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RESEARCH ARTICLE

Growth and yield of caraway plants (*Carum carvi* L.) as influenced by organic fertilizer and moringa leaves extract under newly reclaimed soils

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Abstract

An experiment was carried out during the two winter seasons of 2020/ 2021 and 2021/ 2022 at Agriculture Research Station of Al-Marashda, Qena Governorate as newly reclaimed soil, Egypt to evaluate the growth, yield and its attributes of caraway plants (*Carum carvi* L.) under organic fertilizer and moringa leaves extract. The experiment was arranged in a split-plot applied by randomized complete block design (RCBD) with three replicates. Four levels of organic fertilizer (Ramada; the commercial name is Kunuz Al Ard) obtained from AGIAD company, Cairo, Egypt (0, 1, 2 and 3%) were presented in the main-plots, while moringa leaves extract treatments (0, 2.5 and 5 %) were assigned to sub-plots as foliar spraying of the caraway plants. The control plots were supplied with the recommended dose of mineral fertilizers NPK, while 50% of these amounts were supplied for other plots of the experiment. Obtained results proved the superiority of organic fertilizer and/ or moringa leaves extract via inducing growth performance, yield and its component of *Carum carvi* plants in comparing with the chemical fertilizer only. However, the most increment of the vegetative parameters as plant height, number of branches and fresh and dry weight of herb/ plant were recorded with caraway plants that supplied with 3 % organic fertilizer and 5% moringa leaves extract. Compared to the other treatments, the yield characteristics of caraway were driven by the same treatment. While the optimum percentages of volatile oils, total carbohydrates, phosphorus, and potassium contents were primarily found when caraway plants were treated with 3% of an organic fertilizer and 2.5% of an extract produced from moringa leaves.

Keywords: caraway plants; *Carum carvi* L.; Moringa leaves extract; Organic fertilizer.

1. Introduction

The Caraway (*Carum carvi* L.) is an aromatic biennial plant belongs to Apiaceae family and native to Europe, Asia and North Africa. Its fruitsare a schizocarp and called commonly as seeds with characteristic flavor and aroma (Iacobellis *et al*., 2005). The seeds have many uses in foods, soft drinksand they have allelopathic potential.Its oil has distinct antifungal, antioxidant and antibacterial properties as well as having a wide range of uses in pharmaceutical, cosmetics and health care industry (Seidler-Łozykowska *et al*., 2014).It is known that the growth, yield and composition of volatile oil are genetically determined, but it also depends on the soil and climatic conditions during stages of growth, fruit formation and ripening (Sedlakova *et al*., 2003). Agro technique is also very important for the growing of this plant, among which are growing media and fertilization (NurzyĔska-Wierdak, 2013). The moringa leaf extract has the ability to operate as a natural growth stimulant because it is a natural derivative of phenolics, cytokinin, vitamin E, proteins, vital amino acids, ascorbates, and various mineral components (Rady *et al*., 2015).

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Moreover, many studies showed that moringa extract plays as a plant hormone in enhancing growth, antioxidant content and yield of crops (Sakr*et al*., 2018). Maximum growth parameters and total fruit yield and fruit chemical contents of pepper were to apply moringa leaves extract at 4% (Abou El-Nour and Ewais, 2018).

In the most developing countries, the cost of chemical fertilizer is often limited to small scale farms, since farmers are typically resource poor (Smestad *et al*., 2002). It is imperative that other sustainable alternatives for soil fertility management are researched to improve crop production and, consequently, improved food security. Alternatively, organic fertilizers can be used as safety source for plant nutrients and increase the long-term sustainability of agricultural ecosystems (Shaji *et al*., 2021). Organic fertilizers are important for the medicinal and aromatic plants to produce the best quantity and quality and it is also very safe for human health and environment. This is made by recycling organic materials as plant and animal wastes and food scraps in a controlled process. Organic fertilizers can serve as alternative to the mineral ones for improving soil structure (Dauda *et al*., 2008) and microbial activities (Suresh *et al*., 2004). Results of Ali *et al.* (2016) proved that using organic fertilization improved the plant height, herb dry weight/ plant and fruit yield of khella plants. El-Banna and Fouda (2018) revealed that organic fertilizer improved growth and yield of caraway plants and the results were in harmony with Sharaf-El-Deen *et al*. (2012) on fennel and Darzi (2012) on dill plants. Thereby, in light of the foregoing, this field experiment was conducted to evaluate the use of Ramada as organic fertilizer and moringa leaves extract on the growth and yield components of caraway plants under newly reclaimed soils.

2. Material and methods

The present work was conducted during the two seasons of 2020/ 2021 and 2021/ 2022 at the Agricultural Research Station of Al-Marashda, Qena Governorate, ARC, Egypt (26° 9' N, 32° 42' E). Seeds of *Carum carvi* L. were obtained from the Medicinal and Aromatic Plants Department, Agricultural Research Center and sown on 1st November in both seasons. The experiment area was divided into plots of 10.5 m^2 (3.5 m length and 3.0 m width) including seven rows with 50 cm in width and each row contained 12 hills (84 plant per plot or 33600 plants per feddan). Thinning was performed two weeks after planting to maintain two plants per hill. Three weeks after seed sowing, thinning took place by leaving one plant per hill. Some physical and chemical properties of the soil under study were shown in Table 1. Drip irrigation is used to irrigate caraway plants as necessary, depending on the soil's condition and the water analysis provided in Table 2. Throughout the two seasons under study, all additional caraway plant cultural procedures were carried out.

Table 1. The physical and chemical characteristics of soil the experimental site.

Texture	Particle size distribution			$CaCO_3$ %		EC(dSm^{-1}	pH
class	Sand %	Silt %	Clay %			(1 : 2.5)	(1-5)
Sandy	81.1	12.6	6.3	12.50		3.00	8.03
Cation (meq L^{-1})				Anion (meq L^{-1})			
Na^+	K^+	Ca^{++}	Mg^{++}	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}
30.02	0.88	11.10	6.2	0.0	0.70	30.2	17.3

Table 2. Chemical analysis of the water used as drip irrigation.

TDS	pH	EC(dSm^{-1})	Soluble cations (mg/l.)				Soluble anions (mg/l.)			
mg/l	(1 : 5)	(1 : 2.5)	Ca^{++}	Mg^{++}	Na^+	K^+	CO_3^{--}	HCO_3^-	$SO4^{--}$	CL^-
225.0	7.5	3.22	28.2	8.5	31.1	6.4	24.3	110.2	41.1	31.0

2.1. Preparation of moringa leaves extract

Moringa leaves were dried in an electric oven at 70º C for 48 hr., then grind in a grindery and passed through a 40mesh screen. 50 g of each ground leaves were macerated in 500 ml distilled water. Solution was placed in orbital shaker at room temperature for 24 hr. The extract was filtered using Whatman filter paper No.1 (Bashir *et al.*, 2014). The obtained extract was diluted to achieve the concentrations of 2.5 and 5%. Each aqueous extract was applied three times after one month from sowing and after each two weeks later. The control plots were supplied with the tap water as foliar spray. The mineral contents of moringa leaves extract were shown in Table 3.

Table 3. Mineral content of the used moringa leaves extract (mg/100g DW).

Macro-elements					Micro-elements				
N	P	K	Ca	Mg	Fe	Zn	Mn	B	Cu
21.0	7.3	10.8	30.1	2.5	1.0	23.4	42.3	33.1	11.5

Ramada as organic fertilizer (Kunuz Al Ard) obtained from AGIAD company, Cairo, Egypt; used at the concentration of 1, 2 and 3% as foliar spray until drop-off by using a hand-sprayer at three times, after 30, 60 and 100 days from sowing. View of Ramada (organic fertilizer) used in the experiment was shown in Table 4. Physical and chemical analyses of the soil used in the experiment, water analysis as well as mineral contents of moringa leaves extract were carried out at the laboratory of water and soil analysis, Qena Agriculture Directorate, Ministry of Agriculture, Egypt.

Table 4. View of Ramada (organic fertilizer) used in the experiment.

Trade name	Zn	Fe	Mn	Amino acids	B
Ramada (Kunuz Al Ard)	1.5%	1%	1.5%	10.25%	1%

2.2. Experimental design

The experiment was arranged in a split- plot in a randomized complete block design (RCBD) and contained of 12 treatments. Four levels of Ramada as organic fertilizer (0, 1, 2 and 3%) were presented in the main-plots, while spraying with moringa leaves extract treatments i.e. 0, 2.5 and 5 % at three times per season were assigned in sub-plots for foliar spraying the caraway plants. The control plots were supplied with the recommended dose of mineral fertilizers NPK i.e. 200 Kg/ fed calcium superphosphate (9-10% P) was added during the preparation of soil for cultivation, 300 Kg/ fed ammonium sulfate (20.5 % N) and 50 Kg/ fed potassium sulphate (40 % K) were added in two equal doses, the 1st dose was added one month after sowing and the 2nd one was applied at the flowering stage. Meanwhile, the rest of the experimental plots were supplied with 50% of the quantity that was added to the control plots.

2.3. Recorded data

A random sample of nine plants from each treatment were taken at the harvesting stage for determination of vegetative growth, i.e., plant height, branches number, herb fresh and dry weight. Fruit characteristics as umbels number/ plant (cm), weight of 1000-fruit (g), fruit yield/ plant (g) and fruit yield/ feddan (kg) were recorded. The chemical constituents in herb as total N, P and K were determined according to Mertens (2005 a &b). Total carbohydrates content (%) in leaves was determined calorimetrically according to Herbert *et al*. (1971). Volatile oil percentage in fruits was extracted by hydro-distillation as described by Guenther (1961).

2.4. Statistical analysis

The obtained data were statistically analyzed and means were compared with the least significant differences (L.S.D) test at 0.05 % according to the method of Gomez and Gomez (1984).

3. Results and discussion

3.1. Vegetative growth traits

The influence of organic fertilizer and moringa leaves extract foliar application on the tested vegetative growth i.e. plant height, number of branches/ plant as well as herb fresh and dry weight of caraway plant for the two seasons were shown in Table 5. It was proved that application of organic fertilizer treatments was significantly improved these traits compared to the control. The highest values of growth parameters were recorded with 3%, followed by 2% levels of organic fertilizer compared to apply full mineral fertilization in the 1st and 2nd seasons. On the other side, the different vegetative traits of caraway plants were significantly increased by spraying of moringa leaves extract in both seasons. Moreover, the highest values of the studied traits were due to apply 5% moringa leaves extract. The effect of interaction between the organic fertilizer and moringa extract was significantly different.

Table 5. Influence of organic fertilizer and moringa extract treatments on the plant height (cm), No. of branches/ plant, herb FW/ plant (g) and herb DW/ plant (g) of caraway plants during 2021 and 2022 seasons.

Organic fertilizer Treatments (%) (Ramada)	Moringa leaves extract (%)							
	1st season				2nd season			
	Plant height (cm)							
	0	2.5	5	Mean A	0	2.5	5	Mean A
Control	85.37	87.37	89.37	87.37	83.87	87.80	90.03	87.23
1	88.27	89.73	96.30	91.43	86.27	90.17	97.30	91.24
2	90.10	91.97	98.23	93.43	89.90	91.30	98.90	93.37
3	93.63	93.87	105.90	97.80	92.70	92.87	107.10	97.56
Mean B	89.34	90.73	97.45		88.18	90.53	98.33	
LSD 5%	A=0.91 B=1.04 AB=1.93				A=0.90 B=0.99 AB=1.85			
	Number of branches/ plant							
Control	9.30	10.60	11.53	10.48	8.83	10.43	11.13	10.13
1	10.27	11.57	12.47	11.43	9.87	11.40	12.23	11.17
2	11.33	12.20	13.63	12.39	10.83	12.00	13.40	12.08
3	12.13	13.03	14.63	13.27	11.80	12.83	14.27	12.97
Mean B	10.76	11.85	13.07		10.33	11.67	12.76	
LSD 5%	A=0.43 B=0.31 AB=0.66				A=0.63 B=0.30 AB=0.80			
	Herb fresh weight/ plant (g)							
Control	242.33	254.33	266.33	254.33	244.00	257.00	267.33	256.11
1	246.00	257.67	274.67	259.44	247.67	261.67	276.00	261.78
2	255.00	265.67	278.00	266.22	257.00	267.67	279.67	268.11
3	263.00	274.33	284.00	273.78	266.00	275.67	286.00	275.89
Mean B	251.58	263.00	275.75		253.67	265.50	277.25	
LSD 5%	A=3.8577 B=2.25 AB=5.31				A=4.07 B=2.29 AB=5.51			
	Herb dry weight/ plant (g)							
Control	92.67	97.67	111.00	100.44	91.67	95.67	110.00	99.11
1	97.33	106.00	120.00	107.78	94.67	103.00	118.67	105.44
2	103.67	113.00	126.67	114.44	102.00	112.33	125.00	113.11
3	107.67	120.33	135.00	121.00	106.00	119.00	132.00	119.00
Mean B	100.33	109.25	123.17		98.58	107.50	121.42	
LSD 5%	A= 3.20 B=1.84 AB=4.37				A=3.63 B=1.58 AB=4.44			

The most increment of the tested vegetative parameters was recorded with caraway plants received 3 % organic fertilizer plus 5% moringa leaves extract in the two studied seasons. Our results revealed that the possibility of partial replacement of the chemical fertilizers by adding

organic fertilizer and bio stimulators to improve the plant growth parameters of caraway plants as compared with the recommended dose of NPK. The importance of using of chemical fertilizers at 50% quantity may be due to the vital role of mineral fertilizer in the different physiological and biochemical processes like cell division, cell elongation and metabolism of protein and carbohydrate compounds (Marschener, 1995). These results were in agreed with that of El-Banna and Fouda (2018). Similar results were found by Basra (2011) and Abou El-Nour and Ewais (2018) who illustrated that moringa leaves extract was the active inducer to increase growth characteristics of caraway plants. The positive effects of moringa extract may be due to the presence of growth-promoting substances that improved the growth (Muhammad *et al*., 2013). Moreover, the positive effects of organic fertilizer on caraway plants were in accordance with those reported by Ali *et al*. (2016).These effects of organic fertilizer may be due to its effect on physical, chemical and biological properties of the soil as well as it provides soil with essential elements like N, P, S and some micro elements after its mineralization under soil conditions (El-Banna and Fouda, 2018).

3.2. Fruit yield and its attributes

Caraway fruit yield and its attributes as affected by organic fertilization, moringa leaves extract and their interactions are shown in Table 6. Data pointed out that the yield parameters were significantly affected by the studied factors in 1st and 2nd seasons.

Table 6. Influence of organic fertilizer and moringa extract treatments on the number of umbels/ plant, weight of 1000- fruits (g), fruit yield/ plant (g) and fruit yield/ feddan (kg) of caraway during 2021 and 2022 seasons.

Organic fertilizer Treatments (%) (Ramada)	Moringa leaves extract (%)							
	1st season				2nd season			
	Number of umbels/ plant							
	0	2.5	5	Mean A	0	2.5	5	Mean A
Control	41.67	46.33	52.67	46.89	44.00	48.00	53.67	48.56
1	45.33	52.67	63.00	53.67	47.00	55.00	64.00	55.33
2	50.00	57.67	70.33	59.33	51.33	59.00	71.00	60.44
3	55.67	63.67	75.33	64.89	56.67	65.00	76.00	65.89
Mean B	48.17	55.08	65.33		49.75	56.75	66.17	
LSD 5%	A=1.54 B=1.14 AB=2.41				A=1.82 B=1.12 AB=2.57			
	Weight of 1000- fruits (g)							
Control	6.47	7.70	8.73	7.63	6.73	7.83	8.93	7.83
1	7.27	8.40	9.60	8.42	7.73	8.70	9.80	8.74
2	8.47	9.27	11.20	9.64	8.73	9.77	11.50	10.00
3	9.60	10.40	12.37	10.79	9.43	10.60	12.67	10.90
Mean B	7.95	8.94	10.48		8.16	9.23	10.73	
LSD 5%	A=0.398 B=0.213 AB=0.527				A=0.307 B=0.156 AB=0.398			
	Fruit yield/ plant (g)							
Control	15.00	17.00	19.00	17.00	16.00	18.00	20.00	18.00
1	17.00	19.33	22.67	19.67	18.00	20.33	23.67	20.67
2	18.00	21.00	27.00	22.00	19.33	22.00	28.00	23.11
3	20.00	22.67	31.67	24.78	21.67	23.67	32.67	26.00
Mean B	17.50	20.00	25.08		18.75	21.00	26.08	
LSD 5%	A=0.922 B=0.677 AB=1.436				A=0.922 B=0.629 AB=1.377			
	Fruit yield/ feddan (kg)							
Control	503.80	571.20	638.40	571.13	537.60	604.80	672.00	604.80
1	571.20	649.33	761.60	660.71	604.80	683.20	795.20	694.40
2	604.80	705.60	907.20	739.20	649.60	739.20	940.80	776.53
3	672.00	761.57	1064.00	832.52	794.67	795.20	1097.27	895.71
Mean B	587.95	671.93	842.80		646.67	705.60	876.32	
LSD 5%	A=31.12 B=22.71 AB=48.29				A=59.32 B=32.65 AB=79.55			

The highest values of umbels number/ plant were noticed with spraying with 3% organic fertilizer plus 50% NPK, while the lowest values were due to the control (full recommended NPK) in the two seasons. The presented data, also proved that the highest fruit yield traits were obtained with spraying by 5% moringa leaves extract plus 50% NPK in comparison with that of the control. Regarding the interaction between organic fertilizer and moringa extract, it is obvious that the higher yield was produced as a result of adding 3% organic fertilizer with 5% moringa extract compared to the other treatments, in the two studied seasons. The positive effects of organic fertilizer were in harmony with those mentioned by Gomaa and Youssef (2008), Sharaf-El-Deen *et al.* (2012) and Darzi (2012) and El-Banna and Fouda (2018). Moreover, the significant effects of moringa leaves extract may be attributed to its effect on the growth parameters, which increased photosynthesis and sink capacity through photo-assimilates from leaves and translocation to build high fruit quality and yield (Thomas and Howarth, 2000). Also,moringa extract is rich in zeaten like cytokinin that induced cytokinin bio-synthesis and number of photosynthetic active leaves, which reflect on plant yield (Azooz *et al*., 2004).

3.3. Phytochemical compositions

3.3.1. Essential oil percentage

Data in Table 7 demonstrated how organic fertilizer, moringa leaf extract, and their interactions during the 2020–2021 and 2021–2022 seasons affected the percentage of essential oil produced by caraway plants. The obtained results proved that there were significantly differences between the tested treatments for volatile oil percentage during both seasons. The maximum values of the volatile oil percentage (2.93 and 2.94%) were produced as a result of applying organic fertilizer at the rate of 3% in the 1st and 2ndseasons, respectively. Also, spraying caraway plants by 2.5% moringa extract obtained the highest values of volatile oil in the mean of the two seasons compared to the control. Moreover, the highest values of volatile oil percentage (3.10 and 3.20 %) were recorded mostly when caraway plants were sprayed with organic fertilizer at 3% and that sprayed with moringa leaves extract at 2.5% in the 1st and 2nd seasons, respectively. Our results revealed that, spray caraway plants with organic fertilizer is more effective for delivering macro and micro nutrients than chemical fertilizers alone.These treatments increased vegetative growth and fruit yield, which led to increase volatile oil percentage. Moreover, Prabhu *et al.* (2010) and Mazrou (2019) assured that moringa leaves extract have been discovered as bio-stimulant for improving not only crop growth but also yield. Also, Aslam *et al.* (2016) proved that plant treated with moringa leaves extract had major impacts on average rise in oil concentrations. Increasing the essential oil in coriander by moringa leaves extract could be due to its components asnutrient elements, amino acids and phytohoromes that induce the accumulation of the secondary metabolites **(**Ali *et al*., 2018).

Table 7. Influence of organic fertilizer and moringa extract treatments on volatile oil (%) of caraway during 2021 and 2022 seasons.

Organic fertilizer Treatments (%)	1st season				2nd season			
	Moringa leaves extract (%)							
(Ramada)	0	2.5	5	Mean A	0	2.5	5	Mean A
Control	2.10	2.30	2.60	2.33	2.20	2.40	2.70	2.43
1	2.40	2.67	2.70	2.59	2.50	2.70	2.73	2.64
2	2.57	2.93	2.80	2.77	2.63	3.00	2.77	2.80
3	2.80	3.10	2.90	2.93	2.83	3.20	2.80	2.94
Mean B	2.47	2.75	2.75		2.54	2.83	2.75	
LSD 5%	A=0.084	B=0.095	AB=0.175		A=0.095	B=0.069	AB=0.147	

3.3.2. Nitrogen, phosphorus and potassium contents

Nitrogen contents in *Carum carvi* leaves were significantly varied by application of organic fertilizer, moringa leaves extract as well as their interaction (Table8). Spraying organic fertilizer at the rate of 2% led to produce the higher nitrogen percentage in caraway leaves than in any other treatments for the mean of both seasons. Moreover, it can be said that spraying caraway plants with moringa leaves extract at 5% level resulted in the highest values of nitrogen content in their leaves compared to the other treatments. Regarding the effect of interaction between organic fertilizer and moringa extract, it is clearly proved that the most pronounced effect (1.81 and 1.83 %) was due to apply the combination treatment of organic fertilizer at the rate of 2% with spraying plants by 5% moringa extract in the 1st and 2nd seasons, respectively. These findings are in agreement with results previously recorded by Noor El-Deen (2005); EL-Shayeb (2009) and Sakr *et al*. (2018).

Table 8. Influence of organic fertilizer and moringa extract treatments on leaves nitrogen, phosphorus and potassium contents (%) in caraway leaves during 2021 and 2022 seasons.

Organic fertilizer Treatments (%) (Ramada)	Moringa leaves extract (%)							
	1st season				2nd season			
	Nitrogen (%)							
	0	2.5	5	Mean A	0	2.5	5	Mean A
Control	1.43	1.53	1.57	1.51	1.45	1.54	1.58	1.52
1	1.48	1.55	1.63	1.55	1.48	1.57	1.65	1.57
2	1.56	1.64	1.81	1.67	1.57	1.66	1.83	1.69
3	1.63	1.67	1.70	1.67	1.65	1.68	1.72	1.68
Mean B	1.52	1.60	1.68		1.54	1.61	1.70	
LSD 5%	A=0.030 B=0.024 AB=0.049				A=0.026 B=0.016 AB=0.037			
	Phosphorus (%)							
Control	0.36	0.39	0.41	0.39	0.35	0.37	0.40	0.37
1	0.38	0.41	0.46	0.42	0.37	0.43	0.45	0.42
2	0.40	0.49	0.47	0.45	0.39	0.52	0.46	0.46
3	0.41	0.54	0.48	0.48	0.40	0.55	0.47	0.47
Mean B	0.39	0.46	0.46		0.38	0.47	0.45	
LSD 5%	A=0.007 B=0.006 AB=0.012				A=0.010 B=0.007 AB=0.015			
	Potassium (%)							
Control	1.30	1.39	1.42	1.37	1.33	1.40	1.44	1.39
1	1.36	1.43	1.47	1.42	1.38	1.45	1.48	1.44
2	1.40	1.65	1.52	1.53	1.42	1.67	1.53	1.54
3	1.42	1.68	1.54	1.54	1.44	1.69	1.55	1.56
Mean B	1.37	1.54	1.49		1.39	1.55	1.50	
LSD 5%	A=0.019 B=0.016 AB=0.032				A=0.027 B=0.011 AB=0.033			

There were significantly differences between phosphorus and potassium contents in *Carum carvi* leaves as affected by application of organic fertilizer, moringa leaves extract as well as their interaction (Table 8). However, spraying organic fertilizer as Ramada at the rate of 3% produced the higher contents of the two elements in caraway leaves than in any other treatments for both seasons. Also, spraying plants with moringa leaves extract at the rate of 2.5% produced the highest values of these contents in caraway leaves compared to the other treatments. The highest values of phosphorus and potassium contents in caraway leaves (0.54 and 0.55 %) and (1.68 and 1.69 %) were recorded with the combination between organic fertilizer at 3% plus spraying

plants moringa extract at the rate of 2.5 % in the 1st and 2nd seasons, respectively. These results were in agreed with those of Salim (2006); Hanafy *et al*. (2012) and Sakr *et al*. (2018).

3.3.3. Total carbohydrates in leaves of caraway

The obtained results in Table 9 revealed that application the organic fertilizer, moringa leaves extract and their interaction treatments caused significant differences for total carbohydrate contents in caraway leaves during the two seasons. However, maximum of carbohydrate content was due to spray organic fertilizer at the rate of 3% compared to the control in both seasons. When taking the effect of moringa leaves extract into account, spraying plants with moringa leaves extract at the rate of 2.5% produced the highest values of total carbohydrate in caraway leaves compared to the other treatments. The interaction between organic fertilizer and moringa extract levels pointed out that the highest values (18.57 and 18.37%) were due to apply organic fertilizer at 3% and moringa extract at 2.5 % in the 1st and 2ndseasons, respectively. Obtained results were in agreement with Hanafy *et al*. (2012) and Sakr *et al*. (2018).

Table 9. Influence of organic fertilizer and moringa extract treatments on total carbohydrates (%) in leaves of caraway during 2021 and 2022 seasons.

Organic fertilizer Treatments (%)	1st season				2nd season			
	Maringa leaves extract (%)							
(Ramada)	0	2.5	5	Mean A	0	2.5	5	Mean A
Control	10.90	11.63	12.63	11.72	11.13	11.87	12.87	11.96
1	11.67	12.67	13.70	12.68	12.67	12.77	13.87	13.10
2	12.50	17.67	15.50	15.22	13.50	18.07	15.73	15.77
3	14.43	18.57	16.13	16.38	15.43	18.37	16.37	16.72
Mean B	12.38	15.13	14.49		13.18	15.27	14.71	
LSD 5%	A=0.358 B=0.220 AB=0.505				A=0.315 B=0.205 AB=0.458			

4. Conclusion

It could be concluded that the other treatments, the yield characteristics of caraway were driven by the same treatment. While the optimum percentages of volatile oils, total carbohydrates, phosphorus, and potassium contents were primarily found when caraway plants were treated with 3% of an organic fertilizer and 2.5% of an extract produced from moringa leaves.

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Institutional Review Board Statement
All Institutional Review Board Statements are confirmed and approved.

Data Availability Statement
Data presented in this study are available on fair request from the respective author.

Ethics Approval and Consent to Participate
Not applicable

Consent for Publication
Not applicable.

Conflicts of Interest
The author disclosed no conflict of interest starting from the conduct of the study, data analysis, and writing until the publication of this research work.

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