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SEED YIELD AND QUALITY OF SUNFLOWER (*Helianthus annuus* L.) AS INFLUENCED BY INTEGRATED MINERAL AND ORGANIC NITROGEN FERTILIZATION SYSTEMS

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ABSTRACT

Two field experiments were conducted during the two successive seasons of 2013 and 2014 at El- Gemmeiza Research Station (30º 47′ 22.5″ N, 31° 07′ 34″ E, elev. 10 m), Agriculture Research Center, El-Gharbia Governorate, Egypt to study the effect of integrated fertilization of N- mineral and organic fertilizer combined with bio fertilizer (including the genera *Azotobacter and Azospirillium*) on sunflower (c.v. Sakha 53) seed yield and quality. The experiment was laid out in a randomized complete block design with three replicates. The experimental treatments comprised partial substitution of the recommended mineral N (MNRec.) rate (30kgN/fed.) with organic N fertilizer (ONF) as compost combined with bio fertilizer. Results revealed that application of T_4 (50%MNRec. +25% ONF +Bio) significantly improved yield, as well as yield attributes and protein and oil yields as compared to 100%ONF(T_8) or 100%MN(T_1) only .The integrated MN with ONF(25-50%ONF)always gave higher values than those obtained with full N rate as mineral or organic only. However, maximum seed oil percentage was recorded, when crop was fertilized by T_6 (100%ONF+Bio) followed by T_5 (25%MNRec. +75% ONF) while maximum seed oil yield was recorded by T_2 (50% MN Rec. +50% ONF) followed by T_4 (50%MN Rec. +25% ONF +Bio). According to the results of this experiment, unsaturated fatty acids, mainly linoleic and oleic acids raised in response to the integrated fertilization system while the saturated fatty acid (palmitic and stearic acid) were reduced. High percentages of oleic acids (50.17%) and linoleic acid (45.29%) were observed in T_4 and T_9. So, bio- organic fertilizer could be considered as a suitable substitute (25-50%) for mineral nitrogen fertilizer in agricultural systems.

Keywords: Fatty acid composition, Sunflower seeds, Mineral nitrogen, Bio-fertilizer, Organic fertilizer, Oil yield

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is the fifth most important source of edible oil after soybean, rapeseed, cotton, and peanut, due to high content of edible oil (38- 53%) and protein (20 -40%) and its high content of unsaturated fatty acids as well as to the lack of cholesterol ,sunflower oil has a desirable quality (Abdel-Motagally and Osman, 2010). The vital role of the sunflower crop depends mainly on the characteristics of the oil produced, which can be used directly or after processing in food and non-food industries (Vermeercsh, 1996). Sunflower oil is practically free of significant toxic compounds and contains four important fatty acids, namely palmitic (16:0), stearic (18:0), oleic (18:1), and linoleic (18:2) acids (Baydar and Erbas, 2005). Among the plant nutrients, N is one of the major nutrients that enhance the metabolic processes that based on protein, leads to increases in vegetative, reproductive growth and yield of the crop. Application of N-mineral fertilizers has contributed significantly to the huge increase in the world food production. But the adverse impacts of excessive inputs of chemical fertilizers in conventional agricultural practices are being well documented (Banerjee *et al*., 2011and Garai *et al.,* 2014). Nowadays increase in the prices of chemical fertilizers, lack of consistency in feeding the soil and endangering human health caused an increase in the use of manure for soil fertility. Manure can improves soil fertility, increase water-holding capacity, decrease soil erosion, improves amount of oxygen, and promotes beneficial organisms and productivity (Hamza and Abd-Elhady, 2010). Munir *et al.,* (2007)investigated the effects of organic and inorganic fertilization on seed and oil yield of sunflower and found that the highest values of seed oil content and oil yield were produced from sunflower plants received the nitrogen fertilizer at the recommended rate (30 kg N/fed) alone or in combination with 20 or 30 m^3 farmyard manure. Biological fertilizers or bio fertilizers contain useful microorganisms, which could colonize in the rhizosphere and promote plant growth through increasing the supply or availability of essential nutrients to the plants (Vessey, 2003)

The aim of this study is to investigate the effect of Integrated N fertilizer management on sunflower yield and quality.

MATERIALS AND METHODS

Field Experiments

Two field experiments were conducted at El-Gimmeiza Research Station, Agricultural Research Center, El-Gharbia Governorate, Egypt, during the two successive seasons of 2013 and 2014, to study the effect of integrated fertilization of N- mineral fertilizer combined with, bio fertilizer (including the genera *Azotobacter and Azospirillium*) and compost on yield and seed quality of sunflower (c.v. Sakha 53). The treatments were arranged in a complet randomized block design with three replicates. Randomized soil surface (0-30 cm) samples were taken from the experimental site before sowing, as well as compost samples to determine the physical and chemical properties according to Page *et al.,* (1982)as shown in Tables (1 & 2). Compost was added and mixed thoroughly with soil surface two weeks before seeding. The experiments included 10 treatments as follows:

T1 –100%mineral N Recommended (M N Rec.) =30kgN/fed. in the form of amide (Urea 46%N).

T2 –50 %M N Rec. (15kgNfed^{-1}) + 50 %N Rec. (15kg Nfed^{-1}) as organic N fertilizer (ONF) (1.06 t compost fed^{-1}).

T3 –75%M N Rec. (22.5kgNfed^{-1}) + 25 % N Rec. (7.5kgNfed^{-1}) as (ONF) (0.53 t compost fed^{-1})

T4- 50%M N Rec. (15kgNfed^{-1}) + 25 % N Rec. (7.5kgNfed^{-1}) as ONF (0.53 t compost fed^{-1}) + Bio fertilizer (containing10^{8} cfu ml^{-1} from each bacterium of *Azotobacter and Azospirillum*).

T5 –25%M N Rec. (7.5kgNfed^{-1}) + 75 %N Rec. (22.5kg Nfed^{-1}) as organic N fertilizer (ONF) (1.58 t compost fed^{-1}).

T6 – 100 % N Rec. (30kgNfed^{-1}) as organic N fertilizer (ONF) (2.11 t compost fed^{-1}). + Bio

T7 –25%M N Rec. (7.5kgNfed^{-1}) + 50 %N Rec. (15kg Nfed^{-1}) as ONF (1.06 t compost fed^{-1}) + Bio

T8 – 100 %N Rec. (30kg Nfed^{-1}) as ONF (2.11 t compost fed^{-1}).

T9 –75%M N Rec. (22.5kgN^{-1}fed.) + Bio

T10-75 %N Rec. (22.5kg Nfed^{-1}) as ONF (1.58 t compost fed^{-1}) + Bio

Table 1. Physical and chemical properties of the experimental soil (averaged in 2013 and2014 seasons)

Property	**Value**
Particle size distribution (%)	
Sand	21.5
Silt	31.2
Clay	47.3
Texture grade	clay
pH(1:2.5 soil water suspension)	7.80
EC (dSm^{-1}) (soil paste extract)	1.74
Saturation Percent (%)	40
Soluble cations (meqL^{-1})	
Ca^{++}	4.50
Mg^{++}	3.50
Na^{+}	8.95
K^{+}	0.42
Soluble anions (meqL^{-1})	
CO_3^{--}	-
HCO_3^{-}	0.50
Cl^{-}	9.50
SO_4^{--}	7.37
Organic matter (%)	1.62
Available nutrient (mgkg^{-1})	
N	40.00
P	7. 35
K	375.00
DTPA-extractable ((mgkg^{-1})	
Fe	3.74
Mn	1.94
Zn	0.78

Table 2. Physical and chemical properties of the compost (averaged in 2013 and2014 seasons)

Properties	**Value**
EC value (1:10) (dSm^{-1})	7.90
pH value (1:10)	6.70
Moisture content (%)	28.00
Organic matter (%)	44.48
Organic carbon (%)	25.80
Total nitrogen (%)	1.42
C/N ratio	18.20
Soluble ammonia-N (ppm)	615.00
Soluble nitrate-N (ppm)	362.00
Total P (%)	0.57
Total K (%)	0.82

Inoculation was carried out by dipping the sunflower seeds in the cell suspension of 10^{8} CFU/ml for 15 min. A local isolates, *Azotobacter* and *Azospirillum* bacteria used in this study were supplied by the Department of Microbiology, Soils, Water and Environ. Res. Institute, Agriculture Research Center, Giza, Egypt. Each experimental plot was 4 m long and 2.5 m wide. Each plot consisted of 8 rows 50 cm apart, two plants/hill and 20 cm between hills. The plants were thinned to a single plant per hill after 21 days from sowing. Single super phosphate (15 % P_2O_5) applied as a basal dose at the rate of 15kg P_2O_5fed^{-1} at the time of planting. Potassium sulfate (48% K_2O) was applied as soil application at the rate of 24kg K_2Ofed^{-1} in two

equal splits, 30 and 45 days after sowing. Nitrogen fertilizer (as urea 46%N) was added according to the above mentioned treatments in three equal portions, i.e. 21, 30 and 45 days after sowing.

At harvesting time, plants of the two inner ridges of each plot were harvested and left 10 days until fully air dried. In addition, a representative ten plants were taken randomly from each plot to record the following characteristics: Plant height(cm), head weight (g plant^{-1}), seed weight head^{-1} (g), 1000- seed weight (g), seed and straw and biological yields (kg fed^{-1}), harvest index (HI) (%) which is the ratio of seed yield to biological yield was calculated by using the following formula: Harvest index (HI) = (seed yield / biological yield) x 100, protein (%), protein yield (kg fed^{-1}) = protein percentage x seed yield, seed oil content (%), oil yield (kg fed^{-1}) = seed yield × oil percentage., Seed protein content was determined by measuring the total nitrogen content with the Micro-kjeldhal method and multiplying it by 5.75 to express total protein content (Bremner, 1996). Seed oil content was determined according to A.O.A.C. (1990) using soxhlet apparatus and diethyl ether as a solvent. Also, phosphorus content was determined by colorimetric method (A.O.A.C, 1990) and potassium content was analyzed by Flame-photometer (Chapman and Pratt, 1978).Sunflower seed oil obtained from each sample was analyzed to determine the relative composition of different fatty acids (oleic, linoleic, palmitic, and stearic acids) with gas chromatography fatty acid analyzer according to A.O.A.C. (1990).

Statistical analysis:

Data collected were statistically analyzed for ANOVA using the Fisher's ANOVA technique. The least significant difference (LSD) test at 0.05 was used to compare means (Steel *et al.,* 1997).

RESULTS AND DISCUSSION

I. Yield attributes

(1) Plant height

Plant height was significantly influenced by the application of N- mineral fertilizer and its combination with bio fertilizer and organic manures (Table 3). Plant height produced by T_4 (238cm), T_2 (235 cm), T_9 (230), T_3 (228) and T_1 (225cm) were significantly higher than that of all other treatments and the lowest plant height, (209 cm) was obtained with the application of ONF only (T_8). It was observed that application of organic manure alone had significant reduction effect on plant height compared with 100%M N Rec. This clearly indicated the need for adding organic manures to the soil conjunctive with inorganic fertilizers, which increased the availability of nutrients considerably resulting in a positive effect on growth parameters. These findings are in accordance with the results of Abdel Gader, (2007), Abd El-Lattief, (2011) and Bilal *et al.,* (2000).

Table 3. Effect of integrated mineral N, biological and organic manure on Yield and its components of sunflower (averaged in 2013 and2014 seasons)

	Treatments	Plant height (cm)	Head diameter (cm)	Head Weight (g)	seed weight head^{-1} (g)	1000-seed weight (g)	Seed yield (kg fed^{-1})
T1	100% M NF	225	18.9	97 .0	253	79	2150
T2	50% M NF+50% ONF	235	20.8	122.0	309	85	2630
T3	75% M NF +25% ONF	228	19.3	109.0	277	81	2360
T4	50% M NF+25%ONF+Bio	238	22.2	123.5	328	88	2790
T5	25% MNF +75% ONF	221	18.4	95.0	248	77	2140
T6	100%ONF+Bio	215	16.6	85.2	225	72	1940
T7	25% MNF +50 ONF + Bio	218	17.8	91.6	227	75	2110
T8	100% ONF	209	15.2	78.8	188	69	1600
T9	75% MNF +Bio	230	19.6	112.9	290	83	2470
T10	75 % ONF + Bio	213	15.4	81.8	194	70	1910
	L.S.D.at5%	6.0	2.3	3.6	16.0	6.0	77.0

MNF =mineral nitrogen fertilizer ONF =organic nitrogen fertilizer

(2) Head diameter

Head diameter is one of the most important yield characters in sunflower crop. The maximum head diameter (22.2cm) was produced by T_4 (50 %M N Rec. +25% ONF +Bio) with 17.5%significant increase over 100%MN only and the minimum head diameter (15.2 cm) was recorded in the plot that was fertilized with 100% ONF which induced significant reduction in HD by 19.6% compared with 100% MN. These results validate the findings of Munir *et al.,* (2007) those have also the evidence regarding to positive effects of nitrogen on head diameter. The increase of head diameter may be due to more photosynthetic activities of the plant on the account of adequate supply of nitrogen in this treatment which include MN, ONF and bio fertilizers, since nitrogen has an important role in encouraging cell elongation, cell division and consequently increasing vegetative growth and activation of photosynthesis process which enhance the amount of metabolites necessary for building plant organs (Wajid *et al.,* 2012).

(3) Seed weight head^{-1}

The results showed that the combined treatmentsT_3, T_4 and T_9 showed significant increase in seed weight head^{-1} over T_1 9.5%,29.6% and 14.6% respectively(Table 3). Combination of T_4 (50%M N Rec. +25% ONF +Bio) produced the highest seed weight head^{-1} (328g) compared with the other treatments, may be because of the superior effect of combined fertilization in balanced nutrient supply and improving soil fertility and nutrient uptake .

(4)1000-seed weight

The average of 1000- seed weight is a critical yield contributing factor, which takes up an important role in representing the potential of respective treatments. Regression analysis revealed a significant positive association of 1000-seed weight with seed yield (R2 = 0.9515) (Fig. 1). Maximum seed index was 88g with the integrated application of T_4 (50% MN Rec. +25% ONF +Bio), followed by T_2 (50% MN Rec. +50% ONF) that produced 85g followed by T_9 (75%M N Rec. +Bio) that produced 83g.The minimum 1000-seed weight 69g was obtained by T_8 (100% ONF). This may be due to the availability of higher amount of nitrogen to the plant in the integrated manuring treatments (Ayeni and Adetunji, 2010).

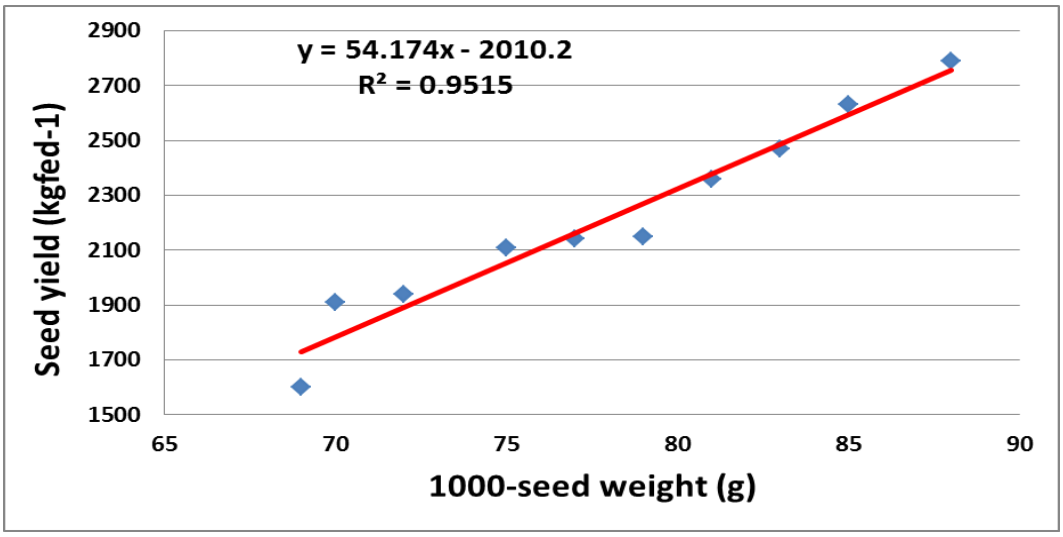

Fig.1 Relationship between 1000-seed weight (g) and seed yield (kg fed^{-1}) in sunflower

II-Yield

(1)Seed yield

Table (3) illustrated that different treatments (T_2, T_3, T_4 and T_9) have highly significant effect on seed yield. Maximum seed yield (2790 kg fed^{-1}) resulted from T_4 with significant increase 29.8% over MN Rec. only (T_1) (Fig2). Integration of N- mineral fertilizer with compost and bio was superior in seed yield than the application of chemical fertilizer or organic manure alone. Integrated fertilization systems including T_4, T_2, T_9 and T_3produced about 29.77, 22.33,14.88 and 9.77% more seed yield than T_1(100% MN Rec.) and 74.38, 64.38, 54.38 and 47.5% than T_8(100% ONF),respectively .The combined use of inorganic fertilizers ,organic manures and bio fertilizers can enhance the inherent nutrients supplying capacity of the soil with respect to both macro- and micronutrients (Jayabal and Chelliah ,2000) and also improve the physical properties of the soil, which promote better rooting, higher nutrient uptake by the crop and increase in leaf area, plant height and therefore, the dry matter production and seed yield. These findings confirm those obtained by Zubillaga *et al.*, (2002). The beneficial effects of using organic fertilizers along with N- mineral fertilization on increasing yield could be due to their effect on providing plants with their requirements from different nutrients at a longer time as well as their effect on increasing the availability of nutrients in the soil for uptake by plants and enhancing the nutritional status of the plant in favors of yield and seed weight.

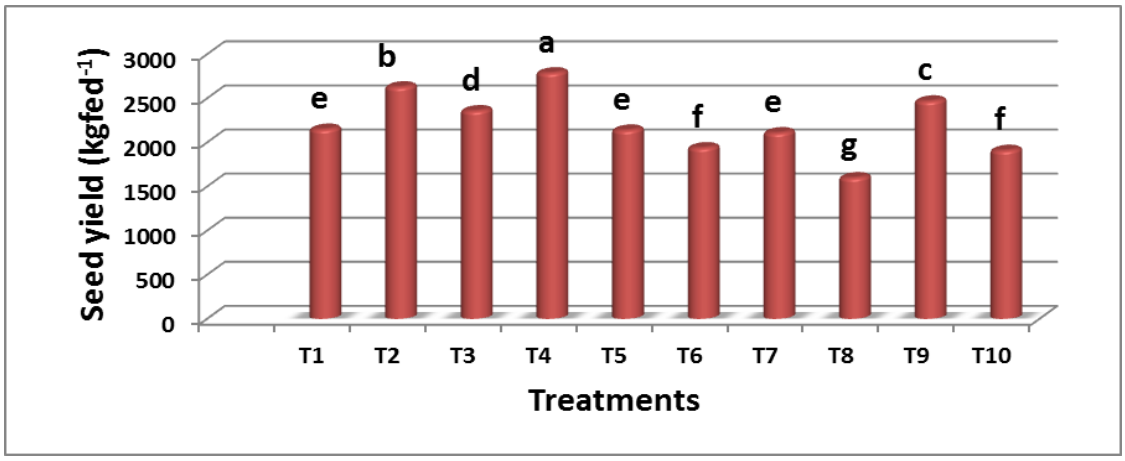

Fig. 2 Effect of integrated N-fertilizer management on seed yield (kg/fed)

(2)Biological yield

The results in Table (4) indicated that biological yield was affected by application of the integrated nitrogen treatments. Significant increase in biological yield by19.7% over T_1 was observed due to the treatment T_4 (50%M N Rec. +25% ONF +Bio) followed by T_2 (50%M N Rec. +50% ONF), T_9 (75%M N Rec. +Bio) and T_3 (75%M N Rec. +25% ONF) by 19.7, 14.7, 9.7 and 5.9% respectively, compared to T_1 (100% MN). The response to applied fertilizers could be attributed to availability of nutrients in the soil during the physiological growth and development stages of the plants as recently reported by Yasin *et al*., (2013). On the other hand the minimum biological yield (4290 kgfed^{-1}) was obtained when ONF only was applied (T_8). Bio fertilizers increase the effect of organic and chemical fertilizers on agricultural production by increasing the activity of microbial biomass (Shehata and El-Khawas, 2003).

Table4. Effect of integrated mineral N, biological and organic manure on biological Yield, seed protein and oil contents of sunflower (averaged in 2013 and2014 seasons)

	Treatments	Biological yield (kg fed-1)	Harvest index (HI) (%)	Protein (%)	Protein yield (kg fed^{-1})	Oil (%)	Oil yield (kg fed^{-1})
T1	100% M NF	5790	37.13	21.28	457.52	40.0	860.00
T2	50% M NF+50% ONF	6641	39.60	21.74	571.76	43.6	1146.68
T3	75% M NF +25% ONF	6133	38.48	21.56	508.82	43.7	935.18
T4	50% M NF+25%ONF+Bio	6932	40.25	22.43	625.80	40.7	1135.53
T5	25% MNF +75% ONF	5695	37.58	20.41	436.77	45.9	1083.24
T6	100%ONF+Bio	5049	38.42	20.01	388.19	46.6	904.04
T7	25% MNF +50 ONF + Bio	5585	37.78	20.13	424.74	44.8	945.28
T8	100% ONF	4290	37.30	18.23	291.68	43.2	691.20
T9	75% MNF +Bio	6350	38.90	21.74	536.98	40.3	995.41
T10	75 % ONF + Bio	5203	36.71	18.92	361.37	44.1	842.31
	L.S.D.at5%	130.68	1.20	2.52	63.14	1.75	46.87

MNF =mineral nitrogen fertilizer **ONF =organic nitrogen fertilizer**

(3)Harvest Index

Regression analysis revealed a significant positive relationship (R_2= 0.7159) between harvest index and seed yield (kg fed^{-1}) as shown in Fig. (3). The integrated N nutrition had a positive and significant effect on the harvest index (Table 4).The highest and lowest harvest index were obtained in T_4(50%M N Rec. +25% ONF +Bio) with an average 40.25% and T_{10}(75% ONF +Bio) with an average 36.71%, respectively.

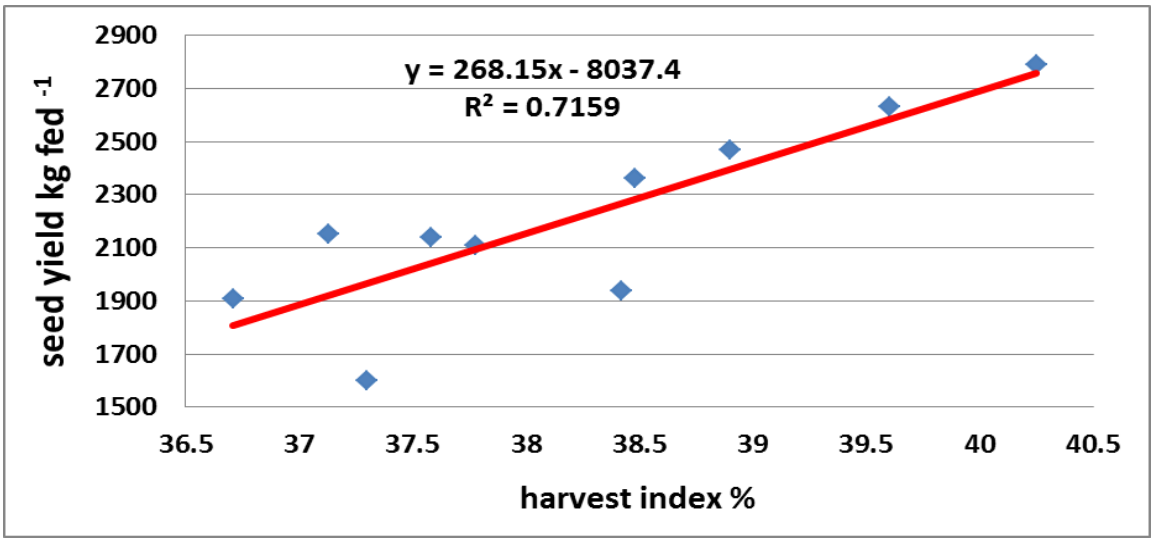

Fig. 3 - Relationship between harvest index (%) and seed yield (kg fed^{-1}) in sunflower

IV-Seed protein content

Protein percentage in sunflower seeds was not significantly affected by the applied treatments except T_8 (100%NOF) which gave significant reduction by 16.7% compared T_1 (100%MN). Although protein percentage in sunflower seed was not significantly affected by the integrated treatments compared with MN alone (T_1), protein yield fed^{-1} was significantly augmented by T_4 (36.8%), T_2 (25%) and T_9 (17.4%) compared with T_1 (100%MN).Meanwhile the integrated N fertilizers containing ONF and/or bio fertilizer (without MN) induced significant decreases in seed

protein yield compared with T_1 showing the magnitude effect of mineral fertilizer.

V-Seed oil content

Most integrated treatments induced significant increases in both oil percentage and oil yield compared to T_1 (100%MN) in favor of T_2 (50%M N +50% ONF) and T_4 (50%MN +25% ONF +Bio) which gave 33.3%and 32% increase in oil yield over T1 (100%MN) respectively (fig. 4), while application of ONF only (T_8) caused significant reduction in oil yield by 19.6%. On the other hand T_5 (25%MN +75% ONF) and T_6 (100%ONF +Bio) gave significant increase in oil %over T_1 by 16.5 %and 14.75%.Both of T_2 and T_4 recorded the highest oil and protein yields . This may be due to the improvement in the soil's physical, chemical and biological properties as well as nutritional status due to the addition of organic manures which must have contributed to the higher yield. Similar results were also reported by Awad *et al.*, (2003).

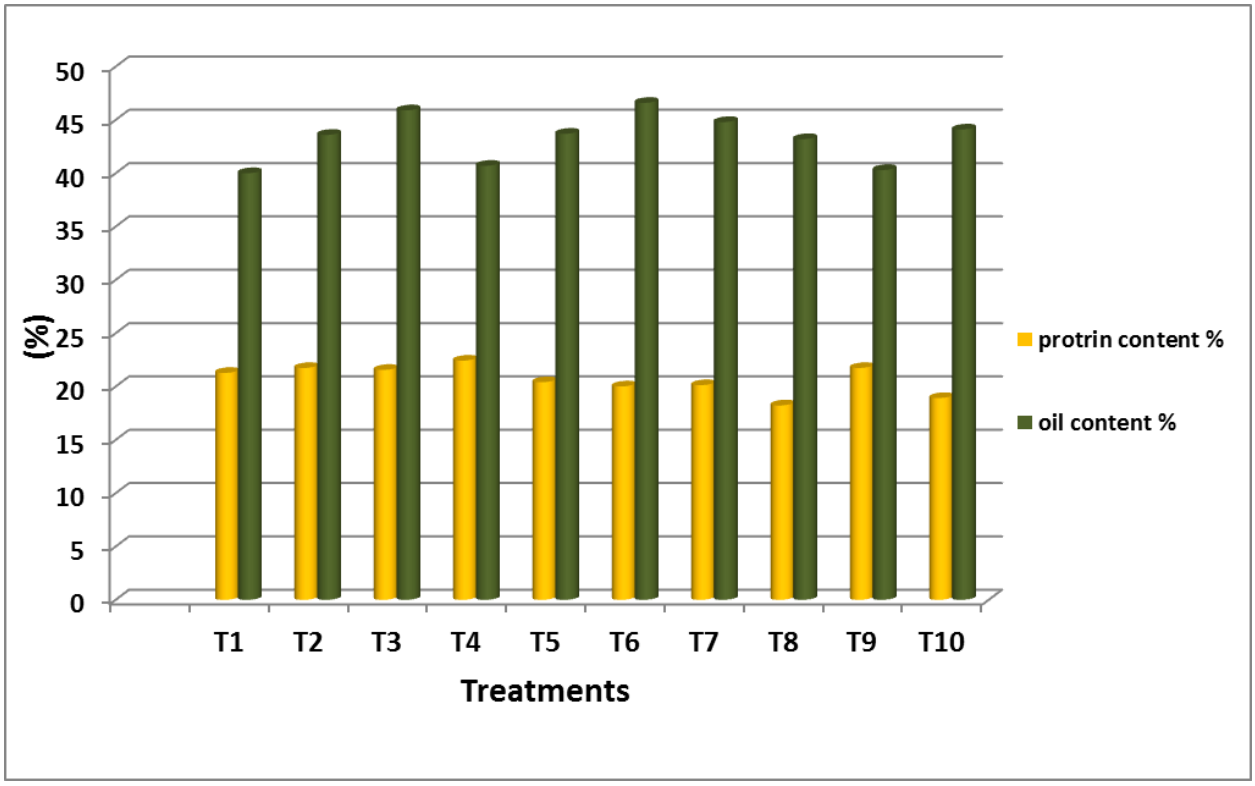

Fig.4 Effect of integrated N-fertilizer management on protein and oil content (%)

III-Nutrient uptake in seeds

The contents of N, P and K taken up in sunflower seeds were significantly influenced by different treatments. The N, P and K uptake increased by application of N- mineral fertilizer and its combination with bio fertilizer and organic manures. The N uptake in seeds varied from 50.72 kg fed^{-1} for (100%ONF) to 108.81 kg fed^{-1} for T_4 being the highest content recorded(36.8% overT_1) .T_2 (99.41kgfed^{-1}) and T_9 (93.37kgfed^{-1}) were also significantly higher than the other treatments (Table 5 and Fig.5). Although N% in sunflower seeds was not significantly affect by the applied treatments compared with T_1, N uptake fed^{-1} in seeds was significantly increased by substituting 25-50% of MN with ONF and /or bio fertilizer. Worth mentioning that ,application of 100% of N as ONF alone or combined with bio fertilizer significantly reduced N uptake by about 36% and 15% respectively, compared with T_1(100%MN). Combined application of inorganic N with bio fertilizers as a partial substitute for chemical fertilizers was very effective in stimulating nutrient concentration and uptake of sunflower plant. This could be attributed to the important role of bio fertilizers in N_2-fixation process which was reflected on the nitrogen supplementation uptake (Singh and Sinsinwar 2006). These results are in harmony with those reported by EI-Hadded *et al.*, (1993)

Table5. Effect of integrated mineral N, biological and organic manure on N, P and K contents in seeds of sunflower (averaged in 2013 and 2014 seasons)

	Treatments	Nitrogen		Phosphorus		Potassium	
		%	Content (kgfed$^{-1)}$	%	Content (kgfed$^{-1)}$	%	Content (kgfed$^{-1)}$
T1	100% M NF	3.70	79.55	0.36	7.74	0.77	16.56
T2	50% M NF+50% ONF	3.78	99.41	0.45	11.84	0.84	22.09
T3	75% M NF +25% ONF	3.75	88.5	0.39	9.20	0.81	19.12
T4	50% M NF+25%ONF+Bio	3.90	108.81	0.40	11.16	0.93	25.95
T5	25% MNF +75% ONF	3.55	75.97	0.45	9.63	0.75	16.05
T6	100%ONF+Bio	3.48	67.51	0.48	9.31	0.75	14.55
T7	25% MNF +50 ONF + Bio	3.50	73.85	0.49	10.34	0.72	15.19
T8	100% ONF	3.17	50.72	0.52	8.32	0.70	11.2
T9	75% MNF +Bio	3.78	93.37	0.37	9.14	0.85	21.00
T10	75 % ONF + Bio	3.29	62.84	0.55	10.51	0.72	13.75
	L.S.D.at5%	0.44	11.03	0.06	1.22	0.09	2.42

MNF =mineral nitrogen fertilizer **ONF =organic nitrogen fertilizer**

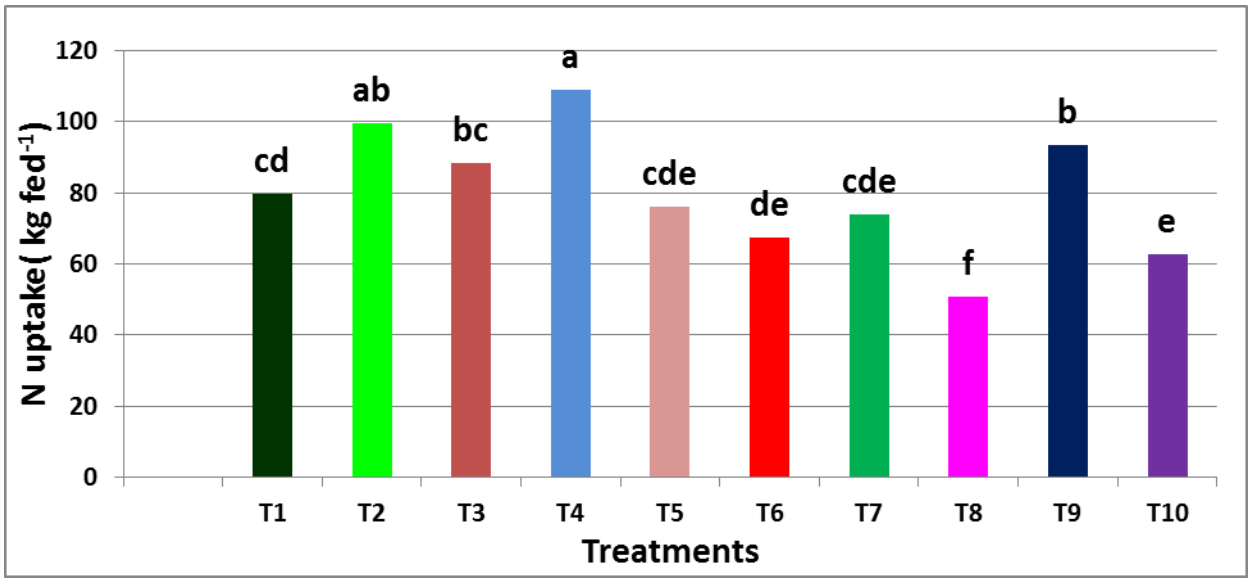

Fig.5 Effect of integrated N-fertilizer management on N uptake (kg fed^{-1})

The maximum P taken up in seeds (11.84kgfed^{-1}) was noted withT_2 (50%M N Rec. +50% ONF) followed by the integration ofT_4 (50% MN Rec. +25% ONF +Bio) (Fig.6) .This may be due to the benefits of organic matter supply to the soil on the basis of anion replacement or competition between humate and phosphate ions on the active sites of adsorbing surfaces. Products of organic decay such as organic acids and humus are thought to be effective in forming complexes with iron and aluminum compounds which are mainly responsible for P fixation in soils El- Sherbieny *et al.*, (2003).

The highest K uptake (25.95kg fed^{-1}) in seeds was observed in T_4 followed by T_2 (22.09kg fed^{-1}) (Fig.7) when 50%MN was replaced by ONF and bio-fertilizer. The beneficial effects of using organic fertilizers along with mineral -N fertilizer on increasing nutrients uptake of sunflower plant could be due to their effect on providing plants with their requirements from different nutrients at a longer time as well as their effect on increasing the availability of nutrients in the soil for uptake by plants and enhancing the nutritional status of the plants in favors of yield and quality.

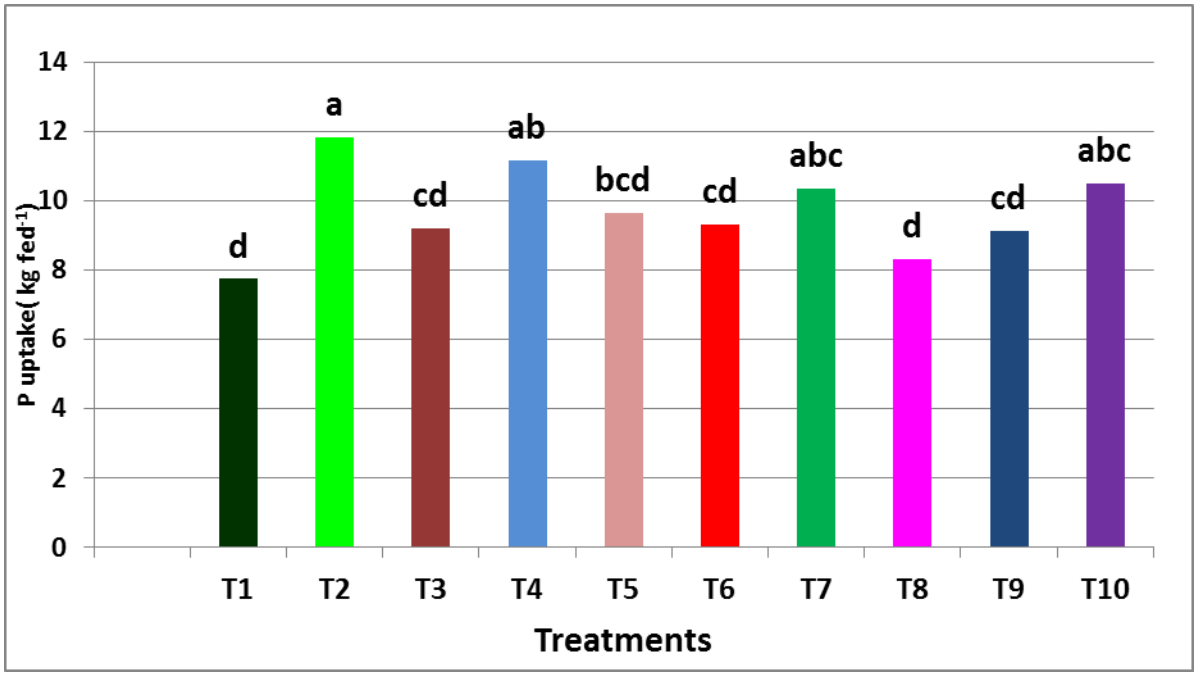

Fig.6 Effect of integrated N-fertilizer management on P uptake (kg fed^{-1})

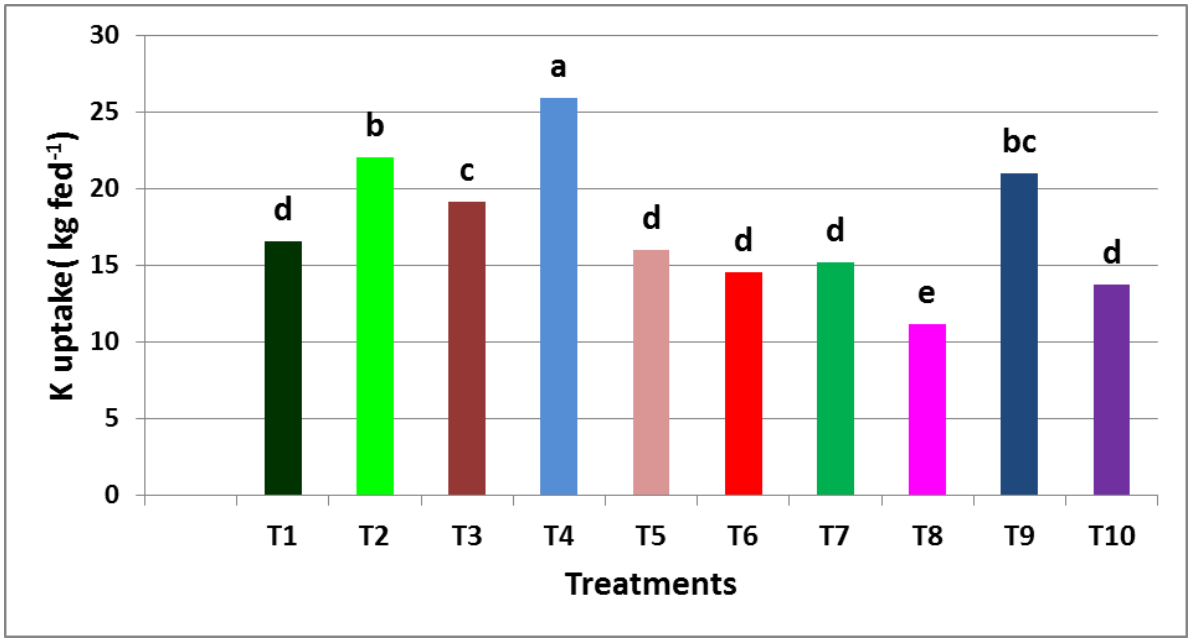

Fig.7 Effect of integrated N-fertilizer management on K uptake (kg fed^{-1})

VI-Fatty acid composition of seed oil

Sunflower oil is an important edible vegetable oil source which contains high level of unsaturated fatty acid than saturated fatty acid .It consists of different types of saturated (mainly palmitic acid and stearic acid) and unsaturated fatty acids (mainly linoleic acid and oleic acid). The quality of sunflower oil is associated with fatty acid composition. Oil with high proportion of oleic acid is more stable than others which is desirable for improved shelf life. In this research, oleic acid and linoleic acid in sunflower oil was more affected by treatments. All treatments produced higher contents of unsaturated fatty acid (oleic acid and linoleic acid) with corresponding decrease in saturated acids (palmitic acid, stearic acid) compared with T_1. High amounts of unsaturated fatty acids, mainly oleic and linoleic acids, with more than 48 and 38% respectively, were found in the sunflower oil under different treatments (Table 6 and Fig.8).

Table 6. Effect of integrated mineral N, biological and organic on the content of fatty acids in sunflower oil (averaged in 2013 and 2014 seasons)

	Treatments	16:0 Palmitic	18:0 Stearic	18:1 Oleic	18:2 Linoleic	TU/TS
T1	100% M NF	5.52	3.63	44.12	37.20	8.89
T2	50% M NF+50% ONF	4.71	2.98	49.12	43.19	12.00
T3	75% M NF +25% ONF	4.95	3.02	48.49	43.49	11.54
T4	50% M NF+25%ONF+Bio	4.58	2.65	50.17	42.63	12.84
T5	25% MNF +75% ONF	4.99	3.05	46.15	41.33	10.88
T6	100%ONF+Bio	5.10	3.30	44.6	39.47	10.01
T7	25% MNF +50 ONF + Bio	5.08	3.08	44.84	40.03	10.40
T8	100% ONF	4.94	3.04	49.19	43.17	11.57
T9	75% MNF +Bio	4.81	2.97	44.55	45.29	11.55
T10	75 % ONF + Bio	5.32	3.58	49.82	38.58	9.93

MNF =mineral nitrogen fertilizer **ONF =organic nitrogen fertilizer**

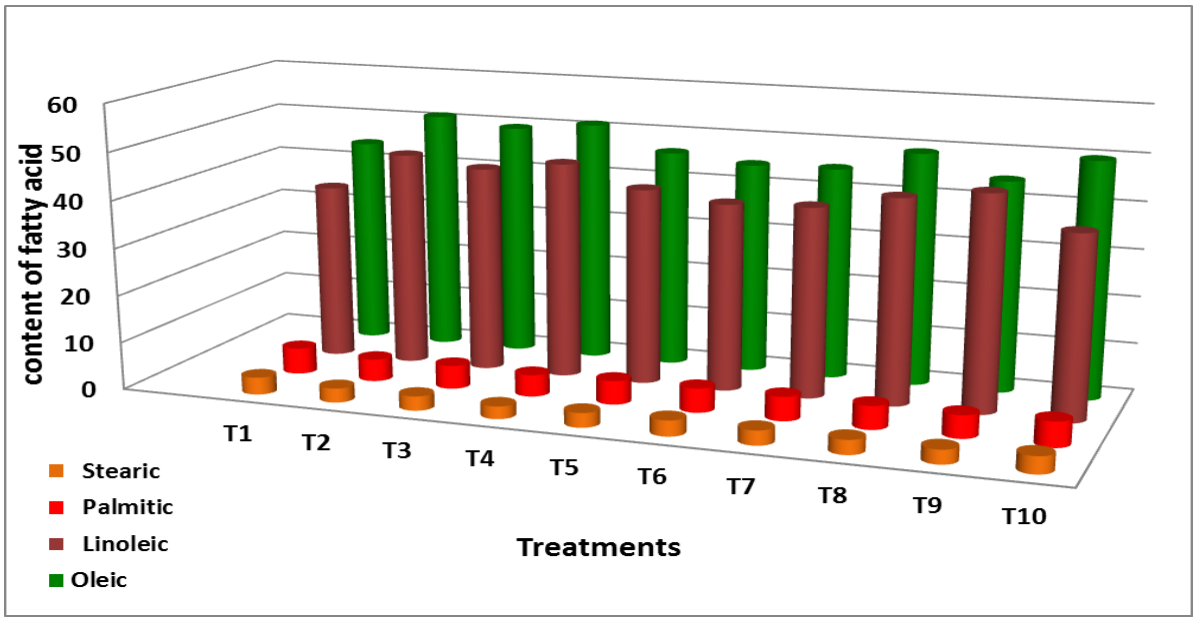

Fig. 8 Effect of integrated N-fertilizer management on fatty acid composition of sunflower seed oil

The highest value for oleic acid (50.17%) was detected by T_4 (50%M N Rec. +25%ONF +Bio) followed by T_{10} (75 % ONF + Bio), T_2 (50%M N Rec. +50% ONF) andT_3 (50% MN Rec. +25% ONF) having oleic acid concentrations of 49.82, 49.12and 48.49%, respectively. There were also variations among different treatments regarding linoleic acid concentration.T_9 (75%MNRec. +Bio) had the highest linoleic acid content (45.29%), followed by$T_3$and T_2 having linoleic acid concentration of 43.49 and 43.19 % respectively. On the other hand, all the applied treatments reduced the contents of both saturated fatty acids stearic and palmitic acids in sunflower oil .These results agree with Munir *et al.,* (2007). The presence of bio and organic manure can have positive effects on plant growth, which increase unsaturated fatty acids, with corresponding decrease in saturated fatty acids (Shehata and EL-Khawas, 2003), which are in consistent with the results of this study. In fact, saturated fatty acids decrease while unsaturated fatty acids increase with the increase in the amount of nitrogen (Khaliq, 2004).

CONCLUSION

In this study it was found that combined treatments of T_4 (50% MN Rec. +25% ONF +Bio) followed by T_2 (50%M N Rec. +50% ONF), T_9 (75%M N Rec. +Bio) and T_3 (75% MN Rec. +25% O.N.F.) increased the yield and yield components compared with T_1 (100%MN). Thus it can be stated that the integrated combined use of bio-fertilizers and/or organic plus N-mineral, increase the seed yield and decrease the use of chemical fertilizers in order to reduce the environmental pollution caused by their use. It seems that the integrated nutrition system of bio-fertilizers and manures is justifiable for both economically and environmentally and also compatible with the environment in permanent farming.

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إنتاجية وجودة محصول عباد الشمس تحت تأثير أنظمة التسميد المتكاملة للنيتروجين المعدنى والعضوى

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اجريت تجربتان حقليتان خلال موسمى٢٠١٣ و ٢٠١٤ فى محطة بحوث الجميزة-محافظة الغربية-مركز البحوت الزراعية-الجيزة لدراسة تأثير التسميد المتكامل من الاسمدة العضوية والنيتروجين المعدنى والاسمدة البيولوجية(تشتمل على اجناس الازوتوباكتروالازوسبيريلم) على المحصول ومكوناتة فى بذور عباد الشمس صنف (سخا ٥٣)،تم تصميم التجربة فى قطاعات كاملة العشوائية بثلاثة مكررات .

اظهرت نتائج التجربة ان جميع قياسات النمو تأثرت معنويا باستخدام معاملات التسميد.

أدى استخدام التسميد المتكامل الى زيادات معنوية فى ارتفاع النبات وقطر القرص ووزن البذور/ قرص ووزن ١٠٠٠بذرة واظهرت النتائج ايضا ان المعاملات المتكاملة و التى تحتوى على الاسمدة البيولوجية والعضوية مع التسميد الازوتى المعدنى اعطت زيادة معنوية فى محصول البروتين ومحصول البذور والمحصول البيولوجى ومحصول الزيت وسجلت أعلى القيم لهذه القياسات فى المعاملات رقم (٤)،(٢)،(٩)و(٣) مقارنة بالنباتات التى استخدم فيها الازوت المعدنى معاملة(١) او التسميد العضوى فقط معاملة (٨).

كانت المعاملة رقم (٤) والتى تحتوى على (٥٠ %نيتروجين معدنى+٢٥%نيتروجين عضوى+حيوى) متفوقة على باقى المعاملات و أثرت ايجابيا على وزن ١٠٠٠بذرة ومحصول البذور وايضا على مكونات المحصول ومحتوى البروتين مقارنة بالمعاملات الاخرى.

من ناحية اخرى سجلت المعاملة رقم (٦)والتى تحتوى على (١٠٠%نيتروجين عضوى+حيوى) ويليها المعاملة رقم (٥) والتى تحتوى على (٢٥% نيتروجين معدنى+٧٥% نيتروجين عضوى) سجلت اعلى نسبة زيت فى البذور بينما سجلت المعاملة رقم (٢) والتى تحتوى على (٥٠% نيتروجين معدنى+٥٠% نيتروجين عضوى) ويليها المعاملة رقم (٤)والتى تحتوى على(٥٠ %ازوت معدنى+٢٥%نيتروجين عضوى+حيوى) على أعلى محصول زيت فى البذور.

ووفقا لنتائج هذه التجربة كانت الاستجابة عالية للتسميد المتكامل على نسبة الاحماض الدهنية الغير مشبعة مثل (حمض الاوليك واللينوليك) فى حين انخفضت نسبة الاحماض الدهنية المشبعة مثل (البالمتيك والاستياريك) بالمقارنة بالمعاملة (١) وكانت اعلى نسبة لحمض الاوليك(٥٠,١٧%) وتم الحصول عليها من المعاملة رقم (٤) وحمض اللينوليك(٤٥,٢٩%) وتم الحصول عليها من المعاملة رقم (٩).

لذلك يمكن اعتبار ان الاستبدال الجزئى للاسمدة المعدنية الازوتية بالاسمدة العضوية والحيوية بديلا لتوفير او للاقلال من ا لاسمدة النيتروجينية المعدنية فى الانظمة الزراعية .