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EFFECT OF APPLICATION OF Ca, S, Mg and UREA ON GROWTH, YIELD AND CHEMICAL COMPOSITION OF *Nigella sativa* L., PLANTS.

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ABSTRACT

This work was carried out at the Experimental Farm of Fac. of Agriculture at Moshtohor, Benha Univ. for two successive seasons (2003/2004 and 2004/2005). It aimed to study the effect of foliar spray with some nutrient elements (calcium, sulfur, and magnesium) at the rate of 200ppm plus control combined with urea at rates of 0.0, 0.5, 1.0 and 1.5% on vegetative growth, seed yield and chemical composition of *Nigella sativa* plants. A split plot design with three replications was used. Urea levels occupied in the main plots and those calcium, sulfur, and magnesium plus control were allocated at random in the sub plots. Plant growth parameters such as plant height, number of branches, fresh and dry weights of herb/plant, seed yield/plant and per feddan were recorded and seed quality was estimated by measuring volatile and fixed oils percentage as well as the main components of the volatile oil. Herb was chemically analyzed to determine N,P,K and total carbohydrates percentages. The obtained results showed that foliar spraying of *Nigella sativa* plants with each of urea or calcium, sulfur and magnesium elements increased the different parameters such as plant height, fresh and dry weights of herb/plant, number of capsules, seed yield/plant or per feddan and also increased each of volatile or fixed oils percentage in plant seeds as well as N,P,K and total carbohydrates percentages in plant herb compared with control treatment in both seasons. Also, all interaction treatments between the different levels of urea and each of calcium, sulfur or magnesium elements attained significant increase in growth and seed yield characters and also caused a relative increase in seeds content of volatile and fixed oils percentage as well as N,P,K and total carbohydrates percentage in plant herb compared with control treatment. The highest values of seed yield/plant or/feddan as well as volatile and fixed oil percentages were resulted from the application of urea at the rate of 1.5% + Mg at the rate of 200 ppm.

The G.L.C. determination revealed the presence each of α, and β pinene, limonene, borneol and the thymoquinone compounds of volatile oil of seeds. Spraying plants with Mg + urea at the rate of 0.5% gave the highest value of thymoquinone compound in the volatile oil compared with all other treatments.

It was recommended to supply *Nigella sativa* plants with urea at the rate of 1.5% plus Mg at the rate of 200 ppm in order to maximize vegetative growth and both seed yield and oil production.

Key words: *Nigella sativa*, Black cumin, G.L.C., Volatile oil, Fixed oil, Thymoquinone, ∝-Pinene and d-Limonene.

INTRODUCTION

Black cumin, (*Nigella sativa* L.) plant is one of the most important medicinal plants which belongs to family Ranunculaceae. It is native to some parts of Mediterranean Sea region and is considered as a member of the drug and condiment crops. The seeds are widely used as spice in cooking, pickling baking purposes for flavouring nature, and also they are edibly as a nutritive factor. They are medicinally used as carminative, stomaching and diuretic. The expressed oil had been used for treatments of asthmac (Muschler, 1912). The seeds oil or powdered seeds are used as antinflammatory (Al-Okbisy *et al*., 1997 and Bhatnagar, 1996), antibacterial (Tesaki *et al*., 1998), antifertility, anticancer and cardiovascular activities (Siddiqui and Sharma, 1996).

Gelani *et al*. (2001) indicated that the crude extract of *N. sativa* seeds exhibits spasmolytic and bronchodilator activities and usefulness for diarrhea and athma in traditional medicine.

Morikawa *et al*. (2004) reported that nigellamines were isolated from the seeds of *N. sativa* decreased triglyceride levels, the arterial blood pressure, blood glucose and cholesterol levels.

El-Malt *et al*. (1998) reported that the analysis of *Nigella sativa* L. seeds showed that they are rich in fat (38.78%), protein (26.25%) and carbohydrates (24.0%).

The volatile oil which contained thymoquinone, and carvacrol, t-anethole and 4-terpeneol- demonstrated respectable radical scavening property. These four constituents and essential oil possessed variable antioxidant activity (Burits and Bucar, 2000)

Mineral nutrients not only have major effects upon flower formation, seed development and yield responses, but also required for chloroplast formation and sink limitations (Terashima and Evans, 1988 and Gerendas and Sattelmacher, 1990). Furthermore, foliar spray of mineral nutrients represents the more quick and efficient method in many cases for supply of these elements (Marschner. 1995 and Bastawisy and Sorial, 1998).

Baier and Baierova (1999) mentioned that the increased nutrients uptake through roots after foliar fertilization has been proved in the majority of field crops and this fact can explain even often-unexpected yield grains being confronted with a small amount of nutrients applied in the farm of spraying.

Many investigations were carried out dealing with N fertilization and its effect on growth and yield of medicinal and aromatic plants (Hussein and Abou El-Magd, 1991; Khan *et al.*, 1992; Abou-Hadid *et al.*, 1993; Omer *et al.*, 1995 and Adam, 2002).

Meanwhile few reports are found in the literature dealing with the effect of some macronutrients applied singly to this plants. Dayanand *et al.* (1999) on *Trigonella foenum-graecum* L:. found that plant height, number of branches, dry matter/plant, seed yield and active ingredients were significantly increased by using sulfur. In addition, increasing sulfur application from 0 up to 450 kg/fed. increased onion plant growth mineral uptake, yield and bulb quality (El-Desuki and Sawan, 2001).

Aly and Ismail (2000) mentioned that guava fruits from trees treated with either $CaCl_2$ were firmer and had higher acid %, TSS%, vitamin C (mg/100 ml juice) and insoluble pectin contents than control fruits.

This work aimed to improve the average yield and quality of *Nigella sativa* plants by using foliar application with some nutrient elements (Ca, S, Mg and urea).

MATERIALS AND METHODS

This study was conducted on *Nigella sativa* L. plants during two successive seasons 2003/2004 and 2004/2005 at the Experimental Farm at Moshtohor, Benha University, to investigate the effects of calcium, sulfur, magnesium at the rate of 200 ppm plus control and combined with four levels of urea at rates of 0.0, 0.5, 1.0 and 1.5% on growth, yield and chemical composition.

Seeds of *Nigella sativa* L. were obtained from the Medicinal and Aromatic Plants Research Section of the Ministry of Agricultural at El-Kanater El-Khairia Experiment Station. The seeds were sown in rows on 15th of November for the two seasons. Space between rows was 50 cm and the distance between hills in rows was 30cm. The seeds were sown as four to six per hill. Plants were thinned to two plants per hill after forty days from sowing the seeds.

Treatments were performed in a split plot design with three replicates, where urea fertilization rates were assigned for the main plot (A) and Ca, S and Mg fertilization for the sub-plot (B). Each replicate contained 30 hills (60 plants)..

Urea was sprayed on the plants after 60, 75 and 90 day from sowing, respectively. While each of Ca, S and Mg was sprayed on the plants after 70, 85 and 100 days from sowing the seeds, respectively. The plants were sprayed till run off. The control plants were sprayed with a tap water. All other agricultural practices required for treated plants were performed whenever needed.

All experimental unit (area) received organic fertilization at the rate of 2 ton/fed. of a manufactured compost.

At harvesting time, the following data were recorded, plant height, (cm), number of branches/plant, fresh and dry weights of herb and seed yield/plant (g) as well as per feddan (kg).

Volatile and fixed oils in the seeds were extracted by the method of Gad *et al.* (1963) and A.O.C.S. (1970). The volatile oil of the second season (mixed oil of replicates per treatment) was subjected to analysis by G.L.C. technique in the Central Laboratory of Fac. Agric., Cairo, Univ..

The total carbohydrates percentage was determined in the herb at the flowering stage according to Herbert *et al.* (1971).

The N,P and K percentages in the dry herb were also determined at flowering stage according to Wilde *et al.* (1985).

Data recorded in both seasons were subjected to analysis of variance according to Snedecor and Cochran (1989) and L.S.D. method was used to compare the different means of treatments.

The chemical analysis of the used soil was shown in Table (1).

Table (1): Physical and chemical analysis of the used soil.

Analysis		First season 2003/2004	Second season 2004/2005
Physical properties			
Soil texture		**Clay**	**Clay**
Clay	**(%)**	47.4	47.6
Silt	**(%)**	29.4	29.5
Sand	**(%)**	21.9	21.6
Chemical analysis			
Ca	**(meq/L)**	2.47	2.49
Mg	**(meq/L)**	2.61	2.60
Na	**(meq/L)**	3.42	3.43
K	**(meq/L)**	3.2	3.5
N	**(meq/L)**	184.5	184.8
P	**(meq/L)**	5.10	5.11
HCO_3	**(meq/L)**	2.50	2.53
Cl	**(meq/L)**	3.07	3.08
Fe	**(ppm)**	18.25	18.29
Zn	**(ppm)**	1.11	1.10
Mn	**(ppm)**	7.55	7.50
Cu	**(ppm)**	13.17	13.15
Organic matter	**(%)**	1.85	1.88
E.C. (mmhos/cm)		1.81	1.82
pH		7.78	7.80

RESULTS AND DISCUSSION

1- Effect of different nutrient treatments on growth characters:

Data illustrated in Tables (2 and 3) showed that, foliar spraying of urea at different levels or different nutrient elements as Ca, S and Mg at 200 ppm for each increased plant height and number of branches/plant compared with control treatment in both seasons. Also combining levels of urea with any nutrient element increased each of plant height and branches number/plant compared with untreated plants in both seasons. The highest value of mean branches number per plant in both seasons was attained by spraying *Nigella sativa* plants with urea at the rate of 1.0% + S at the rate of 200ppm, this treatment gave 56.25 and 52.94% over control plants in the first and second seasons, respectively. The relation between plant height and number of branches/plant of different medicinal and aromatic plants to the response of different nutrient elements was reported by Dayanand *et al.* (1999) on *Trigonella foenum graecum*, Golcz *et al.* (1977) on *Origanum majoranum*, and Magnifico *et al.* (1998) on fennel.

It is also obvious from data listed in Tables (4 and 5) that fresh and dry weights/plant of black cumin plants sprayed with the different nutrient elements exceeded those of the control plants. The increase was parallel to the increase in the applied rate of urea, furthermore the applied different nutrient elements also increased the fresh and dry weights characters compared to the control plants. Significant differences were obtained in most cases in this respect that could show that combining any level of urea with any element was more affective than spraying with any element alone. The most effective treatment in the first season was the application of the highest rate of urea (1.5%) plus Mg at the rate of 200 ppm, this treatment attained 61.67 or 63.89% over control plants for the fresh or dry weight respectively. In the second season, similar observations were reported.

It can be concluded that foliar spraying with nutrient elements increased all growth characters i.e plant height, number of branches and fresh and dry weights of herb/plant over control plants in both seasons with significant differences in most cases. Such increase in the growth characters might be due to that foliar fertilization might play an active role in initiating and development of the new cells and participating in the growth and enlargement of those cells and/or organs, consequently the increase in plant height. Furthermore, fertilizer treatments might stimulate the growth, beside the effect on activating the metabolic activities in plants resulting in heavier weight of herb per plant. Moreover, nitrogen in its combination with nutrient elements, might cause removing of the apical dominance, resulting in more branching per plant. Similar results were obtained by Golcz *et al.* (1977) on *Origanum majoranum*, Magnifico *et al.* (1998) on fennel and Singh and Singh (1999) on *Nigella sativa.* In this respect, urea may improve the permeability of the cuticle and thus favours diffusion conditions as well as urea as a nitrogen source for spraying the foliage of crop plants is characterized by high percentage of nitrogen, high water solubility and it less toxicity to plants. Furthermore, urea spray enhanced the protein biosynthesis in the leaves which may increase the stability of the photosynthetic apparatus and in turn enhance its activity (Moursi *et al.*, 1979).

Also Dayanand *et al.* (1999) on *Trigonella foenum-graecum* L. found that, growth characters in terms of plant height, number of branches, dry matter/plant, seed yield and active ingredients were significantly increased by using sulfur. For Magnesium it is found abundantly in leaves as an atom of Mg is contained by each molecule of chlorophyll and other plant pigments such as xanthophylls and carotenoids. Some Mg is also present in protoplasm in a combined from, while over 70% of the plant Mg is in cell sap are free or combined as inorganic and organic salts (Mengel & Kirkby 1978). They also mentioned that, magnesium plays an important role as an activator of several enzymes, involved in synthesis of nucleic acids, essential for the formation of oils and fats and is associated with the transportation of P within the plant. Mg is also related to the movement of carbohydrates from the leaves to the stems.

2- Effect of different nutrient treatments on yield of *Nigella sativa* plants:

Data in Tables (6 & 7) showed that, the capsules number and weight of seeds/plant were highly significant increased as a result of spraying urea, Ca, S and Mg separately or in combinations. The highest values for capsules number and weight of seeds/plant were obtained as a result of using Mg combined with urea at rate of 1.0 or 1.5% treatment in two seasons. This could be attributed to the favourable effect of these elements on the photosynthetic activity of the leaves which might account much for high accumulation of metabolites in the reproductive organs. In this respect Khan and Sagar (1967) mentioned that fruit yield per plant, is mainly dependent on phytohormones activity and probably also on nutrition in a more indirect way. Also Froster (1973) stated that, the filling process and also the number of fruits per plant depend on the nutritional status of the plant. Moreover, Ashoub *et al.* (2004) on sunflower mentioned that there was a positive and near perfect correlation between seed yield and each of biological yield or oil yield at any regime of magnesium sulphate fertilization.

As for seed yield/feddan data in Table (8) reveal that the application of urea at different rates or any nutrient elements at the rate of 200ppm to *Nigella sativa* plants alone or in combinations resulted in significant increases in seed yield/feddan compared with control plants. The most effective treatment for this character was the highest rate of urea combined with Mg at the rate of 200ppm which increased seed weight/fed. over the control plants by 95.48 and 85.73% in the first and second seasons respectively. In this respect, Singh and Singh (1999) found that, the application of N fertilizer increased seed yield of *Nigella sativa* L. They recommended 60 kg/ha of N fertilizer, for this crop. Also, Wanas (2002) on *Vicia faba* found that Mg was more effective for increasing pod and seed yields/plant as well as the seed index compared with the control plants. This might be due to the favourable effect of these nutrients on photosynthetic activity of leaves which improves the mobilization of photosynthetic materials, having through and direct impact capsule weight and increased weight of seeds (Bottril *et al.*, 1970).

Table (2): Effect of foliar application with Ca, S, Mg and urea on plant height (cm) of *Nigella sativa*, L during the two seasons of 2003/2004 and 2004/2005.

Treatments	First season					Second season				
Urea (%) A / B Nutrient elements (ppm)	0.0	0.5	1.0	1.5	Mean	0.0	0.5	1.0	1.5	Mean
Control	44.0	51.5	54.5	56.5	51.63	47.5	51.0	55.0	58.0	52.88
Ca 200	45.5	53.5	59.5	60.0	54.63	50.0	56.0	64.0	61.0	57.75
S 200	49.0	55.5	60.0	60.5	56.25	53.0	59.0	68.0	59.0	59.75
Mg 200	50.5	56.5	65.0	60.5	58.13	53.0	59.0	65.0	58.0	58.75
Mean	47.25	54.25	59.75	59.38		50.88	56.25	63.0	59.0	

L.S.D. at 5%	First season	Second season
A = Urea levels	2.90	1.93
B = Nutrient elements	1.18	1.22
A x B = Interaction	2.37	2.41

Table (3): Effect of foliar application with Ca, S, Mg and urea on the number of branches/plant of *Nigella sativa*, L. during the two seasons of 2003/2004 and 2004/2005.

Treatments	First season					Second season				
Urea (%) A / B Nutrient elements (ppm)	0.0	0.5	1.0	1.5	Mean	0.0	0.5	1.0	1.5	Mean
Control	8.0	9.0	10.0	5.8	9.50	8.5	9.5	11.0	11.5	10.13
Ca 200	9.0	11.0	12.0	9.5	10.88	9.5	10.5	12.0	12.5	11.13
S 200	8.5	11.0	12.5	10.0	11.00	10.0	11.5	13.0	12.0	11.63
Mg 200	10.0	11.5	12.0	10.5	11.38	10.5	11.5	12.5	11.5	11.50
Mean	8.88	10.63	11.63	9.63		9.63	10.75	12.13	11.88	

L.S.D. at 5%	First season	Second season
A = Urea levels	0.76	0.79
B = Nutrient elements	0.43	0.41
A x B = Interaction	0.85	0.89

Table (4): Effect of foliar application with Ca, S, Mg and urea on herb fresh weight/plant (g) of *Nigella sativa*, L. during the two seasons of 2003/2004 and 2004/2005.

Treatments	First season					Second season				
Urea (%) A / B Nutrient elements (ppm)	0.0	0.5	1.0	1.5	Mean	0.0	0.5	1.0	1.5	Mean
Control	113.5	137.5	150.5	150.5	138.0	117.0	145.0	169.5	170.5	150.5
Ca 200	125.0	149.5	162.0	166.0	150.6	128.0	160.5	184.0	186.5	164.8
S 200	134.5	164.0	176.5	178.5	163.4	151.0	176.0	193.5	204.5	181.3
Mg 200	138.0	166.5	179.0	183.5	166.8	157.5	188.0	205.0	208.5	189.8
Mean	127.8	154.4	167.0	169.6		138.4	167.4	188.0	192.5	

L.S.D. at 5%		
A = Urea levels	11.42	11.71
B = Nutrient elements	9.68	9.74
A x B = Interaction	13.72	13.87

Table (5): Effect of foliar application with Ca, S, Mg and urea on herb dry weight/plant (g) of *Nigella sativa*, L. during the two seasons of 2003/2004 and 2004/2005.

Treatments	First season					Second season				
Urea (%) A / B Nutrient elements (ppm)	0.0	0.5	1.0	1.5	Mean	0.0	0.5	1.0	1.5	Mean
Control	18.0	22.0	24.0	24.0	22.00	19.0	23.0	27.0	27.0	24.00
Ca 200	20.0	24.0	26.0	27.0	24.25	20.0	26.0	30.0	30.5	26.63
S 200	21.0	26.5	28.0	29.0	26.25	24.0	29.0	32.0	33.0	29.50
Mg 200	22.0	26.5	29.0	29.5	26.75	25.0	30.0	33.0	33.5	30.38
Mean	20.38	24.75	26.75	27.38		22.0	27.0	30.5	31.0	

L.S.D. at 5%		
A = Urea levels	2.35	1.95
B = Nutrient elements	1.08	0.92
A x B = Interaction	2.13	2.06

Table (6): Effect of foliar application with Ca, S, Mg and urea on capsules number/plant of *Nigella sativa*, L. during the two seasons of 2003/2004 and 2004/2005.

Treatments	First season					Second season				
Urea (%) A / B Nutrient elements (ppm)	0.0	0.5	1.0	1.5	Mean	0.0	0.5	1.0	1.5	Mean
Control	32.0	39.0	41.0	45.5	39.38	36.0	42.0	46.0	49.5	43.38
Ca 200	36.0	44.5	46.0	50.0	44.13	40.0	47.0	51.0	55.0	48.25
S 200	38.5	48.0	52.0	52.0	47.63	41.0	51.5	55.0	56.5	51.0
Mg 200	38.5	50.0	53.0	53.5	48.75	42.0	53.0	56.0	57.5	52.13
Mean	36.25	45.38	48.0	50.25		39.75	48.38	52.0	54.63	

L.S.D. at 5%	First season	Second season
A = Urea levels	2.88	2.95
B = Nutrient elements	1.58	1.63
A x B = Interaction	3.11	3.04

Table (7): Effect of foliar application with Ca, S, Mg and urea on seeds weight/plant (g) of *Nigella sativa*, L. during the two seasons of 2003/2004 and 2004/2005.

Treatments	First season					Second season				
Urea (%) A / B Nutrient elements (ppm)	0.0	0.5	1.0	1.5	Mean	0.0	0.5	1.0	1.5	Mean
Control	6.86	9.04	11.01	10.13	9.26	7.50	9.61	10.53	11.52	9.79
Ca 200	7.93	9.55	12.33	11.33	10.29	8.60	10.87	12.15	12.89	11.13
S 200	8.30	10.41	12.70	12.77	11.05	8.88	11.65	13.08	13.68	11.82
Mg 200	8.42	10.79	13.41	12.98	11.40	9.38	12.29	13.56	13.93	12.29
Mean	7.88	9.95	12.36	11.80		8.59	11.12	12.33	13.00	

L.S.D. at 5%	First season	Second season
A = Urea levels	1.31	1.55
B = Nutrient elements	0.68	0.69
A x B = Interaction	1.33	1.38

3- Effect of different nutrient treatments on oils productivity of *Nigella sativa* plants:

a- Volatile oil percentage:

Data recorded in Table (9) showed that, volatile oil percentage of black cumin seeds was increased in both seasons due to spraying the plants with any level of urea. The high level of this treatment, (1.5%) was the most affect than low and medium levels or control treatment as attained 6.33 and 7.41% over control plants in the first and second seasons, respectively.

Also, Table (9), revealed that foliar spraying with Ca, S and Mg elements separately or combined with any level of urea caused a significant increase in volatile oil percentage compared with control plants in both seasons except for the case of Ca foliar application for two seasons which slightly increased volatile oil percentage over control treatment. It is clear from the obtained results that the highest rate of urea combined with Mg at the rate of 200ppm gave the best results for the volatile oil percentage, this treatment resulted 18.99 and 17.28% over control plants in the first and second seasons, respectively.

b- Fixed oil percentage:

Data in Table (10) revealed that treating the *Nigella sativa* plants with any level of urea or Ca, S and Mg alone or in combination had significant effects on fixed oil percentage compared with control treatment. The highest value for this character was obtained from spraying black cumin plants with mixture of urea at the rate of 1.5% + Mg at the rate of 200ppm which caused the most appreciable increase of 34.63 and 30.70% over control plants in the first and second seasons, respectively. These results are in line with those of vegetative growth and seed yield since the chemical N fertilizer induced rapidly plant growth which led to more metabolities accumulation involving ``synthesizing of more secondary products as volatile or fixed oil. The effect of application of nutrient elements on oil percentage and production of different aromatic plants was stated by several workers. Mengel & Kirkby 1978, Dayanand *et al.* (1999) on *Trigonella foenum-graecum*, and Ahsoub *et al.* (2004) on sunflower who mentioned that there was a positive and near-perfect correlation between seed yield and each of biological yield or oil yield. Also between biological yield and each of straw yield or oil yield at any regime of magnesium sulphate fertilization.

4- Effect of nutrient elements treatments on total carbohydrates % of *Nigella sativa* plants:

Illustrated data in Table (11) showed that, the total carbohydrates percentage in plant herb was increased by spraying the *Nigella sativa* plants with different nutrient elements compared with control plants in both seasons. In this respect the interaction treatments between high level of urea (1.5%) with any element (Ca, S and Mg) were the most effective compared with all other treatments. The highest value for total carbohydrates percentage were obtained by using high level of urea combined with Mg treatment, this treatment produced 28.35 and 31.05% over control treatment in the first and second seasons respectively.

Table (8): Effect of foliar application with Ca, S, Mg and urea on seeds weight/feddan (kg) of *Nigella sativa*, L. during the two seasons of 2003/2004 and 2004/2005.

Treatments	First season					Second season				
Urea (%) A / B Nutrient elements (ppm)	0.0	0.5	1.0	1.5	Mean	0.0	0.5	1.0	1.5	Mean
Control	274.4	361.6	440.4	405.2	370.4	300.0	384.4	421.2	460.8	391.6
Ca 200	317.2	382.0	493.2	453.2	411.4	344.0	434.8	486.0	515.6	445.1
S 200	332.0	416.4	508.0	510.8	441.8	355.2	466.0	523.2	547.2	472.9
Mg 200	336.8	431.6	536.4	536.4	460.3	375.2	491.6	542.4	557.2	491.6
Mean	315.1	397.9	494.5	476.4		343.6	444.2	493.2	520.2	

L.S.D. at 5%	First season	Second season
A = Urea levels	48.3	52.6
B = Nutrient elements	25.8	27.2
A x B = Interaction	53.6	55.3

Table (9): Effect of foliar application with Ca, S, Mg and urea on seeds volatile oil percentage of *Nigella sativa*, L. during the two seasons of 2003/2004 and 2004/2005.

Treatments	First season					Second season				
Urea (%) A / B Nutrient elements (ppm)	0.0	0.5	1.0	1.5	Mean	0.0	0.5	1.0	1.5	Mean
Control	0.79	0.82	0.81	0.84	0.82	0.81	0.82	0.86	0.87	0.84
Ca 200	0.81	0.83	0.86	0.86	0.84	0.82	0.83	0.87	0.89	0.85
S 200	0.83	0.85	0.89	0.90	0.87	0.85	0.86	0.88	0.93	0.88
Mg 200	0.84	0.86	0.91	0.94	0.89	0.85	0.86	0.90	0.95	0.89
Mean	0.82	0.84	0.87	0.89		0.83	0.84	0.88	0.91	

L.S.D. at 5%	First season	Second season
A = Urea levels	0.07	0.05
B = Nutrient elements	0.04	0.03
A x B = Interaction	0.09	1.08

Table (10): Effect of foliar application with Ca, S, Mg and urea on fixed oil percentage of *Nigella sativa*, L. seeds during the two seasons of 2003/2004 and 2004/2005.

Treatments	First season					Second season				
Urea (%) A / B Nutrient elements (ppm)	0.0	0.5	1.0	1.5	Mean	0.0	0.5	1.0	1.5	Mean
Control	21.60	26.00	26.80	27.68	25.52	22.8	25.15	28.15	28.30	26.10
Ca 200	22.31	26.41	27.00	28.15	25.97	23.43	26.12	29.10	28.66	26.83
S 200	22.90	26.52	27.03	28.50	26.24	23.65	27.15	28.66	23.20	27.17
Mg 200	24.70	27.00	27.56	29.08	27.09	24.19	28.15	29.20	29.80	27.84
Mean	22.88	26.48	27.10	28.35		23.52	26.64	28.78	28.99	

L.S.D. at 5%	First season	Second season
A = Urea levels	2.18	2.12
B = Nutrient elements	0.35	0.30
A x B = Interaction	3.85	3.78

Table (11): Effect of foliar application with Ca, S, Mg and urea on total carbohydrates percentage in the leaves of *Nigella sativa*, L. during the two seasons of 2003/2004 and 2004/2005.

Treatments	First season					Second season				
Urea (%) A / B Nutrient elements (ppm)	0.0	0.5	1.0	1.5	Mean	0.0	0.5	1.0	1.5	Mean
Control	22.01	21.33	22.07	23.05	22.12	22.93	22.16	22.90	23.75	22.94
Ca 200	24.18	22.08	24.13	26.38	24.19	25.12	22.90	25.16	27.09	25.07
S 200	25.04	22.83	25.25	27.14	25.07	25.63	23.40	25.52	27.01	25.39
Mg 200	27.16	23.77	25.57	28.25	26.19	28.25	24.38	28.08	30.05	27.69
Mean	24.60	22.50	24.26	26.21		25.48	23.21	25.42	36.98	

L.S.D. at 5%	First season	Second season
A = Urea levels	N.S	N.S
B = Nutrient elements	0.04	0.06
A x B = Interaction	0.11	0.14

These results are in agreement with those obtained by Wanas (2002) on *Vicia faba* who found that K and Mg were more effective for increasing pod and seed yields/plant as well as the seed index compared with the control plants. Furthermore, seed contents of N,P,K and crude protein, reducing and total sugars were also increased with different applied nutrients.

5- Effect of different nutrient treatments on minerals content of *Nigella sativa* plants:

The results in Tables (12, 13 and 14) revealed that, foliar application of urea at the different levels increased N and P % in the plant leaves compared with untreated plants in both seasons while the potassium content in plant leaves was markedly decreased with the application of urea at rates of 1.0 and 1.5% compared with control plants in both seasons.

Meanwhile, foliar application of Ca, S or Mg at 200 ppm as a nutrient element separately or combined with any level of urea increased N, P and K % in the leaves. The highest value for N% was attained by using 1.5% urea + 200 ppm Mg treatment which gave 35.82 and 30.56% over control plants in the first and second seasons, respectively.

However, the highest value of P% in plant leaves was attained by treating plants with 1.0% urea + 200 ppm Mg in the first season and 1.0% urea + 200ppm S treatment in the second one.

Table (14) showed that the maximum value of K% was found as a result of spraying Mg + 0.5% urea in the first season but in the second season, the applied 1.5% urea combined with 200 ppm of Mg gave the highest concentration of potassium in the leaves. Similar results were obtained by El-Desuki and Sawan (2001) on onion and Dayanand *et al.* (1999) on *Trigonella foenum graecum*.

El-Desuki and Sawan (2001) showed that the onion plant growth, NPK uptake, yield and bulb quality were increased with increasing level of NPK fertilizers. Increasing sulphur application from 0 up to 450 kg S/fed. caused an increase in growth, mineral uptake, yield and bulb quality.

In general the highest rate of urea (1.5%) + 200ppm of Mg resulted in better growth, seed yield, volatile oil, fixed oil and NPK contents of *Nigella sativa* plants.

6- Volatile oil composition:

The gas liquid chromatography determination of volatile oil obtained from the seeds of *Nigella sativa* L. plants was shown in Table (15) and Figs. (1:16). The results revealed the presence of each of $\propto$, β pinene, limonene, borniol and thymoquinone compounds in the volatile oil. Thymoquinone, is an important bioactive compound, (Mozaffari *et al.*, 2000).

Table (12): Effect of foliar application with Ca, S, Mg and urea on nitrogen percentage in the leaves of *Nigella sativa*, L. during the two seasons of 2003/2004 and 2004/2005.

Treatments	First season					Second season				
Urea (%) A / B Nutrient elements (ppm)	0.0	0.5	1.0	1.5	Mean	0.0	0.5	1.0	1.5	Mean
Control	2.01	2.45	2.62	2.65	2.43	2.16	2.52	2.69	2.74	2.53
Ca 200	2.15	2.53	2.68	2.70	2.52	2.25	2.58	2.75	2.78	2.59
S 200	2.19	2.53	2.70	2.72	2.54	2.32	2.61	2.75	2.82	2.63
Mg 200	2.20	2.55	2.70	2.73	2.55	2.32	2.62	2.76	2.82	2.63
Mean	2.14	2.52	2.68	2.70		2.26	2.58	2.74	2.79	

L.S.D. at 5%		
A = Urea levels	0.13	0.14
B = Nutrient elements	0.09	0.11
A x B = Interaction	0.16	1.12

Table (13): Effect of foliar application with Ca, S, Mg and urea on phosphorous percentage in the leaves of *Nigella sativa*, L. during the two seasons of 2003/2004 and 2004/2005.

Treatments	First season					Second season				
Urea (%) A / B Nutrient elements (ppm)	0.0	0.5	1.0	1.5	Mean	0.0	0.5	1.0	1.5	Mean
Control	0.264	0.312	0.313	0.307	0.299	0.283	0.322	0.331	0.319	0.314
Ca 200	0.325	0.316	0.318	0.320	0.320	0.344	0.329	0.347	0.338	0.340
S 200	0.345	0.321	0.327	0.335	0.332	0.345	0.341	0.350	0.341	0.344
Mg 200	0.346	0.342	0.350	0.323	0.340	0.345	0.345	0.342	0.342	0.343
Mean	0.320	0.323	0.327	0.321		0.329	0.334	0.343	0.335	

L.S.D. at 5%		
A = Urea levels	0.04	0.05
B = Nutrient elements	0.03	0.03
A x B = Interaction	0.07	0.09

Table (14): Effect of foliar application with Ca, S, Mg and urea on potassium percentage in the leaves of *Nigella sativa*, L. during the two seasons of 2003/2004 and 2004/2005.

Treatments	First season					Second season				
Urea (%) A / B Nutrient elements (ppm)	0.0	0.5	1.0	1.5	Mean	0.0	0.5	1.0	1.5	Mean
Control	2.27	2.30	2.26	2.23	2.27	2.31	2.33	2.25	2.20	2.27
Ca 200	3.59	3.61	3.58	3.57	3.59	3.69	3.72	3.67	3.61	3.67
S 200	3.58	3.82	3.79	3.78	3.74	3.76	3.79	3.76	3.80	3.78
Mg 200	3.63	3.84	3.61	3.77	3.71	3.74	3.82	3.80	3.85	3.80
Mean	3.27	3.39	3.31	3.34		3.38	3.42	3.37	3.37	

L.S.D. at 5%	First season	Second season
A = Urea levels	0.08	0.11
B = Nutrient elements	0.03	0.06
A x B = Interaction	0.20	0.21

Table (15): Effect of foliar application with Ca, S, Mg and urea on the identification of constituents of *Nigella sativa*, L. seeds volatile oil obtained from G.L.C. chromatograms and calculated as relative percentages in the second season.

Treatments		α-Pinene	β-Pinene	d.Limonene	Borniol	Thymoquinone
1	Control	13.46	5.81	32.09	1.42	23.01
2	Ca at rate of 200	18.78	7.86	37.22	2.06	7.06
3	S at rate of 200	-	-	30.33	3.79	3.73
4	Mg at rate of 200	16.36	7.32	31.77	2.45	14.80
5	Urea at rate of 0.5 g/L.	16.83	4.00	13.75	29.02	18.11
6	Ca + Urea	12.06	5.49	31.66	13.66	8.78
7	S + Urea	13.51	6.44	27.38	14.39	7.61
8	Mg + Urea	-	-	17.87	9.30	38.37
9	Urea at rate of 1.0 g/L.	6.93	3.78	20.15	9.07	8.31
10	Ca + urea	10.75	4.06	36.74	14.31	9.17
11	S + Urea	15.93	6.56	44.90	16.54	8.80
12	Mg + Urea	7.34	3.89	24.16	11.77	32.17
13	Urea at rate of 1.5 g/L.	13.96	8.29	31.86	16.98	13.17
14	Ca + urea	17.10	4.05	13.82	25.05	17.77
15	S + Urea	3.45	5.67	13.78	12.68	20.15
16	Mg + Urea	5.92	2.03	22.42	11.41	22.07

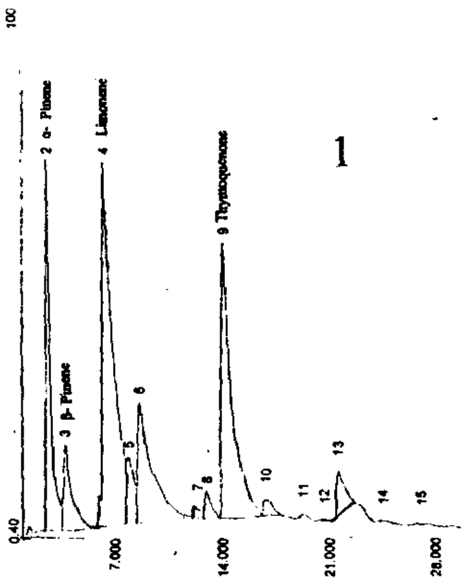

Fig. (1): GLC chromatogram of *Nigella sativa* oil distilled from seed of control plant.

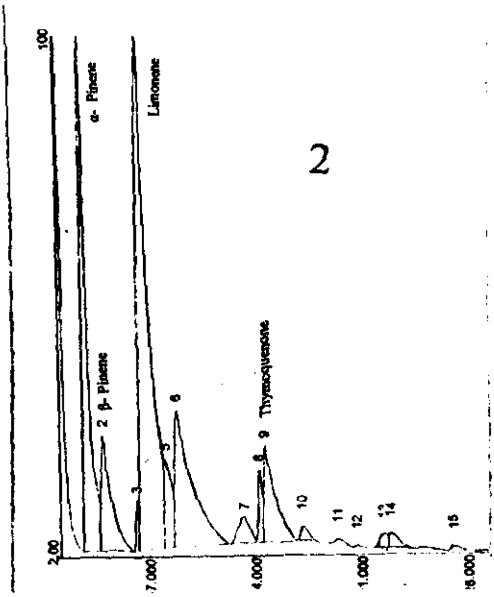

Fig. (2): GLC chromatogram of *Nigella sativa* oil distilled from seed of plant treated by calcium.

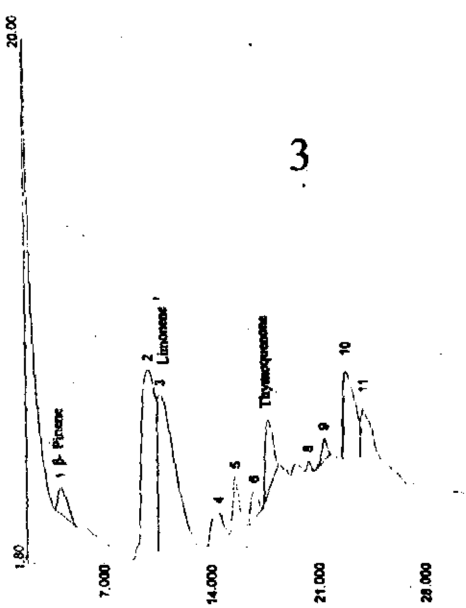

Fig. (3): GLC chromatogram of *Nigella sativa* oil distilled from seed of plant treated by sulpher.

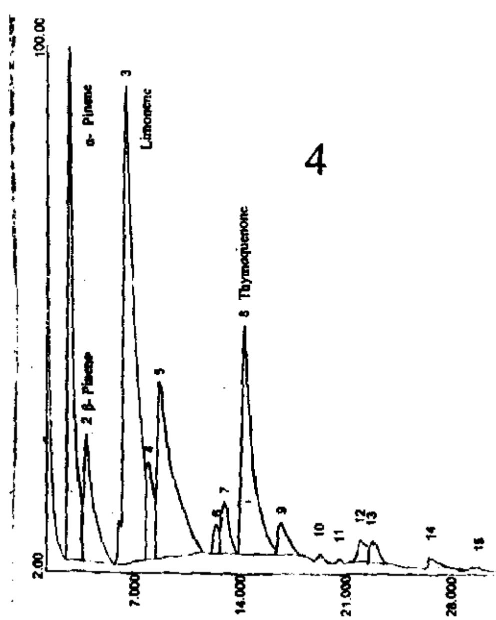

Fig. (4): GLC chromatogram of *Nigella sativa* oil distilled from seed of plant treated by magnesium.

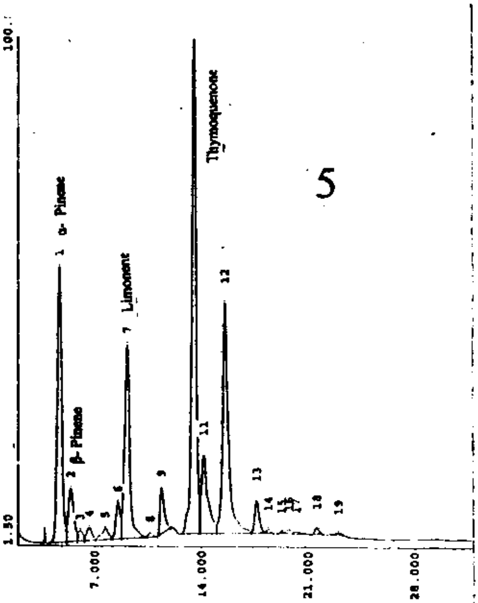

Fig. (5): GLC chromatogram of *Nigella sativa* oil distilled from seed of plants treated by urea at 0.5g/L, rate.

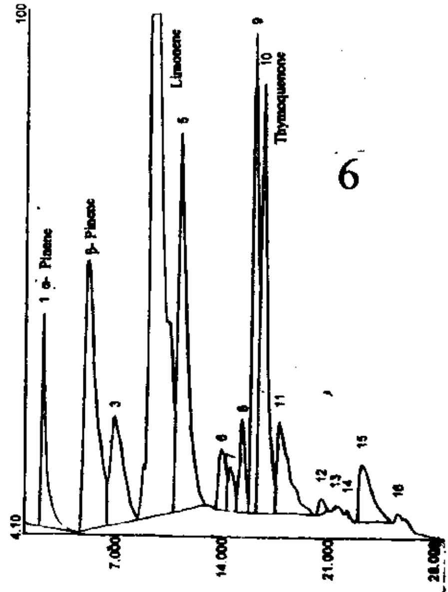

Fig. (6): GLC chromatogram of *Nigella sativa* oil distilled from seed of plants treated by urea at rate of 0.5g/L. combined with calcium.

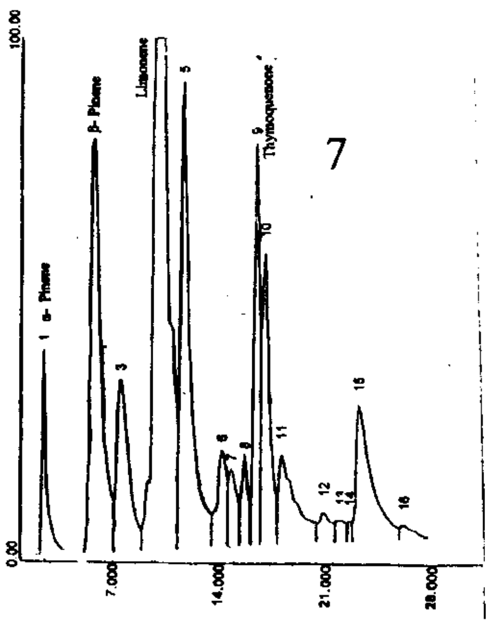

Fig. (7): GLC chromatogram of *Nigella sativa* oil distilled from seed of plants treated by urea at rate of 0.5g/L. combined with sulpher

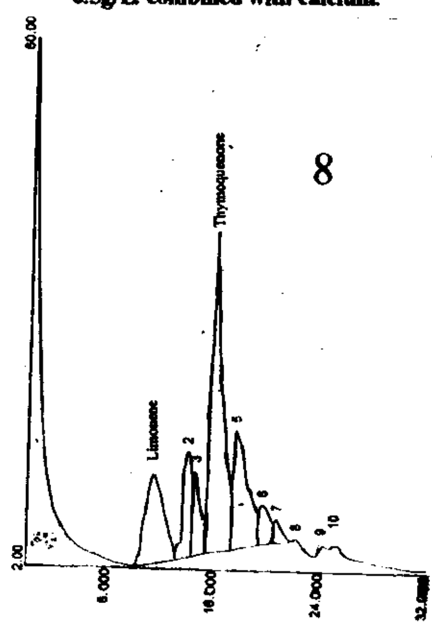

Fig. (8): GLC chromatogram of *Nigella sativa* oil distilled from seed of plants treated by urea at rate of 0.5g/L. combined with magnesium.

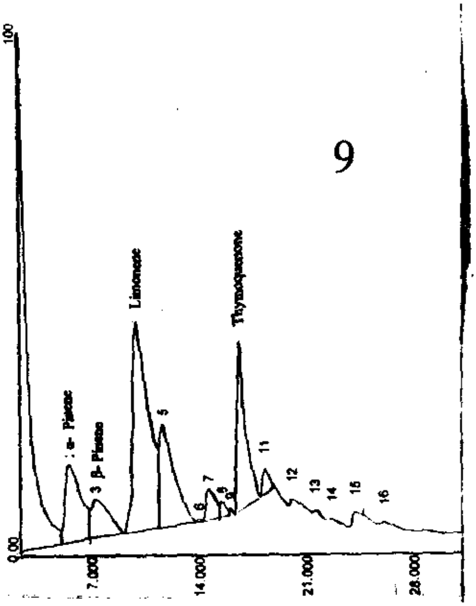

Fig. (9): **GLC chromatogram of *Nigella sativa* oil distilled from seed of plants treated by urea at 1.0g/L, rate.**

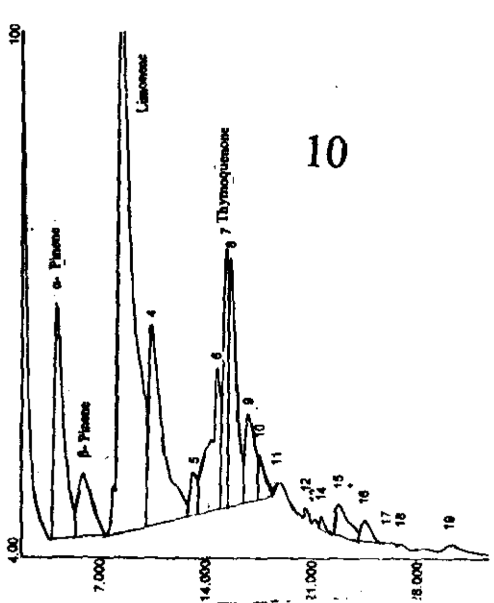

Fig. (10): **GLC chromatogram of *Nigella sativa* oil distilled from seed of plants treated by urea at rate of 1.0g/L. combined with calcium.**

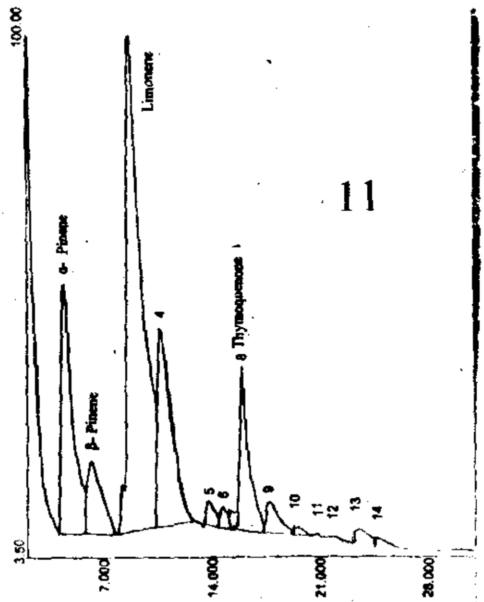

Fig. (11): **GLC chromatogram of *Nigella sativa* oil distilled from seed of plants treated by urea at rate of 1.0g/L. combined with sulpher.**

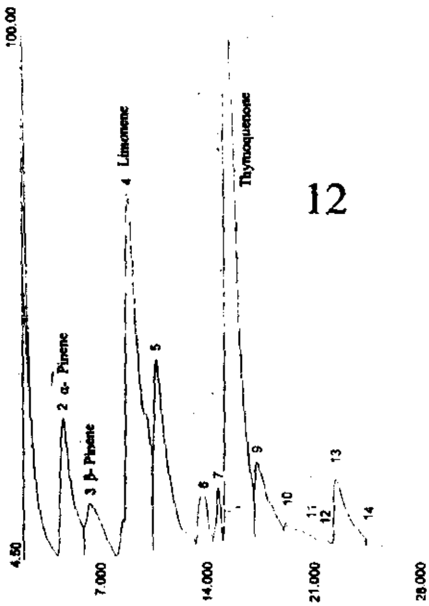

Fig. (12): **GLC chromatogram of *Nigella sativa* oil distilled from seed of plants treated by urea at rate of 1.0g/L. combined with magnesium.**

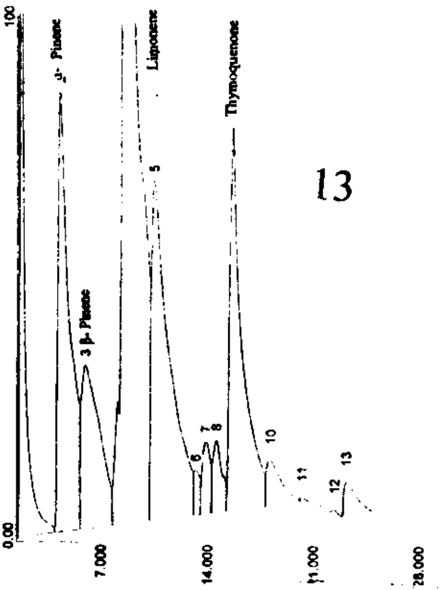

Fig. (13): **GLC chromatogram of *Nigella sativa* oil distilled from seed of plants treated by urea at 1.5g/L rate.**

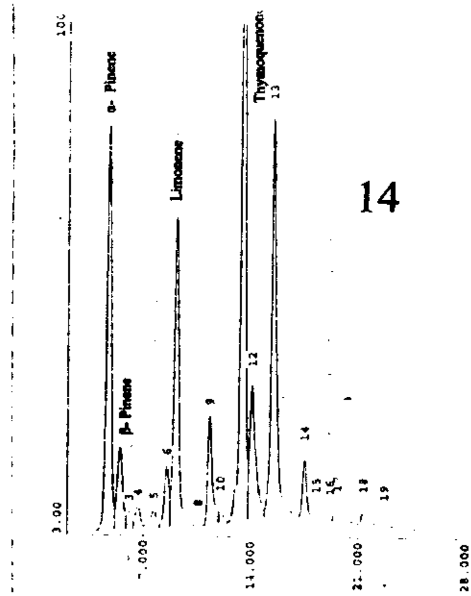

Fig. (14): **GLC chromatogram of *Nigella sativa* oil distilled from seed of plants treated by urea at rate of 1.5g/L combined with calcium.**

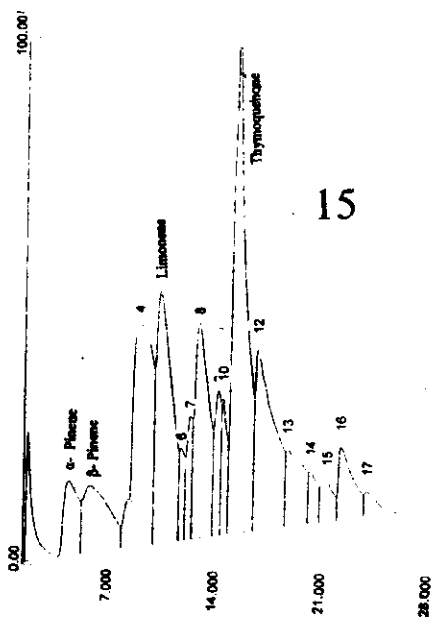

Fig. (15): **GLC chromatogram of *Nigella sativa* oil distilled from seed of plants treated by urea at rate of 1.5g/L combined with sulpher.**

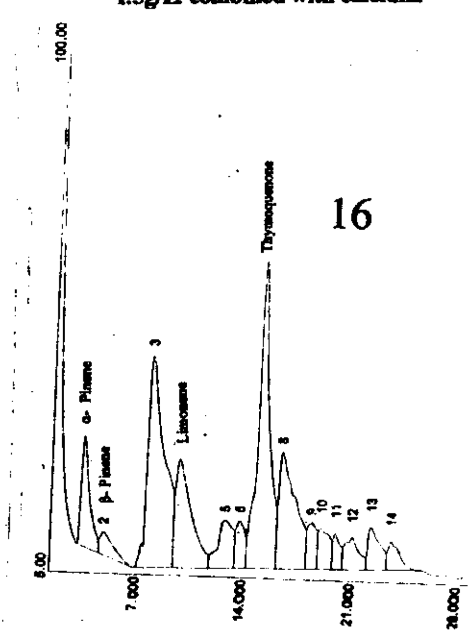

Fig. (16): **GLC chromatogram of *Nigella sativa* oil distilled from seed of plants treated by urea at rate of 1.5g/L combined with magnesium.**

Data in the same Table reveal that, the application of urea at different concentrations as well as S and Mg at the rate of 200 ppm decreased the limonene content of the oil. However, spraying Ca alone and Ca or S combined with urea at the rate of 1.0% exhibited an opposite trend, as gave a pronounced increase, reaching 37.22, 36.74 and 44.9%, respectively compared to control plants. It can be summarized that limonene content in the seeds oil was not affected by the different rates of urea. These results are in agreement with those obtained with Kandil (2002). Data demonstrated also that spraying plants with the different nutrients decreased thymoquinone percentage in volatile oil compared with control plants. The highest percentage of thymoquinone was obtained from the plants treated with urea at 0.5 or 1.0% combined with Mg at the rate of 200 ppm, the thymoquinone values for these treatments were 38.57 and 32.17%, while was only 23.01% for control treatment. The data in the same Table (15) and Figs. (1:16) clear that the borniol values in volatile oil were more increased by spraying *Nigella sativa* plants with urea, Ca, S and Mg as separately or combined, the highest value for this character was attained by using urea at rate (0.5%).

Mineral nutrients not only have major effects upon flower formation and yield responses but also required for chloroplast formation and sink limitation (Terashima and Evans 1988). Foliar spray of mineral nutrients represents the more quick and efficient method in many cases for mineral elements supply (Bastawisy and Sorial 1998). The results are in agreement with those obtained by Atta *et al.* (1999 who stated that N application little effect on oil content of sweet fennel (var. dulce).

REFERENCES

A.O.C.S. (1970): Official and Tentative Methods of American Oil Chemists Society 11th Ed. Washington. D.C.

Abou-Hadid, A.F.; Hussein, M.S. and El-Soeid, H.M. (1993): Heavy metal composition of leafy vegetables as influenced by different nitrogen sources. Egypt. J. Hort., 20(2):205.

Adam, S.M. (2002): Growth and productivity of *Vicia faba* plants as influenced by some different bio- and chemical nitrogen fertilizers. Egypt, J. Hort., 29: 83-98.

Al-Okbisy, S.H.; Ammar, .N.M. and Abd El-Kader, M.A. (1997): Studies of some biochemical, nutritional and anti-inflammatory effects of *Nigella sativa* seeds. Egypt. J. Pharm, Sci. 38,4.

Aly, E.Z. and Ismail, H.A.. (2000): Effect of preharvest GA3, CaCl2 and boron treatments on quality and enzymatic browning in Balady guava fruits. Annals of Agric. Sc., Moshtohor, 38(2): 1101-1108.

Ashoub, M.A.; Gohary, M.N.; Shahin, M.M. and Hanna, L.I. (2004): Irrigation intervals and magnesium treatments in relation to sunflower yield. Abstracts 9th Conf. Agric. Dev. Res. Fac. Agric. Ain Shams Univ. Cairo, Egypt. (2004).

Atta, A.M.A., Khattab, M.E., Lasheene, Z. and Abdallah, M.M. (1999): Fennel production as a new vegetable and aromatic crop in Egypt. Effect of variety, selected planting distance and fertilizing with different nitrogen sources on fennel swollen base yield quality and oil constituents. Arab Universities J. of Agric. Sci., 7(1): 223-246.

Baier, J. and Baierova, V. (1999): Influence of foliar fertilizers on nutrient uptake through roots. Second International Workshop on Foliar Fertilization Banjkok, Thailand 4-10 April 1999 (in press).

Bastawisy, M.H. and Sorial, M.E. (1998): The physiological role of spraying some mineral nutrients on the growth, flowering, abscission, endogenous auxin and yield of faba bean. J. Agric. Res. Zagazig Univ., 25(2): 271-284.

Bhatnagar, U. (1996): Antifertility activity of *Nigella sativa* Linn in albino rats. Ind. J. Environments and Toxicology, 6 (2): 56.

Bottrill, D.E.; Possingham, J.V. and Kriedemann, P.E. (1970): The effect of nutrients deficiencies on photosynthesis and respiration in spinach. Plant and Soil. 32,. 424.

Burits, M. and Bucar, F. (2000): Antioxidant activity of *Nigella sativa* essential oil. Phytother Res. Aug.; 14(5): 323-8.

Dayanand-Sharma, O.P.; Fageria, M.S. and Mani, R. (1999): Influence of phosphorus and sulphur on nutrient uptake and quality of seed production of fenugreek (*Trigonella foenum-graeum* L.) cvRmt-1 Indian Journal of Arecanut species and Medicinal Plants, 14: 125-126.

El-Desuki, M. and Sawan, Omaima M.M. (2001): Effect of mineral fertilizers and sulphur application on growth, yield and quality of onion bulb. Annals of Agric. Sc., Moshtohor, 39(1): 617-628.

El-Malt, E.A.; Ghazy, M.A.; Metry, S.W. and Naroz, A.Y. (1998): Chemical analysis of *Nigella sativa* seeds grown in Minia Governorate Egypt. J Agric. Sci. Mansoura Univ., 23(3): 1303-1318.

Froster, H. (1973): Relationship between the nutrition and the appearance of green back and blossom-end rot in tomato fruits. Acta Hort, 29: 319-326.

Gad, A.M.; El-Dakhakhny, M. and Hassan, M. (1963): Studies on the chemical constituents of Egyptian *Nigella sativa* L. oil. Plant a Medica, 11: 13.

Gelani, A.H.; Aziz, N.; Khurram, I.M.; Chaudhary, K.S.; Iqbal, A. (2001): Bronchodilator, spasmolytic and calcium antagonist activities of *Nigella sativa* seeds (Kalonji): a traditional herbal product with multiple medicinal uses. J. Pak. Med Assoc. Mar; 51(3): 115-20.

Gerendas, J. and Sattelmacher, B. (1990): Influence of nitrogen form and concentration on growth and ionic balance of tomato and potato. In Plant Nutrition. Physiology and Application (M.L. van Beusichen, ed.), p. 33-37. Kluwer Academic, Dordrecht.

Golcz, L., Kordana, S.; Nowak, K. and Zalecki, R. (1977): Effect of nitrogen and calcium fertilization on herbage yield and nutrient uptake by marjoram. Herba Polonica, 23(4): 313-324.

Herbert, D.; Philpps, P.J. and Strange, R.E. (1971): Determination of total carbohydrate. Methods in Microbiol, 58: 209-344.

Hussein, M.S. and Abou El-Magd, M.M. (1991): Effect of nitrogenous fertilization on the growth, vegetative yield, seed yield and oil content of sweet fennel *Foeniculum vulgare* var Dulce. African J. Agric. Sci., 18(1): 135.

Kandil, M.A.M.H. (2002): The effect of fertilizers for conventional and organic farming on yield and oil quality of fennel (*Foeniculum vulgar* Mill.) in Egypt. Von Der Gemeinsamen Naturwissenschaftilichen Fakulät der Technischen Universität Carolo-Wilhelmina.

Khan, A.A. and Sagar, G.R. (1967): Translocation in tomato. The distribution of the products of photosynthesis of the leaves of tomato plant during the phase of food production. Hort. Res, 7: 60-69.

Khan, M.M.A.; Samiullah, S.H. and Afridi, M.M.R.K. (1992): Yield and quality of fennel (*Foeniculum vulgare* Mill.) in relation to basal and foliar application of nitrogen and phosphorus. J. Plant Nutrition, 15(11): 2505-2515.

Magnifico, V.; Parente, A. and Tallarico, R. (1998): Nutritional requirements and the use of fertilizers in fennel. Informatore Agrario; 54(31): 41-43.

Mengel, K. and Kirkby, E.A. (1978): Principles of Plant Nutrition of Citrus. Soil Sci. Soc. Amer, Proc., 21: 85-88.

Marschner, H. (1995): Mineral Nutrition of Higher Plants 2nd Ed., Academic Press. Pub., New York. (USA).

Morikawa, T.; Xu, F.; Ninamiya, K; Matsuda, H. and Yoshikawa, M. (2004): Nigellamines A3, A4, A5 and C, new dolabellane type diterpene alkaloids, with lipid metabolism promoting activities from the Egyptian medicinal food black cumin. Chem. Pharm. Bull. (Tokyo). Apr., 52(4): 494-7.

Moursi, M.A.; Nour El-Din, N.A.; El-Bagoury, O.H.; Saad, A.O.M. and Ashour, N.I. (1979): Photosynthetic apparatus as influenced by spraying maize plants with urea Egypt. J. Agron, 4(1): 43-54.

Mozaffari, F.S.; Ghorbanli, M.; Babal, A. and Sepehr, M.F. (2000): The effect of water stress on the seed oil of *Nigella sativa* L. J. Essential Oil Research, 12(1): 36-38.

Muschler, R. (1912): "Annual Flora of Egypt" R. Fried Lander. Un Sohn, Berlin.

Omer, E.A.; Ibrahim, M.E.; Razin, A.M. and Ahmed, S.S. (1995): Effect of spacing, nitrogen and potassium fertilization on *Silybum marianum*, L. cultivated in newly reclaimed lands. Egypt. J. Hort, 22: 97-108.

Siddiqui, A.A. and Sharma, R.K.R. (1996): Chemical importance of *Nigella sativa* Linn. Harndard-Medicus, 39(4): 38.

Singh, S.K. and Singh, S. (1999): Response of nigella (*Nigella sativa* L.) to nitrogen and phosphorus. Crop Research (Hisar), 18(3): 478-479.

Snedecor, G.W. and Cochran, W.G. (1989): Statistical Methods 8th Ed., Iowa State Univ., Press, Iowa, U.S.A.

Terashima, I. and Evans, J.R. (1988): Effects of light and nitrogen nutrition on the organization of the photosynthetic apparatus in spinach. Plant Cell Physiol, 29: 143-155.

Tesaki, S., Tanab, S.; Ono, H., Fukushi, E., Kawabata, J. and Watanake, M. (1998): 4- Hydroxy-3- nitrophenyl acetatic and sinapic acids as antibacterial compounds from mustard seeds. Bio Science, Biotechnology and Biochemistry, 62(5): 998.

Wanas, A.L. (2002): Response of faba bean (*Vicia faba* L.) plants to foliar spray with some nutrients. Annals of Agric. Sc., Moshtohor, 40(1): 243-258.

Wilde, S.A.; Corey, R.B.; Lyer, J.G. and Voigt, G.R. (1985): Soil and Plant Analysis for Tree Culture 3rd Ed. Oxford and IBH Publishing Co. New Delhi.

تأثير الرش بالكالسيوم والكبريت والماغنسيوم واليوريا على النمو والمحصول والتركيب الكيماوى لنبات حبة البركة

عبدالله صالح محمد الخياط*، حسناء عبالحسيب حسن جوده**

* قسم البساتين – كلية الزراعة بمشتهر – جامعة بنها.

** الهيئة القومية للرقابة والبحوث الدوائية.

- أجريت الدراسة بمزرعة التجارب والبحوث الزراعية بكلية الزراعة بمشتهر – جامعة بنها خلال الموسمين ٢٠٠٣/٢٠٠٤، ٢٠٠٤/٢٠٠٥ لدراسة تأثير الرش ببعض العناصر المغذية (الكالسيوم، الكبريت، والماغنسيوم بتركيز ٢٠٠ جزء فى المليون بالإضافة الى الكنترول والتفاعل مع تركيزات مختلفة من اليوريا (صفر، ٠,٥، ١,٠، ١,٥%) على النمو الخضرى ومحصول البذور والتركيب الكيماوى لنباتات حبة البركة.
- وقد إتبع تصميم القطع المنشقة مرة واحدة فى ثلاث مكررات حيث وزعت تركيزات اليوريا فى القطع الرئيسية ومعاملات التغذية بالكالسيوم – الكبريت – الماغنسيوم فى القطع المنشقة وتم أخذ بيانات النمو والمحصول وبعض التحاليل الكيماوية مثل إرتفاع النبات والوزن الطازج والجاف للعشب وعدد الأفرع ومحصول البذور للنبات الواحد والفدان وتم تقدير النسبة المئوية للزيت الطيار والزيت الثابت والنسبة المئوية لمكونات الزيت الطيار وأيضا النسبة المئوية لكل من النيتروجين – الفوسفور – البوتاسيوم والكربوهيدرات الكلية فى العشب، وكانت أهم النتائج المتحصل عليها مايلى:–
- أدى رش نباتات حبة البركة بكل من التركيزات المختلفة لليوريا أو الكالسيوم – الكبريت – الماغنسيوم الى زيادة القياسات المختلفة مثل طول النبات والوزن الطازج والجاف للعشب للنبات وعدد الكبسولات ومحصول البذور للنبات وللفدان، كما أدت الى زيادة النسبة المئوية للزيت الطيار والزيت الثابت فى البذور وكذلك أدت الى زيادة النسبة المئوية لعناصر ن، فو، بو والكربوهيدرات الكلية فى العشب وذلك بالمقارنة بنباتات الكنترول فى كلا الموسمين.
- حققت كل معاملات التفاعل بين التركيزات المختلفة لليوريا مع الكالسيوم أو الكبريت أو الماغنسيوم زيادة معنوية فى كل صفات النمو والمحصول، كما أدت الى زيادة النسبة المئوية من الزيت الطيار أو الزيت الثابت فى البذور وكذلك النسبة المئوية

للنيتروجين والفوسفور والبوتاسيوم والكربوهيدرات الكلية فى العشب وذلك بالمقارنة بنباتات الكنترول.

- أعلى القيم لمحصول البذور للنبات الواحد أو للفدان وكذلك النسبة المئوية للزيت الطيار والزيت الثابت تحصل عليها برش النباتات باليوريا بتركيز ١,٥% + الماغنسيوم بتركيز ٢٠٠ جزء فى المليون.
- أدى التحليل الكروماتوجرافى للزيت الطيار لبذور نباتات حبة البركة الى وجود المكونات الأتية: الفابينين، بيتابينين، د- ليمونين ، بورنيول وكذلك الثيموكونين. وقد أعطت معاملة النباتات بالماغنسيوم + اليوريا بتركيز ٠,٥% الى الحصول على أكبر نسبة لمركب الثيموكونين فى الزيت الطيار وذلك بالمقارنة بالمعاملات الأخرى فى هذه التجربة.
- ومن ذلك يوصى بإمداد نباتات حبة البركة بالمستوى المرتفع لليوريا (١,٥%) بالإضافة الى الماغنسيوم بتركيز ٢٠٠ جزء فى المليون وذلك للحصول على أفضل جودة للنمو الخضرى وأعلى إنتاجية من محصول البذور والزيت.