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Impact of foliar spray treatments on yield, quality traits and total aflatoxin content of some peanut cultivars in sandy soils.

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ABSTRACT

Two field experiments were conducted in agronomy department farm, faculty of agriculture sadat city, al-azhar university, el-menofia governorate, Egypt, during 2020 and 2021 seasons, to study the effect of foliar spraying treatments (Control, ZnO, CuO, MgO with concentrate 1cm^3/l. in nanoparticles form and salicylic acid with concentrate 1.25g/l.). on yield ,quality–traits and seed content of aflatoxin, at and after harvest of some Peanut cultivars (Giza5, Giza6 and Gergory). Results indicated that the differences between foliar spray concentrations for pods yield/fed. oil and protein content as% in seeds as well as total aflatoxin as% were significant in the two seasons. peanut plants spraying with 1cm^3/L. ZnO gave the –vital–for Pods yield/fed. oil and protein content as % in seeds in both seasons, While spraying with CuO gave the highest values for total aflatoxin as% in the two seasons. Also, results indicated that Giza6 cultivar pronounced its superiority and scored the best values for pods yield/fed. total aflatoxin after drying and after three months, while giza5 cultivar gave the highest values for protein content in seeds and total aflatoxin at harvest. On the other hand gerogory cultivar gave the highest values- for oil% in the two seasons. Results showed that foliar spraying of Giza 6 led to increase pods yield/fed., quality traits and decrease total aflatoxin content in seeds and after three months in storage under sandy soil conditions.

KEYWORDS: Nanoparticles, ZnO, MgO, CuO, Salicylic acid, Peanut, sandy soils, aflatoxin.

1. INTRODUCTION

Peanut (*Arachis hypogaea, L*)considered one of essential oil crops in the world. Peanut seeds contain high oil about 45%, protein from 26-28%, carbohydrates 20% and fiber about 5%.Peanut is considered an important export crop where it consumes about 65-70, vital role play in enhancement the yield especially~~,~~ in sandy soils, Fageria *et al*. (1997). Its seeds have high nutritive value for crop human and animal feeding. The area cultivated with peanut in egypt during 2016 season was about 58000 hectare (FAO, 2016). Recently in egypt peanut has been given great attention because about its ability for growing in newly reclaimed sandy soil conditions. Also, most these soils are sandy soil and poor in plant nutrients and organic matter, there many factors affecting on fertilizers availability, for example insolubility, leaching and decomposition enhancement and also pollution problems, (Zhang and Hua.,2011). Also, recent studies show that nanofertilizer could tremendous beneficial effect on seedling growth, development, seed yield, also, enhanced most crops productivity. The foliar application of Feo, Zno, Cuo and Mno, SNMS in field crops enhances growth, development and yield, these due to improve fertilizer unit use efficiency, especially, in alkaline soils. Zinc oxide, iron oxide, copper oxide are essential of micronutrients required for plant growth and development, that its role in catalytic activity of different metabolic enzymes, including dehydrogenases, aldoses, isomerizes, transphosphorylases, RNA and DNA and it is also involved in the synthesis of tryptophan, cell division, maintenance of membrane structure and potential and photosynthesis and acts as a regulatory cofactor in protein synthesis~~.~~ Copper nanoparticles (CuNPs) are found to be of significant technological interest and have attracted more attention due to their high conductivity, cost effectiveness, eco friendliness, easy availability, and nontoxicity. Copper-based fertilizers are most used in formulation for crop protection. It is an essential micronutrient being incorporated into many proteins and enzymes and has a significant role in the health as well as nutrition of plants (Tarafdar *et al*., 2014) and (Rawat *et al*., 2018).

Moreover, there is no, specific investigations on the effect of nanoparticles in plants.Prasad *et al*(2012). found that zinc foliar spray as zince nano on peanut increased yield by 30% compared with the control (without–foliar spray). Delfani *et al*.(2014)

indicated that salicylic acid application can protect the plants from various diseases to get quality traits seeds of soybean. AL-Qaisi .(2015). Indicated that the high efficiency of the importer and local Mgo nano materials particles when inhibited *Aspergillus flavus* growth by 100% in stored corn seed, consequantly , reduce Aflatoxin B1 compared with the control. Also, EL-Metwally *et al*.(2018). found that using Feo, Zno, and Mno as nanofertilizer foliar at 30 PPm gave the maximum values for yield and quality traits in peanut seed giza6 cultivar compared the control under sand soil conditions. Priyanka *et al*.(2019).indicated that use zno and cuo nanoparticles in peanut fertilizer improve yield and quality traits Hussein and Al-wahab (2020).Confirmed that Mgo adding as nanoparticles at 1, 2 and 3% concentration, fungal growth inhibition with 95 and 100%, respectively compared with the control. Afify *et al*. (2019). Found that peanut in a sensitive crop of zinc, iron and manganese deficiency, especially in alkaline soils. In these soils, also, found that ratio of iron, zinc, manganese available to Plants is less than 10%, this led to decrease yield and quality traits. Ludmila *et al*.(2020).Found that the use of Mno, Cuo Zno and Feo in forms nanoparticles improved final product quality of soybean.

Mycotoxins are produced by molds under bad storage conditions, especially seeds moisture content above 12%, 95% relative humidity (RH) and temperatures greater than 35 °C which contribute to fungal growth. Aflatoxins (AFs) are secondary toxic fungal metabolites produced during the growth of *Aspergillus flavus* and *A. parasiticus* (*A. flavus* group) (Criseo *et al*., 2001).In addition,aflatoxins (AFs) cause lipid peroxidation as well as oxidative damage to DNA, so they are well known hepatotoxic, mutagenic agents and hepatocarcinogenic, especially ~~a~~flatoxin B1 (Ismaiel and Tharwat, 2014).Several compounds have a critical role in inducing systemic acquired resistance (SAR) in different plant tissues, so that it has been recorded as a promising approach to control *A. flavus* infection and reduce AFs production in pistachio fruits (Panahirad *et al*., 2014).

Nanotechnology approaches seem to be a promising, effective and low-cost way to minimize the harmful effects of mycotoxins. Nanoparticles (NPs) may affect agricultural crops at biochemical, physiological and molecular levels through changes in mineral nutrition and photosynthesis (Rizwan *et al*., 2017). There are three main strategies for nanoparticles (NPs): mold inhibition, mycotoxin adsorption and reducing the toxic effect (Horky *et al*., 2018).Consequently, this—study aimed to investigate the effect of foliar spray with nanoparticles treatments on yield and quality traits of some peanut cultivars in reclaimed sandy soils.

2. MATERIALS AND METHODS

The present investigation was carried out at the research farm of Dept. of Agronomy, Fac. of Agric., Sadat City, Al-Azhar Univ., Menofia Governorate, Egypt, during the two successive summer seasons of 2020 and 2021, to study the effect of foliar spraying treatments (Control, CuO, MgO, ZnO with concentrate $1cm^3$/l. and Salicylic with 1.25 g/l concentrate) on the yield quality traits and aflatoxin content as% at and after harvest of some peanut (*Arachis hypogaea,* L.) cultivars (Giza 5, Giza 6 and Gregory)

2.1. foliar spraying treatments :

1. Control (sprayed with tap water).
2. NPs CuO (Nano-particles of copper oxide), NPs MgO (Nano-particles of magnesium oxide, NPs ZnO (Nano-particles of zinc oxide with concentration of $1cm^3$/l. and Salicylic acid (at the rate of 1.25 g/l were applied at 50, 65 and 80 day from sowing).

Some physical and chemical characteristics of the studied soil before planting in 2020 and 2021 season were–presented in Table 1 which was determined according to Page *et al.*, (1982).

2.2. Examined Materials:

The cultivars (Giza 5, Giza 6 and Gregory) were obtained from agricultural research center, Giza, Egypt. While NPs (CuO, MgO and ZnO) were prepared in the laboratory of Plant pathology research institute, Agricultural Research |Center, Nanotechnology unit, Giza, Egypt, according to Lu *et al*. (2018).

2.3. Nanoparticles (NPs) Characterizations:

Powders of NPs were characterized at laboratory of Plant pathology research institute, agricultural research center, on scanning electron microscopy (SEM) (JOEL, JSM 5300) with high resolution at an accelerating voltage of 120 kev. An aliquot of them was coated on a copper grid and scanned for its size and shape. electron dispersive analysis (EDA) was performed using X-ray Oxford detector unit (model 6647, England) equipped with SEM (JOEL, JSM 5300) to achieve the purity of prepared NPs.

A field experiment was carried out split plot a randomized complete block design (RCBD) with three replications. The main plots were assigned to varieties while, foliar spraying treatments were allocated of sub plots. The sub plot area was $10.5m^2$ (5 ridges X 0-60 m width X 3.5 long).

Table 1. Physical and chemical analysis of soil at the experimental site in2020 and 2021 seasons.

Physical properties		
Components	**2020 season**	**2021 season**
Sand (%)	51.50	50.89
Silt (%)	25.20	27.65
Clay (%)	23.3	21.46
Soil Texture class	Sandy clay loam	
Chemical properties		
Ph	7.66	7.55
EC (1:2.5) ds/m	2.87	2.68
OM %	0.46	0.48
Soluble cations (1:2) (cmol/kg soil)		
K^+	1.55	1.51
Ca^{++}	8.77	8.80
Mg^{++}	9.80	9.77
Na^+	10.90	10.95
Zn^{++}	0.84	0.90
Cu^{++}	1.32	1.63
Soluble anions (1:2) (cmol/kg soil)		
Calcium Carbonate (%)	7.20	6.98
So_4^-	12.60	12.48
Total Nitrogen (%)	1.26	1.30
Available Phosphate (mg/kg)	3.60	3.40
Cl^-	15.33	14.90
$Co_3^- + HCo_3^-$	2.60	2.76

[*]1:2.5 w/v soil: water suspension [**]Soil paste extract HC: Hydraulic conductivity

Seed were sown on April 18th in both seasons. Seeds were inoculated with okadeen (*Rhizobium spp.*) and sown in hills 15 cm apart on one side of each ridge at a rate of 3 seeds/hill. All other cultural practices recommended for peanut crop under reclaimed soils were done in both seasons.

The above-mentioned compounds were sprayed on peanut plants three times; 1st spray at flowering stage (50 days from sowing), 2nd and 3rd after two weeks each (Alghandour *et al*., 2019) (at 50, 65 and 80 day from sowing). Tap water was used as a control.

2.4. Studied characters:

1. Pod yield/ fad, in (kg) were taken from whole plot.
2. Seed oil content, as % samples was crushed using an electric grinder and the oils were extracted according to Folch et al. (1957).
3. Protein content, in seeds as % the crude protein content was evaluated by digestion of the sample method (Devani et al., 1989) nitrogen determination by a spectrophotometric method described by (Devani et al., 1989).
4. Total aflatoxin% (AFs), a total of 120 groundnut samples (30 per region) were used for aflatoxin analysis. Aflatoxin content of samples was determined using high performance liquid chromatography (HPLC). Standards of AFB1, B2, G1 and G2 were obtained from Romer Labs, Austria. Sodium chloride (NaCl), anhydrous magnesium sulphate ($MgSO_4$), acetonitrile and methanol (HPLC grade) were purchased from Merck, USA. The extraction of aflatoxins in groundnut samples was carried as described by Sirhan, Tan, Al-Shunnaq, Abdulra'uf, and Wong (2014) with some modifications. Briefly, samples were milled and homogenized using a preethi Mixer Grinder. Two grams of sample was weighed into a 15 ml centrifuge tube, 5 ml of distilled water was added, and the tube was shaken for 1 min. The solution was allowed to stand for 5 min. A volume of 5 ml 1% (v/v) acetic acid in acetonitrile solution was added.

Seeds of all treatments were harvested and packed in plastic packages. The effect of the previous treatments on weight of 100 seeds (g), and total of AFs after three months of storage were evaluated.

2.5. Statistical analysis

All collected data were analyzed with analysis of variance (ANOVA) Procedures, using the "MSTAT-C" computer software package and least significant difference (LSD) method was used to test the differences between treatments means at 5 % level of probability as published by Gomez and Gomez (1984).

3. RESULTS AND DISCUSSION

Effect of foliar spraying treatments on yield, quality traits and seed content of total a flatoxin at and after harvest of some peanut cultivars in 2020 and seasons are Presented in Tables 2and 3.

Results indicated that the differences between foliar spraying treatments for Pods yield /Fed., oil and protein content as % in seeds as well as seed content of total a flatoxin at and after harvest were significant in the two seasons. Peanut plants spraying with Icm^3/L., from Zno gave the highest values-for pods yield /fed, oil and Protein content as % in seeds in both seasons. On the other hand, CuO foliar spraying with the same concentrate gave the lowest values for seed content of total aflatoxin at and after harvest in the two seasons. Positive effect of foliar spraying treatments on yield, quality traits and decrease seed content of totel aflatoxin at and after harvest may be due to several from ZnO and CuO benefits, especially, of Peanut cultivars such as that zinc one of the essential micronutrients required for plant growth and development. zinc is required for the catalytic activity of different metabolic enzymes and it is also, involved in the synthesis of tryptophan, Cell division, maintenance of membrane structure and potential and photosynthesis and acts as a regulatory cofactor in Protein. Also, a zinc oxide nanoparticle is nontoxic and it can be quickly transported through the plant transporters and included in the metobelic processes. On the other hand, zinc oxide nanoparticles could serve as important micronutriens for plant growth. Also, Cuo nanoparticles is required for various important physiological, function ,such as cellular transportation, mitochondrial respiration, ant oxidative activity and hormone signaling of plants.These results are in agreement with Tarafdar *et al*.(2014). Ditta and Arshad (2016),Jabeen *et al*. (2017), Javed *etal*.(2017). Rawat *etal*. (2018) and Vishveshvark *etal*.(2018).

Table 2. Effect of foliar spraying treatments and their interactions on–pods–yield (kg/fed)., oil content% and protein content% in seed of some peanut cultivars in 2020 and 2021 seasons.

Varieties (B)	Spraying treatments (A)	Pods yield (kg/fed)		Oil content% in seed		protein content% in seed	
		Season 2020	Season 2021	Season 2020	Season 2021	Season 2020	Season 2021
Giza5	control	1049.35	1103.27	42.91	44.17	24.13	25.83
	MgO	1225.71	1266.16	43.90	45.57	27.11	29.63
	CuO	1359.93	1430.72	44.95	47.32	28.69	31.93
	ZnO	2021.11	2085.62	48.06	50.83	29.14	32.67
	Salsalic	1660.91	1715.06	45.84	47.79	29.00	31.99
	Means	1463.40	1520.17	45.13	47.14	27.62	30.41
Giza6	control	1240.18	1286.67	45.68	47.69	22.79	26.59
	MgO	1569.21	1635.14	47.12	49.49	24.56	28.02
	CuO	1884.50	1928.56	49.42	52.19	25.21	28.59
	ZnO	2313.42	2386.85	51.58	53.82	28.49	31.54
	Salsalic	2016.93	2075.38	50.08	52.62	27.22	30.67
	Means	1804.85	1862.52	48.78	51.16	25.65	29.08
Gergory	control	1101.44	1162.32	46.19	48.77	21.93	25.07
	MgO	1344.84	1401.06	49.76	52.52	22.00	25.14
	CuO	1516.85	1572.59	51.33	53.83	23.32	26.13
	ZnO	2025.13	2054.77	52.49	55.26	25.60	29.12
	Salsalic	1842.47	1912.05	50.92	53.83	24.60	27.60
	Means	1566.14	1620.56	50.14	52.84	23.49	26.61
Mean Spraying treatments	control	1130.32	1184.09	44.93	46.88	22.95	25.83
	MgO	1379.92	1434.12	46.93	49.19	24.56	27.60
	CuO	1587.10	1643.96	48.57	51.11	25.74	28.88
	ZnO	2119.89	2175.75	50.71	53.30	27.74	31.11
	Salsalic	1840.10	1900.83	48.95	51.41	26.94	30.09
LSD AT 5%	A	58.58	57.00	0.50	0.52	0.56	0.68
	B	75.63	73.58	0.65	0.67	0.72	0.88
	AxB	130.99	127.45	1.12	1.17	1.25	1.52

Table 3. Effect of foliar spraying treatments and their interactions on total aflatoxin % in Seed at and after harvest of some peanut cultivars in 2020 and 2021 seasons.

Varieties	Spraying treatments	total aflatoxin % (µg/g)					
		At harvest		After drying		After three months in storage	
		Season 2020	Season 2021	Season 2020	Season 2021	Season 2020	Season 2021
Giza5	Control	1.09	1.08	52.71	51.31	151.11	148.28
	MgO	0.33	0.30	51.54	48.18	141.49	136.82
	CuO	0.13	0.12	47.04	43.92	124.17	116.17
	ZnO	0.27	0.21	48.60	48.22	133.14	130.08
	Salsalic	0.18	0.11	49.10	45.67	119.93	122.65
	Means	0.40	0.36	49.80	47.46	133.97	130.80
Giza6	Control	0.96	0.91	56.69	53.27	123.14	118.47
	MgO	0.44	0.41	50.82	42.26	120.78	118.25
	CuO	0.18	0.11	38.41	35.88	112.54	109.12
	ZnO	0.43	0.37	45.77	46.33	117.99	114.48
	Salsalic	0.35	0.31	43.04	38.37	116.08	111.59
	Means	0.47	0.42	46.94	43.22	118.10	114.38
Gergory	Control	1.05	1.00	72.73	69.67	187.87	184.75
	MgO	0.68	0.62	63.16	63.56	162.99	159.56
	CuO	0.34	0.16	53.85	51.02	132.03	130.62
	ZnO	0.66	0.61	67.32	64.06	146.70	144.27
	Salsalic	0.45	0.38	65.59	58.49	139.66	136.29
	Means	0.64	0.55	64.53	61.36	153.85	151.10
Mean Spraying treatments	Control	1.03	0.99	60.71	58.08	154.04	150.50
	MgO	0.48	0.44	55.17	51.34	141.75	138.21
	CuO	0.22	0.13	46.43	43.61	122.91	118.64
	ZnO	0.45	0.39	53.90	52.87	132.61	129.61
	Salsalic	0.33	0.26	52.57	47.51	125.22	123.51
LSD AT 5%	A	0.08	0.06	1.56	1.57	2.78	2.84
	B	0.10	0.08	2.01	2.02	3.59	3.66
	AxB	0.17	0.14	3.48	3.50	6.22	6.34

Regarding response of peanut cultivars of foliar treatments result In Tables 2 and 3 indicated that the differences were significant for all studied traits in the two seasons. Giza 6 cultivar pronounced its superiority and scored the highest values for pods yield/ fed. and the lowest values for total aflatoxin after harvest and after three months in both seasons, on the other hand, Giza 5 cultivar recorded the best values for protein content in seed and seed content from ~~total~~ aflatoxin as % at harvest, while, Geragory cultivar recorded the highest values for oil content in seed as % in both seasons. These results may be due integrated genotypes with environmental conditions under sand soil conditions. These results are in agreement with El. Metwally *et al*. (2018), and AFify *etal*.(2019).

The effect of interaction between foliar spraying treatments and studied cultivars was significant for all studied traits in both seasans. Peanut plants spraying with Icm^3/L. concentrate from ZnO with Giza 6 gave the highest values of all studied traits, compared with the other interaction treatments in both seasons

It could be concluded that, foliar spraying from ZnO with Giza 6 cultivar conseqwantly led to Increase pods yield, and decreased seed content from total aflatoxins as % under sand soil conditions.

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الملخص العربي

تأثير معاملات الرش الورقي علي المحصول وصفات الجودة والأفلاتوكسين لبعض أصناف الفول السوداني في الأراضي الرمليه.

احمد حسيني محمد محمود حجازي، جمال الدين حسن عبد الحي، السيد عبدالله السيد مصباح و ايمن مفرح ابو طاحون

قسم المحاصيل كلية الزراعه بالقاهرة جامعة الازهر الشريف

أجريت تجربتان حقليتان في قسم المحاصيل_ كليه زراعة السادات _ جامعة الأزهر محافظة المنوفية_ مصر خلال موسمي الدراسة ، ٢٠٢٠و ٢٠٢١ لدراسة تأثير معاملات الرش الورقي (كنترول وهو الرش بماء الصنبور ، الرش بأكسيد الزنك ، الرش بأكسيد النحاس ، الرش بأكسيد الماغنسيوم بتركيز ١سم^{٣}/لتر في الصورة النانوميترية والرش بحمض السالساليك بتركيز ١,٢٥ جرام/لتر) علي المحصول وصفات الجودة والأفلاتوكسين لبعض أصناف الفول السوداني (جيزة ٥ , جيزة ٦ , جيروجوري) في الأراضي الرملية.

ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلي:

١- أظهرت النتائج تأثيرا معنويا لمعاملات الرش الورقي علي صفات محصول القرون /فدان، محتوي الزيت والبروتين في البذور كنسبة مئوية والمحتوي الكلي للأفلاتوكسين في البذور كنسبة مئوية في كلا الموسمين ؛ كما أظهرت النتائج أن رش نباتات الفول السوداني بتركيز ١سم^{٣}/لتر من أكسيد الزنك أعطي أحسن القيم لمحصول القرون/فدان بالكجم ومحتوي الزيت والبروتين في البذور كنسبة مئوية في كلا الموسمين ، علي الجانب الاخر ، اعطي الرش بنفس التركيز بأكسيد النحاس الي خفض المحتوي الكلي للافلاتوكسين في البذور كنسبة مئوية عند وبعد بثلاثة اشهر من الحصاد في كلا الموسمين.

٢- كما أظهرت النتائج أيضا تفوق الصنف جيزة ٦وتسجيله لأعلا القيم لصفتي محصول القرون/فدان بالكجم ومحتوي البذور من الأفلاتوكسين الكلي كنسبه مئوية بعد التجفيف مباشرة وبعد ثلاثة اشهر من الحصاد كلا الموسمين، بينما أعطي الصنف جيزة ٥ لأعلا القيم بالنسبة لمحتوي البروتين في البذور كنسبة مئوية وخفض المحتوي الكلي للافلاتوكسين في البذور كنسبه مئويه عند الحصاد فقط في كلا الموسمين علي الجانب الأخر، اعطي الصنف جيروجوري أعلي القيم بالنسبة لمحتوي الزيت في البذور كنسبه مئوية في كلا الموسمين.

٣- كان التفاعل بين معاملات الرش الورقي وأصناف الدراسة تأثيرا معنويا موجبا علي كل الاصناف المدروسة في موسمي النمو ، وقد أدى الرش بأكسيد الزنك بتركيز ١سم^{٣} /لتر مع الاصناف جيزة ٦او جيزة ٥ او جيروجوري بالترتيب تأثير معنويا موجبا علي كل الصفات المدروسة في كلا الموسمين. توصية : من النتائج يتضح ان الرش بتركيز ١سم^{٣}/لتر من اكسيد الزنك النانومتري مع زراعه صنف جيزة ٦ أدي الي زيادة ناتج القرون/ وخفض المحتوي الكلي للأفلاتوكسين في البذور بعد التجفيف مباشرة تحت ظروف أرض التجربه (الاراضي الرملية).