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Evaluation of Growth, Fruit Yield, Volatile Oil Productivity and Chemical Constituents of Coriander under Different Rates of Phosphorus Fertilization and Biomagic

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ABSTRACT

A field experiment was done at privet Farm in Taha El-Marg Village, Diarb Nigm District, Sharkia Governorate, Egypt during the 2021/2022 and 2022/2023 seasons. Thus, to evaluate the influence of various phosphorus fertilization rates (0.0, 15.5, 31.0 and 46.5 kg P_2O_5/ feddan), biomagic rates (0.0, 3, 5 and 7 ml/ l) and their combined treatments on the growth and productivity of coriander (*Coriandrum sativum* L.) plants. The results referred that fertilized coriander plants with 31 kg P_2O_5/ feddan significantly increased plant height, branches count per plant and total plant dry weight compared to the other phosphorus rates. Moreover, the highest values of yield components (umbels number per plant and fruit yield per plant and per feddan) and production of volatile oil (volatile oil % and its yield per plant and per feddan) as well as total chlorophyll content, total carbohydrates and phosphorus percentages were produced with 46.5 kg P_2O_5/ feddan rate. Generally, the best treatment in all studied parameters of coriander was recorded when plants sprayed with 7 ml biomagic /l with significant differences with the other rates under study. In mostly, fertilized coriander plants with 31.0 kg P_2O_5/ feddan and sprayed with 7 ml /l of biomagic recorded the highest values in growth, yield and volatile oil production without significant differences between them. Finally, GS-MS analysis revealed that the major constituents of volatile oil were linalool, camphor, geraniol, alpha-pinene and gamma-terpinene.

KEYWORDS: *Coriandrum sativum*, phosphorus, biomagic, growth, fruit yield, volatile oil, chlorophyll

1. INTRODUCTION

The coriander plant, Coriandrum sativum L., belongs to the Apiaceae family. It is a herbaceous plant that grows to a height of about 100 cm. The fruits are a yellowish-green tint, and the leaves have feathery flowers. According to Arslan *et al*. (2002), coriander is widely grown in Iran, Tunisia, various nations of South American, southern Europe, Morocco and Algeria. Additionally, coriander was used to treat colds, regulate digestion, get rid of gas and diarrhea, prevent high blood pressure and arteriosclerosis, lower cholesterol and blood sugar levels, treat fungal infections, and treat anemia. It also plays a significant role in the treatment of anemia. Because it contains calcium, it is also used in the treatment of rheumatism (Erdogdu, 2012). Fresh herb of coriander is rich in vitamin A, B_2 and C and is very popular for their usefulness in salads, seasoning, chutney and soups (Lokesh *et al*., 2018). Moreover, El Shayeb *et al.* (2021) indicated that the main components of the volatile oil of coriander were linalool, camphor, geraniol, gamma-terpinene, geranyl acetate and alpha-pinene. Abd-Allah *et al*. (2021) reported that one of the most widely grown medicinal plants in the Egypt is coriander, which is utilized in Egyptian traditional food. Coriander is one of the most well-known and widely used spices in the world, which is utilized as either a well-known green plant or dried fruits.

The total dry coriander cultivated area in 2020 in Egypt was 2, 451 fed. (353 fed. in New reclaimed land and 2.098 fed. in ancient agricultural land) which produced 2.868 tons (156 tons from new reclaimed land and 2.712 tons from ancient agricultural land) with average 1.170 ton/fed. (0.442 tons / fed. in new reclaimed land and 1.293 tons/ fed. in ancient agricultural land) according to Statistics of the Ministry of Agriculture (2020).

Phosphorous plays structural, energy transfer and root development improvement roles, as well as adjusting the effects of additional nitrogen on maturity delay. According to Maurya (1989), phosphorus causes an increase in the leaf area index. An increase in the leaf area index leads to an increase in relative growth and production rate. Admar *et al*. (2003) discovered that phosphorus fertilizer with root and shoot growth increased vegetative production in the coriander medicinal plant. Singh and Singh (2019) indicated that phosphorus fertilization enhanced yield attributes *viz.,* number of umbels per plant, seed weight per coriander plant and ultimately higher seed yield per hectare. According to Al-Whaili and Al-Rubai'i (2020), adding 60 kg.ha-1 of phosphorus resulted in the greatest mean for the coriander plant's growth and physiological parameters.

Biomagic is a biological promoter derived from microorganism origins; this product contains a variety of biological compounds that influence plant development and growth. Biomagic product is made up of macro and microelements that participated in all cellular and metabolic processes, as well as amino acids and vitamins that are necessary for plant development, growth and various metabolic processes (Suman *et al*., 2017). According to El-Sibaie (1995), this in turn lengthens the vegetative development phase and the time of production, improving photosynthesis and promoting the uptake of nutrients and water from the soil. Also, Hafez (2013) found that the highest values of the Jerusalem artichoke's growth traits, tuber yield components and chemical and quality of tuber makeup were produced by Biomagic at a rate of 7.5 g/l. Also, pot marigold flower dry weight, flower count, fresh and dry weights of flower (g/plant and kg / fed.), total chlorophyll content in leaves, carotenoids content in flowers, total carbohydrates percentage and vitamin A content were all significantly affected by biomagic foliar application (Hashem, 2016).

The purpose of this study was to evaluate the impacts of fertilization rates of phosphorus and foliar spraying of biomagic on coriander, particularly on growth characteristics, yield components, chemical components, and volatile oil production under the conditions of the Sharkia Governorate.

2. MATERIALS AND METHODS

A field experiment was done during the two consecutive winter seasons of 2021/2022 and 2022/2023 at a private farm in Taha El-Marg Village, Diarb Negm District, Sharkia

Governorate, Egypt. This experiment assessed to evaluate the influence of various fertilization rates of phosphorus (0.0, 15.5, 31.0 and 46.5 kg P_2O_5/feddan), various biomagic rates (0.0, 3, 5 and 7 ml /l as foliar spray) and their combined treatments on growth, yield, chemical constituents and volatile oil yield and its components of coriander plant. Prior to sowing, a random soil sample was taken at 0-30 cm depth to conduct a physical and chemical examination using the standard procedure outlined in Table 1 by Chapman and Pratt (1978).

Table 1. Physical and chemical properties of experimental soil (average of the two seasons)

Physical analysis										Soil texture
Clay (%)		Silt (%)		Sand (%)						Clayey
54.27		34.32		11.41						
Chemical analysis										
pH	EC dSm^{-1}	Organic matter (%)	$CaCO_3$ (%)	Soluble cations (meq./ L)				Soluble anions (meq. /L)			
				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}
8.09	2.96	0.63	0.54	13.12	10.79	1.94	5.07	0.00	10.78	3.89	16.26
Available nutrient (mg kg^{-1}soil)											
N		P		K		Fe		Zn		Cu	Mn
51.14		20.08		261		1.87		0.75		0.68	0.55

2.1. Fruits source and cultivation

The Medicinal and Aromatic Plants Research Centre, Dokky, Giza, is where the coriander fruits were purchased. In the experimental plots, coriander fruits were sowed (3-5 fruits/hill) on October 8th and 11th of the 1st and 2nd seasons, respectively. The experimental unit measured 14.40 m^2 (4 m × 3.60 m) and comprised 6 ridges spaced 60 cm apart and coriander plants (2 plants per hill) planted 30 cm apart on either side of each ridge.

2.2. Fertilization

The rates of N and K_2O fertilization for NK were 60 and 50 kg N and K_2O /feddan, respectively. Ammonium sulphate (20.5% N) served as the nitrogen supply, and potassium sulphate (48.5% K_2O) served as the source of potassium. Additionally, soil drench fertilization rates of phosphorus (0.0, 15.5, 31.0, and 46.5 kg/feddan P_2O_5) were added as calcium super phosphate (15.5% P_2O_5). During the soil preparation process, all of the P fertilizer was added. In contrast, N and K fertilizers were applied to the soil at 30, 55, and 80 days from the date of sowing in three equal amounts. The normal agricultural practices for coriander plants were carried out as commonly followed in the district.

2.3. Biomagic source and application

The biomagic product (as solution) which was used a biological promoter of microbial origins (El-Sibaie, 1995). Biomagic was provided from Microbiology Department, D. R. C. Biomagic is devoid of synthetic phyto-hormones but rich in biological compounds that stimulate plant development, boost yield, and protect against pathogens. Biomagic has pH of 5.5 and consists of the following: Amino acids (1.907%) i.e. cystine, arginine, histidine, glycine, lysine, leucine, isoleucine, phenyl alanine, theronine, tryptophane, tyrosine and valine. Vitamins (0.38%) i.e. thiamin, folic acid, biotene, choline, niacin, potothinic, rhiboflavin and pyrodxine. Macro elements (in mg/l) i.e. N (1125), P_2O_5 (550) and K_2O (625). Micro elements (in mg/l) i.e. Fe (160), Mn (100), Zn (124), Cu (45), Mg (45), Mo (12), B (14), Cd (7) and Ni (4). The coriander plants were sprayed using hand-held sprayer and the used volume of the solution was maintained just to cover the whole plant foliage completely at 30, 45 , 60 and 75 days after sowing.

2.4.Experimental Design

Three replicates of this experiment were set up using complete randomized block design following the split- plot arrangement. Four phosphorus fertilization rates took up residence in the main plots. There were four biomagic rates available for the sub plots. There were 16 different combinations of phosphorus fertilization and biomagic rates.

2.5.Sampling and Collecting Data

2.5.1. Plant growth

Three coriander plants were randomly selected from each plot after 108 days (just before flowering) to determine the plant growth parameters: plant height (cm), branch count per plant, and dry weight (g) of the plant (branches + leaves).

2.5.2. Yield and its components

Three coriander plants were randomly selected from each plot 155 days after sowing to estimate the parameters for the yield components: The number of umbels per plant, fruit yield per plant (g), and fruit yield per feddan (kg).

2.5.3. Chemical and volatile oil constituents

According to Markwell *et al.* (1995), coriander leaves (the top 4 or 5 leaves of the plant) were tested for total chlorophyll content (SPAD unit) after 108 days from the planting date using a SPAD- 502 meter. Total carbohydrate percentage and total phosphorus percentage in fruits of coriander was determined according to the method adapted by Dubois *et al*., (1956) and Hucker and Catroux (1980), respectively, at the end of experiment in both seasons.

According to Guenther (1961), the volatile oil from dried coriander fruits was isolated for 3 hours by hydro distillation after 155 days from the sowing date in order to obtain the volatile oil, also, the yield of coriander volatile oil per plant (ml) and per feddan (l) was calculated. Active ingredients of volatile oil were determined under the optimum treatments for phosphorous and biomagic rates as well as their mixtures were utilized to obtain the oil, and the coriander volatile oil from the samples (2022/2023 season) was analyzed by GLC (Gas Chromatography-Mass) (Hewlett, Packed, HP6890 series) to determine the volatile oil components.

2.6.Statistical Analysis

This experiment utilized a split-plot experiment with a completely randomized block design for its statistical layout. According to Gomez & Gomez (1984), data were evaluated. The means were compared using Statistix Version 9 (Analytical software, 2008) computer software.

3. RESULTS AND DISCUSSION

3.1.Plant growth

Plant growth of coriander (plant height, branches number and total plant dry weight) significantly increased with increasing phosphorus up to 46.5 kg P_2O_5/ feddan with no significant differences between 31 and 46.5 P_2O_5/ feddan with respect to branches number as well as total yield. This means that 46.5 kg P_2O_5 increased plant height and 31 kg P_2O_5 increased branches number and total dry weight, at 108 days after sowing in both seasons (Table 2). The increase in total dry weight of the coriander plant was about 1.87 and 2.07 g/ plant for 15.5 kg P_2O_5/ feddan, 5.60 and 5.31 g/ plant for 31.0 kg P_2O_5/ feddan and 4.50 and 5.69 g/ plant for 46.5 kg P_2O_5/ feddan, in 1st and 2nd seasons, over the control respectively. According to Pareek and Sethi (1985), phosphorus is essential for storing energy, photosynthesis, cell growth and division, respiration, and many other functions. It also has a positive influence on plant growth. Moreover, Javiya *et al.* (2017), Farahani *et al.* (2018) and Al-Whaili and Al-Rubai'i (2020) on coriander found similar results.

The highest values of coriander height (113.92 and 115.58 cm), branches number per plant (10.67 and 10.92 branches/plant) as well as total dry weight (52.08 and 52.09 g/ plant) were achieved with 7.0 g/l of biomagic in both seasons, respectively (Table 2). In general, all biomagic rates significantly enhanced coriander growth traits in comparison with unsprayed plants in both seasons. Biomagic contains many components, such as amino acids and vitamins as well as

Table 2. Influence of phosphorus fertilization (P), biomagic rate (B) and their interaction treatments (P×B) on plant height (cm), number of branches and dry weight (g) /plant of coriander plant during 2021/2022 and 2022/2023 seasons

Phosphorus fertilization (P_2O_5 kg/ feddan) (P)	Biomagic (ml/l) (B)									
	0.0	3	5	7	Mean (P)	0.0	3	5	7	Mean (P)
	2021/2022 season					2022/2023 season				
	Plant height (cm)									
Control	98.67	101.00	101.67	107.00	102.08	100.33	103.67	107.00	106.00	104.25
15.5	101.00	107.67	110.33	114.00	108.25	102.33	108.00	112.33	115.67	109.58
31.0	108.00	111.33	116.00	119.67	113.75	107.67	112.30	119.33	124.00	115.75
46.5	106.67	110.00	112.67	115.00	111.08	106.67	109.67	117.33	116.67	112.58
Mean (B)	103.58	107.50	110.17	113.92		104.25	108.33	114.00	115.58	
L.S.D. at 5 %	P= 0.74		B= 0.93		P×B= 1.78	P= 1.46		B= 1.54		P×B= 3.04
	Number of branches per plant									
Control	6.33	6.67	7.33	7.00	6.83	6.67	7.33	7.67	7.00	7.17
15.5	7.67	9.33	9.33	10.67	9.25	8.33	8.67	9.67	10.33	9.25
31.0	10.33	11.67	11.67	12.67	11.58	9.67	11.33	12.33	13.33	11.67
46.5	9.33	10.33	11.33	12.33	10.83	10.00	11.00	12.00	13.00	11.50
Mean (B)	8.42	9.50	9.92	10.67		8.67	9.58	10.42	10.92	
L.S.D. at 5 %	P= 0.50		B= 0.42		P×B= 0.88	P= 0.53		B= 0.46		P×B= 0.95
	Dry weight per plant (g)									
Control	42.67	44.97	47.10	47.17	45.48	40.80	43.37	48.37	48.13	45.17
15.5	44.33	46.90	48.30	49.87	47.35	41.70	47.60	48.97	50.70	47.24
31.0	45.30	49.97	52.73	56.30	51.08	45.63	49.60	51.17	55.50	50.48
46.5	44.87	48.83	51.23	55.00	49.98	46.20	50.53	52.57	54.03	50.83
Mean (B)	44.29	47.67	49.84	52.08		43.58	47.78	50.27	52.09	
L.S.D. at 5 %	P= 0.59		B= 0.44		P×B= 0.96	P= 1.00		B= 0.80		P×B= 1.70

macro- and micro-nutrients, which play an effective role in the growth and development of plants. It was noted from the results of the current study that the growth of coriander plants improved compared to the control. Likewise, Khalid (2012) noticed that the most effective rate was nitrogen and phosphorus plus trace elements fertilization, resulting in a positive enhance in vegetative growth traits of anise, sweet fennel and coriander. Furthermore, EL-Zefzafy et al. (2016) found that all amino acid treatments increased the growth traits of Artemisia abrotanum.

The combination of phosphorus fertilization (31.0 kg P_2O_5/ feddan) and biomagic (7.0 g/l) rates gave the highest values of coriander height (119.50 and 124.00 cm), branches number per plant (12.67 and 13.33 branches) and total dry weight (56.30 and 55.50 g/ plant), in the 1st and 2nd seasons, respectively as presented in Table 2. Increasing the phosphorus fertilization rate up to 31.0 kg P_2O_5/ feddan under any biomagic rate gradually increased coriander growth parameters in both seasons. Moreover, under any phosphorus rates increasing biomagic gradually increased plant growth parameters. Furthermore, as was already noted, both P fertilization and biomagic treatments (each alone) accelerated coriander growth; hence, when combined, they maximize their benefits, resulting in the tallest plant, the most branches per plant, and the plant with the greatest dry weight.

3.2.Yield and its components

All phosphorus fertilization rates (15.5, 31.0, and 46.5 kg P_2O_5/ feddan) significantly enhanced the number of umbels per plant as well

as fruit yield per plant (g) and per feddan (kg) compared to untreated plants with phosphorus in both seasons (Table 3). The highest fruit yield per feddan (1319.3 and 1347.4 kg/ feddan) was recorded when coriander plants fertilized with 46.5 kg P_2O_5/ feddan, followed by 31.0 kg P_2O_5/ feddan which gave (1295.6 and 1328.2 kg/ feddan) in 1st and 2nd seasons, respectively with no significant differences between 31 and 46.5 P_2O_5 in the 2nd season. Phosphorus fertilization accelerated coriander growth parameters resulting in more umbels per plant, heaviest plant and feddan yields.

Table 3. Influence of phosphorus fertilization (P), biomagic rate (B) and their interaction treatments (P×B) on number of umbels per plant and fruit yield/ plant (g) and / feddan (kg) of coriander plant during 2021/2022 and 2022/2023 seasons

Phosphorus fertilization (P_2O_5 kg/ feddan) (P)	Biomagic (ml/l) (B)									
	0.0	3	5	7	Mean (P)	0.0	3	5	7	Mean (P)
	2021/2022 season					2022/2023 season				
	Number of umbels per plant									
Control	34.00	38.33	41.67	49.00	40.75	36.67	41.67	46.00	52.00	44.08
15.5	36.00	41.33	49.33	55.67	45.58	39.67	44.33	50.00	58.33	48.08
31.0	37.67	44.00	49.33	58.33	47.33	41.33	46.33	53.67	62.67	51.00
46.5	39.33	50.33	53.33	59.00	50.50	42.33	49.00	53.67	61.67	51.67
Mean (B)	36.75	43.50	48.42	55.50		40.00	45.33	50.83	58.67	
L.S.D. at 5 %	P= 0.77		B= 0.89	P×B= 1.72		P= 1.15		B= 0.60	P×B= 1.54	
	Fruit yield per plant (g)									
Control	11.33	12.50	13.77	14.33	12.98	11.77	12.00	13.43	14.50	12.93
15.5	11.80	12.93	13.93	15.60	13.57	12.47	13.67	15.07	25.60	14.20
31.0	13.00	13.90	15.50	15.90	14.58	13.40	14.33	16.03	16.00	14.94
46.5	13.53	13.90	15.73	16.20	14.84	14.00	14.67	15.63	16.33	15.16
Mean (B)	12.42	13.31	14.73	15.51		12.91	13.67	15.04	15.61	
L.S.D. at 5 %	P= 0.16		B= 0.19	P×B= 0.37		P= 0.36		B= 0.22	P×B= 0.52	
	Fruit yield per feddan (kg)									
Control	1007.4	1111.1	1223.7	1274.1	1154.1	1045.9	1066.7	1194.1	1288.9	1148.9
15.5	1048.9	1149.6	1238.5	1386.7	1205.9	1108.1	1214.8	1339.3	1386.7	1262.2
31.0	1155.6	1235.6	1377.8	1413.3	1295.6	1191.1	1274.1	1425.2	1422.2	1328.2
46.5	1203.0	1235.6	1398.5	1440.0	1319.3	1244.4	1303.7	1389.6	1451.9	1347.4
Mean (B)	1103.7	1183.0	1309.6	1378.5		1147.4	1214.8	1337.0	1387.4	
L.S.D. at 5 %	P= 14.7		B= 16.9	P×B= 32.6		P= 31.6		B= 19.2	P×B= 45.9	

In addition, Moslemi *et al*. (2012) showed that application of phosphorous significantly increased all yield and coriander yield components compared to control. In the same line, Javiya *et al*. (2017) suggested that, coriander yield attributes *viz*., number of umbels per plant, weight of fruits per plant, total fruits yield per hectare of coriander up to 40 kg P_2O_5/ha, the yield shown a positive correlation with the increasing concentration of P_2O_5, but, it did not reach a statistically significant level.

Yield components of the coriander plant (umbels number, fruit yield per plant and per feddan) significantly enhanced when coriander plants were sprayed with biomagic 4 times/seasons at different rates (3, 5 and 7 ml/l) under study compared to control in both seasons (Table 3). The increase in fruit yield per feddan of coriander plant were about 79.3 and 67.4 kg for

3.0 ml/l, 205.9 and 189.6 kg for 5.0 ml/l and 274.8 and 240.0 kg/ feddan for 7.0 ml/l over the control, in 1st and 2nd seasons, respectively. The increase in total yield of coriander plant supplemented with biomagic product may be due to the availability of micro and macro nutrients, amino acids and vitamins to coriander leaves and herb, which ultimately resulted in better growth (Table 2) that lead to more number of umbels/plant and this in turn increased total fruit yield per unit. According to Izgi *et al*. (2020), phosphorus doses have a significant favorable impact on the coriander plant's characteristics, including the number of umbels and fruit yield.

Increasing biomagic rates from 3 to 7 ml/l under each rate of phosphorus significantly increased umbels number per plant and fruit yield per plant and per feddan in both seasons (Table 3), in most cases. The best combination treatments 31.0 and 46.5 kg P_2O_5/ feddan combined with 7 ml/l biomagic for increasing umbels number/ plant as well as dry fruit yield/ plant (g) and/ feddan (kg) in comparison with the other combinations in the two consecutive seasons. Furthermore, the increase in coriander fruit yield per feddan was about 432.6 and 406.0 kg/ feddan for combination between 46.5 kg P_2O_5/ feddan with 7.0 ml biomagic /l compared to the control, in 1st and 2nd seasons, respectively. This means that P_2O_5 at 31 kg/feddan and biomagic at 7 ml/l increased umbels number/ plant as well as dry fruit yield/ plant and/ feddan.

Moreover, coriander plants produced the most umbels per plant and 1000 seeds per plant with 45 kg P/ha (Jan *et al*., 2011). The medium dose of P, according to Kumar *et al*. (2015), also produced the greatest results in terms of seed output per hectare, seed weight, and straw weight per coriander plant. According to Hossain and Pariari (2018), using 40 kg P_2O_5/hectare considerably increased the umbels number per coriander plant and the amount of seed produced per hectare. In terms of the biomagic effect, Abd El-Moaty and El-Sayed (2016) showed that the biomagic treatment was the best one and provided a highly significant increase in flowers dry weight per marigold plant compared to the control treatment.

3.3.Chemical and volatile oil constituents

Total chlorophyll content in coriander leaves as well as total carbohydrates and phosphorus percentages significantly rose by using any phosphorus fertilization rate compared to control (Table 4). The highest values in this connection were produced with the highest rate of phosphorus (46.5 kg P_2O_5/ feddan) in both seasons. According to Abd ELAziz and Mohammad (2018) reported that the treatment (160.8 kg/ha of P_2O_5) significantly outperformed the other treatments in terms of its impact on phosphorus, crude protein and nitrogen, whereas the treatment (214.4 kg/ha) enhanced the phosphorus content of seeds in each of these three categories. All phosphorus fertilization rates (15.5, 31.0 and 46.5 kg P_2O_5/ feddan) significantly increased production of volatile oil (volatile oil %, yield/plant as ml and yield/ feddan as l) compared to control in the two seasons (Table 5). With acceptable parameters for the chemical profile, the significant equations found permitted the calculation of the dose of 77 mg/dm3 of phosphorus for maximal volatile oil production (Peçanha *et al*., 2021).

Utilizing biomagic as a foliar spray (4 times/ seasons) significantly increased leaves total chlorophyll content as well as total carbohydrates and total phosphorus in fruits in comparison with control (Table 4). Generally, increasing biomagic rates up to 7 ml/l gradually increased volatile oil percentage as well as volatile oil yield per plant and per feddan (Table 5). The increase in volatile oil yield per feddan of coriander plant were about 0.85 and 1.31 l/ feddan for 3.0 ml/l, 2.65 and 2.93 l/ feddan for 5.0 ml/l and 3.80 and 3.67 l/ feddan for 7.0 ml/l, in 1st and 2nd seasons, respectively. In the same line, Hashem (2007) on thyme plants pointed out that using complete fertilizer and biomagic significantly enhanced total carbohydrates and phosphorus percentages as well as total chlorophyll content and volatile oil production compared to control. In general, these results may be due to the biomagic contents of vitamins, amino acids and some micro and macro nutrients (Hafez, 2013).

Table 4. Influence of phosphorus fertilization (P), biomagic rate (B) and their interaction treatments (P×B) on total chlorophyll content (SPAD unit) as well as total carbohydrates and total phosphorus percentages of coriander plant during 2021/2022 and 2022/2023 seasons

Phosphorus fertilization (P_2O_5 kg/ feddan) (P)	Biomagic (ml/l) (B)									
	0.0	3	5	7	Mean (P)	0.0	3	5	7	Mean (P)
	2021/2022 season					2022/2023 season				
	Total chlorophyll content (SPAD)									
Control	32.33	33.33	33.67	36.33	33.92	30.33	31.67	32.67	36.67	32.83
15.5	32.33	35.33	37.67	41.33	36.67	33.00	37.33	38.33	40.33	37.25
31.0	34.33	39.33	41.33	42.67	39.42	35.33	38.67	39.33	42.33	38.92
46.5	37.33	41.33	42.33	43.33	41.08	37.00	40.00	41.67	42.33	40.25
Mean (B)	34.08	37.33	38.75	40.92		33.92	36.92	38.00	40.42	
L.S.D. at 5 %	P= 0.43		B= 0.49	P×B= 0.95		P= 0.67		B= 0.71	P×B= 1.39	
	Total carbohydrates (%)									
Control	14.23	14.50	14.77	14.47	14.49	14.40	14.30	14.50	14.87	14.52
15.5	14.67	14.87	15.23	16.33	15.28	14.93	15.20	15.70	16.67	15.63
31.0	15.33	15.57	16.47	17.73	16.28	14.70	16.00	17.20	17.83	16.43
46.5	15.13	16.13	17.90	18.30	16.87	15.23	15.83	17.47	17.80	16.58
Mean (B)	14.84	15.27	16.09	16.71		14.82	15.33	16.22	16.79	
L.S.D. at 5 %	P= 0.11		B= 0.09	P×B= 0.20		P= 0.15		B= 0.12	P×B= 0.25	
	Total phosphorus (%)									
Control	0.320	0.337	0.333	0.340	0.333	0.333	0.343	0.343	0.350	0.343
15.5	0.350	0.367	0.383	0.397	0.374	0.347	0.387	0.403	0.417	0.388
31.0	0.353	0.377	0.407	0.453	0.398	0.377	0.407	0.423	0.463	0.418
46.5	0.377	0.393	0.423	0.443	0.409	0.387	0.413	0.433	0.457	0.423
Mean (B)	0.350	0.368	0.387	0.408		0.361	0.388	0.401	0.422	
L.S.D. at 5 %	P= 0.011		B= 0.005	P×B= 0.014		P= 0.008		B= 0.007	P×B= 0.014	

Concerning the combination effect, using phosphorus fertilization at 31.00 or 46.50 kg P_2O_5/ feddan combined with 7 ml biomagic/l significantly improved total chlorophyll content, total carbohydrates, total phosphorus (Table 4) as well as volatile oil % and yield per plant and per feddan (Table 5) compared to the other combination treatments in both seasons. All combination treatments significantly increased chemical constituents and volatile oil production of the coriander plant compared to control (without phosphorus and biomagic application).

The results obtained from Gas liquid chromatographic analysis in Figs 1, 2 and 3 pointed out that in most cases the combined treatments between phosphorus fertilization at 31.00 kg P_2O_5/ feddan with foliar spray of biomagic at 7 ml/l gave the highest values of coriander volatile oil main active constitutes (linalool, gamma- terpinene, camphor, P-cymene, Alpha-pinene, Beta-pinene, Geranyl acetate, limonene and Citronellol) compared to control. While, the highest values of Geraniol was obtained from 46.5 kg P_2O_5/ feddan with foliar spray of biomagic at 7 ml/l compared to the other ones.

Table 5. Influence of phosphorus fertilization (P), biomagic rate (B) and their interaction treatments (P×B) on volatile oil percentage, volatile oil yield /plant (ml) and /feddan (l) of coriander plant during 2021/2022 and 2022/2023 seasons

Phosphorus fertilization (P_2O_5 kg/ feddan) (P)	Biomagic (ml/l) (B)									
	0.0	3	5	7	Mean (P)	0.0	3	5	7	Mean (P)
	2021/2022 season					2022/2023 season				
Volatile oil percentage										
Control	0.673	0.687	0.727	0.753	0.710	0.653	0.670	0.710	0.733	0.692
15.5	0.693	0.733	0.773	0.827	0.757	0.710	0.757	0.767	0.797	0.758
31.0	0.720	0.727	0.837	0.890	0.793	0.693	0.790	0.863	0.903	0.813
46.5	0.747	0.780	0.850	0.890	0.817	0.737	0.840	0.920	0.927	0.856
Mean (B)	0.708	0.732	0.797	0.840		0.698	0.764	0.815	0.840	
L.S.D. at 5 %	P= 0.011		B= 0.007	P×B= 0.016		P= 0.012		B= 0.008	P×B= 0.018	
Volatile oil yield per plant (ml)										
Control	0.076	0.086	0.100	0.108	0.093	0.077	0.080	0.095	0.107	0.090
15.5	0.082	0.095	0.108	0.129	0.103	0.088	0.104	0.115	0.124	0.108
31.0	0.094	0.101	0.130	0.141	0.116	0.093	0.113	0.138	0.145	0.122
46.5	0.101	0.109	0.134	0.144	0.122	0.103	0.123	0.144	0.152	0.131
Mean (B)	0.088	0.098	0.118	0.131		0.090	0.105	0.123	0.132	
L.S.D. at 5 %	P= 0.002		B= 0.001	P×B= 0.003		P= 0.003		B= 0.002	P×B= 0.004	
Volatile oil yield per feddan (l)										
Control	6.72	7.63	8.90	9.60	8.21	6.83	7.15	8.48	9.45	7.98
15.5	7.27	8.43	9.58	11.46	9.19	7.87	9.19	10.26	11.04	9.59
31.0	8.32	8.98	11.53	12.58	10.35	8.26	10.06	12.30	12.85	10.87
46.5	8.98	9.64	11.89	12.82	10.83	9.17	10.95	12.78	13.46	11.59
Mean (B)	7.82	8.67	10.47	11.62		8.03	9.34	10.96	11.70	
L.S.D. at 5 %	P= 0.24		B= 0.12	P×B= 0.31		P= 0.24		B= 0.17	P×B= 0.38	

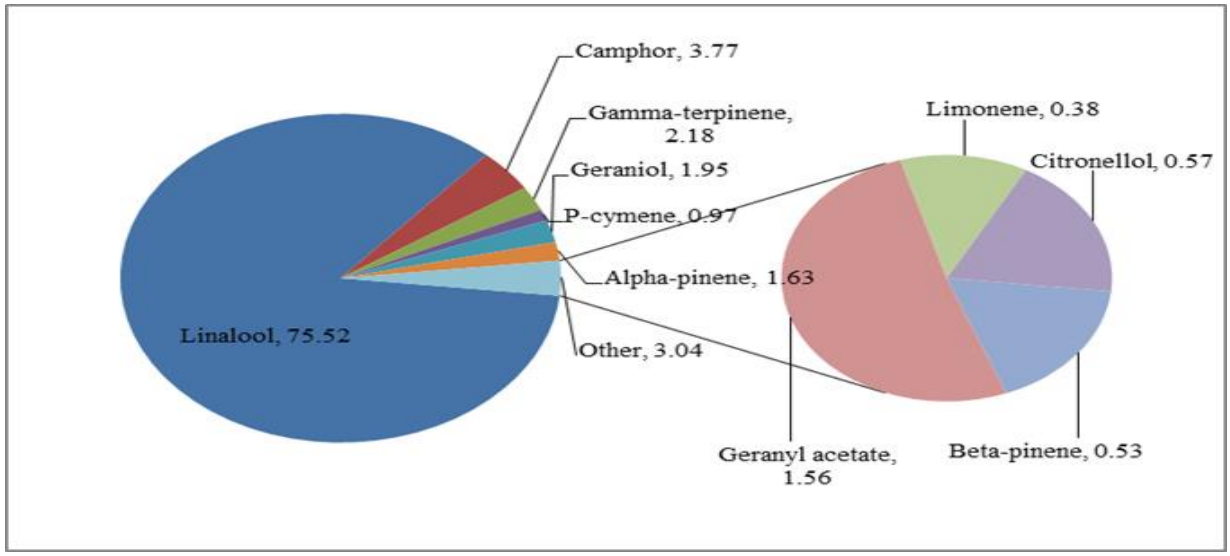

Fig. 1. Active ingredients of coriander volatile oil under control

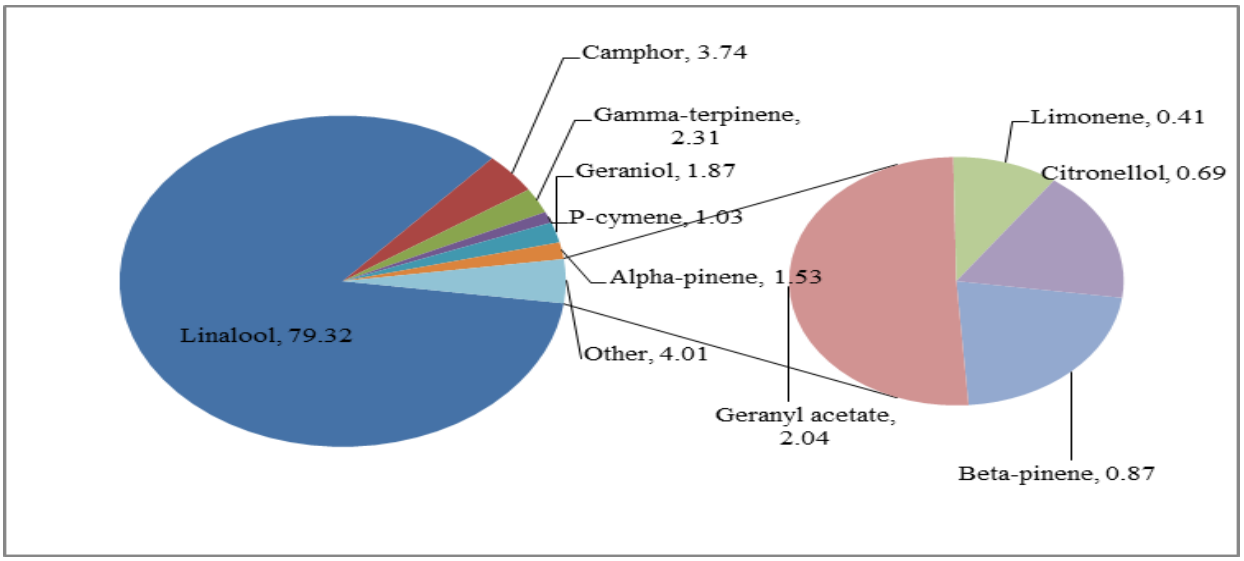

Fig. 2. Active ingredients of coriander volatile oil under combination treatment between 31.00 kg P_2O_5/ feddan combined with 7 ml biomagic/l

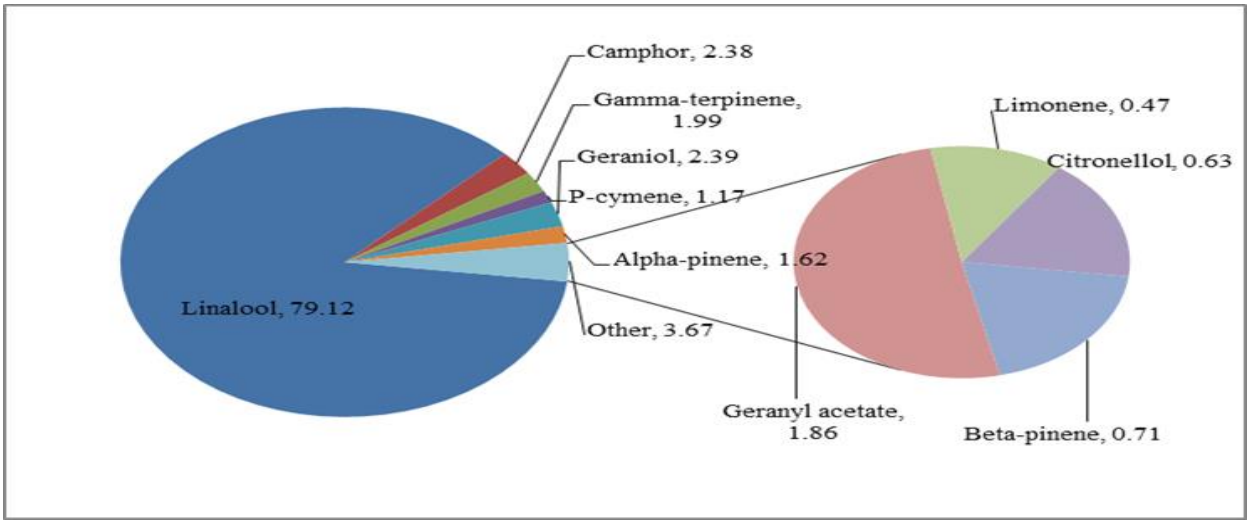

Fig. 3. Active ingredients of coriander volatile oil under combination treatment between 46.50 kg P_2O_5/ feddan combined with 7 ml biomagic/l

4. CONCLUSION

Based on the findings, it is recommended to apply a biomagic rate of 7.0 ml/l to *Coriandrum sativum* plants, combined with a phosphorus fertilization rate of 31.0 kg P_2O_5/ feddan, in order to promote the growth, yield components, volatile oil production, and chemical constituents of coriander plant under the conditions of Sharkia Governorate.

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الملخص العربي

تقييم النمو ومحصول الثمار وإنتاجية الزيت الطيار والمكونات الكيميائية للكزبرة تحت معدلات مختلفة من التسميد الفوسفوري والبيوماجيك

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أجريت تجربة حقلية بقرية طحا المرج بمركز ديرب نجم، محافظة الشرقية، مصر خلال الموسمين المتتاليين ٢٠٢١/٢٠٢٢ و٢٠٢٢/٢٠٢٣. وذلك، لتقييم تأثير معدلات التسميد المختلفة من الفسفور (صفر، ١٥,٥، ٣١,٠ و٤٦,٥ كجم فو٢أ٥/ فدان)، ومعدلات البيوماجيك (صفر، ٣، ٥ و٧ مللي/ لتر) ومعاملات التداخل بينهما على نمو وإنتاجية نباتات الكزبرة. أشارت النتائج إلى أن تسميد نبات الكزبرة بـ ٣١ كجم فو٢أ٥/ فدان أدى إلى زيادة معنوية في ارتفاع النبات وعدد الأفرع للنبات والوزن الجاف الكلي للنبات مقارنة بمعدلات الفسفور الأخرى. علاوة على ذلك، فإن أعلى النتائج المحصولية (عدد النوارات للنبات ومحصول الثمار للنبات والفدان) وإنتاجية الزيت العطري (نسبة الزيت العطري المئوية ومحصول الزيت العطري للنبات والفدان) وكذلك محتوى الكلوروفيل الكلي والنسب المئوية للكربوهيدرات الكلية والفسفور الكلي تم الحصول عليها بالتسميد بمعدل ٤٦,٥٠ كجم فو٢أ٥/ فدان. وبشكل عام سجلت أفضل المعاملات في جميع الصفات المدروسة للكزبرة عند رش النباتات ٤ مرات/الموسم بـ ٧ مللي بيوماجيك/ لتر مع وجود فروق معنوية مع المعدلات الأخرى تحت الدراسة. وفي معظم الحالات، سجلت نباتات الكزبرة المسمدة بـ ٣١ كجم فو٢أ٥/ فدان والرش بـ ٧ مللي/ لتر من البيوماجيك أعلى القيم في النمو والمحصول وإنتاج الزيت الطيار دون فروق معنوية بينهما. أخيرا، كشف التحليل الكروماتوجرافي أن المكونات الرئيسية للزيت الطيار هي الليناليول، والكافور، والألفا والبيتا سايمين والجيرانيول، وجاما تربينين، وألفا بينين.

الكلمات المفتاحية: الكزبرة، الفسفور، البيوماجيك، النمو، محصول الثمار، الزيت الطيار، الكلوروفيل