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ORIGINAL ARTICLE

EFFECT OF FOLIAR SPRAYING WITH PLANT EXTRACTS ON THE VEGETATIVE AND FLOWERING GROWTH OF *TAGETES ERECTA* L.

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Abstract: This study was conducted in one of the nurseries of Basra province (Karma Ali municipality nursery) 2019-2020. To know the effect of the aqueous extracts of the rhizomes of ginger, cinnamon and the interaction between them in the vegetative, flowering growth and the content of fresh flowers of beta-Carotene and lutein pigment of *Tagetes erecta* L., the following results were shown: The treatment of spraying with aqueous extract of ginger rhizomes at a concentration of 5 g/L gave the best results in plant height, the number of branches, percentage of dry matter of the vegetative total, as well as all flowering traits, as well as the content of flowers of the pigments beta-Carotene and lutein. Plants treated with cinnamon extract at a concentration of 5 g/L and 2.5 g/L excelled in plant height, number of branches, as well as the percentage of dry matter of the Vegetative growth. The results also gave a significant increase for the traits of the flowering group and the beta-Carotene and lutein pigments at a concentration of 5 g/L. The bi-interaction of both ginger and cinnamon rhizomes significantly excelled for both plant height at a concentration of 2.5 g/L for ginger rhizomes and 5 g/L for cinnamon treatment. Whereas, the effect of the bi-interaction of ginger rhizomes at a concentration of 2.5 g/L and cinnamon at a concentration of 5 g/L increased the flower content of the lutein dye, as well as the effect of the bi-interaction with a concentration of 5 g/L of ginger and cinnamon in all the remaining vegetative and flowering traits.

***Key words*:** Foliar spraying, Vegetative growth, *Tagetes erecta* L., Randomized complete block design (R.C.B.D.)

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1. Introduction

The Marigold plant (*Tagetes ereta* L.) belongs to the Asteraceae family and it is considered one of the annual plants common in our gardens and its cultivation is successful in all parts of Iraq [Al-Sultan *et al*. (1992)]. The plant is used in garden coordination, where some short Marigold cultivars are grown, such as pot plants or as determinants of flower borders. As for medium or tall cultivars, they are grown as a bedding plant and Marigold flowers are cut flowers, especially the perennial ones [Gilman and Howe (1999)]. In addition to the coordination and aesthetic value of this plant, it is an important source for many compounds used in the medical field that are used in the pharmaceutical industries, which contributed to the re-evaluation of the medical study of this plant, as it was found that Marigold flowers contain carotenoids that have been used for years in the food industry to color food, drinks and dairy products. The plant also contains volatile oils that are used in the manufacture of perfumes, cosmetics and soaps**.** There are many factors that affect plant growth, such as the use of fertilizers and growth regulators and due to the negative effects of such materials on increasing pollution of the environment and soil in the long run, the trend has been towards the use of natural (plant) extracts that are safe to grow and increase flower production due to the mineral elements contained in these extracts, vitamins, growth regulators and to determine the effectiveness of the aqueous extracts of ginger and cinnamon rhizomes, then use them to find

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out their effect on the growth and production of flowers of Marigold plant, due to the ease of obtaining such plants and their low cost and the lack of studies on each of them regarding the effect of such extracts on the Marigold plant, where the chemical analysis indicates that ginger contains effective compounds, vitamins and volatile oils, as many studies have shown that the initial disclosures contain carbohydrates, flavonoids and phenols [Muhammad (2012)]. Jagetia *et al*. (2003) also indicated that ginger contains gels, starchy substances, phenols and some vitamins such as (B) and vitamin (C) in addition to the essential oil and Thamer *et al*. (2010) showed that dry ginger rhizome powder at concentrations 4, 8, 12 g/kg soil played a significant role in the significant increase in the elongation of the vegetative system and the dry and fresh weight of the vegetative total at concentrations 8 and 12 g/kg as well as in the leaf area and the number of leaves of *Triticum aestium* L.. Al-Qaisi *et al*. (2013) also explained in a study on the effect of aqueous ginger extract on the number of chickpea plant increases at a concentration of 20% and 30% where the percentage increase in plant height was about 142% and 123% for both concentrations, respectively. The chemical composition of ginger rhizomes contains 3-6% fat, 9% protein, 60-70% carbohydrates, 3-8% coarse fiber, about 8% ash and 12% water, in addition to many minerals, which are iron, calcium, phosphorous and some vitamins like Niacin and Riboflavin and Thiamine, vitamin G and C, the average of containing ginger from volatile oils is 2-3% in addition to its containment of other compounds [Abdel Wahid (2006)]. Also, the qualitative chemical detection of some active compounds of the aqueous extract of cinnamon bark showed that it contains glycosides, tannins, resins, soaps and phenols [Hashem *et al*. (2008)]. The results of the gas chromatographic analysis showed that cinnamon oil contained 22 chemical compounds, but the main components were BenZaldehyte, Benzoic acid, Benzylalcohol and Cinamaldehyde, but the highest percentage was Cinamaldehyde [Ali *et al*. (2007)].

2. Materials and Methods

This study was conducted in one of the nurseries of Basra province (Karma Ali municipality nursery) for the year 2019-2020, to study the effect of aqueous extracts of ginger and sepals (cinnamon) on vegetative, flowering growth and the flower content of lutein and beta-carotene pigment. The seeds were grown in cork dishes on 10/15/2019 and the seedlings were transferred after about a month on 11/15/2019 to plastic anvils with a diameter of 20 cm, filled with soil consisting of peat moss and river soil. All service operations were performed from irrigation whenever the need arises.

2.1 Experiment treatments

The research included a study of the effect of two factors: aqueous extract of ginger rhizomes with a concentration of 0, 2.5, 5 g/L and aqueous extract of cinnamon extract at a concentration of 0, 2.5, 5 g/L, where the plants were sprayed until complete wetness twice between one spray and another for 21 days and the first spray was a month after cultivation. The aqueous extracts for rhizomes of ginger and cinnamon were prepared according to the method of Harborne (1984). The content of fresh flowers from beta-Carotene and lutein in the spices of fresh Marigold flowers was estimated according to the method of Abbas and Abbas (1992).

2.2 Experimental design

The factorial experiment was conducted according to the Randomized complete block design (R.C.B.D.). The experiment included an interaction between the two rhizomes of ginger and cinnamon and with three replications and five plants per treatment. The statistical analysis of the results was done using the Genstat 2013 program and the averages were compared according to the L.S.D. test at a probability level of 0.05 [Alrawi and Khalaf Allah (1980)].

2.3 Studied traits

1. Plant height (cm).
2. Number of branches/plant: all branches were calculated on the main stem.
3. The percentage of dry matter for vegetative growth.
4. Number of flowers/plant: The total number of flowers formed on the plant was calculated.
5. Flower Diameter/cm: Measure the diameter between the two farthest consecutive points on the flower, using Vernier when flowering.
6. The flowering period on the plant (day): The number of days that the flower remained on the plant until it wilted was calculated.
7. The flower content of beta-Carotene pigment mg/100g.
8. The flower content of gluten pigment mg/100 gm.

Table 1: The effect of spraying with extract of rhizomes of ginger and cinnamon and the interaction between them on the trait of the Plant height (cm) of the Marigold plant.

Concentrations of ginger rhizomes ($g.L^{-1}$)	Cinnamon concentrations ($g.L^{-1}$)			The average effect of ginger rhizomes
	0	2.5	5	
0	28.83	35.33	40.5	34.89
2.5	30.67	43.33	46.5	40.17
5	34.67	39.17	42.33	38.72
The average effect Cinnamon concentrations ($g.L^{-1}$)	31.39	39.28	43.11	
L.S.D 0.05	Ginger rhizomes = 2.784	Cinnamon Concentrations = 2.784	Interaction = 4.823	

3. Results

3.1 Plant height (cm)

Table 1 showed that the use of ginger rhizomes with both concentrations of 2.5 and 5 g/L gave a significant increase in the height of Marigold plant compared to the untreated plants at the time that there were no significant differences between them. The results also showed a significantly excellence for the treated plants with a concentration of 5 g/L compared to the treated plants with a concentration of 2.5 g/L and the untreated plants. Also, the treated plants at a concentration of 2.5 g/L gave a significant increase in the plant height compared to the untreated plants (Table 1). As for the interaction, the treatment of ginger rhizomes with a concentration of 2.5 and the treatment of cinnamon at a concentration of 5 g/L gave the highest results compared to the rest of the treatments, which reached 46.50 cm. Whereas, the treatment of ginger and cinnamon rhizomes at a concentration of 0 g/L gave the lowest results of 28.83 cm in the plant height.

3.2 The number of lateral branches

The results in Table 2 showed that the plants treated with ginger Rhizomes at a concentration of 5 g/L recorded a significant increase in the rate of the number of branches compared with the plants treated at a concentration of 2.5 g/L, as well as the untreated plants in the trait of the number of branches of the Marigold plant. As for the average effect of cinnamon, the results of the same table showed that the plants treated with cinnamon at a concentration of 5 and 2.5 g/L gave a significant increase compared with the untreated plants in the number of lateral branches. As for the effect of the bi-interaction, the interaction treatment between ginger rhizomes at a concentration of 5 g and cinnamon at a concentration of 5 g/L also gave a significant increase in the number of lateral branches compared with the rest of the treatments studied.

3.3 The percentage of dry matter for the vegetative total

The treatment of Marigold plants with ginger rhizomes at a concentration of 5 and 2.5 g/L significantly increased the average percentage of dry matter for the vegetative total compared with the control plants (Table 3). The results also show that there was a significant increase in cinnamon at a concentration of 5 and 2.5 g/L sprayed on leaves compared with untreated plants. Statistical analysis of Table 3 data also showed a significantly excellence of the plants treated with a concentration of 5 g/L for each of the rhizomes of ginger and cinnamon compared with the rest of the treatments studied for bi-interference.

3.4 Number of flowers

The results in Table 4 showed a significantly excellence for sprayed plants with ginger rhizomes at

Table 2: The effect of spraying with extract of rhizomes of ginger and cinnamon and the interaction between them on the trait of the number of lateral branches of the Marigold plant.

Concentrations of ginger rhizomes ($g.L^{-1}$)	Cinnamon concentrations ($g.L^{-1}$)			The average effect of ginger rhizomes
	0	2.5	5	
0	4.25	6.50	7.58	6.11
2.5	4.50	7.83	8.17	6.83
5	5.25	7.50	9.33	7.36
The average effect Cinnamon concentrations ($g.L^{-1}$)	4.67	7.28	8.36	
L.S.D 0.05	Ginger rhizomes = 0.730	Cinnamon Concentrations = 0.730	Interaction = 1.264	

Table 3: The effect of spraying with extract of rhizomes of ginger and cinnamon and the interaction between them on the trait of the percentage of dry matter for the vegetative total of the Marigold plant.

Concentrations of ginger rhizomes ($g.L^{-1}$)	Cinnamon concentrations ($g.L^{-1}$)			The average effect of ginger rhizomes
	0	2.5	5	
0	16.00	20.33	23.33	19.89
2.5	16.00	20.33	24.00	20.11
5	23.67	21.67	25.00	23.44
The average effect Cinnamon concentrations ($g.L^{-1}$)	18.56	20.78	24.11	
L.S.D 0.05	Ginger rhizomes = 1.128	Cinnamon Concentrations = 1.128	Interaction = 1.953	

Table 4: The effect of spraying with extract of rhizomes of ginger and cinnamon and the interaction between them on the trait of the Number of flowers of the Marigold plant.

Concentrations of ginger rhizomes ($g.L^{-1}$)	Cinnamon concentrations ($g.L^{-1}$)			The average effect of ginger rhizomes
	0	2.5	5	
0	4.00	6.33	6.67	5.67
2.5	3.33	6.33	7.66	5.78
5	4.33	6.67	7.67	6.22
The average effect Cinnamon concentrations ($g.L^{-1}$)	3.89	6.44	7.33	
L.S.D 0.05	Ginger rhizomes = 1.078	Cinnamon Concentrations = 1.078	Interaction = 1.867	

a concentration of 5 g/L, reaching 6.22, compared with untreated plants and treated plants with a concentration of 2.5 g/L. As for the treatment of cinnamon, the results did not show significant differences between the concentration of 5 and 2.5 g/L in increasing the number of flowers, but it significantly excelled to that of untreated plants. The results, with the effect of bi-interaction, showed the highest results, reaching 7.33 for the treatment of ginger and cinnamon rhizomes at a concentration of 5 g/L. While the lowest results were 4.00 for ginger and cinnamon at a concentration of 0 g/L for both of them.

3.5 Flower diameter (cm)

The data in Table 5 showed that plants treated with ginger rhizomes at a concentration of 5 g/liter gave a significant increase in flower diameter compared with plants treated with a concentration of 2.5 g/L and control plants. Whereas, the plants treated with cinnamon, spraying the leaves at a concentration of 5 g/L showed a significant increase of 4.78 cm, while the lowest value for the flower diameter was for the untreated plants, which was 3.11 cm. The bi-interaction showed no significant differences between the two treatments of ginger at a concentration (2.5 and 5 g/L) and cinnamon at a concentration of 5 g/L. As, the bi-interaction treatment for rhizomes of ginger at a concentration of 2.5 g/L and cinnamon at a concentration of 5 g/L, but they excelled on the rest of the interaction treatments for the flower diameter trait of the same table.

3.6 The flowering period on the plant (day)

Table 6 showed significantly excelled of treatment with ginger rhizomes at a concentration of 5 g/L at the flowering period on the plant compared to the treated plants with a concentration of 2.5 g/L and control plants.

Table 5: The effect of spraying with extract of rhizomes of ginger and cinnamon and the interaction between them on the trait of the Flower diameter (cm) of the Marigold plant.

Concentrations of ginger rhizomes ($g.L^{-1}$)	Cinnamon concentrations ($g.L^{-1}$)			The average effect of ginger rhizomes
	0	2.5	5	
0	3.00	4.00	4.67	3.89
2.5	3.00	4.67	4.33	4.00
5	3.33	5.33	5.33	4.67
The average effect Cinnamon concentrations ($g.L^{-1}$)	3.11	4.67	4.78	
L.S.D 0.05	Ginger rhizomes = 0.572	Cinnamon Concentrations = 0.572	Interaction = 0.990	

Table 6: The effect of spraying with extract of rhizomes of ginger and cinnamon and the interaction between them on the trait of flowering period on the plant (day) of the Marigold plant.

Concentrations of ginger rhizomes ($g.L^{-1}$)	Cinnamon concentrations ($g.L^{-1}$)			The average effect of ginger rhizomes
	0	2.5	5	
0	11.67	13.33	14.50	13.17
2.5	13.00	15.25	17.00	15.80
5	12.50	17.25	19.00	16.25
The average effect Cinnamon concentrations ($g.L^{-1}$)	12.39	15.28	16.83	
L.S.D 0.05	Ginger rhizomes = 1.217	Cinnamon Concentrations = 1.217	Interaction = 2.108	

Table 7: The effect of spraying with extract of rhizomes of ginger and cinnamon and the interaction between them on the trait of flower content of beta-Carotene pigment (mg / 100 g) of the Marigold plant.

Concentrations of ginger rhizomes ($g.L^{-1}$)	Cinnamon concentrations ($g.L^{-1}$)			The average effect of ginger rhizomes
	0	2.5	5	
0	11.75	13.28	16.56	13.86
2.5	12.17	15.32	20.29	15.93
5	14.45	18.13	19.68	17.42
The average effect Cinnamon concentrations ($g.L^{-1}$)	12.79	15.58	18.85	
L.S.D 0.05	Ginger rhizomes = 1.664	Cinnamon Concentrations = 1.664	Interaction = 2.882	

It is also noted from the same table that the plants treated with cinnamon at a concentration of 5 g/L showed a significant increase in the age of the flower on the plant compared to the plants treated with a concentration of 2.5 g/L Cinnamon and untreated plants. The effect of the bi-interaction showed that there were significant differences in the flowering period on the plant between all treatments. As the treatment a concentration of 5 g/L for each of the rhizomes of ginger and cinnamon gave 19.00 (day) compared to the lowest result obtained from the control treatment, which was 11.67 (days). (Table 6).

3.7 The flower content of beta-Carotene pigment (mg/100 g)

The results in Table 7 showed a significant effect of the treatment of ginger rhizomes at a concentration of 5 and 2.5 g/L in increasing the flower content of beta-Carotene pigment to reach the highest percentage of 17.42 by treatment of ginger at a concentration of 5 g/L and the lowest percentage for the control plants, which reached 13.86. The highest percentage of beta-Carotene pigment was achieved by the effect of spraying with cinnamon at a concentration of 5 g/liter, reaching 18.85 mg/100 g, while the lowest percentage for the control treatment was 12.79 mg/100 g and the effect of the bi-interaction on the traits of the flower beta-Carotene pigment, where the highest percentage was 19.68 mg/100 g, for the interaction treatment between the rhizomes of ginger and cinnamon at a concentration of 5 g/L for both of them.

3.8 The flower content of lutein pigment mg/100 g

From Table 8, we note that there are significant differences between the spraying ginger rhizomes treatments on the Marigold plant. As treatment with

Table 8: The effect of spraying with extract of rhizomes of ginger and cinnamon and the interaction between them on the trait of flower content of lutein pigment mg / 100 g of the Marigold plant.

Concentrations of ginger rhizomes ($g.L^{-1}$)	Cinnamon concentrations ($g.L^{-1}$)			The average effect of ginger rhizomes
	0	2.5	5	
0	14.67	16.35	17.95	16.33
2.5	17.63	19.66	20.54	19.28
5	17.47	21.73	21.62	20.28
The average effect Cinnamon concentrations ($g.L^{-1}$)	16.59	19.25	20.04	
L.S.D 0.05	Ginger rhizomes = 0.920	Cinnamon Concentrations = 0.920	Interaction = 1.594	

ginger at a concentration of 5 g/L gave a higher result of 20.04 mg/100 g, with regard to the treatment of cinnamon, the results of the same table showed that there were no significant differences between the two treatments of cinnamon at a concentration of 5 and 2.5 g/L, which were significantly excelled to the untreated plants. Whereas, the bi-interaction with the two treatments of ginger and cinnamon gave the highest average content of fresh flowers for the lutein pigment, reaching 21.73 mg/100 g, for the treatment of ginger at a concentration of 5 g/L and cinnamon at a concentration of 2.5 g/L (Table 8).

4. Discussion

The results showed a significant increase in both the vegetative and flowering traits and beta-Carotene and lutein pigments when treating plants with ginger rhizomes. Perhaps the reason is because it contains secondary compounds that work to break down adenosine triphosphate (ATP) as well as inhibit the work of some plant growth regulators such as Auxin, responsible for cell division and elongation, which affected the increase in plant height, as for the increase in the number of branches. As the chemical analysis indicated that it contains many effective compounds and vitamins that play a major role in their effects on vegetative and flowering growth by increasing the strength and activity of plant growth and improving its flowering traits represented by pigments [Muhammad (2012)], as for cinnamon the results showed the role that cinnamon plays in stimulating growth by containing the aqueous extract of cinnamon containing growth-promoting vitamins such as vitamin B12, B3, B1, B2 in addition to containing many elements such as zinc, manganese and Iron, phosphorous, potassium and selenium which positively affects the increase in vegetative and flowering growth. These results were in agreement with Thamer *et al*. (2010) on the vegetative growth of the wheat plant.

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