Iraqi Journal of Market Research and Consumer Protection
(2026) 18(1): 56-68.
DOI: http://dx.doi.org/10.28936/jmracpc18.1.2026.(6)
Al-Badri & Al-Amrani

المجلة العراقية لبحوث السوق
وحماية المستهلك

THE FLOWER YIELD OF MARIGOLD *CALENDULA OFFICINALIS* PLANT AND THE CONTENT OF CAROTENOIDS AND TOTAL PHENOLICS UNDER THE INFLUENCE OF SPRAYING WITH MORINGA LEAF EXTRACT AND YEAST AND ADDITION OF HUMIC ACID

Saja N. Al-Badri[1] *, ***Hussein A. Al-Amrani***[2]

[1]Department of Horticulture and Landscape, College of Agricultural Engineering Sciences, University of Baghdad, Baghdad, Iraq. Saja.Najeeb1105a@coagri.uobghdad.edu.iq
[2]Assistant Professor, Unit of Medical and Aromatic Plants Research, College of Agricultural Engineering Sciences, University of Baghdad, Baghdad, Iraq. Hussain.hamem@coagri.uobghdad.edu.iq

Received 1/ 4/ 2024, Accepted 2/ 5/ 2024, Published 31/ 3/ 2026

ABSTRACT

A field experiment was carried out at College of Agricultural Engineering Sciences - University of Baghdad, during the fall seasons of 2021-2022 and 2022-2023. The aim of study the effect of foliar spraying with moringa extract and yeast, and the addition of humic acid was determi need, on the flower yield, carotenoids content, and total phenolics. A factorial experiment within a Randomized Complete Block Design (RCBD) with three replicates. Was implemeuted The study included three factors: foliar spraying with moringa leaf extract at concentrations of 0%,4%, 6% and 8% (M0-M1-M3-M2), yeast suspension at concentrations of 0 g L^{-1} , 5 g L^{-1} and 10 g L^{-1} (Y0-Y1-Y2), and adding humic acid at concentrations of 0 ml L^{-1} and 5 ml L^{-1} (H0-H1). Additionally, a control treatment (M0Y0H0) was included. The results showed a significant superiority of the interaction treatment M3Y2H1 in flower number, flower diameter, fresh flower yield, dry flower yield, carotenoid content, and total phenolics. Specifically, it recorded 37.43 flower $plant^{-1}$, 7.960 cm, 571.3 kg ha^{-1}, 78.81 kg ha^{-1}, 168.6 mg 100 g^{-1}, and 156.7 mg 100 g^{-1} for the first season and 35.15 flower plant-^{1}, 7.950 cm, 523.2 kg ha^{-1}, 72.33 kg ha^{-1}, 164.5 mg 100 g^{-1}, and 155.1 mg 100 g^{-1} for the second season, respectively, compared to the control treatment.

Keywords: Plant Extracts, Organic Farming, Plant Pigments, Antioxidants

***The article is taken from the doctoral thesis of the first researcher.**

الحاصل الزهري لنبات الاقحوان *Calendula officinalis* ومحتواه من الكاروتينات والفينولات الكلية تحت تأثير الرش بمستخلص المورنجا والخميرة واضافة حامض الهيومك

سجى نجيب عبد الرزاق البدري [1] **،** ***حسين عنيد هميم العمراني*** [2]

[1] كلية علوم الهندسة الزراعية، جامعة بغداد، بغداد، العراق، Saja.Najeeb1105a@coagri.uobghdad.edu.iq

[2] الاستاذ المساعد، كلية علوم الهندسة الزراعية، جامعة بغداد، بغداد، العراق، Hussain.hamem@coagri.uobghdad.edu.iq

الخلاصة

أُجري البحث في المحطة البحثية A التابعة الى كلية علوم الهندسة الزراعية، جامعة بغداد في الموسمين الخريفي 2021-2022 و 2022-2023 بهدف دراسة تاثير الرش بمستخلص المورنجا والخميرة واضافة حامض الهيومك على الحاصل الزهري لنبات الاقحوان ومحتواه من الكاروتينات والفينولات الكلية ، نفذ البحث كتجربة عاملية ضمن تصميم R.C.B.D. بثلاث مكررات ضمت ثلاثة عوامل للدراسة هي الرش الورقي بمستخلص أوراق المورينجا بالتركيز 4-6-8 % (M_3-M_2-M_1) فضلا عن معاملة القياس M0 على الترتيب، ومعلق الخميرة بالتركيز 5-10 غم لتر $^{-1}$ (Y_2-Y_1) فضلا عن المعاملة بدون رش Y0على الترتيب واضافة حامض الهيومك وبتركيزين 0-5 مل لتر $^{-1}$ (H1-H0) على الترتيب، اظهرت النتائج تفوقا معنويا لمعاملة التداخل M3Y2H1 في عدد الازهار وقطر الزهرة والحاصل الطري للازهار والحاصل الجاف للازهار والكاروتين والفينولات الكلية وسجلت 37.43 زهرة نبات $^{-1}$ و 7.960 سم و571.3 كغم هكتار $^{-1}$ و78.81 كغم هكتار $^{-1}$ و168.6 ملغم 100 غم $^{-1}$ و156.7 ملغم Gallic 100غم $^{-1}$ للموسم الأول و 35.15 زهرة نبات $^{-1}$ و 7.950 سم و523.2 كغم هكتار $^{-1}$ و72.33 كغم هكتار-1 و164.5 ملغم 100 غم و155.1 ملغم Gallic 100غم-1 للموسم الثاني بالتتابع مقارنة بمعاملة القياس.

الكلمات المفتاحية: مستخلصات نباتية، الزراعة العضوية، صبغات نباتية، مضادات اكسدة.

INTRODUCTION

Calendula officinalis, commonly known as marigold, is a perennial herbaceous plant belonging to the Asteraceae family. Marigold is one of the most widely used medicinal plants and is extensively cultivated worldwide (**Baghchejooghi *et al.*, 2023**) Its native habitat includes Western Asia, Central and Southern Europe, as well as the United States. Marigold is grown globally for ornamental purposes, as cut flowers and potted plants. Additionally, its flowers are valued for pharmaceutical, biological, medicinal, herbal, and cosmetic purposes (**Szopa *et al.*, 2020**). Researching natural antioxidants to replace synthetic ones is a health priority for humanity. Marigold plants contain phenolic and flavonoid compounds that act as natural antioxidants. Extracts from marigold flowers offer a promising source of natural antioxidants (**Chroho *et al.*, 2021**). recent years, plant extracts have garnered widespread interest for their use in plant nutrition and their positive effects in enhancing growth (Rafiee et al., 2016). Moringa leaf extract, in particular, has gained attention as an environmentally safe, easily prepared, and cost-effective alternative source of nutrients. It is rich in protein, essential amino acids, and minerals, making it a good substitute for non-organic fertilizers (**Al-Taweel & Al-Anbari, 2019; Ibrahim & Ameen, 2017; Saini *et al.*, 2016**). It also serves as a primary source of calcium, potassium, vitamins, zinc, magnesium, iron, copper, proteins, carotenoids, amino acids, sulfur, and various phenolic compounds (**Salman & Abdul Rasool, 2022b; Daghaghele *et al*., 2021; Mehwish *et al*., 2021). Jan et al., (2022**) found that foliar spraying with moringa leaf extract could enhance the vegetative and floral growth of Antirrhinum majus (Snapdragon) using various concentrations (0%,10%,20%,30%). The treatment with 30% concentration exhibited the highest plant height, leaf number per plant, stem diameter, flower number, flowering duration, and flowering age compared to the control treatment. **Salman & Abdul-Qader (2023)** found that foliar spraying of Pelargonium graveolens L. with moringa leaf extract at a concentration of 10 g L-1 led to a significant increase in most of the vegetative and root traits. These traits included stem diameter, branches numbers, leaves number, leaf area, fresh and dry weight of the shoot, leaf chlorophyll content, root length and dry weight, number of primary root branches, plant active compounds, yield, and the percentage of essential oil. additionally, yeast was used to further enhance the production and processing of growth regulators (**Al-Asadi, 2018**).

Essaa (2023) found in a study on marigold plants that foliar spraying with a yeast suspension at a concentration of 6 mg/L resulted in significant superiority. however, this concentration significantly delayed flowering. this delay in flowering significantly enhanced plant height, number of lateral branches, number of leaves, percentage of plant dry matter, flowers number, petals number, flower diameter, flower stalk length, percentage of flowers dry matter, and content of some active substances in flowers.

AL-Asdi (2014) concluded that foliar spraying of marigold plants Calendula officinalis L. with a yeast suspension at a concentration of 4 g L-1 and a rate of three applications achieved a significant increase in plant height, leaves number, leaf area, flowers number, and flower diameter .

It is important to study and develop strategies and methodologies to maintain the sustainability of plant production. This includes the use of selected organic biofertilizers, such as humic acid, to achieve higher levels of quality and yield in sustainable agricultural practices (**Zaferanchi *et al*., 2020**).

Al-Zubaidi & Al-Hasnawi (2021) found that marigold plants treated with humic acid surpassed those in the control group. specifically, at a concentration of 6 ml L-1, they exhibitated the highest average plant height, number of leaves, leaf area, number of flowers, flower diameter, and flower stalk length compared to the control treatment.

Shaabani et al., (2022) confirmed the significant effects exhibited by Calendula officinalis L. 'Mandarin' plants when treated with humic acid at concentrations of 0, 200, 400, and 600 mg L-1. The study observed significant effects on chlorophyll a, total chlorophyll, carotenoids, relative water content in flowers, and flower count at a 1% probability level.

flavonoids and chlorophyll b also showed significant effects at a 5% probability level. Based on these findings, the study aimed to work within a sustainable farming system to improve the flower yield of marigold plants and their content of carotenoids and total phenolics under the influence of foliar spraying with moringa leaf extract, yeast, and addition of humic acid.

MATERIALS AND METHODS

The experiment was conducted in the open field during the fall seasons of 2021 and 2022 at Research Station A, College of Agricultural Engineering Sciences, University of Baghdad, on marigold plants (W-Blak variety). Seeds were sown in the nursery to obtain homogeneous seedlings, were then transplanted to the open field on December 29, 2021, for the first season, and December 29, 2022, for the second season. The plants were planted in rows spaced 30 cm apart and 22 cm between plants, with a density of 20 plants per experimental unit. The experiment was factorial with three factors within a Randomized Complete Block Design (RCBD) with three replications, including moringa extract at concentrations of 4%, 6%, and 8% (denoted as M0,M1, M2, and M3, respectively) (**Mohammed & Majeed, 2023**), yeast suspension at concentrations of 5 g L-1 and 10 g L-1 (represented by Y1 and Y2, respectively) (**Essaa, 2023; Malik & Almrani, 2023**), and adding humic acid to the soil (on the 10th of the first month for both seasons) at a concentration of 5 ml L-1 (represented by H1) (**Al-Bayati & Al-Khalifa, 2019**), in addition to the control treatment for each factor. The plants were sprayed three times during the growing season at intervals of 10 days between each spray (Moringa extract and yeast were sprayed on the 11th and 13th of the first month, respectively, for both seasons (Furthermore, all plants were fertilized with compound fertilizer N-P-K (20-20-20) at a concentration of 0.5 g L-1, applied twice with a two-week interval between applications.

As for the study indicators, a random sample of 5 plants was taken from each experimental unit to measure number of flowers (flowers plant-1), Flower diameter (cm), fresh yield (kg he-1), Dry flower yield (kg he-1). The percentage of carotenoids was measured according to De **Carvalo *et al.*, (2012**), while the percentage of total phenolics was measured according to **Liu *et al*,.(2011).**

RESULTS AND DISCUSSION

The results presented in (Table, 1) indicate a significant effect of the study factors on the floral growth characteristics and its content of carotenoids and total phenolics for both seasons. The results showed a significant superiority of the triple interaction treatment M3Y2H1 in number of flowers, flower diameter, fresh yield, dry yield, carotenoids, and total phenolics. respectively, with rate 37.43 flower plant-1, 7.960 cm, of 571.3 kg ha-1, 78.81 kg ha-1, 168.6 mg 100 g-1, and 156.7 mg Gallic 100 g-1 for the first season. Similarly, for the second season, this treatment recorded 35.15 flower plant-1, 7.950 cm, 523.2 kg ha-1, 72.33 kg ha-1, 164.5 mg 100 g-1, and 155.1 mg Gallic 100 g-1. compared to the control treatment, which recorded 21.55 flower plant-1, 4.640 cm, 333.3 kg ha-1, 45.73 kg ha-1, 123.7 mg 100 g-1, and 112.6 mg Gallic 100 g-1for the first season, and 18.24 flower plant-1, 4.610 cm, 315.2 kg ha-1, 43.32 kg ha-1, 110.3 mg 100 g-1, and 100.3 mg Gallic 100 g-1 for the second season.

Table (1): Effect of three -way interaction foliar application on some flowering traits of the plant and its content of carotenoids and total phenols of the plant for two seasons.

M* Y* H	First season2021-2022						Second season 2022-2023					
	number of flowers(flower plant^{-1})	flower diameter (cm)	fresh yield (kg ha^{-1})	dry yield (kg ha^{-1})	percentage of carotenoids (mg 100	Total phenols (mg Gallic 100 g-	number of flowers(flower plant^{-1})	flower diameter (cm)	fresh yield (kg ha^{-1})	dry yield (kg ha^{-1})	percentage of carotenoids (mg 100	Total phenols (mg Gallic 100 g-
M0Y0	**21. 55**	**4.640**	**333.**	**45.7**	**123.7**	**112.6**	**18.24**	**4.610**	**315.**	**43.3**	**110.3**	**100.3**
M0Y0	**24.24**	**5.930**	**393.**	**53.9**	**135.0**	**115.4**	**22.99**	**5.900**	**332.**	**45.5**	**125.6**	**105.5**
M0Y1	**21.33**	**4.980**	**340.**	**46.9**	**121.5**	**113.4**	**18.55**	**6.690**	**262.**	**36.4**	**113.6**	**101.6**
M0Y1	**26.42**	**6.340**	**398.**	**54.8**	**128.7**	**118.4**	**24.91**	**6.300**	**359.**	**49.6**	**120.5**	**109.7**
M0Y2	**24.01**	**6.470**	**408.**	**55.9**	**126.6**	**114.6**	**22.60**	**5.420**	**372.**	**51.5**	**117.0**	**103.4**
M0Y2	**30.08**	**6.940**	**479.**	**65.9**	**141.3**	**124.2**	**28.50**	**6.920**	**452.**	**62.6**	**136.7**	**115.7**
M1Y0	**23.93**	**5.870**	**359.**	**49.5**	**123.7**	**116.9**	**21.98**	**6.810**	**287.**	**39.5**	**115.6**	**107.6**
M1Y0	**27.60**	**5.960**	**392.**	**54.2**	**137.5**	**128.8**	**25.43**	**5.920**	**348.**	**48.2**	**130.6**	**116.9**
M1Y1	**23.96**	**6.270**	**372.**	**51.3**	**131.2**	**120.4**	**22.41**	**6.260**	**314.**	**43.2**	**123.7**	**115.0**
M1Y1	**29.12**	**6.380**	**434.**	**60.0**	**145.7**	**138.4**	**26.37**	**6.370**	**408.**	**56.3**	**141.2**	**131.3**
M1Y2	**27.22**	**6.760**	**422.**	**58.3**	**143.5**	**135.7**	**25.29**	**6.720**	**393.**	**54.2**	**138.9**	**128.5**
M1Y2	**32.72**	**7.430**	**509.**	**70.3**	**147.6**	**133.4**	**31.97**	**7.400**	**456.**	**63.0**	**143.5**	**126.9**
M2Y0	**24.09**	**6.110**	**414.**	**57.2**	**136.0**	**122.6**	**23.51**	**6.100**	**337.**	**46.6**	**128.6**	**113.8**
M2Y0	**31.50**	**6.660**	**497.**	**68.6**	**136.0**	**141.3**	**29.13**	**6.660**	**417.**	**57.5**	**148.4**	**134.6**
M2Y1	**29.16**	**6.890**	**457.**	**63.0**	**151.2**	**126.9**	**27.28**	**7.860**	**370.**	**51.3**	**133.7**	**117.4**
M2Y1	**33.18**	**7.610**	**538.**	**74.0**	**139.3**	**152.3**	**31.15**	**7.580**	**498.**	**68.7**	**157.7**	**147.6**
M2Y2	**30.00**	**7.300**	**487.**	**67.3**	**159.4**	**146.7**	**27.65**	**6.280**	**408.**	**56.4**	**153.8**	**138.9**
M2Y2	**35.30**	**7.940**	**562.**	**77.5**	**155.6**	**153.3**	**33.16**	**7.910**	**512.**	**70.8**	**160.4**	**149.6**
M3Y0	**29.67**	**6.660**	**447.**	**61.6**	**164.2**	**130.3**	**27.76**	**7.660**	**366.**	**50.5**	**145.8**	**123.7**
M3Y0	**34.53**	**6.980**	**526.**	**72.6**	**149.4**	**142.3**	**32.40**	**6.950**	**484.**	**66.9**	**151.4**	**136.2**
M3Y1	**31.33**	**7.230**	**469.**	**64.6**	**153.6**	**148.6**	**29.70**	**7.200**	**382.**	**52.9**	**156.7**	**141.3**
M3Y1	**36.79**	**7.800**	**550.**	**75.9**	**157.6**	**154.7**	**34.31**	**7.790**	**507.**	**70.0**	**161.2**	**152.7**
M3Y2	**32.82**	**7.880**	**517.**	**71.3**	**166.2**	**150.2**	**31.86**	**7.870**	**473.**	**65.3**	**159.7**	**144.7**
M3Y2	**37.43**	**7.960**	**571.**	**78.8**	**168.6**	**156.7**	**35.15**	**7.950**	**523.**	**72.3**	**164.5**	**155.1**
LSD	**1.84**	**0.061**	**8.0**	**1.22**	**7.3**	**6.1**	**1.57**	**0.057**	**7.1**	**1.00**	**6.3**	**8.0**

The results presented in Table 2 a significant impact of the study factors on the floral growth characteristics of the plant and its content of carotenoids and total phenolics for both seasons. The results showed a significant superiority of M3Y2 treatment in flower number, flower diameter, fresh flower yield, dry flower yield, carotenoids, and total phenolics. respectively, 35.12 flower plant-1, 7.920 cm, 544.3 kg ha-1, 75.07 kg ha-1, 167.4 mg 100 g-1, and of 153.4 mg Gallic 100 g-1 for the first season. Similarly, for the second season, 33.50 flower plant-1, 7.910 cm 498.1 kg ha-1, 68.85 kg ha-1, 162.1 mg 100 g-1, and 149.9 mg Gallic 100 g-1. Additionally, the interaction treatment M3H1 exhibited superiority in flower diameter, fresh flower yield, dry flower yield, total phenolics, and carotenoid content, recording 7.580 cm, 549.3 kg ha-1, 75.80 kg ha-1, 151.2 mg Gallic 100 g-1 for the first season, and a 7.560 cm, 505.2 kg ha-1, 69.77 kg ha-1, 148.0 mg Gallic 100 g-1 for the second season, along with a carotenoid content of 159.0 mg 100 g-1for the same season the interaction treatment (M3H0) exhibited superiority in total carotenoid content, recording 161.3 mg 100 g-1 for the first season, compared to the control M3H0 which recorded 22.30 flower plant-1, 5.360 cm, 360.6 kg ha-1, 49.55 kg ha-1, 123.9 mg 100 g-1, of 113.5 mg Gallic 100 g-1 for the first season, and 19.80 flowers plant-1, 5.240 cm , 316.8 kg ha-1, dry 43.77 kg ha-1, 113.6 mg 100 g-1, 101.8 mg Gallic 100 g-1 for the second season.

The interaction treatment Y2H1 exhibited superiority in flower diameter, fresh flower yield, dry flower yield, carotenoids, and total phenolics, recording 7.570 cm, of 530.5 kg ha-1, 73.16 kg ha-1, 153.3 mg 100 g-1, of 141.9 mg Gallic 100 g-1 for the first season, and 7.540 cm, fresh 486.4 kg ha-1, 67.21 kg ha-1, 151.3 mg 100 g-1, and 136.8 mg Gallic 100 g-1 for the second season. compared to the control treatment, which recorded a 5.820 cm, 388.8 kg ha-1, 53.54 kg ha-1, 136.9 and 120.6 mg Gallic 100 g-1, respectively, in the first season, and 5.790 cm, a 326.5 kg ha-1, 45.02 kg ha-1, 125. mg 100 g-1and 111.4 mg Gallic 100 g-1, for the second season respectivel .

Table (2): The two-way interaction effect of foliar application on some flowering traits of the plant and its content of carotenoids and total phenols for two seasons.

	First season2021-2022						Second season 2022-2023					
M*Y	number of flowers (flower plant-1)	flower diameter (cm)	fresh yield (kg ha-)	dry yield (kg ha-1)	percentage of carotenoids (mg 100 g-1)	Total phenols (mg Gallic 100 g-1)	number of flowers(flower plant-1)	flower diameter (cm)	fresh yield (kg ha-1)	dry yield (kg ha-1)	percentage of carotenoids (mg 100 g-1)	Total phenols (mg Gallic 100 g-1)
M0Y0	22.90	5.290	363.2	49.85	129.3	114.0	20.62	5.250	323.8	44.42	117.9	102.9
M0Y1	23.88	5.660	369.6	50.88	125.1	115.9	21.73	5.490	310.9	43.04	117.1	105.7
M0Y2	27.05	6.710	443.5	60.95	133.9	119.4	25.55	6.670	412.9	57.06	126.9	109.5
M1Y0	25.76	5.920	376.0	51.88	130.6	122.9	23.71	5.860	318.0	43.88	123.1	112.3
M1Y1	26.54	6.330	403.4	55.70	138.5	129.4	24.39	6.310	361.2	49.80	132.5	123.2
M1Y2	29.97	7.100	466.0	64.33	145.5	134.6	28.63	7.060	424.9	58.65	141.2	127.7

M2Y0	27.79	6.390	455.9	62.94	136.0	132.0	26.32	6.380	377.2	52.12	138.5	124.2
M2Y1	31.17	7.250	497.8	68.54	145.3	139.6	29.21	7.220	434.7	60.03	145.7	132.5
M2Y2	32.65	7.620	525.2	72.49	157.5	150.0	30.40	7.600	460.3	63.64	157.1	144.2
M3Y0	32.10	6.820	487.0	67.14	156.8	136.3	30.08	6.800	425.5	58.75	148.6	130.0
M3Y1	34.06	7.510	510.0	70.32	155.6	151.6	32.01	7.500	445.1	61.49	159.0	147.0
M3Y2	35.12	7.920	544.3	75.07	167.4	153.4	33.50	7.910	498.1	68.85	162.1	149.9
LSD M *Y	1.30	0.043	5.6	0.86	5.2	4.3	1.11	0.040	5.0	0.71	4.5	5.7
M* H												
M0H0	22.30	5.360	360.6	49.55	123.9	113.5	19.80	5.240	316.8	43.77	113.6	101.8
M0H1	26.92	6.400	423.6	58.24	135.0	119.3	25.47	6.370	381.7	52.58	127.6	110.3
M1H0	25.04	6.300	385.1	53.08	132.8	124.3	23.23	6.260	331.6	45.68	126.1	117.1
M1H1	29.81	6.590	445.1	61.52	143.6	133.5	27.92	6.560	404.5	55.87	138.4	125.0
M2H0	27.75	6.770	453.2	62.55	148.9	132.1	26.15	6.750	372.0	51.47	138.7	123.4
M2H1	33.33	7.400	532.7	73.43	143.6	149.0	31.15	7.380	476.1	65.72	155.5	143.9
M3H0	31.27	7.260	478.2	65.89	161.3	143.0	29.77	7.240	407.3	56.28	154.1	136.6
M3H1	36.25	7.580	549.3	75.80	158.5	151.2	33.95	7.560	505.2	69.77	159.0	148.0
LSD M*H	N.S	0.035	4.6	0.70	4.2	3.5	N.S	0.033	4.1	0.58	3.7	4.6
Y * H												
Y0H0	24.81	5.820	388.8	53.54	136.9	120.6	22.88	5.790	326.5	45.02	125.1	111.4
Y0H1	29.47	6.380	452.2	62.37	139.5	132.0	27.49	6.360	395.8	54.56	139.0	123.3
Y1H0	26.44	6.340	410.1	56.51	139.4	127.3	24.49	6.250	332.5	45.99	131.9	118.8
Y1H1	31.38	7.030	480.3	66.21	142.8	141.0	29.19	7.010	443.5	61.19	145.2	135.3
Y2H0	28.51	7.100	459.0	63.26	148.9	136.8	26.85	7.070	411.8	56.89	142.3	128.9
Y2H1	33.88	7.570	530.5	73.16	153.3	141.9	32.19	7.540	486.4	67.21	151.3	136.8
LSD Y*H	N.S	0.031	4.0	0.61	3.7	3.1	N.S	0.028	3.6	0.50	3.2	4.0

The results presented in (Table, 3) indicate a significant effect of the study factors on the floral growth characteristics and content of carotenoids and phenolics for both seasons. respectively, treatment M3 showed significant superiority in flowers number , flower diameter, fresh flower yield, dry flower yield, total carotenoid content, and total phenolic content. In the first season, it recorded 33.76 flowers plant-1, 7.420 cm, 513.7 kg ha-1, 70.84 kg ha-1, 159.9 mg 100 g-1 and 147.1 mg Gallic 100 g-1, respectively. Similarly, in the second season, treatment M3 showed improvement 31.86 flowers plant, 7.400 cm, a 456.2 kg ha-1, 63.03 kg ha-1, 156.6 mg 100 g-1and 142.3 mg Gallic 100 g-1 , respectively, compared to the control treatment, which recorded 24.61 flowers plant-1 5.880 cm, 392.1 kg ha-1, 53.89 kg ha-1, 129.4 mg 100 g-1 and 116.4 mg Gallic 100 g-1 , respectively, in the first season, and 22.63 flowers plant-1, 5.810 cm, 349.2 kg ha-1, 48.17 kg ha-1, 120.6 mg 100 g-1 and 106.0 mg Gallic 100 g-1, respectively, in the second season .

Additionally, treatment Y2 had significant effect in the same characteristics and recorded 31.20 flowers plant-1, of 7.340 cm, 494.7 kg ha-1, 68.21 kg ha-1, 151.1 and 139.3 mg Gallic 100 g-1, respectively,for the first season. In the second season, treatment Y2, recorded 29.52 flowers plant-1, 7.310 cm, 449.1 kg ha-1, of 62.05 kg ha-1, 146.8 mg 100 g-1 and 132.8 mg Gallic 100 g-1, respectively, compared to the control treatment, which recorded 27.14 flowers plant-1, 6.100 cm, 420.5 kg ha-1, 57.95 kg ha-1, 138.2 mg 100 g-1 and 126.3 mg Gallic 100 g-1, respectively, in the first season, and 25.18 flowers plant-1, 6.070 cm, 361.1 kg ha-1, 49.79 kg ha-1, 132.0 and 117.3 mg Gallic 100 g-1, respectively, in the second season. Furthermore, treatment H1 also had significant effect in the same characteristics, recording 31.58 flowers plant-1, 7.000 cm, 487.7 kg ha-1, 67.25 kg ha-1, 145.2 mg 100 g-1 and 138.3 mg Gallic 100 g-1, respectively, for the first season. In the second season, treatment H1 continued to exhibit superiority, with 29.62 flowers plant-1, 6.970 cm, 441.9 kg ha-1, 60.99 kg ha-1, and 145.1 mg 100 g-1 and 131.8 mg Gallic 100 g-1, respectively, compared to the control treatment, which recorded 26.59 flowers plant-1, 6.420 cm, 419.3 kg ha-1, 57.77 kg ha-1, 141.7 mg 100 g-1 and 128.2 mg Gallic 100 g-1, respectively, in the first season, and 24.74 flowers plant-1, 6.370 cm, 356.9 kg ha-1, 49.30 kg ha-1, 133.1 mg 100 g-1 and 119.7 mg Gallic 100 g-1, respectively, in the second season .

Table (3): The main effect of foliar application on somes flowering traits of the plant and its content of carotenoids and total phenols for two seasons.

M	First season 2021-2022						Second season 2022-2023					
	number of flowers(flower plant-^{1})	flower diameter (cm)	fresh yield (kg ha^{-1})	dry yield (kg ha^{-1})	percentage of carotenoids (mg 100 g^{-1})	Total phenols (mg Gallic 100 g^{-1})	number of flowers(flower plant-^{1})	flower diameter (cm)	fresh yield (kg ha^{-1})	dry yield (kg ha^{-1})	percentage of carotenoids (mg 100 g^{-1})	Total phenols (mg Gallic 100 g^{-1})
M0	24.61	5.880	392.1	53.89	129.4	116.4	22.63	5.810	349.2	48.17	120.6	106.0
M1	27.43	6.450	415.1	57.30	138.2	128.9	25.58	6.410	368.0	50.77	132.3	121.0
M2	30.54	7.090	492.9	67.99	146.3	140.5	28.65	7.070	424.1	58.60	147.1	133.7
M3	33.76	7.420	513.7	70.84	159.9	147.1	31.86	7.400	456.2	63.03	156.6	142.3
LSD	0.75	0.025	3.3	0.50	3.0	2.5	0.64	0.023	2.9	0.41	2.6	3.3
Y												
Y0	27.14	6.100	420.5	57.95	138.2	126.3	25.18	6.070	361.1	49.79	132.0	117.3
Y1	28.91	6.690	445.2	61.36	141.1	134.1	26.84	6.630	388.0	53.59	138.6	127.1

Y2	31.20	7.340	494.7	68.21	151.1	139.3	29.52	7.310	449.1	62.05	146.8	132.8
LSD	0.65	0.022	2.8	0.43	2.6	2.2	0.55	0.020	2.5	0.36	2.2	2.8
H												
H0	26.59	6.420	419.3	57.77	141.7	128.2	24.74	6.370	356.9	49.30	133.1	119.7
H1	31.58	7.000	487.7	67.25	145.2	138.3	29.62	6.970	441.9	60.99	145.1	131.8
LSD H	0.53	0.018	2.3	0.35	2.1	1.8	0.45	0.016	2.1	0.29	1.8	2.3

The increase in the number of flowers, flower diameter, and both fresh and dry flower yields observed when spraying with organic nutrients can be attributed to the content of both moringa extract and yeast suspension, which contain sugars, proteins, amino acids, organic acids, and vitamins (**Salman & Abdul Rasool, 2022a**). Additionally, these substances contain natural growth hormones such as gibberellins, which stimulate the formation of floral buds in plants requiring a period of cold, or Vitamin C, which enhances flowering for the plant by the biosynthesis of gibberellins (**Cho *et al.*, 2017**). Furthermore, the increase in the number of flowers is also attributed to their content of amino acids, which act as vital stimulants enhancing plant growth and improving nutrient availability and product quality (***Rouphael et al*., 2018)**. Additionally, some amino acids are linked to the biosynthesis of growth-regulating substances such as cytokinins, auxins, and brassinosteroids, which have an active role in cell elongation (**Yong *et al.*, 2014**). Moreover, gibberellins stimulate cell division and elongation, and they also contribute to the synthesis of phenolics, which inhibit the oxidative enzymes of natural auxins, thereby increasing their production and synthesis. This, in turn, along with cytokinins, contributes to cell division, elongation, and cell expansion (**Al-Khafaji, 2014**). Increasing of flower diameter is also attributed to these plant nutrients' role in increasing carbon assimilation products such as carbohydrates and proteins, leading to an accumulation of dry matter, thereby increasing the fresh weight of the flowers. this positively reflects on their dry weight. When these accumulated compounds are broken down, Acetyl CoA is produced, which represents the basic substance in the synthesis of beta-carotene. Additionally, the increase in flower phenolic content may be attributed to the improvement in growth indicators by study factors and the resulting carbohydrates and sugars involved in the shikimic acid pathway, which is one of the pathways responsible for the production and synthesis of phenolic compounds (**Lin *et al.*, 2016**). The improvement in floral growth indicators and qualitative flower traits with the addition of humic acid may be attributed to its role in stimulating numerous biological processes that contribute to plant growth .

This includes stimulating root growth and the formation of root hairs, as well as increasing membrane permeability, thereby enhancing water and nutrient uptake of N, P, K, Ca, and Mg (**Al-Abody *et al*., 2021**). These nutrients provide the plant with balanced nutrition and promote good vegetative growth, enabling the plant to respond to cold-induced flowering stimuli. Additionally, the increase in carbon assimilation products and carbohydrates, reflected in the carbon-to-nitrogen ratio positively correlated with flower bud initiation (**Ravishankar *et al.*, 2014**). These results are consistent with the findings of **Jawad & Majeed (2017**) when adding humic acid to gerbera plants, contributes to the increase in flower number and diameter, Furthermore, the enhancement of the plant's efficiency in carbon assimilation increases both primary and secondary metabolite production, positively affecting the fresh and dry weight of the flowers, which are essential in the synthesis of beta-carotene and phenolics. The results of the interaction between organic nutrient spraying and the addition of humic acid may lead to increased carbon assimilation products, as the plant exploits favorable environmental conditions in terms of energy and nutrients to increase flower yield and improve its quality.

CONCLUSIONS AND RECOMMENDATIONS

Based on the foregoing, we conclude that spraying marigold plants with a 8% concentration of moringa extract and a 10 g L-1 concentration of yeast suspension, along with the addition of humic acid at a concentration of 5 ml L-1, has a clear role in improving floral growth indicators and increasing the content of total phenolics and total carotenoids in the flowers. This has led to an increase in flower yield, which is economically significant, along with an improvement in the qualitative yield. Furthermore, the study treatments are environmentally friendly, emphasizing the importance of reducing chemical substances and environmental pollution.We recommend using the same concentrations on other medicinal plants and higher concentrations on marigold plants to further enhance their growth and yield.

REFERENCES

1. Al-Abody, M. A. K., Ramadhan, M. N. & Muhsin, S. J. (2021) Effect of Humic acid on the growth, yield components, and yield of three sunflower cultivars (*Helianthus annuus L*.) *Eco. Env. & Cons*. 27 (2): 548-554.
2. Al-Asadi, M. H. S. (2018). *The basics of medicinal plants and their effective compounds*. Dar Al-Kutub and Documents, Baghdad, First edition, p: 324.
3. AL-Asdi, Z. N. (2014) Effect of spraying with a suspension of active yeast and chelated iron on the vegetative and flowering growth of the chrysanthemum officinalis Clendula L., *Karbala University Journal*, 12(3) :226-235.
4. Al-Bayati, M. Y. & Al-Khalifa, A. K-D. (2019) Study of the response of chrysanthemum plants. *Calendula officinalis* L. To determine the effect of humic and fulvic acids on it under woody canopy conditions. Kirkuk University. *Agricultural Engineering Sciences*. 10 (1) :55 – 61.

5. Al-Taweel, S. K. & Al-Anbari, I. H. A. (2019). *Moringa oleifera*: A Review on the phytochemical screening, proximate analysis, medicinal, nutritional and plant bio stimulants values of its leaves, pods, seeds and roots. *Plant Archives*, 19(2): 1612-1622.
6. Al-Khafaji, M. A. (2014). *Plant growth regulators and their horticultural applications and uses*. University House for Printing, 1st Edition, Publishing and Translation. Iraq. P: 348.
7. Al-Zubaidi, S. A. K. & Al-Hasnawi, H. A. K. (2021). The effect of foliar feeding with brosol and ground application of humic on the growth and flowering of chrysanthemum (*Calendula officinalis* L.), *Fayoum Journal of Agricultural Research and Development*, 35(1): 80-86.
8. Baghchejooghi, H. T., Salteh, S. A. & Matloobi, M. (2023). The Effect of Fulvic Acid and Triacantanol Foliar Application on some Biochemical and Physiological Properties and Active Ingredients of (*Calendula officinalis* L.) *Journal of Horticultural Science*, 37 (1): 167-179.
9. Chroho, M., Drioiche, A., Saidi, S., Zair, T. & Bouissane, L. (2021). Total phenolic and flavonoids contents and in vitro evaluation of antioxidant activity of several Calendula officinali (Marigold) extracts, *Journal of Biological Research-Bollettino della Società Italiana di Biologia Sperimentale*, 94 (1):21-26.
10. Cho, L., Yoon J. & An, G. (2017) The control of flowering time by environmental factors. *The Plant Journal*. 90:708-719.
11. Daghaghele, S., Kiasat, A. R., Ardebili, S. M. S. & Mirzajani, R. (2021) Intensification of Extraction of Antioxidant Compounds from *Moringa Oleifera* Leaves Using Ultrasound-Assisted Approach: BBD-RSM Design. *International Journal of Fruit Science* 21(1) :693-705.
12. De-Carvalo, L. M. J., Gomes, P. B., de-Oliveira Godoy, R. L., Pacheco, S., do-Monte, P. H. F., de-Carvalho, J. L., Nutti, M. R., Neves, A. C. L., Vieira, A. C. R. A. & Ramos, S. R. R. (2012) Total carotenoid content, α-carotene and β-carotene, of landrace pumpkins (Cucurbita moschata Duch*): A preliminary study*. *Food Research International*, 47: 337–340.
13. Essaa, W. M. (2023) Effect of Spraying with Humic Acid and Active Yeast Suspension on the Growth Indicators and Active Substances of *Calendula officinalis* L., 4th International Conference of Modern Technologies in Agricultural Sciences IOP Conf. Series*: Earth and Environmental Science*.V.1262 (042041).
14. Ibrahim, I. R. & Ameen, S. K. M. (2017). In vitro propagation of *Moringa oleifera*. *Iraqi Journal of Agricultural Science*. 48(4):1089- 1098.
15. Jan, A., Noor, F., Uddin, S., Mukhtar, H., Ramzan, M., Raheel, M. & Wisal, S. (2022) Exogenous application of moringa leaf extract influences growth, flowering and vase life

of snap dragon (*Antirrhinum majus*) cultivars. *Pure and Applied Biology* (PAB),11(2): 459-467

16. Jawad, R. M. & Majeed, B. H. (2017) Response of vegetative growth for the treatment of organic nutrient and Calcium chloride for Gerbera plant *Gerbera jamesonii*, *The Iraqi Journal of Agricultural Science*. 48 (1): 266-273.
17. Lin, D. , Xiao, M. , Zhao, J. , Li, Z. , Xing, B. , Li, X. , Kong, M. , Li, L. , Zhang, Q. , Liu, Y. , Chen, H. , Qin, W. , Wu, H. & Chen, S. (2016) An Overview of Plant Phenolic Compounds and Their Importance in Human Nutrition and Management of Type 2 Diabetes, *National Library of Medicine*, 21 (10): 1374.
18. Liu, J., Wang, C., Wang, Z., Zhang, C., Lu, S. & Liu, J. (2011). The antioxidant and free-radical scavenging activities of extract and fractions from corn silk (Zea mays L.) and related flavone glycosides. *Food Chemistry*. 126: 261–269.
19. Malik, I. & Almrani, H. A. (2023). Volatile Oil Yield and its Components of Menthol and Limonene of Peppermint Affected by Foliar Spray and Lighting Intensity. 4th International Conference of Modern Technologies in Agricultural Sciences IOP Conf. Series: *Earth and Environmental Science*, V. 1262, PP.1-12.
20. Mehwish, H. M., Rajoka, M. S. R., Xiong, Y., Cai, H., Aadil, R. M., Mahmood, Q. & Zhu, Q. (2021). Green synthesis of a silver nanoparticle using Moringa oleifera seed and its applications for antimicrobial and sun- light mediated photocatalytic water detoxification. *Journal of Environmental Chemical Engineering*, 9(4) :105290
21. Mohammed, R. R. & Majeed, B. H. (2023) Effct of Moringa leaves Extract, CalciumAL, and Potassium Silicate on the growth, Yield, and quality of Strawberry Frutts. *Iraqi Journal of Agricultural Sciences.* 54(6) :1703- 1715.
22. Rafiee H., Naghdi, H., Mehrafarin, A., Zarinpanjeh, A. N., Sekara, A. & Zand, E. (2016). Application of plant biostimulants as new approach to improve the biological responses of medicinal plants- A Critical Review. *Journal of Medicinal Plants*.15(59):1-34.
23. Ravishankar, H., Singh, V. K., Misra, A. K. & Mishra, M. (2014) *physiology of flowering in perennial fruit crops. National seminar-cum-workshop*. Central Institute for Subtropical Horticulture, Published by President, SDSH & Director, CISH Central Institute for Subtropical Horticulture, Lucknow - 226 101, U.P., India No 8121 :164-172
24. Rouphael, Y., Spíchal, L., Panzarová, K., Casa, R. & Colla, G. (2018). High-Throughput plant phenotyping for Developing novel bio stimulants: From lab to field or from field to lab? Front. *Plant Sciences*. V. 9, Article 1197, pp;1-6
25. Saini, R. K., Sivanesan, I. & Keum, Y. S. (2016). Phytochemicals of *Moringa oleifera*: a review of their nutritional, therapeutic and industrial significance. *3 Biotech* 6(2) :1-14.
26. Salman, A. D. & Abdul Rasool, E. J. (2022a) Effect of ozone enrichment and spraying with coconut water and moringa extract on vegetative growth and yield of broccoli plant

under hydroponic system with modified NFT technology. *Iraqi Journal of Agricultural Sciences*, 53(2): 406-414.
27. Salman, A. D. & Abdul Rasool, E. J. (2022b). Effect of ozone enrichment and spraying with organic nutrient on nutrient and water use efficiency and fertilizer productivity of broccoli plant cultivated hydroponically with modified NFT technology. *Iraqi Journal of Agricultural Sciences*, 53(2): 660-668.
28. Salman, S. A. A. & Abdul-Qader, Z. M. (2023) Effect of harvest dates, mycorrhiza and some biostimulants on some vegeta tive growth properties and yield of volatile oil for sweet scented geranium plant (Pelargonium graveolens L.Herit.) , *Bionatura ,Latin American Journal of Biotechnology and Life Sciences*, Issue 4, V. 8 (1): 1-26.
29. Shaabani, M., Iriti M., Mortazavi S. N., Amirmohammadi F. Z. & Zamanian K. (2022). The effects of two organic fertilizers on morpho-physiological traits of Marigold (*Calendula officinalis* L.), *South African Journal of Botany*,148: 330-335
30. Szopa, A., Klimek- Szczykutowicz, M., Jafernik, K., Koc, K. & Ekiert, H. (2020). Pot marigold (*Calendula officinalis* L.) a position in classical phytotherapy and newly documented activities. *Acta Scientiarum Polonorum. Hortorum Cultus*, 19 (3): 47-61.
31. Yong, J. W. H., Letham, S. D., Wong, C. S. & Graham, D. F. (2014) Rhizobium-induced elevation in xylem cytokinin delivery in pigeon pea induces changes in shoot development and leaf physiology. *Funct. Plant Biol*. 41:1323-1335.
32. Zaferanchi, S., Salmasi, S. Z., Lisar, S. Y. S. & Sarikhani, M. R. (2020) Bio Inoculants and Organics Influence on Mineral Nutrition and Productivity in *Calendula officinalis* L., *Journal of Medicinal plants and By-product*, 9(1): 43- 50.