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CHEMICAL VERSUS NONCHEMICAL FERTILIZER SOURCES TO ENHANCE THE YIELD OF THREE EDIBLE OIL CROPS IN EAST EL-OWINATE REGION IN EGYPT

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ABSTRACT

The objective of this study was to determine the appropriate combination of chemical and nonchemical fertilizers (biofertilizer, cow manure and compost) to be applied to three oil crops (soybean, sunflower and canola) in the sandy soil of East El-Owinatregionin 2016/17 and 2017/18 growing seasons to attain high yield, and to encourage organic cultivation in this region. Seven fertilizer treatments were studied in a randomized complete blocks design with three replicates. The treatments were: control (chemical fertilizer, 100%CF), nonchemical fertilizer treatments (100% biofertilizer (100%BF), 100% cow manure (100%CM) and 100% compost (100%CP) and integrated fertilizer sources (50%CF+50%BF, 50%CM+50%BF, and 50%CP+50%BF).For the three studied crops, the results showed that the yield and its components were significantly affected by fertilizer treatments. Under nonchemical fertilizer treatments, the highest yield of the three crops was obtained when 100% CP was applied. In the integrated fertilizer sources treatments, the highest yield were obtained under the application of 50%CF+50%BF followed by the yield obtained from application of 50%CP+50%BF treatment.The yield of soybean under 50%CP+50%BF treatment was lower than the yield obtained under 50%CF+50% BF by 25 and 20% in the first and second seasons, respectively. Similarly, sunflower yield was lower by 8 and 15% when 50% CP+50%BF treatment was applied compared to 100% CF+50%B Ftreatment in the first and second season, respectively. Likewise, the decline in canola yield was 4 and 9% when 50% CP+50%BF treatment was applied compared to 50%CF+50%BF treatment application in the first and second season, respectively. Application of this treatment could also improve soil fertility and could obtain healthy seeds of the three studied crops. Although yield quantity of the studied crops was reduced under this treatment compared to application of chemical fertilizer, the improvement in seeds quality as organic seeds could attain higher prices and compensate for yield losses.

(Key words: biofertilizer, cow manure, compost, chemical fertilizer, integrated fertilizer sources, soybean, sunflower, canola)

INTRODUCTION

The continuous use of chemical fertilizers in farming is known to affect soil pH of the farms leading to acidic environment that promotes nutrients solubility, bioavailability and mobility of heavy metals (Elliott *et al.*, 2013).These large increases in the use of chemical fertilizer resulted in leaching it by the runoff and an increase in its concentration in the groundwater (Wu and Ma, 2015). Fertilizers are grouped as chemical fertilizer (nitrogen, phosphorus and potassium fertilizers) and nonchemical fertilizer, namely organic (farmyard manure and compost) and biofertilizers (Khan *et al.*, 2018).The most important nutrient for crop production is nitrogen (Brady and Weil, 2012). However, only 50% of the applied chemical nitrogen is used by the plants, 2-20% is lost through evaporation and 15-25% reacts with organic components in the soil and the remaining penetrates to the ground water (Korkmaz, 2007).

Organic agriculture is system of ecological production management which promotes and improves biodiversity, matter circulation and biological soil activity (Cvijanovic *et al.*, 2010). Organic fertilizer is an alternative fertilization method to avoid soil degradation consequences (Cvijanovic *et al.*, 2012). They are naturally occurring compounds produced from farm by-products, which assess in the sustainable use of available resources (Mondini and Sequi, 2008). It can partially substitute for chemical nitrogen,

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phosphorus and potassium (Raj and Vasanthi 2019). It is characterized by slow release of the nutrients in the soil. These low amounts of nitrogen will be immediately absorbed by the growing plants and that will result in no nitrogen availability for weeds to uptake in the rhizosphere (Mohammadi and Rokhzadi, 2012). Using organic fertilizer led to increase in soil organic matter contents, soil structure improvement and root growth enhancement (Mohammadi and Rokhzadi, 2012) and it maintains soil aeration, and growth of soil microorganisms (Jenkinson, 1988) and it improves water holding capacity (Posner *et al*., 2008). Using organic fertilizer reduces the attraction rate of pests to the growing plants as a result of free nitrogen in plant tissue (Mohammadi and Rokhzadi, 2012). Additionally, it minimizes problems related to farm wastes disposal and reduces environmental pollution caused by excessive application of mineral fertilizers (Maiorana *et al.*, 2005).

Cow manure is a type of organic fertilizer, which is considered as a valuable input to soil for higher crop production (Ezung and Jami, 2019). It improves soil health by inducing favorable physical, chemical and biological conditions (Allam *et al*.,2010).It is a cheap way for society to conserve the environment (El Sheikha, 2016), and it has a high organic matter, nitrogen content contents (Moral *et al*., 2005) and a variety of micronutrients (Cayuela *et al*., 2009). Compost is another type of organic fertilizer and an alternative soil amendment, which characterized by its slower nutrient release potential, compare to chemical fertilizer (Akanbi *et al*., 2007). Furthermore, adding compost improves soil fertility by increasing both the quantity and the quality of soil organic matter (Rivero *et al*., 2004). According to Eghball (2002), compost application in excess of crop requirements can last for several years in the soil since only a fraction of nitrogen and other nutrients in compost become available in the first year after application.

On the other hand, biofertilizer refers to living microorganisms in a symbiotic and asymbiotic way to supply nutrients to the growing plants, resulting in significant improvement in crops yield and reduction of soil nutrients depletion (Dhanasekar and Dhandapani, 2012), as well as it decreasessoil pH, which had led to increase the availability of trace elements that enhance plant growth (Hafeez *et al*., 2002). It helps in increasing gibberellin level, which increases root growth, where higher rate of root growth increases the uptake of soil nutrients, increases the permeability of the soil, and increases soil water holding capacity (Hamidi *et al*., 2015). In addition, biofertilizers are eco-friendly and have been proved to be effective and economical alternate of chemical fertilizers with lesser input of capital and energy (Hafeez*et al*., 2002).It is an important part of environment friendly sustainable agricultural practices (Akbari *et al*., 2011).

There is a recent emphasis on integrated use of different sources of nutrients, such as organic manure, compost and biofertilizer in combination with chemical fertilizers for its known benefits (Patidar and Malhi, 2004).Evidence shows that the use of organic fertilizers combined with inorganic sources enhances nutrient availability, improves crop productivity, improves environmental conditions and public health (Kombiok *et al*., 2008).

Three important edible oil crops are cultivated in Egypt, namely soybean, sunflower and canola. Because there is a large gap between the production and consumption of edible oil in Egypt, its cultivation in the newlyreclaimed area outside the Nile Delta and Valley, namely East El-Owinate region in Egypt may provide an opportunity to overcome some of deficiency of edible oil production. It could also help in reducing competition exists in the old lands between oil crops and other strategic crops.

Soybean is a pulse crop with multiple food and economic advantages. It has the capacity to ûx atmospheric nitrogen from the air through symbiosis with rhizobium bacteria and thus contributes to improve soil fertility (Dianda *et al*., 2016). Soybean seeds contain 43% protein, 20% fat, 21% carbohydrate and other nutrients (calcium, phosphorus, and iron), as well as vitamins (Rahman, 1982).On the other hand, sunflower is an essential crop due to its high oil quality. Sunflower oil contains large amount of vitamins (A, D, E and K) and 20-40% proteins (Dhanasekar and Dhandapani, 2012). It is adapted to warm season and it is considered drought tolerant crop (Ahmed *et al*., 2015).Furthermore, previous research in Egypt indicated that canola could be successfully grown in newly reclaimed lands in order to avoid the competition with other crops grown in the old cultivated area (Sharaan and Gallab, 2002). Canola seeds contain 40-45% oil and 36-40% protein. Canola oil has low content of erucic acid and glucosinolates, and it has high content of omega 3 and vitamin E (Tomm *et al*., 2010).

Several researches were done work on the effect of integration of organic fertilizer with chemical fertilizer locally and internationally. For example, Khamparia *et al.,* (2018) indicated that integration of chemical fertilizer with organic fertilizer positively affected soil health and soybean yield. Khaim *et al*. (2013) indicated that application of chemical fertilizer in combination with biofertilizer to soybean increased its yield and yield contributing characters. Similar trend was obtained when chemical fertilizer in combination with biofertilizer was applied to sunflower (Dhanasekar *et al*., 2018). Furthermore, Mohamed *et al*. (2017) indicated that the interaction among different levels of mineral nitrogen fertilizer and biofertilizer attained higher canola yield. However, few attempts were made to evaluate the effect of application of these sources of nonchemical fertilizer alone, with combination of each other or with chemical fertilizer on the yield of these three oil crops. Thus, this research was implemented to determine the appropriate combination of chemical and nonchemical fertilizers (biofertilizer, compost and cow manure) to be applied to three oil crops (soybean, sunflower and canola)in the sandy soil of East El-Owinatregionto attain high yield, and to encourage organic cultivation.

MATERIALS AND METHODS

Two field experiments were conducted in a private farm inEast El-Owinat (latitude= 22.3 N, longitude= 28.0 E and elevation= 128.3 m above sea level) during the two growing seasons of 2015/16 and 2016/17 in order to study the effect of seven fertilizer treatments applied to soybean, sunflower and canola on its yield contributing components and yield. The experiments were implemented on sandy soil under sprinkler system. To determine soil physical and chemical properties of the experimental site, soil samples were collected in two depths, namely from 0-30 cm and from 30-60 cm.The standard methods conducted described by Tan (1996) was used to determine soil physical and chemical properties and it presented in Table (1).

Table 1. Soil physical and chemical properties of the experimental site

Soil characters	0-30 cm	30-60 cm
Physical properties		
Clay (%)	3	2
Silt (%)	8	10
Sand (%)	89	88
Texture	Sandy	Sandy
Chemical properties		
pH	8.5	8.6
EC (dS/m^{-1})	0.1	0.1
$CaCo_3$	4.0	4.5
N (ppm)	7.1	6.3
P (ppm)	10.0	9.2
K (ppm)	65.0	60.0

Maximum temperature in the winter season is between 22-33^{o}C and in the summer season is between 36-38 ^{o}C. Whereas, minimum temperature in the winter season is between 4-16^{o}C and in the summer season is between 20-21 ^{o}C.The experiment was laid out in a randomized complete blocks design with three replicates for each crop. The area of the experimental plot was 42 m^2 (6 m X 7m) for each of the studied crops.

The studied treatments were: control (100% chemical fertilizer, 100%CF); nonchemical fertilizer treatments (100% biofertilizer, (100%BF); 100% cow manure (100%CM); and 100% compost (100%CP)); and integrated fertilizer sources treatments (50% chemical fertilizer and 50% biofertilizer (50%CF+50%BF); 50% cow manure and 50% biofertilizer (50%CM+50%BF); and 50% compost and 50% biofertilizer (50%CP+50%BF)).

For the chemical fertilizer treatment (control), the recommended dose of nitrogen fertilizer in sandy soil for soybean was obtained from Legume Crops Department and the recommended dose for sunflower and canola was obtained from Oil Crops Department; Field Crops Research Institute; Agricultural Research Center; Egypt. The applied dose was 144 kg N ha^{-1} for each crop.

For each of the three crops, nitrogen fertilizer treatment was added in three doses, the first was added at planting date (20% in the form of ammonium sulphate (20.6% N). The second and the third doses were added as 40% each of the total dose in the form of ammonium nitrate (33.5% N), 30 and 45 days after sowing, respectively. Calcium super phosphate (15.5% P_2O_5) was added at the rate of 74.4 kg P_2O_5ha^{-1} during land preparation and potassium sulphate (48%K_2O) was added at the rate of 108.2 kg K_2O ha^{-1}, 30 days after planting. The rest of the studied treatments were adjusted to contain the recommended nitrogen fertilizer dose for each crop.

With respect to the nonchemical fertilizer treatments, biofertilizer treatment was applied using Micropbin (*Azospirilum* sp., *Azotobacter* sp., *Bacillus megatheruim* var. phosphaticum, *Pseudomonas* sp., and *Mycorriza* sp.) obtained from the General Organization of Agricultural Equalization Fund (GOAEF), Ministry of Agriculture and Land Reclamation, Egypt. The recommended dose of inculcation with the biofertilizer was performed by mixing 1 g of bacteria with100 g of seeds of each crop. Thus, each seed received approximately 10 million bacteria on its surface. Inculcation with biofertilizer treatment was performed by mixing it with the seeds before sowing according to seeding rate of each crop.

Cow manure was old and obtained from cow farm near the experimental site. It was added for each crop before land ploughing.Chemical composition of the used cow manure is presented in Table 3.The amounts of cow manure applied to each crop are presented in Table 4. Furthermore, the used compost was ready-made manufactured using rice hay (60%), farmyard manure (25%), poultry manure (10%) and fertile soil (5%).Chemical composition of the used compost is presented in Table 3 and the amounts of compost applied to each crop are presented in Table 4.

Table 3. Chemical composition of the used cow manure and compost in the experiment

Characters	Cow manure	Compost
Organic matter (%)	13.6	24.6
Total nitrogen (%)	0.35	0.41
Total phosphorus (%)	0.25	0.28
Total potassium (%)	0.10	0.31

To summarize, the amount of nonchemical and chemical nitrogen fertilizer applied to the three crops, which represent the recommended dose of nitrogen fertilizer are presented in Table 4.

Table 4. Amount of different source of nitrogen fertilizer applied to each crop

	Biofertilizer (g)	Cow manure (m^3 ha^{-1})	Compost (ton ha^{-1})	Chemical (kg N ha^{-1})
Soybean	840	63.4	24	144
Sunflower	120	63.4	24	144
Canola	60	63.4	24	144

No any other chemicals were applied to the three crops under biofertilizer, cow manure and compost treatments. Weeds control was done manually.

The studied crops were soybean, sunflower and canola. Soybean cultivar Giza 22 was sown on 15th and 16th of May and harvested on 1st of September in 2016 and 2017 growing seasons, respectively using the recommended soybean seeding rate, namely 84 kg ha^{-1}. Fallow preceded soybean in the first growing season, whereas the preceding crop in the second season was wheat. It was planted on ridges, 60 cm in width in hills, 20 cm apart on both sides of the ridge. The soybean seedlings were thinned to two plants $hill^{-1}$. Ten soybean plants from each plot were randomly selected to determine plant height (cm), number of pods $plant^{-1}$, seeds weight $plant^{-1}$ (g) and seed yield (ton ha^{-1}).

Sunflower cultivar Sakha 53 was sown on 15th and 16th of May and harvested on 30th of August and 1st of September in 2016 and 2017 growing seasons, respectively using the recommended sunflower seeding rate of 12 kg ha^{-1}. Fallow preceded sunflower in the first growing season, whereas the preceded crop in the second season was faba bean. Sowing was done on ridges, 60 cm in width in hills, 25 cm apart on one side of the ridge. The sunflower seedlings were thinned to one plant $hill^{-1}$.Yield and its components, namely plant height (cm), head diameter (cm), weight of seeds $head^{-1}$ (g) and seed yield (ton ha^{-1}) were determine from randomly selected ten sunflower plants from each plot.

Canola cultivar Serw 4 was sown on 15th and 16th of October in 2016 and 2017, respectively and was harvested on 1st of April in 2017 and 2018 growing seasons, respectively using 6 kg ha^{-1}, which is the recommended canola seeding rate. Maize preceded canola in the first growing season, whereas the preceding crop in the second season was peanut. It was planted on ridges, 50 cm in width in hills, 10 cm apart on one side of the ridge. The seedlings were thinned to one plant $hill^{-1}$. Ten plants from each plot were randomly selected to determine plant height (cm), number of branches $plant^{-1}$, and seed yield (ton ha^{-1}).

The data were statistically treated using the analysis of variance (ANOVA) for randomized complete block design and the least significant difference (LSD) at 5% level of significance according to Freed (1991) and was used for mean separation (P d” 0.05) following T test (0.05) to compare between treatments according to Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

1. Soybean

The results in Table 5 clearly showed that the soybean yield and its components were significantly affected by fertilizer treatments in both growing seasons. The results also showed that the control treatment (100% chemical fertilizer) attained the highest soybean yield, which could be attributed to the fact that chemical fertilizer is more accessible to plants roots in the rhizosphere than nonchemical fertilizer (Khan *et al*., 2018). However, on the long run, the continuous application and excessive use of chemical fertilizer will cause environmental problems. Lal *et al*. (2011) indicated that, in developing countries, most of the farmers facing increasing fertilizer costs, environmental degradation and food quality deterioration.

Table 5 also showed that, under the nonchemical fertilizer treatments, the lowest values of yield contributing components and yield were obtained under application of 100% of biofertilizer.Although, Hayat *et al*. (2010) indicated that Azotobacter and Azospirillum provide direct and indirect effect on plant growth and pest resistance, our results showed that application of biofertilizer produced low yield values compared to all other treatments. Billah and Bano (2015) indicated that the availability of organic matter in the rhizosphere is a proponent for favorable conditions and it affects plant-microbe interactions.That statement explains the low yield value of soybean under application of biofertilizer only, where the soil of the experiment have low organic content as shown in Table 3. Low yield under biofertilizer application could be also attributed to the fallow preceded soybean in the first growing season.

Furthermore, application of 100% compost attained the highest yield and its attributes under the nonchemical fertilizer treatments.Soybean yield under application of 100% compost was higher by 51 and 53% in the first and second season, respectively compared to application of 100% of biofertilizer (Table 5). Hammed *et al*. (2019) indicated that organic fertilizer with animal-based had less positive effect on soybean, compared to organic fertilizer with plant-based.

The results in Table 5 also showed that integrated fertilizer treatments attained higher yields, compared to application of one nonchemical treatment. Application of 50% cow manure and 50% biofertilizer attained the lowest soybean yield and its components in the integrated fertilizer treatments. Whereas, application of 50% chemical fertilizer and 50% biofertilizer treatment attained the highest values of soybean yield and its components under the integrated fertilizer treatments. It was reported by Abou Elkhair *et al*. (2014) and Attia *et al.* (2014) that the application of biofertilizer and chemical fertilizer to soybean resulted in a significant increase in soybean yield. Under this treatment, soybean yield was increased by 37 and 36% under application of 50% chemical fertilizer and 50% biofertilizer, in the first and second season, respectively. Khaim *et al*. (2013) indicated that application of chemical fertilizer in combination with biofertilizer to soybean had a very positive effect and increased its yield and yield contributing characters. Furthermore, application of 50% compost and 50% biofertilizer achieved the second best yield, where it was lower by 25 and 20% in the first and second season, respectively compared to the yield obtained under 50% chemical fertilizer + 50% biofertilizer treatment. In this context, Khaim*et al*. (2013) indicated that the highest soybean yield wasfound when 100% of chemical fertilizer was applied, which was statistically identical with 75% of chemical fertilizer + 1 ton ha^{-1} of poultry manure, as well as 75% of chemical fertilizer + 3 ton ha^{-1} cow manure. The reduction in chemical fertilizer cost occurred under using 50% compost and 50% biofertilizer treatment, in addition to higher price of soybean as an organic product could be attained. Hartman *et al*. (2016) indicated that the price of organic soybean seed almost three folds of the price of seeds produced using chemical fertilizers.

Additionally, the yield contributing components and yield of soybean were lower in the second growing season under 100% biofertilizer, 100% compost, as well as 50% chemical fertilizer with 50% biofertilizer treatments, compared to its values in the first growing season (Table 5). Zerihun *et al.* (2013) indicated that cultivation of soybean as a legume crop is expected to have positive effects on soil

Table 5. Soybean yield and its components as affected by nonchemical and chemical fertilizer in 2016 and 2017 growing seasons

Treatments	Plant height (cm)		Number of pods plant^{-1}		Seeds weight plant^{-1} (g)		Seeds yield (ton ha^{-1})	
	2016	2017	2016	2017	2016	2017	2016	2017
Control								
100%CF	71.0^{a}	71.3^{a}	52.3^{a}	56.0^{a}	15.70^{a}	16.63^{a}	2.71^{a}	2.74^{a}
Nonchemical								
100%BF	38.7^{c}	36.7^{d}	22.3^{b}	20.0^{c}	5.43^{c}	4.97^{c}	0.82e	0.77^{e}
100%CM	44.7^{c}	50.3^{bc}	22.0^{b}	26.7^{c}	5.43^{c}	5.47^{c}	1.42^{d}	1.46^{d}
100%CP	47.7^{c}	47.0^{c}	23.0^{b}	25.7^{c}	5.43^{c}	5.13^{c}	1.66^{cd}	1.63^{cd}
Integrated								
50%CF+50%BF	68.0^{a}	66.7^{a}	45.0^{a}	49.0^{a}	14.67^{a}	15.83^{a}	2.33^{b}	2.28^{b}
50%CM+50%BF	44.0^{c}	44.7^{c}	26.0^{b}	25.3^{c}	5.97^{bc}	5.70^{c}	1.46^{d}	1.63^{cd}
50%CP+50%BF	57.3^{b}	55.7^{b}	30.0^{b}	35.7^{b}	7.20^{b}	6.70^{b}	1.75^{c}	1.82^{c}
$LSD_{0.5}$	9.27	7.85	9.34	8.33	1.37	0.98	0.24	0.24

CF=chemical fertilizer, BF= biofertilizer, CM=cow manure, CP= compost fertility because it ûx nitrogen, in addition to its residue decomposition and that should benefit the following crop. In our experiment, it is seen that cultivation of wheat in the first growing season depleted all nutrients in such low fertile soil, which negatively affected soybean yield in the second growing season. WoŸniak and Soroka (2018) indicated that cultivation of wheat could involve adverse changes in the soil including decreasing contents of organic matter. Furthermore, it could be noticed from the table that soybean yield was improved in the second year under the rest of the studied treatments, which can be attributed to the residual effect of organic fertilizer treatments.

Sunflower

The response of sunflower to the studied treatments was similar to the response of soybean and in the trend of the effect of all fertilizer treatments as shown in Table 6.The sunflower yield contributing components and yield were significantly affected by all fertilizer treatments in both growing seasons. Furthermore, the results showed that the highest values of yield contributing components and yield were obtained under application of 100% of chemical fertilizer in both growing seasons. With respect to nonchemical fertilizer treatments,the lowest values of yield contributing components and yield were obtained under application of 100% of biofertilizer.This could be a result of being preceded by fallow and to the unavailability of organic matter that the biofertilizer can use as it was stated by Hamidi *et al.,*(2015).Furthermore, Table 6 indicated that application of 100% compost resulted in the highest sunflower yield by 38 and 33%, as compared to application of 100% biofertilizer. Similar results were obtained by Akbari *et al.*(2011), when they individually applied biofertilizer and compost to sunflower.

Under integrated fertilizer treatments, application of 50% chemical fertilizer and 50% biofertilizer attained the highest sunflower yield, compared to the other integrated fertilizer treatments(Table 6). Arif *et al*. (2016) stated thatapplication of chemical nitrogen fertilizer with biofertilizer positively affected sunflower yield contributing components and yield, as well as soil chemical and biological fertility. Furthermore, Namvar *et al.* (2012) stated that the highest plant height, head diameter, and grain yield were obtained from the highest level of nitrogen fertilizer (200 kg N ha^{-1}) and biofertilizer inoculation. Similar results were obtained by Khandekar *et al.* (2018), where they indicated that sunflower yield was improved under the combination of nitrogen fertilizer and biofertilizer compared to using either fertilizer type alone. On the other hand, the second best integrated fertilizer treatment was application of 50% compost and 50% biofertilizer, which was lower than the yield resulted from application of 50%chemical fertilizer and 50% biofertilizer by 15 and 8% in the first and second season, respectively. Furthermore, there were no significant differences between application of 50% cow manure and 50% biofertilizer treatment and 50% compost and 50% biofertilizer treatments, where the first treatment was lower by 3 and 0% than the second treatment in the first and second season, respectively.

It could be also noticed from the Table that sunflower yield was higher in the second season as compared to the first season because it was preceded by faba bean in the second growing season.

Table 6. Sunflower yield and its components as affected by nonchemical and chemical fertilizer in 2016 and 2017 growing seasons

Treatments	Plant height (cm)		Head diameter (cm)		Seeds weight $plant^{-1}$ (g)		Seeds yield (ton ha^{-1})	
	2016	2017	2016	2017	2016	2017	2016	2017
Control								
100% CF	134^{a}	140^{a}	25^{a}	23^{a}	32.5^{a}	35.4^{a}	3.10^{a}	3.12^{a}
Nonchemical								
100% BF	83^{e}	90^{d}	15^{d}	13^{d}	18.1^{d}	16.5^{d}	1.27^{f}	1.80^{d}
100% CM	109_{c}	91^{d}	20^{bc}	14^{d}	18.3^{cd}	20.9^{bc}	1.73^{e}	2.16^{cd}
100% CP	95^{d}	100^{cd}	18^{cd}	15^{cd}	20.1^{bcd}	22.6^{b}	1.75^{de}	2.40^{bc}
Integrated								
50% CF+50% BF	122^{b}	135^{a}	22^{ab}	21a^{b}	30.8^{a}	32.8^{a}	2.27^{b}	2.88^{ab}
50% CM+50% BF	112^{c}	110^{bc}	20^{bc}	15c^{d}	21.2^{b}	19.3^{cd}	1.88^{cd}	2.64^{abc}
50% CP+50% BF	113^{c}	112^{b}	22^{ab}	18b^{c}	20.3^{bc}	21.6^{bc}	1.94^{c}	2.64^{abc}
$LSD_{0.5}$	6.58	10.15	3.99	3.47	2.06	3.07	0.12	0.53

CF=chemical fertilizer, BF= biofertilizer, CM=cow manure, CP= compost

Canola

Table 7 showed that the canola yield contributing components and its yield were significantly affected by all the fertilizer treatments in both growing seasons, which was similar response and similar trend to the one of soybean and sunflower in our experiment. The highest canola yield value was obtained under application of 100% chemical fertilizer.Ahmadi and Bahrani (2009) indicated that yield contributing components of canola, such as plant height, number of branches plant^{-1}, number of pods plant^{-1}, as well as seed yield were positively correlated to soil nitrogen level.

Under nonchemical treatments, the lowest canola yield was obtained under application of 100% biofertilizer and the highest value was obtained under the application of 100% compost. Mohammadi and Rokhzadi (2012) stated that compost have more positive effect that stimulate soil microbial activity than organic manure. Whereas, Ali *et al.* (2011) and El Sabagh *et al.* (2015), stated that the individual application of biofertilizer, compost and organic manure increased canola yield, as compared to no nitrogen application.

The results in Table 7 showed that,under integrated fertilizer sources treatments, the highest yield value was obtained from application of 50% chemical fertilizer and 50% biofertilizer, compared to the other integrated fertilizer treatments. Ali *et al.* (2011) and Mohamed *et al.* (2017) obtained similar results, where they indicated that the interaction among the used levels of mineral fertilizer and biofertilizer attained higher canola yield, compared to no fertilizer application.Moreover, application of 50% compost and 50% biofertilizer treatment attained lower yield than the application of 50% chemical fertilizer and 50% biofertilizer treatment by 4 and 9% in the first and second seasons, respectively. Application of integrated fertilizer sources to canola was studied by several researchers. El Sabagh *et al.* (2015) indicated that application of biofertilizer could increase the efficiency of nitrogen uptake and it could be more effective with the application of compost. Abd El-Gawad *et al.* (2009) indicated that application of biofertilizer with organic manure resulted in high improvement in canola yield attributed components and yield. Kazemeini *et al.,* (2010) reported that 50% of the required nitrogen fertilizer to canola could be replaced by compost application. Whereas, application of sheep manure with biofertilizer increased canola plant height, number of branches plant^{-1}, and seed yield (Abd El-Gawad *et al.,* 2009).

The results in Table 7 also showed that canola yield was higher in the second growing season, compared to the first growing season as a result of peanut preceded canola in the second growing season.

Table 7. Canola yield and its components as affected by nonchemical and chemical fertilizer in 2016/17 and 2017/18 growing seasons

Treatments	Plant height (cm)		Number of branches plant^{-1}		Seeds yield (ton ha^{-1})	
	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17
Control						
100% CF	150^{a}	145^{a}	7^{a}	7^{a}	2.87^{a}	2.97^{a}
Nonchemical						
100% BF	125^{c}	115^{d}	3^{b}	2^{c}	0.96^{e}	1.14^{e}
100% CM	130^{c}	130^{c}	5^{ab}	5^{ab}	1.19^{de}	1.43^{de}
100% CP	122^{c}	120^{d}	5^{ab}	5^{ab}	1.79^{c}	1.92^{c}
Integrated						
50% CF+50% BF	145^{ab}	140^{ab}	6^{a}	6^{ab}	2.40^{ab}	2.63^{ab}
50% CM+50% BF	140^{b}	132^{c}	5^{ab}	4^{bc}	1.44^{d}	1.61^{cd}
50% CP+50% BF	140^{b}	135^{bc}	6^{a}	5^{ab}	2.30^{b}	2.39^{b}
$LSD_{0.5}$	9.36	7.45	2.57	2.33	0.33	0.39

CF=chemical fertilizer, BF= biofertilizer, CM=cow manure, CP= compost.

Sustainable use of soils necessitates the reduction or elimination of the use of chemical fertilizers to reduce soil and groundwater pollutions. In this research, we determine the appropriate combination of integrated fertilizer sources to be applied to soybean, sunflower and canola in the sandy soil of East El-Owinatregionto attain high yield, and to encourage organic cultivation. Our results showed that application of 50% compost and 50% biofertilizer attained high yield of the three crops. Application of this treatment could also improve soil fertility and could obtain healthy seeds as organic seeds of the three studied crops. Although yield quantity of the studied crops was reduced under this treatment, compared to application of chemical fertilizer, the improvement in seeds quality as organic seeds could attain higher prices and compensate for yield losses.

Future research should include the test of the effects of other integrated fertilizer sources, treatments, with different percentages. Furthermore, the assessment of the residual effects of nonchemical fertilizer (biofertilizer, manure, and compost) on soil microbial activities and seed quality should be implemented.

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