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PRODUCTION OF NIGELLA SATIVA, L. AS AFFECTED BY APPLICATION OF ORGANIC VERSUS MINERAL FERTILIZATION

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ABSTRACT

A field experiment was conducted to study the effect of NPK as a chemical fertilizer versus the organic fertilizer El-Takamolia (sugar can industry waste) on *Nigella sativa*, L. during two successive winter seasons. El-Takamolia was utilized at rate of 4 and 8 tons/feddan. Both the recommended NPK mineral fertilizer and unfertilized plants were utilized as control treatments. The highest level of El Takamolia fertilizer (8 ton /fed) was the best one for improving vegetative growth parameters compared to the other treatments in both seasons. The data revealed a significantly enhanced seed yield per plant and per feddan in addition to increase the number of capsules as a result of using El-Takamolia at rate of 8 tons/feddan comparing with the NPK treatments. Application of any fertilizer treatment increased oils production (volatile and fixed oil percentages and yields) as compared to the untreated control. Also, Leaf content of both chlorophyll a and b were increased. An increase in leaf and seed contents of carbohydrates and leaf content of phosphorus and potassium were detected. It could be concluded that El- Takamolia organic fertilizer may be efficiently used in the production of *Nigella sativa*, L.

Keywords: *black seed, filer mud cake, habbet el baraka, NPK, plant industry waste, sugar can industry*

INTRODUCTION

***Nigella sativa*, L. is an annual herbaceous plant belongs to family Ranunculacea and widely distributed in countries bordering the Mediterranean Sea, middle Europe and western Asia. It has several names such as: black seed, black cumin and habbet el-baraka. The economical importance of black cumin plants is attributed to its seeds which contain valuable oils. The seeds contain 30 - 35% of oils (fixed and volatile oil) which have several uses in pharmaceutical and food industries. The seeds have a potential reducing effect on blood level of both glucose and cholesterol, and can be used as complementary therapies in diabetes mellitus (Bamosa *et al*., 2010; Badar *et al*., 2017).**

Mineral fertilizers have played an important role in crop production over the past century. However, current interests in the environmental and human health issues and in the sustainable agriculture oriented development are not in favor of intensive chemical-dependent crop production system (Abdel-Monem *et al*., 1997). Organic production, therefore, has received a great attention especially for production of food crops including medicinal plants and in particular for exportation. A research team from Assiut University has formulated a new organic fertilizer using filter mud cake and vinasse (industry waste of sugar companies in Egypt) at 2:1 ratio. This fertilizer was enriched with P, K and S to formulate the so-

called El-Takamolia fertilizer which proved to be of a great benefit as an organic fertilizer for some crops such as sugar cane, wheat and corn plantations (Hassanein, 1999).

The present investigation was carried out to evaluate the use of El Takamolia fertilizer at two different rates as an organic fertilizer compared to recommended mineral fertilizer (NPK) on the growth and seed and oil yield of *Nigella sativa,* L.

MATERIALS AND METHODS

The present study was carried out for two successive seasons at the Floriculture Experimental Farm, Faculty of Agriculture Assiut University to evaluate using of El Takamolia fertilizer (as organic fertilizer) at two different rates, compared to the recommended chemical fertilizer (NPK) on vegetative growth, fruit yield and oil yield of Nigella sativa, L. plant. Seeds of Nigella sativa L were obtained from local farmers and EL-Takamolia manure was obtained from the Sugarcane Factory in Abo Korkas, EL Minia governorate, Egypt.

PRACTICES AND EXPERIMENTAL DESIGN

The experiment was arranged in a complete randomized block design (CRBD) with four replicates. EL-Takamolia fertilizer was added at rates of 0, 4 and 8 tons /feddan and the recommended chemical fertilizer (N, P, K), was added as ammonium nitrate 180 kg /fed (33.5%N), calcium super phosphate 300 kg/fed (15.5% P_2O_5) and potassium sulphate 100 kg /fed (48% K_2O).

DATA RECORDED

At capsule ripening stage, 20 plants were randomly collected from each treatment per replicate for estimating the following parameters:

- **a- Vegetative characteristics: plant height (cm), branch number per plant, stem diameter (cm), plant fresh and dry weight.**
- **b- Fruit parameters: capsule number per plant , number of seeds per capsule, seed yield (gm) per plant and seed yield (kg per feddan)**
- **c- Chemical analysis:**
  Oil percentage (Volatile and fixed oil)
  Plant pigments (chlorophyll *a*, *b* and total carotenoids),
  Total carbohydrates (% of dry leaves and seeds weight), and N, P and K (% in dried leaves)

STATISTICAL ANALYSIS

Data were subject to statistical analysis of variance and means were compared according to Gomez and Gomez (1984).

RESULTS

a) Vegetative characteristics

In general, application of El Takamolia fertilizer and chemical fertilizer increased all vegetative growth parameters compared to untreated control (Table1). The highest level of El Takamolia fertilizer (8

ton /fed) was the best one for improving growth parameters compared to the other treatments in both seasons.

b) Fruit parameters

Data shown in Table (2) indicate that adding any treatments of fertilizations resulted in a significant increment in capsule number per plant, and seed yield (kg per fed) compared to the control treatment in both seasons. In general the applications of El-Takamolia fertilizer at the high level (8 ton /feddan) gave a significant increment in seed yield per plant (gm) and seed yield per feddan (kg) compared to either 4 ton/feddan or inorganic NPK fertilizer in both seasons.

C- Chemical analysis

Oil percentage (volatile and fixed oil) and seeds content of carbohydrates

Oil production, volatile and fixed oil percentages and yields (Table 3) were in general increased as a result of plant treating with organic and inorganic fertilizers compare to the control. Moreover, using El-Takamolia fertilizer at the high rate gave the greatest value of yields of both volatile and fixed oil.

Plant pigments (chlorophyll *a, b* and total carotenoids) and Total carbohydrates (% of leaf dry weight)

Data represented in Table (4) revealed that application of both types of fertilizer resulted in a highly significant increment in Chlorophyll (*a*) and (*b*) content in leaves compared to the untreated control. The application of El-Takamolia organic fertilizer at the high level (8 on /feddan) led to the highest Chlorophyll (*a*) and (*b*) content in leaves compare to other treatments. There are no significant effects of using organic and inorganic fertilizers on carotenoids content of leaves. The percentage of carbohydrates content in leaves was increased with adding any treatment of fertilizer (Table 4) and the highest value resulted from El-Takamolia fertilizer at rate of 8 ton per feddan.

Nitrogen, Phpsphorus and Potasium NPK (% in dried leaves)

In general, application of the organic fertilizer (El-Takamolia) at the two levels studied or inorganic N.P.K fertilizer resulted in a significant increment in nitrogen, phosphor and potassium percentage in leaves compare to their control (Table 5). The maximum phosphorus and potassium percentage in leaves obtained using the high level of El-Takamolia organic fertilizer (8 ton /feddan) compare to other treatments. Using organic fertilizer at the two levels studied and the inorganic (NPK) fertilizer led to a significant elevation in the nitrogen percentage in leaves compared to their control in both seasons.

DISCUSSION

Nowadays, using mineral fertilizer in agriculture production have resulted in serious problem in the soil and the contamination of the under ground water. It also accumulates in food chain causing hazardous effects (Savci 2012). Accordingly, many researchers recommended organic fertilizers or a combination of both organic and inorganic as the best solution to avoid soil pollution and many other threats to environment and life caused by over use of chemical fertilizers (Hendawy, 2008; Azzaz *et al,* 2009; Sharafzadeh & Ordookhani, 2011) Therefore, a field experiment was conducted to assess the effect of NPK as a chemical fertilizer, versus El-Takamolia (sugar can industry waste) as an organic fertilizer, on *Nigella sativa*, L. production and to determined which fertilizer is available, cheep and gives the most

potential yield of seeds and oil of Nigella to be recommend to the growers in the upper region of Egypt. Our results revealed that all tested fertilization treatments gave a significant increment in the vegetative growth parameters, seeds yield and oil yield compared to the control treatment (no fertilizer applied). The high level of El-Takamolia fertilizer was more effective in this respect. This is may be due to the enhancement of soil biological activity, which improves nutrient mobilization from organic and chemical sources and decomposition of toxic substances (Chen, 2006). Nevertheless, it clearly appears that there is no significant difference between using El-Takamolia fertilizer (4 ton /feddan) and NPK fertilizer in seed and oils yields per feddan of black cumin plant. However, using El-Takamolia as an organic fertilizer at the highest rate (8 ton /feddan) enhanced the growth and increased seed and oil yield of *Nigella sativa*. In conclusion, this study proposes using El-Takamolia as a potent eco-friendly alternative to the chemical fertilizer (NPK) when growing *Nigella sativa* to obtain the highest yield of seeds and oils.

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Table (1): Vegetative growth characteristics of *Nigella sativa*, L. as affected by application of organic and mineral fertilization for two successive seasons

Fertilization Treatments	First Season				
	Plant height (cm)	Branch number/ plant	Stem diameter (cm)	Fresh weight of herb (gm per plant)	Dry weight of herb (gm per plant)
Control	**73.60**	**11.51**	**0.75**	**55.76**	**25.11**
El- Takamolia 4 ton / feddan	**76.92**	**13.70**	**0.85**	**66.38**	**29.83**
El- Takamolia 8 ton / feddan	**82.82**	**15.23**	**0.91**	**79.61**	**41.19**
Mineral N.P.K	**78.82**	**14.08**	**0.85**	**68.73**	**37.07**
L S.D $_{0.05}$	**2.22**	**0.64**	**0.07**	**9.20**	**3.54**
	Second Season				
Control	**79.99**	**11.55**	**0.74**	**56.48**	**27.09**
El- Takamolia 4 ton /feddan	**85.63**	**12.72**	**0.80**	**72.00**	**31.50**
El- Takamolia 8 ton /feddan	**86.82**	**13.66**	**0.86**	**79.36**	**38.49**
Mineral N.P.K	**86.58**	**12.82**	**0.78**	**74.23**	**38.51**
L S.D $_{0.05}$	**3.85**	**0.91**	**0.04**	**4.97**	**3.69**

Table (2): Fruit parameters of *Nigella sativa*, L.as affected by application of organic and mineral fertilization for two successive seasons

Fertilization Treatments	First Season			
	Capsule number / plant	Number of seeds per capsule	Seed yield (gm) per plant	Seed yield (kg) per feddan
Control	**40.07**	**101.62**	**5.08**	**298.73**
El- Takamolia 4 ton / feddan	**53.01**	**104.08**	**6.85**	**402.72**
El- Takamolia 8 ton / feddan	**64.06**	**109.67**	**9.02**	**530.26**
Mineral N.P.K	**51.16**	**101.56**	**6.83**	**401.72**
L S.D $_{0.05}$	**6.26**	**4.07**	**1.10**	**70.71**
	Second Season			
Control	**40.19**	**102.21**	**4.80**	**282.24**
El- Takamolia 4 ton /feddan	**52.94**	**103.83**	**6.68**	**392.37**
El- Takamolia 8 ton /feddan	**59.62**	**106.90**	**8.22**	**483.39**
Mineral N.P.K	**53.09**	**103.09**	**6.74**	**396.17**
L S.D $_{0.05}$	**4.30**	**N.S**	**0.91**	**53.75**

Table (3): Oil percentage (volatile and fixed oil) and seeds content of carbohydrates of *Nigella sativa*, L. as affected by application of organic and mineral fertilization for two successive seasons.

Fertilization Treatments	First Season				
	Volatile oil percentag	Volatile oil yield (ml) per feddan	fixed oil percentage	fixed oil yield (kg) per feddan	(%) Seed content of carbohydrates
Control	**0.27**	**799.71**	**34.30**	**101.30**	**9.37**
El- Takamolia 4 ton / feddan	**0.35**	**1416.15**	**37.28**	**149.40**	**9.37**
El- Takamolia 8 ton / feddan	**0.35**	**1855.39**	**35.96**	**190.88**	**9.82**
Mineral N.P.K	**0.32**	**1266.50**	**35.64**	**140.84**	**9.32**
L S.D $_{0.05}$	**0.03**	**241.37**	**N.S**	**24.25**	**0.08**
	Second Season				
Control	**0.24**	**674.37**	**30.68**	**86.84**	**9.43**
El- Takamolia 4 ton /feddan	**0.32**	**1280.79**	**32.62**	**125.04**	**9.52**
El- Takamolia 8 ton /feddan	**0.34**	**1621.94**	**33.48**	**162.06**	**9.82**
Mineral N.P.K	**0.31**	**1189.21**	**31.77**	**125.17**	**9.47**
L S.D $_{0.05}$	**0.04**	**284.71**	**1.95**	**19.88**	**0.07**

Table (4): Plant pigments (chlorophyll *a*, *b*, carotenoids) and leave content of carbohydrates of *Nigella sativa*, L. as affected by application of organic and mineral fertilization for two successive seasons.

Fertilization Treatments	First Season			
	chlorophyll *a* content	chlorophyll (*b*)	leaf caroten- oids content (mg/gm, FW)	(%) Leaf content of carbohydrates
Control	**1.15**	**0.41**	**0.51**	**3.76**
El- Takamolia 4 ton / feddan	**1.46**	**0.53**	**0.41**	**4.00**
El- Takamolia 8 ton / feddan	**1.64**	**0.63**	**0.56**	**4.32**
Mineral N.P.K	**1.46**	**0.52**	**0.54**	**4.03**
L S.D $_{0.05}$	**0.91**	**0.05**	**NS**	**0.06**
	Second Season			
Control	**1.13**	**0.41**	**0.49**	**3.74**
El- Takamolia 4 ton /feddan	**1.45**	**0.50**	**0.45**	**4.23**
El- Takamolia 8 ton /feddan	**1.60**	**0.62**	**0.60**	**4.28**
Mineral N.P.K	**1.46**	**0.55**	**0.48**	**4.18**
L S.D $_{0.05}$	**0.04**	**0.04**	**N.S**	**0.06**

Table (5): **Leaf content of nitrogen, phosphorus and potassium of *Nigella sativa*, L. as affected by application of organic and mineral fertilization for two successive seasons.**

Fertilization Treatments	First Season		
	Leaves content of nitrogen	Leaves content of phosphorus	Leaves content of potassium
Control	1.92	0.54	1.37
El- Takamolia 4 ton / feddan	2.12	0.61	1.43
El- Takamolia 8 ton / feddan	2.01	0.63	1.45
Mineral N.P.K	2.06	0.62	1.43
L S.D $_{0.05}$	**0.07**	**0.02**	**0.01**
	Second Season		
Control	1.82	0.54	1.47
El- Takamolia 4 ton / feddan	2.16	0.65	1.50
El- Takamolia 8 ton / feddan	2.01	0.66	1.55
Mineral N.P.K	2.19	0.64	1.50
L S.D $_{0.05}$	**0.09**	**0.01**	**0.02**

تأثير السماد العضوى والمعدنى على إنتاج نبات حبه البركه

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الملخص :

أجريت تجربه حقليه خلال موسمين متتاليين من فصل الشتاء وذلك بهدف دراسة تأثير مستوين مختلفين ٤ و ٨ أطنان / فدان من السماد عضوي (التكامليه) علي النمو والمحصول لنبات حبه البركة. وقد تم استخدام كلا من السماد الكيماوي (نتروجين–فوسفور–بوتاسيوم) الموصى به والنباتات غير المعامله للمقارنه. وقداشتملت الدراسة علي قياسات مختلفة للنمو الخضري والزهري والثمري والزيت (نسبه الزيت الطيار والثابت في البذرة–ومحصول الزيت الطيار والثابت للفدان) كما أجريت التحليلات الكيمائية لدراسه محتوي الأوراق من كلوروفيل ا، ب والكاروتينات ومحتواها المعدني من النتروجين–الفوسفور– البوتاسيوم، بالاضافه إلي محتوي الكربوهيدرات الكلية في كل من الأوراق و البذور.أكدت نتائج الدراسه أن للسماد التكاملى (٨ طن / فدان) أفضل تأثير لتحسين معظم قياسات النمو الخضري مقارنة مع المعاملات الأخرى في كلا الموسمين. وكشفت البيانات عن زيادة معنوية في محصول البذور بالإضافة إلى زيادة عدد الكبسولات نتيجة استخدام السماد التكاملى بمعدل ٨ طن / فدان مقارنة بالسماد المعدنى. وقد أدى إستخدام الأسمدة العضوية وغير العضوية إلى زيادة إنتاج الزيوت (النسب المئوية للزيت الطيار والثابت) مقارنة بالمعامله المقارنه (بدون تسميد). أيضا، تم زيادة محتوى الأوراق من الكلوروفيل أ و ب. كما أدى التسميد إلى زيادة في محتوى الأوراق والبذور من الكربوهيدرات ومحتوى الورقة من الفوسفور والبوتاسيوم. يمكن الأستنتاج من نتائج الدراسه أن السماد العضوى (التكاملية) يمكن استخدامه بكفاءة في إنتاج وتحسين نمو نبات حبه البركه لتقليل الأحتياجات من السماد الكيماوى مما يقلل من تلوث البيئه وتكاليف الزراعه.