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Enhance Sunflower Productivity by Nitrogen Fertilizer Sources and Antioxidants Foliar Application under Sandy Soil Conditions of Toshka Region

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ABSTRACT

In order to study the enhancement of sunflower production under sandy soil of Toshka region. The present study was undertaken during 2017 and 2018 seasons to examine the impact of using four nitrogen sources (N) *i.e*., N_1=45 kg N/fed as a mineral form (min), N_2=45 kg N/fed as organic form (org.), N_3=30 kg N/fed min.+15 kg N/fed org., N_4=15 kg N/fed min.+30 kg N/fed org., and four foliar spraying with antioxidants (A) *i.e*., A_1= without spraying, A_2=200ppm salicylic acid (SA), A_3=3g/L yeast extract (YE) and A_4=200ppm ascorbic acid (AA) as well as their interaction on the vegetative growth, yield and its quality as well as economics return of sunflower *cv*. Sakha-53. The obtained results indicated that application of nitrogen sources and antioxidants foliar spraying had significant influence on No. of leaves/plant, leaf area/plant, stem diameter, total chlorophyll, flowering date, plant height, head diameter, 100-seed weight, seed and oil yield as well as oil and protein percentage in both seasons. The results recorded fertilizing with 30 kg N/fed min.+15 kg N/fed org. (N_3) increased seed yield (ton/fed) by 5.95 and 9.20 % in 1st and 2nd seasons, respectively compared to the N_2 treatment. Spraying with yeast extract at 3 g/L (YE) gave the highest values of seed and oil yield in both seasons when compared with salicylic acid and ascorbic acid treatments. The interaction significantly affected seed yield and some of its traits. The highest seed yield (1.90 and 1.91 ton/fed) was recorded for 30 kg N/fed min.+15 kg N/fed org. and foliar spraying with yeast extract in 1st and 2nd seasons, respectively as well as net return (4409.15 L.E/fed) as an average of the two seasons, but highest economic efficiency was (96 %) resulted from $N_1 \times A_3$. It could be recommended with fertilizing with 30 kg N/fed as mineral+15 kg N/fed as organic fertilizer with foliar spraying yeast extract at 3g/L for maximizing sunflower seed yield and net return under Toshka region.

Keywords: Sunflower - N mineral - El-Nil compost - Yeast extract - Salicylic acid - Ascorbic acid - Seed yield.

INTRODUCTION

Sunflower (*Helianthus annuus* L.) has considered one of the most important species belongs to the family *Compositae*. It is an important oilseed crop ranks the fourth next to palm oil, soybean and canola as a source of edible oil in the world (FAS-USDA, 2017). So it can be grown twice a year and it grows in different soil type and climate conditions (El-Saidy *et al*., 2011). These characters gave the importance of cultivation such crop in the newly reclaimed land. In general, the aim of planting sunflower is for its seed that contains oil (36-52 %) and protein (28-32%) as reported by (Henen, 2011 and Oshundiya *et al*., 2014).

In Egypt, there is a great shortage of edible oil due to the limited cultivated area of oilseed crops and a rapid increase in population growth rate. The average total cultivated area of sunflower in Egypt reached 8000 ha and the final production gained 22.000 tons with an average of 2.75 ton/ha (FAO, 2016). Increasing the oilseed production depends on, either by the horizontal expansion of cultivation in newly reclaimed lands or vertical expansion by applying suitable management of N rates and sources or natural and ecofriendly substances. The newly reclaimed lands are suffering from drought, salinity and soil temperature fluctuation as well as nutrient deprivation.

The application of mineral fertilizers at enormously high rates for long-term, reduce the potential activity of micro-flora and crop yield due to soil acidification, loss of soil biological activity, loss of soil physical properties and soil nutrient imbalance (Adediran *et al*., 2004 and Rizk *et al*., 2016), it may also affect the seed quality, reducing its oil content and decrease yield through an increase of plant loading (Scheiner *et al*., 2002 and Akbari *et al*., 2011). In addition to, the use of mineral fertilizers leads to environmental pollution and ecological damage which increase the crop production costs, as well as potentially dangerous influences of chemical residues in plant tissue on the health of human and animal consumers.

To face this situation, the addition of organic manure can improve soil fertility and amount of oxygen, decrease soil erosion, increase water holding capacity, intensify organic matter and promotes beneficial organisms and productivity (Lamyaa *et al*., 2016). Proper application of mineral and organic N fertilizers is very fundamental not only for obtaining optimum yield, its attributes and great quality in crops but also to maintain soil fertility as well as sustainability for a longer period (Ahmad *et al*., 2017 and Irika *et al*., 2018).

Egyptian scientists have been made great efforts to use natural and biostimulants substances in order to increase plant growth and productivity. Salicylic acid (SA) (2-hydroxybenzoic acid) is one of the these substances that is an endogenous growth hormone of phenolic nature and acts as potential non-enzymatic antioxidant which participates in the regulation of many physiological processes in plants, such as stomata closure, photosynthesis, ion uptake and transport, inhibition of ethylene biosynthesis, transpiration, membrane permeability, and plays an important role in plant growth and development (Mona Dawood *et al*., 2012; Abdel-Motagally *et al*., 2015; Ebtessam Yossef *et al*., 2015 and EL-Sabagh *et al*., 2017). Application of SA able to reduce the adverse influence of environmental stresses on crops and increase the yield components through morphological, physiological and biochemical mechanisms (Khademian and Yaghoubian, 2018). Additionally, ascorbic acid (vitamin C) is a product of D-glucose metabolism which synthesized in higher plants. It plays an important role in plant growth and development like regulation of cell division, photosynthesis, cell wall expansion, flowering and other development (Barth *et al*., 2006). Abdel-Motagally *et al*. (2015) and Rania El Mantawy (2017) found that plant height, yield and its components, as well as oil % in sunflower, was increased with application of ascorbic acid.

Regarding to, Yeast extract (YE) as one of the richest natural safety biofertilizer source contains many of the nutrient elements (*i.e.* calcium, cobalt, iron etc), vitamins (*i.e.* B1, B2, B6 and B12) and phytohormones (especially cytokinins), which is usually added to soil or as foliar spray to crops (Abbas, 2013 and Abou-Aly *et al*., 2015). Seadh *et al*. (2017) reported that foliar application and soaking of maize with (YE) leads to a gradual increase in growth parameters, yield and its components. Many researches indicated that, the improving growth, yield and its attributes of many crops by using foliar application with (YE) has stimulatory effects on faba bean (Mady, 2009), faba bean (Neama *et al*., 2014), wheat (Abou-Aly *et al*., 2015), sunflower (Amal Ahmed *et al*., 2016) and sunflower (Hassanein *et al*., 2017).

The main objectives of this investigation were elucidating the effect of integrated mineral and organic N fertilization treatments and foliar spray of some bio-stimulants substances on growth, yield and its quality as well as the economics return of sunflower *cv*. Sakha-53 under sandy soil conditions at Toshka, Aswan.

MATERIALS AND METHODS

The present investigation was carried out at Agricultural Research Station Farm of the South Valley Research Station at Toshka area, Aswan Governorate, during the two consecutive summer seasons of 2017 and 2018, to study the effect of integrated fertilization of N mineral and organic fertilizers sources and foliar application of some materials on growth, yield and its quality as well as economics return of sunflower *cv*. Sakha-53 in sandy soil. The experiment was arranged in a strip-plot in randomized complete block design, with three replicates. Where, the vertical plots were distributed to the following four different N fertilizer treatments: (N1) 45 kg N/fed as a mineral form (min.), (N2) 45 kg N/fed as organic form (org.), (N3) 30 kg N/fed (min.)+15 kg N/fed (org.) and (N4) 15 kg N/fed (min.)+30 kg N/fed (org.), while, the four foliar application treatments (A) *i.e*., (A1) without spraying, (A2) salicylic acid (200 ppm), (A3) yeast extract (3 g/L) and (A4) ascorbic acid (200 ppm) were occupied the horizontal plots.

Soil samples were randomly taken before fertilizers application at depth 30 cm to measure the mechanical and chemical properties according to Page *et al*. (1982) is shown in Table 1. Analysis of organic manure is presented in Table 2.

Phosphorus as calcium superphosphate (15.5% P_2O_5) was applied before planting at the rate of 150 kg/fed, also potassium 50 kg/fed in the form of potassium sulphate (48% K_2O) was applied during seedbed preparation.

Table 1. Soil physical and chemical characteristics of the experimental site during 2017 and 2018 seasons.

Season	Physical properties					Chemical properties (Soil extract 1: 2.5)					
	Sand %	Silt %	Clay %	Texture Grade	pH	EC (ds m^{-1})	$CaCO_3$ (%)	Total N (ppm)	OM %	Available P (ppm)	K (ppm)
2017	67.05	20.13	12.82	Sandy	8.07	0.96	11.65	186	0.08	4.00	164
2018	66.55	20.03	13.42	loam	8.16	1.05	12.15	190	0.10	4.01	165

Table 2. Some chemical analysis of the organic manure ' El-Nil compost' during 2017 and 2018 seasons.

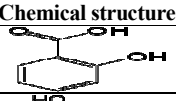
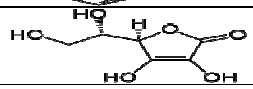
Parameters		Moisture %	O.M %	pH (1:5 susp.)	EC ds m^{-1} (1:5 extract)	C/N Ratio	Total N %	Total P %	Total K %	Weight of m^3 dry, kg
Season	2017	24	31	7.15	3.2	1 : 15.8	1.50	0.83	1	610
	2018	25	32	7.20	3.0	1: 16	1.45	0.80	1	615

The El-Nil compost was obtained from "Egyptian Company for Solid Waste Recycling" ECARU", Egypt.
The quantity of plant compost needed to represent 15 kg organic N was 1 ton /fed in the 1st season and 1.03 ton fed^{-1} in the 2nd season

Organic manure (El-Nil compost) was added during soil preparation before planting in the two seasons. The amount of N fertilizer (N=45 kg N/fed) in the form of ammonium nitrate (NH_4NO_3-33.5%). The treatments of N as a mineral added on six equal portions, the first one after 20 days from planting at thinning, while the rest were added weekly with water irrigation.

Yeast extract was prepared from brewer's yeast (*Saccharo mycescerevisiae*) was dissolved in water followed by mixing sugar at a ratio of 1: 1 and kept one day in a warm place for reproduction. The compounds used in this study are shown in the following Table (3).

Table 3. Characteristics of the materials used in this study.

Materials name	Molecular formula and weight	Rate and time of application	Chemical structure
1- Salicylic acid (2-Hydroxybenzoic acid)	$C_7H_6O_3$ (138.121 g /mol)	200 ppm (sprayed twice at 35 and 45 days after planting, DAP)	
2- Ascorbic acid (Vitamin C)	$C_6H_8O_6$ (176.124 g /mol)		
3- Yeast extract (Baker's yeast extract)	$C_{19}H_{14}O_2$ (274.319 g /mol)	3 g /L (sprayed twice at 35 and 45 DAP)	

The plot area was 20 m^2 including 4 ridges. The fourth ridge was used for collecting the growth parameters, while the two middle ridges to estimate yield and its components at harvesting. Seeds were planted manually on April 28th and 26th in the 1st and the 2nd seasons, respectively by hand planted (4 seeds /hills) around the drip point (30 cm spaces between droppers) and thinned to 8 plants/m to give the optimum number of plant/unit area about 33.600 thousand plant/fed. The irrigation was done every two hours daily. Seeds of sunflower cv. Sakha-53 was obtained from Oil Crops Research Section, Agriculture Research Center (ARC) at Giza, Egypt. The preceding crop was wheat and

clover in 1st and 2nd seasons, respectively. All other cultural practices for growing sunflower in the studied area were followed according to the recommendation of Oil Crops Research Section, ARC, Ministry of Agriculture.

Studied characteristics:

A- Vegetative growth traits: Five guarded plants were taken from each plot after flowering stage (65 days after planting), to determine number of leaf /plant, leaf area /plant (dm^2), stem diameter (cm) and total chlorophyll which was estimated by using SPAD-502 plus. Konica Minolta, INC., Japan.

B- Yield and its quality: At harvesting, a random sample of five guarded plants were taken from the inner two ridges of each plot to estimate the following characters:

1- Flowering date number of days from planting to full opening.
2- Plant height (cm).
3- Head diameter (cm).
4- 100-seeds weight (g).
5- Seed yield (kg /fed): all heads on plants in each plot were collected and seed were then separated from their heads, air dried and weighed to record and converted to seed yield kg/fed.
6- Seed oil content (%) and seed protein content (%), were determined according to the procedure reported by A.O.A.C. (2000).
7- Oil yield (kg /fed): It was determined from calculation of, seed yield × oil % in seeds.

C- Economic Assessment: Total cost of production for use in the study was done based on the prevailing market prices of inputs, N sources i.e., chemical and organic, seeding & planting, land preparation, harvesting, rent values and labor cost. Estimate economic analysis using the following formula described by (CIMMYT, 1988).

- Net income = Seed yield × Seed price (was 4765 L.E/ton) as an average for the two seasons (Bulletin of Statistical Cost Production and Net return, 2016).
- Net return = Net income – Total Cost.
- Economic Efficiency % = Net return/Total Cost × 100

D- Statistical analysis: All obtained data were subjected to the analysis of variance using the MSTAT.C statistical for the strip-plot design according to Gomez and Gomez (1984). The LSD at 5% probability level of significance was recruited to differentiate every two significant means.

RESULTS AND DISCUSSION

1. Effect of integrated mineral and organic nitrogen fertilizers (N):

The presented results in Table 4 show that all vegetative growth traits were significantly influenced by N sources (N) in both seasons. The maximum values were recorded from the plants that treated with N_3, followed by N_1 and N_4 in both seasons. Application of 30 kg N/fed min.+15 kg N/fed org. (treatment N_3) gave the greatest mean values of number of leaves /plant (19.9 and 19.8 leaves), leaf area / plant (58.3 and 62.4 dm^2), stem diameter (3.2 and 3.2 cm) and total chlorophylls (4.3 and 4.3 mg dm^{-2}) after flowering stage in the 2017 and 2018 seasons, respectively. While, the minimum mean values of No. of leaves /plant (18.7 and 18.5 leaf), leaf area /plant (53.1 and 57.0 dm^2), stem diameter (2.8 and 2.8 cm) and total chlorophylls (3.9 and 4.0 mg dm^{-2}) after flowering stage were obtained by applying 45 kg/fed organic fertilizer (N_2) in the 1st and 2nd seasons, respectively.

Table 4. Vegetative growth traits of sunflower as influenced by different forms of N fertilizers, antioxidants foliar spraying and their interaction during 2017 and 2018 growing season.

Treatments		Vegetative growth traits							
		No. of leaves /plant		Leaf area /plant (dm^2)		Stem diameter (cm)		Total chlorophyll (mg dm^{-2})	
Nitrogen sources (N)	Some compounds (A)	2017	2018	2017	2018	2017	2018	2017	2018
N1: 45 kg N /fed mineral	A1: Untreated plants	18.2	17.5	52.1	55.3	2.7	2.7	3.4	3.6
	A2: 200 ppm Salicylic acid	19.4	19.7	56.5	63.5	3.2	3.1	4.3	4.3
	A3: 3 g /L Yeast extract	20.8	20.3	61.2	64.9	3.4	3.4	4.7	4.8
	A4: 200 ppm Ascorbic acid	19.1	19.2	55.9	63.2	3.1	3.0	4.3	4.2
Mean of N1		19.4	19.2	56.4	61.7	3.1	3.1	4.2	4.2
N2: 45 kg N /fed organic	A1: Untreated plants	17.7	17.1	50.7	51.2	2.1	2.1	3.1	3.3
	A2: 200 ppm Salicylic acid	19.2	19.0	53.2	57.5	3.0	2.8	4.1	4.1
	A3: 3 g /L Yeast extract	19.8	19.4	56.7	62.2	3.1	3.0	4.4	4.4
	A4: 200 ppm Ascorbic acid	18.2	18.6	52.4	57.3	2.9	2.8	4.1	4.0
Mean of N2		18.7	18.5	53.1	57.0	2.8	2.8	3.9	4.0
N3: 30 kg N /fed mineral + 15 kg N /fed organic	A1: Untreated plants	18.3	17.8	54.2	56.2	2.8	2.9	3.5	3.7
	A2: 200 ppm Salicylic acid	20.1	20.0	58.2	64.0	3.2	3.2	4.4	4.3
	A3: 3 g /L Yeast extract	21.5	21.6	63.4	65.8	3.5	3.4	4.9	4.9
	A4: 200 ppm Ascorbic acid	19.8	19.7	57.3	63.3	3.2	3.1	4.3	4.3
Mean of N3		19.9	19.8	58.3	62.4	3.2	3.2	4.3	4.3
N4: 15 kg N /fed mineral + 30 kg N /fed organic	A1: Untreated plants	17.8	17.3	51.3	54.4	2.6	2.7	3.3	3.5
	A2: 200 ppm Salicylic acid	19.3	19.3	54.0	62.0	3.1	3.1	4.2	4.2
	A3: 3 g /L Yeast extract	19.9	19.6	59.1	63.6	3.2	3.2	4.5	4.6
	A4: 200 ppm Ascorbic acid	17.9	18.7	53.3	62.6	3.1	3.0	4.1	4.1
Mean of N4		18.7	18.7	54.4	60.7	3.0	3.0	4.0	4.1
Mean of A	A1: Untreated plants	18.0	17.5	52.1	54.3	2.6	2.6	3.3	3.5
	A2: 200 ppm Salicylic acid	19.5	19.5	55.5	61.8	3.1	3.1	4.3	4.2
	A3: 3 g /L Yeast extract	20.5	20.2	60.1	64.1	3.3	3.3	4.6	4.7
	A4: 200 ppm Ascorbic acid	18.8	19.0	54.7	61.6	3.	3.0	4.2	4.1
LSD at 5 %	N	0.24	0.44	1.27	2.17	0.04	0.11	0.09	0.05
	A	0.32	0.29	0.62	2.36	0.20	0.15	0.18	0.12
	N × A	0.39	0.55	1.38	NS	0.12	0.08	NS	NS

These increases could be attributed to the effect of El-Nil compost on increasing the efficiency of mineral fertilizer which helps increase the availability of nutrients and their uptake during the early stages of sunflower crop development and consequently greater cell division, elongation, higher leaf area index that improve plant growth, total chlorophylls and activation of photosynthesis process which increase the quantity of metabolites necessary for building plant organs (Wajid *et al*., 2012). Keshta *et al*. (2008), Radwan *et al*. (2015), Buriro *et al*. (2015), Abd-Elhamied and Fouda (2018), Irika *et al*. (2018), Lokhande *et al*. (2018) and Patil *et al*. (2018) also reported similar results on sunflower.

The effect of different forms of N fertilizers on yield components of sunflower *cv*. Sakha-53 in sandy soil was presented in Table 5. The results obtained from the statistical analysis of data showed that all N fertilizer treatments were highly significant for all studied parameters in both seasons. N_3 treatment (30 kg N/fed mineral+15 kg N/fed organic) recorded the highest mean values of flowering date (58.3 and 58.1 days), plant height (194.7 and 196.2 cm), head diameter (19.8 and 19.6 cm) and 100-seed weight (7.8 and 7.8 g) in the 1st and 2nd seasons, respectively, followed by N_1 and N_4 Conversely, the lowest mean values of flowering date (56.1 and 54.8 days), plant height (185.8 and 184.7 cm), head diameter (18.4 and 18.8 cm) and 100-seed weight (7.0 and 7.2 g) were obtained by N_2 in the first and second seasons, respectively. Treated of sunflower plants by the treatment (N_3) caused to increase flowering date, plant height, head diameter and 100-seed weight by (3.92 and 6.02 %), (4.79 and 6.23 %), (7.61 and 4.26 %) and (11.43 and 8.33 %) as compared to the treatment N_2, respectively at the first and second seasons, respectively.

Adding organic fertilizers to the soil in conjunctive with mineral fertilizers, allow more balanced availability of nutrients at the critical stages of sunflower growth, improving soil fertility, decreased the loss of soil moisture and element uptake (Mahrous *et al*.,2014). Moreover, the applied organic manure enhanced the ability rate of leaves for the photosynthetic process, increased the seed filling intensity that leads to increasing the seed weight. Lamyaa Abd El-Rahman *et al*. (2016) found that plant height, head diameter, 100-seed weight were significantly influenced by integrated mineral and organic N fertilization. Similar results were reported by Keshta *et al*. (2008), Aowad and Mohamed (2009), Radwan *et al*. (2015), Abd-Elhamied and Fouda (2018), Irika *et al*. (2018), Lokhande *et al*. (2018) and Patil *et al*. (2018).

Table 5. Yield components of sunflower as influenced by different forms of N fertilizers, antioxidants foliar spraying and their interaction during 2017 and 2018 growing season.

Treatments		Yield components							
		Flowering date (days)		Plant height (cm)		Head Diameter (cm)		100-Seed Weight (g)	
Nitrogen sources (N)	Some compounds (A)	2017	2018	2017	2018	2017	2018	2017	2018
N1: 45 kg N /fed mineral	A1: Untreated plants	56.4	55.6	181.2	186.4	16.8	17.7	7.0	6.8
	A2: 200 ppm Salicylic acid	58.0	57.7	193.0	194.7	20.2	19.2	7.4	7.9
	A3: 3 g /L Yeast extract	58.5	58.7	197.6	198.5	20.7	20.5	8.2	8.2
	A4: 200 ppm Ascorbic acid	57.6	58.0	192.3	194.0	20.0	19.2	7.4	7.7
Mean of N1		57.6	57.5	191.0	193.4	19.5	19.2	7.5	7.6
N2: 45 kg N /fed organic	A1: Untreated plants	55.2	53.2	178.2	176.7	16.3	17.4	6.3	6.2
	A2: 200 ppm Salicylic acid	56.3	54.5	187.4	185.0	19.0	19.0	7.1	7.5
	A3: 3 g /L Yeast extract	57.1	56.8	191.1	192.3	19.8	19.8	7.7	7.7
	A4: 200 ppm Ascorbic acid	55.8	54.7	186.6	184.7	18.6	18.9	7.1	7.4
Mean of N2		56.1	54.8	185.8	184.7	18.4	18.8	7.0	7.2
N3: 30 kg N /fed mineral + 15 kg N /fed organic	A1: Untreated plants	56.9	56.3	183.6	187.8	17.1	17.9	7.2	6.9
	A2: 200 ppm Salicylic acid	58.6	58.2	197.4	197.8	20.6	19.7	7.7	8.0
	A3: 3 g /L Yeast extract	59.4	59.5	201.3	202.0	21.0	21.1	8.4	8.5
	A4: 200 ppm Ascorbic acid	58.2	58.4	196.7	197.3	20.5	19.7	7.7	8.0
Mean of N3		58.3	58.1	194.7	196.2	19.8	19.6	7.8	7.8
N4: 15 kg N /fed mineral + 30 kg N /fed organic	A1: Untreated plants	56.0	55.0	180.0	181.9	16.6	17.5	6.9	6.7
	A2: 200 ppm Salicylic acid	57.0	56.6	191.2	191.2	19.6	19.1	7.2	7.7
	A3: 3 g /L Yeast extract	57.8	58.3	194.5	196.1	20.0	20.4	8.1	8.0
	A4: 200 ppm Ascorbic acid	56.5	56.9	190.3	190.3	19.4	19.0	7.2	7.5
Mean of N4		56.8	56.7	189.0	190.0	18.9	19.0	7.3	7.5
Mean of A	A1: Untreated plants	56.1	55.0	180.7	183.2	16.7	17.6	6.8	6.6
	A2: 200 ppm Salicylic acid	57.4	56.8	192.3	192.2	19.9	19.2	7.4	7.8
	A3: 3 g /L Yeast extract	58.2	58.3	196.1	197.2	20.4	20.5	8.1	8.1
	A4: 200 ppm Ascorbic acid	57.0	57.0	191.6	191.6	19.6	19.2	7.3	7.7
LSD at 5 %	N	0.54	0.76	1.09	2.02	0.37	0.26	0.07	0.11
	A	0.64	0.61	1.72	1.63	0.30	0.49	0.33	0.14
	N × A	NS	NS	1.52	NS	NS	NS	NS	NS

The two forms of N fertilizers had a significant effect on seed yield of sunflower *cv*. Sakha-53 in both seasons (Table 6). Seed yield/fed was greatest (1.78 and 1.78 ton/fed) under treatment N_3, followed by N_1 and N_4 with (1.76 and 1.73 ton) and (1.75 and 1.70 ton) seed yield/fed in the 2017 and 2018 seasons, respectively. The minimum seed yield (1.68 and 1.63 ton /fed) was declined from treatment N_2. The maximum seed yield was (5.95 and 9.20 %) higher over the fertilizing by 45 kg N/fed organic (N_2) in both seasons, respectively. The combination of N mineral fertilizer with organic manure was superior in seed yield than the addition of mineral fertilizer or organic fertilizer alone. The increase in

the seed yield of sunflower was mainly associated with the increase in its components, *i.e.* head diameter and 100-seed weight. Helmy and Ramadan (2009) reveal that seed yield was significantly increased due to the addition of organic and inorganic manures over the control treatments. The Increase in seed yield of sunflower due to integrated nutrients management where led to increasing microbial activity, availability of nutrients to achieve healthy growth and development of the crop. An increase in the seed yield under a combination of El-Nil compost plus chemical fertilizer application may be due to improving the soil properties, that promote better rooting, higher nutrient uptake by the plant and increase in leaf area, height of the plant and consequently, the dry matter production and seed yield. The increase of seed yield in the treatments was proportional due to the maximum leaf area /plant, flowering date, head diameter and 100-seed weight and their increase were attributed to the availability of nutrients in the soil as showed by significant and positive correlated noticed among seed yield and available N statues in the soil. Similar results were obtained by (Mahrous *et al*., 2014; Buriro *et al*., 2015; Ahmad *et al*., 2017; Abd-Elhamied and Fouda, 2018; Irika *et al*., 2018; Lokhande *et al*., 2018 and Patil *et al*., 2018).

In both seasons N sources had a significant effect on seed quality (Table 6). Treating plants with 45 kg N/fed as organic (N_2) produced the highest value of oil %, followed by plants fertilized with 15 kg N/fed mineral+ 30 kg N/fed organic (N_4) and lastly that fertilized with was 30 kg N/fed mineral+ 15 kg N/fed organic (N_3). The increments may be due to the influence of organic fertilizer by improvement physical structure of the soil and nutritional status that must have contributed to the higher yield. In addition to, application of fertilizer treatments could be attributed to the availability of nutrients in the soil during the physiological growth and development stages of the plants as recently reported by (Yasin *et al*., 2013 and Oshundiya *et al*., 2014). In this concern, Keshta *et al*. (2008) showed that the application different sources of fertilizers have a positive effect on oil seed content compared with control treatment.

Regarding the influence of N sources on protein %, data in the same table indicated that addition 45 kg N /fed as mineral (N_1) gave the maximum value of protein % as (19.1 and 19.9 %), respectively in 2017 and 2018 seasons. These increases of protein% may be due to increasing available nitrogen, which led to greater vegetative growth and thus more absorption of nitrogen and more crude protein synthesis. El-Gizawy and Salem (2010) reported that the maximum value of grain protein content in both seasons was obtained by addition of 120 kg N/fed as a mineral form. The maximum oil yield (703.2 and 670.0 kg /fed) was observed from N_1 that was statistically similar to N_4 and N_2 which recorded (700.6 and 657.2 kg/fed) and (684.9 and 650.0 kg/fed) in 1st and 2nd seasons, respectively. Abd-Elhamied and Fouda (2018) support these results.

2. Effect of foliar application treatments (A):

Vegetative growth parameters of sunflower show some significant results by using different some compounds as shown in Table 4. Sunflower plants sprayed with yeast extract gave the highest values of number of leaves/plant, leaf area /plant, stem diameter and total chlorophylls as compared with the control treatment during the two growing seasons. These increases were 13.89, 15.36, 26.92 and 39.39 % for 2017 season and 15.43, 18.05, 26.92 and 34.29 % for 2018 season, respectively. The enhancement of sunflower plant growth in response to foliar application with yeast extract may be due to its contain a considerable quantities of free amino acids, vitamin B, mineral elements (Abou El-Yazied *et al*., 2012) and improvement of some phytohormones, increasing enzyme activity and increase release of CO_2 which lead to improving net photosynthesis and increased growth of plant (Dawood *et al*., 2013 and Mervat Sadak, 2016). Moreover, Amal Ahmed *et al*., (2016) indicate that foliar application with yeast extract on sunflower plant produced the highest significant values of growth parameters compared to control treatment. These results are in a good agreement with those obtained by Neama Marzauk *et al*. (2014) on faba bean, Hassanein *et al*. (2017) on sunflower and Seadh *et al*. (2017) on maize.

Yield components of sunflower show significant results by foliar spraying with some substances (A) during the two growing seasons 2017 and 2018 (Tables 5). Data also show that plants sprayed with yeast extract, salicylic acid or ascorbic acid exerted the highest values of flowering date, plant height, head diameter, and 100-seeds weight in both growing seasons. Yeast treatment A_3 recorded significantly higher values of yield components, followed by A_2 and A_4 compared to control treatment in both growing seasons. Spraying sunflower plants with yeast extract (A_3) increased flowering date, plant height, head diameter and 100-seed weight by (3.74 and 6.00 %), (8.52 and 7.64%), (22.16 and 16.48 %) and (19.12 and 22.73 %) compared with the control treatment (A_1) in the first and second seasons, respectively. Foliar application with yeast extract improved yield components of sunflower plants may be due to the high content auxins, cytokinins, vitamin B_5 and elements yeast composition might be playing a considerable role in orientation and translocation of metabolites from leaves to the productive organs. The trend of these results is supported by Neama Marzauk *et al*. (2014) on faba bean, Abou-Aly *et al*. (2015) on wheat, Amal Ahmed *et al*. (2016) on sunflower, Seadh *et al*. (2017) on maize.

Mean of seed yield of sunflower was significantly affected by foliar spraying of some compounds in both seasons, as shown in Table 6. Maximum seed yield (1.86 and 1.87 ton /fed) resulted from (A_3) in the first and the second seasons, respectively. Treating plants with various substances including A_3, A_2 and A_4 produced about (16.25 and 23.03 %), (9.38 and 14.47 %) and (8.75 and 13.16 %) more seed yield than untreated plants (A_1) in 2017 and 2018 seasons, respectively. Dewedar and Ibrahim (2016) found that foliar application of dry yeast on rice gave the highest values of yield and yield components. The positive effect of yeast extract upon seed yield attributed to the early vigorous growth of sunflower plants (Tables 4 and 5) which increasing seed yield per unit area. Similar results were obtained by Mahmoud *et al*. (2013) on pea, Neama Marzauk *et al*. (2014) on faba bean, Abou-Aly *et al*. (2015) on wheat, Amal Ahmed *et al*. (2016) on sunflower and Seadh *et al*. (2017).

Results presented in Table (6) showed that spraying sunflower plants with some compounds caused significant promotion of seeds quality of sunflower, *i.e.*, , oil yield, oil %and protein% particularly in yeast extract (A_3) treated plants to about (27.72 and 28.94 %), (10.11 and 4.75 %) and (13.79 and 12.29 %) above the control value during the

two growing seasons, respectively. All some compounds especially yeast extract had an essential role in improving plant growth characters and accumulation of more assimilates, which translocated to seeds, consequently increasing in oil and protein contents in sunflower seeds. These results are in a good agreement with this obtained by Amal Ahmed *et al*. (2016) and Hassanein *et al*. (2017).

3. Interaction Effects (N × A):

The available data in Table (4) showed that there were significant influences by the interaction between the nitrogen sources (N) and foliar appication of treatments on No. of leaves /plant and stem diameter during the two growing seasons and leaf area in the 1st season only, except total chlorophyll was not significant in both seasons. Generally, the obtained results clear that the highest values of plant growth attributes expressed as number of leaves/plant, leaf area /plant and stem diameter were recorded with the addition of 30 kg N /fed min.+15 kg N/fed org. (N_3) under foliar spraying with yeast extract at 3 g/L (N_3 × A_3) as compared to other interactions treatment. The second best interaction treatment was 45 kg N/fed mineral (N_1) and foliar spraying with yeast extract (A_3) followed by N_1 × A_2, while the lowest values of mentioned vegetative growth parameters were resulted from N_2 × A_1, in both seasons treatment. This attributed to performed utilization of N fertilizer in metabolism and meristimic activity through general improvement and the ability of yeast extract to increase the production of stimulants for plant growth which improved these charters. These results ara in agreement with this obtained by Hassanein *et al*., (2017) and Rania El Mantawy (2017).

The data illustrated in Table (5) observed that the interaction effect between different forms N fertilizers × foliar spraying of some compounds had extracted a significant impact on plant height in first season only. The highest mean values of plant height (201.30 and 202.00 cm) was recorded from addition 30 kg N/fed mineral+15 kg N/fed organic (N_3) and spray with 3 g /L yeast extract (A_3) in first and second seasons, respectively. While, the lowest mean values of plant height (178.20 and 176.70 cm) was obtained by N_2 × A_1 in 2017 and 2018 seasons, respectively. These may be attributed to the impact of N sources and yeast extract in the metabolic processes and physiological activities of meristematic tissues which are responsible about cell division and elongation. Similar results were also reported by Hassanein *et al*., (2017) and Rania El Mantawy (2017).

From the same (Table 6 and fig. 1) show that seed yield was significantly affected by the different forms N fertilizers × foliar application with yeast extract interaction in first season. Maximum values of seed yield /fed (1.90 and 1.91 ton /fed) were produced from addition N sources (30 kg N /fed mineral+15 kg N/fed organic) and foliar application with yeast extract (N_3 × A_3), followed by (1.87 and 1.89 ton/fed) from plants that received 45 kg N /fed mineral fertilizer and foliar application with yeast extract and N_1 × A_3 during 2017 and 2018 seasons as graphically demonstrated in figure 1. On the other hand, treated plants with 45 kg N/fed org. (N_2)+ spray with A_1 (without spraying) resulted in the lowest values of seed yield/fed in both seasons (N_2 × A_1). It could be concluded that treated sunflower plants by nitrogen sources may become more efficient with foliar application of yeast extract to produce high seed yield. The positive effect of N sources plus yeast extract on seed yield are in harmony with those obtained by Hassanein *et al*., (2017) and Rania El Mantawy (2017).

Table 6. Yield parameters of sunflower as influenced by different forms of N fertilizers, antioxidants foliar spraying and their interaction during 2017 and 2018 growing seasons.

Treatments		Yield							
		Seed yield (ton /fed)		Oil yield (kg /fed)		Oil Percentage		Protein Percentage	
Nitrogen sources (N)	Some compounds (A)	2017	2018	2017	2018	2017	2018	2017	2018
N1: 45 kg N /fed mineral	A1: Untreated plants	1.64	1.54	624.4	586.7	38.1	38.1	17.9	18.3
	A2: 200 ppm Salicylic acid	1.77	1.76	712.8	680.6	40.3	38.7	19.0	20.1
	A3: 3 g /L Yeast extract	1.87	1.89	778.5	744.1	41.6	39.4	20.4	20.9
	A4: 200 ppm Ascorbic acid	1.75	1.74	697.0	668.7	39.8	38.4	19.1	20.2
Mean of N1		1.76	1.73	703.2	670.0	40.0	38.6	19.1	19.9
N2: 45 kg N /fed organic	A1: Untreated plants	1.48	1.44	567.3	555.8	38.3	38.6	17.0	17.2
	A2: 200 ppm Salicylic acid	1.71	1.65	702.3	658.9	41.1	39.9	18.2	19.1
	A3: 3 g /L Yeast extract	1.81	1.81	774.7	736.7	42.8	40.7	19.1	19.0
	A4: 200 ppm Ascorbic acid	1.70	1.63	695.3	648.7	40.9	39.8	18.3	19.2
Mean of N2		1.68	1.63	684.9	650.0	40.8	39.8	18.2	18.6
N3: 30 kg N /fed mineral + 15 kg N /fed organic	A1: Untreated plants	1.66	1.59	607.6	586.7	36.6	36.9	17.4	18.1
	A2: 200 ppm Salicylic acid	1.78	1.80	679.4	687.1	38.2	38.2	18.7	19.8
	A3: 3 g /L Yeast extract	1.90	1.91	737.8	748.2	38.8	39.2	20.2	20.4
	A4: 200 ppm Ascorbic acid	1.77	1.80	673.8	681.7	38.1	37.9	18.8	19.9
Mean of N3		1.78	1.78	674.7	675.9	37.9	38.0	18.8	19.6
N4: 15 kg N /fed mineral + 30 kg N/ fed organic	A1: Untreated plants	1.63	1.50	610.1	567.5	37.4	37.8	17.2	17.8
	A2: 200 ppm Salicylic acid	1.75	1.73	708.2	673.5	40.5	38.9	18.4	19.5
	A3: 3 g /L Yeast extract	1.86	1.85	786.2	732.6	42.3	39.6	19.5	20.2
	A4: 200 ppm Ascorbic acid	1.74	1.71	697.7	658.4	40.1	38.5	18.6	19.3
Mean of N4		1.75	1.70	700.6	657.2	40.1	38.7	18.4	19.2
Mean of A	A1: Untreated plants	1.60	1.52	602.3	574.2	37.6	37.9	17.4	17.9
	A2: 200 ppm Salicylic acid	1.75	1.74	700.7	675.0	40.0	38.9	18.6	19.7
	A3: 3 g /L Yeast extract	1.86	1.87	769.3	740.4	41.4	39.7	19.8	20.1
	A4: 200 ppm Ascorbic acid	1.74	1.72	691.0	664.4	39.7	38.7	18.7	19.7
LSD at 5 %	N	0.04	0.03	18.28	22.98	0.34	0.59	0.43	0.47
	A	0.04	0.03	17.87	11.98	0.62	0.25	0.45	0.46
	N × A	0.05	NS	23.14	NS	0.71	NS	NS	0.21

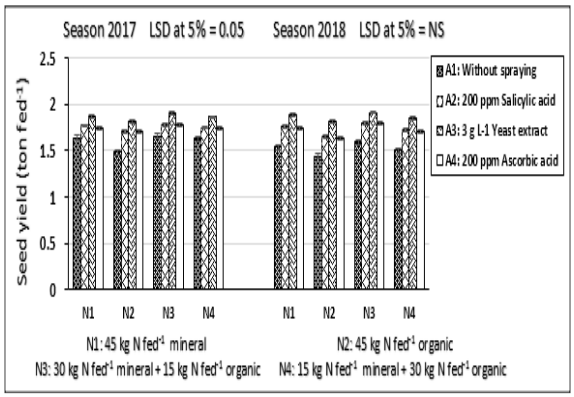


Figure 1. Seed yield affected by the interaction among nitrogen sources and antioxidants foliar application during 2017 and 2018 growing seasons.

Results presented in (Table 6) show that the effect of interaction among fertilizer treatments × foliar application of some substances was significant for oil % and oil yield in 2017 season, but protein % in 2018 season. Treating plants with (30 kg N/fed min.+15 kg N/fed) plus foliar spraying with yeast extract gave the highest value (786.2 kg /fed) for oil yield in the 1st season. In same season the interaction among N_2 with A_3 gave the maximum value (42.80 %) for oil %. Concerning the interaction effect among 45 kg N /fed min. (N_1) besides foliar spraying with yeast extract (A_3) produced the highest value (20.90 %) for protein % in 2018 season. The increases of seeds quality of sunflower by N×A might be attributed to increase of vegetative growth and yield which in turn reflected positively on seeds quality (Hassanein *et al*. 2017).

4- Economics of sunflower cultivation:

Economics is essential to judge the experimental treatments in this study, it might thus feasible to evaluate for economic regard for adaptation suitable agronomic practices of any viable finding for the farmers level. The estimated total costs, net return and economic efficiency for the production of sunflower *cv*. Sakha-53 in the average of the two seasons are depicted in Table 7. The total estimated cost of production /fed of sunflower was ranged from 4496 to 4983 L.E /fed Table 7. The highest value of net income for the interaction treatments was recorded with the treatment $N_3 \times A_3$ (9101.15 L.E/fed) as compared to other treatments, this attributed to higher seed yield. $N_3 \times A_3$ gave the highest value of the net return (4409.15 L.E/fed) which was found par with the interaction of $N_1 \times A_3$ (4355.55 L.E/fed), $N_4 \times A_3$ (4025.90 L.E/fed) and $N_1 \times A_2$ (3918.05 L.E/fed). Data in respect of the economic efficiency % of sunflower as affected by different N fertilizers and some compounds application are furnished in Table 7. The higher economic efficiency (96%) was obtained from the interaction treatment $N_1 \times A_3$ followed by $N_3 \times A_3$, $N_1 \times A_2$ and $N_1 \times A_4$. This increase due to the highest productivity under N+A which increased net income.

Table 7. Economic feasibility of sunflower as influenced by nitrogen sources and antioxidants foliar spraying in average two seasons.

Treatments (combined N × A)		Seed yield (ton/fed)	Net income (L.E/fed)	Total cost (L.E/fed)	Net return (L.E/fed)	Economic Efficiency %
N1	A1: Untreated plants	1.59	7576.35	4496	3080.35	69
	A2: 200 ppm Salicylic acid	1.77	8434.05	4516	3918.05	87
	A3: 3 g /L Yeast extract	1.87	8901.55	4546	4355.55	96
	A4: 200 ppm Ascorbic acid	1.75	8338.75	4516	3822.75	85
Mean of N_1		1.750	8312.68	4518.50	3794.18	84
N2	A1: Untreated plants	1.46	6956.90	4933	2023.90	41
	A2: 200 ppm Salicylic acid	1.68	8005.20	4953	3052.20	62
	A3: 3 g /L Yeast extract	1.81	8624.65	4983	3641.65	73
	A4: 200 ppm Ascorbic acid	1.67	7957.55	4953	3004.55	61
Mean of N_2		1.660	7909.90	4955.50	2954.40	60
N3	A1: Untreated plants	1.63	7766.95	4642	3124.95	67
	A2: 200 ppm Salicylic acid	1.79	8529.35	4662	3867.35	83
	A3: 3 g /L Yeast extract	1.91	9101.15	4692	4409.15	94
	A4: 200 ppm Ascorbic acid	1.79	8529.35	4662	3867.35	83
Mean of N_3		1.780	8481.70	4664.50	3817.20	82
N4	A1: Untreated plants	1.57	7481.05	4787	2694.05	56
	A2: 200 ppm Salicylic acid	1.74	8291.10	4807	3484.10	72
	A3: 3 g /L Yeast extract	1.86	8862.90	4837	4025.90	83
	A4: 200 ppm Ascorbic acid	1.73	8243.45	4807	3436.45	71
Mean of N_4		1.725	8219.63	4809.50	3410.13	71
Mean of some materials	A1: Untreated plants	1.56	7433.40	4714.50	2718.90	58
	A2: 200 ppm Salicylic acid	1.75	8338.75	4734.50	3604.25	76
	A3: 3 g/ L Yeast extract	1.86	8862.90	4764.50	4098.40	86
	A4: 200 ppm Ascorbic acid	1.74	8291.10	4734.50	3556.60	75

Price of chemical and organic N fertilizers were 220 L.E for 50 kg N from ammonium nitrate and 365 L.E ton^{-1} for El Nil compost, 2016. Total cost was 3836 L.E without fertilization (Bulletin of Statistical Cost Production and Net return, 2016).

CONCLUSION

It can be concluded from this work that fertilizing sunflower *cv*. Sakha-53 with 30 kg N /fed (mineral)+15 kg N /fed (organic) and foliar spraying with yeast extract at 3 g/L improve growth and increase seed yield and net return per unit area under sandy soil conditions of Toshka region, Aswan Governorate, Egypt.

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تحسين إنتاجية عباد الشمس بمصاد التسميد النيتروجين والرش الورقى ببعض مضادات الأكسدة تحت ظروف الأراضى الرملية بمنطقة توشكا

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أجريت تجربة حقلية خلال موسمى 2017 ، 2018 م فى محطة البحوث الزراعية لجنوب الوادى بمنطقة توشكا التابعة لمركز البحوث الزراعية لدراسة تأثير إستخدام 4 معاملات للتسميد النيتروجينى العضوى والمعدنى وهى (45 كجم للفدان نيتروجين معدنى ، 45 كجم للفدان نيتروجين عضوى ، 30 كجم نيتروجين معدنى+15 كجم نيتروجين عضوى ، 15 كجم نيتروجين معدنى+ 30 كجم نيتروجين عضوى) والرش الورقى بأربع مضادات أكسدة وهى (بدون رش ، 200 جزء فى المليون حمض السالسليك ، 3 جرام لكل لتر مستخلص الخميرة ، 200 جزء فى المليون حمض الأسكوربيك) بعد 35 ، 45 يوم من الزراعة على صفات النمو والمحصول وجودته ودراسة الجدوى الإقتصادية لمحصول عباد الشمس صنف سخا 53. ويمكن تلخيص أهم النتائج فيما يلى : 1- أظهرت النتائج أن تطبيق مصادر النيتروجين ومعاملات الرش الورقى كان لهم تأثير معنوى على عدد الأوراق ، ومساحة الورقة لكل نبات ، وقطر الساق ، والكلوروفيل الكلى ، وعدد الأيام من الزراعة للإزهار(ميعاد الإزهار) ، وإرتفاع النبات ، وقطر القرص ، ووزن 100 بذرة ، ومحصول البذور والزيت وكذلك والنسبة المئوية للبروتين والزيت فى الموسمين. أدى إضافة السماد المعدنى بمعدل 30 كجم +15كجم عضوى لكل فدان (معاملة 3) إلى زيادة فى محصول البذور بمعدل (5،95 و 9،20 %) بالمقارنة بمعاملة التسميد العضوى (معاملة 2) فى الموسمين الأول والثانى على التوالى. 2- أوضحت النتائج أن نباتات عباد الشمس التى تم رشها بخلاصة الخميرة أعلى قيم لمحصولى البذور والزيت خلال موسمى الزراعة بالمقارنة بمعاملات حمض السالسيليك والأسكوربيك.3- لقد كان للتفاعل بين مصادر النيتروجين ومضادات الأكسدة تأثيراً معنوياً بمحصول الحبوب ومكوناتة. سجلت أعلى قيمة لمحصول البذور عند التسميد بـ 30 كجم نيتروجين معدنى+ 15كجم عضوى للفدان مع الرش الورقى بمستخلص الخميرة (1،90 و 1،91 طن لكل فدان) بالموسمين الأول والثانى على التوالى وصافى العائد بمقدار 4409،15 جنية للفدان لمتوسط الموسمين، بينما سجلت أعلى كفاءة إقتصادية عند التسميد بـ 45 كجم لكل فدان نيتروجين معدنى مع الرش الورقى بالخميرة. من أجل تعظيم إنتاجية البذور وجودتها لوحدة المساحة وكذلك الحصول على أعلى عائد إقتصادى يسمد عباد الشمس بمعدل 30 كجم نيتروجين معدنى+15 كجم نيتروجين عضوى أو 45 كجم نيتروجين معدنى مع الرش الورقى بمستخلص الخميرة تحت ظروف منطقة توشكى ـ محافظة أسوان.