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EFFECT OF MINERAL NITROGEN RATES, BIO-FERTILIZATION AND ZN ON PRODUCTIVITY AND QUALITY OF CANOLA (*Brassica napus* L.)

Amal H. El-Guibali
Soils, Water and Environ. Res., Inst., Agric. Res. Center, Giza, Egypt

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ABSTRACT: *Two field experiments were carried out at Agricultural Research Farm of Soil Water and Environment Inst. Res. Agric., Giza, Egypt (30°01'14.6"N 31°12'41.1"E) during two successive winter seasons of 2013/2014 and 2014/2015 to study the effect of mineral nitrogen, bio-fertilization and Zn individually and together on yield and yield component of canola (Brassica napus L.) c.v. Serw 4. The experiments were conducted in split-split plot designs with three replicates. Treatments consisted of three levels of mineral nitrogen (50, 75, and 100% of its recommended dose (RD) i.e. 30kg N/fed), two levels of bio-fertilizer treatments (without and with inoculation) containing mixture of Azotobacter and Azospirillum and two levels of elemental zinc (0 and 0.3gZn/L). The results indicated that there are a significant increases in height of plant, number of pods/plant, pods weight/plant, seeds weight/plant, 1000-seed weight, seed yield, protein content, protein and oil yield. As a result of mineral N application, plots that received highest dose of N (30kgN/fed.) obtained maximum height of plant, number of pods/plant, 1000-seed weight and seed yield. Protein content of 26.14% and 18.98 % were detected at high and low N rates, respectively. Under high N rate, the lowest oil content (41.31%) was observed. In contrast, highest oil contents were found for lowest N rate plots (44.28%). Inoculation of canola seed by N2-fixing bacteria (Azotobacter and Azospirillum) significantly increased yield and its components compared with the uninoculated treatments. Zinc treatments increased all the tested growth parameters as compared to control plants. Results emphasize that N fertilization rates 75or100% of RD, bio-fertilization and Zn significantly influenced on the productivity of oil seeds rape and their interactions. So, it is suggested to use a combination of inorganic fertilizer and bio-fertilization to achieve the highest yield without a negative effect on seed quality that will lead to sustainable environment.*

***Key words**: Bio-fertilizer, Canola, Growth parameters, Nitrogen, Oil and Protein content, Zinc.*

INTRODUCTION

Oil plants in general appear to be one of the most promising plants since their gamut of products range from proteins to carbohydrates to fats. In Egypt, there is a big problem concerning edible oil production. The local production of oil satisfies only 20% of the total requirements .Canola, safflower and sunflower have thus a bright future as sources of oil in Egypt.

Canola (*Brassica napus* L.) is one of the major oil crops in Asia and Europe Recently, canola was introduced to Egypt to help contribute reduce the oil shortage. Canola is new winter oil seed crop containing more than 40% oil. Despite canola having only been considered as a new crop product (relative to other well established crops) it has the capacity to grow on reclaimed lands under wide soil variations as drought and salinity as revealed by some studies carried out under Egyptian conditions (Ibrahim *et al.* 1989). Nitrogen is the most important nutrient supplied to most non-legume crops, including canola. The most important role of N in the plant is its presence in the structure of protein and nucleic acids, which are the most important building and information substances of every cell (Grant *et al.* 2011). Therefore, an adequate supply of N is necessary to achieve high yield potential in crops. N fertilizer is known to affect the plant height, number of pods per plant, number of seeds per pod, 1000-seeds weight, seed yield and biological yield of rapeseed (El-Habbasha and Taha, 2011 and Azimzadeh and Azimzadeh 2013). Grant *et al*. (2011) investigated rapeseed response to different levels of nitrogen fertilizer and stated that oil yield increased with low to moderate N rates, but stabilized or fell with high N rates while, chlorophyll content increased with increasing N rates.

Increasing and extending the role of bio-fertilizers can reduce the need for chemical fertilizers and decrease adverse environmental effects. They can play a significant role in fixing atmospheric N and production of plant growth promoting substances. Therefore, in the development and implementation of sustainable agriculture techniques, bio-fertilization has great importance in alleviating environmental pollution and deterioration of nature (Namvar and Khandan, 2013). *Azotobacter* and *Azospirillum* are used as bio-fertilizers in the cultivation of many agricultural crops. The estimated contribution of these free-living N fixing prokaryotes to the N input of soil ranges from 0–60 kg ha^{-1} per year (Vessey, 2003). Existence of microbial communities like *Azotobacter* and Azospirillum in the rhizosphere promotes the growth of the plant through the cycling and availability of nutrients, increasing the health of the roots during the growth stage by competing with root pathogens and increasing the absorption of nutrients and water (Vessey, 2003 and Hasanalideh and Hojati, 2010). El-Habbasha and Taha (2011) studied the effects of inoculation with different bio-fertilizers on rapeseed and observed that inoculated rapeseed plants gave higher plant height, pods per plant, grains per pod, grain weight, biological yield, grain yield and oil yield compared to non-inoculated plants.

Zinc is an essential micronutrient for higher plants especially oil crops where it is required for the activity of various types of enzymes (dehydrogenases, RNA and DNA polymerases), carbohydrate metabolism and protein synthesis. Zinc also plays an important role in the production of biomass (Kaya and Higgs, 2002). Bybordi and Malakouti (2007) found that application of zinc had a significant effect on seed yield, seed oil content and 1000-seed weight.

The objectives of this study are to determine the effect of different N fertilization rates, inoculation with bio - fertilizer, and foliar application of Zn individually and together on growth, yield and quality of canola.

MATERIALS AND METHODS

Two field experiments were carried out at Agricultural Research Farm of Soil Water and Environment Inst. Res. Agric., Giza, Egypt, during two successive winter seasons 2013/2014 and 2014/2015 to study the effect of nitrogen fertilizer levels, bio-inoculants and foliar application of Zn on the productivity of canola (*Brassica napus* L.) c.v. Serw 4 in a clay soil. Randomized the soil surface samples (0-30 cm) were taken from the experimental site before sowing and prepared to determine some physical and chemical properties according to Page *et al.,* (1982) and Klute (1986) as shown in Table (1).

Each experiment included 12 treatments, which were the combination of two levels of Zn as foliar application (0 and 0.3g/L), bio-fertilizers in two levels (no inoculation and combined inoculation of *Azotobacter* + *Azospirillum*) and three N-fertilizer levels

(50, 75 and 100% of the recommended dose). Different treatments were arranged in split- split-plot design with three replications. Three N-fertilizer levels treatments were randomly arranged in the main plots, Bio-fertilization treatments were assigned at random in sub-plots, whereas the Zn-treatments were allocated in the sub -sub –plots. The experimental unit area was 10.5m^2 (1/400feddan).

Bio fertilizer

Nitrogen fixing bacteria; i.e. "*Azotobacter* and *Azospirillum"* were kindly obtained from Microbial. Dept., Soils, Water and Environ. Res. Inst., Agric. Res. Center, Giza, Egypt.

Inoculation procedure:

Vermiculate based inoculate was prepared by mixing cell culture suspension of mixture *Azotobacter and Azospirillum* with pre- sterilized vermiculate and peat moss at the rate of 1:1which used as standard carrier for these microbes. The prepared inoculate (containing10^7 cfu ml^{-1} from each bacterium) was applied to the seeds after being mixed with a suitable amount of Arabic gum solution as adhesive agent, then carefully mixed to ensure enough coating with the bacterial inoculum. Inoculated seeds were air dried by spreading over a plastic sheet for 2 hrs. time before sowing. The control treatment was done using uninoculated seeds (treated with the culture media without bacteria).

Table (1): Some physical and chemical properties of the experimental soil

Parameters	Value
Physical properties	
Practical size distribution (%)	
Clay%	50.25
Silt%	26.55
coarse sand%	3.68
fine sand%	19.52
Soil texture	Clayey
Chemical properties	
pH(1:2.5 soil: water suspension)	8.25
EC(ds m^{-1}) (Soil paste)	3.21
Calcium carbonate %	2.94
Organic matter %	1.86
Available nutrients(mg/kg)	
N	38.16
P	7.32
K	370
Zn	0.78

Nitrogen fertilizer was applied at three levels of 50, 75 and 100 % of the recommended dose for canola plant (30 kg N/fed as ammonium sulphate). Nitrogen fertilizer was added in three splits: 1/3 at cultivation time as basal fertilization, 1/3 at stem initiation stage and the remaining one was applied at bud initiation before flowering stage in accordance with the treatment variables. Super phosphate was added as a single dose during soil preparation at the rate of 30 kg P_2O_5 /fed. Also, potassium fertilizer (as Potassium sulphate, 48% K_2O) was added at a rate of 50kg K_2O/fed., which was divided into two equal portions applied with the first and second doses of N fertilizer. Two zinc levels (0 and 0.3 g Zn /l as zinc sulfate). The applied treatments of zinc were used as foliar spray twice, at rosette and bud stages with a concentration of 0.83g /L of ZnSO4 - 7H2O (36.3% Zn), volume of foliar solution was 400Lof water/fed.

At the end of the growing season, samples of 10 plants at harvest time were taken randomly from each plot for agronomic and chemical trait measurements; dry weight (DW) of shoot and root (g), plant height (cm), fruiting zone length (cm), No. of pods/plant, weight of seeds/plant(g), seed index(weight of 1000 seeds by g). The dry seed samples were ground and wet digested. So, NPK were determined using the method described by Ryan *et al.* (1996). Zn was determined in seeds using the methods described by (Cottenie *et al.* 1982). Crude protein percentage was calculated by multiplying N% by the converting factor 5.75 (Robinson, 1975). Protein yield (kg/fed.) was also calculated by multiplying crude protein by seed yield. Oil content (%) was determined by soxhelt apparatus using hexane as a solvent as described by A.O.A.C. (1990). Oil yield (kg/fed.) was estimated by multiplying seed yield (kg/fed.) by seed oil percentage. The obtained results of the combined mean average of two seasons were statistically analyzed according to Gomez and Gomez (1984) to define the statistical significance of L.S.D. at 0.05.

RESULTS AND DISCUSSION

I- *Canola yield and its components*

A-*Effect of nitrogen fertilization*:

Data in Tables (2,3 and 4) showed the effect of nitrogen fertilization on yield and yield components i.e. (plant height(cm), dry root weight(g/plant), dry shoot weight, no. of pods/plant, pods weight (g/plant), seeds weight (g/plant), weight of 1000 seed(g), fruiting zone and seed yield (kg fed^{-1})). All the studied characters were significantly increased by the application of nitrogen fertilization. Raising nitrogen rate gradually increased the quantity of canola yield. The highest rate of nitrogen (30 kg $Nfed^{-1}$.) was the superior treatment for increasing yield components and seed yield. Other research generally confirms that N fertilizer mainly increases canola leaf area index, leaf duration, plant weight, growth rates, number of flowering branches, plant height, number of flowers, number and weight of pods and seed yield (Hopkinson *et al*. 2002). Therefore, good N fertility is necessary to produce a large, photosynthetically efficient leaf area that will support high numbers of flowers, pods and seed yield. Result also, indicated that plant height was significantly increased by increasing dose of nitrogen (Table2). Nitrogen at 30 kg $Nfed^{-1}$ gave the highest plant height and it is significantly different than rates of 22.5 and 15kg fed^{-1}. This result might be due to the positive effect of nitrogen on the growth development of stem and leaf; which was reflected into taller plants (Chngo and Mcvtty, 2001 and Al-Barrak 2006). Number of pods per plant is another important character, which directly influence the seed yield. Increase nitrogen levels rendered a significant increase in pods $plant^{-1}$ (Table 3). Maximum of seed

Table 2

Table 3

Table 4

yield and number of pods plant^{-1} were recorded in those plots which received 30 kg fed^{-1}, while lowest were found to be by those plots which received 15 kg fed^{-1}(50 % of the recommended dose). These results are confirmed by Hopkinson *et al*. (2002). The effect of nitrogen levels had significant increase on weight of 1000 seeds (Table 3). The maximum 1000 - seed weight was produced by plots which received 30 kg fed^{-1}. The increase in 1000 - Seed weight with the increase of nitrogen levels might be due to the role of nitrogen in activating the growth and yield components (Ahmed *et al.* 2007). Maximum seed yield was produced by those plots received maximum nitrogen (30 kg N fed^{-1}), while lowest of seed yield was produced by those plots received (15 kg N fed^{-1}). These results might be due to the fact that the yield components were increased with nitrogen increasing. These results are in agreement with those reported by Jackson (2000). There was a positive relationship between the numbers of pods plant^{-1}and seed yield and maximum seed yield was obtained in those plots which produced maximum pods plant^{-1}. Cheema *et al.* (2001) have reported that the increased canola seed yield was mainly due to increasing the number of pods per plant. In this study, the highest nitrogen level caused a significant increase the growth characters of canola.

B-Effect of bio-fertilizers:

Data in Tables (2,3 and 4) showed that inoculation of canola seeds with the mixture of *Azotobacter and Azospirillum* significantly increased all studied characters comparing with those of the uninoculated plants. Such results may be due to the beneficial effects of bio-fertilizer on yield and its components of plant which caused N-fixation or production of plant growth promoting substances. (Keyeo *et al.* 2011). Auxins produced by rhizobacteria can influence plants growth, including root development which improve uptake of essential nutrients thus increasing plant growth (Yasari and Patwardhan 2007).

C-Effect of Zn:

Data in Tables (2,3 and 4) showed that foliar application of Zn increased significantly canola yield and its components compared to those received no Zn. This may be due to the role of zinc in the cell division, cell enlargement and synthesis of protein. Zinc also regulates the membrane function and provides resistance to environmental stress in crop plants (Cakmak, 2000). Moreover, zinc plays important role in increasing plant height, no. of pods/plant, pods weight (g/plant) and seed yield (Bakry *et al.* 2012). Therefore, the increase in plant height, stem length and length of fruiting zone may be because of zinc, which plays a role in the biosynthesis of the protein and oil cell membrane integrity and in plant metabolism (Omidian *et al.* 2012).

The interaction effects:

Data in Tables (2,3 and 4) clearly showed that all aforementioned traits were not significantly affected by the interaction between either N-levels and bio fertilization or zinc. Results also revealed that the interaction effect between N2- fixing bacteria and Zn was insignificantly on canola yield and its components. Concerning the interaction between inoculation with bio-fertilizer, N rates, and Zn on canola yield and its components, data revealed that there were positive significant effects on yield and its components. These results might be attributed to that, the N2- fixing bacteria increase nutrients uptake. On the other hand, effect Zn on canola yield and its components might be attributed to their positive increasing of photosynthesis process and as an activator for IAA (Indol acetic acid) oxidase and carbohydrate assimilation. The maximum seed yield and its components had achieved when plants were fertilized with75 or 100%N of the recommended rates combined with inoculation with bio-fertilizer and foliar application of Zn compared with untreated ones. The highest growth values were due to N applied at rates of 75 or 100% N of the recommended rates combined with inoculation with N2-fixing bacteria. Such results previously were explained by Gouda (2002) who suggested that chemical N addition in combination with bio -fertilizers may activate N2-fixing bacteria in the soil; these bacteria have the ability to supply the plants with fixed –N and release plant growth promoting substances ("GA" gebrellic acid, "IAA" (Indol acetic acid) and cytokinins). Similar results were obtained by Yasari and Patwardhan (2007) who found that all inoculated treatments with the use of high level of inorganic nitrogen increased plant growth and consequently the canola yield. The positive effect of mineral fertilizers on yield and its components may be due to the role of nitrogen in protoplasm formation and all proteins, e.g., amino acids, nucleic acid, many enzymes and energy transfer materials ADP(adonized di-phosphate) and ATP(adonized tri-hosphate). These results are also in harmony with those obtained by Yasari *et al.* (2008).

II-Canola chemical constituents

A-Effect of nitrogen fertilization:

The results illustrated in Tables (5, 6 and 7) showed that increasing the applied rates of nitrogen fertilizer gradually significantly increased the concentration and uptake of N, P and Zn in seeds of canola plant , but these increases for K content in seeds were insignificantly. The highest values of N, P, K and Zn uptake were recorded with the application of 30 kg N/fed. This might be attributed to the role of nutrient nitrogen in building metabolites which increases the dry matter content and subsequently increase nutrients uptake in canola plant. These findings are in harmony with those obtained by Jan *et al*. (2002).

B- Effect of bio-fertilization

Concerning the tested bio-fertilizers influence on N, P, K and Zn in the canola seeds Tables (5, 6 and 7). These data indicated clearly that seed inoculation with bio-fertilizers significantly increased N, P and Zn content in canola seed but these increases for K content in seeds were insignificantly. The positive effect of bio-fertilizer inoculation on nutrient uptake could be described to the high efficiency of bacteria presence in these bio-fertilizers to fix atmospheric nitrogen and /or to produce some biologically active substances, e.g. IAA, gibberellin and cytokinins. Such substances would help in increasing the root biomass and thus indirectly help in greater absorption of nutrients from surrounding environment (Awad, 1998). Moreover, Kotb, (2005) reported that *Azotobacter and Azospirillum* strains produced adequate amounts of IAA and cytokinins, which increase the surface area per unit root length and are responsible for root hair branching and eventually increase the uptake of nutrients.

C-Effect of Zn:

Data in Tables (5, 6 and 7) indicated that the application of Zn produced the highest content of N, P and Zn in canola seed with significant improvement over control treatment but for K concentration and uptake in seeds were insignificantly increases.

The interaction effects

Data in Tables (5, 6 and 7) clearly showed that nutrients content and uptake by canola seeds were not significantly affected by the interaction between N-levels and bio except for N content and uptake in seeds which were significantly. Data also showed that all aforementioned traits were not significantly affected by the interaction between N-levels and Zn.

Table 5

Table 6

Table 7

Regarding to the effect of bio-fertilizers inoculation and Zn on chemical composition of the canola seeds indicate that the inoculation with N2- fixing bacteria combined with foliar application of Zn are insignificant on N,P,K and Zn contents and uptake of seeds .

As for of interaction between N-levels, bio-fertilization and Zn (A x B x C) , data clearly showed that all aforementioned traits were not significantly affected by the interaction among the three tested factors except for N content and uptake in seeds which were significantly.

III-Protein and oil contents in seeds

A- Effect of nitrogen fertilization

The data reported in Tables (7 and8) showed that, the protein content (%) and protein yield (kg/fed.) were significantly increased by increasing N fertilization levels up to 30 kg N/fed. The beneficial effect of nitrogen fertilization on protein yield may be due to, its favorable effect on seed yield and /or to enhance the absorbing efficiency of the roots. Besides, the stimulating effect of nitrogen may be due to its function in plant metabolism as it considered a major constituent of amino acid, protein, nucleic acids and phospholipids (Brennan *et al.* 2000).

Seed oil percentage was depressed by increasing N up to 30kg/fed. The possible reason for the decrease in oil content with N increase may be due to the fact that N is the major constituent of protein so it might increase the percentage of seed protein, as a result there might be decrease in the percentage of oil content since it has inverse relationship with protein. The results agree with those documented by Jan *et al.* (2002) and Özer (2003). This inverse relationship can be attributed to the competition between protein and oil concentrations in seed for carbon skeletons during carbohydrate metabolism; because protein has lower carbohydrate levels than oil, which can result in an increased supply of N in protein synthesis at the expense of fatty acids synthesis in oil seed crops (Rathke *et al.* 2005).

B- Effect of bio-fertilization:

Data in Tables (7 and 8) revealed that inoculation with N2- fixing bacteria as bio-fertilizer had significant positive effect on protein and oil contents in seeds of canola compared with non-inoculation. The increasing in protein content can be attributed to the ability of *Azospirillum and Azotobacter* to fix atmospheric nitrogen together with high production of growth promoting substances that enhance root development and function, stimulating seed germination, shoot and root lengths, and subsequently increased nutrients uptake by canola plants (Yasari and Patwardhan, 2007).

C-Effect of Zn:

Data in Tables (7 and 8) revealed that foliar application of Zn had significant positive effect on protein, oil content, protein and oil yield/fed. in canola seeds compared with the control. Oil is the most important parameter of rape seed quality. A part from the genetic factor, the content of oil in rape seeds is largely determined by mineral fertilization of the plants. Decrease in rape seed oil content may be result from deficit of nutrients, among others of such micronutrients as Zinc that control the metabolic transformations in the plants (Omidian *et al.* 2012).

The interactions effects:

Concerning the impact of interaction between N-levels and bio fertilization (A x B) on protein and oil content (%) and their yield kg/fed. of canola seeds, it was noticed that significant positive effects of protein content (29.19%) and protein yield/fed (359.87kg/fed) but for oil content and its yield/fed in seeds were insignificantly. On the other hand, there are insignificant effects on protein and oil content and their yield/fed in seeds because there is no interaction between N-levels and Zn (A x C) and also, between bio-fertilization and Zn (B x C). In

Table 8

regard to the effect of interaction among N-levels, bio-fertilizers and Zn (A x B x C) on protein and oil content and their yield/fed in canola seeds, it was found that highest significant values of their content and yield.

CONCLUSIONS:

From the obtained data it could be concluded that canola (*Brassica napus* L.) yield and yield components had a strong association with the nitrogen fertilization, bio-fertilizer inoculation and Zn application. Higher rates of nitrogen fertilization, bio-fertilizer (*Azotobacter and Azospirillum*) inoculation and Zn application increased plant height, pods number plant^{-1}, 1000-seeds weight and seed yield. Maximum seed yields were obtained with seed inoculation with the mixture of Azotobacter + Azospirillum combined with the application of mineral N at a rate of 30 kg N/fed. and foliar application of Zn. So, it is suggested to use a combination of nitrogen fertilization, bio-fertilizer (*Azotobacter and Azospirillum*) inoculation and Zn application to achieve the highest yield without negative effect on grain quality that will lead to sustainable environment.

REFERENCES

Ahmed, G., A. Jan, M. Arif, M. T. Jan and R. A. Khattak (2007). Influence of nitrogen and sulphur fertilization on quality of canola (*Brassica napus* L.) under rainfed condition. Zhejiang Univ. Sci. B 8 (10): 731-737.

Al-Barrak, K.M. (2006). Irrigation interval and nitrogen level effects on growth and yield of canola (*Brassica napus* L.), Scie. J. King Faisal Univer. (Basic and Applied Sciences). 7: 87-103.

A.O.A.C. (1990). Association of Official Analytical Chemists Official Methods of Analysis. 1st Ed. The Association, Washington DC. USA

Awad, N. M. (1998). The use of microorganisms in ecological farming systems. Ph.D. Thesis, Fac. Sci., Cairo Univ., Egypt.

Azimzadeh, S.M. and S.J. Azimzadeh (2013). Effect of nitroxin bio-fertilizer and nitrogen chemical fertilizer on yield and yield components of rapeseed (*Brassica napus* L.). Intern. J. of Agric. and Crop Scie. 6(18): 1284–1291.

Bakry, B.A., M.M. Tawfik, B.B. Mekki and M.S. Zeidan (2012). Yield and Yield Components of Three Flax Cultivars (*Linum usitatissimum* L.) In Response to Foliar Application with Zn, Mn and Fe under Newly Reclaimed Sandy Soil Conditions. American- Eurasian J. Agric. & Environ. Sci. 12 (8): 1075-1080.

Brennan, R.F., M.G. Mason and G.H. Walton (2000). Effect of nitrogen fertilizer on the concentrations of oil and protein in Canola (*Brassica napus* L.) seed. Journal of Plant Nutrition 23 (3): 339–348.

Bybordi, A. and M.J. Malakouti (2007). Effects of zinc fertilizer on the yield and quality of two winter varieties of canola. Zinc crops. International Congress of Improving Crop Production and Human Health, 24 – 26 May. Istanbul. Turkey.

Cakmak, I. (2000). Possible role of zinc in protecting plant cells from damage by reactive oxygen species. New Phytol. 146: 185-202.

Cheema, M.A., M.A. Malik, A. Hussain, S.H. Shah and S.M.A. Basra (2001). Effects of time and rate of nitrogen and phosphorus application on the growth and seed and oil yields of canola (*Brassica napus* L.) J. Agron. Crop Sci. 186:103-110.

Chngo, G. and P.B.E. Mcvetty (2001). Relationship of physiological characters to yield parameters in oil seed rape (*Brassica napus* L.). Canadian J. Plant Sci.130:120-128.

Cottenie, A., M. Verloo, L. Kiekens, G. Velge and R. Camerlynck (1982). "Chemical Analysis of Plants and Soils". Lab. Agrochem, State University Ghent, Belgium.

El-Habbasha, S. F. and M.H. Taha (2011). Integration between nitrogen fertilizer levels and bio-inoculants and its effect on canola (Brassica napus L.) plants. American-Eurasian J .Agric. & Enviro. Scie. 11(6): 786–791.

Grant, C.A., D.A. Derksen, D.L. Mclaren and R.B. Irvine (2011). Nitrogen fertilizer and urease inhibitor effects on canola seed quality in a one-pass seeding and fertilizing system. Field Crops Research. 121(2): 201–208.

Gomez, K.A. and A.A. Gomez (1984). Statistical Procedures for Agricultural Research. 2nd Ed., John Wiley and Sons, New York, USA.

Gouda, A.E.A.I. (2002). Study of bio and chemical fertilization on garlic (Allium sativum L.). M.Sc. Thesis, Faculty of Agric. Mansoura Univ., Egypt

Hasanalideh, A. and M. Hojati (2010). Enhancing yield and nitrogen use efficiency of Brassica napus L. using an integrated fertilizer management. Adva. in Enviro. Biology. 6(2): 641–647.

Hopkinson, S., U.R. Bishnoi and E. Cebert (2002). Sowing dates, seeding and nitrogen rates effects yield and yield components of canola. Crop Research, 24(3): 407-416.

Ibrahim, A.F., E.O. Abusteit and M.A. El-Metwally (1989). Response of rapeseed (Brassica napus L.) growth, yield, oil content and its fatty acids to nitrogen rates and application times. J. Agron. Crop Sci. 162:107-112.

Jackson, G.D. (2000). Effects of N and S on canola yield and nutrient uptake. Agron. J. 92: 644-649.

Jan, A., N. Khan, I.A. Khan and B. Khattak (2002). Chemical composition of canola as affected by nitrogen and sulphur. Asian J. Plant Sci., 1: 519-521.

Kaur, P. and M. S. Sidhu (2006). Effect of sowing date, nitrogen level and row spacing on oil quality of Ethiopian mustard. Environ. Ecol., 24: 1112-1114.

Keyeo, F., O.N. Ai'shah and H.G. Amir (2011). The effects of nitrogen fixation activity and phytohormone production of diazotroph in promoting growth of rice seedlings. Biotechnology, 10: 267-273.

Kaya, C. and D. Higgs (2002). Response of tomato (*Lycopersicon esculentum* L.) cultivars to foliar application of zinc when grown in sand culture at low zinc. Sciences of Horticulture. 93: 53-64.

Klute, A.A. (1986). 'Methods of Soil Analysis". American Society of Agronomy, Inc. Publishers, Madison, Wisconsin, U.S.A., 2nd Edition.

Kotb, M. Th. (2005). Increasing the efficiency of chemical N-fertilizers using bio-fertilizers for wheat. Egypt. J. of Appl. Sci., 20(9): 352-374.

Namvar, A. and T. Khandan (2013). Response of wheat to mineral nitrogen fertilizer and biofertilizer (*Azotobacter sp. and Azospirillum sp*.) inoculation under different levels of weed interference. Ekologija. 59(2): 85–94.

Omidian, A., S.A. Seyadat, R. Naseri and M. Moradi (2012). Effects of Zinc- sulfate foliar on yield, oil content and seed protein of four cultivar canola. Iranian j. Agric. Sci., 14: 26-28.

Özer, H. (2003). Sowing date and nitrogen rate effects on growth, yield and yield components of two summer rapeseed cultivars. Eur. J. Agron. 19:453-463.

Page, A.L., R.H. Miller and D.R. Keeny (ed.) (1982). Methods of Soil Analysis, part2. Chemical and Microbiological Properties. Amer. Soc. of Agronomy. Madison, Wisconsin, USA.

Rana, D. S. (2002). Yield and yield attributes, nutrients uptake, nitrogen-use efficiency and economics of oleiferous brassicas as influenced by time of sowing and fertility levels. Ind. J. Agric. Sci. 72: 519 -524.

Rathke, G. W., O. Christen and W. Diepenbrock (2005). Effects of nitrogen source and rate on productivity and quality of winter oilseed rape (*Brassica napus* L.) grown in different crop rotations. Field Crops Res. 94: 103113.

Robinson, R.G. (1975). Amino acids and elemental composition of sunflower and pumpkin seeds. Agron. J., 61:541.

Ryan, J., S. Garabet, K. Harmsen and A. Rashid (1996). Soil and Plant Analysis. Manual Adapted for the west Asia and North Africa Region. ICARDA, Aleppo, Syria. 140pp.

Vessey, J. K. (2003). Plant growth promoting rhizobacteria as biofertilizers. Plant and Soil. 255: 571–586.

Yasari, E. and A.M. Patwardhan (2007). Effects of *Azotobacter and Azospirillum* inoculants and chemical fertilizers on growth and productivity of canola (*Brassica napus* L.). Asian J. Plant Sci., 6: 77-82.

Yasari, E., A.M. Patwardhan, V.S. Ghole, G.C. Omid and A. Ahmad (2008). Relationship of growth parameters and nutrients uptake with canola (*Brassica napus* L.) yield and yield contribution at different nutrients availability. Pak. J. Biol. Sci., 11: 845-853.

تأثير معدل النيتروجين المعدنى و التسميد الحيوى والزنك على انتاجية وجودة الكانولا

أمال حسن الجبالى

معهد بحوث الاراضى والمياه والبيئة – مركز البحوث الزراعية

الملخص العربى

أجريت تجربة حقلية فى مزرعة محطة البحوث الزراعية بالجيزة خلال موسمين شتويين متتاليين ٢٠١٣/٢٠١٤، ٢٠١٤/٢٠١٥ لدراسة تأثير إضافة مستويات مختلفة من النيتروجين(٥٠ و٧٥و١٠٠%) الموصى به والتلقيح الحيوى للبذور(بدون تلقيح، التلقيح بالازوتوباكتر والازوسبيرلليم) والرش بكبريتات الزنك(بدون رش– مع الرش) وايضا التفاعل بينهما على حالة النمو ومحصول الكانولا (صنف سرو ٤) ومكوناته وايضا الكمية الممتصة من النيتروجين والفوسفور والبوتاسيوم والزنك بواسطة البذور وكذلك محتوى البذور من البروتين والزيت، حيث استخدم التصميم الاحصائى للقطع المنشقة مرتين فى ثلاثة مكررات. وتشير النتائج ان هناك زيادة معنوية للنيتروجين على ارتفاع النبات,عدد القرون/نبات, وزن القرون/نبات , وزن البذور/نبات, وزن ١٠٠٠ بذرة, محصول البذور,محتوى البروتين ومحصول البروتين والزيت. اوضحت الدراسة ان المعاملة ١٠٠% من النيتروجين الموصى به للفدان هى اكثر المعاملات التى حققت زيادة فى المحصول ومكوناته وكان اعلى محتوى من البروتين (٢٦.١٦%) فى المعدل العالى من النيتروجين واقل محتوى للبروتين (١٨.٩٨%) فى المعدل المنخفض للنيتروجين. على العكس تم الحصول على اقل محتوى زيت (٤١.٣١%) فى المعدل العالى من النيتروجين واعلى محتوى زيت (٤٤.٢٨%) فى المعدل المنخفض للنيتروجين.

ادى التلقيح الحيوى بالبكتريا المثبتة للنيتروجين الجوى الى حدوث زيادة معنوية على المحصول ومكوناته مقارنة بالمعاملات الغير ملقحة. اظهر الرش بالزنك حدوث زيادة معنوية فى جميع صفات النمو والمحصول مقارنة بالكنترول. اظهر التفاعل بين التسميد النيتروجينى بالمعدلات (٧٥ أو١٠٠%) من المعدل الموصى به مع التلقيح الحيوى والرش بالزنك الى زيادة معنوية فى بعض مكونات المحصول.

لذلك يقترح استخدام مزيج من الأسمدة الغير عضوية والتسميد الحيوى لتحقيق اعلى محصول دون تاثير سلبى على جودة البذور والتى سوف تؤدى الى بيئة مستدامة.

السادة المحكمين:

١- أ.د/ محمود حنفى محمـــــــــود   الأستاذ بمعهد بحوث الأراضى والمياه والبيئة – مركز البحوث الزراعية

٢- أ.د/ الحسينى عبدالغفار أبوحسين   الأستاذ بكلية الزراعة بشبين الكوم – جامعة المنوفية

Table 2. Effects of mineral nitrogen fertilizer, bio-fertilizer inoculation and Zn application on yield components in canola.

Treatments		Plant height(cm)			Dry root weight (g/plant)			Dry shoot weight (g/plant)		
Nitrogen rates (kg fed^{-1})	Bio-fertilizer	-Zn	+Zn	Mean	-Zn	+Zn	Mean	-Zn	+Zn	Mean
50% RD	B non	164.50	169.00	166.75	14.74	18.35	16.55	76.40	80.27	78.34
	B with	174.17	174.83	174.50	19.64	20.10	19.87	80.42	82.42	81.42
	Mean	169.34	171.92	170.63	17.19	19.23	18.21	78.41	81.35	81.35
75% RD	B non	179.17	180.17	179.67	21.05	22.18	21.62	86.15	88.15	78.15
	B with	180.33	181.83	181.08	22.22	22.35	22.29	89.82	94.08	78.15
	Mean	179.75	181.00	180.38	21.64	22.27	21.96	87.99	91.12	89.56
100% RD	B non	182.67	183.67	183.17	23.74	24.42	24.08	94.60	97.10	95.85
	B with	185.50	189.00	187.25	24.47	35.45	29.96	100.32	104.43	102.38
	Mean	184.09	186.34	185.21	24.11	29.94	27.03	97.46	100.77	99.12
Average Bio	B non	175.45	177.61	176.53	19.84	21.65	20.75	85.72	88.51	87.12
	B with	180.00	181.89	180.94	22.11	25.97	24.04	90.19	93.64	91.92
	Mean	177.73	179.75	178.74	20.98	23.81	22.40	87.96	91.08	89.52
L.S.D at 5%	N (A)	4.71			4.49			23.20		
	Bio(B)	3.83			3.05			12.98		
	Zn (C)	2.27			2.30			10.01		
	AXB	n.s.			n.s.			n.s.		
	AXC	n.s.			n.s.			n.s.		
	BXC	n.s.			n.s.			n.s.		
	AXBXC	11.53			5.64			24.53		

RD: Recommended dose (30 kg N /fed.)

Table 3. Effects of mineral nitrogen fertilizer, bio-fertilizer inoculation and Zn application on yield components in canola

Treatments		No. of pods/plant			Pods weight (g/plant)			Seeds weight (g/plant)		
Nitrogen rates (kg fed^{-1})	Bio-fertilizer	-Zn	+Zn	Mean	-Zn	+Zn	Mean	-Zn	+Zn	Mean
50% RD	B non	222.0	251.0	236.50	123.52	125.40	124.46	57.35	61.99	59.67
	B with	262.0	266.0	264.00	131.23	134.65	132.94	63.18	63.73	63.46
	Mean	242.0	258.5	250.25	127.38	130.03	128.71	60.27	62.86	61.57
75% RD	B non	269.0	309.0	289.00	137.00	140.05	138.53	64.02	64.63	64.33
	B with	326.0	344.0	335.00	146.68	151.70	149.19	69.88	74.49	72.19
	Mean	297.5	326.5	312.00	141.84	145.88	143.86	66.95	69.56	68.26
100% RD	B non	354.0	368.0	361.00	154.98	155.42	155.20	75.34	75.55	75.45
	B with	421.0	428.0	424.50	160.82	165.98	163.40	82.23	88.07	85.15
	Mean	387.5	398.0	392.75	157.90	160.70	159.30	78.79	81.81	80.30
Average Bio	B non	281.76	309.33	295.55	138.50	140.29	139.40	65.57	67.39	66.48
	B with	336.33	346.00	341.17	146.24	150.78	148.51	71.76	75.43	73.60
	Mean	309.05	327.67	318.34	142.37	145.54	143.96	68.67	71.41	70.04
L.S.D at 5%	N (A)	27.06			16.03			10.54		
	Bio(B)	19.04			13.91			6.13		
	Zn (C)	12.93			12.99			7.55		
	AXB	n.s.			n.s.			n.s.		
	AXC	n.s.			n.s.			n.s.		
	BXC	n.s.			n.s.			n.s.		
	AXBXC	31.67			31.82			18.48		

RD: Recommended dose (30 kg N /fed.)

Table 4. Effects of mineral nitrogen fertilizer, bio-fertilizer inoculation and Zn application on yield and its components in canola .

Treatments		Weight of 1000 seed(g)			Fruiting zone(cm)			Seed yield (kg fed^{-1})		
Nitrogen rates (kg fed^{-1})	Bio-fertilizer	-Zn	+Zn	Mean	-Zn	+Zn	Mean	-Zn	+Zn	Mean
50% RD	B non	3.40	3.58	3.49	154.67	159.67	157.17	849.5	857.7	853.6
	B with	3.88	3.92	3.90	163.17	164.83	164.00	867.8	884.5	876.2
	Mean	3.64	3.75	3.70	158.92	162.25	160.59	858.7	871.1	864.9
75% RD	B non	3.99	4.28	4.14	168.33	171.17	169.75	903.7	952.7	928.2
	B with	4.42	4.50	4.46	172.00	172.50	172.25	978.3	1096.6	1037.5
	Mean	4.21	4.39	4.30	170.17	171.84	171.01	941.0	1011.2	982.85
100% RD	B non	4.56	4.57	4.57	173.83	175.33	174.58	1117.3	1151.3	1134.3
	B with	4.65	5.41	5.03	176.67	180.50	178.59	1184.5	1233.0	1208.8
	Mean	4.61	4.99	4.80	175.25	177.92	176.59	1150.9	1192.2	1171.6
Average Bio	B non	3.98	4.14	4.07	165.61	168.72	167.17	956.8	987.2	972.0
	B with	4.32	4.61	4.47	170.39	172.61	171.61	1010.2	1071.4	1040.8
	Mean	4.15	4.38	4.27	168.00	170.67	169.39	983.5	1029.3	1006.4
L.S.D at 5%	N (A)	0.63			3.51			91.05		
	Bio(B)	0.45			2.04			75.31		
	Zn (C)	0.36			4.32			65.68		
	AXB	n.s.			n.s.			n.s.		
	AXC	n.s.			n.s.			n.s.		
	BXC	n.s.			n.s.			n.s.		
	AXBXC	0.88			10.58			184.5		

RD: Recommended dose (30 kg N /fed.)

Table 5. Effects of mineral nitrogen fertilizer, bio-fertilizer inoculation and Zn application on chemical constituents in seeds of canola .

Treatments		N-conc. (%)			N-uptake (kg fed^{-1})			P conc. (%)		
Nitrogen rates (kg fed^{-1})	Bio-fertilizer	-Zn	+Zn	Mean	-Zn	+Zn	Mean	-Zn	+Zn	Mean
50% RD	B non	3.27	3.29	3.28	27.78	28.19	27.99	0.43	0.46	0.45
	B with	3.31	3.33	3.32	28.75	29.46	29.11	0.49	0.52	0.51
	Mean	3.29	3.31	3.30	28.27	28.83	28.55	0.46	0.49	0.48
75% RD	B non	3.39	3.77	3.58	30.66	35.93	33.30	0.55	0.56	0.56
	B with	3.81	3.97	3.89	37.31	43.49	40.40	0.57	0.60	0.59
	Mean	3.60	3.87	3.74	33.99	39.71	36.85	0.56	0.58	0.57
100% RD	B non	4.04	4.09	4.07	45.10	47.08	46.09	0.61	0.63	0.62
	B with	4.98	5.08	5.03	58.98	62.59	60.79	0.64	0.65	0.65
	Mean	4.51	4.59	4.55	52.04	54.84	53.44	0.63	0.64	0.64
Average Bio	B non	3.57	3.72	3.65	34.51	37.07	35.79	0.53	0.55	0.54
	B with	4.03	4.13	4.08	41.68	45.18	43.43	0.57	0.59	0.58
	Mean	3.80	3.93	3.87	38.10	41.13	39.61	0.55	0.57	0.56
L.S.D at 5%	N (A)	044			5.02			2.54		
	Bio(B)	0.29			4.44			1.72		
	Zn (C)	0.30			4.08			1.64		
	AXB	0.50			7.07			2.84		
	AXC	n.s.			n.s.			n.s.		
	BXC	n.s.			n.s.			n.s.		
	AXBXC	0.73			10.88			4.21		

RD: Recommended dose (30 kg N /fed.)

Table 6. Effects of mineral nitrogen fertilizer, bio-fertilizer inoculation and Zn application on chemical constituents in seeds of canola

Treatments		P-uptake kg/fed			K-conc. (%)			K-uptake kg/fed		
Nitrogen rates (kg fed$^{-1)}$	Bio-fertilizer	-Zn	+Zn	Mean	-Zn	+Zn	Mean	-Zn	+Zn	Mean
50% RD	B non	3.65	3.65	3.28	0.58	0.63	0.61	4.90	5.43	5.17
	B with	4.22	4.22	3.32	0.64	0.66	0.65	5.55	5.84	5.70
	Mean	3.94	3.94	3.30	0.61	0.65	0.63	5.23	5.64	5.44
75% RD	B non	4.97	4.97	3.58	0.69	0.71	0.70	6.25	6.80	6.53
	B with	5.58	5.58	3.89	0.72	0.73	0.73	7.08	7.95	7.52
	Mean	5.28	5.28	3.74	0.71	0.72	0.72	6.67	7.38	7.03
100% RD	B non	6.78	6.78	4.07	0.75	0.76	0.76	8.38	8.75	8.57
	B with	7.58	7.58	5.03	0.77	0.80	0.79	9.12	9.90	9.51
	Mean	7.18	7.18	4.55	0.76	0.78	0.78	8.75	9.33	9.04
Average Bio	B non	5.13	5.13	3.65	0.67	0.70	0.69	6.51	6.99	6.75
	B with	5.79	5.79	4.08	0.71	0.73	0.72	7.25	7.90	7.58
	Mean	5.46	5.46	3.87	0.69	0.72	0.71	6.88	7.45	7.17
L.S.D at 5%	N (A) Bio(B) Zn (C) AXB AXC BXC AXBXC	0.39 0.54 0.47 n.s. n.s. n.s. n.s.			0.39 0.54 0.47 n.s. n.s. n.s. n.s.			2.54 1.72 1.64 2.84 n.s. n.s. 4.21		

RD: Recommended dose (30 kg N /fed.)

Table 7. Effects of mineral nitrogen fertilizer, bio-fertilizer inoculation and Zn application on chemical constituents and protein content in seeds of canola .

Treatments		Zn-conc.(mg/kg)			Zn-uptake g/fed			Protein content (%)		
Nitrogen rates (kg fed^{-1})	Bio-fertilizer	-Zn	+Zn	Mean	-Zn	+Zn	Mean	-Zn	+Zn	Mean
50% RD	B non	27.23	31.67	29.45	23.14	27.16	25.15	18.80	18.90	18.85
	B with	29.17	33.03	31.10	25.31	29.22	27.27	19.05	19.15	19.10
	Mean	28.20	32.35	30.28	24.23	28.19	26.21	18.93	19.03	18.98
75% RD	B non	29.50	35.00	32.25	26.66	33.35	30.01	19.51	21.69	20.60
	B with	34.27	35.93	35.10	33.52	39.40	36.46	21.93	22.80	22.37
	Mean	31.89	35.47	33.68	30.09	36.38	33.24	20.72	22.25	21.49
100% RD	B non	35.00	37.80	36.40	39.11	43.52	41.32	23.21	23.51	23.36
	B with	36.10	39.63	37.87	42.76	48.87	45.82	28.63	29.19	28.91
	Mean	35.55	38.72	37.12	40.94	46.20	43.57	25.92	26.35	26.14
Average Bio	B non	30.58	34.82	32.70	29.64	34.68	32.16	20.51	21.37	20.94
	B with	33.18	36.20	34.69	33.86	39.16	36.52	23.20	23.71	23.46
	Mean	31.88	35.51	33.70	31.75	36.92	34.34	21.86	22.54	22.20
L.S.D at 5%	N (A)	1.22			2.37			2.54		
	Bio(B)	0.85			3.17			1.72		
	Zn (C)	1.73			3.13			1.64		
	AXB	n.s.			n.s.			2.84		
	AXC	n.s.			n.s.			n.s.		
	BXC	n.s.			n.s.			n.s.		
	AXBXC	n.s.			n.s			4.21		

RD: Recommended dose (30 kg N /fed.)

Table 8. Effects of mineral nitrogen fertilizer, bio-fertilizer inoculation and Zn application on quality in seeds of canola .

Treatments		Protein yield (kg fed^{-1})			Oil content (%)			Oil yield (kg fed^{-1})		
Nitrogen rates (kg fed^{-1})	Bio-fertilizer	-Zn	+Zn	Mean	-Zn	+Zn	Mean	-Zn	+Zn	Mean
50% RD	B non	159.71	162.12	160.92	43.80	44.01	43.91	372.13	377.52	374.83
	B with	165.33	169.41	167.37	44.59	44.70	44.65	386.91	395.32	391.12
	Mean	162.52	165.77	164.15	44.20	44.36	44.28	379.52	386.42	382.98
75% RD	B non	176.32	206.62	191.47	42.36	42.38	42.37	382.82	403.80	393.31
	B with	214.55	250.05	232.30	42.50	42.98	42.74	415.81	471.31	443.56
	Mean	195.44	228.34	211.89	42.43	42.68	42.56	399.32	437.56	418.44
100% RD	B non	259.30	270.68	264.99	40.84	41.01	40.93	456.31	472.10	464.21
	B with	339.11	359.87	349.49	41.64	41.72	41.68	493.26	514.39	503.83
	Mean	299.21	315.28	307.25	41.24	41.37	41.31	474.79	493.25	484.02
Average Bio	B non	198.44	213.14	205.79	42.33	42.47	42.40	403.75	417.81	410.78
	B with	239.66	259.78	249.72	42.91	43.13	43.02	431.99	460.34	446.17
	Mean	219.05	236.46	227.76	42.62	42.80	42.71	417.87	439.08	428.48
L.S.D at 5%	N (A)	28.87			2.10			19.46		
	Bio(B)	25.54			0.91			44.57		
	Zn (C)	23.45			1.01			37.77		
	AXB	40.61			n.s.			n.s.		
	AXC	n.s.			n.s.			n.s.		
	BXC	n.s.			n.s.			n.s.		
	AXBXC	62.58			2.47			92.53		

RD: Recommended dose (30 kg N /fed.)