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Evaluation agronomic traits of canola *(Brassica napus L.)* under organic, bio- and chemical fertilizers

Kuzey Mısır Deltasında, biyo, organik ve mineral azotta yetiştirilen kanolanın (Brassica napus L.) *agronomik özelliklerinin değerlendirilmesi*

Ayman El Sabagh[1], Abd Elhamid Omar[1], Hirofoumi Saneoka[2], Celaleddin Barutçular[3]

[1]*Department of Agronomy, Faculty of Agriculture, Kafrelsheikh University, Egypt*
[2]*Department of Plant Nutritional Physiology, Graduate School of Biosphere Science, Hiroshima University, Japan*
[3]*Department of Field Crops, Faculty of Agriculture, University of Cukurova, Turkey*

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ABSTRACT

This study was carried out to evaluate the effect different sources and rates of nitrogen fertilizers on yield traits of canola under Egyptian conditions. The experiment was conducted at the Experimental Farm of Faculty of Agriculture, Kafr El-Sheikh University, Egypt during the two successive winter season of 2004/2005 and 2005/2006. The experimental design was a strip - split plot with four replicates, Bio-fertilizer was in horizontal plots: without bio-fertilizer and with bio-fertilizer. Compost was in vertical plots: control, 6, 12 and 18 ton ha-1. Nitrogen was arranged in sub vertical plots: (control, 36, 72 and 108 kg N ha-1). Result revealed that, the bio fertilizer effects on seed yield and yield traits was significant as compare to control. Compost significantly improved yield and yield components of canola and the rate up to 18 ton ha-1 was more effective. Chemical nitrogen significantly improved on yield parameters and the rate of 108 kg ha-1 produced the highest seed yield and yield traits. The findings clearly showed that combined application of bio-fertilizer plus 108 kg N ha-1 adding with 18 ton compost ha-1 has resulted in obtaining highest seed yield and yield components. While, according to the results, bio-fertilizer could be increased the nitrogen uptake efficient and could be helpful with compost rate (<12 ton compost ha-1) or moderated chemical nitrogen (>72 kg N ha-1). So, using bio-fertilizer combined with organic and inorganic nitrogen could be improve seed yield and reducing the need for chemical fertilizers and that will lead to sustainable agriculture.

Keywords: *Canola, Bio-fertilizer, Compost, N-fertilizer, Yield*

ÖZET

Bu çalışma, Kuzey Mısır Deltasında, farklı kaynaklı ve miktardaki azotlu gübrelerin kanolanın verim özelliklerine etkisini araştırımak amacıyla yapılmıştır. Deneme, Mısır'ın Kafr El-Sheikh Üniversitesi, Ziraat Fakültesinin Deneme Çiftliğinde 2004/2005 ve 2005/2006 iki kış sezonunda yürütülmüştür. Deneme, şerit bloklarında bölünmüş parsellerde dört tekrarlamalı tesadüf parseller olarak, biyo-gübre dikey parseller (Biyo-gübresiz ve biyo-gübreli) olarak planlanmıştır. Kompost, yatayda: kontrol, 6, 12 ve 18 kg compost ha-1 olarak düzenlenmiştir. Mineral azot, dikey alt parseller: kontrol, 36, 72 ve 108 kg N ha-1 olarak düzenlenmiştir. Biyo-gübre uygulamasının, bitkide dal sayısı, bitkide harnup sayısı, harnupta tohum sayısı, 1000-tohum ağırlığı, bitkide veya hektarda tohum verimi, biyolojik verim ve hasat indeksine etkileri önemli bulunmuştur. Verim özellikleri, compost ve azot düzeyindeki yükselişlerle birlikte iyileşmiştir. Biyo-gübrenin verime etkisi, mineral gübre artışı ile önemli etkileşim yaparak yüksek tohum verimini sağlamıştır. Sonuçlar, biyo-gübre, organik azotun sınırlı (<12 ton compost ha-1) veya mineral azotun yüksek olduğu (>72 kg N ha-1) alanlarda azot alımını artırmış olduğunu göstermiştir. Biyo-gübrenin, organik veya inorganik azot ile birlikte kullanımı dikkate alındığında, verimi önemli düzeyde artırmış ve çevre konusunda da yeni bir bakış açısı sağlamıştır.

Anahtar sözcükler: *Kanola, Biyo-gübre, Kompost, Azotlu gübre, Verim*

Corresponding address: Ayman El Sabagh
E-mail: aymanelsabagh@gmail.com

1.Introduction

Canola *(Brassica napus L.)* is one of the most important annual oil and protein crops in the world. Generally, Canola plant oil has lowest saturated fatty acids content among vegetable oils and thus presents an increasing demand for consumers of diet conscious. Moreover, the residue left after oil extraction is rich in proteins and can be used for animal feeding (1). Canola Cultivation in Egypt may provide an opportunity to overcome some of deficiency of edible oil production in Egypt. In addition to, Canola could be successfully grown in newly reclaimed land outside the old land of Nile valley in order to avoid the competition with other crops occupied the old cultivated area (2,3). Canola Suitability growing under Egyptian conditions, compared with other oil crops, may be due to the tolerance of canola to harsh environmental influences frequently prevailing in such newly reclaimed land like, salinity and drought (4). Several studies show that canola is very responsive to N (5) and N is a critical limiting factor for the yield (6).Canola Characteristics such as plant height, number of branches per plant, number of pods per plant, seed yield and oil content are positively correlated with soil N level (7). Canola yield traits is affected indirectly by N as a result of increased stem length, higher number of flowering branches, total plant weight, seeds per pod, and number and weight of pods and seeds per plant (8).

Currently, the Intensive use of chemical fertilizers a significant problem to environmental and increasing of production cost. Moreover, There environmental problems has raised interest in environmental friendly sustainable agricultural practices, which can reduce input costs (9).Concerning application of bio-fertilizers on soils has decreased the pH, which had led to increase the availability of trace elements that enhance plant growth. In addition to, bio-fertilizers are eco-friendly and have been proved to be effective and economical alternate of chemical fertilizers with lesser input of capital and energy (10). Also, adding of compost improves soil fertility by increasing both the quantity and the quality of soil organic matter (11). Therefore, keeping in view the importance of this technique the present study was planned to improve and maximizing the productivity of Canola under North Delta of Egypt by studying the effect of bio - organic and nitrogen fertilizers on yield and its traits.

2. Materials and Methods

Two field experiments were carried out in the Farm of the Faculty of Agriculture, Kafr El-Sheikh University, Egypt during the two successive winter season of 2004/2005 and 2005/2006, to study the effect of different sources and rates of nitrogen fertilizers on yield of Canola (Brassica napus L. var. serw4) under North Delta of Egypt. All treatments were arranged in a strip spilt plot design with four replications. The Horizontal plots were as follows: without bio-fertilizer and with bio-fertilizer. The vertical plots were devoted to the four soil application of compost fertilizer rates as follows; control, 6, 12 and 18 ton ha-1. Sub vertical plots were devoted to the nitrogen fertilizer treatments in the form ammonium sulphate (20.6%) which distributed randomly in sub-sub plots as follows; control, 36, 72 and 108 kg N ha-1. Before soil preparation, soil samples of the experimental sites were taken at the depth of 0- 30 cm. Mechanical and chemical analysis was determined according to Cohenie et al. (12) and Page et al. (13) (Table1).

Each plot area was 10.5 m2 and each plot included 6 rows (3.5 m long and 50 cm. apart) with 20 cm between hills. Compost is manufactured using rice hay (60%), farmyard manure (25%), poultry manure (10%) and fertile soil (5%). Farmyard manure, poultry manure and soil were thoroughly mixed. Seeds were sown on 15th and 10th of November in the first and the second seasons, respectively. Seeds of canola were successively washed and soaked for 30 minute in culture of efficient strain of Azotobacter according treatments. Bacterial strain was obtained from microbiology departmen. Soil and Water Res. Inst., ARC, Giza, Egypt. Nitrogen fertilizers in the form of ammonium sulfate (20.5 % N) was applied in two doses, one third at planting time and the residual after thinning just before the first irrigation. Phosphorus and potassium fertilizers were added before sowing at the rate

Table 1: Mechanical and chemical analysis of the experimental soils.

Determination	**Season**	
	2004/ 2005	**2005/ 2006**
Mechanical features		
Sand %	12	11
Silt %	32	33
Clay %	56	57
Soil texure	Clay	Clay
Chemical features		
pH	8.25	8.1
Organic matter	1.55	1.65
Available nitrogen p.pm	22	21
Available phosphors p.pm	13.9	14.8
Available potassium p.pm	255	275

of (200) and (100) kg ha-1 of calcium supper phosphate (15.5% P2O5) and potassium sulphate (48% K2O), respectively.

2.1. Measurements

Branches plant-1: branches plant-1 was determined at maturity by counting on the main stem per ten randomly selected plants from each plot.

Pods plant-1: Ttotal number of pods per ten randomly selected plants from each plot were counted and then averaged.

Seeds pod-1: Number of seeds in 100 pods were counted and then averaged per pod.

1000 seed weight (g): Three samples each of 1000-seeds, were taken at random from the seed lot of each plot, weighed and their average was calculated.

Seed yield plant-1 (gm): This trait was determined by weighting the average of seed weight of ten plants in grams (after natural dryness).

Seed yield kg ha-1: Harvesting was carried out at 160 and 170 days after sowing in two growing seasons, respectively. Plants of two square meters from the middle part of each plot were harvested and estimated the seed yield plot-1 and then converted to ton/fad-1.

Biological yield (ton ha-1): Crop was harvested at maturity, sun dried and then weighed with the help of spring balance to determine the total biomass plot-1 and then converted to kg ha-1.

Harvest index (%): Harvest index was estimated according to Yoshida (14) by subdividing weight of dry grain yield in (kg) on the total dry weight (Weight of grains and straw).

$$\text{H. I \%} = \frac{\text{Seed yield}}{\text{Biological yield}} \text{x}100$$

2.2. Statistical analysis

The analysis of variance was carried out according to Gomez and Gomez (15). Treatment means were compared by Duncan's Multiple Range Test (16). Stastical analysis was performed using analysis of variance technique by means of "MSTATC" computer software package.

3. Results and Discussion

3.1. Number of Branches

Number of branches per plant significantly increased in bio-fertilizer inoculated plant in both seasons (Table. 2). This finding was supported by Yasari and Patwardhan (17). Performance of bio-fertilizers could be explained by the fixation of sufficient atmospheric nitrogen, production of plant growth promoters, decreasing the ethylene production in plants and solubilization of minerals such as phosphorus (18,19).

The application of 18 ton compost per hectare was produced the highest number of branches per plant in both seasons (Table 2). Similar results were reported by Premi et al. (20, 21). Number of branches per plant was significantly increased with increasing nitrogen levels gradually from zero up to 108 kg N ha-1 (Table 2). This increase may be due to the basis that nitrogen is essential for building up protoplast and proteins which induce cell division and elongation which reflected on the progress happened in branches plant-1.These results harmony with these of Sharief and Keshta; Leilah et al. (22, 23). Several other studies have also been reported by Butter et al. and Ozer (24, 25) with the positive effects of the rate of N-fertilization on the number of branches in canola, which is not far from expectation as N fertilizers stimulate better plant growth and development.

3.2. Number of Pods Per Plant

Number of pods plant-1 was statistically increased by the application of bio-fertilizer (Table. 2). The results are in agreement with the findings of Gupta and Samnotra (26) who concluded that simultaneous application of Azotobacter had a significant effect on yield traits. Yasari et al., (27,28) reported that treatment canola with bio-fertilizer resulted in maximum seed yield coinciding with maximum number of pods plant-1.

Application of 18 ton ha-1 of compost produced the highest of number of pods plant-1 (Table 2). These might be due to the improvement in plant growth and could help in increasing nutrient availability from applied and native sources and mineralization of macro and microelements particularly nitrogen, which may increase the minerals availability to the plants. The results are in agreement with the results of Premi et al. and Eghball (20,21,29).

Number of pods plant-1 increased significantly with increasing nitrogen levels in the two seasons. Each increment of applied nitrogen resulted in a significant

Table 2: Means of number of brances and pods per plant, seeds per pod and 1000-seed weight as as affected by different nitrogen sources and rates during 2004 and 2005 season.

Factor	Branches plant^{-1}		Pods plant^{-1}		Seeds pod^{-1}		1000- seed weight, g	
	2004	2005	2004	2005	2004	2005	2004	2005
Biofertilizer (A)								
Without inoculation	10.983b	11.031b	473.938b	477.234b	26.714b	27.169b	3.991b	3.913b
Inoculation(Azotobacter)	11.495a	11.480a	525.672a	525.859a	28.078a	28.002a	4.212a	4.077a
F. test	**	**	**	**	**	**	**	**
Compost rate (ton/ ha) (B)								
Control	9.325d	9.425d	472.906c	481.219d	25.813b	25.850d	3.749d	3.814d
6	10.819c	10.166c	484.406b	478.875c	26.50b	26.187c	3.962c	4.013c
12	11.966b	12.134b	483.063bc	490.813b	28.406a	28.237b	4.223b	3.966b
18	12.847a	13.297a	558.844a	555.281a	28.875a	30.66a	4.472a	4.168a
F. test	**	**	**	**	**	**	**	**
N. level (kg N/ ha) (C)								
Control	10.216d	9.916d	447.719d	445.469d	25.250d	26.584d	3.821d	3.835d
36	10.753c	10.687c	477.406c	482.906c	26.50c	27.469c	3.962c	3.901c
72	11.025b	11.719b	510.594b	519.219b	27.875b	28.028b	4.166b	3.947b
108	12.462a	12.700a	563.500a	558.594a	29.969a	28.59a	4.458a	4.247a
F. test	**	**	**	**	**	**	**	**
Interaction								
A * B	N. S	N. S	*	**	*	*	N. S	*
A * C	N. S	N. S	N. S	**	N. S	N. S	N. S	**
B * C	N. S	**	**	**	*	**	**	**
A * B * C	N. S	N. S	*	**	N. S	**	N. S	*

***: highly significant at the 1% level of probability .means within the same column of each factor followed by a common latter is not significantly different at 5% level, by DMRT.*

increase in number of pods plant-1. The increase in amount of metabolites synthesized by plant under nitrogen fertilization treatments could possibly be due to more transformation of photosynthates to reproductive parts. Similar results were also reported by Bali et al. (30); Taha (31, 32); Singh and Singh (33).

3.3. Number of Seeds Per Pod

Number of seeds pod-1 was significantly increased by inoculation with Azotobacter bio-fertilizer in both seasons (Table.2). Similar results were reported by Sushlila and Giri (34).

Number of seeds per pod was significantly increased by each increment of applied compost fertilizer in both seasons (Table. 2). Such increase could be due to availability to growing plants as well as on improving soil physical properties and provide plant with different nutrient elements. Premi et al. (20,21) and Maamoun (35) also found the similar results in Indian mustard. Higher number of pods and bolder seeds as a result of availability of major and minor nutrients at all the essential stages of growth and development. According to Edwards et al. (36) vermi-compost had significant effects on plants germination, growth, flowering, fruiting and yields. Seed number per pods influenced by bio fertilizer treatments.

Number of seeds pod-1 also significantly increased with increase of applied nitrogen fertilizer (Table 2). Similar findings were reported by Bali et al. (30), Taha (31,32), Momoh et al. (37). Several workers like Ozer (25) have also reported positive response of canola by increasing level of N fertilization.

3.4. Weight of 1000-Seed

Weight of 1000-seed was significantly increased by seed inoculation with bio-fertilizer (Table 2). Bio-fertilizers improved photosynthesis may be by increasing water and nutrients absorption leading to produce more assimilate and improve plant growth and thus, 1000-seed weight increased in compared with non-inoculation treatment. The results are in agreement with the results of Hamidi et al. (38).

Weight of 1000-seed was also significantly increased by each increment of applied compost fertilizer in both seasons (Table 2). It might be due to the increased available nutrient elements in the soil and improve soil structure. Some researchers such as Allen and Morgan (39) suggest that at this short time window, the supply of assimilates to the pod and eventually to the seed has a crucial role in the seed development.

Increasing nitrogen level application from 36 to 108 kg N ha-1 had significantly increased 1000-seed weight in the two seasons (Table 2). Similar results were also reported by Sharief and Keshta (22), Taha (31,32) and Momoh et al. (37) in rape and mustard. Ahmadi and Bahrani (7) did not find any significant effect for increased N levels on 1000-seed weight.

3.5. Seed Yield Per Plant

Inoculation with bio-fertilizer was highly significant on the seed yield per plant in both seasons (Table 3). This may be due to N2- fixation, which improves plant growth, and reflected on seed yield plant-1. These results are in agreement with Mohamed (40). Compost application significantly increased seed yield per plant in both seasons (Table 3). Compost amended soil, improved organic matter content which enhanced the seed yield. Compost can provide all nutrients in readily available form and also enhance uptake of nutrients by crops as reported Nagavallemma et al. (41).

Increasing nitrogen levels up to 108 kg N ha-1 significantly increased seed yield per plant in both seasons (Table 3). This might be due to the increase in different yield components and improvement of growth parameters, thus led to maximum of yield plant-1. Similar result was obtained by (Singh and Singh (33).

3.6. Seed Yield Per Hectar

Adding bio-fertilizer significantly increased seed yield ha-1 and this fact is true in the two seasons (Table 3). These results are in agreement with those obtained by Ahmed (42), Farag (43), and Mohamed (40). Yasari et al. (27) reported that treatment of canola with bio-fertilizer resulted in maximum seed yield coinciding with maximum number of pods plant-1.

Application of compost fertilizer potentially improved seed yield per hectare in both seasons (Table 3). The positive effects of adding compost fertilizer (18 ton ha-1) on seed yield was mainly due to the role of organic manure in increasing the contents of organic matter which increase the biological activities of soils. Similar results were reported by Subbiah and Kumaraswamy (44) in rice and Leilah et al. (45) in mustard. Organic matter improves soil structure, beside its role in increasing water holding capacity and exchange capacity. It also decreases susceptibility to erosion, lead to an increase in the availability of nutrient. In addition, to increase the activity of macro and trace elements and this was reflected in increasing seed yield ha-1 as reported by Haikle et al. (46), Maamoun (35) and Abdel-Ati (47).

Table 3: Means of seed yield (g plant^{-1}) and seed yield (kg ha^{-1}), biological yield (kg ha^{-1}) and harvest index (%) as influenced by different nitrogen sources and rates during 2004 and 2005 season.

Factor	Seed yield (g plant^{-1})		Seed yield (ton ha^{-1})		Biological yield (ton ha^{-1})		Harvest index (%)	
	2004	2005	2004	2005	2004	2005	2004	2005
Biofertilizer (A)								
Without inoculation	32.700b	31.842b	3.519b	3.793b	14.229b	15.387b	24.624b	24.570b
Inoculation(Azotobacter)	35.142a	34.880a	3.940a	4.172a	15.100a	16.204a	25.908a	25.543a
F. test	**	**	*	**	**	**	*	**
Compost rate (ton ha^{-1}) (B)								
Control	28.669d	29.391d	3.039d	3.387d	11.891d	13.360j	25,4	25.260a
6	31.498c	31.622c	3.564c	3.332c	13.606c	14.674c	25,981	25.721a
12	33.802b	34.609b	3.882b	4.041b	15.679b	16.595b	24,544	24.192b
18	38.334a	37.822a	4.431a	6.689a	17.480a	18.553a	25,139	25.052ab
F. test	**	**	**	**	**	**	N. S	*
N. level (kg N ha^{-1}) (C)								
Control	27.845d	29.394d	2.740d	2.888d	12.910d	14.009d	21.433d	20.854c
36	32.922c	32.197c	3.560c	3.915c	14.028c	15.171c	25.410c	25.787b
72	36.156b	34.697b	4.103b	3.308b	15.300b	16.488b	26.806b	26.077b
108	38.766a	37.156a	4.512a	4.813a	16.419a	17.515a	27.417a	27.507a
F. test	**	**	**	**	**	**	**	**
Interaction								
A * B	**	**	*	**	**	N. S	*	**
A * C	**	**	**	**	N. S	N. S	*	**
B * C	**	**	**	**	*	N. S	**	**
A * B * C	**	*	*	N. S	N. S	N. S	N. S	N. S

** and **: ignificant at the 5% and 1%, respectively.*
Means within the same column of each factor followed by a common latter is not significantly different at 5% level, by DMRT.

Increasing nitrogen fertilizer up to 108 kg N ha-1 significantly increased seed yield (ton ha-1) (Table 3). This increment in seed yield might be due to the application of nitrogen influenced and improved growth attributes and seed components. Similar results were reported by Mahal and Singh (48), Taha (31,32), Singh and Singh (33), El-Kholy et al. (49). Similar studies opined by Ahmadi, Bahrani (7) and Butter et al. (24) that canola seed yield increase as a result of high rate application of N fertilizer.

Regarding the combination among chemical fertilizer, organic and bio-fertilizer were positive on seed yield (Figure 1). The highest seed yield was obtained from combined application of bio-fertilizer plus 108 kg N ha-1 adding with 18 ton compost ha-1 has resulted in obtaining highest growth and seed yield. While, Moderate nitrogen (72 kg ha-1) and compost application (12 tha-1) with combining Azotobacter inoculated can be more effective and beneficial to improve seed yield of canola plants. Ram et al. (50) and Mohamed (51) observed the similar results in rice. These results are in a good harmony with those reported by Yadav et al. (52) for wheat.

3.7. Biological Yield

Data presented in (Table. 3) indicated that inoculation of bio-fertilizer had a highly significant effect on biological yield. These results are in harmony with the finding of Ahmed (42) and Farag (43). It seems that bio-fertilizers had the highest effect on economical and biological yield compared to without bio fertilizer (53). The increase in biological yield might be due to the increase in yield component of canola with bio-fertilizer inoculation and bacteria produce plant growth regulators in N-free media which improved plant growth, Ibiene et al (54).

Application of compost exhibited on biological yield (Table 3).The best value of biological yield were obtained at application of 18 ton compost ha-1 in both seasons. These results are in agreement with by Ram et al. (50). Organic manure plays a very vital role in the process of grain filling, increase leaf area of the crop and may result in increased dry matter production by intercepting more sun light Wu et al. (55).

Increasing nitrogen fertilizer from 36 to 108 kg N ha-1 was highly significant on the increasing biological yield in the two seasons (Table 3). This may be due to the role of nitrogen in increasing the growth parameters and this in turn led to an increase in biological yield. Similar results were obtained by Singh and Singh (33).

3.8. Harvest Index

Adding bio-fertilizer significantly influenced on the harvest index canola in the consecutive two years (Table 3). Brown and Walker (56) supported the results. Brown (57) indicated the beneficial impacts on plant growth of canola. Moreover, its main function is N2 fixation that leads to the improvement of canola yield and yield attributes as reported by Bali et al. (30) in brown sarson, Farag (43) in wheat and Kumar et al. (58) in Brassica species.

The data in (Table 3) showed that compost fertilizer application significantly improved harvest index. Similar results were reported by Sedeek (59). Organic matter

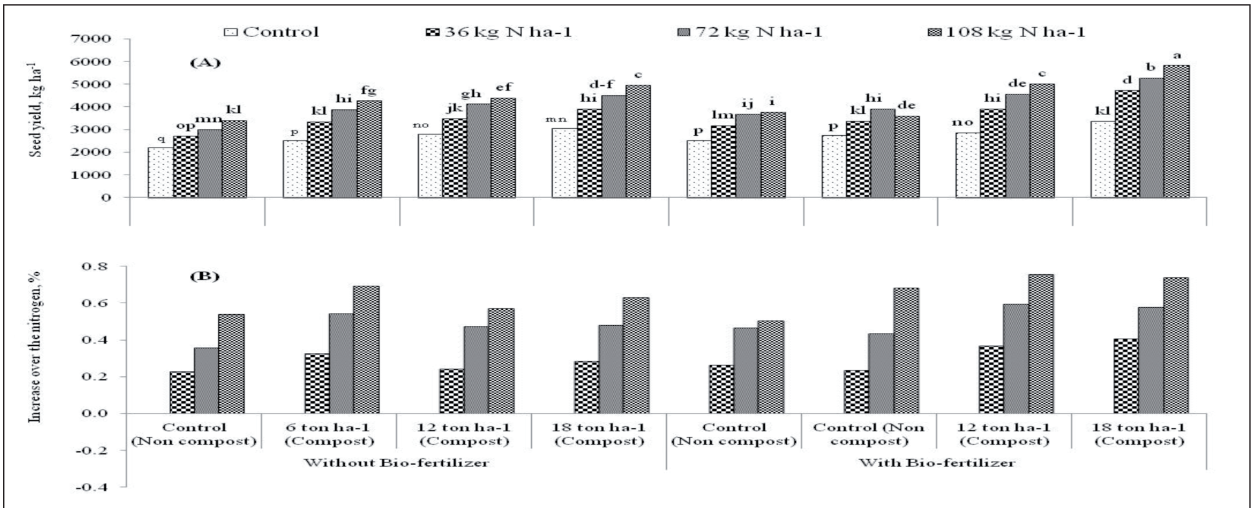

Figure 1: Effects of organic and chemical nitrogen fertilizer with and without bio-fertilizer on seed yield (kg ha-1) (A) and gain of nitrogen on yield comparing to control nitrogen (B) during the 2004/2005 and 2005/2006 seasons.

play role in decreasing susceptibility to erosion, lead to an increase in the availability of nutrient and increasing the activity of macro and trace elements and this was reflected in increasing seed yield ha-1 ,these results were obtained by Haikle et al. (46), Maamoun (35) and Abdel-Ati (47).

Nitrogen fertilizer levels had a highly significant influence on harvest index and HI increased with increasing nitrogen levels. The highest value of HI was obtained at the application of 108 kg N ha-1 in both seasons (Table 3). Similar results were reported by Mahal and Singh (48). Increasing the rate of fertilizer application was shown to increase the HI in other studies such as Faramarzi et al. (60), Cheema et al. (61) in the same species.

4. Conclusion

The findings of this study have clearly showed that combined application of bio-fertilizer plus 108 kg N ha-1 adding with 18 ton compost ha-1 has resulted in obtaining highest seed yield. While, bio-fertilizer could be increased the efficiency of nitrogen uptake and its helpful with compost rate (<12 ton compost ha-1) or moderated chemical nitrogen (>72 kg N ha-1). So it could be considered using bio-fertilizer combined with organic and inorganic nitrogen significantly improved the productivity of canola and a suitable substitute from the environmental point of view.

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