

# Response of Canola Plant (*brassica napus* L.) To Reducing Nitrogen Fertilizer Rates by Adding Humic Substance

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## ABSTRACT

Two field experiments were carried out at Itay El-Baroud Agricultural Research Station Farm – El Behira Governorate- Egypt during two successive winter seasons of 2016 /2017 and 2017/2018 to investigate the possibility of reducing nitrogen fertilizer rates by adding humic substance (Actosol®) and their effects on growth, yield, yield components and some chemical properties of Serow 4 canola variety plants. The studied treatments consisted of seven different doses of recommended nitrogen (30 kg N / fed) with or without Actosol (6 liters / fed) as follows: 50 % nitrogen without Actosol (50 % N-Act.), 75 % nitrogen without Actosol (75 % N-Act.), 100 % nitrogen without Actosol (100 % N-Act.), zero nitrogen with Actosol (0 % N+Act.), 50 % nitrogen with Actosol (50 % N+Act.), 75 % nitrogen with Actosol (75 % N+Act.), and 100 % nitrogen with Actosol (100 % N+Act.). The experimental design was randomized complete block with three replicates. Results showed that decreasing nitrogen rates with or without humic substance (Actosol) linearly decreased plant height, number of branches and fruits/plant, 1000-seed weight, seed yield/plant, seed yield/fed and seed oil yield/fed, while it had increased, but non-significantly, seed oil content. However, application of Actosol increased all characters, except seed oil content where it had no significant effect on that trait at all studied nitrogen rates. Treatment of (75 % N+Act.) was better than (100 % N-Act.) for most studied characters. Therefore, nitrogen fertilization rate can be reduced by about 25% of the recommended by adding the recommended dose of Actosol (6 liters / fed).

**Keywords:** nitrogen fertilization, humic substance, Actosol, canola, seed oil content.

## INTRODUCTION

Canola (*Brassica napus* L. var. Serow 4) is a winter oilseed plant grown in Egypt, its seeds contain about 40 % oil and 23 % protein. Canola oil Had high mono- and polyunsaturated fatty acids (Oleic, linoleic and linolenic) content, so it could be used as an edible oil. The seed meal can be used as animal feed or as a crop nutrient source when returned to the field. (Gao *et al.*, 2010). It is very useful in beekeeping and food industries, where it considered a good source of food for bees that ensure dust intake from yellow flowers of rapeseed during March-April, when the flowers are scarce. Canola oil with high erucic acid content can be

used as industrial lubricant oil. Due to the shortage and volatility of the world petroleum supply at the end of the 20<sup>th</sup> century, high oil content crops have gained substantial attention as important alternative bioenergy resources (Gao *et al.*, 2010). Cropping structure in Egypt does not allow the existence of oil crops, there is a wide gap between the production and consumption, and this gap can be reduced by increasing the area of oil crops sown by new oil crops such as canola that have the ability to grow in new reclaimed and saline lands.

Nitrogen fertilization is the most important element and a critical limiting factor for canola production (Jackson, 2000). Canola yield indirectly affected by nitrogen as a result of increasing stem length, number of flowering branches, total plant weight, seeds per pod, number and weight of pods and seed per plant (Taylor *et al.*, 1991). Though chemical fertilizers increase crop production, it's not only nourish plants and microbes, but also may have harmful effects on the soil and its life, especially when they are very concentrated by overuse of chemical fertilizers (Mourad and Teileb, 2019). To avoid these risks, organic fertilizers should be mixed with mineral N-fertilizers to reduce soil pollution by reducing the amount of mineral N-fertilizers, enhancing soil fertility, and improving soil physical and chemical properties, such as permeability, aeration, aggregation, ability to retain water, ion transport and availability through buffering of pH, (Tan, 2003).

Humic substances (humic and fulvic acids) are the major component of soil organic matter and the term "humus" is widely accepted as synonymous with soil organic matter (Chen and Aviad, 1990). Humic substances affect the solubility of many nutrient elements by building complex forms or chelating agents of humic matter with metallic cations (Lobartini *et al.*, 1997). Humic acids play a major role in plant nutrients uptake and plant growth parameters during vegetative and generative stages (Ulukan, 2008). The beneficial effect of humic acid on plant growth referred to increase cell membrane, oxygen uptake, respiration and photosynthesis, nutrients uptake, root and cell elongation, and ion transport (Nardi *et al.*, 2002). Therefore, the aim of this study was to investigate the possibility of reducing nitrogen fertilization rate by

DOI: 10.21608/asejaiqsae.2021.151650

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adding Actosol® as a humic substance, and its effect on growth, yield, yield components, and seed oil content.

## MATERIAL AND METHODS

Two field experiments were conducted at Itay El-Baroud Agricultural Research Station Farm – El Behira Governorate- Egypt during two successive winter seasons of 2016 /2017 and 2017/2018. Humic substance source (Actosol® product, is a natural organic fertilizer which contain 20% humic substance, and commercially known as potash Actosol® and manufactured by ARCTECH Inc. Chantilly, VA, USA). The main characteristics of humic substance in the form of Actosol used in this study are presented in Table 1. Serow 4 as a canola (*Brassica napus* L.) cultivated variety was obtained from Oil Crops Research Department, Field Crops Research Institute, Giza, Egypt. Seven different treatments of nitrogen levels from recommended dose combined with or without humic substance (Actosol®) as follows: 1- 50 % nitrogen without Actosol (50 % N-Act.), 2- 75 % nitrogen without Actosol (75 % N-Act.), 3- 100 % nitrogen without Actosol (100 % N-Act.), 4- zero nitrogen with Actosol (0 % N+Act.), 5- 50 % nitrogen with Actosol (50 % N+Act.), 6- 75 % nitrogen with Actosol (75 % N+Act.), and 7- 100 % nitrogen with Actosol (100 % N+Act.) were used in this study. The experimental design was randomized complete block with three replicates. Nitrogen levels were added in two equal doses at the first and second irrigations. The recommended nitrogen dose is 30 kg N/fed added on the form ammonium nitrate (33.5 % N). Six liters of humic substance (Actosol®) per feddan as a recommended dose were divided to three doses as follows: the first dose (3 liters/fed) was added by spraying on the soil during soil preparation, second and third doses were added as foliar spraying on canola plants at 30 and 45 days after sowing

at a rate of 1.5 liters per feddan each. The main chemical and physical properties of experimental soil which presented in Table (2) were analyzed according to (Jackson, 1958). The experiment was planted in 20<sup>th</sup> and 25<sup>th</sup> October of the two seasons, respectively. Seeds of canola were sown directly in hills at the rate of 2 kg / fed. After three weeks from planting, seedlings were thinned to one plant per hill. The recommended doses of 100 kg single supper phosphate (15.5 % P<sub>2</sub>O<sub>5</sub>) per feddan was incorporated at the soil preparation and 50 kg potassium sulfate (48 % K<sub>2</sub>O) per feddan was added with the second irrigation of the two seasons. Other agriculture practice were applied as recommended. After flowering stage chlorophyll content index using the portable meter Chlorophyll Meter, model SPAD-502 (Minolta, 1989) was measured. Measurements with the SPAD-502 meter produce relative SPAD meter values that are proportional to the amount of chlorophyll present in the leaf. At harvest ten guarded plant were randomly chosen from each plot to measure plant height (cm), number of branches/plant, number of fruits/plant, 1000-seed weight(g), seed yield/plant(g) and seed yield/fed (kg). Seed oil content (%) was determined using Soxhelt extraction technique using diethyl ether as organic solvent (AOAC 1990) and seed oil yield/fed (kg) was calculated.

The collected data were analyzed with analysis of variance (ANOVA) procedures using COSTAT version 6.311 according to Sendecor and Cochran (1976). The least significant differences (LSD) were used to test the significance between different treatment means at 95% level of probability. The average of the two seasons used to illustrate the results in figures after confirmation of homogeneous for all studied traits except seeds oil content using F.max test method of Hartley (1950).

**Table 1. Main characteristics potash Actosol® used in the study**

components	%	components	%
Humic substances (Humic-Folvic-Alimic)	20	Fe	0.1
N	2	Zn	0.1
P	5	Mn	0.1
K	6	Cu	0.05
Mg	1.5	B	0.05
S	1.5	Mo	0.01
Ca	0.02	Marine algae	0.5
Amino acids	1		

**Table 2. The main chemical and physical properties of the experimental soil**

Soil analysis	2016/2017	2017/2018
Sand %	21.0	22.3
Silt %	24.2	25
Clay %	54.8	52.7
Texture	Clay	Clay
EC (dSm <sup>-1</sup> ) (1:1)	1.5	1.3
pH (1:2.5)	7.8	8.0
Total CO <sub>3</sub> <sup>-</sup> (%)	6.8	7.2
Organic matter %	1.2	1.7
KCl- N (ppm)	50	47
NaHCO <sub>3</sub> - P (ppm)	47	40
NH <sub>4</sub> OAC- K (ppm)	241	229

## RESULTS AND DISCUSSION

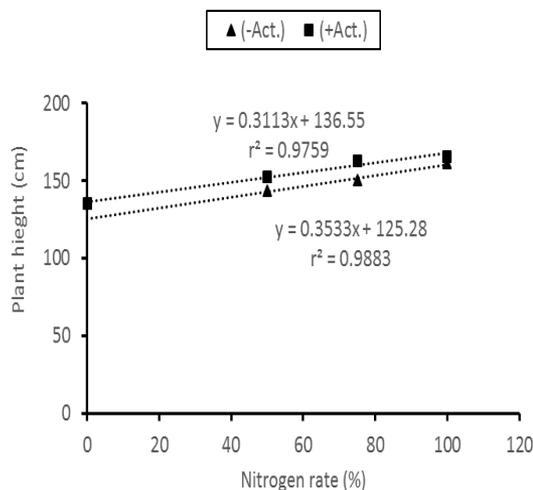
### Plant height

Data in Table 3 and Figure 1 showed that decreasing of nitrogen rates with or without humic substance (Actosol) decreased significantly canola plant height in both studied seasons. Application of humic substance (Actosol) increased significantly canola plant height at all nitrogen levels in both seasons. There were no significant differences between 100 % N dose without Actosol with 75 % N dose with Actosol for plant height during the two seasons. The mean increasing percentages of plant height in the two seasons as a result of application Actosol were 6.2, 8.0, and 2.7 % at 50, 75, and 100 % N doses, respectively. The relation between canola plant height mean of the two seasons and nitrogen levels without Actosol was linear relationship with equation ( $y = 0.3533x + 125.28$ ) with  $r^2 = 0.9883$ , while was linear relationship with equation ( $y = 0.3113x + 136.55$ ) with  $r^2 = 0.9759$  with nitrogen levels combined with Actosol as shown in Figure 1.

### Number of branches per plant

Data presented in Table 3 and Figure 2 showed that decreasing nitrogen levels up to 50 % N dose without Actosol significantly decreased number of branches per plant in both seasons. However, application of Actosol increased significantly number of branches per plant at 50 % N dose compared 50 % N dose without Actosol in both seasons. There were no significant differences between 100 % N dose without Actosol with 50, 75 and 100 % N doses with Actosol on number of branches per plant in both studied seasons. The mean increasing percentages of number of branches per plant in the two seasons as a result of application Actosol were 15.3, 1.6, and 1.6 % at 50, 75, and 100 % N doses, respectively. The relation between mean number of branches per

plant of the two seasons and nitrogen levels without Actosol was quadratic equation ( $y = -0.0006x^2 + 0.1053x + 1.7667$ ) with  $r^2 = 1$ , while was quadratic equation ( $y = -0.0002x^2 + 0.0401x + 4.9158$ ) with  $r^2 = 0.99$  with nitrogen levels with Actosol as shown in Figure 2.

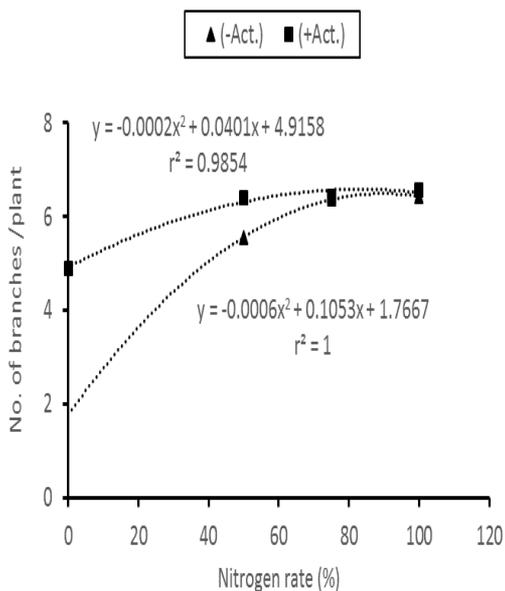


**Fig. 1. Effect of nitrogen rates with or without Actosol on canola plant height mean in the two seasons**

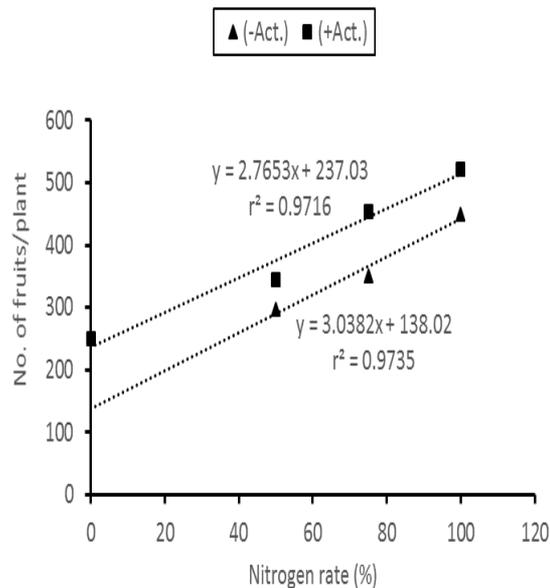
### Number of fruits per plant

The results in Table 3 and Figure 3 showed that decreasing nitrogen levels with or without Actosol significantly decreased number of fruits per plant in both seasons. While, application of Actosol increased significantly number of fruits per plant at all nitrogen levels in both seasons. There were no significant

differences between 100 % N dose without Actosol with 75 % N dose with Actosol on number of fruits per plant in both studied seasons. Moreover, in both seasons, the treated canola plants with Actosol gave an increases in the fruits number percentage per that of 16.2, 28.9, and 16.3 % at 50, 75, and 100 % N doses, respectively. The relation between mean number of fruits per plant in the two seasons and nitrogen levels without Actosol was linear equation ( $y = 3.0382x + 138.02$ ) with  $r^2 = 0.97$ , and linear equation ( $y = 2.7653x + 237.03$ ) with  $r^2 = 0.97$  with nitrogen levels combined with Actosol as shown in Figure 3.



**Fig. 2. Effect of nitrogen rates with or without Actosol on mean No. of branches per plant of the two seasons**



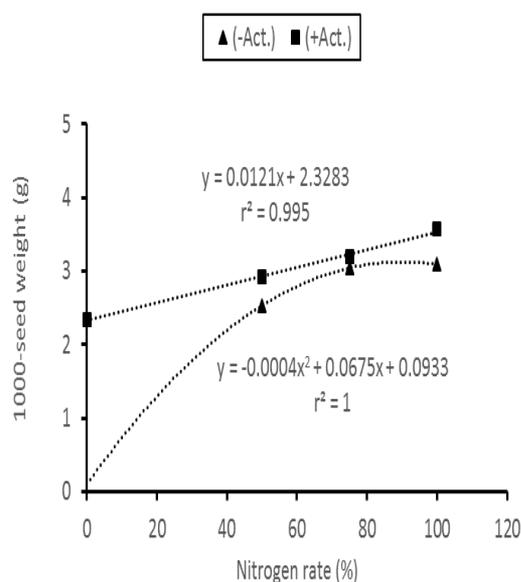
**Fig. 3. Effect of nitrogen rates with or without Actosol on mean No. of fruits per plant of the two seasons**

**1000-seed weight**

Data presented in Table 4 and Figure 4 indicated that 1000-seed weight of canola in both seasons was significantly affected by using Actosol with the different N rates. Where decreasing N rates to 50 % without Actosol gave less 1000-seed weight than the same N rate with Actosol and the other N rates except 0 N rate. Whereas, Application of Actosol increased significantly the 1000-seed weight of canola at all N rates in both seasons. Also 75 % N dose with Actosol gave a significant increase in 1000-seed weight more than 100 % N dose without Actosol in both seasons. The application of Actosol gave an increase in the average 1000-seed weight of both seasons in the percent of 16.0, 4.9, and 14.5 % at 50, 75, and 100 % N rates, respectively. The relation between mean 1000-seed weight of the two seasons and nitrogen levels without Actosol was curve linear equation ( $y = -0.0004x^2 + 0.0675x + 0.0933$ ) with  $r^2 = 1$ , while was linear equation ( $y = 0.0121x + 2.3283$ ) with  $r^2 = 0.995$  with nitrogen levels with Actosol as shown in Figure 4.

**Table 3. Effect of nitrogen fertilization rates with or without Actosol on plant height, number of branches/plant and number of fruits/plant of canola plant**

Treatments		Plant height (cm)		No .of branches /plant		No .of fruits /plant	
Nitrogen (%)	Actosol	2016/2017	2017/2018	2016/2017	2017/2018	2016/2017	2017/2018
100	+Act	165.7 <sup>a</sup>	165.3 <sup>a</sup>	6.6 <sup>a</sup>	6.5 <sup>a</sup>	521.3 <sup>a</sup>	523.3 <sup>a</sup>
	-Act	161.0 <sup>b</sup>	161.3 <sup>b</sup>	6.4 <sup>a</sup>	6.5 <sup>a</sup>	448.9 <sup>b</sup>	449.2 <sup>b</sup>
75	+Act	162.3 <sup>b</sup>	163.0 <sup>ab</sup>	6.5 <sup>a</sup>	6.4 <sup>a</sup>	455.9 <sup>b</sup>	449.8 <sup>b</sup>
	-Act	151.0 <sup>c</sup>	150.3 <sup>c</sup>	6.3 <sup>a</sup>	6.4 <sup>a</sup>	344.8 <sup>c</sup>	358.0 <sup>c</sup>
50	+Act	152.7 <sup>c</sup>	152.0 <sup>c</sup>	6.4 <sup>a</sup>	6.4 <sup>a</sup>	344.0 <sup>c</sup>	346.3 <sup>c</sup>
	-Act	143.7 <sup>d</sup>	143.3 <sup>d</sup>	5.6 <sup>b</sup>	5.5 <sup>b</sup>	297.3 <sup>d</sup>	297.0 <sup>d</sup>
0	+Act	135.3 <sup>e</sup>	136.2 <sup>e</sup>	5.0 <sup>c</sup>	4.8 <sup>c</sup>	249.0 <sup>e</sup>	251.0 <sup>e</sup>
LSD <sub>0.05</sub>		3.0	3.5	0.4	0.4	24.8	33.0

**Fig. 4. Effect of nitrogen rates with or without Actosol on mean Canola 1000-seed weight of the two seasons**

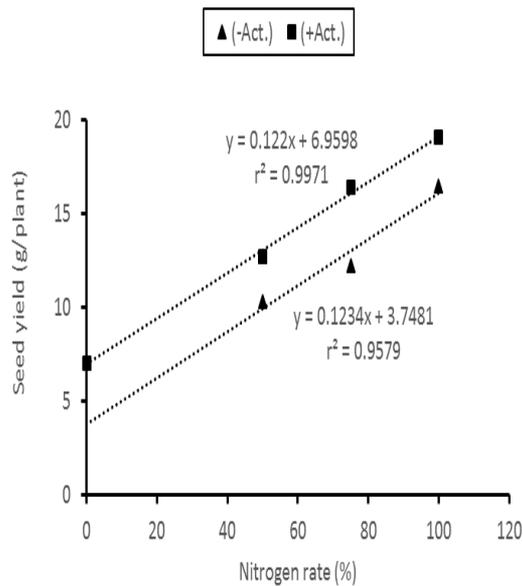
#### Seed yield per plant

Data in Table 4 and Figure 5 showed that decreasing nitrogen rates to 50 % with or without Actosol and to 75 % without Actosol significantly decreased seed yield/plant as compared with 100 % N dose without Actosol in both seasons. Furthermore, application of Actosol in both seasons gave a significant increase seed yield/plant at all N rates. Also, 75 % N dose with Actosol gave the same seed yield/plant that of 100 % N dose without Actosol in the two seasons. However, the average seed yield/plant in both seasons clearly showed

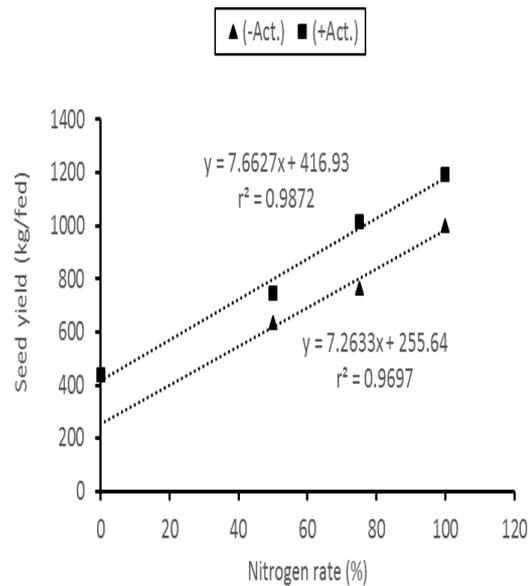
an increase as a result of application Actosol of 23.3, 34.3, and 16.1 % at 50, 75, and 100 % N doses, respectively. The relation between mean seed yield per plant of the two seasons and nitrogen levels without Actosol was linear equation ( $y = 0.1234x + 3.7481$ ) with  $r^2 = 0.9579$ , and was linear equation ( $y = 0.122x + 6.9598$ ) with  $r^2 = 0.9971$  with nitrogen levels with Actosol as shown in Figure 5.

#### Seed yield per feddan

The obtained data in Table 4 and Figure 6 indicated that decreasing N rates to 50 % N dose with or without Actosol and to 75 % N dose without Actosol significantly decreased seed yield per feddan as compared with 100 % N dose without Actosol in the two seasons. However, application of Actosol significantly increased seed yield per feddan at all nitrogen levels in both seasons. Nitrogen rate of 75 % with Actosol was insignificantly higher in seed yield per feddan than 100 % N dose without Actosol in both seasons. The average increasing percentages of seed yield per feddan in the two seasons as a result of Actosol application were 16.9, 33.1, and 19.2 % at 50, 75, and 100 % N doses, respectively. Although, 75 % N rate with Actosol gave more seed yield/fed (33.11 %) than the same N rate without Actosol in both seasons, however, the same treatment of 75 % N dose with actosol gave more seed yield/fed (1.57 %) than the recommended rate of nitrogen (100 % N dose) without Actosol. The highest seed yield/fed was observed with the 100 % N dose with Actosol. The relation between mean seed yield per feddan of the two seasons and nitrogen levels without Actosol was linear equation ( $y = 7.2633x + 255.64$ ) with  $r^2 = 0.97$ , while was linear equation ( $y = 7.6627x + 416.93$ ) with  $r^2 = 0.99$  with nitrogen levels combined with Actosol as shown in Figure 6.



**Fig. 5. Effect of nitrogen rates with or without Actosol on mean Canola seed yield per plant of the two seasons**



**Fig. 6. Effect of nitrogen rates with or without Actosol on mean Canola seed yield per feddan of the two seasons**

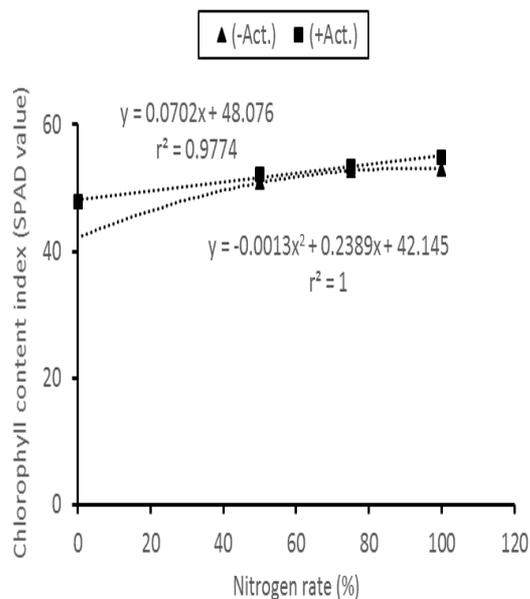
**Table 4. Effect of nitrogen fertilization rates with or without Actosol on seed yield per plant, seed yield per feddan and 1000-seed weight of canola plant**

Treatments		1000-seed weight(g)		Seed yield (g/plant)		Seed yield (kg/fed)	
Nitrogen (%)	Actosol	2016/2017	2017/2018	2016/2017	2017/2018	2016/2017	2017/2018
100	+Act	3.5 <sup>a</sup>	3.6 <sup>a</sup>	18.7 <sup>a</sup>	19.5 <sup>a</sup>	1187.3 <sup>a</sup>	1197.3 <sup>a</sup>
	-Act	3.1 <sup>c</sup>	3.1 <sup>c</sup>	16.7 <sup>b</sup>	16.2 <sup>b</sup>	997.7 <sup>b</sup>	1003.3 <sup>b</sup>
75	+Act	3.2 <sup>b</sup>	3.2 <sup>b</sup>	16.7 <sup>b</sup>	16.2 <sup>b</sup>	1017.0 <sup>b</sup>	1015.3 <sup>b</sup>
	-Act	3.0 <sup>c</sup>	3.1 <sup>c</sup>	12.3 <sup>c</sup>	12.2 <sup>c</sup>	755.0 <sup>c</sup>	771.7 <sup>c</sup>
50	+Act	3.0 <sup>c</sup>	2.8 <sup>d</sup>	12.9 <sup>c</sup>	12.5 <sup>c</sup>	736.7 <sup>c</sup>	753.3 <sup>c</sup>
	-Act	2.5 <sup>d</sup>	2.5 <sup>e</sup>	10.3 <sup>d</sup>	10.3 <sup>d</sup>	630.0 <sup>d</sup>	644.7 <sup>d</sup>
0	+Act	2.3 <sup>e</sup>	2.4 <sup>f</sup>	7.0 <sup>e</sup>	7.1 <sup>e</sup>	453.3 <sup>e</sup>	423.3 <sup>e</sup>
LSD <sub>0.05</sub>		0.1	0.1	1.3	1.1	49.3	28.8

### Chlorophyll content index

The obtained data in Table 5 and Figure 7 showed that decreasing N rates with or without Actosol significantly decreased chlorophyll content index of canola plant in both seasons. However, the application of Actosol increased the chlorophyll content index of canola plants at all N rates in both seasons, but these increase did not reach to the level of significance except the treatment of 50 % N dose was significant in the first season only. Also, The average increase of the two seasons in chlorophyll content index as a result of

Actosol application were 2.9, 1.0, and 3.4 % at 50, 75, and 100 % N rates, respectively. The relation between mean chlorophyll content index of the two seasons and nitrogen levels without Actosol was curve linear equation ( $y = -0.0013x^2 + 0.2389x + 42.145$ ) with  $r^2 = 1$ , while was linear equation ( $y = 0.0702x + 48.076$ ) with  $r^2 = 0.98$  with nitrogen levels with Actosol as shown in Figure 7.



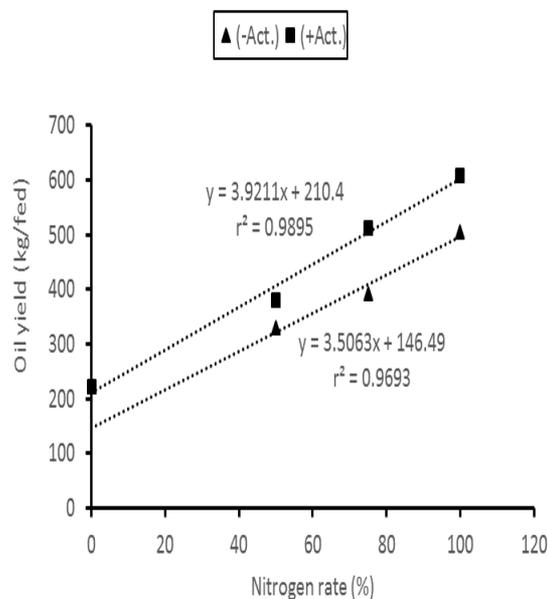
**Fig. 7. Effect of nitrogen rates with or without Actosol on mean Canola chlorophyll content index of the two seasons**

#### Seeds oil content

Data presented in Table 5 showed that the percentage of seed oil content did not significantly affected by using different N rates either with or without Actosol. However, no clear trend was found on the seed oil content percentage with using the different N rates with or without Actosol.

#### Oil yield per Feddan

The results presented in Table 5 and Figure 8 indicated that 50 % N rate with or without Actosol and 75 % N rate without Actosol decreased oil yield/fed significantly as compared with the recommended N dose (100 %) in both seasons. Whereas, 75 % N rate with Actosol gave the same oil yield / fed as the recommended N rate (100 %) in both seasons. Moreover, 100 % N dose with Actosol increased oil yield / fed significantly than all other treatments in both seasons. The average increasing percentages of oil yield / fed in both seasons as a result of Actosol application were 15.1, 31.1, and 20.3 % at 50, 75, and 100 % N rates, respectively. The relation between mean oil yield per feddan of the two seasons and nitrogen levels without Actosol was linear equation ( $y = 3.5063x + 146.49$ ) with  $r^2 = 0.97$ , while was linear equation ( $y = 3.9211x + 210.4$ ) with  $r^2 = 0.99$  with nitrogen levels with Actosol as shown in Figure 8.



**Fig. 8. Effect of nitrogen rates with or without Actosol on mean Canola oil yield per Fedden of the two seasons**

Nitrogen rates and Actosol application generally affected the growth, yield and yield components of canola plants, since several studies showed the important of N and the beneficial effect of the organic substances on different plant species. Our results in respect are harmony with those obtained by Asare and Scarisbrick (1995), Hassan and El-Hakeem (1996), Abd El-Dayem, *et al.* (2000), Cheema *et al.* (2001), Ahmad *et al.* (2007), Ali *et al.* (2011) and Al-Solaimani *et al.* (2015). El-Nakhlawy and Bakhshwain (2009) they showed that as nitrogen fertilizer rate decreased, plant height, number of fruits/plant, 1000-seed weight and seed weight/plant decreased. This may be due to nitrogen being an essential nutrient for plant metabolism, as it is directly related to the synthesis of amino acids, nucleic acids, and proteins. Its supply to the plant will influence the amount of protein, protoplasm and chlorophyll formed. Its absence limits plant growth and its availability has been associated with the increase in cell division and expansion, leaf area and photosynthesis (Bybordi, 2012). It is important to mention that higher leaf area is a desirable aspect in plants, because it allows the interception of greater amount of solar energy and, combined with adequate nitrogen supply, provides better conditions for converting this energy into photoassimilates (Rathke *et al.*, 2006).

**Table 5. Effect of nitrogen fertilization rates with or without Actosol on chlorophyll content index, seeds oil content and oil yield per feddan of canola plant**

Treatments		Chlorophyll content index		Seeds oil content (%)		Oil yield (kg/fed)	
Nitrogen (%)	Actosol	2016/2017	2017/2018	2016/2017	2017/2018	2016/2017	2017/2018
100	+Act	54.3 <sup>a</sup>	55.3 <sup>a</sup>	51.3	50.8	609.4 <sup>a</sup>	608.0 <sup>a</sup>
	-Act	53.2 <sup>ab</sup>	52.8 <sup>ab</sup>	50.5	50.6	504.3 <sup>b</sup>	507.9 <sup>b</sup>
75	+Act	53.3 <sup>ab</sup>	53.3 <sup>ab</sup>	50.3	50.8	511.2 <sup>b</sup>	515.4 <sup>b</sup>
	-Act	52.6 <sup>ab</sup>	52.9 <sup>ab</sup>	52.2	50.4	394.0 <sup>c</sup>	388.9 <sup>c</sup>
50	+Act	52.4 <sup>b</sup>	52.1 <sup>b</sup>	51.6	50.6	380.0 <sup>cd</sup>	381.5 <sup>c</sup>
	-Act	50.4 <sup>c</sup>	51.2 <sup>b</sup>	53.1	50.8	334.2 <sup>d</sup>	327.4 <sup>d</sup>
0	+Act	47.4 <sup>d</sup>	48.1 <sup>c</sup>	50.1	50.7	227.6 <sup>e</sup>	214.5 <sup>e</sup>
LSD <sub>0.05</sub>		1.8	2.6	ns	ns	56.6	13.8

Our results indicated that application of humic substance (Actosol) increased growth and yield components of canola plant. This may be due to the effect of humic acid on stimulate the biochemical processes in plants such as photosynthesis and total chlorophyll content which consequently increased yield and quality (Akinremi *et al.* 2000). Also, may be due to the role of humic acid in increasing root growth in a manner similar to auxin (O'Donnell, 1973). In addition, the beneficial role of humic acid on growth and yield, it has no harmful threat to the quality of the environment (Senn, 1991). These results are in agreement with those reported by Sani, (2014), Kandil *et al.*, (2016) and Mahmoud *et al.*, (2019).

Our results showed that decreasing nitrogen rates was non-significantly increased seeds oil content of canola plant. Also, application of Actosol had no significant effect on that trait. Likewise, Zhao *et al.*, (1993), Dubey *et al.*, (1994), Asare and Scarisbrick (1995) and Cheema *et al.*, (2001) obtained low oil content with higher doses of nitrogen. However, Brennan *et al.*, (2000) reported that oil content in canola seed unaffected by nitrogen rates. Several reasons have been given by different researchers for the decrease in oil content with increasing nitrogen rates. For example, Kutcher *et al.*, (2005) stated that it might be due to the dilution effect of increase seed yield with increasing nitrogen fertilization levels and the inverse relationship of protein and oil content. Jackson (2000) believed that nitrogen delays plant maturity which results in poor seed filling and greater proportion of green seed. Holmes (1980) reported that better supply of nitrogen increases the formation of nitrogen containing protein precursors so that protein formation competes more strongly for photosynthates; as a result, less of the latter are available for fat synthesis. Likewise, Rathke *et al.*, (2005) linked this fact with reduced availability of

carbohydrates for oil synthesis at high nitrogen application. Decreasing oil content of canola with the increasing levels of nitrogen is consistent with other reports (Jackson, 2000; Cheema *et al.*, 2001; Kutcher *et al.*, 2005; Rathke *et al.*, 2005). El-Nakhlawy and Bakhshwain (2009) reported that oil content of canola was the highest under low nitrogen rate, but significantly decreased under the higher nitrogen rates.

## CONCLUSION

Decreasing nitrogen rates with or without humic substance (Actosol<sup>®</sup>) linearly decreased growth, yield components and oil yield of canola plant in most traits, while it had non-significantly increased seed oil content. However, application of Actosol increased growth, yield components and oil yield, while it had no significant effect on oil content of canola plant at all nitrogen rates. From the abovementioned results, it is clear that 75 % of recommended nitrogen rate with Actosol treatment was better than 100 % N without Actosol for most studied parameters of canola. Therefore, nitrogen fertilization rate can be reduced by about 25% of the recommended fertilizer rates by adding the recommended dose of Actosol. Reduction of nitrogen application due to application of Actosol is very important for the non-pollution of environment with nitrogenous fertilizers, furthermore it reducing production cost thus increasing the profitability.

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## الملخص العربي

### استجابة نبات الكانولا لخفض معدلات السماد النيتروجيني بإضافة مادة دبالية

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انخفاض معدلات النيتروجين مع أو بدون المادة الدبالية (أكتوسول) أدى إلى انخفاض خطي لطول النبات، وعدد الأفرع و الثمار / نبات ، ووزن ١٠٠٠ بذرة ، محصول البذور / نبات، و محصول البذور / فدان، و محصول زيت البذور / فدان لنبات الكانولا، بينما أدت إلى زيادة غير معنوية في محتوى زيت البذور. إلا أن استخدام الأكتوسول أدى إلى زيادة جميع الصفات باستثناء نسبة الزيت بالبذرة حيث لم تسجل أى تأثيرات معنوية عند جميع معدلات النيتروجين. كما أشارت النتائج إلى تفوق المعاملة ٧٥ ٪ من النيتروجين الموصى به مع إضافة الأكتوسول (75 % N-Act.) على المعاملة ١٠٠ ٪ من النيتروجين الموصى به بدون أكتوسول (100 % N-Act.) لمعظم الصفات المدروسة. لذلك يمكن التوصية بإمكانية تقليل معدل التسميد النيتروجيني لحوالي ٢٥ ٪ من معدلات السماد الموصى بها لنبات الكانولا عن طريق إضافة الجرعة الموصى بها من الأكتوسول (٦ لتر/فدان).

تم إجراء تجربتين حقليتين بمزرعة محطة إيتاي البارود للبحوث الزراعية بمحافظة البحيرة - مصر خلال الموسمين الشتويين ٢٠١٦/٢٠١٧ و ٢٠١٧/٢٠١٨ لبحث إمكانية خفض معدلات السماد النيتروجيني بإضافة مادة دبالية (أكتوسول) وتأثيرها على النمو والمحصول ومكوناته وبعض الخواص الكيميائية لنبات الكانولا صنف Serow 4. تضمنت المعاملات المختبرة سبعة مستويات من النيتروجين الموصى به (٣٠ كجم نيتروجين/فدان) مع أو بدون أكتوسول (٦ لتر/فدان) على النحو التالي: ٥٠ ٪ نيتروجين بدون أكتوسول (N-Act. 50 %)، ٧٥ ٪ نيتروجين بدون أكتوسول (N-Act. 75 %)، ١٠٠ ٪ نيتروجين بدون أكتوسول (N-Act. 100 %)، ٠ ٪ نيتروجين مع أكتوسول (N+Act. 0 %)، ٥٠ ٪ نيتروجين مع أكتوسول (N+Act. 50 %)، ٧٥ ٪ نيتروجين مع أكتوسول (N+Act. 75 %)، ١٠٠ ٪ نيتروجين مع أكتوسول (N+Act. 100 %). نفذت التجربة بتصميم القطاعات كاملة العشوائية بثلاث مكررات. أظهرت النتائج أن