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RESPONSE OF SESAME TO GAMMA IRRADIATION AND NITROGEN FERTILIZER LEVELS ON NEWLY RECLAIMED SANDY SOILS

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ABSTRACT

The present study was conducted in an Extension field at Belbees district, Sharkia Governorate during 2009 and 2010 seasons to investigate the influence of four gamma-irradiation doses (zero, 10, 20 and 30Gy) and five N fertilizer levels (zero, 40, 60, 80 and 100 KgN/fad.), on yield and it's attributes of sesame cultivar Giza 32. Gamma irradiation doses were arranged randomly in the main plots, while the five N fertilizer levels were assigned to the sub-plots. Decreasing gamma irradiation doses from 30 to 20 and 10 Gy, consistently and significantly increased plant height (cm), height to the first fruiting branch (cm), fruiting zone length (cm), number of branches and capsules/plant, 1000-seeds weight (g), seed weight(g /capsule), seed weight(g /plant), seed yield (kg/fad.) seed oil content (%) as well as oil yield (kg/fad.). Increasing N fertilizer level up 100 Kg/fad., significantly increased plant height (cm), height to the first fruiting branch (cm) fruiting zone length (cm), number of branches and capsules/plant. 1000-seeds weight (g), seed weight (g/capsule), seed weight/ plant (g), seed yield (kg/fad.) and oil yield (kg/fad.).

Keywords: Gamma irradiation, nitrogen fertilizer levels, sandy soils, sesame, yield attributes.

INTRODUCTION

Sesame (*Sesamum indicum* L) also known as Beniseed in West Africa and Sim-sim in East Africa, is an oil crop belonging to the family "Pedaliaceae" ,grown in both tropical and sub-tropical regions of Africa, Asia and Latin America. The importance of sesame lies in it's high quality oil which is often referred to as the "queen "of vegetable oil. The crop is now grown mainly for it's seeds which contain 50-52% oil, 17-19% protein and 16-18% carbohydrate (Ustimenko-Bakumovsky, 1983), and are used mainly for cooking purposes, salad oil and margarine (Coote,1998). The oil contains about 47% Oleic and39% Linoleic acid, and is also used in manufacture of soaps ,paints ,perfumes, pharmaceuticals and insecticides (Oplinger *et al.*, 1990; FAO, 2002; RMRDC, 2004; Biabani and Pakniyat, 2008) In Egypt, most of the seed production is consumed as edible products such as Tehena. Halawa tahiniya and bakery products. The total production of edible oil is about 10% of the consumption in Egypt. Therefore, many attempts are being made to raise total production of oil crops particularly sesame for narrowing oil deficiency gap. In Egypt, expanding sesame area should be taken in newly reclaimed sandy soils, which are facing many problems like low fertility, poverty and high loss of nutrients by leaching.

Gamma rays have been proved economical and effective as compared to other ionizing radiations because of it's ease in availability and power of penetration .This penetration power of gamma rays helps in it's wider application for improvement of sesame. It has been reported that irradiation of seeds prior to sowing, held great promise from the viewpoint of it's practical application in agriculture (Ayiecho and Nyabundi, 2001). It was generally agreed that low doses of gamma rays stimulate cell division,

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growth, yield and development in various organisms including animals and plants. This phenomenon named "hormesis", has been analyzed and discussed by authors in various species (Narimanov and Korystov, 1997 as well as Ashri, 2007). It has been reported that the material and energy necessary for initial growth are already available in the seed, so the young embryo has no need to form new substances, but only to activate those already stored in the cotyledons . Low doses of gamma radiations may increase the enzymatic activation and awakening the young embryo, which result in stimulating the rate of cell division, and affects not only germination, but also vegetative growth and flowering (Sjodin, 1962). Exposing the dry seeds to low gamma irradiation doses (5-100 Gy) resulted in increasing yield of some plants such as safflower, sesame and wheat (Abo-Hegazi *et al.*, 1988; El-Shafie *et al.*, 1993 as well as Farag and El-Khawaga, 2012).

Nitrogen is the most important essential nutrient in plant nutrition. It is a constituent of a large number of necessary organic compounds such as amino acids, proteins, coenzymes, nucleic acids, ribosomes, chlorophyll, cytochrome and some vitamins (Marschner, 1986 and Noorka *et al.*, 2009). Many workers recorded the meliorate role of nitrogen on growth, yield attributes, seed yield and quality of sesame. In Egypt, Basha (1994) avouched that, raising N fertilizer level up to 75 kg/fad., significantly increased plant height ,fruiting zone length, No. of branches and capsules/plant, seed weight/ plant,1000-seeds weight as well as seed and oil yields kg/fad., while oil % was decreased due to raising N-fertilization. Furthermore, El-Quesni *et al.* (1994) in Egypt, explicated that, applying 30 or 45 kg N/fad., significantly increased sesame plant height, weight of pods. They added that raising N fertilizer level from 15 to 30 or 45 Kg N/fad., caused significant increments in number of pods /plant, seed weight/plant and seed yield/fad., of Giza-32 sesame cultivar. El-Emam *et al.* (1997) as well as Bassiem and Anton (1998) came to similar results. Fayed *et al.* (2000) educed that plant height, height to the first capsule, number of capsules/plant, seed weight/plant and seed yield/fad., were increased due to raising N fertilizer level from 71 to 142 Kg/ha. Further Ashfaq *et al.* (2001); Abdel-Rahman *et al.* (2003); El-Mahdi (2008); El-Nakhlawy and Shaheen (2009); Shehu *et al.* (2010) and El-Sanatawy (2112), elicited that plant height, number of branches and capsules/plant, seed index and seed yield/fad., were increased by increment N level up to 120 Kg/fad.

MATERIALS AND METHODS

Two field experiments were conducted in an Extension field at Belbees district, Sharkia Governorate during two summer successive seasons, 2009 and 2010 to investigate the influence of four gamma-irradiation doses (zero, 10, 20 and 30 Gy) and five nitrogen fertilizer levels (zero, 40, 60, 80 and 100 Kg N/fad.), on yield and it's attributes of sesame cultivar Giza 32, grown in sandy soil.

The chemical analysis of the experimental field (30 cm depth) refers to coarse sand, fine sand, silt and clay as values as 59.61%, 19.88%, 10.37% and 10.08%, in the same respective order.

Factors Studied and Experimental Design

The two factors studied in this work were (A) gamma irradiation, where pure dry seeds of sesame cultivar Giza 32 were irradiated with 10,20 and30 Gy doses of gamma irradiation, irradiation facility used was ,Co-60 gamma chamber 4000-A-India, National Center for Radiation Research and Technology, (NCRRT), Nasr City, Cairo, Egypt. (B) Nitrogen fertilizer levels where, five nitrogen levels (zero, 40, 60, 80 and 100 Kg N/fad.,) were applied in form of Ammonium sulphate (20.5% N), each level was supplied in five equal doses. Phosphorus in form of Calcium super-phosphate (15.5% P_2O_5) and Potassium in form of Potassium-sulphate (48% k_2O) were applied at sowing and after thinning in levels of 46.5 Kg P_2O_5 and 48 kg K_2O/fad., in respective order. Preceding crop in both seasons was barley.

Sesame seeds were sown in hills, 20cm apart and 50 cm between rows, each hill included two plants. Irrigation via drip system was done each 2-3 days. The sub- plot area was 15 m^2 (3 × 5m), which included 6 rows, 50cm apart, the other cultural practices were applied as recommended.

Each experiment included 20 treatments, which were the combination of four gamma irradiation doses and five nitrogen fertilizer levels. A split plot design with four replicates was used in both seasons, gamma irradiation doses were assigned to the main plots and the sub plots were devoted to nitrogen fertilizer levels.

At harvest time, after 121 and 109 days after sowing in first and second seasons, respectively, samples of 10 guarded plants were randomly taken from the inner ridges in each sub plot to estimate plant height (cm), height to the first fruiting branch (cm), fruiting zone length (cm), number of branches and capsules/plant, 1000-seeds weight (g) seed weight(g /capsule) and seed weight/plant (g). Seed yield (Kg/fad.) was determined from the plants of the two middle ridges (the 3rd and 4th ridges) in each plot. Seed oil content (%) was determined by using Soxhlet continuous extraction apparatus with petroleum either as an organic solvent according to A.O.A.C. (1980) and seed oil yield (ton /fad.) was calculated by multiplying oil percentage and seed yield per fad.

The analysis of variance of split plot design with three replicates was used according to Snedecor and Cochran (1982). Means were compared for significant according to Duncan's . Multiple Range Test at 5% level of significance (Duncan, 1955). Alphabetical letters were applied to distinguish transactions and according to the presence or not of statistical differences .

RESULTS AND DISCUSSION

Plant Height (cm), Height to the First Fruiting Branch (cm) and Fruiting Zone Length (cm)

Effect of gamma irradiation

Data in Table 1 clearly reflected a real proportial relation between gamma irradiation doses and each of plant height (cm), height to the first fruiting branch (cm) and fruiting zone length (cm) of sesame. The highest value for each of the aforementioned yield attributes, was attained in response to the lowest dosage (10Gy). The further treatment of gamma irradiation dose up to 30 Gy, was accompanied by significant reduction in each of plant height (cm), height to the first fruiting branch (cm) and fruiting zone length (cm).In general it could be noted that, all gamma irradiation doses surpassed the control (non irradiated plants) in each of plant height, height to the first fruiting branch and fruiting zone length.

Several workers reported that gamma irradiation at low doses, have positive and stimulatory effects on the plant growth, development and yields (Fowler and Macqueen, 1972).

Effect of nitrogen

Data in Table 1 obviously indicated the stimulatory role of nitrogen in plant growth, whereas adding N with any level, caused significant increase in plant height, height to the first fruiting branch and fruiting zone length, comparing to the control. Also the results illustrated that, increasing nitrogen fertilizer level up to 100 kg N/fad., consistently and significantly increased plant height, height to the first fruiting branch and fruiting zone length. The differences between the levels of N were significant and that was true in 2009 and 2010 seasons. These results were expected since nitrogen stimulates cell division and extension in turn increases number and length of internodes resulting in taller plants. Confirming results were detected by Bassiem and Anton (1998) up to 142 Kg N/ha, Ali (2002) up to 178.5 Kg N/ha and Muhamman and Gungula (2008) up to 90 Kg N/ha.

Effect of the interaction

The interaction between the two main factors under study, affected insignificantly on sesame plant height and height to the first fruiting branch in both seasons, but fruiting zone length was significantly influenced, the effect of the interaction was likely to the main effect, wherein the longest fruiting zone length was attained due to using the lowest irradiated does (10 Gy) and the highest N level.

Table 1. Effect of gamma irradiation and nitrogen fertilizer levels on plant height, height to the first fruiting branch and fruiting zone length of sesame (2009 and 2010 seasons)

Main effect and interaction	Plant height (cm)		Height to the first fruiting branch (cm)		Fruiting zone length (cm)	
	2009	2010	2009	2010	2009	2010
Gamma irradiation (R)						
Control	132.43d	148.19d	32.21d	33.24d	51.39d	53.64d
10 GY	160.16 a	177.91 a	44.41 a	46.43 a	63.41 a	67.48 a
20 GY	155.41 b	169.16 b	40.91 b	42.67 b	59.11 b	64.06 b
30 GY	148.41 c	161.41 c	37.83 c	38.96 c	55.23 c	58.70 c
F-test	*	*	*	*	*	*
Nitrogen fertilizer levels (kg N/fad.)(N)						
Control	126.93e	142.87e	29.76e	30.74e	48.13e	51.24e
40	130.58 d	150.24 d	32.91 d	34.32 d	53.91 d	57.25 d
60	148.58 c	161.57 c	39.47 c	40.81 c	57.64 c	61.04 c
80	165.58 b	177.24 b	43.58 b	45.86 b	62.68 b	66.65 b
100	173.91 a	188.91 a	48.24 a	49.76 a	64.12 a	68.71 a
F-test	*	*	*	*	*	*
Interaction						
R × N	N.S.	N.S.	N.S.	N.S.	*	*

N.S.,*=insignificant and significant probability level at 5%,respectively.

Number of Branches/Plant, Number of Capsules/Plant and 1000-Seeds Weight (g)

Effect of gamma irradiation

Results in Table 2 obviously indicate that, the low dose of 10 Gy, enhanced significantly each of, number of branches /plant, number of capsules/plant and 1000-seeds weight (g) of sesame variety Giza 32. Each raising in gamma irradiation dose over the control was accompanied by a significant reduction in the tested traits.

The stimulatory effect of gamma irradiation at a low dose was reported by several workers such as Irfag and Nawab (2003), Mohibullah Khan *et al.* (2003) as well as Singh and Datta (2010). Also the negatively and inhibitory effects of high gamma irradiation dose had been recorded by many workers (Mashev *et al.*, 1995; Rahm Din *et al.*, 2003; Mohibullah Khan *et al.*, 2003 as well as Irfag and Nawab, 2003).

Effect of nitrogen

Number of branches per plant was increased significantly due to supplying any level of nitrogen in comparison with no fertilized plants in the control treatment. Also it is important to note that increasing N level from 40 to 100 kg/fad., was accompanied by significant increase in number of branches / plant in the two growing seasons (Table 2). That might be due to the fact that N encourages the meristemtic activity and photosynthesis rate, which produced more number of branches/plant. In this respect, Ashfaq *et al.* (2001) noted similar finding by applying N up to 120 Kg/ha and El-Mahdi (2008) up to 40 Kg N/ha. Appling nitrogen fertilizer produced more number of capsules/ plant of sesame comparing to the control. The differences between the five levels of N (zero, 40, 60, 80 and 100 Kg N/fad.) were significant in 2009 and 2010 seasons (Table 2). The increase in number of capsules/plant might be due to the favorable effect of N on the amount of metabolites synthesized and pods setting. In this respect, Fayed *et al.* (2000) with 142 Kg N/ha; Muhamman *et al.* (2009) with 90 Kg N/ha, showed similar results.

Data in Table 2 indicate that 1000-seeds weight of sesame, significantly increased by increasing

Table 2. Effect of gamma irradiation and nitrogen fertilizer levels on number of branches / plant, number of capsules /plant and 1000-seeds weight of sesame (2009 and 2010 seasons)

Main effect and interaction	Number of branches /plant		Number of capsules /plant		1000-seeds weight (g)	
Seasons	2009	2010	2009	2010	2009	2010
Gamma irradiation (R)						
Control	09.21d	10.11d	62.32d	63.51d	2.93d	3.01d
10 GY	11.85a	12.64 a	81.83 a	83.16 a	3.40 a	3.46 a
20 GY	11.30b	12.31 b	77.08 b	78.41 b	3.30 b	3.36 b
30 GY	10.85c	11.63 c	71.82 c	72.15 c	3.21 c	3.26 c
F-test	*	*	*	*	*	*
Nitrogen fertilizer levels (kg N/fad.)(N)						
Control	8.66e	9.86e	47.31e	49.55e	2.83e	2.84e
40	9.13 d	9.92 d	57.44 d	61.54 d	2.93 d	2.95 d
60	10.60 c	11.32 c	71.00 c	72.22 c	3.13 c	3.17 c
80	12.13 b	12.92 b	86.66 b	87.99 b	3.42 b	3.53 b
100	13.50 a	14.35 a	98.98 a	100.31a	3.74 a	3.86 a
F-test	*	*	*	*	*	*
Interaction						
R × N	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

N.S.,*=insignificant and significant probability level at 5%, respectively.

N level over the control up to 100 Kg N/fad., in 2009 and 2010 seasons. The favorable effect of nitrogen fertilizer on 1000-seeds weight, may be due to the reason that N stimulated plant growth such as plant height and number of branches/plant, which increased that amount of light energy intercepted by leaves. In addition, N increased photosynthetic pigments content and photosynthesis rate, which in turn increased the amount of metabolites synthesized and consequently resulted in higher dry matter accumulation in leaves and partitioned to seeds. These results are in harmony with those reported by Basha (1994) and Malik *et al.* (2003).

Effect of the interaction

All the dulist interactions reveled insignificant effect on each of number of branches/ plant, number of capsules /plant and 1000-seeds weight.

Seed Weight (g/capsule), Seed Weight (g/ plant) and Seed Yield (kg/fad.)

Effect of gamma irradiation

Gamma irradiation in low dose (10, 20 and 30Gy), significantly enhanced each of seed weight (g/capsule), seed weight (g/plant) seed yield (kg/fad.), as shown from Table 3. Raising gamma irradiation dose over 10 Gy (i.e. 20 and 30 Gy) had negative and inhibitor impact on sesame yield attributes, whereas seed weight (g/capsule), seed weight (g/plant) and seed yield (kg/fad.), significantly decreased due to each increase at gamma irradiation dose.

Gamma irradiation at 10 Gy had also positive and stimulatory effects on Plant height (cm),height to the first fruiting branch (cm) and fruiting zone length (cm) (Table 1) as well as number of branches /plant, number of capsules /plant and 1000-seeds weight (g) of sesame (Table 2).

Augmentation of seed weigh / plant and seed yield/ fad., due to low gamma irradiation dose was conformed with the findings of Khan *et al.* (2010); Rahm Din *et al.* (2010) and Singh and Datta (2010).

Effect of nitrogen

Fertilizing sesame plants with100 kg N/fad., produced the heaviest weight of seeds/capsule and plant with significant differences between

the four levels of nitrogen fertilizer as well as the control, that was true in the two growing seasons as shown in Table 3. These results were expected since encouraged plant growth, number of capsules/plant and 1000-seeds weight in turn increased seed weight/plant. These results are in agreement with each of Fayed *et al.* (2000) and Muhamman *et al.* (2009) who found that seed weight/ plant was increased by adding N fertilizer up to 142 and 90 Kg /ha, respectively.

It is clearly evident from Table 3 that seed yield/fad., increased significantly and consistently as N fertilizer level was increased over the control up to 100 Kg N/fad., in both seasons (2009 and 2010). The positive effect of increasing N fertilizer level on seed yield/fad., of sesame might be attributed to the beneficial role of nitrogen on stimulating plant growth. Plant traits, i.e., plant height, number of branches/plant and fruiting zone length, which reflects favor on yield attributes, i.e. capsules number/plant, 1000-seeds weight and seed weight/plant in turn, increased seed yield/fad. Many researchers reported increasing in seed yield by applying N fertilizer (Basha, 1994; Bassiem and Anton1998; Fayed *et al.,* 2000; Ali, 2002; Malik *et al.,* 2003 and Muhamman and Gungula, 2008), respectively.

Effect of the interaction

Interactions between the main treatments had, insignificantly affected seed weight (g/ capsule) in both seasons and seed weight (g/plant) in 1st season. Results of seed weight (g/plant) in the 2nd season and of seed yield (kg/fad.) in both seasons exhibited significant response to the interaction effect which was in accordance to the main effects where the highest seed weight (g/plant) and the highest yield (kg/fad.) of sesame could be obtained due to the use of the lowest gamma irradiation dose (10Gy) and use of the highest N level (100 kg/fad.).

Table 3. Effect of gamma irradiation and nitrogen fertilizer levels on seed weight (g/capsule), seed weight (g/plant) and seed yield (kg/fad.), of sesame (2009 and 2010 seasons)

Main effect and interaction	Seed weight(g/ capsule)		Seed weight(g/ plant)		Seed yield(kg/fad.)	
Seasons	2009	2010	2009	2010	2009	2010
Gamma irradiation (R)						
Control	0.1732d	0.1955d	10.01d	11.59d	358.3d	448.1d
10 GY	0.1785a	0.2019a	14.49 a	16.43 a	688.4a	760.5a
20 GY	0.1771b	0.1986b	13.56 b	15.57 b	520.3 b	615.8b
30 GY	0.1759c	0.1976c	12.64 c	14.57 c	451.7c	504.4c
F-test	*	*	*	*	*	*
Nitrogen fertilizer levels (kg N/fad.)(N)						
Control	0.1673e	0.1859e	8.99e	10.62e	311.1e	401.5e
40	0.1699d	0.1916d	9.76 d	11.71 d	423.7d	503.7d
60	0.1720c	0.1937c	12.04 c	14.13 c	502.3c	584.5c
80	0.1790b	0.1981b	14.72 b	17.04 b	592.4b	668.5b
100	0.1927a	0.2252a	17.72 a	19.22 a	693.7 a	751.9a
F-test	*	*	*	*	*	*
Interaction						
R × N	N.S.	N.S.	N.S.	*.	*	*

N.S.,*=insignificant and significant probability level at 5%, respectively.

Seed Oil Content (%) and Oil Yield (kg/fad.)

Effect of gamma irradiation

In both seasons, gamma irradiation dose of 10 Gy, gave the highest seed oil content (%) and oil yield (kg/fad.) compared with either the control or the other gamma irradiation doses.

These results are rather expected as the entire yield attributes were significantly increased due to the lowest gamma irradiation dose. These results were assured by the findings of Khan *et al.* (2010) and Singh and Datta (2010).

Effect of nitrogen

Seed oil content (%) was negatively and significantly affected by increasing N level up to 100 kg N/fad., and that held true in both seasons (Table 4). These results were expected since the low nitrogen level resulted in smaller seeds, (1000-seeds weight) and this might be on the expense of carbohydrate storage rather than oils, which resulted in increasing percentage of the later. These results are in a same trend with those found by Basha (1994) who recorded that, seed oil content (%) increased by decreasing N level from 178.5 to 35.7 Kg/ha. Also, Bassiem and Anton (1998) reported similar decreas in seed oil content due to reduction of N from 214 to 71 Kg/ha. Ali (2002) came to similar results.

Table 4 show that, increasing nitrogen fertilizer level over the control up to 100 kg N/fad., significantly increased oil yield/fad., in 2009 and 2010 seasons. The increase in oil yield/fad., by increasing nitrogen level might be mainly due to the increase in seed yield/fad., regardless the negative effect of that on seed oil percentage. Confined results were emphasized by Basha (1994) and Ali (2002).

Effect of the interaction

The interaction between gamma irradiation and nitrogen fertilizer levels, insignificantly affected both of seed oil content (%) and oil yield (kg/fad.) in both seasons.

Table 4. Effect of gamma irradiation and nitrogen fertilizer levels on seed oil content and oil yield of sesame (2009 and 2010 seasons)

Main effect and interaction	Seed oil content (%)		Oil yield (kg/fad.).	
Seasons	2009	2010	2009	2010
Gamma irradiation (R)				
Control	48.95d	49.27d	175.39d	220.78d
10 GY	52.95 a	54.10 a	364.51a	411.43a
20 GY	51.26 b	52.06 b	266.71b	320.59b
30 GY	46.83c	47.21 c	211.53c	238.13c
F-test	*	*	*	*
Nitrogen fertilizer levels (kg N/fad.) (N)				
Control	48.6d	48.79d	151.19e	195.89e
40	54.32 a	55.11 a	230.15d	277.59d
60	50.05 b	50.96 b	251.40c	297.86c
80	48.70 c	49.43 c	288.50b	330.44b
100	48.33 e	48.99 e	335.27a	368.36a
F-test	*	*	*	*
Interaction				
R × N	N.S.	N.S.	N.S.	N.S.

N.S.,*=insignificant and significant probability level at 5%,respectively .

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استجابة السمسم لمستويات من الإشعاع الجامى والسماد النيتروجينى فى الأراضى الرملية حديثة الاستصلاح

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أجريت تلك الدراسة بحقل إرشادى فى مركز بلبيس محافظة الشرقية وذلك خلال موسمى الزراعة (٢٠٠٩ ،٢٠١٠) لدراسة تأثير أربع جرعات من أشعة جاما (صفر ، ١٠ ، ٢٠ ، ٣٠ جراى) بالإضافة إلى خمسة مستويات من السماد الأزوتى (صفر ، ٤٠ ، ٦٠ ، ٨٠ ، ١٠٠ كجم للفدان) وذلك على المحصول ومكوناته لصنف السمسم جيزة ٣٢. نباتات السمسم الناتجة من معاملة التشعيع الجامى بجرعة منخفضة (١٠ جراى) تفوقت على تلك الناتجة من معاملتى التشعيع الأخرى (٢٠ ، ٣٠ جراى) وكذلك المعاملة القياسية (عدم التشعيع) فى كل من ارتفاع النبات (سم)، طول الكبسولة (سم)، ارتفاع أول كبسولة (سم) عدد الأفرع /نبات، عدد الكبسولات / نبات ،وزن١٠٠٠ بذرة (جم) وأخيرا محصول البذور/فدان ومحتوى الزيت فى البذور. وأوضحت الدراسة أن التسميد النيتروجينى أثر معنويا على جميع الصفات وقد أدت الزيادة المتدرجة فى معدلات النيتروجين حتى أعلى معدل إضافة (١٠٠ كجم للفدان) إلى زيادة معنوية فى ارتفاع النبات، ارتفاع أول فرع ثمرى، طول المنطقة الثمرية، عدد الأفرع والكبسولات للنبات، وزن ١٠٠٠ بذرة، وزن البذور للكبسولة والنبات وكذلك محصول البذور (كجم/فدان) بالإضافة إلى محصول الزيت (كجم/فدان).