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.

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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 P₂O₅, %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 m² (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:

$$\text{Oil} \% = \frac{[W_2-W_1] \times 100}{S}$$

\(W_1\) = 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).

$$\text{Conc. of the Sample (mg/mL)} = \frac{\text{Peak Area of Sample}}{\text{Peak Area of Standard}} \times 100$$

**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. | 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              |
| Calcium (Ca\(^{+2}\))   | 0.39             | 1.72               |
| Potassium (K\(^{+}\))   | 0.12             | 0.16               |
| Sodium (Na\(^{+}\))     | 0.31             | 0.46               |
| Carbonate (CO\(_3^{2-}\)) | 0.00 | 0.00 |
| Bicarbonate (HCO\(_3^{+}\)) | 3.11 | 2.99 |
| Chloride (Cl\(^{-}\))   | 0.49             | 0.48               |
| Sulphate (SO\(_4^{2-}\)) | 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).

Figure 1. A chromatogram of Stander detection of essential oil constituents
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%, 1.471%, 54.828 mg ml\(^{-1}\), and 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≤0.05) | 29.896            | 1.926      | 0.046           | 7.442             | 7.366               |
| LSD (p≤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≤0.05) | 38.688            | 1.723      | 0.040           | 21.568            | n.s                 |
| LSD (p≤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≤0.05) | 22.615            | 1.054      | 0.023           | 0.599             | 0.928               |
| LSD (p≤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    | 1.370          | 31.812                   | 28.194                    |
| Control     | NPK        | 484.827                   | 19.758    | 1.313          | 40.907                   | 41.065                    |
| NPK         | 518.950    | 20.680                   | 1.370     | 52.297         | 30.538                    |
| 1% O.M     | 563.743    |                          |           |                |                          |                           |
| 2% O.M     | 614.760    |                          |           |                |                          |                           |
| 3% O.M     | 513.857    |                          |           |                |                          |                           |
| L.S.D (p\(\leq\)0.05) | n.s | n.s | n.s | 10.525 | 10.418 |
| L.S.D (p\(\leq\)0.01) | n.s | n.s | n.s | n.s | n.s |
| Kanipanka Location |          |                       |           |                |                          |                           |
| N. Sativa   | Control    | 583.300                   | 20.24    | 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                   | 51.924                    |
| Control     | NPK        | 505.423                   | 15.958    | 1.337          | 86.031                   | 87.370                    |
| NPK         | 582.667    | 20.567                   | 1.417     | 50.031         | 52.300                    |
| 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                    |
| L.S.D (p\(\leq\)0.05) | n.s | n.s | 0.056 | 30.502 | 38.147 |
| L.S.D (p\(\leq\)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                    |
| Control     | NPK        | 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                    |
| L.S.D (p\(\leq\)0.05) | n.s | n.s | n.s | 0.847 | 1.312 |
| L.S.D (p\(\leq\)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.

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