RESPONSE OF YIELD AND CHEMICAL COMPOSITION OF BLACK CUMIN TO DIFFERENT FERTILIZER IN SULAIMANI REGION

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ABSTRACT

Two field experiment were conducted to evaluate the effect of different fertilizer on seed yield and oil content of two Black cumin species (*Nigella sativa* and *Nigella arvensis*), the first experiment was conducted at Qlyasan Agricultural Research Qlyasan Agricultural Research Station, College of Agricultural Engineering Sciences, University of Sulaimani, and the second experiment was conducted at Kanipanka Research Station, Sulaimani Agricultural Directorate, Ministry of Agriculture and Water Recourses during the autumn season of 2020-2021. The field experiment was laid out according to factorial Completely Randomized Block Design (CRBD), with three replications. The results demonstrated that *Nigella sativa* gave maximum values for seed yield, fixed oil %, and essential oil% while *Nigella arvensis* produced maximum values for chemical constituents Thymoquinone and Nigellone at both location and their averages. The %2 organic matter produced maximum for all studied characters. The variation amount of seed yield, oil %, Essential oil % and chemical Constituents Thymoquinone and Nigellone were noticed due to the interaction treatment of *N. Arvensis* and %2 organic matters, at both locations and their average. Kanipanka location was significantly predominated Qlyasan location in seed yield, essential oil %, Nigellone and Thymoquinone.

Keywords: Medicinal plant, black cumin species, organic fertilizer, essential oil,.
***Part of the M.Sc. thesis of the 1st author.**

استجابة الإنتاج والتركيب الكيميائي لحبة البركة لأسمدة مختلفة في منطقة السليماني

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المستخلص

اجريت تجربة حقلية لتقييم تأثير انواع السماد على محصول البذور ومحتوى الزيت لنوعين من الحبة البركة (*Nigella sativa* و *Nigella arvensis*)، وأجريت التجربة الأولى في محطة أبحاث قليسان للبحوث الزراعية، كلية علوم الهندسة الزراعية، جامعة السليمانية، وأجريت التجربة الثانية في محطة أبحاث كانيبانكا بمديرية زراعة السليمانية، بوزارة الزراعة والموارد المائية خلال موسم الخريف 2020–2021. نفذت التجربة الحقلية باستعمال تصميم القطاعات العشوائية الكاملة (CRBD) بثلاثة مكررات. أظهرت النتائج أن *N. sativa* أعطت اعلى حاصل البذور ونسبة الزيت الثابتة ونسبة الزيت العطري بينما أنتجت *N. arvensis* القيم القصوى للمكونات الكيميائية Thymoquinone و Nigellone في كلا الموقعين ومتوسطهما. اعطيت المادة العضوية ٪٢حد ألاقصاعلى قيم لجميع الصفات المدروسة. لوحظ تباين كمية محصول البذور، نسبة الزيت، نسبة الزيت العطري والمكونات الكيميائية Thymoquinone وNigellone بسبب تفاعل بين *N. arvensis* و المادة العضوية ٪٢ ، في كلا الموقعين ومتوسطهما. موقع كاني بانكة تفوقت بشكل كبيرعلى موقع قلياسان في محصول البذور، ونسبة الزيت العطري،Nigellone و Thymoquinone في كلا الموقعين ومتوسطهما.

الكلمات المفتاحية: النباتات الطبية، انواع الحبة البركة، الاسمدة العضوية، زيت الطيار،شايموكينون و نايجيلون.
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INTRODUCTION

Organic fertilizers are friends to the environment and improve soil structure and texture, water holding capacity, and high cation exchange capacity (20). Also, contain micronutrients, macro and beneficial microorganisms (27). It increases production in a similar way to inorganic fertilizers (19). Chemical fertilizers have enhanced crop yields in high-yielding types of crop plants, but it leads to pollution of water bodies, groundwater, and its storage in crop plants. Therefore, environmental scientists emphasize the necessity of using organic farming, organic fertilizers, biofertilizers, and biopesticides to cultivate crops (1). Excessive use of chemical fertilizers leads to unexpected environmental effects such as plant to pests and diseases by increasing the nitrogen supplied (9). Organic farming is one of susceptibility the effective ways to reduce the negative impact of excessive chemical fertilizers (20). Medicinal plants are important in the prevention and treatment of diseases due to their abundance of antioxidants and other beneficial elements. According to a World Health Organization (WHO) report, more than 80% of the world's population uses traditional medicine for primary health care and treatment (28). Medicinal plant use, however, is not limited to developing countries; in fact, demand for herbal medicine is increasing in many developed countries. Black cumin (*Nigella sp*.) is a genus consisting of 14 species of annual aromatic plants in the family Ranunculaceae and both herb and oil have been used for medicinal purposes for centuries and presently, it is cultivated at many places of the world, including the Asia, the Middle East, and Africa (10, 25). It is one of the most researched plants due to its importance in phytochemical and pharmaceutical aspects (17). Its wide use as a traditional natural remedy for long centuries may have belonged to the Assyrian civilization (23), It is often used for treatments related to respiratory health, stomach and intestinal health, kidney and liver functions, supporting the circulatory and immune system. Also, enhance the amount of milk produced by nursing mothers, improve digestion, and is used as a flavoring, to produce warmth, especially in cold climates. The oil is used to treat eczema, boils, and cold symptoms (25) Seed of black cumin contains protein, carbohydrates, plant fats, and fixed, essential oils and peroxidase enzyme that is used for degradation of reactive dyes (8, 18). It contains all essential amino acids and rich source of vitamins and minerals (16). The essential oil of *Nigella* contains nigellone (Poly thymoquinone) and thymoquinone. Thymoquinone is the main constituent of the essential oil (12, 26). The pharmacological characteristics of the active constituent’s thymoquinone and its polymer nigellone were described by El-Dakhakhny (11) and among the activities of the active principle and polymer are choleric and uricosuric activities. This study was aimed to assess the response of Black cumin plants to different fertilizers (inorganic and organic fertilizer) supply and their effect on Yield component and variation in the Thymoquinone and its polymer nigellone chemical composition of black cumin.

MATERIALS AND METHOD

This study was conducted at two locations at Sulaimani Governorate, Qlyasan Agricultural Research Station, College of Agricultural Engineering Sciences, University of Sulaimani and Kanipanka Nursery Station, Sulaimani Agricultural Directorate, Ministry of Agriculture and Water Recourses during the fall season of 2020-202. The metrological data of both locations shown in Table1. The experiment was containing two factors, two species of Black cumin (*Nigella sativa* and *Nigella arvensis*) was implement as the first factor and the second factor was the fertilization, *i.e.* No fertilizer, NPK Fertilizer (18:18:18), Full Green Granular with three percentages (%1, %2 and %3), which contains (%10 Nitrogen, %10 P_2O_5, %5 Ca, %0.5 Mg, %5 S, %0.02 B, %1 Fe, %1 Mn, %1 Zn and %56 Organic Matter), the field experiment was laid out according to the factorial experiment with in Completely Randomized Block Design (RCBD), with three replicates. Each block contained 10 uniform experimental plots of 1 m^2 (1×1) m and 0.5 m apart. The seed of both Black cumin species were directly sown in the plots during fall season 2020. Soil of the experiment was prepared for cultivation by irrigating the field before ploughing the field using mold broad plow and harrow. Weeds were controlled manually whenever necessary, and all other cultural practices were conducted uniformly as needed for all treatment. The some chemical and physical properties of the soil at a depth of (50 cm) of the both locations which were measured are presented in Table 2.

Seed yield and oil content characters

Seed yield (kg ha^{-1}): **Fixed oil determination**

Two grams of the harvested seed of each treatment was powdered by electric blender. Digital soxhlet instrument used for oil distillation, with solvent n-hexane (BDH, UK), (2, 4), the oil content calculated as follows:

$$\textbf{Oil}\ \% = \frac{[(\mathbf{W_2}-\mathbf{W_1})\times\mathbf{100}]}{\boldsymbol{S}}$$

W_1 = weight of the empty flask (g).

W_2 = weight of the flask and the extracted oil (g)

S = weight of the sample.

Separation of the essential oil

Sample of 100 g seeds powdered of *Nigella sp*. was put in distillation apparatus (Clevenger device) and distillation was carried out a temperature of 76 °C for 4 hours (7, 12). The collection and storage of volatile oil was done at 0 °C till use

HPLC Analysis

Essential oil samples as prepared in above section were qualitatively and quantitatively analyzed by using C18 (150 mm × 4.6 mm) column packed with 5 µm Intersil ODS - 3v particles High-Performance Liquid Chromatography (HPLC). The concentration of 1000 µg/mL of Thymoquinone and Thymohydroquinone was prepared by adding 10 mg of each standard Thymoquinone and Thymohydroquinone (purity 99%) to 10 ml methanol the solvent was shacked until the powder dissolved. This solution was used as stock solution for Thymoquinone. The prepared samples was analyzed by HPLC using mobile phase of water and methanol (40 : 60, v/v) in an isocratic system with a flow rate of 1.5 mL/min and 260 nm with a detection wavelength (15). The 10 μL Sample solution was injected into the system. The identities of peaks of Thymoquinone and Thymohydroquinone were determined by comparing the chromatogram of each sample solution with that of standards. The amount of Thymoquinone and Thymohydroquinone present in the sample was calculated by using the following formulas (14, 22).

$$\textbf{Conc. of the Sample}\ \left(\frac{\textbf{mg}}{\textbf{ml}}\right) = \frac{\textbf{Peak Area of Sample}}{\textbf{Peak Area of Standard}}\times\mathbf{100}$$

Statistical Analysis

The Analysis of variance was performed as a general test for the (2×5) factorial experiment with in RCBD, and the means were tested according to least significant difference (L.S.D) using significant level of 0.05 confirmed by (21).

Table 1. Metrological data at Qlyasan and Kanipanka environments during the growing season 2020-2021

Period	*Qlyasan Location*			*Kanipanka Location*		
	Temp. C°		*Rainfall mm*	*Temp. C°*		*Rainfall mm*
	Max.	*Min.*		*Max.*	*Min.*	
2020 Nov	**15.7**	**20.9**	**204.2**	**23.8**	**16.2**	**172.1**
Dec	**10.1**	**16.3**	**21**	**22.7**	**14.6**	**14.5**
2021 Jan	**9.0**	**15.3**	**65.4**	**20.1**	**13.4**	**53.3**
Feb	**11.0**	**17.5**	**71.4**	**27.2**	**12.5**	**41.4**
Mar	**14.0**	**20.2**	**30.4**	**28.4**	**14.1**	**20.9**
Apr	**21.7**	**29.4**	**10.7**	**30.4**	**15.2**	**3.8**
May	**27.9**	**35.4**	**4.2**	**33.1**	**20.2**	**0.0**
Jun	**31.3**	**40.0**	**0.0**	**39.3**	**34.3**	**0.0**
Total			**407.3**			**306**

Table 2. Soils physical and chemical properties at Qlyasan and Kanipanka locations in 2020-2021

Soil Properties	Qlyasan Location	Kanipanka Location
P.S.D	Silty clay	Clay
Sand (g/Kg)	58.3	41.6
Silt (g/Kg)	420.7	429.2
Clay (g/Kg)	521.0	529.2
pH	7.13	7.64
E.C. (dS/m)	0.61	0.54
Organic Matter (g/Kg)	21.60	27.8
Total Nitrogen (mg/Kg)	1.07	1.03
Available Phosphate (mg/Kg Soil)	5.95	5.45
CaCO3 (g/Kg)	107.00	119.4
Soluble Cations and Anions (mmole/ L)		
Calcium (Ca^{+2})	0.39	1.72
Potassium (K^{+})	0.12	0.16
Sodium (Na^{+})	0.31	0.46
Carbonate ($CO3^{=}$)	0.00	0.00
Bicarbonate ($HCO3^{=}$)	3.11	2.99
Chloride (Cl^{-})	0.49	0.48
Sulphate ($SO4^{=}$)	0.77	0.83

RESULTS AND DISCUSSIONS

Preparative HPLC analysis for the essential oil samples showed retention times on HPLC chromatograms as listed, in Figure (1). These correspond to nigellone and thymoquinone as each compound listed to its correspondent retention 2.662 and 2.958 respectively as each compound listed to its correspondent retention. Figure (1) reveal the resolution of these two chemical constituents of essential oil with retention time (2, 3, 14).

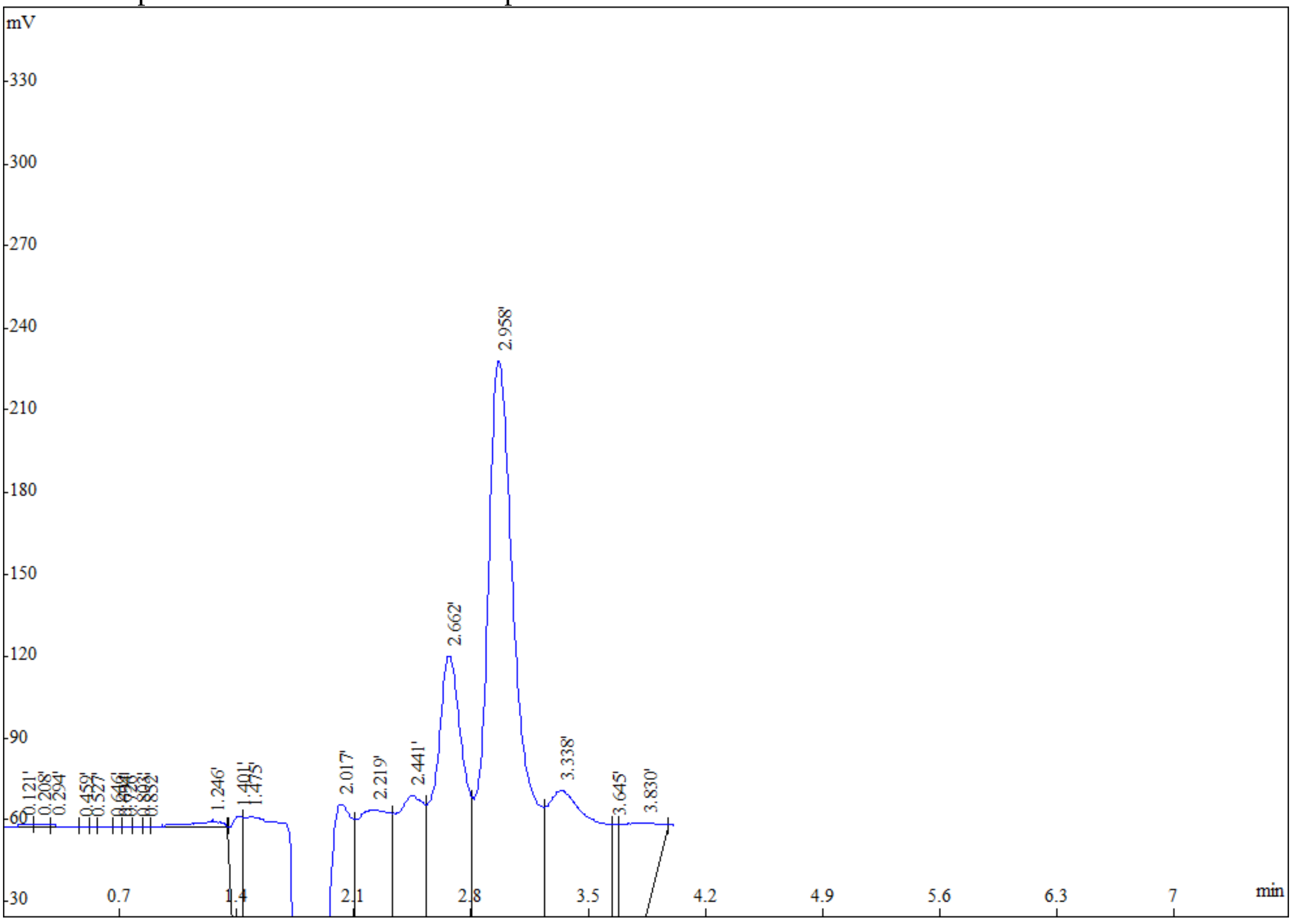

Figure1. A chromatogram of Stander detection of essential oil constituents

Rank	Time	Area%	Area
1	0.121	0.01576	6431
2	0.208	0.01174	4791
3	0.294	0.01001	4082
4	0.459	0.001716	700
5	0.527	0.001315	537
6	0.646	0.004099	1672
7	0.694	0.003654	1491
8	0.726	0.004416	1802
9	0.803	0.004219	1721
10	0.852	0.00286	1167
11	1.246	0.07996	32623
12	1.401	0.8224	335512
13	1.475	13.75	5610618
14	2.017	15.52	6333061
15	2.219	14.31	5836674
16	2.441	11.88	4848576
17	2.662	14.3	5832740
18	2.958	19.03	7762158
19	3.338	8.104	3306252
20	3.645	0.4758	194097
21	3.830	1.667	680122
Total		**100**	**40796827**

Data in Table (3) shows the seed yield and oil contents of two Black cumin species, In Qlyasan location, the data were realized that *N. sativa* surpassed *N. arvensis* significantly in seed yield which gained 562.047 Kg ha^{-1} while at Kanipanka and the average of both locations *N. sativa* produced highly significant with the value of 651.953 and 607.000 Kg ha^{-1}, respectively. Oil % highly responded to species, *N. Sativa* gave the values of 22.495, 23.015, and 22.755% in Qlyasan, Kanipanka, and the average of both locations respectively. At Qlyasan location, did not significant effect was observed concerning the essential oil % between both species, while at Kanipanka and the average of both locations *N. arvensis* gave the maximum values of 1.471 and 1.428% respectively. HPLC analysis for nigellone and thymoquinone had highly significant at Qlyasan with the values of 50.106 and 45.747 $mgml^{-1}$ respectively due to *N. arvensis*, while the average of both locations gave the values of 59.074 and 57.174 $mgml^{-1}$ respectively. No significant effect was observed at Kanipanka location for both nigellone and thymoquinone chemical constituents. Regarding the data obtained from both locations, *N. sativa* surpassed *N. arvensis* in seed yield, fixed oil %, and essential oil%, this could be due to the tolerance and adaptation of this species to Sulaimani environment, same result was obtained by (21, 24).

Table 3. Means of seed yield and oil content affected by two Black Cumin species

Species	Seed yield Kg ha^{-1}	Fixed oil%	Essential oil %	Nigellone mg ml^{-1}	Thymoquinone mg ml^{-1}
			Qlyasan Location		
N. Sativa	562.047	22.495	1.411	31.014	27.943
N. arvensis	539.227	19.788	1.385	50.106	45.747
LSD (p≤0.05)	18.908	1.218	n.s	4.707	4.659
LSD (p≤0.01)	n.s	1.668	n.s	6.449	6.383
			Kanipanka Location		
N. Sativa	651.953	23.015	1.471	55.336	54.791
N. arvensis	590.178	20.692	1.395	68.043	68.600
LSD (p≤0.05)	24.468	1.089	0.025	n.s	n.s
LSD (p≤0.01)	33.524	1.493	0.035	n.s	n.s
			Average of both Locations		
N. Sativa	607.000	22.755	1.441	43.175	41.367
N. arvensis	564.703	20.240	1.390	59.074	57.174
LSD (p≤0.05)	14.303	0.666	0.015	0.379	0.587
LSD (p≤0.01)	19.179	0.893	0.019	0.508	0.787

The effect of different fertilizer treatments at both locations and their average showed a large effect on seed yield and oil content except for nigellone which did not reach significant effects as was represented in Table (4). At Qlyasan, Kanipanka and average of both locations %2 organic fertilizer treatment gave highly significant effect on seed yield kg ha^{-1}, fixed oil %, essential oil%, nigellone mg ml^{-1}, and thymoquinone mg ml^{-1} with values of 620.608 Kg ha^{-1}, 23.262%, 1.472%, 54.828 mg ml^{-1}, and 50.086 mg ml^{-1}, 697.792 Kg ha^{-1}, 25.158%, 1.522%, and 85.607 mg ml^{-1}, and 659.200 Kg ha^{-1}, 24.210%, 1.497%, 70.217 mg ml^{-1} and 62.987 mg ml^{-1}, respectively. Concerning both locations and their average control recorded the minimum values for characters seed yield and essential oil % which were found to be 492.463 kg ha^{-1}, 1.333%, 544.362 Kg ha^{-1}, 1.363%, and 518.413 kg ha^{-1}, and 1.348%, respectively. Fixed oil% gave minimum value with 19.704% due to %1 organic fertilizer, while at Kanipanka and the average of both locations control recorded minimum values with 18.100 and 19.052%, respectively. Regarding to nigellone, the lowest value was 34.063 mg ml^{-1} recorded by control, however NPK fertilizer gave minimum values with 45.359 mg ml^{-1} and 41.461 mg ml^{-1} at Kanipanka and the average of both locations. At Qlyasan and the average of both locations NPK fertilizer recorded minimum values of 50.086 mg ml^{-1} and 62.987 mg ml^{-1} for thymoquinone, respectively. Chemical and organic fertilizers help the growth and development of plants. Organic fertilizer has ability to increase oil content may be related to its simulative influence on fresh mass, as well as the activation of enzymes involved in oil synthesis metabolism. Thus data realized that application of %2 organic fertilizers can significantly affect the seed yield, fixed oil and content of essential oil, these results relatively agreed with (6, 24) who reported that adequate amount of organic fertilizer increase each of seed yield and oil content.

Table 4. Means of seed yield and oil content affected by Fertilizer

Fertilizer	Seed yield Kg ha^{-1}	Fixed oil%	Essential oil %	Nigellone mg ml^{-1}	Thymoquinone mg ml^{-1}
Qlyasan Location					
Control	492.463	20.004	1.333	34.063	35.507
NPK	532.970	22.278	1.390	37.563	24.468
1% O.M	576.850	19.704	1.380	36.571	34.820
2% O.M	620.608	23.262	1.472	54.828	50.086
3% O.M	530.295	20.458	1.415	39.775	39.343
LSD ($p \leq 0.05$)	29.896	1.926	0.046	7.442	7.366
LSD ($p \leq 0.01$)	40.961	2.638	0.064	10.197	10.093
Kanipanka Location					
Control	544.362	18.100	1.363	68.492	74.135
NPK	593.128	21.533	1.422	45.359	48.202
1% O.M	633.378	22.458	1.398	51.944	54.444
2% O.M	697.792	25.158	1.522	85.607	75.888
3% O.M	636.667	22.017	1.458	57.046	55.810
LSD ($p \leq 0.05$)	38.688	1.723	0.040	21.568	n.s
LSD ($p \leq 0.01$)	53.006	2.360	0.055	29.550	n.s
Average of both Locations					
Control	518.413	19.052	1.348	51.277	54.821
NPK	563.049	21.906	1.406	41.461	36.335
1% O.M	605.114	21.081	1.389	44.258	44.632
2% O.M	659.200	24.210	1.497	70.217	62.987
3% O.M	583.481	21.238	1.437	48.410	47.577
LSD ($p \leq 0.05$)	22.615	1.054	0.023	0.599	0.928
LSD ($p \leq 0.01$)	30.324	1.413	0.031	0.803	1.244

Results in Table (5) shows significant and no significant effects of interaction between Black cumin species and fertilizer on seed yield and oil content at both locations and their average. At Qlyasan location oil content nigellone and thymoquinone reached maximum values of 57.808 mg ml^{-1} and 54.715 mg ml^{-1}due to interactions between *N. arvensis* and %2 organic matter, respectively. whereas the minimum values were recorded by the interaction between *N. sativa* and 1% organic matter with the values of 21.361 mg ml^{-1} and 17.715 mg ml^{-1}, respectively. The interaction between *N. sativa* and 2% organic matter produced a maximum value of 1.560 for essential oil% at Kanipanka location, while the lowest value was recorded by an interaction between both treatment *N. arvensis* and control, and *N. arvensis* and 1% organic matter with the value of 1.337%. nigellone and thymoquinone responded significantly to the treatment interaction between *N. sativa* and 1% organic matter with the values of 102.129 mg ml^{-1} and 96.700 mg ml^{-1}, respectively. While the minimum values of 27.910 mg ml^{-1} and 20.877 mg ml^{-1} were recorded by interaction between *N. sativa* and NPK fertilizer at Kanipanka location, respectively. Data in the same table shows highly significant effects of *N. arvensis* and %2 organic matter treatment on nigellone and thymoquinone with the values of 79.968 mg ml^{-1} and 75.708 mg ml^{-1}, respectively in the average of both locations, and the minimum values were 25.369 mg ml^{-1} and 19.638 mg ml^{-1}due to the treatment interactions between *N. sativa* and NPK fertilizer, respectively. As shows in table, the interaction between the species and fertilizer did not show a significant effect on each seed yield, fixed oil %, and volatile oil %, but with regard to the interaction between *N. arvensis* and 2% organic matter, it led to an increase in the chemicals content of volatile oil nigellone and thymoquinone, and perhaps the reason is due to response of the genetic inheritances present in this species to environmental factors, these results are also partial agreement with the earlier findings of (5, 13, 24).

Table 5. Means of seed yield and oil content affected interaction between Black cumin species and Fertilization

Species	Fertilizer	Seed yield Kg ha^{-1}	Fixed oil%	Essential oil %	Nigellone mg ml^{-1}	Thymoquinone mg ml^{-1}
			Qlyasan Location			
N. Sativa	Control	500.100	20.250	1.353	27.218	29.949
	NPK	546.990	24.267	1.410	22.829	18.399
	1% O.M	589.957	20.200	1.370	21.361	17.715
	2% O.M	626.457	25.733	1.470	51.847	45.457
	3% O.M	546.733	22.025	1.450	31.812	28.194
N. arvensis	Control	484.827	19.758	1.313	40.907	41.065
	NPK	518.950	20.290	1.370	52.297	30.538
	1% O.M	563.743	19.208	1.390	51.781	51.924
	2% O.M	614.760	20.790	1.473	57.808	54.715
	3% O.M	513.857	18.892	1.380	47.737	50.492
LSD (p≤0.05)		n.s	n.s	n.s	10.525	10.418
LSD (p≤0.01)		n.s	n.s	n.s	n.s	n.s
			Kanipanka Location			
N. Sativa	Control	583.300	20.242	1.390	50.952	60.900
	NPK	603.590	22.500	1.427	27.910	20.877
	1% O.M	660.390	23.600	1.460	67.673	68.476
	2% O.M	727.150	25.833	1.560	69.085	55.076
	3% O.M	685.333	22.900	1.517	61.061	68.626
N. arvensis	Control	505.423	15.958	1.337	86.031	87.370
	NPK	582.667	20.567	1.417	62.808	75.527
	1% O.M	606.367	21.317	1.337	36.216	40.411
	2% O.M	668.433	24.483	1.483	102.129	96.700
	3% O.M	588.000	21.133	1.400	53.031	42.994
LSD (p≤0.05)		n.s	n.s	0.056	30.502	38.147
LSD (p≤0.01)		n.s	n.s	n.s	n.s	n.s
			Average of both Locations			
N. Sativa	Control	541.700	20.246	1.372	39.085	45.424
	NPK	575.290	23.383	1.418	25.369	19.638
	1% O.M	625.173	21.900	1.415	44.517	43.096
	2% O.M	676.803	25.783	1.515	60.466	50.267
	3% O.M	616.033	22.463	1.483	46.437	48.410
N. arvensis	Control	495.125	17.858	1.325	63.469	64.217
	NPK	550.808	20.428	1.393	57.553	53.032
	1% O.M	585.055	20.263	1.363	43.999	46.168
	2% O.M	641.597	22.637	1.478	79.968	75.708
	3% O.M	550.928	20.013	1.390	50.384	46.743
LSD (p≤0.05)		n.s	n.s	n.s	0.847	1.312
LSD (p≤0.01)		n.s	n.s	n.s	1.136	1.760

Regarding the results in Table (6) Kanipanka location was significantly predominated Qlyasan location in seed yield, essential oil %, nigellone and thymoquinone with values of 621.065 Kg ha^{-1}, 1.433%, 61.690 mg ml^{-1}, and 61.696 mg ml^{-1}, respectively. While no significant effect was recorded in fixed oil % between both locations. At Kanipanka location most of the characters led to better results compared to the Qlyasan location. Perhaps the reason is due to the availability of environmental conditions, especially the moderate temperature. this approach was confirmed by the metrological data in table (1).

Table 6. Means of seed yield and oil content affected by locations

Locations	Seed yield Kg ha^{-1}	Fixed oil%	Essential oil %	Nigellone mg ml^{-1}	Thymoquinone mg ml^{-1}
Qlyasan	**550.637**	**21.141**	**1.398**	**40.560**	**36.845**
Kanipanka	**621.065**	**21.853**	**1.433**	**61.690**	**61.696**
LSD (p≤0.05)	**19.102**	**n.s**	**0.017**	**0.449**	**0.921**
LSD (p≤0.01)	**31.677**	**n.s**	**0.029**	**0.744**	**1.528**

CONCLUSIONS

This study characterized that *N. sativa* surpassed *N. arvensis* in seed yield, fixed oil, essential oil, and its content. Kanipanka location is more favorable for the production of Black cumin species and also utilizing 2% organic fertilizer led to increasing productivity of them.

REFERENCES

1. Abou El-Leel, O. F., R. W., Maraei and A. A. E. H ALY 2019. Studying the response of *Nigella Sativa* plants to different fertilizers. Analele Universitatii din Oradea, Fascicula Biologie, 26(1): 14-20

2. Ahmed, R. M. 2019. Oil percent and unsaturated fatty acid response of rapeseed cultivars to nitrogen and phosphorus fertilizers in two different sowing date. Tikrit Journal for Agricultural Sciences 18(4): 29-38

3. Ahmed, R. M., A. A., Askari and S. O. Baban 2018. Effect of Fertilizer Types and Plant Densities on Oil Components of Milk Thistle (*Silybum marianum* L.) Under Rainfed and Irrigated Conditions. Journal of Zankoy Sulaimani- Part A, Special Issue, 2nd Int. Conference of Agricultural Sciences. pp :115-126

4. Al-Jubouri, I. I. 1997. Effect of Sowing Dates and Harvesting on The Quality of Oil and Its Component for Two Types of Sesame Crop *(Sesamum indicum*. College of Agriculture. Baghdad University, pp: 3-22

5. Al-Mohammedi, A. N., A. F., Al-mehemdi, and O. H. Al-Mehemdi 2016. Some physical properties of essential oil of barakaseed *Nigella sativa* L. impacted by bat guano Otonycteris hemprichii Camd and seaweed extract. The Iraqi Journal of Agricultural Science, 47(4): 11124-1131

6. Ashraf, M., Ali, Q., and E. S. Rha 2005. The effect of applied nitrogen on the growth and nutrient concentration of Kalonji (*Nigella sativa*). Australian Journal of Experimental Agriculture, 45(4): 459-463

7. Askari, A. A., S. O. Baban, and R. M Ahmed 2013. Effect of Fertilizer type and Plant Density on Flavonoligans Yield of Milk Thistle (*Silybum marianum* L.) under Rainfed and Irrigated Conditions. Journal of Zankoy Sulaimani- Part A, Special Issue, 1st Int. Conference of Agricultural Sciences. pp 363-378

8. Aziz, G. M., S. I., Hussein, S. D., Abbass, A. L., Ibrahim, and D. K. Abbas, 2021. Degradation of reactive dyes using immobilized peroxidase purified from *Nigella sativa*. Iraqi Journal of Agricultural Sciences, 52(6), 1365-1374

9. Chen, J. H. 2006. The combined use of chemical and organic fertilizers and/or bio fertilizer for crop growth and soil fertility. In International workshop on sustained management of the soil-rhizosphere system for efficient crop production and fertilizer.16, (20): 1-11. Land Development Department Bangkok

10. Dwivedi, S., S., Shrivastava, D., Dubey, S., Kapoor, and S. Jain 2007. Status and conservation strategies of herbal oral contraceptives. Planta Indica, 3(1): 5-7

11. El-Dakhakhny, M. 1965. Studies on the Egyptian *Nigella sativa* L. part IV: some pharmacological properties of the seed's active principle in comparison to its dihydro compound and its polymer. Arzneim. Forsch., 15, 1227-1229

12. Ferreira-Dias, S., D. G. Valente and J. M. Abreu, 2003. Comparison between ethanol and hexane for oil extraction from *Quercus suber* L. fruits. Grasas y Aceites, 54(4), 378-383

13.Ghafoor, B. S. and A. A. Rasool 2017. Performance of Two Species of Black Cumin (*Nigella sativa*) and (*Nigella arvensis*) Under Different Sowing Dates in Spring and Autumn at Halabja Province/ Iraq Kurdistan Region. M.Sc. Thesis. Halabja Technical College of Applied Sciences, pp:24- 63

14. Habib, N., and S. Choudhry 2021. HPLC Quantification of Thymoquinone Extracted

from *Nigella sativa* L.(Ranunculaceae) Seeds and Antibacterial Activity of Its Extracts against Bacillus Species. Evidence-Based Complementary and Alternative Medicine, vol. 2021, Article ID 6645680,11pages

15. Hadad, G. M., R. A., Abdel Salam, R. M. Soliman, and M. K. Mesbah 2012. High-performance liquid chromatography quantification of principal antioxidants in black seed (*Nigella sativa* L.) Phytopharm-aceuticals. Journal of AOAC International, 95(4), 1043-1047

16. Jadayil, S. A., S. K., Tukan, and H. R. Takruri 1999. Bioavailability of iron from four different local food plants in Jordan. Plant Foods for Human Nutrition, 54(4), 285-294

17. Kamil, Z. H. 2013. Spectacular black seeds (*Nigella sativa*): Medical importance review. Medical Journal of Babylon, 10(4):1-9

18. Karim, M., R. M. Himel, J. Ferdush, and M. Zakaria 2017. Effect of irrigation levels on yield performance of black cumin. International Journal of Environment, Agriculture and Biotechnology, 2(2), 238754

19. Maske, S. N., G. R. Munde and N. M. Maske 2015. Effect of manures and fertilizer on brinjal (*Solanum melongena* L.) CV Krishna. BIOINFOLET-A Quarterly Journal of Life Sciences, 12(3b), 678-679

20. Mehdizadeh, M., E. I. Darbandi, H., Naseri-Rad and A. Tobeh 2013. Growth and yield of tomato (*Lycopersicon esculentum* Mill.) as influenced by different organic fertilizers. International Journal of Agronomy and plant production, 4(4): 734-738

21. Muhammad, A. G., R. M., Ahmed and K. E. Muhammed 2017. Response of growth, yield and oil content of two Black seed species to nitrogen fertilizer in Sulaimani District. Euphrates Journal of Agriculture Sciences 9(4), 18-52

22. Neamah, S. I. 2018. In vitro production of some terpenoids compounds from Nigella sativa with different explants type and PEG concentrations. Iraqi Journal of Agricultural Sciences, 49(4):534- 540

23. Rahmani, A. H., and S. M. Aly 2015. *Nigella sativa* and its active constituents thymoquinone shows pivotal role in the diseases prevention and treatment. Asian Journal Pharmaceutical and Clinical Research, 8(1), 48-53

24. Rasool, A. A., and A. G. M. Rashid 2014. Effect of nitrogen fertilization and gibberellic acid spray on seed yield and oil content of black seed (*Nigella sativa* L.). Journal of Zankoy Sulaimani-Part A, 16, 355-362

25. Riaz, M., M. Syed, and F. M. Chaudhary 1996. Chemistry of the medicinal plants of the genus *Nigella*. Hamdard Medicus, 39(2), 40-45

26. Sergio Ochatt and S.M. Jain 2007. *Nigella sativa* a potential commodity in crop diversification traditionally used in healthcare. Breeding of neglected and under-utilized crops, spices and herbs, 1st edition, 215-230

27. Sreenivasa, M. N., N. Naik and S. N. Bhat 2010. Beejamrutha: A source for beneficial bacteria. Karnataka Journal of Agricultural Sciences, 22(5): 1038- 1040

28. Wienkotter, N., D. Hopner, U. Schutte, K. Bauer, F. Begrow, El-Dakhakhny, M., and E. J. Verspohl 2008. The effect of nigellone and thymoquinone on inhibiting trachea contraction and mucociliary clearance. Planta medica, 74(02): 105-108.