Assiut J. Agric. Sci., 50 (3) 2019 (16-26) *ISSN: 1110-0486*
Website: www.aun.edu.eg/faculty_agriculture/journals_issues_form.php *E-mail: ajas@aun.edu.eg*

Response of Two Sunflower Cultivars to Foliar Spray by Different Zinc Oxide Nanoparticles Concentrations

Abou-Bakr, Asmaa S.; E.M.M. Shalaby; A.M. Mahmoud; E.A. Ali and A. M. Hassan

[1]Agronomy Dep., Agric. Fac., Assiut Univ., Egypt.
[2]Food Science and Technology Dep., Agric. Fac., Assiut Univ., Egypt.

Received on: 11/6/2019 **Accepted for publication on:** 18/6/2019

Abstract

A field experiment was conducted at the Agronomy Department Farm, Faculty of Agriculture, Assiut University during 2017 and 2018 seasons to study the response of two sunflower cultivars to foliar spray by different zinc oxide nanoparticles concentrations. The field experiment was carried out in a randomized complete block design (RCBD) using a strip plot arrangement with three replications. Zinc oxide nanoparticles (ZnO NPs) concentrations (control, 100, 200, 300, 400 and 500 ppm) were allotted horizontally, while two sunflower cultivars (Sakha-53 and Giza-102) were assigned vertically. The obtained results showed that number of seeds head^{-1}, seed index and seed weight head^{-1} (g), Seed yield (kg fed.$^{-1}$), oil percentage (%) and oil yield (kg fed.$^{-1}$) were affected significantly by different zinc oxide nanoparticles concentrations in both seasons, except number of seeds head^{-1} in the second season. Sunflower plants which were sprayed by 200 ppm ZnO NPs gave the highest mean values of seed yield fed.$^{-1}$ (1751.99 and 1515.18 kg/fed) and oil yield fed.$^{-1}$ (676.79 and 600.81 kg/fed) in the first and second seasons, respectively. Furthermore, Giza102 sunflower cultivar gave the highest means for mention traits in the two growing seasons. Also, the interaction between ZnO NPs concentrations and sunflower cultivars had a significant ($P \leq 0.01$) effect on the all studied traits in both seasons. Giza 102 plants which were sprayed by 200 ppm ZnO NPs concentration gave the highest mean values of oil yield (723.61and 701.37 kg/fed in the first and second seasons, respectively).

Keywords: *Sunflower, Cultivars, Zinc Oxide Nanoparticles, Seed and Oil yields.*

Introduction

Sunflower *(Helianthus annuus* L.) is one of the most widely cultivated oil crops in the world. In the recent years, the planted area has increased because its high oil yields. Sunflowers do not require as much applied fertilizer as cereals. Sunflowers have an extensive root system which may help in utilizing residual soil nutrients (Al-Doori, 2013).

In Egypt, sunflower production was about 19998 metric tonne (M.T.) which was produced from 14826.33 Feddan with an average yield of 82367.68 kg/ha (FAO. 2017).

Zinc (Zn) is typically the second most abundant transition metal in organisms after iron and the only metal represented in all six enzyme classes {oxide reductases, transferases, hydrolases, lyases, isomerases and ligases} (Auld, 2001). Zinc has been considered as an essential micronutrient for metabolic activities in plants. It regulates the various enzyme ac-

tivities and required in biochemical reactions leading to formations of chlorophyll and carbohydrates. Zinc ions are also part of the transcription factor family, known as 'zinc fingers' that control the proliferation and differentiation of cells (Palmer and Guerinot, 2009). The crop yield and quality of produce can be affected by the deficiency of Zn.

Zinc Nano-particle is used in various agricultural experiments to understand its effect on germination, growth and various other properties (Auld, 2001; Baybordi, 2006; Jamali and Sammut, 2011).

ZnO in the Nano scale form is absorbed by plants to a larger extent unlike bulk ZnSO4. These particles proved effective in enhancing plant growth, development and yield. A lower dose of foliar application is proved to be significantly productive (Prasad and Ulrich, 2012).

Nano-particles with smaller particle size and large surface area are expected to be the ideal material for use as Zn fertilizer for plants. Application of micronutrient in the form of nano-particles (NPs) is an important route to release required nutrients gradually and in a controlled way, which is essential to mitigate the problems of soil pollution caused by the excess use of chemical fertilizers. A number of researchers have reported the essentiality and role of zinc for plant growth and yield (Fageria, 2002; Laware and Raskar, 2014). ZnO nanoparticles can also potentially mitigate the effects of other types of abiotic stress on plants. (Torabian and Khoshgoftar, 2016). Praksh and Halaswamy (2004) and Al-Doori (2013) revealed that the addition of zinc sprayed on the sunflower plants leaves led to a significant increase in characteristics number of seeds head^{-1}, weight of thousand seed, seed yield, seed oil content and seed oil yield in the two growing seasons.

Many investigators found a significant effect of ZnO NPs on sunflower indicated that sunflower cultivars exhibited significant differences in all studied traits. Plants of Sakha-53 were superior significantly than Giza-102 in all studied traits number of seeds/head, seed index, seed yield/plant, oil percentage as well as seed and oil yields/Feddan. **(**El-Aref *et al.,* 2011; Al-Doori and Al-Dulaimy, 2012; Al-Doori, 2013; Abd El-Satar *et al.,* 2017. Also, Nasim *et al.*, 2017).

The objective of this study was to study the response of two sunflower cultivars to foliar spray by different zinc oxide nanoparticles concentrations.

Materials and Methods

This work was carried out during 2017 and 2018 seasons at the Agronomy Department Experimental Farm, Agriculture Faculty, Assiut University to study the effect of foliar spray by different zinc oxide nanoparticles concentrations on seed yield and its components as well as oil yield of two sunflower cultivars (Giza102 and Sakha53). The mechanical and chemical analyses of the experimental soil are presented in Table 1.

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

Properties	2017	2018
Mechanical analysis (%)		
Sand	27.00	27.80
Silt	23.00	22.20
Clay	50.00	50.00
Soil type	Clay	Clay
Chemical analysis:		
pH	7.63	7.85
Organic matter %	1.80	1.70
Total N%	0.09	0.08

Experimental treatments and design:

The experiment was laid out in randomize complete blocks design (RCBD) using strip plot arrangement with three replications. Six zinc dioxide nanoparticles concentrations (control, 100, 200, 300. 400 and 500 ppm) were allocated horizontally, while, the two sunflower cultivars were arranged vertically. Each sub plot area was 10.5 m^2 (3.5 long 3.0 m width).

Cultural practices

Sunflower seeds were hand sown on rows 60 cm distance in hills 25cm apart on 25 and 26 May in the first and second seasons, respectively. Control plants were treated with water (without ZnO NPs) while the others were sprayed by the certain concentration of ZnO NPs. All sprayed treatments were done at 45 days after sowing. The preceding winter crop was wheat in both seasons. All other recommended cultural practices for sunflower crop were done in both seasons.

Measured traits:

1- Yield components traits: At harvest ten guarded plants from each experimental unit were taken randomly then number of seeds $plant^{-1}$, 100 seed weight and seed weight $plant^{-1}$ were measured.

2- Seed yield (kg $fed.^{-1}$): Heads of two bagged inner ridges of each plot were harvested and left two weeks until fully air dried and seeds were manually separated then weighted and transferred into kg $fed.^{-1}$.

3- Oil percentage (%): Oil percentage in sunflower seeds was estimated by extraction using Soxhlet apparatus and petroleum ether (Bp40-60°C) as solvent according to A.O.A.C. (1995).

4- Oil yield (kg $fed.^{-1}$).

Oil yield = Seed yield $fed.^{-1}$ × oil percentage.

Statistical analysis:

All collected data were analyzed with analysis of variance (ANOVA) Procedures, using the SAS Statistical Software Package v.9.2 (SAS, 2008). Differences between means were compared by revised least significant difference (RLSD) at 5% level of significant (Gomez and Gomez, 1984).

Results and Discussion

Yield components traits:

The presented data in Tables 2, 3 and 4 reveal that the studied zinc oxide nanoparticles (ZnO NPs) concentrations had a significant ($P \leq 0.01$) effect on seed index and seed weight $head^{-1}$ in the two growing seasons,

while number of seeds head^{-1} was significantly different during first season only. Thus, the highest mean values of seeds number head^{-1} (1032.11 and 931.26), seed index (6.34 and 7.21g) and seed weight head^{-1}(63.12 and 57.71 g) were obtained from sunflower plants which were sprayed by ZnO NPs concentration at 200 ppm for number of seeds/ head and seed weight head^{-1} and 400 ppm for seed index trait. This may be due to that zinc oxide nanoparticles increase the zinc absorption via sunflower plants and consequently increased photosynthesis process which led to an increment in metabolic translocation from sources to seeds. These findings are in a good line with those obtained by Praksh and Halaswamy (2004), Gitte *et al. (*2005), Babaeian *et al.* (2011) and Al-Doori (2013).

In addition, the illustrated data in the same Tables results show that the tested sunflower cultivars varied significantly ($P \leq 0.01$) in number of seeds head^{-1} trait in the both seasons, while seed index and seed weight head^{-1} were significantly different during second season only. Giza 102 sunflower cultivar superior Sakha 53 in this respect and registered the highest mean values of these traits (977.40, 5.85 g and 56.15 g for number of seeds head^{-1}, seed index and seed weight head^{-1} in the first season, respectively being 998.12, 6.49 g and 58.48 g in the second season in the same order). This is may be due to the genetic behavior in combination with the environmental conditions which was suitable for Giza 102 cultivar than Sakha 53. These results are in agreement with those stated by El-Aref *et al*. (2011), Al-Doori and Al-Dulaimy (2012), Al-Doori (2013) and Nasim *et al.* (2017).

In case of interaction effects in this respect, the presented data in Tables 2, 3 and 4 show that the interaction between ZnO NPs concentrations and sunflower cultivars had a significant effect on number of seeds head^{-1}, seed index and seed weight head^{-1} in the two growing seasons. Thus, the highest mean value of seeds number head^{-1} (1090.44) was noted from Giza 102 cultivar which was sprayed by ZnO NPs at 200 ppm in the first season, while in the second season the highest mean value of this trait (10194.99) was recorded from Giza 102 cultivar which was sprayed by ZnO NPs at 300 ppm. Meanwhile, the highest mean value of seed index in the first season (6.56 g) was obtained from Giza 102 cultivar which was sprayed by ZnO NPs at 500 ppm, but the highest mean value in the second season (7.38 g) was registered from Giza 102 cultivar which was sprayed by ZnO NPs at 300 ppm. Also, the highest mean values of seed weight head^{-1} (63.77 and 65.99 g in the first and second seasons, respectively) were obtained from Giza 102 cultivar which was sprayed by ZnO NPs at 200 ppm. Similar trend was observed by Al-Doori (2013).

Table 2. Effect of zinc oxide nanoparticles concentrations, sunflower cultivars and their interaction on number of seeds head^{-1}.

Season	2017			2018		
Zinc oxide nanoparticles (ppm)	Cultivars		Mean	Cultivars		Mean
	Giza 102	Sakha 53		Giza 102	Sakha 53	
Control	844.25	830.34	**837.30**	965.63	756.66	**861.15**
100	1073.71	741.59	**907.65**	1006.15	790.43	**898.29**
200	1090.44	973.77	**1032.11**	1124.70	737.81	**931.26**
300	997.23	795.80	**896.52**	1194.99	649.11	**922.05**
400	871.77	706.59	**789.18**	969.56	661.60	**815.58**
500	986.97	930.93	**958.95**	727.66	709.31	**718.49**
Mean	**977.40**	**829.84**	**----**	**998.12**	**717.49**	**----**
F test and R. LSD 0.05	F test	R. LSD 0.05		F test	R. LSD 0.05	
ZnO NPs	**	67.07		N s	156.60	
Cultivars	*	----		**	----	
Interaction	**	82.59		*	180.00	

*and ** mean significant 5 and 1% at level of probability, respectively
Ns mean non- significant.

Table 3. Effect of zinc oxide nanoparticles concentrations, sunflower cultivars and their interaction on seed Index of sunflower.

Seasons	2017			2018		
Zinc oxide nanoparticles (ppm)	Cultivars		Mean	Cultivars		Mean
	Giza 102	Sakha 53		Giza 102	Sakha 53	
Control	5.65	5.95	**5.80**	5.15	6.17	**5.66**
100	5.39	5.39	**5.39**	5.54	5.44	**5.49**
200	5.85	5.66	**5.75**	6.44	6.32	**6.38**
300	5.43	5.46	**5.45**	7.38	5.07	**6.22**
400	6.20	6.49	**6.34**	7.24	7.18	**7.21**
500	6.56	4.72	**5.64**	7.21	6.13	**6.67**
Mean	**5.85**	**5.61**	**----**	**6.49**	**6.05**	**----**
F test and R. LSD 0.05	F test	R. LSD 0.05		F test	R. LSD 0.05	
ZnO NPs	*	0.62		**	0.47	
Cultivars	Ns	----		**	----	
Interaction	**	0.63		**	0.43	

*and ** mean significant 5 and 1% at level of probability, respectively
Ns mean non- significant.

Table 4. Effect of zinc oxide nanoparticles concentrations, sunflower cultivars and their interaction on weight of seeds head -1 (g).

Season	2017			2018		
Zinc oxide nanoparticles (ppm)	Cultivars		Mean	Cultivars		Mean
	Giza 102	Sakha- 53		Giza 102	Sakha- 53	
Control	52.55	42.24	**47.40**	49.31	46.66	**47.99**
100	57.17	55.61	**56.39**	55.82	47.07	**51.45**
200	63.77	62.47	**63.12**	65.99	49.43	**57.71**
300	49.27	57.38	**53.33**	62.43	52.51	**57.47**
400	56.44	59.85	**58.15**	61.20	47.90	**54.55**
500	57.72	51.07	**54.40**	56.11	42.86	**49.49**
Mean	**56.15**	**54.77**	**----**	**58.48**	**47.74**	**----**

F test and R. LSD 0.05	F test	R. LSD 0.05	F test	R. LSD 0.05
ZnO NPs	**	4.48	**	6.39
Cultivars	N s	----	*	----
Interaction	*	6.80	*	7.80

* and ** mean significant 5 and 1% at level of probability, respectively

2- Seed yield (kg/ fad.)

Seed yield (kg/fed) trait reacted significantly (P≤0.01) to the tested zinc oxide nanoparticles concentrations (ZnO NPs) in the two growing seasons (Table 5). Thus, the highest mean values of seed yield head^{-1} (1751.99 and 1515.18 kg/fed. during the first and second seasons, respectively) were obtained from 200 ppm of ZnO NPs concentration. This is to be expected since the same trend was observed with regard to seed weight head^{-1} (Table 4). The previous results are in accordance with those obtained by Trehan and Sharma (2000), Sankaran *et al.* (2001), Praksh and Halaswamy (2004), Gitte *et al. (*2005), Babaeian *et al.* (2011), Al-Doori (2013), Seghatoleslami and Forutani (2015), Parmar (2016) and Ghasemi *et al.* (2017).

Also, the recorded data in Table 5 denote that the tested sunflower cultivars had a significant influence on seed yield trait in the second season only while, sunflower cultivars failed to reach a significant level at 5% level of probability in the first season. Whatever, Giza 102 sunflower cultivar superior Sakha53 in this respect and gave the highest mean values of seed yield head^{-1} (1441.62 and 1483.55 kg/fed in the two respective seasons). This is to be expected since the same trend was observed with regard to seed weight head (Table 4). These results are in agreement with those mentioned by El-Aref *et al.* (2011), Al-Doori and Hasan, (2012), Al-Doori (2013), Abd El-Satar *et al*. (2017) and Nasim *et al.* (2017).

Concerning the interaction effect on seed yield trait, the exhibited data in Table 5 reveal that the interaction between ZnO NPs concentrations and sunflower cultivars had a significant effect in this respect during the two successive seasons. The highest mean values of seed yield head^{-1} (1767.62 and 1665.04 kg/fed during in the first and second seasons, respectively) were obtained from Giza 102 cultivar which was sprayed by ZnO NPs at 200 ppm. Similar trend was observed by Al-Doori (2013).

Table 5. Effect of zinc oxide nanoparticles concentrations, sunflower cultivars and their interaction on seed yield (kg/fed.).

Season	2017			2018		
Zinc oxide nanoparticles (ppm)	Cultivars		Mean	Cultivars		Mean
	Giza 102	Sakha- 53		Giza 102	Sakha-53	
Control	1274.28	1182.77	**1228.53**	1380.77	1139.72	**1260.25**
100	1348.82	1248.38	**1298.60**	1407.81	1308.57	**1358.19**
200	1767.62	1736.35	**1751.99**	1665.04	1365.31	**1515.18**
300	1379.79	1295.96	**1337.88**	1471.37	1243.76	**1357.57**
400	1262.3	1289.93	**1276.12**	1507.68	1194.67	**1351.18**
500	1616.91	1099.98	**1358.45**	1468.6	1277.92	**1373.26**
Mean	**1441.62**	**1308.895**	--	**1483.55**	**1254.99**	--
F test and R. LSD 0.05	F test	R. LSD 0.05		F test	R. LSD 0.05	
ZnO NPs	**	126.65		*	126.83	
Cultivars	Ns	----		*	----	
Interaction	*	190.32		*	88.80	

*and ** mean significant 5 and 1% at level of probability, respectively
Ns mean non-significant.

3-Oil percentage of seeds (%):

Illustrated data in Table 6 state that the studied zinc oxide nanoparticles (ZnO NPs) concentrations had a significant and highly significant ($P \leq 0.01$) effect on oil percentage in the 1st and 2nd seasons, respectively). Thus, the highest mean values of oil percentage (41.67 and 42.09 % in the first and second seasons, respectively) were obtained from 300 ppm ZnO NPs concentration. This is may be ascribed to the superiority of its capability in transformation of sugar to fat in seed tissue. These results are in agreement with those obtained by Sankaran *et al.* (2001) and Gitte *et al.* (2005).

Also, the recorded data in Table 6 denote that the tested sunflower cultivars had a significant and highly significant influence on oil percentage in the 1st and 2nd seasons, respectively. Whatever Giza 102 sunflower cultivar superior Sakha 53 in this respect and gave the highest mean values of oil percentage (41.71 and 41.16% in the first and second seasons, respectively). This is may be ascribed to the superiority of its capability in transformation of sugar to fat in seed tissue than the other cultivars. Similar trend was obtained by Zheljazkov *et al.* (2009).

Here too, the exhibited data in Table 6 denote that the interaction between ZnO NPs concentrations and sunflower cultivars had a highly significant effect on oil percentage in both seasons. The highest mean values of oil percentage in the first season (45.40%) was obtained from Giza 102 cultivar which was sprayed by ZnO NPs at 100 ppm, while the highest mean value in the second season (42.51%) was registered from Giza 102 cultivar which was sprayed by ZnO NPs at 300 ppm. The previous results are in accordance with those obtained by Al-Doori (2013).

Table 6. Effect of zinc oxide nanoparticles, sunflower cultivars and their interaction on oil Percentage (%).

Season	2017			2018		
Zinc oxide nanoparticles(ppm)	Cultivars		Mean	Cultivars		Mean
	Giza 102	Sakha- 53		Giza 102	Sakha- 53	
Control	38.50	38.05	**38.28**	37.21	36.88	**37.05**
100	45.40	34.81	**40.11**	41.09	39.38	**40.24**
200	40.92	36.27	**38.60**	42.12	36.63	**39.38**
300	41.88	41.46	**41.67**	42.51	41.66	**42.09**
400	42.08	31.78	**36.93**	42.49	40.95	**41.72**
500	41.46	33.78	**37.62**	41.53	37.68	**37.05**
Mean	**41.71**	**36.03**	-----	**41.16**	**38.86**	-----

F test and R. LSD 0.05	F test	R. LSD 0.05	F test	R. LSD 0.05
Zno NPS	*	2.37	**	0.49
Cultivars	*	----	**	----
Interaction	**	2.98	**	0.85

*and ** mean significant 5 and 1% at level of probability, respectively.

4- Oil yield (kg/ fed.):

It is clear from the data in Table 7 that had a highly significant ($P \leq 0.01$) effect on oil yield. The heaviest mean of values of oil yield (676.79 and 600.81 kg/fed during the first and second seasons, respectively) were obtained from 200 ppm ZnO NPs concentration. This is to be logic since the same trend was observed with regard to seed yield and oil percentage traits as mentioned before (Tables 5 and 6). These findings are in harmony with those obtained by Praksh and Halaswamy (2004) and Gitte *et al. (*2005).

Data in the same Table exhibited that the studied sunflower cultivars had a highly significant influence on oil yield trait. Giza 102 sunflower cultivar superior Sakha 53 in this respect and gave the highest mean values of oil yield (600.66 and 611.62 kg/fed in the two respective seasons). This is to be expected since the same trend was observed with regard to seed yield trait as mentioned before (Table 5). These results are in agreement with those reported by Al-Doori and Al-Dulaimy (2012).

Also, the obtained data in Table 7 reveal that the interaction between ZnO NPs concentrations and sunflower cultivars had a highly significant effect on oil yield. The highest mean values of oil yield (723.61 and 701.37 kg/fed during the two respective seasons) were obtained from Giza 102 cultivar which was sprayed by ZnO NPs at 200 ppm.

Table 7. Effect of zinc oxide nanoparticles, sunflower cultivars and their interaction on oil yield (kg/fad.)

Season	2017			2018		
Zinc oxide nanoparticles (ppm)	Cultivars		Mean	Cultivars		Mean
	Giza 102	Sakha 53		Giza 102	Sakha- 53	
Control	489.75	450.02	**469.89**	513.78	420.22	**467.00**
100	612.29	432.01	**522.15**	578.52	515.44	**546.98**
200	723.61	629.97	**676.79**	701.37	500.25	**600.81**
300	577.26	537.75	**557.51**	625.52	518.02	**571.77**
400	531.09	407.84	**469.47**	640.37	489.19	**564.78**
500	669.98	373.06	**521.52**	610.18	481.77	**545.97**
Mean	**600.66**	**471.78**	**----**	**611.62**	**487.48**	**----**
F test and R. LSD 0.05	F test	R. LSD 0.05		F test	R. LSD 0.05	
Zno NPS	**	**74.96**		**	**52.65**	
Cultivars	*	**----**		**	**----**	
Interaction	**	**57.11**		**	**33.90**	

*and ** mean significant 5 and 1% at level of probability, respectively

References

Abd EL-Satar, M.A.; A.A.-E.-H Ahmed and T.H.A. Hassan (2017). Response of seed yield and fatty acid compositions for some sunflower genotypes to plant spacing and nitrogen fertilization. Information Processing in Agric., 4(3):241-252.

Al-Doori, S. A. M. and M. Y. H., Al-Dulaimy (2012). Influence of Zinc Fertilization levels on Growth, Yield and Quality of Some Sunflower Genotypes (*Helianthus annuus L., Compositae*). J. Res., 11(4):714-730.

Al-Doori, S. A. M. and M. Y. Hasan (2012). Effect of Leaves Defoliation and Plant Density on Growth, Yield and Quality of Some Sunflower Genotypes (*Helianthus annuus L.*). J. Res., 11(3): 724-751.

Al-Doori, S.A.M. (2013). Effect of Different Levels and Timing of Zinc Foliar Application on Growth, Yield and Quality of Sunflower Genotypes (*Helianthus annuus* L., *Compositae*). College of Basic Edu. Res. J., 13 (1):907-922.

A.O.A.C. (1995). Association of official Agriculture Chemists" Official Methods of Analysis.

Auld, D. S. (2001). Zinc coordination sphere in biochemical zinc sites. In Zinc Biochemistry, Physiology, and Homeostasis (pp. 85-127). Springer, Dordrecht.

Babaeian, M.; I. Piri; A. Tavassoli; Y. Esmaeilian and H. Gholami (2011). Effect of water stress and micronutrients (Fe, Zn and Mn) on chlorophyll fluorescence, leaf chlorophyll content and sunflower nutrient uptake in Sistan region. Afr. J. Agric. Res., 6(15): 3526-3531.

Baybordi, A. (2006). Effect of Fe, Mn, Zn and Cu on the quality and quantity of wheat under salinity stress. J. Water and Soil Sci, 17, 140-150.

El-Aref, Kh. A. O. A. S. A. Abo-El-Hamd and A.M.A. Abd El-Monem (2011). Influence of filter mud cake fertilization under low levels of nitrogen on yield and its components for two sunflower cultivars. J. Plant Production, Mansoura Univ., 2 (2): 165-178.

Fageria, N. K. (2002). Influence of micronutrients on dry matter yield and interaction with other nutrients in annual crops. Pesquisa Agropecuária Brasileira, 37(12):1765-1772.

FAO (2017). Http://www.fao.org/faostat/en.

Ghasemi, M; G. N. Mohammadi; H. Madani; H.R. Mobasser and M. Nouri (2017). Effect of foliar application of zinc nano oxide on agronomic traits of two varieties of rice (*Oryza sativa* L.). Crop Res. 52 (6): 195-201.

Gitte, A. N; S.R. Patil and M.A. Tike (2005). Influence of zinc and boron biochemical and yield characteristics of sunflower. J. of plant Physiology. 10(4): 431-438.

Gomez, K.A. and A. A. Gomez (1984). Statistical Procedures for Agricultural Research. 2nd Edn., John Wily and Sons, New York, pp: 68.

Jamali., and C. Sammut, (2011). Majority voting: Material classification by *tactile sensing using surface texture.* IEEE Transactions on Robotics, 27(3): 508-52.

Laware, S. L. and S. Raskar (2014). Effect of titanium dioxide nanoparticles on hydrolytic and antioxidant enzymes during seed germination in onion. Int. J. Curr. Microbiol. App. Sci, 3(7), 749-760.

Nasim, W; A. Ashfaq; S. Ahmad; M. Nadeem; N. Masood and M. Shahid (2017). Response of sunflower hybrids to nitrogen application grown under different agro-environments. J. Plant Nutr., 40 (1):82-92.

Palmer, C. M., and M. L. Guerinot (2009). Facing the challenges of Cu, Fe and Zn homeostasis in plants. Nature chemical biology, 5(5), 333.

Praksh, B. G. and K. M. Halaswamy (2004). Effect of seed hardening through chemical treatments in indication of drought tolerance in sunflower (*Helianthus annuus* L.). Madras J. of Agric., 91(4-6): 330-332.

Prasad, P. N., and D. R. Ulrich (Eds.). (2012). Nonlinear optical and electro active polymers. Springer Science & Business Media.

Sankaran, M. S.; S. Mani and S. Savtthri (2001). Effect of teprosyn and zinc on yield and quality parameters of sunflower (*Helianthus annuus* L.), Madras J. of Agric, 88 (10-12): 717-718.

SAS institute (2008). The SAS System for Windows, release 9.2. Cary NC: SAS Institute.

Seghatoleslami, M. and R. Forutani (2015). Yield and Water Use Efficiency of Sunflower a Affected by nano ZnO and Water Stress. J. Adv. Agric. Tech., 2 (1): 34-3 Springer Science & Business Media.

Torabian, S., M. Z. and A. H. Khoshgoftar (2016). Effects of foliar spray of two kinds of zinc oxide on the growth and ion concentration of sunflower cultivars under salt stress. J. Plant Nutr., 39 (2): 172-180.

Trehan, S. P and R. C. Sharma (2000). Phosphorus and zinc uptake efficiency of potato in comparison to wheat, maize and sunflower. Indian J. Agric. 70: 840-845.

Zheljazkov, V.D; B.A. Vick; B.S. Baldwin; N. Buehring; T. Astatkie and B. Johnson (2009). Oil content and saturated fatty acids in sunflower as a function of planting date, nitrogen rate, and hybrid. Agronomy journal, 101(4): 1003-1011.

Assiut J. Agric. Sci., 50 (3) 2019 (16-26) *ISSN: 1110-0486*
Website: www.aun.edu.eg/faculty_agriculture/journals_issues_form.php ***E-mail: ajas@aun.edu.eg***

استجابة صنفين من عباد الشمس للرش الورقي بتركيزات مختلفة من اكسيد الزنك النانومتري

اسماء سيد ابوبكر، السيد محمود محمد شلبي ، عادل محمد محمود، السعدي عبد الحميد علي

و منال عبد الحميد محمود حسن

[1] قسم المحاصيل – كلية الزراعة – جامعة اسيوط
[2]قسم علوم وتكنولوجيا الاغذية – كلية الزراعة – جامعة اسيوط

الملخص

اجريت تجربة حقلية بمزرعة قسم المحاصيل، كلية الزراعة، جامعة أسيوط خلال موسمي ٢٠١٧ و ٢٠١٨ م وذلك لدراسة استجابة صنفين من عباد الشمس للرش الورقي بتركيزات مختلفة من أكسيد الزنك النانومتري. وقد استخدم تصميم القطاعات كاملة العشوائية بترتيب الشرائح المنشقة بثلاث مكررات. وقد رتبت تركيزات أكسيد الزنك النانومترية (صفر و ١٠٠ و٢٠٠ و٣٠٠ و٤٠٠ و٥٠٠ جزء في المليون) أفقيا بينما رتبت الأصناف (سخا٥٣- جيزة ١٠٢) رأسياً. اشارت النتائج الى ان الصفات التى تم دراستها وهي عدد البذورللقرص ، وزن المائة بذرة (جم)، وزن البذورللنبات، محصول البذور(كجم/فدان)، نسبة الزيت (٪) ومحصول الزيت (كجم/فدان) تأثرت معنويا بتركيزات اكسيد الزنك النانومترية لكلا الموسمين. حيث اعطت نباتات عباد الشمس الذي رشت ورقيا بمعدل ٢٠٠ جزء في المليون اعلي متوسط لصفات محصول البذور للفدان (١٧٥١,٩٩ و ١٥١٥,١٨ كجم للفدان) ومحصول الزيت للفدان (٦٧٦,٧٩ و ٦٠٠,٨١ كجم للفدان) للموسم الاول والثاني علي التوالي. كذلك أعطى الصنف جيزة ١٠٢ اعلى متوسط للصفات المشار إليها في الموسمين. أيضا اثر التفاعل بين تركيزات اكسيد الزنك النانومترية واصناف عباد الشمس معنويا علي تلك الصفات لكلا الموسمين وتم الحصول علي اعلي متوسطات لصفة محصول الزيت للفدان (٧٢٣,٦١ و ٧٠١,٣٧ كجم للفدان للموسم الاول والثاني علي التوالي) من زراعة صنف عباد الشمس جيزة ١٠٢ المرشوشة بتركيز ٢٠٠ جزء في المليون من اكسيد الزنك النانومتري.