EFFECT OF USING SOME BIOLOGICAL PRODUCTS OF (*NIGELLA SATIVA* L.) ON IMPROVING CUCUMBER PRODUCTIVITY AND THE MICROBIAL ACTIVITY ASSOCIATED WITH PLANT GROWTH

El-Sayed, Mahmoud A.M.[*1] and Mohamed R. Hafez[2]
[1]Department of Soil Fertility and Microbiology, Desert Research Center, El-Matareya, Cairo, Egypt
[2]Department of Plant Production**,** Desert Research Center, El-Matareya, Cairo, Egypt
[*]E-mail: mahalyed@yahoo.com, mahalyeg30@gmail.com

Two field experiments were conducted to study the effect of black cumin (*Nigella sativa* L.) seed oil and seed cake on cucumber productivity (Prince cv.) and associated microorganisms. Seed cake was applied as soil addition before transplanting at rates of 0, 5, and 10 g per plant, while seed oil in 0, 0.5, 1and 1.5% solutions was applied as foliar application three times every 10 days beginning within 30 days of transplanting. Plants receiving the highest levels of seed cake (10 g) and seed oil (1.5%) showed high density of total bacterial counts; *Azotobacter chroococcum*, *Azospirillum brasilense* and *Bacillus megaterium*, and high rates of CO_2 evolution. However, the same treatments gave the lowest density of total fungal counts, including some pathogenic fungi (*Fusarium*, *Rhizopus* and *Aspergillus niger*). Both soil amendment and foliar application improved the growth characters of the cucumber, including the percentage of stand, the number of branches, plant height, the number of flowers and total chlorophyll as well as, the yield and fruit size.

Keywords: cucumber, biological products, *Nigella sativa*, microbial activity, growth, productivity

Cucumber (*Cucumis sativus* L.) is a widely cultivated plant in the gourd family Cucurbitaceae. The plant has a creeping vine, which bears cylindrical edible fruits. It could be cultivated year-round in desert lands by employing open field and green houses. Cucumber plants are susceptible to fungal diseases.

Organic fertilization is a very important technique in this respect. Significant attentions have been paid by both growers and agricultural authorities to replace synthetic chemical fertilizers with natural organic fertilizers, which appear to be safe for the environment and improve soil fertility (David, 2002).

Also, plant extracts have been demonstrated to increase the productivity of tomato (plant length, leaf area, the number of branches, fresh and dry weight/plant and chlorophyll content) as well as the number of flowers and fruits (El-Dougdoug et al., 2007). Powdery mildew (PM) of cucumber was reduced from 52 to 7.7% for plants treated with 0.5% black seed oil (BSO), to 18.6% for plants treated with rape seed oil, and to 20% for plants treated with paraffin oil. Therefore, it is important to give more attention to BSO and other plant oils as an alternative disease control method in organic food production (Hafez, 2008). The use of BSO reduced PM disease by about 52%.

The antifungal activity of essential oil of black cumin plants in combination with biocontrol bacteria *Azotobacter* and/or *Bacillus megaterium* and N-fertilizer were examined against four phytopathogenic fungi (El-Sayed, 2006). Also, Thoppil et al. (1998) studied the activity of essential oils from four varieties of *Nigella sativa* against *Fusarium semeticum*, *Aspergillus niger* and *Rhizopus stolonifer*. They observed that all essential oils exhibited activity; the essential oil from *Basilicum* var. *purpurascens* was the most potent.

The obtained data also revealed that plant treated with mixed inoculants of *Azotobacter chroococcum* and *Bacillus megaterium* in the presence of half dose of inorganic N-fertilizer allowed essential oils to have more inhibitory effect against the tested plant pathogenic fungi when compared with addition of full dose of N-fertilizer in combination with separate inoculation. This result was observed in the two seasons for all treatments (El-Sayed, 2006).

Powdery mildew disease is one of the most serious plant diseases, causing large yield losses in a number of crops (Kiss, 2003). The disease affects the leaves, stems and fruits of cucumber (*Cucumis sativus* L.) grown in greenhouses and in the field (Bettiol et al., 2008). Powdery mildew of cucumber is one of the most common foliage diseases, attacking cucumber plants in Egypt and other countries (Harfoush and Salama, 1992; Mosa, 1997; Reuveni et al., 1997 and Verhaar et al., 1997). Using water extract of black cumin (3.0%) led to elimination of TYLCV and produced virus-free tomato by tissue culture technique.

The main objective of the present work was to improve growth, yield and quality of cucumber under North Sinai conditions by addition of seed cake of *Nigella sativa* to the soil and by foliar spray with seed oil. It is also

speculated that these treatments may reduce fungal infection, release nutrients to plant, and stimulate CO_2 evolution.

MATERIALS AND METHODS

This study was carried out in the experimental farm of the Desert Research Center at El Sheikh Zowayed area, North Sinai Governorate, during the two summer growing seasons of 2009 and 2010.

Products from *Nigella sativa* (seed cake and seed oil) were produced under bioorganic agricultural conditions. The results of chemical analysis of seed cake and seed oil are given in table (1 & 2). Prince cv. seeds were sown in early or mid-April. The transplanting date was 25 days from sowing.

Table (1). Physical and chemical properties of essential oils of *N. sativa* untreated (A) and treated with *A. chroococcum* and *B. megaterium* (B).

***Nigella sativa* seed oils (%)**					
Fractions	**A**	**B**	**Fractions**	**A**	**B**
Acidity % (as oleic acid)	3-35	2-95	**α- Thujene**	1.60	3.68
Peroxide value (m-equiv.O_2/kg sample)	48.33	29.83	**α- pinene**	0.87	0.84
Iodine value (Hanus)	130.40	130.41	**Sapinene**	0.87	0.84
Color units			**ß- pinene**	2.50	4.18
Yellow	35.00	35.00	**p- cymene**	46.90	50.15
Red	17.30	17.30	**d- limonene**	2.19	2.25
Blue	11.00	11.00	**Longifolene**	3.78	4.88
Fatty acids %			**Longipinene**	1.17	1.22
Palmitic acid (C16:0)	13.31	13.25	**4-Terpineol**	3.15	2.43
Stearic acid (C 18:0)	1.80	1.32	**Thymoquinone**	28.70	11.87
Oleic acid (C 18:1)	25.21	25.96	**Carvacrol**	0.00	0.43
Linoleic acid (C 18:2)	59.37	59.47	**Total**	97.52	97.37
Linolenic acid (18:3n-2)	0.31	0.00			
Total faty acids %	100	100			

(A): Control (without inoculation) (B): Mixed (*A. chroococcum* and *B. megaterium*)

The experiment consisted of two factors: Soil application by adding some outputs of *Nigella sativa* (seed cake) with different doses (0, 5 and 10 g seed cake /plant) one week after transplanting, and by spraying solutions

containing different concentrations (0, 0.5, 1 and 1.5%) of oil extracted from *Nigella sativa* seed on the vegetative parts of the plant three times every ten days, the first spray after 30 days from transplanting.

Table (2). Physical and chemical properties of seed cake of *N. sativa*.

Amino acids							
Essential Amino acids (%)		**Non-Essential Amino acids (%)**		**Macronutrients (%)**		**Micronutrients (ppm)**	
Threonine	3.56	**Aspartic**	2.82	**P**	0.88	**Fe**	413
Valine	4.46	**Serine**	3.67	**Mg**	0.71	**Mn**	40
Methionine	4.98	**Proline**	1.69	**K**	0.58	**Z**	80
Isoleucine	3.63	**Glycine**	10.39	**Ca**	0.27		
Leucine	4.44	**Alanine**	10.92	**N**	0.19		
Phnylalanine	3.71	**Cystine**	0.036				
Lysine	4.35	**Tyrosine**	0.025				
Arginine	2.06	**Glutamic**	21.60				
Histidine	2.90						

A split plots design with three replicates was used. The seed cake concentrations were assigned in the main plots, whereas the foliar spray by seed oil treatments were distributed in sub plots.

The experiment included 36 experimental units, 3 seed cake × 4 foliar spray treatments × 3 replicates. The experimental plot area was 10.5 m^2; plant distance was 50 cm apart. The analysis of soil and irrigation water was performed according to Jackson (1958), Piper (1950) and Richards (1954), respectively, and are presented in tables (3, 4 & 5). Determination of antimicrobial activity of extracted oil was studied according to Jacobs and Gerstein (1960).

A drip irrigation system was used. The length of line was 10.5 m, and the width between lines was 1 m.

Seed cake was added to soil one week after transplanting. Cucumber plants were sprayed three times with an aqueous solution of seed oil during each growing season. The first spray was performed after 30 days from transplanting, whereas, the second was applied three times every 10 days then 30 days. All replicates received similar agricultural practices with regard to cultivation, fertilization, irrigation, and pest disease control.

Chicken manure stable compost was used as fertilizers at 20 m^3 per feddan, 100 kg calcium super phosphate per feddan and 100 kg agricultural sulfur before planting. Ammonium sulfate at 300 kg, potassium sulfate at 150 kg and 15 kg phosphoric acid were divided into small quantities and added weekly in drip irrigation system during the growing seasons.

Table (3). Chemical analysis of the soil at North Sinai Research Station-El Sheikh Zowayed area.

Depth (cm)	PH	E.C. mmhos/cm	Soluble anions (meq./L.)			Soluble cations (meq./L.)				O.M %	O.C. %	Available P_2O_5	$CaCO_3$%
			$CO_3^=$	$H_2CO_3^-$	Cl^-	$SO_4^=$	Ca^{++}	Mg^{++}	Na^+ K^+				
0 – 30	8.47	0.90	-	1.91	3.00	4.74	4.08	0.82	4.50 0.25	0.52	0.30	7.00	2.80

Table (4). Particle size distribution of the soil at North Sinai Research Station - El Sheikh Zowayed area.

Fine sand (%)	Coarse sand (%)	Silt (%)	Clay (%)	Texture
31.96	58.16	7.43	2.25	Sandy

Table (5). Chemical analysis of irrigation water at North Sinai Research Station -El Sheikh Zowayed area.

PH	EC.	Soluble Anions (meq./L)				Soluble cations (meq./L)			
	ppmmmhos/cm	$Co_3^=$	$H_2CO_3^-$	Cl^-	$SO_4^=$	Ca^{++}	Mg^+	Na^+	K^+
7.4	2491	3.892	--	2.72	8.7	33.38	7.0	10.5	25.3	2.01

1. Microbiological Determinations

Rhizosphere soil samples were collected from soil after germination at 30, 60 and 90 days from transplanting to estimate the number of different microbial types and total microbial counts on Bunt and Rovira agar medium (Bunt and Rovira, 1955), total fungal counts on Martin's medium (Allen, 1959), *Azotobacter* spp. on nitrogen deficient medium (Abd El Malek and Ishac, 1968), *Azospirillum* spp. on semi-solid malate medium (Dobereiner, 1978). *Bacillus* spp. was quantified on modified Bunt and Rovira medium (Abd El-Hafez, 1966) using the dilution frequency method. CO_2 evolution was measured according to Pramer and Schmidt (1994).

2. Determination of Antimicrobial Activity of Extracted Oil

The effect of the extracted oil of black cumin with concentrations of 500, 750, 1000 and 1250 ppm on the growth of pathogenic fungi was studied by measuring the inhibition zone and minimum inhibitory concentration as described by Sleigh and Timburg (1981).

Disc diffusion method was used for determining the antimicrobial activity of extracted oil against the pathogenic fungi (*Aspergillus niger, Fusarium semeticum and Rhizopus stolonifer*) as described by Jacobs and Gerstein (1960).

3. Plant Parameters

Five plants were randomly taken from each experimental plot after 50 days from transplanting. Data on vegetative growth, fruit yield, and fruit quality were recorded as following:

3.1. Vegetative growth

1. Percentage of stand
2. Fresh and dry weight (g)
3. Plant length (cm)
4. Total chlorophyll using chlorophyll meter according to A.O.A.C. (1990)
5. Number of flowers/ plant

3.2. Total yield and fruit quality

During each experimental season all fruits from each plot were harvested ten times and total fruits were collected. The yields per plant and per plot as well as per feddan were then calculated. The data that have been taken were as following:

1. Fruit length (cm)
2. Average fruit weight (g)
3. Fruit diameters (mm)
4. Total yield (g/plant or ton/fed)
5. Dry weight per fruit (g)

4. Statistical Analysis

Data were analyzed using ANOVA according to Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

1. Effect of Using Some Biological Products of *Nigella sativa* L. on Total Counts of Bacteria and Fungi

Data presented in table (6) show the effect of using seed cake and seed oil of *Nigella* at different levels on total bacterial counts during two seasons and at different stages of plant growth. With respect to adding seed oil at different rates, data show that increasing seed oil addition in the absence of seed cake increased total bacterial counts for all stages of plant growth.

In the presence of seed cake at 5 g with or without seed oil, total count also increased more than in case of seed cake absence. Increasing seed cake to 10 g /plant with adding seed oil levels at 1.5% gave the highest density of total bacterial counts at different stages of plant growth, reaching 99, 277, 259 $\times 10^5$ CFU/g dry soil for 30, 60 and 90 days for the first season and 105, 297, 265 $\times 10^5$ CFU/g dry soil at the same stages during the second season.

Table (6). Effect of using some biological products of *Nigella sativa* L. on total bacterial counts during 2009/2010 seasons.

Seeds dregs	Seeds oil	Total Bacterial counts (Counts × 10^5 CFU/g dry soil)						Average as total microbial counts		
		Season 1			Season 2					
		30 day	60 day	90 day	30 day	60 day	90 day	30 day	60 day	90 day
Control	Zero	32	39	36	35	47	40	34	43	38
	0.5%	39	48	46	44	56	50	42	52	48
	1%	45	65	62	49	77	62	47	71	62
	1.5%	48	67	65	52	80	66	50	74	66
5 g	Zero	37	70	65	50	90	81	44	80	73
	0.5%	49	99	89	57	115	105	53	107	97
	1%	60	131	110	69	135	120	65	133	115
	1.5%	65	135	115	71	140	127	68	138	121
10 g	Zero	55	121	97	61	139	120	58	130	109
	0.5%	83	215	210	89	256	227	86	236	219
	1%	95	269	255	101	295	262	98	282	259
	1.5%	99	277	259	105	297	265	102	287	262

*Initial total bacterial count was 65 × 10^2 (CFU/g dry soil).

While the results presented in table (7) show the impact of using seed cake and seed oil of *Nigella* at different levels on total fungal counts during the two seasons and at different stages of plant growth. With respect to adding seed oil at different rates, data show that by increasing seed oil addition, in the absence of seed cake, fungi decreased at different stages of plant growth during two seasons.

Table (7). Effect of using some biological products of *Nigella sativa* L. on total fungal counts during 2009/2010 seasons.

Seeds dregs	Seeds oil	Total fungal counts (Counts × 10^2 CFU/g dry soil)						Average as total fungal counts		
		Season 1			Season 2					
		30 day	60 day	90 day	30 day	60 day	90 day	30 day	60 day	90 day
Control	Zero	70	80	84	60	70	80	65.0	75.0	82.0
	0.5%	47	40	36	50	40	33	48.5	40.0	34.5
	1%	38	32	28	40	35	31	39.0	33.5	29.5
	1.5%	33	22	20	37	31	28	35.0	26.5	24.0
5 g	Zero	35	29	28	37	31	29	36.0	30.0	28.5
	0.5%	23	18	16	25	20	15	24.0	19.0	15.5
	1%	20	16	14	22	17	13	21.0	16.5	13.5
	1.5%	16	13	11	15	12	10	15.5	12.5	10.5
10 g	Zero	30	22	17	31	28	22	30.5	25.0	19.5
	0.5%	16	14	11	22	16	11	19.0	15.0	11.0
	1%	13	10	8	14	11	9	13.5	10.5	8.5
	1.5%	11	8	5	10	5	3	10.5	6.5	4.0

*Initial total fungal count was 90 × 10^2 (CFU/g dry soil).

In the presence of seed cake at 5 g with or without seed oil, total counts of fungi also decreased more than in case of absence of seed cake. Increasing seed cake to 10 g /plant with adding seed oil levels at 1.5% gave the lowest density of total fungal counts at different stages of plant growth and during the two growing seasons, reaching 11, 8, 5 $\times 10^2$ CFU/g dry soil for 30, 60 and 90 days for the first season and to 10, 5, 3 $\times 10^2$ CFU/g dry soil at the same stages during the second season.

The recorded data indicated that control treatment without using any biological products gave higher growth of fungi. This may be due to the production of siderphore compounds, which inhibit fungal spore germination via causing unavailability of nutrients (Jagnow, 1991) or due to the lyses of chitinaceous cell walls of pathogenic fungi by specific enzymes produced by bacteria (Nelson et al., 1986).

2. Effect of Using Some Biological Products of *Nigella sativa* L. on *Azotobacter* spp. and *Azospirillum* spp. Densities

Data in tables (8 and 9) show that when seed oil was applied in the absence of seed cake, the numbers of *Azotobacter* spp. and *Azospirillum* spp. increased at different stages of plant growth during the two seasons. In the presence of seed cake at 5 g with or without seed oil, *Azotobacter* spp. and *Azospirillum* spp. also increased more in case of seed cake absence.

Table (8). Effect of using some biological products of *Nigella sativa* L. on *Azotobacter* densities during 2009/2010 seasons.

Seeds dregs \ Seeds oil		*Azotobacter* Densities (Counts × 10^4 CFU g dry soil)						Average *Azotobacter* counts		
		Season 1			Season 2					
		30 day	60 day	90 day	30 day	60 day	90 day	30 day	60 day	90 day
Control	Zero	11.40	27.60	20.70	16.70	33.40	23.50	14.1	30.5	22.1
	0.5%	13.60	38.70	24.50	22.40	47.30	29.30	18.0	43.0	26.9
	1%	20.70	41.40	34.40	29.70	49.10	37.80	25.2	45.3	36.1
	1.5%	22.30	53.50	39.20	31.20	51.80	41.10	26.8	52.7	40.2
5 g	Zero	24.40	55.20	41.40	31.30	58.60	44.60	27.9	56.9	43.0
	0.5%	39.70	62.40	45.60	41.60	84.30	72.20	40.7	73.4	58.9
	1%	44.90	82.70	72.50	53.40	90.10	77.30	49.2	86.4	74.9
	1.5%	48.80	88.80	75.70	56.90	92.90	80.30	52.9	90.9	78.0
10 g	Zero	49.20	62.40	52.30	50.50	65.80	53.20	49.9	64.1	52.8
	0.5%	52.40	82.80	76.00	56.40	98.50	80.10	54.4	90.7	78.1
	1%	58.80	92.40	79.80	61.90	125.10	101.40	60.4	108.8	90.6
	1.5%	65.70	95.90	83.60	66.80	129.30	107.10	66.3	112.6	95.4

*Initial *Azotobacter* densities was 30×10^2 (CFU/g dry soil).

Table (9). Effect of using some biological products of *Nigella sativa* L. on *Azospirillum* densities during 2009/ 2010 seasons.

Seeds dregs \ Seeds oil		*Azospirillum* Densities (Counts × 10^4 CFU g dry soil)						Average *Azospirillum* counts		
		Season 1			Season 2					
		30 day	60 day	90 day	30 day	60 day	90 day	30 day	60 day	90 day
Control	Zero	14.7	18.6	15.0	15.0	21.0	18.6	14.9	19.8	16.8
	0.5%	17.3	24.0	22.0	21.0	28.0	23.9	19.2	26.0	23.0
	1%	21.0	28.0	24.5	22.0	34.0	28.0	21.5	31.0	26.3
	1.5%	23.9	34.0	28.0	24.5	36.0	30.5	24.2	35.0	29.3
5 g	Zero	21.1	28.0	24.5	22.4	31.0	26.2	21.8	29.5	25.4
	0.5%	24.5	32.0	30.5	28.0	34.0	30.5	26.3	33.0	30.5
	1%	28.0	34.0	32.0	32.0	40.0	36.0	30.0	37.0	34.0
	1.5%	30.5	43.0	34.0	34.0	41.0	39.0	32.3	42.0	36.5
10 g	Zero	28.0	34.0	30.5	26.2	34.0	28.0	27.1	34.0	29.3
	0.5%	34.0	43.0	36.0	36.0	50.0	39.0	35.0	46.5	37.5
	1%	41.5	60.0	43.0	41.5	59.0	41.0	41.5	59.5	42.0
	1.5%	43.0	92.0	64.0	43.0	84.0	50.0	43.0	88.0	57.0

*Initial *Azospirilla* Densities was 30×10^2 (CFU/g dry soil).

Increasing seed cake to 10 g /plant with adding seed oil gave the highest density of *Azotobacter* spp. & *Azospirillum* spp. at different stages of plant growth, with the average densities reaching 66.3, 112.6 and 95.4 $\times 10^4$ CFU/g dry soil for 30, 60 and 90 days for *Azotobacter* spp. and reaching 43, 88 and 57 $\times 10^4$ CFU/g dry soil for *Azospirillum* spp. When plants have been treated with 10 g seed cake combined with foliar application with seed oil at 1.5%, gave the highest density of *Azotobacter* spp. and *Azospirillum* spp. at different stages of plant growth, with the average of *Azotobacter* spp. and *Azospirillum* spp. densities reaching 66.3, 112.6, 95.4, 43.0, 88.0 and 57.0×10^4 CFU/g dry soil, respectively, for 30, 60 and 90 days.

3. Effect of Using Some Biological Products of *Nigella sativa* L. on *Bacillus* spp. Densities

With respect to adding seed oil at different rates, data in table (10) show that increasing seed oil addition in the absence of seed cake increased *Bacillus* spp. densities at different stages of plant growth and during the two seasons.

In the presence of seed cake at 5 g with or without seed oil also increased *Bacillus* spp. densities more than observed in case of absence of seed cake. Increasing seed cake to 10 g /plant with the addition of 1.5% seed oil gave the highest density of *Bacillus* spp. at different stages of plant growth, with the average of *Bacillus* spp. densities reaching 98, 148 and 125 $x10^4$ CFU/g dry soil for 30, 60 and 90 days.

Table (10). Effect of using some biological products of *Nigella sativa* L. on *Bacillus* spp. densities during 2009/ 2010 seasons.

Seeds oil / Seeds dregs		*Bacillus.* spp. densities (counts × 10^4 CFU/g dry soil)						Average of *Bacillus.* spp. counts		
		Season 1			Season 2					
		30 day	60	90	30	60	90	30	60	90
Control	Zero	33	38	35	35	46	37	34	42	36
	0.5%	36	41	38	40	50	42	38	46	40
	1%	39	44	40	45	55	49	42	50	45
	1.5%	42	49	44	50	63	55	46	56	50
5 g	Zero	40	70	55	50	80	60	45	75	58
	0.5%	51	81	70	63	95	78	57	88	74
	1%	57	95	78	70	105	85	64	100	82
	1.5%	63	105	95	85	115	100	74	110	98
10 g	Zero	55	80	65	70	95	80	63	88	73
	0.5%	64	95	85	90	150	105	77	123	95
	1%	71	105	90	100	160	120	86	133	105
	1.5%	80	115	105	115	180	145	98	148	125

*Initial total *Bacillus* count was 35 × 10^2 (CFU/g dry soil).

4. Effect of Using Some Biological Products of *Nigella sativa* L. on CO_2 Evolution

Table (11) describes the effect of using seed cake and seed oil of *Nigella* at different levels of microbial activity through CO_2 evolution (µg / g dry soil / h) in the area of soil surrounding the roots of the plants during the two seasons and at different stages of plant growth.

Table (11). Effect of using some biological products of *Nigella sativa* L. on CO_2 evolution (µg/g dry soil/h) during 2009/2010 seasons.

Seeds oil / Seeds dregs		CO_2 evoluted (µg/g dry soil/ h)						Average of CO_2 evoluted		
		Season 1			Season 2					
		30 day	60 day	90 day	30 day	60 day	90 day	30 day	60 day	90 day
Control	Zero	13.50	14.30	13.80	14.10	15.60	15.12	13.8	14.95	14.5
	0.5%	14.66	15.60	15.10	15.30	16.20	16.10	15.0	15.90	15.6
	1%	15.20	16.10	15.80	16.10	16.70	16.14	15.7	16.40	16.0
	1.5%	16.10	16.90	16.70	16.90	17.30	17.10	16.5	17.10	16.9
5 g	Zero	14.70	15.90	15.00	15.20	16.62	16.12	15.0	16.26	15.6
	0.5%	15.10	17.10	16.10	16.12	18.10	17.10	15.6	17.60	16.6
	1%	16.30	18.00	17.20	16.80	19.10	18.10	16.6	18.55	17.7
	1.5%	16.80	18.70	17.60	17.40	19.60	18.35	17.1	19.15	18.0
10 g	Zero	15.70	17.61	16.10	16.10	18.00	17.31	15.9	17.81	16.7
	0.5%	16.20	18.90	17.11	17.33	20.24	18.60	16.8	19.57	17.9
	1%	16.80	19.30	17.70	17.60	21.10	19.10	17.2	20.20	18.4
	1.5%	17.10	20.00	18.10	18.80	21.52	20.00	18.0	20.76	19.1

*Initial CO_2 evolution is 12.10 µg /100 g soil/24 h.

With regard to adding seed oil at different rates, the data show that increasing seed oil addition in the absence of seed cake increased the rate of

CO_2 evolution (µg / g dry soil / h) at different stages of plant growth and during two seasons.

In the presence of seed cake at 5 g with or without seed oil, the rate of soil CO_2 evolution also increased (µg /g dry soil /h) compared to soils without seed cake. Increasing seed cake to 10 g /plant with adding oil seed gave the highest quantity of CO_2 activity (µg /g dry soil / h) at different stages of plant growth. The average of CO_2 exchange (µg /g dry soil /h) reached 18, 20.78, and 19.10 for 30, 60 and 90 days when plants were treated with 10 g seed cake combined with foliar application with seed oil at 1.5%.

5. Effect of Using Some Biological Products of *Nigella sativa* L. on Some Plant Pathogenic Fungi

The results in table (12) and Fig. (1) show that using solutions with concentrations of 500, 750, 1000 and 1250 ppm of oil from *Nigella sativa* seeds inhibited the growth of some pathogenic fungi to cucumber plant including *Fusarium, Rhizopus* and *A. niger*. The inhibition zones were the largest at concentrations of 1250 and 1000 ppm. The inhibition zones produced by concentrations of 750 and 500 ppm were smaller but still significant compared to control treatments.

6. Cucumber Growth and Yield Characteristics as Affected by *Nigella sativa* L. Treatments

6.1. Growth characteristics

It is clear from results presented in table (13) that soil application with seed cake of *Nigella sativa* at 10 g produced a significant increase in vegetative growth characters, i.e., percentage of stand, plant height, number of flowers/plant, fresh weight/plant and total chlorophyll, except dry matter percentage, which has given the highest values in the two experimental seasons as compared with control treatment. The results were true in both growing seasons.

The effect of foliar spray treatments on growth parameters showed the highest value with *Nigella sativa* oil at 1.5% treatment when compared with the other tested treatments in both seasons, while the control treatment showed the lowest value in both seasons. This result suggests that powdery mildew of cucumber (*Podosphaera xanthii*) was reduced by spraying *Nigella sativa* oil, which is in agreement with Hafez (2008). The combination of soil amendment with seed cake with foliar spray of oil gave a significant improvement on all growth characters in both tested seasons. These results indicated the important role of *Nigella sativa* oil and seed cake in improving growth characteristics of cucumber plants. Also seed cake application alone has positive effect on plant growth by stimulating the growth of rhizosphere microorganisms, which are playing fundamental role in minerals uptake by

plant. Regardless, the result agree with those obtained by Hassan and Vancura (1970) who detected that microbial products of *Azotobacter chroococcum*, *Azospirillum brasilense*, *Bacillus megaterium* had a positive effect on plant length and weight, due to excretion of some growth regulators as gibberellin like substances in microbial culture.

Table (12). Effect of using some biological products of *Nigella sativa* L. on some plant pathogenic fungi during 2009/2010 seasons.

Concentrations of oil (ppm) / Fungi	Diameter of Inhibition zone (cm)							
	A				B			
	500	750	1000	1250	500	750	1000	1250
Fusarium	0.0	0.0	1.20	1.25	1.23	1.77	2.50	3.80
Rhizopus	0.0	0.0	0.40	0.81	1.50	2.68	3.17	4.03
A. niger	0.0	0.0	1.10	1.30	2.07	3.97	4.67	5.83

A= (Control) without inoculation B= Mixed (*A. chroococcum* and *B. megaterium*)

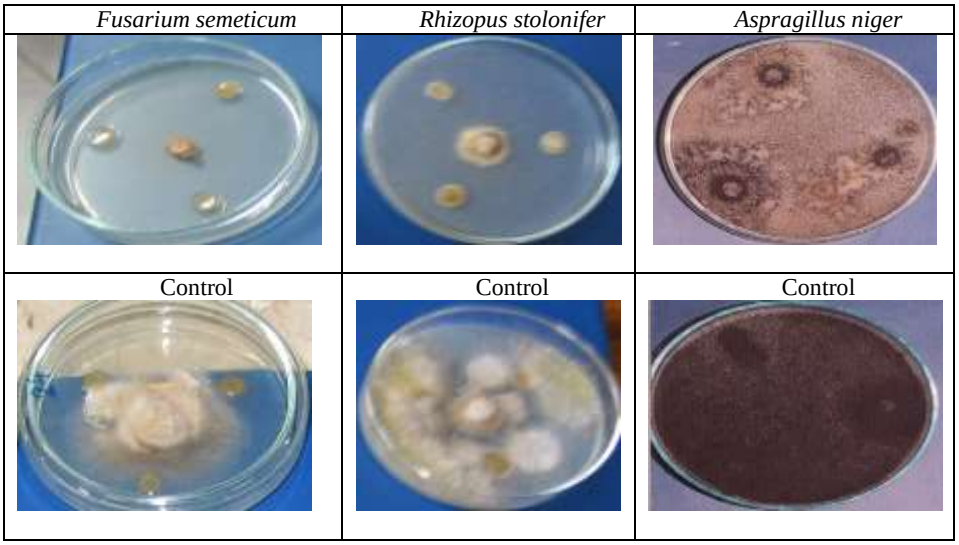

Fig. (1). Effect of using some biological products of *Nigella sativa* L. on some plant pathogenic fungi.

6.2. Yield and its component

It is evident from table (14) that seed cake gave significant increase in total yield and its components, *i.e*. fruit length, average fruit weight fruit diameter and total yield per plant (g) and per fed (ton). The highest values of yield and its components were obtained by application of seed cake at rate of 10 g around plant root, except dry matter (%). Control treatment showed a significant increase in fruit dry matter (%) in both growing seasons.

Foliar spray effect with *Nigella sativa* oil at 1.5% produced the highest value of fruit length, average fruit weight, fruit diameter, dry matter (%) and total yield per plant and per feddan. These results may be due to the role of *Nigella sativa* oil in increasing cell division, as suggested by El-Dougdoug et al. (2007).

The interaction treatment between seed cake at rate of 10 g per plant and *Nigella sativa* oil at 1.5% showed the highest values on total yield and its components, except the dry matter (%) character. These results suggest a role of *Nigella sativa* oil and seed cake in reducing powdery mildew of cucumber and improving soil conditions around the root zone (Harfoush and Salama, 1992; Mosa, 1997; Reuveni et al., 1997 and Verhaar et al., 1997).

Table (13). Effect of using some biological products of (*Nigella sativa* L.) on growth characters of cucumber plant during 2009/ 2010 seasons.

Treatments		Percentage of stand		Fresh weight g/plant		Plant length (cm)		Number of flowers/plant		Total chlorophyll		Dry matter (%/plant)	
Seeds dregs	Seeds oil	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
{ontrol	Zero	32,33	30,67	127,67	210,33	67,00	113,00	4,67	8,67	25,00	30,33	26,83	28,90
	0.5%	34,33	32,33	167,67	244,67	75,00	128,67	12,33	18,00	26,77	34,67	61,03	63,13
	1%	41,00	39,00	149,67	266,00	76,67	141,00	6,00	7,00	31,00	37,00	66,43	64,80
	1.5%	43,00	41,67	167,67	350,67	71,33	144,33	15,00	16,00	28,93	36,23	67,87	65,87
5 g	Zero	35,67	32,67	159,33	173,67	62,33	85,67	9,00	14,67	25,60	29,23	19,30	19,87
	0.5%	41,67	36,00	163,67	261,33	82,00	115,33	11,67	18,00	27,77	31,07	27,23	28,33
	1%	49,67	40,00	179,33	283,33	73,00	113,67	10,00	11,67	30,30	34,67	38,13	39,23
	1.5%	54,67	52,00	267,67	294,67	66,00	130,00	17,00	20,67	28,70	30,33	53,33	54,33
10 g	Zero	40,00	40,67	108,33	304,00	74,33	111,00	13,33	18,00	25,83	26,83	22,37	23,33
	0.5%	49,33	49,33	134,00	320,00	75,67	129,33	16,33	12,67	28,90	34,53	41,90	42,97
	1%	58,00	55,67	149,00	361,67	76,33	136,00	17,33	13,00	30,17	35,40	55,20	55,13
	1.5%	60,33	57,33	245,00	459,67	86,33	145,33	20,33	21,33	29,67	35,60	67,10	66,87
LSD		1,21	0,88	1,93	4,14	1,39	2,61	0,90	1,20	0,41	0,89	0,56	0,99
Control		37,67	35,92	153,17	267,92	72,50	131,75	9,50	12,42	27,93	34,56	55,54	55,68
5 g		45,42	40,17	192,50	253,25	70,83	111,17	11,92	16,25	28,09	31,33	34,50	35,44
10 g		51,92	50,75	159,08	361,33	78,17	130,42	16,83	16,25	28,64	33,09	46,64	47,08
LSD		0,75	0,68	1,35	1,75	0,93	1,61	0,50	0,65	0,28	0,60	0,09	0,43
Control		27,00	26,00	98,83	172,00	50,92	77,42	6,75	10,33	19,11	21,60	17,13	18,03
0.5% oil		31,33	29,42	116,33	206,50	58,17	93,33	10,08	12,17	20,86	25,07	32,54	33,61
1% oil		37,17	33,67	119,50	227,75	56,50	97,67	8,33	7,92	22,87	26,77	39,94	39,79
1.5% oil		39,50	37,75	170,08	276,25	55,92	104,92	13,08	14,50	21,83	25,54	47,08	46,77
LSD		0,70	0,51	1,11	2,39	0,80	1,51	0,52	0,69	0,24	0,51	0,33	0.51

The recorded data indicate that control treatment gave higher fungal counts than seed cake and seed oil of *Nigella sativa* treatments, which contain beneficial bacteria, e.g. *Azotobacter chroococcum*, *Azospirillum brasilense*, *Bacillus megaterium*. Similarly, Kavimandan and Gaur (1971) found that *Bacillus megatherium* can decompose organic phosphates and thereby improve crop yield. This may be due to the production of siderphores compounds, which inhibit fungal spore germination and increase availability of nutrients to plant and improve growth (Jagnow, 1991). Also,

the highest total yield of cucumber plants, which were treated with seed cake and seed oil of *Nigella sativa* than other treatments, may be due to reductions in fruit dropping (Wilocox, 1994) and/or increases in the supply of growth hormones produced by microorganisms (Amara, 1994).

Table (14). Effect of using some biological products of (*Nigella sativa* L.) on yield and its component of cucumber plant during 2009/ 2010 seasons.

Treatments		Fruit length (cm)		Average fruit weight (g/ fruit)		Total yield(g) /plant		Total yield (ton)/fed		Fruit diameter (mm)		Dry matter (%)	
Seeds dregs	Seeds oil	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
control	Zero	12,40	11,97	35,83	36,50	398,33	376,67	39,83	36,33	23,00	25,00	4,57	4,37
	0.5%	12,70	12,30	70,23	72,63	406,33	403,33	40,83	39,00	26,67	30,33	8,17	8,33
	1%	15,67	14,20	57,30	54,53	505,00	490,00	50,50	48,00	25,67	27,00	8,57	8,43
	1.5%	16,53	14,97	80,20	80,97	606,67	585,00	60,67	56,83	26,67	30,67	11,07	10,40
5 g	Zero	14,33	14,20	45,67	46,30	405,00	405,00	40,50	40,50	31,00	31,67	6,37	6,47
	0.5%	13,10	13,80	46,20	47,30	613,33	621,67	69,30	65,67	29,67	36,33	7,73	7,23
	1%	13,40	12,47	44,70	45,17	693,00	670,00	61,33	62,17	33,67	31,67	3,93	3,50
	1.5%	15,10	14,70	69,63	65,00	798,67	793,33	79,87	77,00	34,33	41,00	7,67	8,03
10 g	Zero	14,10	15,00	59,57	60,23	500,00	491,67	50,00	48,17	32,67	31,33	3,73	3,97
	0.5%	15,10	13,87	65,20	64,23	696,67	693,33	69,67	67,67	34,00	32,67	7,60	7,43
	1%	16,33	16,40	45,33	45,17	794,33	793,33	79,43	72,83	35,67	41,33	5,03	4,83
	1.5%	17,33	19,33	106,07	105,63	893,33	890,00	89,33	74,67	36,67	45,67	7,97	8,63
LSD		0,43	0,47	1,26	1,15	7,27	14,58	0,73	1,01	0,67	1,38	0,54	0,32
Control		14,33	13,36	60,89	61,16	479,08	463,75	47,96	45,04	25,50	28,25	8,09	7,88
5 g		13,98	13,79	51,55	50,94	627,50	622,50	62,75	61,33	32,17	35,17	6,43	6,31
10 g		15,72	16,15	69,04	68,82	721,08	717,08	72,11	65,83	34,75	37,75	6,08	6,22
LSD		0,30	0,21	0,52	0,39	3,71	4,05	0,39	0,26	0,44	0,45	0,19	0,17
Control		10,21	10,29	35,27	35,76	325,83	318,33	32,58	31,25	21,67	22,00	3,67	3,70
0.5% oil		10,23	9,99	45,41	46,04	429,08	429,58	44,95	43,08	22,58	24,83	5,88	5,75
1% oil		11,35	10,77	36,83	36,22	498,08	488,33	47,82	45,75	23,75	25,00	4,38	4,19
1.5% oil		12,24	12,25	63,98	62,90	574,67	567,08	57,47	52,13	24,42	29,33	6,68	6,77
LSD		0,25	0,27	0,73	0,66	4,20	8,42	0,42	0,58	0,38	0,80	0,31	0,19

CONCLUSION

From the results obtained, it can be concluded that using *Nigella sativa* L., as seed cake in rates of 10 g/plant as soil application and 1.5% seed oil as foliar spray to cucumber plants, improved growth and productivity of cucumber and reduced fungal diseases under North Sinia conditions.

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أثر إستخدام بعض نواتج حبة البركة المنتجة حيويًا على تحسين إنتاجية الخيار وأثرها على النشاط الميكروبي المصاحب لنمو النبات

محمود علي محمد السيد[1]* ومحمد رائف حافظ[2]
[1]قسم خصوبة وميكروبولوجيا الأراضي، مركز بحوث الصحراء، القاهرة، مصر
[2]قسم الإنتاج النباتي، مركز بحوث الصحراء، القاهرة، مصر

أقيمت تجربتان حقليتان خلال موسمي الزراعة الصيفي ٢٠٠٩- ٢٠١٠ بمحطة تجارب مركز بحوث الصحراء بمنطقة الشيخ زويد بشمال سيناء، لدراسة تأثير بعض نواتج حبة البركة المنتجة حيويًا وذلك بغرض تحسين إنتاجية الخيار صنف البرنس. وقد أستخدم تفل بذور حبة البركة بمعدلات صفر، ٥، ١٠ جرام كإضافة أرضية حول منطقة جذور النبات. بينما أستخدم زيت حبة البركة كرش ورقي بمعدلات صفر ، ٠.٥ ،١، ١.٥٪ رشًا على النباتات بعد الشتل ثلاث مرات كل ١٠ أيام.

وقد تم دراسة تأثير هذه المعاملات على نشاط بعض الميكروبات النافعة والممرضة للنبات وأثر ذلك على صفات النمو والإنتاج والجودة لمحصول الخيار. وكان من أهم النتائج المتحصل عليها، أن إستخدام تفل بذور حبة البركة بمعدل ١٠ جم حول جذور كل نبات من شتلات الخيار وكذلك الرش بزيت حبة البركة بمعدل ١.٥٪ أعطى أعلى كثافة لأعداد البكتريا الكلية وأقل كثافة لأعداد بعض الفطريات الممرضة لنبات الخيار بالتربة المحيطة بجذور النباتات، وكذلك أعلى كثافة لأعداد كل من بكتريا الأزوتوباكتر، ألأزوسبريلليم، باسلس ميجاتيريم بالإضافة الى تقييم النشاط الميكروبي بالتربة من خلال تقدير ثاني أكسيد الكربون، وأيضا دراسة تأثير زيت بذور حبة البركة على تثبيط نشاط بعض الفطريات الممرضة لنبات الخيار.

وبدراسة بعض صفات النمو والإنتاج وصفات الجودة لمحصول الخيار فقد أظهرت نفس المعاملة أعلى النتائج في صفات طول النبات، نسبة البقاء، الوزن الطازج للنبات، عدد الأزهار والكلورفيل الكلي. وأظهرت نفس المعاملة أعلى قيم في إنتاجية النبات والفدان، طول وقطر الثمرة والوزن الطازج بينما أعطت معاملة الكنترول أعلى قيمة لصفة النسبة المئوية للمادة الجافة للنبات والثمار.