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EFFECT OF ORGANIC FERTILIZATION AND SPRAYING *ALOE VERA* EXTRACT ON THE GROWTH AND PRODUCTIVITY OF *CARUM CARVI* L. PLANT UNDER SHALATEEN CONDITIONS IN EGYPT

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Abstract

Filed experiment was carried out at the Shalateen station, Desert Research Center, Egypt during the two successive seasons during 2016/2017and 2017/2018 seasons to study the effect of organic fertilizer and spraying *Aloe vera* extract on the vegetative growth, seed yield, oil yield and chemical constituents of caraway plant *Carum carvi* L. The experiment included twelve treatments, which were the interaction of three levels of organic fertilizer (farmyard manure) rates; *i.e.* 0,5, 10, 15 m3/ fed. = F1, F2, F3 and F4; respectively and four levels of *Aloe vera* extract concentrations 0, 50, 75 and 100 = C1, C2, C3 and C4; respectively. The treatments were arranged in a split plot design with three replicates. The organic fertilizer in the main plots and the *Aloe vera* extract concentrations in the sub-plots. The results are as follows: using of different levels of organic fertilization led to a significant increase in all characteristics under study. The highest treatment gives the highest production when use organic fertilization at 15 m^3/feddan. Also spraying with *Aloe vera* extract produced the highest characteristics under study such as "Vegetative growth, Seed production, Oil yield and Chemical constituents). The best treatment when spraying with a concentration of 100% of *Aloe vera* extract. All characteristics such as Vegetative growth (Plant height (cm), Number of umbel per plant and Fresh and dry weights per plant (g)), Seed production (Seed index (g), (weight of 1000 fruits) and Weight of fruits per plant (g) and per feddan (Kg), Oil yield (Oil percentage, Oil content per feddan (L), Chemical composition of oil by GC/MS) and Chemical constituents (Total nitrogen, phosphorus, potassium and carbohydrate percentages) are increase. The increase was significant when treating (F4+C3) and the use of organic fertilization at a rate of plus spraying with *Aloe vera* extract 75% under study conditions.

Kay word: *Carum carvi*, organic fertilization, *Aloe vera* extract.

Introduction

Caraway (*Carum carvi,* L.) belong to family (Umbelliferae) Apiaceae. Herbaceous plants are native to the Mediterranean countries, reaching a height of 50 - 80 cm and leaves are feathered, mutilated, and small white flowers in tent inflorescences that begin to appear in February and March and ripen in May, It reproduces seeds (fruits). The economic and medical importance of caraway germs is due to the use of seeds in food products such as (bread, pies and biscuits, meat products) to give them a distinct taste and aroma. Begum, *et al.,* (2008) Sedlakova , *et al.,* (2003a).

The seeds are used as a hot drink to treat stomach cramps and intestinal cramps and as a repellent of gases for children. Limonine. Ezzel-Din, *et al*., (2010) Laribi, *et al*., (2010).

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Aloe vera extract contains some of the enzymes, vitamins and amino acids due to the effective effect of *Aloe vera* extract (Josias, 2008). Studies have confirmed that spraying with aloe vera extract helps to speed germination, vegetative and flowering growth (Lindsey *et al*., 2002). Also, *aloe vera* extract can be used as a natural plant growth regulator because it contains some of the oxins (Dong Zhi, *et al*., 2004). On the other hand, an increase in the fresh and dry weight of the *Abelmoschus esculentus*, L plant (Padmaja, *et al.,* 2007) and *Oenothera biennis* plant (El-Shayeb, 2009) when spraying with *Aloe vera* extract. Explain (Mady, 2009) an increase in pigments such as chlorophyll A, B or carotenoids as a significant increase in plant content of carbohydrates was observed. (Shadia, *et al.;* 2014) and (Hamouda, *et al*., 2012) on basil plant indicated that there is significant morphology in both the fresh and dry weight of the leaves and an increase in the proportion of oil and

the yield of leaves and oil per acre, as well as a noticeable increase in the percentage of active ingredients in basil oil, where the proportion of linalool compound increased while the percentage of compound Methyl chavicol.

Despite the importance of chemical fertilizers, however, their excessive use has resulted in damage to human health and the environment, which has led the world's trend to use organic fertilizers and reduce the addition of chemical fertilizers to the lands to prevent environmental pollution, obtain crops with new characteristics and focus the appropriate nutrients in the fruits, without It has harmful effects on human health in the long run. (Darzi and Hadi, 2012) on *Coriandrum sativum* (Balyeri, *et al.,* 2016) on aromatic pepper and (Milica, 2013) on *Carum carvi* L.

Organic fertilizers improve the soil properties and increase the ability of the soil to retain water and increase the soil fertility. Increase the nutrient elements in the soil as a result of the decomposition of the organic material. The acid medium works to dissolve the juice in the soil and make it in a form suitable for plant use and more capable of absorption by roots. Darzi, *et al.,* (2012) on *Pimpinella anisum*, L., (Naser and Firas, 2015) on wheat and (Purbajanti, *et al.,* 2019) on *Arachis hypogaea*.

The aim of the study is to evaluate the use of organic fertilizers and spraying with aloe vera extract and the interaction between them to improve the production of vegetative growth, seed production, oil yield and its active components and the chemical content of caraway plants under the Shalateen conditions.

Materials and Methods

This experiment was conducted to study the effect of organic fertilizer and spraying *Aloe vera* extract on the vegetative growth, seed yield, oil yield and chemical constituents of caraway plant *Carum carvi* L.

The experiment was carried out at the Shalateen station, Desert Research Center, Egypt during the two successive seasons during 2016/2017and 2017/2018 seasons. The seeds of caraway plant were obtained from the Medicinal and Aromatic Plants Research Department, Horticulture Institute, Agricultural Research Center, Dokki, Egypt. The seeds were sown on October 12th in both seasons. The distance between rows was 50 cm and between plants within row was 30 cm. Seedlings were thinned to one plant per hill. The irrigation system of the experiment was drip irrigation with the rate of 4 l/h.The chemical analysis of irrigation water, physical and chemical analyses of experimental farm soil in table, 3 of Shalateen Research Station are shown in tables 1, 2 and 3, respectively. All the obtained data during the two seasons of study were subjected to analysis of variance method according to Snedecor and Cochran (1990). Meanwhile, differences among means were compared using Duncan's multiple range tested at probability of 5 % level (Duncan, 1955).

The chemical fertilizer recommended rates for *Carum carvi* L . plant are 150 kg ammonium sulphate (20.5% N) per feddan and 75 kg potassium sulphate (48% K_2O) per feddan divided into three equal sections and added every two months from planting and 300 kg calcium super phosphate per feddan was added during soil preparation. The normal agricultural practices were followed in this district.

This experiment included 12 treatments, which were the interaction of three levels of organic fertilizer rates; i.e. 0,5, 10, 15 m3/fed.= F1, F2, F3 and F4; respectively and four levels of *Aloe vera* extract concentrations 0,

Table 1: Chemical analysis of irrigation water.

EC, dS/m	PH	Cations me/l			Anions me/l					SAR
		Ca^{++}	Mg^{++}	K^{+}	Na^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$	
2.23	7.65	11.70	8.19	4.05	18.34	0.0	6.00	35.67	0.61	5.56

Table 2: Soil physical properties of the studied area.

Depth, cm	Particle size distribution%				Textural Class	Bd ($Mg.m^{-3}$)	Moisture content, 10^2KPa	
	CoarseSand	Fine Sand	Silt	Clay			0.06	15
0-20	12.91	61.97	20.21	4.91	L.S	1.66	14.55	5.89
20-40	15.22	63.58	18.21	4.99	L.S	1.69	13.96	5.56
40-60	17.11	61.44	17.31	4.14	L.S	1.68	13.58	5.45

L.S = Loamy Sand

Table 3: Soil chemical properties of the studied area.

Depth,Cm	$CaCO_3$,%.	EC,dS/m	PH	% O.M	Cations me/l				Anions me/l			
					Na^{+}	K^{+}	Ca^{++}	Mg^{++}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$
0-20	17.25	0.76	7.9	0.32	0.72	0.31	2.81	3.76	0.0	0.30	3.22	4.08
20-40	14.52	0.67	7.9	0.34	0.73	0.30	2.82	2.85	0.0	0.32	3.09	3.29
40-60	15.58	0.49	7.8	0.65	0.65	0.29	1.89	2.06	0.0	0.28	2.81	1.81

Table 4: Chemical analysis of Farmyard manure added to the experimental field.

OM%	K.%	P.%	C/N Ratio	C.ppm	N.ppm	EC(1:10) dS.m^{-1}	pH (1:10)	Moisture content%	Organic Matter Source
34.3	0.58	0.49	19.52	10.73	1.82	5.29	7.84	18%	farmyard manure

50, 75 and 100 = C1, C2, C3 and C4; respectively the treatments were arranged in a split plot design with three replicates. The organic fertilizer were randomly arranged in the main plots and the *Aloe vera* extract concentrations were randomly distributed in the sub-plots.

The organic fertilizer was added during soil preparation. The chemical analysis of Farmyard manure added to the experimental field are shown in table 4.

Prepare *aloe vera* extract: weigh 100 grams of *Aloe vera* gel in the leaves and mix in the mixer, then filter the resulting mixture, then take 100 ml of the extract and fill it with distilled water to 1000 ml. In the same way, can be prepares all of the concentrations. The plants are applied with *Aloe vera* extract three times; after 30, 60 and 90 days from planting as foliar spray According to Wilfred *et al.,* (1990).

The active ingredients of *Aloe vera* extract by analyzing *Aloe vera* extract it was found to contain some growth regulators such as IAA, GA3, ABA 0.63, 16.00 and 3.06 mg/100gm F.W, respectively; 10.1% Total carbohydrate; 3.2g/100g Glucose, 1 mg/g Protein, Some chemical compounds such as "Total polyphenols, Total flavonoid and Total sterol 23.72, 2.28 and 65.47 (µg/g)" and 18.73 mg/g Cholesterol, according to (Shyamal, *et al*., 1990). *Aloe vera* extract also contains some macro nutrients as for N, P, K, Ca and Mg 80.65, 6.95, 60.14, 40.00 and 14.44 mg/100ml F.W; respectively and some micro nutrients such as Fe, Zn, Mn, Cu and Na0. 229, 0.028, 0.0266, 0.0042 and 51.12 mg/100ml F.W; respectively, according to (Rawe, 1973).

Data recorded

1- Vegetative growth

1.1. Plant height (cm)

1.2. Number of umbel per plant

1.3. Fresh and dry weights per plant (g)

2- Seed production

2.1. Seed index (g) (weight of 1000 fruits)

2.2 Weight of fruits per plant (g) and per feddan (Kg)

3- Oil yield

3.1. Oil percentage of fruits according to British Pharmacopoeia (1936)

3.2. Oil content per feddan (L)

3.3. Chemical composition of oil by GC/MS system according to Adams, (2007)

4- Chemical constituents

4.1. Total nitrogen percentages according to Koch and Mc-Meekin, (1924)

4.2. Total phosphorus percentages according to Troug and Mayer (1939)

4.3. Total potassium percentages according to Brown and Lilleland (1946)

4.4. Total carbohydrate percentage according to Dubios et al. (1956)

Statistical analysis

All data collected were subjected to statistical analysis of variance (ANOVA) and significant differences among means were determined according to (Snedecor and Cochran,1972). In addition significant difference among means were distinguished according to the Duncan's, multiple test range Duncan (1955) whereas, capital and small letters were used for differentiating the values of specific and interaction effects of investigated factors, respectively.

Results

Vegetative growth

Plant height (cm)

Data in table 5 indicate that, the treatment with organic fertilization as farmyard manure led to a significant increase in plant height (cm), during the first and second season. The highest value obtained was F4 which recorded 94.52 and 96.65 cm compared to the control treatment 60.23 and 62.44 cm in the first and second season, respectively.

As for the effect of spraying with *Aloe vera* extract, a significant increase in the plant height which gave the highest value when treated C3 84.29 and 86.85 cm in the first and second season, respectively.

On the other hand, the interaction between the treatments was given to a significant increase, where the highest value was when using organic fertilizer at a rate of 15 m3 + spray 75% *Aloe vera* extract (F4 + C3), where the highest value of plant height was recorded 100.24 and 105.62 cm in the first season and the second respectively.

These results are in agreement with those found by

Table 5: Effect of organic fertilizer and spraying *Aloe vera* extract and their interaction on plant height (cm) of *Carum carvi* L. plant under Shalateen conditions during 2016/2017and 2017/2018 seasons.

Aloe vera extract Organic fertilizer	Plant height (cm)									
	First season					Second season				
	C1	C2	C3	C4	Mean	C1	C2	C3	C4	Mean
F1	54.26o	59.68n	65.56l	70.25k	62.44D	52.63o	60.00n	66.48k	61.80m	60.23D
F2	62.74m	74.55j	75.21i	75.22i	71.93C	63.75l	74.55i	78.16h	72.66j	72.28C
F3	84.32h	91.74f	96.14b	92.45e	91.16B	85.33g	94.38d	97.15c	93.41e	92.57B
F4	88.74g	93.53d	100.24a	95.56c	94.52A	87.34f	94.86f	105.62a	98.78b	96.65A
Mean	72.52D	79.88C	84.29A	83.37B		72.26D	80.95C	86.85A	81.66B	

F1, F2, F3 and F4 = 0, 5, 10 and 15m^3 organic fertilizer (Farmyard manure) per feddan respectively. C1, C2, C3 and C4 = 0 % , 50%, 75% and 100% Spray with *Aloe vera* extract respectively.Mean separation within treatments, dates of spraying of the pomegranate trees and for their interaction according to L.S.D. at 0.05 level.

(Lindsey, *et al.,* 2002); (Adebayo, *et al.,* 2011); on *Moringa oleifera*; (Carrubba and Ascolillo, 2009) on *Coriandrum sativum* L. and (El-Azim, *et al*., 2016) on *Foeniculum vulgare* Mill.

Number of umbel per plant

Data dealing with table 6 the effect of organic fertilization on the caraway plant had a significant effect as the number of inflorescences for each plant increased as a result of an increase in the addition of organic fertilization and the highest increase in the number of inflorescences when treatment F4 was recorded 45.48 and 67.07 in the first and second season on Straight

Data presented in table 6 disclosed that, Spraying with *Aloe vera* extract resulted in a significant increase in the Number of umbels/plant in the first and second seasons, and the best treatment was C3 it gave the highest effect. The treatment C4 gave the best significant increase in the Number of umbels/plant, as it recorded 68.02 and 66.19 compared to the control 45.85 and 47.85 in the first and second season, respectively.

It also clear from data in table 6 that, the number of inflorescences per plant recorded the highest significant increase as a result of the interaction between the organic fertilization treatments and spraying with *Aloe vera* extract. The best treatment was F4 + C3as it produced the highest value of the Number of umbels per plant 72.64 and73.74 while the treatment F1 + C1recorded the lowest value 32.45 and 33.54 during the two seasons.

These results are in consistent with those obtained by (Ahmad, *et al.,* 2017) on Coriander; (Gewefile, *et al.,* 2009 b) On *Nicotiana glauca*; (Haouvang; *et al.,* 2019) and (Moringa, *et al.,* 2014) on Lettuce.

Fresh and dry weights per plant (g)

Data in table 7 showed that, all treatments significantly increased of fresh and dry weights per plant (g) for caraway plants compared to untreated plants during the both seasons. The highest value when treating the fourth level of organic fertilization F4 was the highest value of Fresh and dry weights per plant (g) 408.7 and 225.3 g in the first season while 410.6 and 228.2 g in the second season.

Data illustrated The effect of spraying *Aloe vera* extract on Fresh and dry weights per plant (g) for caraway plants are presented in table 7 it revealed where the more the concentration of the extract increases, the more fresh and dry weights per plant (g) where the

Table 6: Effect of organic fertilizer and spraying *Aloe vera* extract and their interaction on number of umbels per plant and their interaction of *Carum carvi* L. plant Under Shalateen conditions during 2016/2017and 2017/2018 seasons.

Aloe vera extract Organic fertilizer	Number of umbels/plant									
	First season					Second season				
	C1	C2	C3	C4	Mean	C1	C2	C3	C4	Mean
F1	32.45o	33.29n	54.63i	66.74e	46.78S	31.54p	33.54o	46.87m	58.26h	42.55D
F2	42.23m	46.25l	56.17h	67.55d	53.05C	45.62n	48.23l	55.90j	68.74c	54.62C
F3	51.11k	52.24j	68.96c	67.69d	60.00B	53.75k	56.33i	66.35e	67.22d	60.91B
F4	57.59g	61.62f	72.64a	70.08b	45.48A	60.47g	63.54f	73.74a	70.54b	67.07A
Mean	45.85D	48.35C	63.10B	68.02A		47.85D	50.41C	60.72B	66.19A	

F1, F2, F3 and F4 = 0, 5, 10 and 15 m^3 organic fertilizer (Farmyard manure) per feddan respectively.C1, C2,C3 and C4 = 0 %, 50%, 75% and 100 % Spray with *Aloe vera* extract respectively.Mean separation within treatments, dates of spraying of the pomegranate trees and for their interaction according to L.S.D. at 0.05 level.

Table 7: Effect of organic fertilizer and spraying *Aloe vera* extract and their interaction on fresh and dry weights per plant (g) and their interaction of *Carum carvi* L. plant Under Shalateen conditions during 2016/2017and 2017/2018 seasons.

Aloe vera extract / Organic fertilizer	Fresh weight/plant (g)									
	First season					Second season				
	C1	C2	C3	C4	Mean	C1	C2	C3	C4	Mean
F1	188.5o	230.5m	284.8j	260.5l	241.1D	178.6n	239.8l	287.0j	274.8k	245.0D
F2	222.2n	285.2j	350.7g	367.7f	306.4C	231.0m	275.9k	368.5g	372.9f	312.1C
F3	280.6k	305.8h	420.6d	412.7e	354.9B	287.6j	310.9h	430.7c	415.2e	361.1B
F4	294.6i	425.6c	462.5a	452.3b	408.7A	304.8i	436.6b	478.9a	422.3d	410.6A
Mean	246.5D	311.8C	379.6A	373.3B		250.5D	315.8C	391.3A	371.3B	
Dry weight/plant (g)										
F1	97.56m	121.44l	157.6i	145.8j	130.6D	95.89m	125.4l	158.2j	151.2k	132.7D
F2	125.8k	158.2i	170.3g	173.5f	156.9C	127.1l	152.8k	177.3h	182.3g	159.9C
F3	166.5h	190.6e	235.9c	233.2d	206.5B	158.3j	172.6i	242.4c	213.6e	196.7B
F4	169.8g	231.7d	258.4a	241.3b	225.3A	189.8f	245.4b	259.7a	217.8d	228.2A
Mean	139.9D	175.5C	205.6A	198.5B		142.8D	174.01C	209.4A	191.2B	

F1, F2, F3 and F4 = 0, 5,10 and 15 m^3 organic fertilizer (Farmyard manure) per feddan respectively. C1, C2, C3 and C4 = 0%, 50%, 75% and 100% Spray with *Aloe vera* extract respectively. Mean separation within treatments, dates of spraying of the pomegranate trees and for their interaction according to L.S.D. at 0.05 level.

increase was significant and the higher the value of Fresh and dry weights per plant (g) at treatment C3where the fresh weight per plant was recorded 379.6 and 391.3 g while the dry weight per plant was recorded 205.6 and 209.4 g in the first and second season, respectively.

Data dealing in table 7 the treatments of the interaction between organic fertilization and spraying with *Aloe vera* extract F4 + C3 gave significant difference in fresh and dry weights per plant (g) for caraway plant during the two seasons. The treatments F4 + C3 recorded the highest value of fresh weight per plant 462.5 and 478.9 g while the dry weight also increased to 258.4 and 259.7 g during the first and second season, respectively, compared to the other treatments.

These results are in line with those reported by (Abd El-Azim, et al., 2017) on *Foeniculum vulgare*, Mill; (Darzi and Hadi, 2012) on *Coriandrum sativum*; (Balyeri, *et al.,* 2016) on aromatic pepper and (Milica, 2013) on Caraway.

Seed production

Seed index (weight of 1000 fruits(g))

According to the data in table 8 found that, the difference levels of organic fertilization gave a significant effect on the weight of 1000 fruits, the treatment F4 was given the highest value for weight of 1000 fruits 10.82 and 11.11g followed by F3 treatment 8.81 and 8.83 g then F2 treatment 7.72 and 8.01g then treated as a control 7.08 and 7.30 g during the first and second season, respectively.

The highest concentration of *Aloe vera* extract had a significant increase in the weight of 1000 fruits of the spherical plant during the two seasons where the C3 treatment was recorded The highest value of weight of 1000 fruits 9.29 and 9.42 g compared to plants that were not treated 7.75 and 7.80 g during The first and second

Table 8: Effect of organic fertilizer and spraying *Aloe vera* extract on weight of 1000 fruits (g) of *Carum carvi* L. plant Under Shalateen conditions during 2016/2017and 2017/2018 seasons.

Aloe vera extract / Organic fertilizer	Weight of 1000 fruits (g)									
	First season					Second season				
	C1	C2	C3	C4	Mean	C1	C2	C3	C4	Mean
F1	6.45f	6.90f	7.45e	7.50e	7.08D	6.61g	6.98g	7.73f	7.89f	7.30D
F2	6.85f	7.43e	8.31d	8.30d	7.72C	6.77g	7.97f	8.66e	8.63e	8.01C
F3	7.82de	8.21d	9.76c	9.43c	8.81B	7.93f	8.76e	9.30d	9.31d	8.83B
F4	9.87c	10.76b	11.63a	11.00b	10.82A	9.90c	10.82b	12.00a	11.73a	11.11A
Mean	7.75C	8.33B	9.29A	9.06A		7.80C	8.63B	9.42A	9.39A	

F1, F2, F3 and F4 = 0, 5,10 and 15 m^3 organic fertilizer(Farmyard manure) per feddan respectively.C1, C2 ,C3 and C4 = 0 % , 50% , 75% and 100 % Spray with *Aloe vera* extract respectively.Mean separation within treatments, dates of spraying of the pomegranate trees and for their interaction according to L.S.D. at 0.05 level.

season, respectively.

The interaction between organic fertilization and spraying with *Aloe vera* extract led to a significant difference between the treatments, as the effect of the increase in weight of 1000 fruits during the two seasons. The best values when plant are application with organic fertilization 15 m^3 with spraying *Aloe vera* extract 75% (F4 + C3), where the best value 11.63 and 12.00 g were recorded in the first and second season compared to the rest of the other treatments.

These results are in agreement with those obtained by (Dong Zhi, *et al.,* 2004), (Ali, 2002) on *Foeniculum vulgare* Mill.; (El Laban, , *et al*., 2017) on Dutch fennel and (Souzan *et al*., 2006) *Carum carvi* L.

Weight of fruits per plant (g) and per feddan (Kg)

Data dealing with the Different rates of organic fertilization resulted in a significant difference in Weight of fruits per plant (g) and per feddan (Kg) table 9 where the treatment F4 gave a positive effect of increasing Weight of fruits per plant (g) and per feddan (Kg) and recorded the highest value in weight of fruits per plant (g) and per feddan (Kg) 225.3 g and 954.7 kg during the first season, respectively. While the same treatment recorded the highest value of Weight of fruits per plant (g) and per feddan (Kg) 228.2 g and 933.6 kg during the second season; respectively, this increase was significant in both seasons.

Spraying with *Aloe vera* extract produced the highest increase in weight of fruits per plant (g) and per feddan (Kg) for caraway plant, where the increase was significant and was the best treatment when spraying with *Aloe vera* extract 75% (C3) which was registered as for Weight of fruits per plant (g) 205.6 g and 209.4 while the best treatments for weight of fruits per feddan (Kg) was C4 which recorded 826.6 and 8.29.3 kg compared to Untreated plants during the first and second seasons, respectively.

The interaction between organic fertilization and spraying with *Aloe vera* extract gave a significant increase in all treatments compared to untreated plants. Where it produced the highest value on the F4 + C3 that was recorded as for Weight of fruits per plant (g) 258.4g and 259.7 g and as for Weight of fruits per feddan (kg) 1105.1 and 1092.4 in the first and second season, respectively.

These results are similar to those found by (Mady, 2009); (Husien and Amal, 2017) on *Solanum tuberosum,* L.; (Rania and Abd El-Azim, 2016) on *Plantago psyllium* L.; (Yousif *et al*., 2020) on *Lycopersicon esculentum* Mill and (Shadia, *et al.,* 2014).

Oil yield

Oil percentage of fruits

Data in table 10 noted that, all application of organic fertilization resulted in an increase in caraway oil percentage of fruits when compared to control plants. The highest oil percentage of fruits were at treatment F2 as they recorded 3.03 and 2.82% in the first and second season, respectively, compared the other treatments in both seasons.

The effect of spraying with *Aloe vera* extract given

Table 9: Effect of organic fertilizer and spraying *Aloe vera* extract and their interaction on fruit weight/plant (g) and feddan (Kg) of *Carum carvi* L. plant Under Shalateen conditions during 2016/2017and 2017/2018 seasons.

Aloe vera extract / Organic fertilizer	Fruit weight/plant (g)									
	First season					Second season				
	C1	C2	C3	C4	Mean	C1	C2	C3	C4	Mean
F1	97.56m	121.44l	157.6i	145.8j	130.6D	95.89m	125.4l	158.2j	151.2k	132.7D
F2	125.8k	158.2i	170.3g	173.5f	156.9C	127.1l	152.8k	177.3h	182.3g	159.9C
F3	166.5h	190.6e	235.9c	233.2d	206.5B	158.3j	172.6i	242.4c	213.6e	196.7B
F4	169.8g	231.7d	258.4a	241.3b	225.3A	189.8f	245.4b	259.7a	217.8d	228.2A
Mean	139.9D	175.5C	205.6A	198.5B		142.8D	174.01C	209.4A	191.2B	
Fruit yield/fed. (kg)										
F1	475.3p	520.6o	625.7m	634.2l	564.0D	420.6o	490.5n	615.2l	623.0k	537.3D
F2	608.3n	644.6k	666.9j	740.3h	665.0C	598.8m	652.3j	707.8i	731.6h	672.6C
F3	685.7i	821.3f	873.6e	901.5d	820.5B	654.6j	786.3f	843.5e	970.8c	813.8B
F4	762.7g	920.7c	1105.1a	1030.5b	954.7A	747.6g	902.4d	1092.4a	991.8b	933.6A
Mean	633.0D	726.8C	817.8B	826.6A		605.4D	707.9C	814.7B	829.3A	

F1, F2, F3 and F4 = 0, 5,10 and 15 m^3 organic fertilizer(Farmyard manure) per feddan respectively.C1, C2 ,C3 and C4 = 0 % , 50% , 75% and 100 % Spray with *Aloe vera* extract respectively.Mean separation within treatments, dates of spraying of the pomegranate trees and for their interaction according to L.S.D. at 0.05 level

Table 10: Effect of organic fertilizer and spraying *Aloe vera* extract and their interaction on oil percentage of caraway (*Carum carvi* L) plant under Shalateen conditions during 2016/2017and 2017/2018 seasons.

Aloe vera extract / Organic fertilizer	Oil percentage									
	First season					Second season				
	C1	C2	C3	C4	Mean	C1	C2	C3	C4	Mean
F1	2.10ij	2.85b-d	2.65d-f	2.20hi	2.45B	2.08i	2.74cd	2.51ef	2.33f-h	2.42C
F2	3.31a	3.00b	2.92bc	2.90bc	3.03A	3.11a	2.96ab	2.64de	2.55e	2.82A
F3	2.53fg	2.41g	2.66d-f	2.35gh	2.49B	2.77cd	2.86bc	2.30gh	2.28h	2.55B
F4	1.92j	2.21hi	2.74c-e	2.54e-g	2.35C	2.00i	1.95i	2.50ef	2.47eg	2.23D
Mean	2.47C	2.62B	2.74A	2.50C		2.49B	2.63A	2.49A	2.41B	

F1, F2, F3 and F4 = 0, 5,10 and 15 m^3 organic fertilizer(Farmyard manure) per feddan respectively.C1, C2 ,C3 and C4 = 0 % , 50% , 75% and 100 % Spray with *Aloe vera* extract respectively.Mean separation within treatments, dates of spraying of the pomegranate trees and for their interaction according to L.S.D. at 0.05 level

the treatment C3 the highest value in oil percentage of fruits 2.74 and 2.49% when compared to untreated plants 2.47 and 2.49% during the first and second season.

The difference between the treatments gives a significant difference that resulted in a significant increase in the oil percentage during the two seasons. The treatments F2 + C1 gives the highest value of oil percentage 3.31% when compared to the control plants 2.10% in the first season while the same treatment gave the highest value of oil percentage 3.11% compared to the control plants 2.08%. The oil percentage increased when interaction treatment F2 + C1 and this increase was significant. The interaction between organic fertilization and spraying with *Aloe vera* extract was effect of all treatments during the first and second seasons.

These results are in agreement with those found by (Josias, 2008); (Darzi, *et al.,* 2012) on *Pimpinella anisum*, L.; (Rania and Abd El-Azim, 2016) on *Plantago psyllium* L.; (Naser and Firas, 2015) on wheat and (Purbajanti, *et al.,* 2019) on *Arachishypogaea*.

Oil content per feddan (L)

Oil content per feddan (L) for caraway plant when treating organic fertilization *** which gave a significant increase during the first and second season as it was noted that this increase was significant in both seasons.

Data listed in table 11 clear that, The best treatment was when using organic fertilization at the highest rate F4 produced the highest value of oil content per plant per feddan (L) 19.26 and 19.80 l compared to untreated plants that registered 10.91 and 10.84 l during the two seasons.

There is an increase in oil content per plant per feddan (L) as a result of spraying with aloe vera extract during the two seasons. This increase was significant in the first and second season. The best value was oil content per plant per feddan (L) in the first season 17.92 l while in the second season 19.62 l when spraying 100 % of the *aloe vera* extract compared with untreated plants.

The interaction between organic fertilization and spraying with *Aloe vera* extract resulted in a significant increase in both seasons where the treatment F4 + C4 recorded the highest value to increase the oil content per plant per feddan (L) for caraway plant, so it was the highest value 22.60 l in the first season while it was 23.45 l In the second season when treating plants with 15m of organic fertilization + spraying 100 % *aloe vera* extract.

Table 11: Effect of organic fertilizer and spraying *Aloe vera* extract and their interaction on oil yield per fed of caraway(*Carum carvi,* L.) plant Under Shalateen conditions during 2016/2017and 2017/2018 seasons.

Aloe vera extract / Organic fertilizer	Oil yield per fed (L)									
	First season					Second season				
	C1	C2	C3	C4	Mean	C1	C2	C3	C4	Mean
F1	8.56l	9.24k	12.28i	13.56h	10.91D	8.10o	9.03m	11.94k	14.27g	10.84D
F2	9.10k	10.65j	14.52g	14.00h	12.07C	8.87m	10.25l	13.78h	14.75f	11.91C
F3	12.60i	15.90e	20.63c	21.51b	17.66B	12.45j	16.45e	21.15c	22.00b	18.01B
F4	15.33f	18.58d	20.54c	22.60a	19.26A	15.21ef	18.87d	21.65b	23.45a	19.80A
Mean	11.40D	13.59C	16.99B	17.92A		11.16D	13.65C	17.13B	18.62A	

F1, F2, F3 and F4 = 0, 5, 10 and 15 m^3 organic fertilizer (Farmyard manure) per feddan respectively. C1, C2, C3 and C4 = 0%, 50%, 75% and 100% Spray with *Aloe vera* extract respectively. Mean separation within treatments, dates of spraying of the pomegranate trees and for their interaction according to L.S.D. at 0.05 level.

These results are in consistent with those obtained by (El-Shayeb, 2009); (Choudhary, *et al.,* 2008) on *Coriandrum sativum* L.; (El Laban, *et al.,* 2017) on Dutch fennel; (Al-Shammari, 2018) on tomato; (Saud, 2013) on *Cucumis sativus* and (Rania, 2016) on *Cyamopsis tetragonoloba* L.

Chemical composition of oil by GC/MS system

GC-mass analysis of essential oil

showed that there are 33 GC-mass analysis of essential oils of *Carum carvi* L. from second season revealed that carvone and limonene were the main components of oil as in Table 12

Table 12: Chemical composition of the essential oils of caraway plant using GC-MS.

No.	Compound name	(F1+C1)	(F2+C2)	(F3+C3)	(F4+C4)
1	α-Pinene	0.03	0.4	-	-
2	α-Phellandrene	-	-	0.03	-
3	2,6-Dimethyl1,3,5,7-	-	0.36	0.25	0.18
	octat-etraene, E,E				
4	β-Pinene	0.06	-	0.02	0.14
5	α-Myrcene	0.14	-	0.05	-
6	Carveol	1.45	0.89	0.44	0.08
7	D-Limonene	40.37	16.35	32.4	21.65
8	Camphenone	-	-	0.04	-
9	γ-Terpinene	0.04	0.92	-	-
10	Linalool	0.12	1.89	0.07	0.91
11	Perilla alcohol	0.06	0.21	-	0.12
12	α-Terpineol	-	-	0.02	-
13	Limonene oxide	0.32	0.21	0.18	0.16
14	Camphor	-	0.59	-	-
15	2,3-Dimethylcy-	0.06	0.21	-	-
	clohexa1,3-diene				
16	Citral	0.11	-	0.06	-
17	Dihydrocarvone	0.7	0.62	0.47	0.19
18	Carvone	56.43	59.95	65.45	74.56
19	Bornyl acetate	-	1.88		-
20	Thymol	-	3.01		-
21	α-elemene	0.05	0.5		0.15
22	trans-Caryophyllene	-	0.41	-	-
23	α-Bergamotene	-	2.72	0.09	0.56
24	γ-Muurolene	-	2.07	0.13	0.17
25	Humulene	-	0.72	-	-
26	Valencene	-	0.23	-	-
27	Germacrene D	-	0.69	-	-
28	α-Guaiene	-	0.61	-	-
29	Veridiflorol	-	0.54	-	-
30	Cubenol	-	0.48	-	0.09
31	α-Cadinol	-	3.31	-	0.65
32	Longipinocarveol	-	0.22	-	0.05
33	Unknown	0.06	0.01	0.21	0.34
	Total	99.94	99.99	99.79	99.66

The chemical analysis of the oil components by GC-mass analysis compounds and one of the compounds carvone and limonene of the basic chemical compounds in caraway oil with the presence of some other compounds in the oil, but in small quantities.

All chemical compounds were affected by organic fertilization, spraying with *Aloe vera* extract, and the interaction between them. The treatment (F4+C4) gave a greater percentage of compound Carvone where it registered 74.56 % while the treatment (F1+C1) recorded a lower percentage 56.43%. The treatment (F1+C1) was gives the highest percentage for compound D-Limonene where it recorded followed by (F3+C3) then (F4+C4) and (F2+C2) 40.37, 32.4, 21.65 and 16.35 %, respectively.

On the other hand, Carveol Compound was found in all treatments but the treatment (F1+C1) produce the largest value 1.45% while it decreased in the treatment on (F4+C4) 0.08%. Also a compound Linalool was given an increase in the treatment (F2+C2) followed by (F4+C4) then (F1+C1) and finally (F3+C3) 1.98, 0.91, 0.12 and 0.07% respectively. Also, the compound Dihydrocarvone was given an increase in the treatment (F2+C2) followed by (F3+C3) then (F4+C4) and finally (F1+C1) 0.62, 0.47, 0.19 and 0.7% respectively. α-Pinene compound appears in (F1+C1) and (F2+C2) treatments while it did not appear in (F3+C3) and (F4+C4) treatments. α-Phellandrene appears in (F3+C3) 0.03 % treatment, while it did not appear in the other treatments. Also, β-Pinene was found in (F1+C1), (F3+C3) and (F4+C4) 0.06, 0.02 and 0.14%; respectively, while it did not appear in (F2+C2) treatment. Thymol was appear in (F2+C2) but, it did not appear in other treatments.

These results are in agreement with those obtained by (Ezzel-Din, *et al.,*); (Laribi, *et al*.,); (Rahnavard, *et al.,*); (Seidler, *et al.,*); (Meena, *et al.,* 2010); (Begum, *et al.,* 2008); (Sedlakova, *et al.,* 2003, a & 2003, b) on *Carum carvi* L.

Chemical constituents

Total nitrogen, phosphorus, potassium percentages

It is clear from data listed table 13 Total nitrogen, phosphorus, potassium percentages were affected by different rates of organic fertilization, as the percentage of N, P and K percentages in the plant increased and this increase was significant. The treatment F4 gave the highest value

Table 13: Effect of organic fertilizer and spraying *Aloe vera* extract and their interaction on total N, P, K percentage of *Carum carvi* L. plant Under Shalateen conditions during 2016/2017and 2017/2018 seasons.

Aloe vera extract / Organic fertilizer	N %									
	First season					Second season				
	C1	C2	C3	C4	Mean	C1	C2	C3	C4	Mean
F1	1.15i	1.32i	1.62h	1.85g	1.49D	2.28g	1.55i	1.71hi	1.80h	1.84D
F2	2.32f	2.40ef	2.43ef	2.56e	2.43C	2.54ef	2.62ef	2.44fg	2.66e	2.57C
F3	2.86d	2.94cd	3.20ab	3.12bc	3.03B	2.84d	3.01d	3.45b	3.41bc	3.18B
F4	2.97cd	3.12bc	3.28ab	3.35a	3.18A	2.98d	3.25c	3.50b	3.70a	3.36A
Mean	2.33C	2.45B	2.63A	2.72A		2.66C	2.61C	2.78B	2.89A	
P %										
F1	0.47g	0.62f	0.62f	0.68de	0.60D	0.32i	0.51h	0.54h	0.66g	0.51C
F2	0.65ef	0.71cd	0.72cd	0.86a	0.74C	0.66g	0.74f	0.82de	0.91a	0.78B
F3	0.73cd	0.81ab	0.82ab	0.84ab	0.80A	0.65g	0.83c-e	0.88ab	0.87a-c	0.81A
F4	0.70c-e	0.81ab	0.80b	0.74c	0.76B	0.75f	0.80e	0.84b-e	0.85b-d	0.81A
Mean	0.64C	0.74B	0.74B	0.78A		0.60D	0.72C	0.77B	0.82A	
K %										
F1	1.17h	1.32h	1.62g	1.85f	1.49D	1.02j	1.15i	1.21i	1.60gh	1.25D
F2	2.35e	2.40e	2.43e	2.56e	2.44C	1.54gh	1.62g	1.48h	1.66g	1.58C
F3	2.76d	2.94cd	3.20ab	3.12bc	3.01B	2.84c	3.01b	2.70d	2.54e	2.77B
F4	2.97c	3.12bc	3.28ab	3.35a	3.18A	2.78cd	2.25f	3.89a	2.75cd	2.92A
Mean	2.31C	2.45B	2.63A	2.72A		2.05C	2.01C	2.32A	2.14B	

F1, F2, F3 and F4 = 0, 5, 10 and 15 m^3 organic fertilizer (Farmyard manure) per feddan respectively. C1, C2, C3 and C4 = 0%, 50%, 75% and 100% Spray with *Aloe vera* extract respectively. Mean separation within treatments, dates of spraying of the pomegranate trees and for their interaction according to L.S.D. at 0.05 level.

to the three nutrients N, P and K percentages 2.18, 0.78 and 3.18% during the first season in a row. While in the second season, the highest value was for the same transaction as it recorded 3.36, 0.81 and 2.92% respectively.

Total nitrogen, phosphorus, potassium percentages increased when spraying with different concentrations of *Aloe vera* extract as this increase was significant. Where it was found that with the increase in the concentration of *Aloe vera* extract, total nitrogen, phosphorus, potassium percentages increased in the plant and the best treatment C4 that recorded the highest values of N, P and K percentages 2.72, 0.78 and 2.72% during the first season and 2.89, 0.82 and 2.14 % during second season, respectively.

The interaction between organic fertilization and spraying with *Aloe vera* extract causes many significant differences. The best treatment was F4 + C4 which recorded an increase in plant content from nitrogen percentage 3.35 and 3.70 % while the best treatment was F2 + C4 which recorded an increase in plant content from phosphorus percentage 0.6 and 0.91 % during the second season, respectively but the best treatment was F4 + C4 which recorded an increase in plant content from potassium percentage 3.35 % in first season while the best treatment was F4 + C3 which recorded an increase in plant content from potassium percentage 3.89 % in second season, respectively.

These results are in line with those reported by (Hamouda, *et al.,* 2012); (Darzi, 2012) on *Coriandrum sativum*; (Heikal, 2005) on *Thymus vulgaris* L. and (Rania and Abd El-Azim ,2016) on *Plantago psyllium* L.

Total carbohydrate percentage

It also clear from data in table 14 noted that, using of organic fertilization produced the highest value in the total carbohydrate percentage compared to the control in the first and second season. The best treatment F4 when using the highest rate of organic fertilization as it was recorded 26.05 and 26.94 % in the first and second season, respectively.

Also, the result data, found that there was a significant increase in the total carbohydrate percentage when spraying with *Aloe vera* extract. The treatment C4 gives the best value 23.72 and 24.41 % in the total carbohydrate percentage during the first and second season.

The effect of the interaction between organic fertilization and spraying of *aloe vera* extract on increasing the total carbohydrate percentage in the plant, where the treatment F4 + C4 recorded the highest value 28.20 and 28.77 % during the first and second season,

Table 14: Effect of organic fertilizer and spraying *Aloe vera* extract and their interaction on total carbohydrates percentage of *Carum carvi* L. plant Under Shalateen conditions during 2016/2017and 2017/2018 seasons.

Aloe vera extract Organic fertilizer	Total carbohydrates %									
	First season					Second season				
	C1	C2	C3	C4	Mean	C1	C2	C3	C4	Mean
F1	10.17n	13.62m	16.62k	19.55h	14.99D	10.28m	13.55l	15.74k	19.84i	14.85D
F2	16.32l	18.42j	20.43g	21.50f	19.17C	16.59j	19.62i	21.44g	22.62f	20.07C
F3	18.86i	22.94e	23.20e	25.63c	22.66B	20.74h	23.31e	23.45e	26.41c	23.48B
F4	23.54d	26.20b	26.25b	28.20a	26.05A	24.22d	23.25e	27.50b	28.77a	25.94A
Mean	17.22D	20.30C	21.63B	23.72A		17.96D	19.93C	22.03B	24.41A	

F1, F2, F3 and F4 = 0, 5, 10 and 15 m^3 organic fertilizer (Farmyard manure) per feddan respectively. C1, C2, C3 and C4 = 0 %, 50%, 75% and 100% Spray with *Aloe vera* extract respectively. Mean separation within treatments, dates of spraying of the pomegranate trees and for their interaction according to L.S.D. at 0.05 level.

respectively.

These results are similar to those found by (Padmaja, *et al.,* 2007); (Michael, *et al.,* 2010) on red lettuce; (Jasim, *et al.,* 2014) on tomato; (Rania, 2001) on *Carum carvi*; (Milica *et al.,* 2015) on Anise, Carawaya and Coriander (Taj-Alden, *et al.,* 2014) on cauliflower.

Discussion

The use of chemical compounds in agriculture led to great damage to the environment, humans and animals, so the world resorted to using natural and organic products to avoid damage resulting from a third of chemical compounds. So organic and biological fertilizers were used as an alternative to chemical fertilizers and some of the plant extracts as an alternative to pesticides and industrial growth organizations which helped to produce a healthy plant with high specifications and quality that does not cause any harm to the environment, humans and animals.

In this experiment, using of organic fertilizers and *Aloe vera* extract and their interaction were studied to improve vegetative growth and increase the productivity of fruits and oil yields and the active components of the volatile oil of caraway plants under the conditions of Shalateen Research Station.

When studying the effect of using organic fertilizers, noted that, when increasing levels of organic fertilization, there was an increase in Vegetative growth such as (Plant height (cm), Number of umbel per plant, Fresh and dry weights per plant (g)), Seed production such as (Seed index (g) (weight of 1000 fruits) and Weight of fruits per plant (g) and per feddan (Kg)), Oil yield such as (oil percentage, oil content per feddan (L) and Chemical composition) and Chemical constituents such as (total N, P, K and carbohydrate percentage), and this was a significant increase.

High levels of organic fertilization gave the highest values and the best treatment was F4 when using 15 m^3 / feddan organic fertilizer. These results are similar to those found by (Adebayo, *et al.,* 2011) on *Moringa oleifera*; (Carrubba and Ascolillo, 2009) on *Coriandrum sativum* L.; (Ahmad, *et al.,* 2017) on Coriander (Haouvang; *et al.,* 2019) and (Moringa, *et al.,* 2014) on Lettuce.

The resulting increase in Characters under study is due to the addition of organic matter inside the soil, which is decomposed by microorganisms in the soil, which helps to produce acidic compounds that increase the solubility of nutrients inside the soil, and this is evident with the increase in growth and seed production. These results are in line with those reported by (Darzi and Hadi, 2012) on *Coriandrum sativum*); (Balyeri, *et al.,* 2016) on aromatic pepper; (Milica, 2013) on Caraway and (Souzan *et al.,* 2006) on *Carum Carvi*, L.

In addition, when using *aloe vera* extract spray, it was seen that when the *Aloe vera* extract concentration increased, there was an increase in vegetative growth, seed production, oil yield and its active components and the chemical content of caraway plants. This increase was a significant increase, which led to a better production and improvement in growth, which was reflected in all Characters under study. These results are in agreement with those found by (Lindsey *et al.,* 2002); (Rania, 2016) on *Cyamopsis tetragonoloba* L.; (El Laban, *et al.,* 2017) on Dutch fennel; (Rania and Abd El-Azim, 2016) on *Plantago psyllium* L. and (Shadia, *et al.,* 2014).

The best treatment was C4 that gave the highest values of Characters under study when spraying with a high concentration of *Aloe vera* extract 100%. These results are in line with those reported by (Hamouda, *et al.,* 2012); (Rania and Abd El-Azim, 2016) on *Plantago psyllium* L. and (Abd El-Azim, *et al.,* 2017) on *Foeniculum vulgare* Mill.

In addition to that, when analysing aloe extract, it was found that it contains some of the oxins such as

IAA, ABA and some of the amino acids and vitamins. The effect of the aloe extract can be explained as a natural growth regulator that increases the growth and elongation of cells and thus helps to increase the growth of vegetative and syphilis, which is reflected I have to increase the seed yield per acre, and thus the volatile oil yield of caraway plants. These results are similar to those found by (Ahmad, *et al.,* 2017) on coriander; (Gewefile, *et al.,* 2009, b) on *Nicotiana glauca*; (Abd El-Azim, *et al.,* 2017) on *Foeniculum vulgare* Mill; (Dong Zhi, *et al.,* 2004); (El Laban, *et al.,* 2017) on Dutch fennel; (Rania and Abd El-Azim, 2016) on *Plantago psyllium* L.; (Shadia, *et al.,* 2014) and (Josias, 2008).

On the other hand, by studying the effect of the interaction between organic fertilization and spraying with *Aloe vera* extract, it was found that there was a significant increase in Vegetative growth such as (Plant height (cm), Number of umbel per plant, Fresh and dry weights per plant (g)), Seed production such as (Seed index (g) (weight of 1000 fruits) and Weight of fruits per plant (g) and per feddan (Kg), Oil yield such as (oil percentage, oil content per feddan (L) and chemical composition) and Chemical constituents such as (Total N, P, K and carbohydrate percentage) were the best treatment F4 + C3 when using organic fertilizer 15 m with spraying with *Aloe vera* extract 75% . These results are in line with those reported by (Abd El-Azim, *et al.,* 2017) on *Foeniculum vulgare* Mill; (Darzi, and Hadi, 2012) on *Coriandrum sativum*; (Balyeri, *et al.,* 2016) aromatic pepper; (Milica, 2013) on Caraway; (Hamouda, *et al.,* 2012); (Darzi, M.T. 2012) on *Coriandrum sativum*); (Heikal, 2005) on *Thymus vulgaris* L. and Rania and Abd El-Azim (2016) on *Plantago psyllium* L.

Furthermore, the increase was explained by the result of the analysis of organic fertilization added to the soil by the soil microorganisms that produced some of the organic acids such as humic acid, carboxylic and carbonic acid that play an important role in converting the nutrients present in the soil from the non-absorbable form of the plant to the image suitable for plant absorption. Which led to the ease of absorbing the roots of the nutrients present in the soil, which works to increase the transfer of nutrients from the roots and then to the stems and from there to the leaves, where the process of photosynthesis increases, so this is reflected on all the characteristics of growth when spraying the extract *Aloe vera*, which contains some oxins that increase in the growth and cell elongation, which helps to increase vegetative growth and seed yield and oil yield and active ingredients. (Seidler, *et al.,*); (Meena, *et al.,* 2010); (Begum, *et al.,* 2008), (Sedlakova, *et al.,* 2003, a & 2003, b) on *Carum carvi* L.; (Carrubba and Ascolillo, 2009) on *Coriandrum sativum* L. and (Abd El-Azim, *et al*., 2016) on *Foeniculum vulgare* Mill.

Conclusion

To produce a high yield of caraway fruits as well as from the volatile oil containing a high percentage of the main ingredients carvone and limonene it is recommended to use organic fertilizer at a rate of 15 m^3 and spray with *Aloe vera* extract together.

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