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Effect of Intercropping Black Cumin (*Nigella sativa* L.) Plants on Garlic (*Allium sativum*) Plants on Microbial Community of Soil, Productivity and Quality of Both Crops

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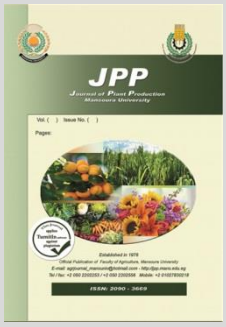

ABSTRACT

The present study was carried out at Farm of Agricultural Research Center in Gemmeiza Agricultural Research Station, Egypt, El- Gharbia Governorate during the two consecutive winter seasons of 2016/2017 and 2017/2018.To evaluate effect of intercropping garlic bulbs on black cumin plants on microbial community of soil, productivity and quality of both crops. And there are 4 levels of intercropping as main plots (50%, 66%, 99%) intercropping, solocropped plants) and the 3 nitrogen fertilization levels were as subplots (50%, 75%, 100% nitrogen) were considered. The obtained results showed the importance of intercropping black cumin plants on garlic plants in improving the growth and yield of black cumin seeds, fixed oil and of volatile oil black cumin plants compared to solocropped plants. The treatment (T6) is increased the weight of (the seeds of one capsule, 1000 seeds, of the capsules / plant, the seeds / plant, the seeds / plot, the seeds / fedd.) and the number of capsules / plant, for black cumin plants and increased the fresh and dry weight both of the head (gm) and dry weight (Kg) / fedd. for garlic bulbs, while the treatment (T5) is resulted in an increase in the volatile oil%, the weight of (the volatile oil and the fixed oil) L/ fedd. on both seasons for black cumin plants and increase the organic acids in the fixed oil and increased the volatile oil % and the weight of volatil oil L/fedd. for garlic bulbs. The treatment (T9) is increased the fixed oil % for black cumin, while (T4) is increased total carbohdrates % in bulbs.

Keywords: Black cumin, Garlic, Intercropping, Nitrogen fertilization,Yield components,Volatile oil,Fixed oil, LER.

INTRODUCTION

Medicinal plants are used for treating many disorders that are either non-curable or rarely cured by modern systems of medicine (Abadi *et al.*, 2015). Over the last three decades, the use of herbal medicinal products and supplements have grown to such an extent that about 80% of the world population relying on them for some part of primary healthcare. (Ekor, 2014). *Nigella sativa* L. plant is an annual medicinal plant belonging to the Ranunculaceae family. It is native to southern Europe, North Africa, South and West Asia (Tuncturk *et al.*, 2012) and widely cultivated throughout Syria, Egypt, Saudi Arabia, Iran, Pakistan, India and Turkeyfor seed yield and oil production (Riaz *et al.*, 1996). Seeds of *Nigella sativa* L. are characterized for their unique chemical properties that may contribute to the improvement of human health. Various surveys have shown that the whole seeds or their extracts have diuretic, antihypertensive, antidiabetic, anticancer, immunomodulatory, anthelmintic, analgesic, antimicrobial, anti- inflammatory, spasmolytic, bronchodilator, hepatoprotective, gastroprotective, nephron-protective, antihypertensive and antioxidant effects (Al-Jassir, 1992); (Riaz *et al*., 1996); Ahmad *et al.*, 2013). Moreover, the seeds are rich in fats, fiber, minerals such as Fe, Na, Cu, Zn, P, Ca and vitamins such as ascorbic acid, thiamin, niacin, pyridoxine, and folic acid (Takruri and Dameh, 1998). *Nigella sativa* L. seeds contain 30-35% oil and 0.5-1.5% essential oil which have several uses for pharmaceutical and food industries (Üstun *et al*., 1990; Ashraf *et al.*, 2006). One of the most important constituents of essential oil is thymoquinone that belongs to the chemical class of terpenoids and imports the plant under investigation about the ability to influence on important human diseases such as cancer (Banerjee *et al.*, 2010).

Garlic (*Allium sativum* L.) plant is one of the main important bulbs vegetable crops grown in Egypt for local consumption and exportation and is next to onion in importance (Hamma *et al.*, 2013). Also, Egypt enjoys a comparative advantage in the high productivity of this crop. It is commonly used as a spice or in the medicinal purposes because it contains antibiotic substances known as garlicin and allistatin (Maly *et al.*, 1998). Therefore, increasing garlic yield and improving bulb quality are essential aims for growers to fulfill the many beneficial health properties. The characteristic flavor and aroma of garlic as well as other

Alliums results from the enzymatic hydrolysis of S-alk(en)yl-L-cysteine sufoxides (ACSO) to produce S compounds and by products pyruvic acid and ammonia (Randle *et al.*, 1995). Garlic is an important allelopathic and antimicrobial crop and many researchers have focused on the garlic extracts (Wei *et al.*, 2011); however a few reports found on garlic root exudates for the suppression of different vegetables diseases and their effects on the soil fertility.

Nitrogen is one of the essential nutrients affecting the plant growth and development, being an essential component of the proteins which builds cell materials and plant tissue (Mokhele *et al*.2012). Several findings have shown the positive effects of N- fertilization on the seed yield and seed

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oil quality of black cumin by (Ashraf *et al.* 2006) and (Shah 2007). The application of different fertilizer sources of nitrogen fertilizer (manure and chemical) and the spray can be a way to increase production in the medical plants. Availability of nitrogen for crops is one of the main limiting factors for agricultural production. The importance of adequate nitrogen nutrition and low available soil nitrogen reserves of nutrients because of other than nitrogen the risk of loss and recovery rates of less than half the applied (of thirty-three percent), agriculture application of nitrogenous fertilizers raises (Ghorbanli *et al.*2006) .

In a research, nitrogen increases the number of flowering branches, biological yield and grain yield Nigella Sativa (Molafilaby *et al.* 2009).

In a previous study that intercropping with green garlic significantly affects nutrient concentrations and the soil nutrient character in cucumber crops. The accumulation of biomass and most nutrient elements (N, P, K, Ca and Mn) in intercropped cucumber was significantly greater than that found in mono-cropped cucumber, and the effect was even sustained to the second growing season. Soil organic matter and available N, P and K were higher in the green garlic-cucumber intercropping system than in a cucumber monocrop- ping system. The regression analysis showed that the concentraions of the most elements were significantly related to the amounts of garlic bulbs, especially the microelements in the experiment of spring 2011. The available soil N and organic matter were linearly related to the amounts of garlic bulbs. (Xuemei, *et al.* 2013)

The main objective of the current research was to overcome the soil deterioration obstacles imposed by successive pepper cultivation by controlling nutrient imbalance, soil physico-chemical characteristics, to focus the change in microbial communities of pepper rhizosphere intercropped with garlic and to index the spectrum of protective enzymes.

MATERIALS AND METHODS

This work was carried out at Farm of Agricultural Research Center in Gemmeiza Agricultural Research Station, El- Gharbia Governorate during the two consecutive winter seasons of 2016/2017 and 2017/2018.

Field preparation:

Field was ploughed two times as cross-ploughing to remove the remains of the previous crops. The field was divided to experimental plots, each one was 7.8m^2 (4 x 1.95m^2) each plot contained 3 rows, the distance between hills was 25 cm, every hill contained 2 to 3 plants of black cumin and each plot contained from 30 to 45 plants, while the distance between hills was 10 cm, every hill contained 2 to 3 bulbs of garlic.

The treatments were:

- (T1) 50% Intercropping garlic bulbs on black cumin plants with(N 50%).
- (T2) 50% Intercropping garlic bulbs on black cumin plants with(N 75%).
- (T3) 50% Intercropping garlic bulbs on black cumin plants with(N100%).
- (T4) 66% Intercropping garlic bulbs on black cumin plants with (N 50%).
- (T5) 66% Intercropping garlic bulbs on black cumin plants with(N 75%).
- (T6) 66% Intercropping garlic bulbs on black cumin plants with(N 100%).
- (T7) 99% Intercropping garlic bulbs on black cumin plants with(N 50%).
- (T8) 99% Intercropping garlic bulbs on black cumin plants with(N 75%).
- (T9) 99% Intercropping garlic bulbs on black cumin plants with(N100%).
- (T10) Solocropping of black cumin plants with(N 50%).
- (T11) Solocropping of black cumin plants with(N 75%).
- (T12) Solocropping of black cumin plants with(N 100%).
- (T13) Solocropping of garlic plants with(N 50%).
- (T14) Solocropping of garlic plants with(N 75%).
- (T15) Solocropping of garlic plants with(N 100%).

The evaluation of Land Equivalent Ratio= LER

Total LER = $LER_b + LER_g$

$LER_b = LER_{bi} / LER_{bs}$

$LER_g = LER_{gi} / LER_{gs}$

Land Equivalent Ratio (LER)

Land Equivalent Ratio of black cuimmin (LER_b)

Land Equivalent Ratio of black cuimmin intercropping (LERbi)

Land Equivalent Ratio of black cuimmin solo intercropping (LERbs)

Land Equivalent Ratio of garlic (LERg)

Land Equivalent Ratio of garlic intercropping (LERgi)

Land Equivalent Ratio of garlic solo intercropping (LERgs)

Black Cuimmin = B.C. ' Garlic = G. '

Intercropped Yield = IY ' Sole Yield = S.Y.

Equivalent Area =E.A. ' N= Nitrogen of fertilizer

Sowing :

Seeds of black cumin and garlic (*Allium sativum* L.) bulbs were obtained from the Medicinal and Aromatic Plants Section of Agricultural Research Center, El-Dokki, Cairo, Egypt. Bulbs of garlic were planted on12th of October and seeds of black cumin were planted on 22th of October during the two seasons, respectively.

This experiment included 15 treatments, which were the combinations between four levels of intercropping between black cumin (*Nigella sativa* L.) plants and Garlic (*Allium sativum* L.) bulbs (50% intercropping garlic bulbs on black cumin plants , (66% intercropping garlic bulbs on black cumin plants , (99% intercropping garlic bulbs on black cumin plants and and solocropping plants for each black cumin plants and garlic bulbs), three levels of nitrogen fertilization (N %50, (N %75) and (N %100) and their combinations on growth and productivity of black cumin and garlic. Garlic was cultivated at 50%, 66% and 99% between the black cumin plants. The plot area was 7.8 m^2 (4.00 ×1.95 m) included three rows; each row was 60 cm apart. The seeds of black cumin were sown in hills on one side of ridge and the distances between hills were 25 cm and after three weeks from sowing, seedlings were thinned to be two plants /hill. The treatments were arranged in a split-plot design with three replicates.

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

Mechanical analysis				Soil texture
Clay (%)	**Silt (%)**	**SP (saturation %)**	**ρb (Mg m^{-3})**	Clayey
51.14	37.17	68.00	1.12	

Chemical analysis										
pH	E C m.mohs/cm	OM (%)	Soluble cations (meq. / l)				Soluble anions (meq. / l)			Available (ppm)
			Mg^{++}	Ca^{++}	K^{+}	Na^{+}	Cl^{-}	HCO_3^{-}	SO_4^{--}	K
8.83	0.55	0.74	0.90	1.70	0.80	2.48	3.29	0.23	1.89	0.80

Fertilization:

Mineral NPK (full dose) of black cumin plants were added at the rate of 200 + 200 + 100kg/ fedd. of ammonium nitrate (33.5 % N), calcium superphosphate (15.5 % P_2o_5), potassium sulphate (48 % k_2O).

Mineral NPK (full dose) of garlic bulbs were added at the rate of 120 +200 + 100 kg/ fedd.

Data recorded:

At harvesting stage of black cumin were plant height (cm), branch number /plant and total plant weight (g) were estimated, number of branches / plant, seeds yield /plant (g) were determined, and then seeds yield (kg/ feddan) was calculated, while data recorded of garlic was the fresh weight of garlic(Kg /plot), the dry weight of garlic (Kg./plot), the fresh weight of garlic (Kg /fedd.), the dry weight of garlic (Kg./fedd.), diameter of head of garlic (cm), head height of bulb(cm), number lobes of bulb, fresh weight of the head (gm), dry weight of the head (gm), volatile oil %, volatil oil L/fedd., carbohdrates %.

A sample of seeds of black cuuimn and bulbs of garlic were randomly taken from each treatment for chemical analysis. The volatile oil from seeds of black cuuimn were extracted by hydro distillation for 3 hr., according to Guenther (1961). Oil yield /plant (ml) and L/feddan were calculated.Furthermore, total phosphorus (%) was determined in seeds of black cumin according to the methods described by Chapman and Pratt (1978). and Fixed oil contents of seeds was estimated as described by Munshi *et al.* (1987).

Powder of each sample was extract using a solvent hexan. Fixed oil are made volatile by converting them in to methyle ester. The esters are identified and quantified by injecting into GLC. The latest compoterised GLC models give concentration of fixed oil directly. Fixed oil yield (ml/plant)and fixed oil yield(L/fedd.)

Also, total carbohydrates percentage of black cuuimn was determined according to the methods described by AOAC (2000).

Soil microorganism:

Population of soil microorganisms including bacteria, fungi and actinomycetes was determined by using standard dilution plate method according to colony forming units (cfu) as described by Fan & Li (1982). The bacteria, fungi and actinomycetes were incubated with beef broth peptone substrate, Gause No.1 substrate and potato dextrose agar (PDA), respectively. Three plates were measured for each parameter of soil sample.

Statistical Analysis

Data of the present study were statically analyzed and the differences between the means of the treatments (levels of intercropping , levels of nitrogen and combination between levels of intercropping and levels of nitrogen) were considered significant when they were more than or equal to the least significant differences (L.S.D) at the 5% level by using computer program of Statistix Version 9 (Analytical Software, 2008).

Microbiological analysis:

A-preparation of serial dilutions:10 g soil of each sample were added to 90 mL of sterile water to make serial decimal dilutions.

B-Enumeration of microorganisms: numeration of heterotrophic bacteria and fungi was carried out by pour plating technique.From each previously prepared serial dilution of the samples, 1 mL was inoculated onto duplicates, using sufficient amount of liquefied standard plate count agar medium (45±1°C). The medium used for the cultivation of bacteria was nutrient agar and potato dextrose agar containingStreptomycin (1mg /100 ml) for fungi.The inoculated nutrient Agar plates were incubated at 35 °C for 24 hours while the potato dextrose Agar plates were incubated at 28°C for 3-5 days. Observed colonies were counted and expressed as colony forming units per gram (cfug- 1).

Table 2. Microbiological analysis:

Soil sample NO.	First stage		Second stage	
	Total bacterial count CFU/gm	Total molds count CFU/gm	Total bacterial count CFU/gm	Total molds count CFU/gm
1	$1.5x10^7$	$1.2x10^5$	3.4 x107	$1.5x10^5$
2	$1.8x10^7$	$1.3x10^4$	$3.6x10^6$	$5.4 x10^5$
3	$2.3x10^6$	$3.1x10^4$	$5x10^6$	$6.4x10^4$
4	$2.0x10^7$	$3.1x10^4$	4.3 x107	$7.3x10^5$
5	2.7x107	$4.6x10^5$	$8.1x10^7$	$8x10^4$
6	$5.1x10^7$	$8.0x10^4$	$8.2x10^7$	$8.6x10^5$
7	2.3x106	$3.2x10^4$	$6.8x10^6$	$7x10^4$
8	$2.5x10^7$	$3.1x10^4$	6.3 x107	$6.4x10^4$
9	2.9x107	$7.0x10^4$	$8.2x10^7$	$8.1x10^5$
10	$1.1x10^7$	$1.1x10^5$	$1.2x10^7$	$1.2x10^5$
11	$1.2x10^7$	$1.0x10^5$	$2.1x10^8$	$1.3x10^5$
12	$1.2x10^7$	$1.2x10^5$	$1.7x10^7$	$1.4x10^5$
13	$1.3x10^7$	$1.4x10^4$	$2.6x10^6$	$1.7x10^5$
14	$1.4x10^8$	$1.5 x10^5$	$2.6x10^6$	$1. 6 x10^5$
15	$2.0x10^7$	$1.4x10^5$	$2.7x10^7$	$3.6 x10^5$

RESULTS AND DISCUSSION

1. Effect of intercropping black cumin (*nigella sativa* l.) plants on garlic (*allium sativum*) plants on land equivalent ratio (ler) under the influence of 3 levels of nitrogen fertilization:

Effect of intercropping black cumin (*Nigella sativa* L.) Plants on garlic(*Allium sativum*) plants on land equivalent ratio (LER) under on the weight of seeds kg/fedd. and dry weight of the heading garlic kg/fedd.

It is quite clear from the data in Table (3) that all treatments had significantly higher LER than solocropped. Also, all intercropping treatments had LER more than 1 without any significant difference Table (3). Considering that all of intercropping treatments had LER more than 1 in

this study, during two seasons were 1.92, 1.72, 1.90 and 1.71in the frist season from (T1), (T3),(T6) and (T9) respectively . In the second season, all of intercropping treatments had LER more than 1 were 1.82, 1.96 and 1.67 from (T1), (T2) and (T3) with three levels of nitrogen and LER more than had 1.55 was (T9). Vahid *et al*. (2017) on Cumin and Chickpea indicated, that LER was achieved more than 1 for all intercropped ratios indicated the superiority of intercropping than solocropped. The results of the current study are in agreement with those of Maryam *et al*. (2018) showed that the yield of soybean, productivity and quality of black cumin were affected by cropping systems and fertilization sources. The highest seed yield (on an average by 247 g m^{-2}) of soybean and land equivalent ratio (1.06) were ob- tained in two rows of soybean plus one row of black cumin under the application of chemical fertilizer. The results of the current study are in agreement with those of Negah *et al*(2014) , Muhammad *et al.*, 2015) and Akooch *et al.*(2014) on black cumin in intercropping with chickpea.

Table 3. Results of means Land Equivalent Ratio (LER) effects of intercropping black cumin (*Nigella sativa* L.) plants on garlic (*Allium sativum*) plants under the influence of three levels of nitrogen fertilization: during 2016/2017& 2017/2018 seasons, which the weight of seeds kg/fedd. and dry weight of the heading garlic kg/fedd.

Season 1			**IY (L/fedd.)**		**S.Y (L/fedd.)**		**E.A.**		**LER**
Crops Treatments			**B.C.**	**G.**	**B.C.**	**G.**	**B.C.**	**G.**	**LER**
50%Intercropping garlic bulbs on black cumin plants	(N %50)	T1	167.0	36.3	170.4	38.5	0.98	0.94	1.92
	(N %75)	T2	248.0	42.4	202.2	44.3	1.23	0.96	2.19
	(N %100)	T3	294.7	45.3	306.1	59.4	0.96	0.76	1.72
66%Intercropping garlic bulbs on black cumin plants	(N %50)	T4	178.0	49.9	170.4	38.5	1.04	1.30	2.34
	(N %75)	T5	320.2	44.7	202.2	44.3	1.58	1.01	2.59
	(N %100)	T6	321.3	50.6	306.1	59.4	1.05	0.85	1.90
99%Intercropping garlic bulbs on black cumin plants	(N %50)	T7	175.2	50.5	170.4	38.5	1.03	1.31	2.34
	(N %75)	T8	185.5	52.7	202.2	44.3	0.92	1.19	2.11
	(N %100)	T9	243.8	54.0	306.1	59.4	0.80	0.91	1.71
Season 2			IY (L/fedd.)		S.Y (L/fedd.)		E.A.		LER
Crops Treatments			B.C.	G.	B.C.	G.	B.C.	G.	LER
50%Intercropping garlic bulbs on black cumin plants	(N %50)	T1	38.2	40.3	44.2	41.9	0.86	0.96	1.82
	(N %75)	T2	108.9	40.5	103.6	44.5	1.05	0.91	1.96
	(N %100)	T3	113.8	47.4	136.8	56.3	0.83	0.84	1.67
66%Intercropping garlic bulbs on black cumin plants	(N %50)	T4	61.4	48.5	44.2	41.9	1.39	1.16	2.55
	(N %75)	T5	164.3	45.5	103.6	44.5	1.59	1.02	2.61
	(N %100)	T6	180.6	49.6	136.8	56.3	1.32	0.88	2.20
99%Intercropping garlic bulbs on black cumin plants	(N %50)	T7	48.0	48.9	44.2	41.9	1.09	1.17	2.26
	(N %75)	T8	77.7	57.7	103.6	44.5	0.75	1.30	2.05
	(N %100)	T9	78.8	54.5	136.8	56.3	0.58	0.97	1.55

LER= Land Equivalent Ratio , B.C.=Black cumin , G.=Garlic , S.Y.= Sole Yield, IY= Intercropped Yield, E.A.= Equivalent Area
(T1) 50% Intercropping garlic bulbs on black cumin plants with(N 50%), (T2) 50% Intercropping garlic bulbs on black cumin plants with(N 75%). (T3) 50% Intercropping garlic bulbs on black cumin plants with(N100%), (T4) 66% Intercropping garlic bulbs on black cumin plants with (N 50%). (T5) 66% (T5) Intercropping garlic bulbs on black cumin plants with(N 75%), (T6) 66% Intercropping garlic bulbs on black cumin plants with(N 100%). (T7) 99% Intercropping garlic bulbs on black cumin plants with(N 50%), (T8) 99% Intercropping garlic bulbs on black cumin plants with(N 75%). (T9) 99% Intercropping garlic bulbs on black cumin plants with(N100%), N= Nitrogen of fertilizer.

2 Effect of intercropping black cumin (*Nigella sativa* L.) plants on garlic (*Allium sativum*) plants on land equivalent ratio (LER) under on the fixed oil yield L/feddan of black cumin and volatile oil yield L/feddan of garlic.

From data in Table (4) it was obvious that, all treatments had significantly higher LER than solocropped. Also, all intercropping treatments had LER more than 1 without any significant difference (Table 4). Considering that all of intercropping treatments had LER more than 1 in this study, during two seasons were the fixed oil yield L/feddan of black cumin and volatile oil yield L/feddan of garlic were 1.99 and 1.6 in the frist season from (T3) and (T6) respectively . In the second season, all of intercropping treatments had LER more than 1 were 1.23, 1.39, 1.79 and 1.35 from (T1), (T3), (T6) and (T9) respectively . The results of the current study are in agreement with those of Vahid *et al.* (2017) mentioned that, The evaluation of indicated that the most LER was related to delayed intercropping treatment in March 16 and the least one was related to intercropped treatment in February 13. Totally, LER was achieved more than 1 for all intercropped ratios indicated the superiority of intercropping than solocropped. The results of the current study are in agreement with those of Negah *et al*(2014) and Muhammad *et al.*, 2015) and Akooch *et al.*(2014) on black cumin in intercropping with chickpea and bean reported that, the effects of intercropping on yield of black cumin in intercropping with chickpea and bean, an experiment was conducted in a complete randomized block design with four replications. Crops were planted as pure stands and intercrops in three arrangements: A) alternating rows of a field crop and a medicinal plant, B) two rows of field crops and one row of medicinal plant, C) alternating double rows of field crops and medicinal plants. Results showed that land equivalent ratio was more than 1 in all treatment indicating seed yield of the plants were higher in pure stands compared to intercrops but the advantages of the intercropping compared to sole cropping.

Table 4. Results of means Land Equivalent Ratio (LER) effects of intercropping black cumin (*Nigella sativa* L.) plants on garlic(*Allium sativum*) plants under the influence of three levels of nitrogen fertilization: during 2016/2017& 2017/2018 seasons, which the fixed oil yield L/feddan of black cumin and Volatile oil yield L/feddan of garlic.

Season 1			**IY (L/fedd.)**		**S.Y (L/fedd.)**		**E.A.**		**LER**
Crops Treatments			**B.C.**	**G.**	**B.C.**	**G.**	**B.C.**	**G.**	**LER**
50%Intercropping garlic bulbs on black cumin plants	(N %50)	T1	43.4	2.02	48.8	1.60	0.89	1.26	2.15
	(N %75)	T2	75.6	2.06	67.9	2.26	1.11	0.91	2.02
	(N %100)	T3	102.4	2.67	75.7	4.14	1.35	0.64	1.99
66%Intercropping garlic bulbs on black cumin plants	(N %50)	T4	47.6	2.73	48.8	1.60	0.98	1.71	2.69
	(N %75)	T5	115.5	2.53	67.9	2.26	1.70	1.12	2.82
	(N %100)	T6	70.5	2.78	75.7	4.14	0.93	0.67	1.6
99%Intercropping garlic bulbs on black cumin plants	(N %50)	T7	58.0	2.76	48.8	1.60	1.19	1.73	2.92
	(N %75)	T8	63.3	3.01	67.9	2.26	0.93	1.33	2.26
	(N %100)	T9	93.5	3.39	75.7	4.14	1.24	0.82	2.06
Season 2			IY (L/fedd.)		S.Y (L/fedd.)		E.A.		LER
Crops Treatments			B.C.	G.	B.C.	G.	B.C.	G.	LER
50%Intercropping garlic bulbs on black cumin plants	(N %50)	T1	12.57	0.84	14.04	2.51	0.90	0.33	1.23
	(N %75)	T2	36.15	2.21	33.54	1.92	1.08	1.15	2.23
	(N %100)	T3	41.74	2.42	42.10	6.00	0.99	0.40	1.39
66%Intercropping garlic bulbs on black cumin plants	(N %50)	T4	20.49	2.90	14.04	2.51	1.46	1.16	2.62
	(N %75)	T5	60.26	2.25	33.54	1.92	1.80	1.17	2.97
	(N %100)	T6	53.50	3.10	42.10	6.00	1.27	0.52	1.79
99%Intercropping garlic bulbs on black cumin plants	(N %50)	T7	15.91	2.92	14.04	2.51	1.13	1.16	2.29
	(N %75)	T8	27.37	3.09	33.54	1.92	0.82	1.61	2.43
	(N %100)	T9	30.36	3.75	42.10	6.00	0.72	0.63	1.35

LER= Land Equivalent Ratio , B.C.=Black cumin , G.=Garlic , S.Y.= Sole Yield, IY= Intercropped Yield, E.A.= Equivalent Area
(T1) 50% Intercropping garlic bulbs on black cumin plants with(N 50%), (T2) 50% Intercropping garlic bulbs on black cumin plants with(N 75%). (T3) 50% Intercropping garlic bulbs on black cumin plants with(N100%), (T4) 66% Intercropping garlic bulbs on black cumin plants with (N 50%). (T5) 66% (T5) Intercropping garlic bulbs on black cumin plants with(N 75%), (T6) 66% Intercropping garlic bulbs on black cumin plants with(N 100%). (T7) 99% Intercropping garlic bulbs on black cumin plants with(N 50%), (T8) 99% Intercropping garlic bulbs on black cumin plants with(N 75%). (T9) 99% Intercropping garlic bulbs on black cumin plants with(N100%), N= Nitrogen of fertilizer.

3. Effect of intercropping black cumin (*Nigella sativa* l.) plants on garlic (*Allium sativum*) plants on land equivalent ratio (LER) under on the volatile oil yield l/feddan of black cumin and volatile oil yield l/feddan of garlic.

Data presented in Table (5) showed that, all treatments had significantly higher LER than solocropped. Also, all intercropping treatments had LER more than 1 without any significant difference (Table 5). Considering that all of intercropping treatments had LER more than 1 in this study, during two seasons were the volatile oil yield L/feddan of black cumin and volatile oil yield L/feddan of garlic were 1.67, 1.2 and 1.52 in the frist season from (T3) ,(T6) and (T9) respectively . In the second season, all of intercropping treatments had LER more than 1 were 1.33, 1.23, 1.08 and 1.1 from (T1), (T3), (T6) and (T9) respectively . The results of the current study are in agreement with those of Negah *et al* (2014). demonstrated that, the effect of different intercropping arrangements of cumin and chickpea on seed yield and quality criteria of cumin was arrangement lines at P1: (100% Cumin), P2: (50% Cumin+50% Chickpea), P3:(60%Cumin+40%Chickpea), P4: (80%Cumin+20% Chickpea), P5: (100% Cumin + 20Chickpea), P6:(100% Chickpea). The results showed that between different intercropping treatments, Land Equivalent Ratio in treatment P2: (50%Cumin+50%Chickpea) was suitable.. The highest Land Equivalent Ratio (1.23), was obtained in treatment P2: (50%Cumin+50%Chickpea) and the lowest (0.90) in treatment P4: (80%Cumin+20%Chickpea) intercropping.

In addition, intercropping of pepper with garlic is much better than sole pepper crop in green house /plastic tunnel with respect to soil microbes, enzymatic activities and nutrition Muhammad *et al.*, 2015) and Akooch *et al.*(2014) on black cumin in intercropping with chickpea and bean.

4. Effect of intercropping black cumin (*nigella sativa* l.) plants on garlic (*allium sativum*) plants on plant growth parameters for each black cumin and garlic under the influence of three levels of nitrogen fertilization:

It is quite clear from the data in Table (6) that, A significance effect of garlic intercropping on plant height, number of branches / plant and total plant weight of black cumin plants and the parameters of garlic plants (diameter of head of garlic (cm), head hieght of garlic (cm) and number lobes of bulb) during the two seasons were the highest values from (T3) and followed (T 2). In our experiment it was found that plant growth parameters of black cumin plants were significantly improved by garlic intercropping and it might be due to better availability of plant nutrients and higher light use efficiency in intercropped treatments . These results are supported by Zhou *et al.*, (2007) that garlic root exudates significantly increased the chlorophyll content of the tested vegetables due to better absorption of nutrients in intercropped treatments. Bhatt *et al.*, (2008) reported that due to better growth and light interception the accumulation of chlorophyll a and b were higher in the leaves of crop species grown in intercropping system. These results are in harmony with those stated by Imran *et al.*,(2013), said, During this study pepper and garlic based intercropping system improved physiological properties of pepper. It can be concluded from this study that intercropping pepper with normal garlic had good impact on chlorophyll contents, photosynthetic rate and antioxidant enzymes as compared to other treatments. These results are supported by Xiao *et al.* (2012),This study indicates that intercropping with green garlic significantly affects nutrient concentrations and the soil nutrient character in cucumber crops. The accumulation of biomass and most nutrient elements (N, P, K, Ca and Mn) in intercropped cucumber was significantly greater than that found in solocropped cucumber.

Table 5. Results of means Land Equivalent Ratio (LER) effects of intercropping black cumin (*Nigella sativa* L.) plants on garlic(Allium sativum) plants under the influence of three levels of nitrogen fertilization: during 2016/2017& 2017/2018 seasons, which the volatile oil yield L/feddan of black cumin and volatile oil yield L/feddan of garlic.

Season 1			IY (L/fedd.)		S.Y (L/fedd.)		E.A.		LER
Crops Treatments			B.C.	G.	B.C.	G.	B.C.	G.	LER
50%Intercropping garlic bulbs on black cumin plants	(N %50)	T1	0.32	2.02	0.25	1.60	1.28	1.26	2.54
	(N %75)	T2	0.67	2.06	0.39	2.26	1.72	0.91	2.63
	(N %100)	T3	0.75	2.67	0.73	4.14	1.03	0.64	1.67
66%Intercropping garlic bulbs on black cumin plants	(N %50)	T4	0.28	2.73	0.25	1.60	1.12	1.71	2.83
	(N %75)	T5	0.99	2.53	0.39	2.26	2.54	1.12	3.66
	(N %100)	T6	0.39	2.78	0.73	4.14	0.53	0.67	1.2
99%Intercropping garlic bulbs on black cumin plants	(N %50)	T7	0.51	2.78	0.25	1.60	2.04	1.73	3.77
	(N %75)	T8	0.32	3.01	0.39	2.26	0.82	1.33	2.15
	(N %100)	T9	0.51	3.39	0.73	4.14	0.70	0.82	1.52
Season 2			IY (L/fedd.)		S.Y (L/fedd.)		E.A.		LER
Crops Treatments			B.C.	G.	B.C.	G.	B.C.	G.	LER
50%Intercropping garlic bulbs on black cumin plants	(N %50)	T1	0.08	0.84	0.08	2.51	1	0.33	1.33
	(N %75)	T2	0.32	2.21	0.21	1.92	1.52	1.15	2.27
	(N %100)	T3	0.30	2.42	0.36	6.00	0.83	0.40	1.23
66%Intercropping garlic bulbs on black cumin plants	(N %50)	T4	0.10	2.90	0.08	2.51	1.25	1.16	2.41
	(N %75)	T5	0.55	2.25	0.21	1.92	2.62	1.17	3.79
	(N %100)	T6	0.20	3.10	0.36	6.00	0.56	0.52	1.08
99%Intercropping garlic bulbs on black cumin plants	(N %50)	T7	0.15	2.92	0.08	2.51	1.88	1.16	3.04
	(N %75)	T8	0.14	3.09	0.21	1.92	0.67	1.61	2.28
	(N %100)	T9	0.17	3.75	0.36	6.00	0.47	0.63	1.1

LER= Land Equivalent Ratio , B.C.=Black cumin , G.=Garlic , S.Y.= Sole Yield, IY= Intercropped Yield, E.A.= Equivalent Area
(T1) 50% Intercropping garlic bulbs on black cumin plants with(N 50%), (T2) 50% Intercropping garlic bulbs on black cumin plants with(N 75%). (T3) 50% Intercropping garlic bulbs on black cumin plants with(N100%), (T4) 66% Intercropping garlic bulbs on black cumin plants with (N 50%). (T5) 66% (T5) Intercropping garlic bulbs on black cumin plants with(N 75%), (T6) 66% Intercropping garlic bulbs on black cumin plants with(N 100%). (T7) 99% Intercropping garlic bulbs on black cumin plants with(N 50%), (T8) 99% Intercropping garlic bulbs on black cumin plants with(N 75%). (T9) 99% Intercropping garlic bulbs on black cumin plants with(N100%), N= Nitrogen of fertilizer.

Table 6. Effect of Levels intercropping black cumin (*Nigella sativa* L.) plants on garlic *(Allium sativum)* plants under the influence of levels of nitrogen fertilization and their combinationson on vegetative growth parameters for both black cumin and garlic plants in the two seasons of 2016/2017 and 2017/2018.

Treatments			Black cumin plants: Plant height (cm) 1st Season	Plant height (cm) 2nd season	Number of branches /plant 1st Season	Number of branches /plant 2nd Season	Herb weight / plant (g) 1st Season	Herb weight / plant (g) 2nd Season	Garlic plants: Diameter of head of garlic (cm) 1st season	Diameter of head of garlic (cm) 2nd season	Head Hieght (cm) of bulb 1st season	Head Hieght (cm) of bulb 2nd season	Number lobes of bulb 1st season	Number lobes of bulb 2nd season
Levels of intercropping														
50%Intercropping garlic bulbs on black cumin plants			117.6	88.0	10.78	9.29	92.0	66.5	5.97	6.070	7.59	7.64	11.15	12.10
66%Intercropping garlic bulbs on black cumin plants			121.2	90.6	9.93	8.48	102.8	72.8	5.53	5.610	7.44	7.49	11.56	11.93
99%Intercropping garlic bulbs on black cumin plants			115.5	84.9	10.56	9.33	94.6	63.9	5.51	5.634	7.82	8.11	11.48	11.27
Solocropping of black cumin plants			114.4	85.3	9.16	7.94	91.1	65.4	--	--	--	--	--	--
Solocropping of garlic plants			--	--	--	--	--	--	5.34	4.960	7.20	7.16	11.11	9.46
LSD at 5%			15.50	3.95	1.229	1.790	7.71	18.26	0.646	0.979	0.809	0.902	0.941	1.650
Levels of nitrogen														
(N 50%)			113.4	83.2	9.46	8.21	81.7	52.8	5.22	5.146	6.95	6.98	10.63	10.10
(N 75%)			119.9	89.3	10.38	9.05	98.4	72.3	5.65	5.498	7.49	7.73	11.40	11.19
(N 100%)			118.2	89.1	10.47	9.03	105.3	76.3	5.88	6.063	8.10	8.10	11.94	12.27
LSD at 5%			9.29	5.62	0.853	1.454	7.88	22.15	0.666	0.479	1.056	0.990	1.031	1.253
Combination between Levels of intercropping and Levels of nitrogen														
50%Intercropping garlic bulbs on black cumin plants	(N50%)	T1	117.2	88.7	10.89	9.65	70.3	50.4	5.41	5.247	6.66	6.75	10.11	9.93
	(N75%)	T2	122.2	90.0	10.56	9.00	102.5	73.8	5.85	6.033	7.45	7.68	11.33	11.52
	(N100%)	T3	113.2	85.3	10.89	9.22	103.1	75.1	6.63	6.930	8.65	8.51	12.00	14.86
66%Intercropping garlic bulbs on black cumin plants	(N50%)	T4	113.3	86.3	8.56	7.43	91.2	59.1	5.04	5.423	7.08	7.17	10.78	10.29
	(N75%)	T5	124.7	91.4	10.33	8.67	101.8	76.8	5.82	5.587	7.56	7.82	11.89	12.32
	(N100%	T6	125.7	94.1	10.89	9.33	115.5	82.5	5.73	5.820	7.70	7.50	12.00	13.18
99%Intercropping garlic bulbs on black cumin plants	(N50%)	T7	112.8	79.8	10.44	9.00	89.9	50.9	5.42	5.517	7.52	7.77	11.22	10.85
	(N75%)	T8	117.2	87.4	11.00	9.89	95.7	68.4	5.48	5.623	7.97	8.44	11.56	11.08
	(N100%	T9	116.4	87.4	10.22	9.11	98.3	72.5	5.62	5.763	7.97	8.11	11.67	11.89
Solocropping of black cumin plants	(N50%)	T10	110.4	77.9	7.95	6.76	75.6	50.8	--	--	--	--	--	--
	(N75%)	T11	115.4	88.5	9.63	8.63	93.7	70.3	--	--	--	--	--	--
	(N100%	T12	117.3	89.6	9.89	8.44	104.2	75.0	--	--	--	--	--	--
Solocropping of garlic plants	(N50%)	T13	--	--	--	--	--	--	5.02	4.397	6.55	6.23	10.40	9.35
	(N75%)	T14	--	--	--	--	--	--	5.47	4.747	6.96	6.98	10.82	9.86
	(N100%	T15	--	--	--	--	--	--	5.53	5.737	8.08	8.27	12.10	9.16
LSD at 5%			19.98	9.64	1.719	2.774	14.21	38.76	1.198	1.153	1.830	1.760	1.833	2.444

(T1) 50% Intercropping garlic bulbs on black cumin plants with(N 50%), (T2) 50% Intercropping garlic bulbs on black cumin plants with(N 75%), (T3) 50% Intercropping garlic bulbs on black cumin plants with(N100%). (T4) 66% Intercropping garlic bulbs on black cumin plants with (N 50%). (T5) 66% (T5) Intercropping garlic bulbs on black cumin plants with(N 75%), (T6) 66% Intercropping garlic bulbs on black cumin plants with(N 100%). (T7) 99% Intercropping garlic bulbs on black cumin plants with(N 50%), (T8) 99% Intercropping garlic bulbs on black cumin plants with(N 75%), (T9) 99% Intercropping garlic bulbs on black cumin plants with(N100%). (T10) Solocropping of black cumin plants with(N 50%), (T11) Solocropping of black cumin plants with(N 75%) , (T12) Solocropping of black cumin plants with(N 100%), (T13) Solocropping of garlic plants with(N 50%). (T14) Solocropping of garlic plants with(N 75%), (T15) Solocropping of garlic plants with(N 100%), N= Nitrogen of fertilizer.

The increased concentrations of these nutrients could be related to the enhancement of soil organic matter and available nutrients. There might be two reasons for the increase in soil organic matter in the intercropping system.

Garlic bulbs (used to grow green garlic) with their abundant nutrients increased the input of nutrient compared to the cucumber solocroped. Plant residues as one of major fractions of soil organic matter may be present in various stages of decomposition Liang *et al.* (1998).

Some studies have shown that intercropping with garlic was able to improve soil enzyme activities, and the effects lasted to the second growing season Xiao *et al.* (2012). Soil enzyme activities can be used as suitable indicators of soil quality and play a crucial role in the decomposition of organic residues and nutrient cycling in the soil Lalande *et al.* (2000).

5. Effect of intercropping black cumin (*nigella sativa* l.) plants on garlic(*allium sativum*) plants on plant growth parameters for each black cumin and garlic under the influence of three levels of nitrogen fertilization:

Regarding the effect of levels of intercropping with levels of nitrogen, data in Table (7) indicated that application of levels intercropping at all levels of nitrogen significantly increased number of capsules/plant, the weight of one capsule seed and the weight 1000 seed compared to solocropped in the second season. The highest values from intercropping were from (T6) treatment of number of capsules/plant, the weight of one capsule seed and the weight 1000 seed in the both seasons, while the least values from intercropping were solocropped treatments with N 50% (T10). There is no significant between treatments in the both seasons except for treatments of intercropping in the second season was significant of number of capsules/plant. The values were (143.6-112.78), (0.18- 0.18gm) and (31.00 – 31.00gm) in the both seasons, respectively. While, the parameters of garlic plants data in Table (7) indicated that significantly increased of the fresh weight of garlic Kg /plot and the dry weight of garlic Kg /plot to compared to solocropped in the both seasons. The highest values from intercropping were from (T9) treatment followed by (T6) treatment. The values were (13.72—14.14 Kg /plot) and fololwed by (11.75 - 12.30 Kg /plot) of the fresh weight of garlic in the both seasons, respectively. that values were (4.80- 5.28 Kg /plot) and followed by the (4.45- 4.64 Kg /plot) of the dry weight of garlic in the both seasons, respectively. The former results were proved by garlic is an important allelopathic and antimicrobial crop and many researchers have focused on the garlic extracts Wei *et al.*, 2011); however a few reports found on garlic root exudates for the suppression of different vegetables diseases and their effects on the soil fertility.

Table 7. Effect of Levels intercropping black cumin (*Nigella sativa* L.) plants on garlic *(Allium sativum*) plants under the influence of levels of nitrogen fertilization and their combinationson on vegetative growth parameters for both black cumin and garlic plants in the two seasons of 2016/2017 and 2017/2018.

Treatments			Black cumin plants						Garlic plants			
			Number of capsules/plant		The weight of one capsule seed (gm)		The weight 1000 seed(gm)		The fresh weight of garlic Kg /plot		The dry weight of garlic Kg /plot	
			1s Season	2nd season	1st season	2nd Season	1st Season	2nd season	1st Season	2nd season	1st season	2nd season
Levels of intercropping												
50%Intercropping garlic bulbs on black cumin plants			109.8	85.00	0.18	0.18	24.67	24.00	7.25	7.56	2.81	2.76
66%Intercropping garlic bulbs on black cumin plants			129.3	98.41	0.16	0.16	26.78	26.67	9.52	9.66	3.56	3.49
99%Intercropping garlic bulbs on black cumin plants			109.6	78.55	0.14	0.14	23.56	23.22	10.80	11.38	4.00	4.09
Solocropping of black cumin plants			114.9	83.83	0.15	0.13	24.01	23.96	--	--	--	--
Solocropping of garlic plants			--	--	--	--	--	--	9.44	9.98	3.43	3.46
LSD at 5%			17.23	5.371	0.039	0.058	3.915	4.504	1.705	0.893	0.728	0.907
Levels of nitrogen												
(N 50%)			94.5	66.38	0.15	0.15	19.31	19.31	8.00	8.50	3.00	2.99
(N 75%)			122.4	91.10	0.17	0.16	26.95	26.08	8.65	8.97	3.14	3.02
(N 100%)			130.7	101.86	0.15	0.15	28.00	28.00	11.11	11.46	4.22	4.34
LSD at 5%			12.52	4.384	0.039	0.042	3.691	3.392	1.260	0.873	0.575	0.688
Combination between Levels of intercropping and Levels of nitrogen												
50%Intercropping garlic bulbs on black cumin plants	(N50%)	T1	80.3	59.56	0.18	0.18	18.67	16.67	5.57	6.06	2.11	2.12
	(N75%)	T2	120.2	93.56	0.20	0.20	27.67	27.67	7.84	8.11	2.75	2.84
	(N100%	T3	129.0	101.89	0.16	0.16	27.67	27.67	8.35	8.51	3.59	3.31
66%Intercropping garlic bulbs on black cumin plants	(N50%)	T4	103.6	74.33	0.15	0.15	20.00	19.67	9.64	9.94	3.38	3.48
	(N75%)	T5	140.7	108.11	0.14	0.14	29.33	29.33	8.31	8.16	3.24	2.86
	(N100%	T6	143.6	112.78	0.18	0.18	31.00	31.00	11.75	12.30	4.45	4.64
99%Intercropping garlic bulbs on black cumin plants	(N50%)	T7	99.7	68.00	0.14	0.14	19.67	18.67	10.62	10.88	4.05	4.14
	(N75%)	T8	113.1	77.11	0.16	0.16	25.33	25.33	10.75	11.32	3.76	3.96
	(N100%	T9	115.9	90.55	0.12	0.12	25.67	25.67	13.72	14.14	4.80	5.28
Solocropping of black cumin plants	(N50%)	T10	94.5	63.63	0.15	0.12	18.92	22.22	--	--	--	--
	(N75%)	T11	115.8	85.63	0.16	0.13	25.45	22.00				
	(N100%	T12	134.3	102.22	0.15	0.15	27.67	27.67	--	--	--	--
Solocropping of garlic plants	(N50%)	T13	--	--	--	--	--	--	6.88	7.50	2.70	2.66
	(N75%)	T14	--	--	--	--	--	--	7.71	8.29	2.79	2.42
	(N100%	T15	--	--	--	--	--	--	9.91	10.50	3.80	3.68
LSD at 5%			24.81	8.354	0.070	0.083	6.769	6.635	2.478	1.587	1.108	1.342

(T1) 50% Intercropping garlic bulbs on black cumin plants with(N 50%), (T2) 50% Intercropping garlic bulbs on black cumin plants with(N 75%), (T3) 50% Intercropping garlic bulbs on black cumin plants with(N100%).

(T4) 66% Intercropping garlic bulbs on black cumin plants with (N 50%). (T5) 66% (T5) Intercropping garlic bulbs on black cumin plants with(N 75%), (T6) 66% Intercropping garlic bulbs on black cumin plants with(N 100%).

(T7) 99% Intercropping garlic bulbs on black cumin plants with(N 50%), (T8) 99% Intercropping garlic bulbs on black cumin plants with(N 75%), (T9) 99% Intercropping garlic bulbs on black cumin plants with(N100%).

(T10) Solocropping of black cumin plants with(N 50%), (T11) Solocropping of black cumin plants with(N 75%) , (T12) Solocropping of black cumin plants with(N 100%), (T13) Solocropping of garlic plants with(N 50%).

(T14) Solocropping of garlic plants with(N 75%), (T15) Solocropping of garlic plants with(N 100%), N= Nitrogen of fertilizer.

6. Effect of intercropping black cumin (*nigella sativa* l.) plants on garlic(*allium sativum*) plants on plant growth parameters for each black cumin and garlic under the influence of three levels of nitrogen fertilization:

Data presented in Table (8) showed that, the levels of intercropping with levels of nitrogen on the parameters of black cumin and garlic plants data in Table (8) indicated that, There is no significant between treatments in the both seasons for the weight of capsules/plant ,while the other p arameters in Table (8) there is significant between them on both plants in the both seasons. The highest values from intercropping with nitrogen were from (T6) 66% intercropping garlic bulbs on black cumin plants with(N 100%) treatment in all parameters in both plants in the both seasons were (27.72, 27.80 gm/plant), (27.78, 27.80 gm/plot), (626.5-352.2 gm/plot) of black cumin plants and ,(169,8, 160.9 gm) and (59.4 56.3 gm/ fresh and dry head, respectively. The followed treatment is (T5) 66% Intercropping garlic bulbs on black cumin plants with(N 75%) for black cumin plant in the both seasons were(26.39, 24.16), (24.23.24.16 gm/plant) and (624.3, 320.3 gm/plot) and for garlic plants the followed treatment is(T9) 99% intercropping garlic bulbs on black cumin plants with(N100%) in the both seasons were(154.2, 155.8, 54.0, 54.5 gm/ fresh and dry head, respectively.

There is high significance between levels of intercropping and levels of Nitrogen on the weight of capsules/plant, the weight of seeds/plant, the weight of the seeds/plot and the weight of the seeds / fed. the in the two seasons . The former results were proved by Mokhele *et al.* (2012) and Ashraf and Iqbal, (2006).

In general these results are in agreement with that obtained by Muhammad *et al.* (2015) concluded that intercropping of pepper with garlic is much better than sole pepper crop. Pepper intercropping with green garlic is the best intercropping system for soil health to overcome the solocropping soil obstacles.

These results are in accordance to Vahid *et al.*(2017) on Cumin and Chickpea plants found that, that economic yield, biologic yield, bush height, and the number of umbel per bush of Cumin were significantly affected by experiment treatment.

Table 8. Effect of Levels intercropping black cumin (*Nigella sativa* L.) plants on garlic *(Allium sativum*) plants under the influence of levels of nitrogen fertilization and their combinationson on the weight of (capsules and seeds) gm/plant and the weight of capsules gm/plant for black cumin plant and the fresh weight of the head(gm) and the dry weight of the head(gm) for garlic plant in the two seasons of 2016/2017 and 2017/2018.

Treatments			Black cumin plants						Garlic plants			
			The Weight of capsules g/plant		The Weight of seeds g/plant		The weight of the seeds g/plot		The Fresh weight of the head (gm)		The Dry weight of the head (gm)	
			1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd season	1st season	2nd season	1st season	2nd season
Levels of intercropping												
50%Intercropping garlic bulbs on black cumin plants			18.03	19.26	19.16	19.26	463.1	169.6	118.0	123.2	41.4	42.7
66%Intercropping garlic bulbs on black cumin plants			23.66	22.60	22.74	22.60	539.5	264.1	138.2	136.5	48.4	47.9
99%Intercropping garlic bulbs on black cumin plants			17.02	18.43	18.45	18.43	433.3	133.0	149.8	153.3	52.4	53.7
Solocropping of black cumin plants			17.57	18.46	17.94	17.69	467.1	170.5	--	--	--	--
Solocropping of garlic plants			--	--	--	--	--	--	128.5	144.5	47.4	47.6
LSD at 5%			2.178	1.485	1.418	3.292	48.56	31.97	41.05	25.22	14.46	12.12
Levels of nitrogen												
(N 50%)			16.08	14.19	14.27	14.02	343.5	94.2	122.8	129.9	43.8	44.9
(N 75%)			19.98	21.09	20.62	20.68	513.5	210.0	128.5	139.8	46.0	47.1
(N 100%)			21.15	23.78	23.83	23.78	570.3	248.6	149.5	148.5	52.3	52.0
LSD at 5%			1.352	2.128	1.458	1.764	40.44	19.73	19.58	18.73	6.91	8.21
Combination between Levels of intercropping and Levels of nitrogen												
50%Intercropping	(N50%)	T1	15.78	12.94	12.91	12.94	325.7	74.5	103.6	115.0	36.3	40.3
garlic bulbs on	(N75%)	T2	18.47	21.99	21.95	21.99	489.0	212.5	121.0	119.1	42.4	40.5
black cumin plants	(N100%	T3	19.84	22.84	22.61	22.84	574.6	222.0	129.4	135.5	45.3	47.4
66%Intercropping	(N50%)	T4	16.88	15.83	16.21	15.83	367.8	119.8	142.4	138.7	49.9	48.5
garlic bulbs on	(N75%)	T5	26.39	24.16	24.23	24.16	624.3	320.3	127.6	129.3	44.7	45.5
black cumin plants	(N100%	T6	27.72	27.80	27.78	27.80	626.5	352.2	169.8	160.9	59.4	56.3
99%Intercropping	(N50%)	T7	16.32	15.55	15.78	15.55	341.7	93.6	144.4	139.8	50.5	48.9
garlic bulbs on	(N75%)	T8	17.17	18.37	18.45	18.37	475.3	151.5	150.7	164.4	52.7	57.7
black cumin plants	(N100%	T9	17.58	21.36	21.11	21.36	483.0	153.7	154.2	155.8	54.0	54.5
Solocropping of black cumin plants	(N50%)	T10	15.33	12.44	12.18	11.78	339.0	89.0	--	--	--	--
	(N75%)	T11	17.89	19.84	17.84	18.18	465.5	155.8	--	--	--	--
	(N100%	T12	19.48	23.10	23.81	23.10	596.9	266.7	--	--	--	--
Solocropping of garlic plants	(N50%)	T13	--	--	--	--	--	--	100.9	126.2	38.5	41.9
	(N75%)	T14	--	--	--	--	--	--	114.8	146.4	44.3	44.5
	(N100%	T15	--	--	--	--	--	--	144.5	141.7	50.6	49.6
LSD at 5%			2.860	3.650	2.624	4.024	76.61	41.85	47.89	36.82	16.88	16.72

(T1) 50% Intercropping garlic bulbs on black cumin plants with(N 50%), (T2) 50% Intercropping garlic bulbs on black cumin plants with(N 75%), (T3) 50% Intercropping garlic bulbs on black cumin plants with(N100%).

(T4) 66% Intercropping garlic bulbs on black cumin plants with (N 50%). (T5) 66% (T5) Intercropping garlic bulbs on black cumin plants with(N 75%), (T6) 66% Intercropping garlic bulbs on black cumin plants with(N 100%).

(T7) 99% Intercropping garlic bulbs on black cumin plants with(N 50%), (T8) 99% Intercropping garlic bulbs on black cumin plants with(N 75%), (T9) 99% Intercropping garlic bulbs on black cumin plants with(N100%).

(T10) Solocropping of black cumin plants with(N 50%), (T11) Solocropping of black cumin plants with(N 75%) , (T12) Solocropping of black cumin plants with(N 100%), (T13) Solocropping of garlic plants with(N 50%).

(T14) Solocropping of garlic plants with(N 75%), (T15) Solocropping of garlic plants with(N 100%), N= Nitrogen of fertilizer.

7. Effect of intercropping black cumin (*nigella sativa* l.) plants on garlic (*allium sativum*) plants on the weight of the seeds black cuminkg / fedd., the fresh weight garlic kg / fedd. and the dry weight garlic kg / fedd. for each black cumin and garlic under the influence of three levels of nitrogen fertilization:

As for intercropping treatments between garlic bulbs on black cumin plants , data in Table (9) indicated that, there is no significant between treatments levels of intercropping and combination between levels of intercropping and levels of nitrogen in the first season , while in the second season there is high significance between treatments in the second season and levels of nitrogen in the first season for the black cumin yield. For the fresh weight garlic Kg / fedd., there is significant between treatments in the both seasons, while the fresh weight garlic Kg / fedd. there is significant between levels of nitrogen in the both seasons and combination between levels of intercropping and levels of nitrogen in the second season. The highest values from intercropping with nitrogen were from (T6) 66% intercropping garlic bulbs on black cumin plants with (N 100%) treatment in all parameters in both plants in the both seasons were (321.3 and 180.6 Kg / fedd. for black cumin plant in the both seasons), (10158, 10472 Kg / fedd. for the fresh weight garlic and 3556 and 3665 Kg / fedd. for the dry weight garlic. The followed treatment is (T5) 66% Intercropping garlic bulbs on black cumin plants with (N 75%) for black cumin plant in the both seasons were(320.2 and 164.3 Kg / fedd.) and for garlic bulbs the followed treatment is (T9) 99% intercropping garlic bulbs on black cumin plants with(N100%) in the both seasons were(8697, 9109, 3044 and 3189) Kg / fedd. for the fresh and dry weight garlic , respectively.

These results agreed with those obtained by Masvaya *et al*. (2017) also demonstrated that maize + cowpea intercropping with low doses of N fertilizer resulted in over-yielding compared to the monoculture, and that such a strategy was a promising option for resource-poor farmers across seasons and soil types in developing countries. and Negah *et a l*(2014). demonstrated that, the effect of different intercropping arrangements of cumin and chickpea on seed yield and quality criteria of cumin was arrangement lines at P1: (100%Cumin), P2: (50%Cumin+50% Chickpea), P3: (60 % Cumin+ 40% Chickpea), P4: (80%Cumin+20%Chickpea), P5: (100%Cumin+20 Chickpea), P6:(100%Chickpea). The results showed that between different intercropping treatments, seed yield, biological yield and harvest index in treatment P2: (50%Cumin+50%Chickpea) was suitable.

Table 9. Effect of Levels intercropping black cumin (*Nigella sativa* L.) plants on garlic *(Allium sativum*) plants under the influence of levels of nitrogen fertilization and their combinationson on the weight of the seedskg / fedd. for both black cumin and the fresh weight garlic Kg / fedd. and the weight of garlic dry weight Kg /fedd. for garlic plants in the two seasons of 2016/2017 and 2017/2018.

Treatments			Black cumin plants		Garlic plants			
			The weight of the seeds kg / fedd.		The fresh weight garlic Kg / fedd.		The weight of garlic dry weight Kg /fedd.	
			1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Levels of intercropping								
50%Intercropping garlic bulbs on black cumin plants			236.6	87.0	5481	5597	1918	2099
66%Intercropping garlic bulbs on black cumin plants			273.2	135.4	7050	7151	2468	2503
99%Intercropping garlic bulbs on black cumin plants			201.5	68.2	7998	8423	2799	2948
Solocropping of black cumin plants			226.2	94.9	--	--	--	--
Solocropping of garlic plants			--	--	6986	7388	2376	2476
LSD at 5%			71.94	12.89	1157.8	660.9	698.3	602.4
Levels of nitrogen								
(N 50%)			172.7	48.00	6005	6293	2032	2210
(N 75%)			239.0	113.6	6407	6642	2260	2341
(N 100%)			291.5	127.5	8224	8484	2879	2970
LSD at 5%			22.77	11.62	910	646.2	471.9	478.7
Combination between Levels of intercropping and Levels of nitrogen								
50%Intercropping garlic bulbs on black cumin plants	(N50%)	T1	167.0	38.2	4455	4484	1559	1570
	(N75%)	T2	248.0	108.9	5807	6002	2032	2522
	(N100%	T3	294.7	113.8	6180	6303	2163	2206
66%Intercropping garlic bulbs on black cumin plants	(N50%)	T4	178.0	61.4	7140	7360	2499	2577
	(N75%)	T5	320.2	164.3	6149	6042	2154	2115
	(N100%	T6	321.3	180.6	10158	10472	3556	3665
99%Intercropping garlic bulbs on black cumin plants	(N50%)	T7	175.2	48.0	7335	7777	2567	2722
	(N75%)	T8	185.5	77.7	7962	8384	2787	2934
	(N100%	T9	153.7	243.8	8697	9109	3044	3189
Solocropping of black cumin plants	(N50%)	T10	170.4	44.2				
	(N75%)	T11	202.2	103.6	--	--	--	--
	(N100%	T12	306.1	136.8	--	--	--	--
Solocropping of garlic plants	(N50%)	T13	--	--	5091	5551	1503	1972
	(N75%)	T14	--	--	5708	6140	2068	1792
	(N100%	T15	--	--	7861	8053	2752	2818
LSD at 5%			75.76	21.54	1755.5	1175.3	961.8	919.8

(T1) 50% Intercropping garlic bulbs on black cumin plants with(N 50%), (T2) 50% Intercropping garlic bulbs on black cumin plants with(N 75%), (T3) 50% Intercropping garlic bulbs on black cumin plants with(N100%).

(T4) 66% Intercropping garlic bulbs on black cumin plants with (N 50%). (T5) 66% (T5) Intercropping garlic bulbs on black cumin plants with(N 75%), (T6) 66% Intercropping garlic bulbs on black cumin plants with(N 100%).

(T7) 99% Intercropping garlic bulbs on black cumin plants with(N 50%), (T8) 99% Intercropping garlic bulbs on black cumin plants with(N 75%), (T9) 99% Intercropping garlic bulbs on black cumin plants with(N100%).

(T10) Solocropping of black cumin plants with(N 50%), (T11) Solocropping of black cumin plants with(N 75%) , (T12) Solocropping of black cumin plants with(N 100%), (T13) Solocropping of garlic plants with(N 50%).

(T14) Solocropping of garlic plants with(N 75%), (T15) Solocropping of garlic plants with(N 100%), N= Nitrogen of fertilizer.

8. Effect of intercropping black cumin (*nigella sativa* l.) plants on garlic (*allium sativum*) plants on volatile oil and fixed oil parameters for each black cumin and garlic under the influence of three levels of nitrogen fertilization:

From data in Table (10) it was obvious that, the levels of intercropping with levels of nitrogen on the (volatile oil%, fixed oil%, weight of volatile oil L/Fedd. and weight of fixed oil L/Fedd.for black cumin seeds) and (volatile oil% and weight of volatile oil L/Fedd. for garlic bulbs. There is significant between treatments levels of intercropping and levels of nitrogen for volatile oil% in both seasons and between treatments combination between levels of intercropping and levels of nitrogen in the the second season of fixed oil% for black cumin seeds in the both seasons between treatments also , there is significant between treatments in the second season between treatments levels of intercropping , levels of nitrogen and combination between them of volatile oil L/Fedd. for garlic bulbs.There is high significance between treatments combination for black cumin seeds in both of volatile oil%, and volatile oil L/Fedd. in the two seasons. the high values from intercropping with levels of nitrogen individually significantly increased oil yields as compared to solocropped in the two seasons. The highest volatile oil %/plant, weight of volatile oil L/Fedd. and weight of fixed oil L/Fedd. for black cumin seeds) and (volatile oil% and weight of volatile oil L/Fedd. for garlic bulbs) were recorded in the plants received (T5) Intercropping garlic bulbs on black cumin plants with(N 75%) were (0.31% -0.33% volatile oil %, (0.99 L/fedd. - 0.55 L/fedd. of volatile oil) and (115.5 - 60.26 L/fedd. of fixed oil L/Fedd. of black cumin seeds) and (0.153% - 0.160% garlic bulbs) and (4.14-6.00 L/Fedd. of garlic bulbs) , respectively on both plants in the both seasons. The highest fixed oil %/plant was (T9) 99% Intercropping garlic bulbs on black cumin plants with (N100%) was (38.45 and 38.81%/plant for black cumin seeds).

The former results were proved by Muhammad *et al.*, 2015) found that, intercropping of pepper with garlic is much better than sole pepper crop in green house/plastic tunnel with respect to soil microbes, enzymatic activities and nutrition.

Table 10. Effect of Levels intercropping black cumin (*Nigella sativa* L.) plants on garlic (*Allium sativum*) plants under the influence of levels of nitrogen fertilization and their combinationson on volatile and fixed oil for black cumin and volatile oil% and weight volatile oil L/fedd. for garlic plants in the two seasons of 2016/2017 and 2017/2018.

Treatments			Black cumin plants								Garlic plants			
			Volatile oil%		Fixed oil%		Weight of Volatile oil L/Fedd.		Weight of fixed oil L/Fedd.		Volatile oil %		Weight of Volatil oil L/fedd.	
			1st Season	2nd season	1st season	2nd Season	1st Season	2nd Season	1st Season	2nd season	1st season	2nd season	1st season	2nd season
Levels of intercropping														
50%Intercropping garlic bulbs on black cumin plants			0.24	0.25	30.39	34.10	0.58	0.23	73.8	30.15	0.140	0.089	2.25	1.82
66%Intercropping garlic bulbs on black cumin plants			0.20	0.20	28.26	33.17	0.56	0.28	77.9	44.75	0.129	0.098	2.68	2.75
99%Intercropping garlic bulbs on black cumin plants			0.23	0.24	35.28	35.82	0.45	0.15	71.6	24.55	0.096	0.116	3.05	3.25
Solocropping of black cumin plants			0.19	0.21	28.99	31.62	0.46	0.21	64.1	29.90	--	--	--	--
Solocropping of garlic plants			--	--	--	--	--	--	--	--	0.097	0.131	2.67	3.48
LSD at 5%			0.030	0.018	0.089	3.95	0.207	0.054	24.06	4.34	0.020	0.0191	0.756	0.774
Levels of nitrogen														
(N 50%)			0.20	0.21	28.64	32.71	0.34	0.10	49.4	15.75	0.117	0.102	2.28	2.29
(N 75%)			0.24	0.25	33.57	34.36	0.59	0.30	80.6	39.33	0.118	0.100	2.47	2.37
(N 100%)			0.21	0.22	29.98	33.97	0.59	0.26	85.5	41.92	0.112	0.123	3.25	3.82
LSD at 5%			0.019	0.036	0.180	1.87	0.054	0.041	7.38	4.41	0.022	0.0137	0.869	0.909
Combination between Levels of intercropping and Levels of nitrogen														
50%Intercropping garlic bulbs on black cumin plants	(N50%)	T1	0.19	0.20	25.93	32.61	0.32	0.08	43.4	12.57	0.133	0.053	2.02	0.84
	(N75%)	T2	0.27	0.29	30.47	33.11	0.67	0.32	75.6	36.15	0.133	0.100	2.06	2.21
	(N100%	T3	0.25	0.27	34.76	36.58	0.75	0.30	102.4	41.74	0.127	0.113	2.67	2.42
66%Intercropping garlic bulbs on black cumin plants	(N50%)	T4	0.16	0.15	26.76	33.12	0.28	0.10	47.6	20.49	0.107	0.113	2.73	2.90
	(N75%)	T5	0.31	0.33	36.07	36.71	0.99	0.55	115.5	60.26	0.153	0.160	4.14	6.00
	(N100%	T6	0.12	0.11	21.96	29.67	0.39	0.36	70.5	53.50	0.153	0.100	2.78	3.10
99%Intercropping garlic bulbs on black cumin plants	(N50%)	T7	0.30	0.31	33.24	33.39	0.51	0.15	58.0	15.91	0.120	0.113	2.76	2.92
	(N75%)	T8	0.17	0.18	34.16	35.25	0.32	0.14	63.3	27.37	0.100	0.113	3.01	3.09
	(N100%	T9	0.21	0.22	38.45	38.81	0.51	0.17	93.5	30.36	0.067	0.120	3.39	3.75
Solocropping of black cumin plants	(N50%)	T10	0.15	0.18	28.64	31.70	0.25	0.08	48.8	14.04	--			
	(N75%)	T11	0.19	0.20	33.57	32.36	0.39	0.21	67.9	33.54		--	--	--
	(N100%	T12	0.24	0.26	24.77	30.81	0.73	0.20	75.7	42.10	--	--	--	--
Solocropping of garlic plants	(N50%)	T13	--	--	--	--	--		--	--	0.107	0.127	1.60	2.51
	(N75%)	T14	--	--	--	--	--	--	--	--	0.110	0.107	2.26	1.92
	(N100%	T15	--	--	--	--	--	--	--	--	0.073	0.080	2.53	2.25
LSD at 5%			0.040	0.061	0.301	4.60	0.213	0.213	0.081	25.22	0.040	0.0272	1.533	1.599

(T1) 50% Intercropping garlic bulbs on black cumin plants with(N 50%), (T2) 50% Intercropping garlic bulbs on black cumin plants with(N 75%), (T3) 50% Intercropping garlic bulbs on black cumin plants with(N100%).

(T4) 66% Intercropping garlic bulbs on black cumin plants with (N 50%). (T5) 66% (T5) Intercropping garlic bulbs on black cumin plants with(N 75%), (T6) 66% Intercropping garlic bulbs on black cumin plants with(N 100%).

(T7) 99% Intercropping garlic bulbs on black cumin plants with(N 50%), (T8) 99% Intercropping garlic bulbs on black cumin plants with(N 75%), (T9) 99% Intercropping garlic bulbs on black cumin plants with(N100%).

(T10) Solocropping of black cumin plants with(N 50%), (T11) Solocropping of black cumin plants with(N 75%) , (T12) Solocropping of black cumin plants with(N 100%), (T13) Solocropping of garlic plants with(N 50%).

(T14) Solocropping of garlic plants with(N 75%), (T15) Solocropping of garlic plants with(N 100%), N= Nitrogen of fertilizer.

In general these results are in agreement with that obtained by Negah *et al* (2014) reported that, the effect of different intercropping arrangements of cumin and chickpea on seed yield and quality criteria of cumin was arrangement lines at P1: (100%Cumin), P2: (50%Cumin+50%Chickpea), P3:(60% Cumin+40%Chickpea), P4: (80%Cumin+ 20% Chickpea), P5: (100%Cumin+ 20Chickpea), P6: (100% Chickpea).

The results showed that between different intercropping treatments, in treatment P2: (50%Cumin+ 50%Chickpea) was suitable. Was not observed any significant effect on seed essential oil. between intercropping treatments, the highest essential oil yield was obtained treatment P2: (50%Cumin+50% Chickpea).

9. Effect of intercropping black cumin (*nigella sativa* l.) plants on garlic *(allium sativum*) plants on total nitrogen , phosphorus , potassium and carbohydrates (%) in seeds of black cumin and total carbohydrates (%) in in bulbs of garlic for each black cumin and garlic under the influence of three levels of nitrogen fertilization:

Regarding the effect of levels of intercropping with levels of nitrogen, data in Table (11) indicated that application of levels intercropping at all levels of nitrogen significantly increased total nitrogen (%) in seeds, total phosphorus (%) in seeds, total potassium (%) in seeds and total carbohydrates (%) in seeds compared to solocropped in the both seasons. The highest values of total nitrogen (%) and total phosphorus (%) in seeds were (4.84%, 2.73, 0.96 and 0.79%) from (T5) 66% (T5) Intercropping garlic bulbs on black cumin plants with(N 75%).The highest values of total potassium (%) in seeds was (0.90 and 0.85%) from (T7) 99% Intercropping garlic bulbs on black cumin plants with(N 50%) , at least the highest values of total carbohydrates (%) in seeds was (33.52% and 30.78%) and (20.41 20.02% in bulbs of garlic) from (T4) 66% Intercropping garlic bulbs on black cumin plants with (N 50%). These results are in accordance to(Tejendra *et al*., 2017).and Maryam *et al* (2018) on black cumin found that, The maximum content of p-cymene and carvacrol of black cumin essential oil was obtained in one row of soybean plus two rows of black cumin under chemical fertilizer and one row of soybean plus one row of black cumin with the application of chemical fertilizer, respectively.

Table 11. Effect of Levels intercropping black cumin (*Nigella sativa* L.) plants on garlic (*Allium sativum*) plants under the influence of levels of nitrogen fertilization and their combinationson on total nitrogen , phosphorus , potassium and carbohydrates (%) in seeds of black cumin and total carbohydrates (%) in in bulbs of garlicfor both black cumin and garlic plants in the two seasons of 2016/2017 and 2017/2018.

Treatments			Black cumin plants								Garlic plants	
			Total nitrogen (%) in seeds		Total phosphorus (%) in seeds		Total potassium (%) in seeds		Total carbohydrates (%) in seeds		Total Carbohdrates % in bulbs	
			1st Season	2nd Season	1st season	2nd season	1st season	2nd season	1st Season	2nd Season	1st season	2nd season
Levels of intercropping												
50%Intercropping garlic bulbs on black cumin plants			3.26	2.26	0.77	0.64	0.84	0.67	23.87	25.66	9.26	9.29
66%Intercropping garlic bulbs on black cumin plants			3.74	2.46	0.82	0.70	0.87	0.74	27.10	27.47	15.96	15.63
99%Intercropping garlic bulbs on black cumin plants			4.58	2.60	0.74	0.64	0.87	0.78	28.12	28.29	15.10	15.06
Solocropping of black cumin plants			3.39	2.16	0.76	0.65	0.72	0.61	29.94	29.75	--	--
Solocropping of garlic plants			--	--	--	--	--	--	--	--	16.68	16.72
LSD at 5%			0.262	0.043	0.012	0.063	0.010	0.084	0.434	0.745	1.659	1.110
Levels of nitrogen												
(N 50%)			3.49	2.32	0.76	0.65	0.88	0.78	31.70	30.22	15.70	15.41
(N 75%)			3.92	2.33	0.78	0.66	0.86	0.73	27.21	27.36	13.95	13.77
(N 100%)			3.82	2.46	0.78	0.66	0.74	0.59	22.87	25.80	13.11	13.36
LSD at 5%			0.197	0.058	0.006	0.035	0.004	0.041	0.301	0.456	1.125	0.967
Combination between Levels of intercropping and Levels of nitrogen												
50%Intercropping garlic bulbs on black cumin plants	(N50%)	T1	3.25	2.31	0.78	0.66	0.86	0.70	31.00	29.21	12.13	11.51
	(N75%)	T2	3.06	2.07	0.75	0.63	0.85	0.69	25.92	26.30	7.04	7.30
	(N100%	T3	3.47	2.42	0.78	0.65	0.80	0.64	14.70	21.49	8.62	9.07
66%Intercropping garlic bulbs on black cumin plants	(N50%)	T4	3.38	2.38	0.70	0.61	0.89	0.84	33.52	30.78	20.41	20.02
	(N75%)	T5	4.83	2.73	0.96	0.79	0.89	0.73	27.13	27.06	17.68	16.72
	(N100%	T6	4.81	2.58	0.81	0.70	0.84	0.67	20.65	24.56	11.31	11.84
99%Intercropping garlic bulbs on black cumin plants	(N50%)	T7	4.11	2.51	0.83	0.74	0.90	0.85	32.07	30.35	16.07	15.74
	(N75%)	T8	3.94	2.51	0.67	0.56	0.89	0.82	28.56	28.73	17.13	16.96
	(N100%	T9	3.89	2.49	0.72	0.62	0.82	0.67	32.39	31.35	18.89	18.33
Solocropping of black cumin plants	(N50%)	T10	3.20	2.10	0.74	0.61	0.85	0.73	30.21	30.56	--	--
	(N75%)	T11	3.92	2.18	0.75	0.67	0.83	0.71	27.22	27.36	--	--
	(N100%	T12	3.04	2.19	0.79	0.68	0.48	0.39	23.74	25.80	--	--
Solocropping of garlic plants	(N50%)	T13	--	--	--	--	--	--	--	--	15.70	16.05
	(N75%)	T14	--	--	--	--	--	--	--	--	13.94	14.09
	(N100%	T15	--	--	--	--	--	--	--	--	12.09	12.49
LSD at 5%			0.385	0.10	0.014	0.079	0.012	0.098	0.607	0.971	20.290	1.808

(T1) 50% Intercropping garlic bulbs on black cumin plants with(N 50%), (T2) 50% Intercropping garlic bulbs on black cumin plants with(N 75%), (T3) 50% Intercropping garlic bulbs on black cumin plants with(N100%).

(T4) 66% Intercropping garlic bulbs on black cumin plants with (N 50%). (T5) 66% (T5) Intercropping garlic bulbs on black cumin plants with(N 75%), (T6) 66% Intercropping garlic bulbs on black cumin plants with(N 100%).

(T7) 99% Intercropping garlic bulbs on black cumin plants with(N 50%), (T8) 99% Intercropping garlic bulbs on black cumin plants with(N 75%), (T9) 99% Intercropping garlic bulbs on black cumin plants with(N100%).

(T10) Solocropping of black cumin plants with(N 50%), (T11) Solocropping of black cumin plants with(N 75%) , (T12) Solocropping of black cumin plants with(N 100%), (T13) Solocropping of garlic plants with(N 50%).

(T14) Solocropping of garlic plants with(N 75%), (T15) Solocropping of garlic plants with(N 100%), N= Nitrogen of fertilizer.

In general these results are in agreement with that obtained by (Xiao *et al.* 2012) reported that intercropping with green garlic significantly affects nutrient concentrations and the soil nutrient character in cucumber crops. The accumulation of biomass and most nutrient elements (N, P, K, Ca and Mn) in intercropped cucumber was significantly greater than that found in solocropped cucumber, and the effect was even sustained to the second growing season, while There is significant between intercropping treatments of total carbohydrates (%) for garlic bulbs in the two seasons.The highest values from (T4) 66% Intercropping garlic bulbs on black cumin plants with (N 50%) were (20.41 and 20.02%) in both seasons followed by the treatment(T9) 99% Intercropping garlic bulbs on black cumin plants with(N100%) were (18.89 and 18.33%)

In addition, intercropping of pepper with garlic is much better than sole pepper crop in green house/plastic tunnel with respect to soil microbes, enzymatic activities and nutrition Muhammad *et al.*, 2015) . In general these results are in agreement with that obtained by Negah *et al* (2014).

10. Effect of intercropping black cumin (nigella sativa l.) plants on garlic (allium sativum) plants on composition fixed oil black cumin and composition of essential oil of garllic for each black cumin and garlic under the influence of three levels of nitrogen fertilization:

Regarding the effect of levels of intercropping with levels of nitrogen, data in Table (12) indicated that composition of fixed oil black cumin. The fixed oil extracted from seeds of black cumin is rich several organic acids like linoleic, oleic, Stearic, Linolenic, Arachdic and palmitic acids. The highest acids from intercropping with nitrogen were from (T5) 66% Intercropping garlic bulbs on black cumin plants with (N 75%) treatment, composition of oil were oleic acid (30.21%), Arachdic (21.68%),Stearic acid (13.76 %), Linolenic acid (7.81 %), palmitic acid (6.75 %), linoleic acid (6.67 %).These results are in agreement with that obtained by Zehra *et al.*(2017), while the highest acids from intercropping with nitrogen were from (T10) Solocropping of black cumin plants with (N 50%) treatment, composition of oil were linoleic acid (39.94%), oleic acid (18.36%), Stearic acid (10.93%), palmitic acid (5.41%), Arachdic (2.59%), Linolenic acid (1.97%). The highest composition essential oil of garllic were Diallyl disulfide, Diallyl trisulfide and Allyl methyl trisulfide in (T4) 66% Intercropping garlic bulbs on black cumin plants with (N 50%). (T5) 66% (T5) Intercropping garlic bulbs on black cumin plants with (N 75%), (T6) 66% Intercropping garlic bulbs on black cumin plants with (N 100%) , respectively.

Table12. Fatty acid composition of the fixed oil of *Nigella sativa* L. and composition of essential oil garllic

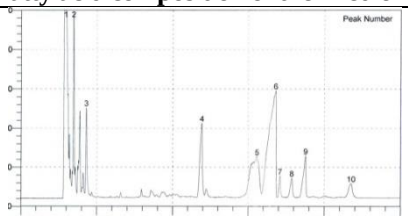

Fig. 1. G.L.C. fixed oil of black cumin during two seasons 2016/2017 and 2017/2018.
(T10) Solocropping of black cumin plants with(N 50%)

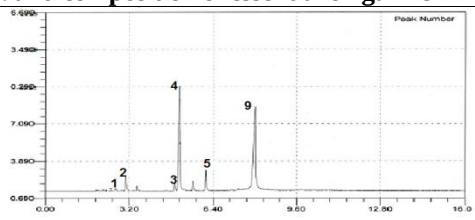

Fig. 2. G.L.C. essential oil of garllic during two seasons 2016/2017 and 2017/2018.
(T3) 50% Intercropping garlic bulbs on black cumin plants with(N100%)

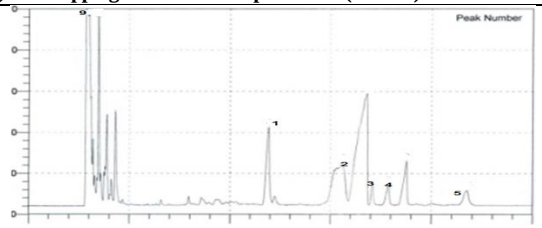

Fig. 3. G.L.C. fixed oil of black cumin during two seasons 2016/2017 and 2017/2018.
(T5) 66% (T5) Intercropping garlic bulbs on black cumin plants with (N 75%)

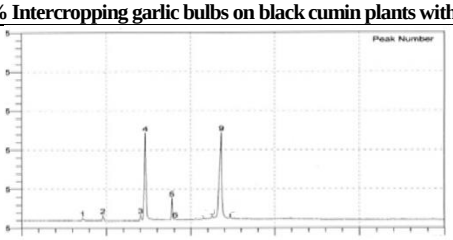

Fig. 4. G.L.C. essential oil of garllic during two seasons 2016/2017 and 2017/2018.
(T6) 66% Intercropping garlic bulbs on black cumin plants with (N 100%)

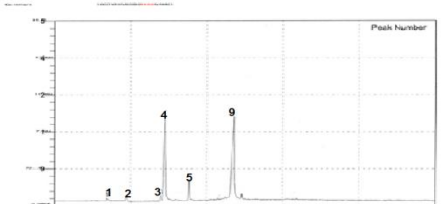

Fig. 5. G.L.C. essential oil of garllic during two seasons 2016/2017 and 2017/2018.
(T5) 66% Intercropping garlic bulbs on black cumin plants with(N 75%)

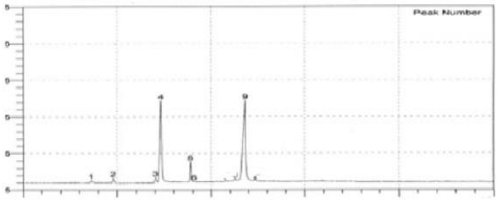

Fig. 6. G.L.C. essential oil of garllic during two seasons 2016/2017 and 2017/2018.
(T4) 66% Intercropping garlic bulbs on black cumin plants with (N 50%)

composition essential oil garllic

1-Diallyl sulfide , 2- Allyl methyl disulfide 3-Dimethyl trisulfide
4-Diallyl disulfide 5- Allyl methyl trisulfide , 9- Diallyl trisulfide

composition fixed oil of black cumin

,3- Palmitic acid 4- Stearic acid 5- Oleic acid
6- Linoleic acid 7- Linolenic acid 8- Arachdic acid

- **(T1) 50% Intercropping garlic bulbs on black cumin plants with(N 50%).,**
- **(T2) 50% Intercropping garlic bulbs on black cumin plants with(N 75%). ,**
- **(T3) 50% Intercropping garlic bulbs on black cumin plants with(N100%).,**
- **(T4) 66% Intercropping garlic bulbs on black cumin plants with (N 50%),**
- **(T5) 66% Intercropping garlic bulbs on black cumin plants with(N 75%).,**
- **(T6) 66% Intercropping garlic bulbs on black cumin plants with(N 100%).,**
- **(T7) 99% Intercropping garlic bulbs on black cumin plants with(N 50%).,**
- **(T8) 99% Intercropping garlic bulbs on black cumin plants with(N 75%).**
- **(T9) 99% Intercropping garlic bulbs on black cumin plants with(N100%)**
- **(T10) Solocropping of black cumin plants with(N 50%)**
- **(T11) Solocropping of black cumin plants with(N 75%).**
- **(T12) Solocropping of black cumin plants with(N 100%).**
- **(T13) Solocropping of garlic plants with(N 50%).**
- **(T14) Solocropping of garlic plants with(N 75%),**
- **(T15) Solocropping of garlic plants with(N 100%).**

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تأثير تحميل نباتات حبة البركة مع نباتات الثوم على المجتمع الميكروبى للتربة وانتاجية والجودة فى كلا المحصولين

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أجريت تجربة حقلية لزراعة نباتات حبة البركة و أبصال الثوم في موسمين ناجحين في المزرعة البحثية بالجميزة بمحافظة الغربية التابعة لمركز البحوث الزراعية ، مصر، لتقييم تأثير تحميل نباتات حبة البركة مع أبصال الثوم على المجتمع الميكروبى للتربة وانتاجية والجودة فى كلا المحصولين خلال 2016 - 2017.و 2017 – 2018 و كان يوجد أربع مستويات من التحميل في القطع الرئيسة (50% ، 66% ،99%) تحميل ، نباتات منفردة) و مستويات التسميد الازوتي الثلاثة كانت في القطع تحت الرئيسية (50% ، 75% ، 100% ازوت) في تصميم قطاعات منشقة .أوضحت النتائج المتحصل عليها أهمية تحميل أبصال الثوم مع نباتات حبة البركة في تحسين نمو و انتاج محصولي حبة البركة و الثوم . و فبذور حبة البركة و الزيت الثابت والزيت الطيار لنباتات حبة البركة كان افضل مقارنة بالنباتات المنفردة . أدت (T6) الي زيادة وزن (بذور الكبسولة الواحدة ، 1000بذرة ، وزن الكبسولات /النبات ، وزن البذور/النبات ، وزن البذور/للقطعة التجريبية ، وزن البذور/للفدان و عدد الكبسولات /النبات لنباتات حبة البركة و ايضا زيادة الوزن الطازج و الجاف لراس الثوم (جم) و لرووس الثوم كجم/للفدان . بينما كانت المعاملة (T5) أدت الي زيادة النسبة المئوية الزيت الطيار ، وزن الزيت الطيار و وزن الزيت الثابت /فدان في كلا الموسمين لنباتات حبة البركة / لتر فدان ، وزيادة الاحماض العضوية في الزيت الثابت و زيادة نسبة الزيت الطيار ، وزن الزيت الطيار/ لتر فدان لابصال الثوم ، كانت المعاملة (T9) أدت الي زيادة النسبة المئوية لزيت الثابت بينما المعاملة (T4) أدت الي زيادة نسبة الكربوهيدرات الكلية في الابصا ل.