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RESPONSE OF CANOLA PRODUCTIVITY AND QUALITY TO BIO- ORGANIC AND INORGANIC N – FERTILIZERS

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ABSTRACT

A field experiment was conducted at the Ismailia A**g**ricultural Research Station during the two growing seasons of 2008-09 and 2009-10, to study the separate application of biofertilizers, organic manure (0, 5, and 10 tons/fed) and mineral N-fertilizer (0, 40, 60, and 80 kg N/fed) and their combined application on plant growth, yield and its components, seed quality (oil and protein content) of canola plants (c.v. Serw 4). Split-spilt plot design with three replicates was used.

Results indicated that the individual application of biofertilizer, organic manure (10 ton/fed) and N-fertilizer at rate 80 kg N/fed caused 5.1 and 4.9 %, 18.5 and 16.6% and 40 and 40.3 % in seed yield during two seasons, respectively over control. Likewise, the interaction among the used levels of mineral N-fertilizer and bio-organic fertilizer revealed significant effect in both studied seasons for all investigated characters of canola plants. In this respect, it is worthy to note that the treatment of 80 kg N/fed of the recommended dose of N did not statistically differ from that of 40 kg N/fed of N fertilizer plus biofertilizer and 10 tons/fed compost manure. As for seed quality of canola, it was also found that protein content was increased by application of bio, organic, and inorganic N-fertilizer. However oil content was decreased by nitrogen application but it was increased with addition of biofertilizer and compost manure. Seed protein and oil content were significantly increased by the integrated fertilizers applications. This mean that inoculated seed of canola plant with biofertilizer containing nitrogen fixer bacteria plus addition of compost manure at 10 ton/fed., substitute half of the recommended dose from the used mineral nitrogen fertilizer.

Keywords: Canola, Productivity, Quality, Bio-organic fertilizer and Inorganic N-fertilizer.

INTRODUCTION

Application of fertilizers has become a necessity in the crop production of oil seed especially canola, because of the ever increasing demand of health conscious population of the world. In Egypt, also, efforts are being made to increase the areas under cover oil seed crops as much of the edible oil is important. It is well known that N-P-K fertilizer help in the healthy growth of crops like canola (Yasari & Patwardhan 2007 and Yasari *et al.* 2009. Canola has relatively high requirement of nitrogen(Karamzadeh *et al.* 2010) and (Kazemeini *et al.* , 2010) Several studies have shown that N is a critical limiting factor for canola production (Jackson, 2000). Characteristics of canola such as plant height, number of branches per plant, number of pods per plant, seed yield are positively correlated with soil N level (Ahmadi and Barhrani, 2009). Canola yield is also indirectly affected by N as a result of increased stem length, higher number of flowering branches, total plant weight, seed per pod, number and weight of pods and seed per plant (Taylor *et al.* 1991). The significance of higher soil nutrient and particulary nitrogen

availability in affecting the yield quantity and quality of winter oilseed crop has been underline by other workers Cheema *et al.* 2001, Hocking *et al.* 2002, Malhi and Gill 2004 Rathke *et al.* 2005 & 2006, Balint and Rangel 2008, Gan *et al.* 2008,. Excessive nitrogen fertilizer of generates that environmental risk and it may also affected canola grain quality, reducing its oil content Ogulela *et al.* 1990, Taylor *et al.* 1991, Rathke *et al.* 2005 and Karamzadeh *et al* 2010.

The current emphases is on the integrated use of different sources of nutrients such as organic manure and bio-fertilizer in combination with chemical fertilizers being less expensive, easily available and eco-friendly, expected improve soil fertility, crop yield and quality (Patidar and Malhi 2004). Further, nitrogen input from organic fertilizer and biological nitrogen fixation might be a substantial source of N depending on the farming system. Nitrogen sources influencing yield of canola include mineral N fertilizers, N mineralized from organic fertilizers, and N mineralized from residue of previous crop (Rathke *et al.* 2005).

Organic agricultural practices aim to enhance biodiversity, biological cycles, and soil biological activity so as to achieve optimal natural systems that are socially, ecologically and economically sustainable (Samman *et al.* 2008). Manure has always been considered as a valuable input to soil for crop production. Composting organic wastes and their enrichment with suitable amount of chemical fertilizer could enhance fertilizer use efficiency and recycle organic waste materials and organic matter into soil, restoring soil health and improving crop yield on sustainable basis. In another study, it was shown that application of 100 kgN/ha with 50 ton/ha compost was adequate of optimum seed yield of canola (Kazemini *et al.* 2010).

Soil microbes play an important role in much critical ecosystem process, including nutrient cycling and homoestasis, decomposition of organic matter, as well as promoting plant health and growth as bio-fertilization (Han *et al.* 2007). Certain strains are referred to Plant Growth – Promoting Rhizobacteria (PGPR), which can be used as inoculants bio-fertilizers (Mantelin and Touraine 2004). These bacteria include species of Azotobacter and Azospirillum, both of which provide direct and indirect effect on plant growth and pest resistance Hayat *et al.* 2010, vega 2007 and Gholamie *et al.* 2009. recently, biofertilizers have emerged as a promising component of integrating nutrient supply system in agriculture. Our whole system of agriculture depends in many important ways on microbial activities and there appears to be a tremendous potential for making use of microorganisms in increasing crop production. Microbiological fertilizers are an important part of environment friendly sustainable agricultural practices (Akbari *et al.* 2011).

Therefore, the present study was carried out to investigate the integrated effect of organic manures, N-fixing bio-fertilizer in combination with mineral N-fertilizer on growth, yield its components, chemical constituents, and seed quality of canola plants grown on sandy soil in an attempt to enhance the productivity of canola yield. Moreover to investigate the possibility of partial or complete substituting chemical fertilizer by N-fixing bio-fertilizer and organic manure combined with different portion from mineral

nitrogen fertilizer recommended rate (100%) which in turn could reduce environmental pollution caused by repeated application of mineral fertilizer.

MATERIALS AND METHODS

Field experiment was conducted at Ismaillia Agriculture Research Station, during two growing seasons of 2008-2009 and 2009-2010 in order to study the effect of inoculation of canola seeds (*Brassica napus* L.c.v. Serw 4) with mixture of nitrogen fixing bacteria namely (Azotobacter sp. and Azospirillum sp), organic manure and chemical nitrogen fertilizer on growth, yield and its components as well as seed quality of canola. The experiment was laid out in split spilt plot design with three replications. Bio-fertilizer was in main plots, at two different levels (1) control (no seed inoculation B0) and (2)(seed inoculation with N-fixing bacteria B1). Organic manure was in subplot at rates of no compost (C_0), 5 tons (C_1) and 10 ton compost/fed (C_2). While the levels of mineral nitrogen fertilizer were allocated for sub-sub main plot as follow:

(N_0) control (no nitrogen).
(N_1) 50% of the recommended dose (40 kg N/fed).
(N_2) 75% of the recommended dose (60 kg N/fed).
(N_3) 100% of the recommended dose (80 kg N/fed).

Some physical and chemical characteristics of the studied soil surface as well as compost analysis were analyzed according to (Jackson, 1973) and are shown in Table 1 and 2.

Seeds of canola were sown when directly in hills at the rate of 2 kg / fed (3 seeds / hill). After three weeks from planting, seedling were thinned out to one plant per hill. Cultural practices were carried out as recommended. The recommended dose of phosphorous in the form of superphosphate(15.5 % P_2O_5) and potassium fertilizer in the form of potassium sulphate and were added at the rates of 60 kg P_2O_5/ fed and 48 kg K_2O/ fed., respectively. Both organic and phosphorous fertilizers were added before sowing during preparation of land. Nitrogen and potassium fertilizer were divided into two equal portions. The first one was added after three weeks from the sowing and the second one was added after a month from the first one.

In both growing seasons samples of plant from each treatment were taken after 90 days from sowing. Plant height, number of branches / plant and dry matter of shoot / plant were recorded.At harvest, the canola plants of three inner rows from each sub-plot were collected to determine the seed yield and yield attributes namely number of pods /plant and weight of 1000 seed (g). Random samples of seed representing to each replicate of all treats were collected, oven dried, digested and assigned for analyzing N (Chapman and Pratt 1961). Crude protein percentage was calculated by multiplying N % by the converting factor 6.25. Seed oil percentage was determined according to (A.O.A.C. 1995). Oil yield (kg/fed) was calculated by multiplying oil percentage by seed yield.

Table 1. Some physical and chemical properties of the studied soil

Soil characteristic	Season 1	Season 2
Particle size distribution %		
- Coorse sand	76.01	75.30
- Fine sand	11.60	12.53
- Silt	4.61	3.97
- Clay	7.78	8.20
- Texture class	Sand	Sand
Calcium carbonate %	0.19	0.21
Organic matter %	0.39	0.43
CEC (c molc/kg soil)	3.31	3.20
pH 1: 2.5 soil water suspension	7.38	7.84
EC dsm^{-1} (soil paste extract)	0.43	0.47
* Soluble cations ($mmol_c/L$)		
- Ca^{+2}	1.13	1.28
- Mg^{+2}	1.77	1.85
- Na^{+}	1.28	1.33
- K^{+}	0.17	0.30
* Soluble anions ($mmol_c/L$)		
- Co_3^{2-}	0.00	0.00
- HCO_3^{-}	2.30	2.70
- Cl^{-}	1.41	1.50
- SO_4^{2-}	0.64	0.56
Available nutrients (mg/kg soil)		
- N	17.5	18.7
- P	8.33	8.92
- K	38.20	37.50

***Soil past extract**

Table 2: Compost manure analysis

Characteristic	Season (1)	Season(2)
Density (g cm^{-3})	0.54	0.49
Organic matter %	24.64	27.03
Organic carbon %	14.33	15.72
Total N %	0.41	0.40
Total P %	0.28	0.30
Total K %	0.31	0.33
C/N Ratio	23.50	24.22
EC dSm^{-1} (manure extract 1:5)	2.4	2.6
pH (1 : 5) suspension	7.66	7.85

RESULTS AND DISCUSSION

Plant growth parameters and yield traits:

Data presented in Tables (3 a, b and c) as well as Tables (4 a, b and c) showed the main effect of bio-fertilizers, compost manure and mineral N fertilizer and their interaction on plant growth characters and yield components during both seasons. Addition of bio-fertilizer significantly increased the values of growth parameters and yield traits compared to uninoculated reeatment in both seasons. The increments in plant growth

characters of canola plant due to bio- fertilization treatment were 5.3 and 5.2% for plant height, 5.2 and 5 % for dry matter plant and 6.9 and 5.5 % for number of branches /plant over control in the first and second seasons, respectively. The effectiveness of bio-fertilizer to increase plant growth parameters could be ascribed to non- symbiotic nitrogen fixation and production of growth hormones. The beneficial effect of Azospirillum on dry matter production was also reported by Kumar 1993, Sharma and Agrawal 2002, Ekram and Mahfouz 2010 and Hayat *et al.* 2010.

Data also revealed that the inoculation with Azotobacter and Azospirillum helped to increased the number of pods /plant where values of 6.2 and 6.4 % were recorded and raised 1000-seed weight to reach 4.4 % and 4.3 % over control during the two seasons, respectively. Similar observations were obtained by Yassari and Patwardhan 2007 and Yassari *et al.* 2009.

Results in Tables (3 a,b and c) showed that manuring canola plant with 10 tons compost /fed resulted in significant increases in all plant growth characters and yield components. These increases were 17.5 and 16.8 % for plant height, 21.9 and 21 % for dry weight of shoot plant, 24 % and 21.4% for number of branch per plant and 22.9 and 21.9 % for number of pods per plant and 14.4 and 13.9 % for weight of 1000-seed in season 1 and 2 respectively over control. Similar results were obtained by Gopinath *et al.* 2008 and Sabahi *et al.* 2010. These increases in all studied characters might be attributed to the stimulating effect of compost manure that supplies plants with nutrients required for growth. It also improves chemical and hydro-physical and nutritional properties as well as improving the microbial activities of treated soils. These results are in harmony with those obtained by Singh and Agarwal 2005, Kazeneini *et al.* 2008 and Hayat *et al.* 2010.

Table 3a: Effect of bio, organic and inorganic N-fertilizers on growth characters of canola plant in two seasons

Treatments		Plant hieght (cm)		Dry weight (g)		No.of branch/plant	
		Season 1	Season 2	Season1	Season 2	Season 1	Season2
Bio-fertilizer	B_0	144.7	145.9	138.9	141.0	13.08	13.8
	B1	152.8	154.1	146.5	148.4	14.05	14.6
L.S.D $_{0.05}$		1.65	1.88	1.01	1.12	0.11	0.13
Compost manure	C_0	134.6	136.6	124.8	127.5	11.7	12.5
	C_1	148.4	149.7	143.4	145.4	13.5	14.0
	C_2	163.1	164.3	159.9	161.5	15.4	15.9
L.S.D $_{0.05}$		5.12	6.29	1.13	1.25	0.15	0.20
Nitrogen levels	N0	121.2	122.7	102.8	104.4	9.4	9.9
	N1	144.5	145.8	136.6	138.6	12.8	13.7
	N2	161.3	163.0	160.7	162.8	15.1	15.8
	N3	167.2	168.4	170.7	173.4	16.8	17.1
L.S.D $_{0.05}$		7.32	8.18	8.66	10.05	0.29	0.33

Table 3 b: Effect of interaction between bio, organic and inorganic N-fertilizers on plant growth characters of canola plant in two seasons.

Treatments		Plant hieght (cm)		Dry weight (g)		No.of branch/plant	
		Season1	Season2	Season1	Season2	Season1	Season2
Biofertilizer X Compost							
B0	**C0**	130.7	132.0	120.4	123.1	11.5	12.2
	C1	144.6	145.9	140.2	142.5	13.0	13.5
	C2	158.7	159.9	156.0	158.0	14.7	15.3
B1	**C0**	138.4	140.0	129.2	132.0	12.0	12.8
	C1	152.2	153.5	146.6	148.4	14.0	14.6
	C2	167.4	168.8	163.8	164.9	16.0	16.4
L.S.D $_{0.05}$		7.25	7.91	12.96	14.67	0.28	0.32
Biofertilizer X Nitrogen levels							
B0	**N0**	114.2	115.4	99.00	100.6	8.8	9.2
	N1	138.7	140.0	130.6	132.9	12.0	13.0
	N2	159.2	160.4	156.0	158.7	14.7	15.6
	N3	166.6	168.0	169.9	172.6	16.7	17.0
B1	**N0**	128.2	130.0	106.6	108.3	10.1	10.6
	N1	150.4	151.7	142.6	144.4	13.6	14.5
	N2	164.4	165.7	165.4	166.9	15.5	16.1
	N3	167.8	168.9	171.5	174.2	16.9	17.1
L.S.D $_{0.05}$		9.98	10.17	15.18	15.50	2.88	3.05
Compost X Nitrogen levels							
C0	**N0**	96.4	98.1	75.9	77.7	7.7	8.4
	N1	127.2	128.9	112.6	115.6	11.1	12.1
	N2	153.8	155.5	149.0	151.2	13.6	13.4
	N3	160.8	161.5	161.6	165.6	14.9	15.1
C1	**N0**	125.8	127.0	110.3	112.0	9.6	9.8
	N1	145.4	146.9	134.2	136.4	12.6	13.5
	N2	159.7	162.8	159.9	162.1	14.8	15.6
	N3	162.8	163.9	169.3	171.1	17.0	17.2
C2	**N0**	141.3	143.1	122.2	123.6	11.0	11.6
	N1	160.9	161.8	162.9	163.8	15.0	15.6
	N2	172.0	173.5	173.2	175.1	17.2	17.6
	N3	178.0	179.1	181.2	183.4	17.9	18.9
L.S.D $_{0.05}$		10.98	12.45	16.34	18.99	3.45	4.35

B: biofertilizer C: compost manure9 **N: Nitrogen levels**

Table 3c: Effect of interaction between bio, organic and inorganic N-fertilizers on plant growth characters of canola plant in two seasons

Treatments			Plant height (cm)		Dry weight (g)		No. of branch/plant	
			Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
B0	C0	N0	93.3	94.2	73.5	74.3	7.4	8.0
		N1	119.1	120.8	106.8	110.2	10.7	11.9
		N2	150.3	152.1	140.2	142.9	13.1	14.1
		N3	160.3	161.0	161.1	165.0	14.8	15.1
	Mean		130.7	132.0	120.4	123.1	11.5	12.2
	C1	N0	116.0	117.2	106.1	108.3	9.0	9.1
		N1	141.3	142.6	128.9	131.2	11.9	12.4
		N2	158.7	159.2	157.7	160.2	14.1	15.3
		N3	162.5	164.8	168.3	170.3	17.0	17.2
	Mean		144.6	145.9	140.2	142.5	13.0	13.5
	C2	N0	133.4	135.0	17.5	119.3	10.1	10.7
		N1	155.7	156.6	156.1	157.2	13.5	14.7
		N2	168.8	170.0	170.3	173.3	17.0	17.5
		N3	177.1	178.2	180.3	182.5	18.4	18.9
	Mean		158.7	159.9	156.0	158.0	14.7	15.3
B1	C0	N0	99.6	102.0	78.3	81.2	8.1	8.8
		N1	135.6	137.0	118.5	121.0	11.5	12.4
		N2	157.4	158.9	158.1	159.6	13.7	14.8
		N3	161.3	162.1	162.1	166.2	15.0	15.2
	Mean		138.4	140.0	129.2	132.0	12.0	12.8
	C1	N0	135.7	136.8	114.5	115.8	10.3	10.5
		N1	149.5	151.3	139.6	141.7	13.3	14.7
		N2	160.7	161.2	162.2	164.1	15.5	16.0
		N3	163.1	164.8	170.3	172.0	17.1	17.3
	Mean		152.2	153.5	146.6	148.4	14.0	14.6
	C2	N0	149.3	151.2	127.2	128.0	11.9	12.6
		N1	166.1	167.0	169.8	170.5	16.0	16.5
		N2	175.2	177.1	176.1	177.0	17.5	17.7
		N3	179.0	180.0	182.1	184.4	18.8	19.0
	Mean		167.4	168.8	163.8	164.9	16.0	16.4
L.S.D $_{0.05}$			13.04	15.29	6.86	8.97	1.48	1.61

B: biofertilizer C: compost manure N: Nitrogen levels

Comparing the effect of different N levels on studied characters in both seasons (Tables 3 a, b and c) and Tables (4 a, b and c), it is clear that using N fertilizer levels especially at rate 80 kg/fed give significant increase in the plant height and shoot dry matter per plant. It is realized that raising the level of mineral N-fertilizer from 0 up to 80 kg N/fed induced significant increase of 27.5 and 27.1 % for plant height, 40 and 39.7% for dry matter, 44.4 and 42.1% for No. of branches /plant, 47 and 45.1 % for No. of pods / plant and 38.1 and 38.6 % for 1000 seed weight over control during the two seasons, respectively. Similar results were obtained by Cheema*et al.* 2001, Hocking *et al.* 2002, Fathi *et al.* 2004, Malhi and Gill 2004, Malhi *et al.* 2007, Balint and Regal 2008 and Gan *et al.* 2008

When the different doses of N-fertilizer were associated with bio-fertilizer, high positive responses in the plant growth and yield characters were recorded against control. It is worthy to note that, using N fertilizer at rate 60 kg N/fed combined with bio- fertilizer gave values in most characters of canola plant equal to or nearly by using 80 kg N/fed alone. This means that inoculated seeds of canola plant with bio-fertilizers containing nitrogen fixers

(Azotobacter sp. and Azospirillum sp.) substitute 25% of the recommended dose. Similar results were obtained by (Chandrase *et al.* 2005) who reported that both morphological and yield parameters showed a better results through the combination of bio-fertilizers and chemical fertilizer than using either of them alone. They also reported that addition of Azospirillum with 100 % urea dose produced the highest yield compared with 100% chemical fertilizer alone.

Successive addition of N-fertilizer in combination with compost manure fertilizer increased growth characters and other yield traits. In this respect, it is worthy to note that the treatment of 80 kg N/fed did not statistically differs than 40 kg N/fed plus 10 tons/fed compost manure or the treatment of 60kg N/fed plus 5 ton/fed compost in absence of bio-fertilizer.

There was a positive and significant effect of compost manure at rate of 10 ton/fed with N-fertilizer at rate of 80 kg N /fed on yield and yield components as compared with the recommended dose of N-fertilizers or compost manure alone.

From these results, it could be concluded that addition of compost manure reduced 50 % of the required N- fertilizer needed by canola plants. These results are in consonance with findings of Singh and Agrawal 2005, Gopinath *et al.* 2008, Hao *et al.* 2008, Kazemeini *et al.* 2010 and Zhong *et al.* 2010 .

Results in Tables (3 a, b and c & 4 a, b and c), showed that dual inoculation with N- fixing bacteria combined with any rate of compost manure, particularly at 10 tons/fed. enhanced growth characters and yield components of canola plant. Data also revealed that the addition of compost manure at 10 tons/fed. combined with N fertilizer at rate of 40 kg N/fed and bio-fertilizer gave values of plant growth characters and yield components higher than that of the treatment received full dose at N- fertilizer alone.

The combined treatment of bio-fertilizer with N fertilizer at rate of 40 kg N/fed and 10 ton/fed. compost manure gives values 5.1 and 3.3 % of dry weight more than using N fertilizer at rate of 80 kg N/fed alone during season 1 and season 2, respectively. Similar results were observed by (Akbari *et al.* 2011).

Seed and straw yield

The obtained data in Tables 4a, b and c indicated that bio-fertilizer increased seed yield about 5.07 and 4.9 % in the first and second seasons, respectively compared to uninoculated control treatment. This appeared mainly related to the proliferation of pods /plant through simultaneously the number of branches and 1000-seed weight whose increased with the addition of bio-fertilizer. It has been reported that bio-fertilizers not only provides nitrogen, but also produces a variety of growth promoting substances, among them Indole Acitic Acid (IAA), giberllins and B-vitamin. These results are in agreement with these obtained by Wu *et al.* 2005, Mirzaei *et al.* 2010 and Bahrani *et al.* 2010 who concluded that simultaneous application of Azotobacter had a significant effect on yield of brassica.

Application of compost manure at either 5 or 10 ton/fed significantly increased seed yield by 10.5 or 18.5 %in season 1 and 10 or 18.7 % in season 2 over the control.

Table 4 a. Effect of bio, organic and inorganic N-fertilizers on yield and yield components of canola plant in two seasons.

Treatments		No.of pods/plant		1000 seed weight,g		Seed yield (Kg/fed.)		Straw yield (Kg/fed.)	
		Season 1	Season 2	Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
Bio-fertilizer	B_0	264.2	270.0	2.99	3.05	390.2	395.3	484.8	487.4
	B1	281.7	288.4	3.13	3.19	411.1	415.9	509.0	513.0
L.S.D $_{0.05}$		1.36	1.44	0.10	0.12	2.59	3.68	3.42	4.01
Compost manure	C_0	235.0	241.9	2.78	2.83	359.3	363.4	443.9	447.9
	C_1	278.7	287.2	3.04	3.11	401.4	406.0	500.3	507.3
	C_2	304.8	309.9	3.25	3.29	441.3	446.9	546.6	543.6
L.S.D $_{0.05}$		4.15	6.77	0.12	0.19	4.15	4.30	7.98	8.86
Nitrogen levels	N0	180.2	188.5	2.29	2.33	287.7	289.0	382.3	385.8
	N1	258.9	266.7	2.90	2.13	395.5	394.3	469.6	472.4
	N2	312.3	319.9	3.2	3.13	249.8	454.4	540.9	543.9
	N3	340.5	343.6	3.7	3.8	477.7	483.8	595.0	598.7
L.S.D $_{0.05}$		5.88	7.49	0.20	0.23	4.45	4.81	8.08	9.06

Table 4 b. Effect of interaction between bio, organic and inorganic N-fertilizers on yield and yield components of canola plant in two seasons.

Treatments		No.of pods/plant		1000 seed weight,g		Seed yield (Kg/fed.)		Straw yield (Kg/fed.)	
		Season1	Season2	Season1	Season2	Season1	Season2	Season1	Season2
Biofertilizer X Compost									
B0	C0	231.4	237.3	2.73	2.78	343.1	347.8	436.4	439.5
	C1	268.8	276.4	2.89	2.95	395.3	399.5	485.0	487.2
	C2	282.5	298.9	3.12	3.46	432.3	438.5	533.0	535.0
B1	C0	239.3	246.5	2.83	2.89	375.6	379.9	451.4	456.2
	C1	288.6	298.0	3.17	3.24	407.4	412.5	515.6	518.6
	C2	317.0	321.0	3.39	3.42	450.4	455.3	560.2	564.2
L.S.D $_{0.05}$		7.04	9.59	0.09	0.10	7.88	9.83	13.20	15.10
Biofertilizer X Nitrogen levels									
B0	N0	167.2	173.6	2.33	2.39	273.0	279.2	369.0	371.3
	N1	246.4	255.5	2.84	2.89	374.4	377.6	449.5	451.7
	N2	304.6	312.0	3.09	3.13	438.1	442.6	529.0	532.0
	N3	338.7	342.3	3.72	3.80	474.9	481.6	591.4	694.7
B1	N0	193.1	203.5	2.25	2.27	295.9	300.0	395.6	400.3
	N1	271.3	277.9	3.09	3.14	406.7	411.1	489.6	493.1
	N2	320.0	327.8	3.43	3.49	461.6	466.2	552.8	555.9
	N3	342.3	344.1	3.75	3.82	481.5	485.9	598.0	602.70
L.S.D $_{0.05}$		9.91	10.61	0.12	0.14	8.02	9.97	12.83	13.76
Compost X Nitrogen levels									
C0	N0	140.1	146.4	1.84	1.87	230.6	236.3	312.5	318.0
	N1	199.5	206.6	2.65	2.7	329.1	330.5	420.9	424.2
	N2	288.9	296.0	3.03	3.07	418.8	422.0	502.6	505.1
	N3	313.0	318.0	3.61	3.70	459.5	466.8	539.9	544.1
C1	N0	189.5	201.4	2.17	2.23	288.2	291.6	397.3	399.9
	N1	273.0	275.9	2.89	2.94	385.7	389.2	471.2	472.6
	N2	302.4	315.4	3.32	3.38	453.6	460.9	534.9	538.2
	N3	351.7	353.5	3.75	3.82	478.5	482.3	597.8	602.0
C2	N0	260.9	271.7	2.36	2.39	335.5	341.8	437.1	439.5
	N1	305.9	317.5	3.37	3.40	457.0	463.4	516.7	520.5
	N2	345.5	348.2	3.43	3.49	477.0	480.4	585.1	588.4
	N3	356.8	358.7	3.86	3.89	495.1	502.2	647.3	649.9
L.S.D $_{0.05}$		13.00	14.40	0.16	0.19	12.3	14.38	15.71	17.87

B: biofertilizer C: compost manure N: Nitrogen levels

Table 4 c. Effect of interaction between bio, organic and inorganic N-fertilizers on yield and yield components of canola plant in two seasons

Treatments			No. of pods/plant		1000 seed weight,g		Seed yield (Kg/fed.)		Straw yield (Kg/fed.)	
			Season 1	Season 2	Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
B0	C0	N0	135.4	142.1	1.81	1.85	219.5	227.5	304.0	307.2
		N1	193.2	201.3	2.60	2.66	299.8	301.0	411.0	413.0
		N2	285.0	287.0	2.91	2.94	395.0	398.0	495.0	498.0
		N3	312.0	319.0	3.60	3.70	458.1	465.0	535.8	540.3
	Mean		231.4	237.3	2.73	2.78	343.1	347.8	436.4	439.5
	C1	N0	176.3	183.4	1.92	2.02	281.5	283.0	379.2	381.7
		N1	260.8	265.0	2.80	2.83	377.4	380.0	445.2	447.3
		N2	288.2	305.2	3.15	3.17	446.4	455.0	520.2	523.0
		N3	350.0	352.0	3.70	3.80	476.2	480.0	595.6	599.0
	Mean		268.8	276.4	2.89	2.95	395.3	3.99.5	485.0	487.2
	C2	N0	190.0	195.5	2.28	2.3	320.0	327.3	423.9	425.0
		N1	285.3	300.4	3.14	3.18	445.8	452.0	492.3	495.0
		N2	340.6	343.8	3.21	3.29	472.9	475.0	572.0	575.0
		N3	354.2	356.1	3.85	3.88	490.5	500.0	643.8	645.1
	Mean		292.5	298.9	3.12	3.16	432.3	438.5	533.0	535.0
B1	C0	N0	144.9	150.9	1.88	1.90	240.6	245.1	321.0	329.0
		N1	305.8	211.9	2.71	2.75	358.5	360.0	430.9	435.4
		N2	292.8	301.1	3.15	3.2	442.6	446.0	510.6	512.3
		N3	314.0	318.4	3.62	3.71	461.0	468.7	543.2	548.3
	Mean		239.3	246.5	2.83	2.89	375.6	379.9	451.4	4456.2
	C1	N0	202.8	219.5	2.42	2.45	295.6	300.2	415.5	418.0
		N1	281.7	291.5	2.98	3.06	392.6	398.4	497.2	498.0
		N2	316.7	325.7	3.50	3.60	460.8	466.8	549.7	553.5
		N3	353.4	355.5	3.80	3.85	480.8	484.7	600.1	605.1
	Mean		288.6	298.0	3.17	3.24	407.4	412.5	515.6	518.6
	C2	N0	231.8	240.1	2.45	2.48	351.6	356.4	450.4	454.0
		N1	326.6	330.4	3.60	3.63	469.2	474.9	541.2	546.0
		N2	350.5	352.6	3.66	3.69	481.1	485.8	598.3	602.0
		N3	359.5	360.9	3.87	3.9	499.8	504.4	650.9	654.8
	Mean		317.0	321.0	3.39	3,42	450.4	455.3	560.2	464.2
L.S.D $_{0.05}$			13.96	18.38	0.35	0.42	13.43	16.80	21.17	24.08

B: biofertilizer C: compost manure N: Nitrogen levels

Amendment of soil with compost manure at the highest rate 10 ton/fed yielded about 69.8 and 70.3 % seed yield as compared to nitrogen fertilizer at rate of 80 kg N/fed. The yield when either 40 kg N/fed of N fertilizer as combined with compost manure at rate 10 ton/fed or when 60 kg N/fed of nitrogen fertilizer combined with 5 ton/fed compost manure was nearly equal with using of N fertilizer at rate 80 kg N/fed alone. However, the yield obtained with 5 tons/fed compost manure + 80 kg N/fed of N fertilizer was achieved with 10 tons compost/fed + 60 kg N/fed of N fertilizer. These findings are in accordance with observations of Kazemeini *et al.* 2008 and Sabahi *et al.* 2010.

Bio-fertilizer in combination with applying of compost manure at rate of 5 tons/fed and treatment of 40 kg N/fed of N fertilizer did not statistically differ in their effects from the treatment of 60 kg N/fed of N fertilizer alone.

The combined interaction of bio-fertilizer, compost manure at rate of 10 ton/fed and 40 kg N/fed of N fertilizer yielded 2.38 and 2.08 % increase in seed yield over soil fertilized with 80 kg N/fed of N fertilizer. The straw yield showed a similar trend. Similar observation was obtained by Sabahi *et al.,* 2010 and Akbari *et al.*, 2011.

Seed quality of canola

Seed protein content and yield

Data presented in Table (5 a) revealed that dual inoculation with N-fixing bacteria induced significantly increase in seed protein content (3.36 and 4.6 %) and protein yield. (13 and 12.3%) over the control treatment in both seasons, respectively. These results are in accordance with those obtained by Tiwana *et al.* (1992). The increase in the crude protein yield is an expected as result to the successive increase in nitrogen level in response to bio-fertilizer treatment (Patel *et al.*, 1992) or to the direct effect of bacteria on root growth, phytohormons production, greater mineral uptake, and transfer of nitrogen to the plant (Yasari *et al.*, 2008). Protein content of the canola seeds also was enhanced by 8.7 % and 8.6 % in season 1 and 17.7 and 18.9 % in season 2 with application of compost manure at 5 and 10 ton/fed, respectively, as compared to control. The beneficial effect of organic manure at the highest rate (10 ton/fed) reflect the high nitrogen content of manure which enhanced nitrogen absorption and in turn increased protein content beside its increase of the yield. These results are in agreement with those obtained by Laxminarayana and Patiram (2005).

Regarding the effect of mineral N-fertilizer in absence of bio-organic fertilizer, data in Table (5 a) revealed that there was significant increase in seed protein content and protein yield per feddan with successive application of nitrogen. The maximum protein content (36.7 and 36.3 %) and protein yield (61.9 and 61.5%) were recorded in the treatment of 80 kg N/fed of N fertilizer. These results are similar to those of Rathke *et al.* (2005) who reported that protein content of grain was increased with increasing nitrogen application. Akbari *et al.* (2011) stated that the high N-rate increased the amino acids synthesis in the leaves and this stimulates the accumulation of protein in the seed rather than oil content. Data also in Tables (5 a, b and c) showed that the integrated fertilizers, significantly increased the seed protein content and protein yield, the integrated fertilizers of 40kgN/fed plus bio and organic fertilizer at 10 tons/fed resulted in significant increase in the seed protein content and protein yield per fed by 40.5% and 72.5 % in the first season and 39.3 % and 70.5% in the second season, respectively over the control which was 7.4 % and 6.3% higher than the treatment of 80 kg N/fed alone.

Table 5 a. Effect of bio, organic and inorganic N- fertilizers on seed quality of canola plant in two seasons.

Treatments		Oil content %		Oil yield kg/fed		protein content %		Protein yield kg/fed	
		Season 1	season 2	Season 1	season 2	Season 1	season 2	Season 1	season 2
Bio-fertilizer	B_0	44.13	44.33	171.90	174.90	18.40	18.70	74.0	76.80
	B1	44.30	44.50	181.50	184.50	19.04	19.60	80.90	84.20
L.S.D $_{0.05}$		0.01	0.02	1.17	1.50	0.26	0.41	1.46	1.86
Compost manure	C_0	43.70	43.90	156.60	159.30	16.70	17.26	62.40	65.10
	C_1	44.20	44.40	176.90	179.60	18.30	18.90	75.70	79.20
	C_2	44.60	44.90	196.50	200.2	20.30	21.30	94.00	97.2
L.S.D $_{0.05}$		0.21	0.23	3.37	4.23	1.39	1.68	6.86	9.60
Nitrogen levels	N0	45.5	45.70	130.00	132.60	14.30	14.70	41.30	43.10
	N1	44.50	44.80	174.10	176.90	17.60	18.00	69.6	72.2
	N2	43.60	43.90	196.40	199.70	19.90	20.70	90.10	94.60
	N3	43.20	43.60	206.40	209.8	22.60	23.10	108.50	112.20
L.S.D $_{0.05}$		0.26	0.29	6.55	5.25	1.45	1.77	12.47	14.62

Table 5 b. Simple interaction between bio, organic and inorganic N-fertilizers on seed quality of canola plant in two seasons.

Treatments		Oil content %		Oil yield, kg/fed		protein content %		Protein yield, kg/fed	
		Season1	season2	Season1	season2	Season1	season2	Season1	season2
Biofertilizer X Compost									
B0	C0	43.5	43.7	148.9	151.6	19.64	16.8	59. 2	60.8
	C1	44.2	44.4	174.1	176.6	17.9	18.5	72.9	76.5
	C2	44.7	44.9	192.5	196.5	20.2	20.7	89.8.2	93.2
B1	C0	43.9	44.1	164.3	166.9	16.9	17.7	65.7	69.5
	C1	44.3	44.5	179.7	182.9	18.7	19.3	78.6	81.9
	C2	44.6	44.8	205.0	203.8	21.4	21.9	98.3	101.2
L.S.D $_{0.05}$		0.32	0.34	9.02	11.69	0.62	0.96	2.78	4.73
Biofertilizer X Nitrogen levels									
B0	N0	45.4	45.5	124.0	126.9	14.0	14.3	38.7	40.4
	N1	44.4	44.7	166.5	169.1	16.9	17.3	63.8	66.3
	N2	43.6	43.8	191.2	194.2	19.7	20.0	86.2	89.8
	N3	43.1	43.3	205.0	208.7	22.5	22.9	107.0	110.8
B1	N0	45.6	45.7	135.0	137.6	14.6	15.1	43.9	45.8
	N1	44.6	44.9	181.7	182.7	18.3	18.9	75.5	78.1
	N2	43.7	44.0	201.0	205.1	20.3	21.2	94.1	99.4
	N3	43.2	43.4	207.7	210.9	22.8	23.3	110.0	113.6
L.S.D $_{0.05}$		0.25	0. 32	13.35	14.95	1.46	1.79	6.55	3.15
Compost X Nitrogen levels									
C0	N0	44.5	44.6	102.4	105.3	12.9	13.5	29.6	31.9
	N1	44.2	44.5	146.0	146.5	15.8	16.2	52.0	54.0
	N2	43.2	43.4	180.9	183.3	18.0	18.7	75.4	79.2
	N3	42.9	43.05	197.3	209.0	20.2	20.5	94.7	95.6
C1	N0	45.1	45.5	132.2	133.9	14.1	14.3	40.8	41.8
	N1	44.4	44.6	171.3	172.9	17.3	17.6	66.8	68.7
	N2	43.6	43.8	197.7	202.0	19.1	20.0	86.8	92.1
	N3	43.0	43.3	206.4	208.0	22.2	23.6	108.6	114.0
C2	N0	45.8	46.0	154.0	157.4	15.9	16.3	53.6	55.7
	N1	44.8	45.1	205.1	208.8	19.7	20.4	90.2	93.9
	N2	44.1	44.5	210.9	213.7	22.7	23.4	108.2	112.4
	N3	43.5	43.6	215.3	219.7	25.1	25.3	124.2	126.8
L.S.D $_{0.05}$		0. 27	0.39	14.80	16.0	1.38	1.41	4.28	7.02

B: biofertilizer C: compost manure N: Nitrogen levels

Seed oil content and yield

As seen in Table (5 a and c) reveal that the application with bio-fertilizer containing beneficial microbes (Azotobacter & Azospirillum) showed a promoting effect in the both studied seasons on seed oil content and oil yield/fed. comparing with the uninoculated treatments, the treatment of bio-fertilizer was increased nearly by 0.4 and 0.5% for seed oil content and 3.63 and 5.6 % for oil yield per feddan in the first and second seasons, respectively.

Table 5c: Effect of the interaction between bio, organic and inorganic N-fertilizers on seed quality of canola plant in two seasons.

Treatments			Oil content %		Oil yield, kg/fed		protein content %		Protein yield, kg/fed	
			Season 1	season 2	Season 1	season 2	Season 1	season 2	Season 1	season 2
B0	C0	N0	44.10	44.20	96.70	100.50	12.60	13.10	27.60	29.80
		N1	44.20	44.50	132.50	133.90	15.60	15.70	46.70	47.20
		N2	43.10	43.30	170.20	172.30	17.90	18.10	70.70	72.00
		N3	42.90	43.00	196.50	199.90	20.10	20.30	92.00	94.30
	Mean		43.50	43.70	148.90	151.60	16.55	19.80	59.2	60.8
	C1	N0	45.80	45.90	128.90	129.80	13.90	14.10	39.12	39.90
		N1	44.50	44.80	167.90	170.20	16.90	17.00	63.70	64.60
		N2	43.60	43.80	194.60	199.20	18.30	19.50	81.60	88.70
		N3	43.10	42.20	205.20	207.30	22.50	23.50	107.10	112.80
	Mean		44.20	44.40	174.10	176.60	17.90	18.50	72.90	76.50
	C2	N0	45.90	46.00	146.80	147.20	15.50	15.80	49.60	51.70
		N1	44.70	45.00	199.20	203.40	18.20	19.30	81.13	87.20
		N2	44.10	44.50	209.00	211.30	22.50	22.90	106.40	108.70
		N3	43.50	43.60	213.30	219.00	24.90	25.10	122.10	125.50
	Mean		44.70	44.90	192.50	196.50	20.20	20.70	89.80	93.20
B1	C0	N0	45.00	45.10	108.20	110.50	13.20	13.90	31.75	34.00
		N1	44.30	44.70	158.50	159.50	16.00	16.90	57.30	60.80
		N2	43.30	43.60	191.60	194.40	18.10	19.40	80.10	86.50
		N3	43.00	43.10	198.20	202.00	20.30	20.70	93.50	97.02
	Mean		43.90	44.10	164.30	166.90	16.90	17.70	65.70	69.50
	C1	N0	45.90	46.00	135.60	138.00	14.40	14.60	42.50	43.80
		N1	44.60	44.80	174.70	175.70	17.80	18.30	69.80	72.90
		N2	43.70	43.90	200.90	204.90	20.00	20.50	92.10	95.60
		N3	43.20	43.40	207.70	210.30	22.90	23.80	110.10	115.30
	Mean		44.30	44.50	179.70	182.90	18.70	19.30	78.60	81.90
	C2	N0	45.80	46.10	161.30	164.30	16.40	16.80	57.60	59.80
		N1	45.00	45.20	211.10	214.60	21.20	21.60	99.40	100.60
		N2	44.20	44.60	212.10	216.10	22.90	23.90	110.10	116.10
		N3	43.60	43.70	217.40	220.40	25.30	25.50	126.40	128.60
	Mean		44.60	44.80	200.50	203.80	21.40	21.90	98.30	101.20
L.S.D $_{0.05}$			0.40	0.45	18.58	19.67	1.58	1.89	9.96	11.3

B: biofertilizer C: compost manure N: Nitrogen levels

These results are also in agreement with those obtained by Akbari *et al.* (2011), who found that, using of Azotobacter and Azospirillum as bio-fertilizer which could enhance the seed oil content and oil yield to the control. From the same Table, it could be shown that the percentage of oil in canola seeds and oil yield per feddan were enhanced by 2.01% and 20.3 % in season 1

and 2.3 % and 20.5 % in season 2 with application of compost manure at 10 ton/fed., respectively over control. Conversely, it was found that increasing level of mineral nitrogen fertilizer from 40 to 80 kg N/fed of N fertilizer induced significant decrease in seed oil content in both studied seasons. The decrease in oil content was 5 % in the first season and it was 4.5 % in the second one at the higher rate of N-fertilizer (80 kg N/fed). This result was confirmed by Karamzadeh *et al.* (2010) who found that there was significant difference in seed oil content with nitrogen rates. Seed oil content was decreased with increasing nitrogen rate. But seed yield was increased due to increase of N, so seed oil yield is also increased and the low oil percentage is compensated. On the other hand, there were positive significant correlations between seed oil yield and seed yield, seed oil percentage, 1000-seed weight and plant height (Faramarzi *et al.* 2009). Nitrogen fertilizer often reduces grain oil concentration through an inverse relationship between grain N (protein) and oil concentrations (Taylor *et al.* 1991 and Rathke *et al.* 2005). During two seasons, increasing the level of the used mineral N-fertilizer induced significant increase in oil yield. The interaction between the used levels of mineral N-fertilizer and bio-fertilizer proved significant effect in both studied seasons. Correspondingly, combined application of bio-fertilizer with 10 tons/fed compost manure and 40 kg N/fed of N fertilizer resulted in significant increase in the seed oil content and oil yield per feddan being 2 % and 54.1 % in season 1 and 2.2 % and 53.1 % in season 2 as compared with the control. However, oil yield in this treatment during two seasons did not differ (the obtained ststatistically) than 80 kg N/fed of N fertilizer plus bio-organic manure at 10 tons/fed.

On basis of results, it could be concluded the fertilized canola plants with40 kg N/fed of N fertilizer along with 10 ton/fed compost manure and bio-fertilizer appeared to be most appropriate and suitable for harvesting a good crop of canola.

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إستجابة إنتاجية وجودة الكانولا للتسميد الحيوى والعضوى والنيتروجين المعدنى

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أقيمت تجربة حقلية بمحطة البحوث الزراعية بالاسماعيلية خلال موسمى ٢٠٠٨/٢٠٠٩، و ٢٠٠٩/٢٠١٠ لدراسة التأثير المنفرد لكل من السماد الحيوى والعضوى والنيتروجين المعدنى وكذلك التأثير المشترك بينهم على النمو وصفات المحصول وعلى جودة الحبوب (محتوى الزيت ، البروتين) لنبات الكانولا (صنف سرو ٤) – استخدم تصميم القطع المنشقة لمرتين فى ثلاث مكررات.

وقد أوضحت النتائج بصفة عامة أن الإضافات المنفردة لكل من السماد الحيوى والعضوى عند مستوى ١٠ طن كمبوست/فدان والسماد النيتروجينى المعدنى عند مستوى ٨٠كجم/فدان من التوصية السمادية أدت الى زيادة فى محصول الحبوب عن الكنترول خلال الموسمين مقدارها ٥,١ ، ٤,٩ % ، ١٨,٥ و١٨,٦ % ، ٤٠,٥ و ٤٠,٣ % على التوالى.

وبالمثل أيضا أظهر التفاعل بين المستويات المستخدمة من الاسمدة المعدنية والعضوية والمخصبات الحيوية تأثيرا معنويا فى كلا الموسمين لكل الصفات تحت الدراسة.

و لقد لوحظ أن المعاملة ٨٠كجم نيتروجين/فدان من النيتروجين من الجرعة الموصى بها لم تظهر إختلافا معنويا فى تأثيرها عن المعاملة ٤٠كجم ن /فدان من الجرعة الموصى بها من السماد النيتروجينى بالاضافة الى السماد العضوى عند مستوى ١٠ طن/فدان كمبوست والمخصبات الحيوية . وهذا يعنى أن معاملة بذور نبات الكانولا بنصف الجرعة الموصى بها من السماد النيتروجينى المعدنى بخليط من المخصبات الحيوية المحتوية على البكتيريا المثبتة للنتروجين مع إضافة سماد الكمبوست بمعدل ١٠طن/فدان تحل محل الجرعة الموصى بها من السماد المعدنى للنتروجين.

ومن حيث جودة بذور الكانولا فقد لوحظ زيادة محتوى البذور من البروتين مع إضافة كل من المخصب الحيوى والسماد العضوى والمعدنى للنتروجين وتناقص محتوى الزيت بإضافة النتروجين – ولكنه زاد مع إضافة كل من المخصبات الحيوية والكمبوست وإضافة الأسمدة المتكاملة ادت الى زيادة محتوى البذور من البروتين والزيت معنويا .

قام بتحكيم البحث

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