44.08 cm) compared to the control plants which gave the lowest length of the flower stalk amounted to (28.17 cm). As for the effect of interaction between the spraying with Moringa leaves extract and zinc, where the plants that sprayed with Moringa leaves extract at a concentration of (10 g.L⁻¹) and zinc at a concentration of (60 mg.L⁻¹) have excelled by giving them the highest length of flower stalk amounted to (46.90 cm) compared to the control plant which gave the lowest length of the flower stalk amounted to (34.16 cm). As for the bi-interaction between the extract of fenugreek seeds soak and zinc, where the plants sprayed with the extract of fenugreek seed soak at a concentration of (6 g.L⁻¹) and zinc at a concentration of (60 mg.L⁻¹) have excelled by giving them the highest length of flower stalk amounted to (45.10 cm) compared to the control plants which gave the lowest length of the flower stalk amounted to (29.57 cm). As for the triple interaction, it had a significant effect on this trait. It is noted from the same table the plants that

were sprayed with the Moringa leaves extract at a concentration of (10 g.L⁻¹) and fenugreek seed soak at a concentration of (6 g.L⁻¹) and zinc at a concentration of (60 mg.L⁻¹) gave the highest length of flower stalk amounted to (51.40 cm) compared to the control plants which gave the lowest length of the flower stalk amounted to (20.20 cm). The same table also showed that the plants that sprayed with Moringa leaves extract at a concentration of (5 or 10 g.L⁻¹) were significantly excelled in the diameter of their flower stalk, which amounted to (4.21, 4.32 mm) respectively, compared to the control plants whose diameter of flower stalk amounted to (3.94 mm). As for the effect of spraying with the fenugreek seeds soak, The plants that sprayed with the extract of the fenugreek seeds soak at a concentration of (6, 3 g.L⁻¹) have excelled by giving them the highest diameter of flower stalk, which amounted to (4.31, 4.16) compared to the control plants that gave the lowest diameter of flower stalk which amounted to (4.00 mm). The plants that sprayed with zinc at a concentration of (60 mg.L⁻¹) were significantly excelled in the diameter of the flower stalk, which amounted to (4.22 mm) compared to the control plants which amounted to (4.09 mm). It was observed that bi-interaction had a significant effect, where the plants that sprayed with Moringa leaves extract at a concentration of (5 g.L⁻¹) and the extract of fenugreek seed soak at a concentration of (6 g.L⁻¹) were characterized by giving them the highest diameter of flower stalk amounted to (4.67 mm) compared to the control plants which gave the lowest diameter of flower stalk amounted to (3.47 mm). As for the bi-interaction between Moringa leaves extract and Zinc, it has a significant effect, where the plants that were sprayed with Moringa leaves extract at a concentration of (10 g.L⁻¹) and zinc at a concentration of (60 mg.L⁻¹) were characterized by giving them the highest diameter of flower stalk amounted to (4.37 mm) compared to the lowest diameter of flower stalk amounted to (3.75 mm) for the control plants. The bi-interaction has a significant effect, where the

plants sprayed with the extract of the fenugreek seeds soak at a concentration of (6 g.L^{-1}) and zinc extract at a concentration of (60 mg.L^{-1}) were significantly excelled by giving them the highest diameter of flower stalk amounted to (4.34 mm) compared to the control plants that gave the lowest diameter of flower stalk amounted to (3.87 mm). Triple interaction had a significant effect in this trait, where the plants

that sprayed with Moringa leaves extract at a concentration of (10 g.L^{-1}) and fenugreek seed soak at a concentration of (3 g.L^{-1}) and zinc at a concentration of (60 mg.L^{-1}) have excelled by giving them the highest diameter of flower stalk amounted to (4.71 mm) compared to the control plants that gave the lowest diameter of flower stalk amounted to (2.73 mm).

Table 6: Effect of spraying with Moringa leaves extract, Fenugreek seed, and Zinc, and their interactions on the length of the flower stalk (cm) and the diameter of flower stalk (mm) for Gerbera plant.

Moringa leaves extract (g.L^{-1})	Fenugreek seed extract (g.L^{-1})	The length of the flower stalk (cm)			The diameter of flower stalk (mm)		
		Zinc (mg.L^{-1})		Moringa \times Fenugreek seed	Zinc (mg.L^{-1})		Moringa \times Fenugreek seed
		0	60		0	60	
0	0	20.20	36.13	28.17	2.73	4.22	3.47
	3	41.53	40.63	41.08	4.58	3.93	4.25
	6	40.73	40.80	40.77	3.96	4.22	4.09
5	0	34.33	43.97	39.15	4.43	3.86	4.15
	3	36.27	35.07	35.67	3.72	3.93	3.83
	6	37.03	43.10	40.07	4.63	4.71	4.67
10	0	34.17	44.70	39.43	4.44	4.30	4.37
	3	43.53	44.60	44.07	4.10	4.71	4.41
	6	36.77	51.40	44.08	4.25	4.09	4.17
				The average effect of Moringa			The average effect of Moringa
Moringa \times Zinc	0	34.16	39.19	36.67	3.75	4.12	3.94
	5	35.88	40.71	38.29	4.26	4.17	4.21
	10	38.90	46.90	42.53	4.26	4.37	4.32
				The average effect of Fenugreek seed			The average effect of Fenugreek seed
Fenugreek seed \times Zinc	0	29.57	41.60	35.58	3.87	4.13	4.00
	3	40.44	40.10	40.27	4.13	4.19	4.16
	6	38.18	45.10	41.64	4.28	4.34	4.31
The average effect of zinc		36.06	42.27		4.09	4.22	
L.S.D. 0.05							
Trait	Moringa	Fenugreek seed	Zinc	Moringa \times Fenugreek seed	Moringa \times Zinc	Fenugreek seed \times Zinc	Moringa \times Fenugreek seed \times Zinc
Number of leaves	1.79	1.79	1.46	3.11	2.54	2.54	4.39
leaf area	0.014	0.014	0.011	0.024	0.019	0.019	0.034

Table (7) shows the significant effect for spraying with Moringa leaves extract, where the

plants that sprayed with Moringa leaves extract at a concentration of (5 or 10 g.L^{-1}) were

significantly excelled in increasing flower diameter which amounted to (11.84, 11.78 cm), respectively, compared to the control plants, where the average diameter of their flowers amounted to (10.89 cm). The plants sprayed with the extract of fenugreek seed soak at a concentration of (6 g.L⁻¹) were significantly excelled in increasing the flower diameter amounted to (12.26 cm) compared to the plants that gave the lowest flower diameter amounted to (11.18, 11.07 cm). The plants sprayed with the extract of fenugreek seed soak at a concentration of (6 g.L⁻¹) were significantly excelled in increasing the flower diameter which amounted to (12.26 cm) compared to the control plants that gave the lowest flower diameter amounted to (11.18, 11.07 cm). The plants that were sprayed with the same extract but at a concentration of (3 g.L⁻¹). As for spraying with zinc, it had no significant effect on this trait. The bi-interaction had a significant effect on the trait of flower diameter, where the plants that were sprayed with the Moringa leaves extract at a concentration of (10 g.L⁻¹) and the extract of fenugreek seed soak at a concentration of (6 g.L⁻¹) gave the highest flower diameter amounted to (12.48 cm) compared to the plants that gave lowest flower diameter amounted to (8.97 cm). As for the interaction between the Moringa leaves extract and the zinc, it had a significant effect, where the plants that sprayed with Moringa leaves extract at a concentration of (10 g.L⁻¹) were characterized by giving them the highest flower diameter amounted to (11.94 cm) compared to the control plants that gave the lowest diameter of flowers amounted to (10.73 cm). The table also showed that the bi-interaction between spraying with the extract of fenugreek seeds soak and zinc had a significant effect, where the plants that sprayed with the extract of fenugreek seeds soak at a concentration of (6 g.L⁻¹) have excelled by giving them the highest diameter of flowers amounted to (12.49 cm) compared to the lowest flower diameter amounted to (10.86 cm), for the control plants. As for the triple interaction, it had

a significant effect on this trait, where the plants that were sprayed with Moringa leaf extract at a concentration of (10 g.L⁻¹) and the extract of fenugreek seed soak at a concentration of (6 g.L⁻¹) were characterized by giving them the highest flowers diameters amounted to (12.83 cm) compared to the control plants that gave the lowest flower diameter amounted to (7.47 cm). Table (7) shows the significant increase in the number of flower petals for plants that sprayed with Moringa leaves extract at a concentration of (5 or 10 g.L⁻¹) which amounted to (52.28, 53.50 petals.plant⁻¹), which enabled them to excelling significantly on the control plants which amounted to (48.72 petals.plant⁻¹). The plants that sprayed with the extract of fenugreek seed soak at a concentration of (3 or 6 g.L⁻¹) were significantly excelled, where the average number of their flower petals amounted to (52.67, 52.67 petals.flower⁻¹), which did not differ significantly between them in the number of their flower petals, but they were significantly excelled on the control plants, where the number of their flower petals amounted to (49.17 petals.flower⁻¹). The plants that sprayed with zinc at a concentration of (60 mg.L⁻¹) were also characterized by giving them the highest number of petals amounted to (53.56 petals.flower⁻¹) compared to the control plants that gave the lowest number of petals amounted to (49.44 petals.plant⁻¹). As for the bi-interaction between spraying with Moringa leaves extract and the extract of fenugreek seed soak, it had a significant effect on the number of petals, where the plants that sprayed with Moringa leaves extract at a concentration of (10 g.L⁻¹) were characterized by giving them the highest number of petals in their flowers amounted to (54.83 petals.flower⁻¹) compared to the lowest petals were In the control plants, which amounted to (41.67 petals.flower⁻¹). The bi-interaction had a significant effect, where the plants sprayed with Moringa leaves extract at a concentration of (10 g.L⁻¹) and zinc at a concentration of (60 mg.L⁻¹) gave the highest number of petals in their flowers amounted to (56.56 petals.flower⁻¹)

compared to the plants that gave the lowest number of petals in flower amounted to (46.22 petals.flower⁻¹). As for the bi-interaction between the extract of fenugreek seeds soak and zinc, it had a significant effect in this trait, where the plants that sprayed with the extract of fenugreek seed soak at a concentration of (6 g.L⁻¹) and zinc at a concentration of (60 mg.L⁻¹) were characterized by giving them the highest number of petals amounted to (54.00 petals.flower⁻¹) compared to the control plant that gave the

lowest number of petals amounted to (45.22 petals.flower⁻¹). As for the triple interaction, the plants that sprayed with Moringa leaves extract at a concentration of (10 g.L⁻¹), the extract of fenugreek seed soak at a concentration of (6 g.L⁻¹) and zinc at a concentration of (60 mg.L⁻¹) have excelled by giving them in the highest number of petals amounted to (58.67 petals.flower⁻¹) compared to the control plants that gave the lowest number of petals amounted to (32.67 petals.flower⁻¹).

Table 7: Effect of spraying with Moringa leaves extract, Fenugreek seed, and Zinc, and their interactions on the diameter of flower (cm) and the number of flower petals (petals.flower⁻¹) for Gerbera plant.

Moringa leaves extract (g.L ⁻¹)	Fenugreek seed extract (g.L ⁻¹)	The diameter of flower (cm)			The number of flower petals (petals.flower ⁻¹)		
		Zinc (mg.L ⁻¹)		Moringa × Fenugreek seed	Zinc (mg.L ⁻¹)		Moringa × Fenugreek seed
		0	60		0	60	
0	0	7.47	10.47	8.97	32.67	50.67	41.67
	3	12.27	11.07	11.67	53.67	52.33	53.00
	6	12.47	11.60	12.03	52.33	50.67	51.50
5	0	12.60	11.67	12.13	48.33	53.67	51.00
	3	10.47	11.77	11.12	53.67	52.33	53.00
	6	12.17	12.37	12.27	53.00	52.67	52.83
10	0	12.50	11.70	12.10	54.67	55.00	54.83
	3	10.50	11.00	10.75	48.00	56.00	52.00
	6	12.83	12.13	12.48	48.67	58.67	53.67
				The average effect of Moringa			The average effect of Moringa
Moringa × Zinc	0	10.73	11.04	10.89	46.22	51.22	48.72
	5	11.74	11.93	11.84	51.67	52.89	52.28
	10	11.94	11.61	11.78	50.44	56.56	53.50
				The average effect of Fenugreek seed			The average effect of Fenugreek seed
Fenugreek seed × Zinc	0	10.86	11.28	11.07	45.22	53.11	49.17
	3	11.08	11.28	11.18	51.78	53.56	52.67
	6	12.49	12.03	12.26	51.33	54.00	52.67
The average effect of zinc		11.47	11.53		49.44	53.56	
L.S.D. 0.05							
Trait	Moringa	Fenugreek seed	Zinc	Moringa × Fenugreek seed	Moringa × Zinc	Fenugreek seed × Zinc	Moringa × Fenugreek seed × Zinc
Number of leaves	0.47	0.47	NS	0.82	0.67	0.67	1.15
leaf area	0.98	0.98	0.80	1.69	1.38	1.38	2.40

The significant increase in the number of leaves when spraying it with the extract of Moringa leaves may be due to the increase in this trait to the nutrient content of this extract sufficiently due to the plants' need for the processes of division and elongating the cells and the consequent effect on the absorption of water and nutrients that increase the vegetative growth (6). Or, the reason may be attributed to the fact that Moringa leaves extract contains growth-promoting substances such as vitamin (B1, B2, and B3), which have an important role in carbohydrate metabolism and building amino acids that are the basic units for building proteins, which is reflected positively in increasing growth, the number of leaves per plant, and leaf area, this result agrees with (21) on garlic plant. The increase in the number of total leaves per plant when treating it with the extract of fenugreek seed soak may be due to its number in the compounds encouraging growth (B1 and B2), which enter as co-enzymatic in the biological processes, concentration of nutrients, accumulation, and transfer of nutrients to new tissues, which positively affected the increase in the number of the total leaves for the plant, or perhaps the reason for the increase in the number of leaves when treated with the extract of fenugreek seed soak is due to the presence of the necessary macro and micronutrients in it that activate the biological and metabolic processes that take place inside the plant and increase its effectiveness to conduct photosynthesis that leads to increase vegetative growth (3). The increases in the leaf area when treating it with the extract of fenugreek seed soak may be attributed to the fact that it contains iron and its role in increasing the efficiency of photosynthesis as well as its role in stimulating a number of enzymes involved in many physiological processes (3). This has led to an increase in the products of photosynthesis, thus providing a high store of materials, which reduced the state of competition between parts of a single plant and orienting it towards providing a better opportunity for the growth and formation

of buds and cells, which led to an increase in the leaf area (12). This result agrees with (11) in their study on the common snapdragon plant and (5) on the Freesia plant. The spraying with Moringa leaves extract at two concentrations led to prolonging the flowering period for the plant due to the fact that these treatments caused increase photosynthesis and production of carbohydrates and as a result of improving the vegetative traits represented by increasing the number of leaves and the leaf area as shown in Table (4), Which reflected positively to prolong the flowering period and that the increase in the length of the flower stalk as a result of spraying plants with the Moringa leaves extract is due to what this extract contains from a high percentage of nutrients as well as vitamins and amino acids where it improved the traits of vegetative growth and it was positively reflected in increasing the length and diameter of the flower stalk. Likewise, the superiority of these treatments is due to the contents of the Moringa leaves extract, which led to improve the traits of vegetative growth as shown in Table (4), which speeds up the encouragement of the growth and development of flower buds (12) Or perhaps the reason is due to the improvement of the traits of vegetative growth due to spraying the extract, this led to an increase in the accumulation and products of photosynthesis and containing the extract of sugars, which led to the production of carbohydrates and proteins that stimulate the emergence of flower buds and flowers as shown in Table (5). where considered the sink parts, which increased the number of petals and flower diameter as shown in table (7) or perhaps the reason is due to the role of the elements involved in the composition of this extract in stimulating the work of enzymes as well as cell division and building proteins, thus an increase in the manufacture of nutrients that help in growth of plant tissue, and that reflected positively in giving the best flowering (20). As for spraying the extract fenugreek seed soak on the Gerbera plant, it led to a significant increase in all traits of flower growth. The reason may be due to the

role of the extract of fenugreek seed soak in promoting vegetative growth because it contains many nutrients and vitamins that play an important role in regulating cell division and increasing the expansion of plant cells, which leads to increase the size of the total vegetative (25), through affecting many physiological processes such as photosynthesis, respiration, and energy production, as well as regulating the activity of hormones and stimulating them to influence bioactivities, which leads to stimulating the transformation of vegetative buds into flower buds, so it speeds up the flowering or perhaps the reason is due to the role of this extract and its organic compounds and mineral elements (potassium, phosphorus, magnesium, micronutrients Fe, Zn, Cu, Mn, etc.), these elements have a role in activating enzymes for different growth activities, including photosynthesis, as well as the entry of mineral elements in the composition of Nucleic acids (RNA and DNA) necessary for cell division, which reflected positively in improving most traits of flower growth represented by the length of flowering period, the number of petals and flower diameter, and this result agrees with both (11) in their study on the common snapdragon plant and (5) on the Freesia plant. Spraying plants with zinc at a concentration of (60 mg.L^{-1}) led to a significant increase in the indicators of flower growth, represented (length of the flowering period, length and diameter of the flower stalk, number of flowers and number of petals). It is due to the role of zinc in building the amino acid (Tryptophan), which is the main material for building the natural hormone (indole acetic acid (IAA)), which is important in the expansion and elongation of plant cells (29), which has a role in the formation of amino acids, carbohydrates and energy compounds in addition to its importance in the formation of RNA and DNA and building of protein (16). Or the reason is that these treatments caused an increase in photosynthesis and increasing leaves content of carbohydrates, which helped absorb the largest possible amount of water and nutrients. These

factors all helped to improve the indicators of flower growth. This result agrees with (8) in their study on rose plants and (9) on the *Jasminum sambac* plant.

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