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IMPACT OF OPENED, NON OPENED POLLINATION AND NITROGEN FERTILIZER ON SESAME PRODUCTION IN THE RECLAIMED LANDS, ISMAILIA GOVERNORATE, EGYPT

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ABSTRACT. The research was conducted at the Agriculture Research Farm, Faculty of Agriculture, University of Suez Canal, during the sesame growing seasons of 2011 and 2012**.** For studying the impact of insect pollination and nitrogen fertilization on sesame production, the experiment was divided to 13 treatments of open pollination and non open pollination, with three different levels of ammonium nitrate (NH_4NO_3) and one level of seryalin as bio-fertilizer. Non opened pollination treatments were covered before the start of flowering period with a perforated net bag, to allow the air to pass through and to prevent insects from approaching the plants. Quantitative and qualitative indicators, were measured as follows: rate of capsule per plant, capsule weight, rate of seeds in each capsule, weight of 1000 seeds, germination (%), seedlings vigour and oil content (%). Results clearly demonstrate that qualitative and quantitative indicators of sesame crop was significantly increased with opened pollination and with the increase of nitrogen fertilizer level up to 40 kg N/ feedan^{-1} plus or minus seryalin, in reclaimed sandy soils, in Ismailia, Egypt.

Key words: Sesame crop; Fertilization; Insect pollination; Qualitative indicators; Quantitative indicators.

INTRODUCTION

Sesame (*Sesamum indicum* L.), otherwise known as sesamum or benniseed, member of the family *Pedaliaceae*, is one of the most ancient oilseeds crop known to mankind. Sesame plays an important role in human nutrition. Most of the sesame seeds are used for oil extraction and the rest are used for edible purposes (El Khier *et al.*, 2008).

Sesame is grown in many parts of the world on over 5 million acres

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(20,000 km^2). The largest producer of the crop in 2007 was India, China, Myanmar, Sudan, Ethiopia, Uganda and Nigeria. Seventy percent of the world's sesame crop is grown in Asia, with Africa growing 26% (Hansen, 2011). The largest producers are China and India, each with an annual harvest around 750,000 tonnes followed by Myanmar (425,000 tonnes) and Sudan (300,000 tonnes).

In Egypt, sesame is considering a food crop rather than oilseed crops, because most of its seeds are directly consumed. It is grown in many Governorates and ranks first among the cultivated oil crops in Ismailia Gov. (El-Bramawy, 2006). Total area under sesame production in Egypt has increased from 11.264 ha, in 1961 to 36.907 ha, by 2010 and the productivity increased from 1145.71 kg/ha, in 2005 to 12503 kg/ha, in 2010 (Faostat, 2012). Low production of sesame is attributed to the fact that the crop is usually grown in less fertile soils. Further, lack of proper nutrient management is one of the major causes for low yield (Purushottam, 2005).

Nitrogen is a component of protoplasm, proteins, nucleic acids, chlorophyll and plays a vital role both in vegetative and reproductive phase of crop growth. Sesame has been recognized as a heavy feeder and uses more nitrogen than any other nutrient element. Higher nitrogen levels are reported to increase plant height, leaf area, dry matter and seed yield (Purushottam, 2005).

Co-evolution of flowering plants and their pollinators started about 225 million years ago (Price, 1975; Maiti and Maiti, 2011). Insufficient number of suitable pollinators causes decline in fruit and seed production (Partap, 2001). Of the total pollination activities, over 80% is performed by insects and bees contribute nearly 80% of the total insect pollination, and therefore, they are considered the best pollinators (Robinson and Morse, 1989). Sesame's blossom structure facilitates cross-pollination, even though the crop is usually viewed as self-pollinating. The rate of cross-pollination lies between 0.5% and 65%, depending on insect activity, environmental conditions and availability of other vegetation (Kumar and Lenin, 2000). Ashri (2007) reported that the cross pollination rates were between 2.7 and 51.7%, in Nigeria.

Both open pollination and bee pollination treatments were effective to increase the seed yield of sesame up to 22 to 33 percent more than that in "pollination without insects" Panda *et al.* (1988). In addition to increasing the yield, cross-pollination also helps to raise quality through a more unified ripening period and an earlier harvesting time. The present investigation was undertaken with the following objectives:

1. To study the impact of bee pollination on quantitative and qualitative indicators of sesame yield.
2. To study the impact of nitrogen levels on sesame growth and seed production.

MATERIALS AND METHODS

This experiment was carried out at the Experimental farm, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt. Sesame crop was established by direct sawn at May 31, 2011 and June 04, 2012. Local culture practices were used during the time of experiments, except the studied treatments. The land used measuring about 3/4 feddan was divided into 39 plots of 8 × 2.4 m each, six rows in each plot with 40 cm spacing between rows and 30 cm between plants. Seeds of cultivar of sesame namely (Shandawil 3) were purchased from the Agriculture Research Center, Giza. These seeds were treated with Rizolex-T (3 g/kg seeds), before sowing to prevent rot infection.

Table 1 - Soil physico-chemical analysis of the experimental site during 2011 and 2012 cropping seasons (Said, 2012**).**

Soil properties	2011/2012
EC dsm $^{-1}$	3.85
pH	7.14
Cations: megl $^{-1}$	
Ca^{2+}	6.6
Mg^{2+}	3.0
Na^{+}	29.3
K^{+}	4.1
Anions: megl $^{-1}$	
HCO_3^{-}	0.3
SO_4^{-2}	21.2
Cl^{-}	17.0
Textural class	
Sand	94.5%
Silt	2.5%
Clay	3.0%

For studying, the impact of insect pollination and nitrogen fertilization on sesame production, the experiment was laid out in randomized block design (RBD), with thirteen treatments, with three replicates. The treatment details are as follows: T_1= Open pollination without nitrogen (control); T_2= Open pollination with 20 kg N /feddan; T_3= Open pollination with 40 kg N /feddan; T_4= Open pollination with 60 kg N /feddan; T_5= Open pollination with 20 kg N /feddan + seryalin; T_6= Open pollination with 40 kg N /feddan+ seryalin; T_7= Open pollination with 60 kg N /feddan+ seryalin; T_8= Non open pollination with 20 kg N /feddan; T_9= Non open pollination with 40 kg N /feddan; T_{10}= Non open pollination with 60 kg N /feddan; T_{11}= Non open pollination with 20 kg N /feddan + seryalin; T_{12}= Non open pollination with 40 kg N /feddan+ seryalin; T_{13}= Non open pollination with 60 kg N /feddan+ seryalin.

Plot size: 8 × 2.4 m; Spacing: 30 ×40 cm. Experiment was divided to 13 treatments of open pollination and non open pollination with three different levels of ammonium nitrate (NH_4NO_3) and one level of seryalin as bio-fertilizer. Normal agriculture practices were applied from preparing of the seed bed till the harvest. The plants were grown insecticide free till harvesting of both growing seasons. The bio-fertilizer (seryalin) consists of *Ozoseyrloum bacteria*, was purchased from the Center of Fertilizers and Algae, Agriculture Research Center, Giza. It was added once during the farming, while ammonium nitrate (33.5 N) was added three times equal as follows: after thinning, after 15 days from thinning and after 30 days from thinning.

For studying the effect of different pollinators in enhancing the productivity and quality of sesame seeds, the flowers

of plants in treatments from T_8 to T_{13} (non open pollination) were covered before the start of flowering period by a perforated paper bag, to allow the air to pass through and to prevent insects. Ten plants were covered from each replicate, for each treatment.

Quantitative and qualitative indicators were measured as follows: capsule weight, number of seeds in each capsule, weight of 1000 seeds, germination percentage, seedling vigour and oil percentage (Dhurve, 2008).

a) Quantitative indices:1 - Number of capsules per plant: it was measured on 25 randomly labeled plants from each treatment. They counted and expressed as number of capsules per plant; 2 - Capsule weight (g): it was measured on 25 randomly labeled capsules from each treatment by using an electronic balance; 3- Number of seeds per capsule: it was counted on 10 randomly plants per treatment and expressed as number of seeds per capsule; 4 - Thousand seed weight (g): it was made by weighing 1000 dried seeds drawn randomly from each treatment using an electronic balance and replicated 4 times for each treatment; 5- Seed yield per plant: at harvest, the capsules of ten plants in each treatment were removed and recorded; the seeds were separated and seed weight was recorded by using electronic balance which expressed in grams per plant.

b) Qualitative indices: 1. Germination percentage: hundred seeds obtained from the different treatments were taken and were placed on germination paper in germination chamber at 27^{o}C and 80% RH. The germination count was made five days after incubation; the germination percentage was expressed based on the number of seedlings obtained in the test out of total seed yield; this test was replicated four times; 2. Seedling vigour: twenty five seedlings were considered from each treatment and length of shoot and root were measured, when the 1st set of true leaves were visible; 3. Oil percentage: dried seeds were ground for solvent extraction (Soxhlet method), 50 g of ground seeds of each treatment were placed into a cellulose paper cone and extracted using light petroleum ether in a Soxhlet extractor for 8 h (Pena *et al*., 1992); each treatment was replicated four times; the oil was recovered by evaporating the solvent using a rotary vacuum evaporator and the percentage of oil content was calculated.

Data obtained from quantitative and qualitative indicators were statistically analyzed through ANOVA (SAS Institute 2002). When F-test was significant, means were separated using Tukey's Honestly Significant Difference (HSD) Test at the 0.05 level of significance.

RESULTS

Soil physico-chemical properties such as salinity, pH, calcium, magnesium, potassium, sulfate ion, bicarbonate, chlorine and percentage of sand, silt and clay were monitored and measured as shown in *Table 1*. Data indicated that the site of experiments was sandy (94.5%).

Results in *Table 2* showed the quantitative indicators that measured in different 13 treatments. Data showed significant differences between the studied treatments in all quantitative indicators (no. of capsule/ plant, capsule weight, and no. of seed/ capsule, weight of 1000 seeds and seed yield/ plant). Capsule weight of sesame crop in all opened pollination

treatments from (T_1 to T_7) had higher values than non opened pollination treatments from (T_8 to T_{13}) in 2011 season, ($F= 26.091$; $P \leq 0.0000$). Number of seed per capsule showed high values in opened pollination than non opened pollination ($F= 88.241$; $P \leq 0.0000$). Thousand seed weight was high in opened pollination than non opened pollination ($F= 57.887$; $P \leq 0.0000$). Seed yield per plant was high in opened pollination than non opened pollination ($F= 659.054$; $P \leq 0.0000$). But, no effect observed on no. of capsule per plant between opened pollination and non opened pollination treatments. Results in *Table* 2 showed that the best treatment was T_6 (Open pollination with 40 kg N /feddan+ seryalin). It produced 2.39 g per capsule weight, 67.1 seeds per capsule, 4.87 g of weight of 1000 seeds and 36.90 g for seed yield per plant. Followed by T_3 (Open pollination with 40 kg N /feddan), 2.34 g, 64.7, 4.78 g and 33.78 g, respectively. Followed by T_5 (Open pollination with 20kg N /feddan + seryalin). It was 2.29 g, 62.4, 4.57 g and 34.10 g, respectively. And then T_2 (Open pollination with 20 kg N /feddan), it was 2.20 g, 61.6, 4.48 g and 30.17 g.

Table 2 - Influence of opened pollination, non opened pollination and nitrogen fertilization on the quantitative indicators of sesame crop in the growing season of 2011.

Treatments	No. of capsule/plant	Capsule weight	No. of seeds/ capsule	Weight of 1000 seeds (g)	Seed yield (g)/plant
T_1	85.5 g	2.15 cd	61.6 bc	4.40 cd	23.17 e
T_2	109.3 bc	2.20 bc	61.6 bc	4.48 bc	30.17 c
T_3	109.2 bc	2.34 a	64.7 ab	4.78 a	33.78 b
T_4	101.7 cde	2.11 cd	59.9 c	4.29 d	26.14 d
T_5	119.6 a	2.29 ab	62.4 bc	4.57 b	34.10 b
T_6	113.6 ab	2.39 a	67.1 a	4.87 a	36.90 a
T_7	95.8 def	2.12 cd	61.4 bc	4.28 d	29.88 c
T_8	97.2 def	2.00 de	40.4 f	3.85 ef	15.16 h
T_9	99.1 de	2.04 cde	51.0 d	3.98 e	20.12 g
T_{10}	94.0 ef	1.74 g	40.4 f	4.02 e	15.27 h
T_{11}	104.7 cd	1.92 ef	46.5 e	3.96 e	19.31 g
T_{12}	101.8 cde	2.05 cde	52.9 d	4.01 e	21.59 f
T_{13}	90.0 fg	1.82 fg	38.7 f	3.73 f	13.01 i
F=	**18.136**	**26.091**	**88.241**	**57.887**	**659.054**
P≤	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**

Means followed by the same letter in a column are not statistically different by Tukey's HSD (P=0.05).

Table 3- Influence of opened pollination, non opened pollination and nitrogen fertilization on the quantitative indicators of sesame crop in the growing season of 2012.

Treatments	No. of capsule/plant	Capsule weight	No. of seeds/ capsule	Weight of 1000 seeds (g)	Seed yield (g)/plant
**T_1	73.1 f	1.95 cd	55.3 c	4.19 e	16.95 f
T_2	76.9 ef	2.01 c	58.2 bc	4.31 d	19.29 d
T_3	95.2 bc	2.23 ab	60.9 ab	4.67 b	27.07 c
T_4	91.4 cd	1.89 de	48.0 d	4.03 f	17.67 e
T_5	105.4 a	2.15 b	60.1 ab	4.54 c	28.83 b
T_6	99.0 b	2.30 a	63.5 a	4.77 a	29.98 a
T_7	77.9 ef	1.90 de	51.1 d	4.13 e	16.45 f
T_8	77.1 ef	1.66 gh	35.6 fg	3.37 j	8.83 i
T_9	77.5 ef	1.74 fg	42.1 e	3.57 h	11.68 h
T_{10}	75.3 f	1.60 h	32.0 g	3.19 k	7.68 j
T_{11}	87.4 d	1.70 gh	38.8 ef	3.47 i	11.77 h
T_{12}	85.1 de	1.81 ef	41.1 e	3.86 g	13.52 g
T_{13}	73.1 f	1.66 gh	32.6 g	3.23 k	7.69 j
F=	**25.427**	**58.589**	**95.091**	**57.887**	**483.241**
$LSD_{0.05}$=	**6.057**	**0.0832**	**3.244**	**0.134**	**0.576**
P≤	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**

Means followed by the same letter in a column are not statistically different by Tukey's HSD (P=0.05).

Also, results in *Table 2* showed the best level of N fertilization in non opened pollination treatments was 40 kg N /feddan+ seryalin (T_{12}), which gave the high results as 2.05 g of capsule weight, 52.9 number of seeds per capsule, 4.01 weight of 1000 seeds and 21.59 g seed yield per plant, followed by 40 kg N /feddan (T_9), with 2.04 g, 51.0, 3.98 g and 20.12 g, respectively. The third level was 20 kg N /feddan+ seryalin (T_{11}), 1.92 g, 46.5, 3.96 g and 19.31 g. Then the level of 20 kg N /feddan (T_8), with 2.0 g, 40.4, 3.85 g and 15.16, respectively.

Data in *Table 3* showed that capsule weight of sesame crop in all opened pollination treatments from (T_1 to T_7) were higher significant than non opened pollination treatments from (T_8 to T_{13}) in 2012 season, ($F= 58.589$; $P \leq 0.0000$). Number of seed per capsule showed high value in opened pollination than non opened pollination ($F= 95.091$; $P \leq 0.0000$). Thousand seed weight was higher in opened pollination than non opened pollination ($F= 57.887$; $P \leq 0.0000$). Seed yield per plant was higher in opened pollination than non opened pollination ($F= 483.241$; $P \leq 0.0000$). But, no effect observed on no. of

capsule per plant between opened pollination and non opened pollination treatments. Results in *Table 3* showed that the best treatment was T_6 (Open pollination with 40 kg N /feddan+ seryalin) It resulted 2.30 g per capsule weight, 63.5 seeds per capsule, 4.77 g of weight of 1000 seeds and 29.98 g for seed yield per plant. Followed by T_3 (Open pollination with 40 kg N /feddan), 2.01 g, 58.2, 4.31 g and 27.07 g, respectively. Followed by T_5 (Open pollination with 20 kg N /feddan + seryalin). It was 2.15 g, 60.1, 4.54 g and 28.83 g, respectively. And then T_2 (Open pollination with 20 kg N /feddan), it was 2.01 g, 58.2, 4.31 g and 19.29 g.

Also, results in *Table 3* showed that T_{12} is the best levels of N fertilization in non opened pollination treatments. The level of 40 kg N /feddan+ seryalin (T_{12}) gave the high results as 1.81 g of capsule weight, 41.1 number of seeds per capsule, 3.86 weight of 1000 seeds and 13.52 g seed yield per plant, followed by 40kg N /feddan (T_9), with 1.74 g, 42.1, 3.57 g and 11.68 g, respectively. The third level was 20 kg N /feddan+ seryalin (T_{11}), 1.70 g, 38.8, 3.47 g and 11.77 g. Then the level of 20kg N /feddan (T_8), with 1.66 g, 35.6, 3.37 g and 8.83, respectively.

Results in *Table 4* showed the qualitative indicators that measured in all 13 treatments in the growing season of 2011. Germination percent recorded high value in (T_6) open pollination with 40 kg N/feddan+seryalin ($F= 5.388$; $P \leq 0.0000$). Seedling vigour (shoot length and root length) recorded high significant value in T_6 with ($F= 223.27$; $P \leq 0.0000$) and ($F= 285.72$; $P \leq 0.0000$), respectively.

Also, oil percent recorded the highest values in T_6 and T_7 than other of treatments. It was ($F= 8.364$; $P \leq 0.0000$). Results in *Table 4* showed that T_{12} (non open pollination with 40 kg N /feddan + seryalin) had significant effect on seedling vigour than the other non opened pollination treatments from T_8 to T_{13}. Shoot length was 7.24 cm and root length was 9.62 cm.

The same trend was found in *Table 5* in the growing season of 2012. Germination percent recorded high value in T_6 open pollination with 40 kg N/feddan+seryalin ($F= 3.363$; $P \leq 0.0011$). Also, seedling vigour (shoot length and root length) recorded high value in T_6 with ($F= 129.96$; $P \leq 0.0000$) and ($F= 448.21$; $P \leq 0.0000$), respectively. Also, oil percent was significant in T_6 and T_7 than the rest of treatments. It was ($F= 7.220$; $P \leq 0.0000$). Results in *Table 5* showed that T_{12} (non open pollination with 40 kg N /feddan+ seryalin) had significant effect on seedling vigour than the rest of non opened pollination treatments from T_8 to T_{13}. Shoot length was 7.72 cm, root length was 8.74 cm.

Table 4 - Influence of opened pollination, non opened pollination and nitrogen fertilization on the qualitative indicators of sesame crop in the growing season of 2011.

Treatments	Germination (%)	Seedlings vigour		Oil (%)
		Shoot length (cm)	Root length (cm)	
T_1	96.50 a	8.0 c	9.84 f	55.75 cde
T_2	96.25 a	8.01 c	10.25 e	56.25 bcde
T_3	95.25 ab	8.44 b	10.55 d	56.25 bcde
T_4	95.25 ab	8.87 a	11.14 b	57.25 abcd
T_5	94.25 abc	8.79 a	10.95 c	57.75 abc
T_6	96.50 a	8.83 a	11.44 a	58.25 a
T_7	93.75 abc	8.27 b	10.36 e	58.75 a
T_8	91.50 abc	6.66 f	8.91 h	54.50 e
T_9	91.50 abc	7.00 e	8.94 h	54.50 e
T_{10}	91.50 abc	6.33 g	8.60 i	54.75 e
T_{11}	90.00 c	6.78 f	8.91 h	55.00 e
T_{12}	90.25 bc	7.24 d	9.62 g	55.25 de
T_{13}	90 c	6.46 g	8.81 h	55.25 de
F=	**5.388**	**223.27**	**285.72**	**8.364**
P≤	**0.0000**	**0.0000**	**0.0000**	**0.0000**

Means followed by the same letter in a column are not statistically different by Tukey's HSD (P=0.05).

Table 5 - Influence of opened pollination, non opened pollination and nitrogen fertilization on the qualitative indicators of sesame crop in the growing season of 2012.

Treatments	Germination (%)	Seedlings vigour		Oil (%)
		Shoot length (cm)	Root length (cm)	
**T_1	91.25 ab	7.97 e	9.20 f	56.25 ab
T_2	94.75 a	8.38 d	9.54 e	56.50 ab
T_3	93.50 ab	8.82 c	9.98 c	55.25 bc
T_4	93.00 ab	9.48 a	10.61 a	55.50 bc
T_5	92.25 ab	9.11 b	10.39 b	56.50 ab
T_6	96.00 a	9.71 a	10.60 a	57.75 a
T_7	93.75 ab	8.73 c	9.73 d	58.00 a
T_8	86.25 b	7.02 g	8.09 j	53.75 c
T_9	87.75 ab	7.23 g	8.51 h	53.50 c
T_{10}	87.75 ab	6.99 g	7.92 k	54.25 bc
T_{11}	88 ab	7.02 g	8.30 i	54.75 bc
T_{12}	88 ab	7.72 f	8.74 g	55.00 bc
T_{13}	87.75 ab	7.02 g	7.94 k	55.00 bc
F=	**3.636**	**129.96**	**448.212**	**7.220**
$LSD_{0.05}$=	**4.938**	**0.247**	**0.1340**	**1.439**
P≤	**0.0011**	**0.0000**	**0.0000**	**0.0000**

Means followed by the same letter in a column are not statistically different by Tukey's HSD (P=0.05).

DISCUSSION

There are very few studies conducted to access yield increment and impact of insect pollination in Egypt. But, it is clear that insect pollination play vital role in producing high yield due to their service in crop pollination. Importance of insects visiting flowers and pollination has been recognized in various crops in many countries (Chandrashekar, 2005; Pattel, 2007; Sajjad, 2009; Dhurve, 2008; Adamson, 2011). Results in (*Tables 2, 3, 4 and 5*) revealed that sesame plants exposed to insect visits had a significant quantity and quality yield than plants from which insects were excluded during the two successive seasons of study. Although some crops can produce without bee pollination, presence of pollinators is important to increase yields, and hence, food security and income. Similarly, bee pollination is essential for reproduction in other crops.

In the present study, there was a significant increase in the quantity and quality of indicators in all treatments of opened pollination field through 2011 and 2012 years. Also, pollination improved of germination and seedling vigour of seeds, so germination is one of the most important stages because if there is a poor stand, no subsequent farmer action or weather condition can produce a high yield. The seedling stage is the most vulnerable stage to perils. At the beginning of the stage, leaf eating insects can destroy the plants, but towards the end, the plants can usually overcome the damage (Langham, 2007). The results obtained from the present study was close in agreement with Cîrnu *et al.* (1978), in Romania, reported that when plants from greenhouses were isolated from honeybees, there was 50-59% fruit set compared to more than 80% fruit set when honeybees were present, and the final yield was 107% high.

In view of the increased cost of chemical fertilizers in recent years, efficient use of fertilizers in combination with organic sources in crop production has became imperative. Balanced fertilization through organic sources and fertilizer would go a long way in maximizing production per unit area, without affecting the soil fertility and productivity. In the present investigation, application of three levels of nitrogen (20, 40 and 60 kg N feddan-^{1}) in the form of ammonium nitrate and three levels of the previous doses with seryalin gave a significant increase in the quantity and quality of parameters in all treatments of opened pollination than non opened pollination field through 2011 and 2012 years. Results recorded significantly increase percent of no. of capsule per plant, capsule weight, no. of seeds per capsule, thousand seeds weight and seed yield per plant seed (32.8, 11.1, 8.9, 10.9 and 59.2% in T_6, 39.8, 6.5, 1.5, 3.8 and 47.1% in T_5, 27.2, 8.8, 5.03, 8.6 and 45.7% in T_3, 27.8, 2.32, 0.0, 1.8 and 30.2 in T_2,

respectively) over absolute control in the growing season of 2011. Also, results showed significantly increase in all quantitative parameters as follows: 35.4, 17.9, 14.8, 13.8 and 76.8% in T_6, 44.1, 10.2, 8.6, 8.3 and 70.08% in T_5, 30.2, 14.3, 10.1, 11.4 and 59.7% in T_3, 5.19, 3.07, 5.2, 2.8 and 13.8 in T_2, respectively, over absolute control in the growing season of 2012 (*Tables 2 and 3*).

Increased seed yield with the application of nitrogen at (40 kg/ feddan) recommended rate in the form of urea (inorganic source) in sesame was in accordance with results reported by Duhoon *et al.* (2004), Deshmukh *et al.* (2002) and Imayavaramban (2002). Application of recommended dose of nitrogen produced significantly higher seed yield over absolute control. The differences in seed yield could be related to the differences in number of capsules per plant, number of seeds per capsule and test weight (*Tables 1 and 2*).

Also, results recorded significantly increase percent in qualitative parameters in the growing season of 2011 as: (T_6), shoot length (8.83 cm) was increased by 10.3 percent, root length (11.44 cm) by 16.2 percent and oil content % (58.25) by 4.48. Also, shoot length of (T_5) increased by 1.2%, root length by 11.2% and oil content by 3.58%. Shoot length of (T_3) increased by 0.68%, root length by 7.2% and oil content by 0.89%. Shoot length of (T_2) increased by 0.12%, root length by 4.1% and oil content by 0.89% over absolute control (T_1). No positive effect was observed in the germination percent in the growing season of 2011.

The similar trend was observed in the growing season of 2012 except recorded significant differences of treatments in germination percent. Germination of (T_6) increased by 5.2%, shoot length by 21.8%, root length by 15.2% and oil content by 2.66%. Germination of (T_5) increased by 1.09%, shoot length by 14.3%, root length by 12.9% and oil content by 0.44%. Germination of (T_3) increased by 2.46%, shoot length by 10.6%, root length by 8.4%. Germination of (T_2) increased by 3.8%, shoot length by 5.1%, root length by 3.9% and oil content by 0.44% than absolute control (T_1). The increase in germination percentage was obviously attributed to the increased bee visitation on crop during the flowering period. These findings are in line with the results of Kalmath and Sattigi (2005) who observed highest germination per cent in onion seeds obtained from plot visited by many species of bees.

The highest seed yield that obtained in opened pollination treatments with 40 kg N feedan^{-1} plus or minus seryalin was supported by the number of capsule per plant. The highest seed yield was due to favorable growth, nitrogen nutrient uptake, higher number of seeds per capsule and heavier seeds. These results agreed with El Mahdi (2008) who found that the highest seed yield and yield components were obtained

with 44 kg N ha^{-1} of sesame crop in Sudan. Also, Noorka *et al*. (2011) stated that increasing N fertilizer level significantly increased plant height, fruiting zone length, height of the first fruiting branch, number of branches and capsule/plant, 1000 seed weight, seed weight /plant, seed oil content and seed and oil yields/ha.

CONCLUSION

The findings of this study recommended that even though application of opened pollination and nitrogen at the level up to 40 kg N $feedan^{-1}$ plus or minus seryalin in reclaimed sandy soils in Ismailia Governorate, Egypt, increased the quantity and quality of sesame yield; higher seed yield could be enhanced through integrated management, especially if this rate is applied in conjunction with other cultural practices such as crop rotation, inter-cropping, planting date manipulation, plant spacing and biological control.

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