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Influence of Foliar Application of Some Micronutrients Levels on Growth, Yield, Yield Attributes, Micronutrients Content and Fatty Acids of Two Groundnut (*Arachis hypogaea* L.) Varieties

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A FIELD experiment was carried out at Arab Elawamr Research Station Farm, Oil Crops Department, Assiut Governorate, Agriculture Research Center (ARC), Egypt, during the summer of 2019 and 2020 season. In order to assess the response of two groundnut varieties (Giza 6 and Sohag 110) to foliar application of some micronutrient (Fe, Zn and Mn) levels cultivated in sandy calcareous soil. The experiment was laid out in randomized complete block design (RCBD) using split-plot arrangement with three replicates. Two groundnut varieties (Giza 6 and Sohag 110) were allocated randomly at the main plot. Four micronutrient (Fe, Zn and Mn) levels (control, 100ppm, 300ppm, 500ppm) were allocated at sub plot. The results showed that there was a significant difference between two the groundnut varieties Sohag 110 suppress Giza 6 at most studied traits in both seasons. The foliar application of micronutrient levels had a significant influence on all studied traits; 300ppm level was superior to all other treatments in both seasons. Also the interaction between varieties and micronutrient levels had a significant impact on growth, yield attributes and yield. The highest mean value of pod yield (4025.2 and 4162.9kg ha^{-1}) and oil yield (1841.9 and 1940.2kg ha^{-1}) were obtained from the interaction between V2 × M2 (300ppm micronutrient on Sohag 110 variety). The micronutrient concentration 500ppm gave the highest value of Fe, Zn and Mn contents in both seed and straw. Saturated and unsaturated fatty acids recorded the maximum value by applied 300ppm micronutrient concentration.

Keywords: Fatty acids composition, Groundnut, Micronutrients content, Yield attributes.

Introduction

Groundnut (*Archis hypogaea* L.) is an important oilseed and food legume crop of tropical and subtropical world. It is the fourth most important source of edible oil and the third most important source of protein in the world. The groundnut seed contain 45-50% oil, which is good from both nutritive and culinary points of view as it contains good quantities of MUFA (oleic acid, 40-50%) and PUFA (linoleic acid, 25-35%), with high oleic/linoleic ratio and relatively longer shelf life (Chaiyadee et al., 2013). There was a significant difference among different varieties of groundnut due to difference in genetic and their interaction with environment (El- Far et al., 2016; Abdel-Motagally et al., 2016).

Nutrient management was one of the most important agronomic factors that affect the yield of all crops. Inadequate and imbalance use of nutrient is the major factors responsible for low yields in groundnut (Singh, 1999). Groundnut is relatively sensitive to the deficiency of iron (Fe), zinc (Zn) and manganese (Mn) (Meena et al., 2007). Therefore, it is most essential to pay a great attention to the nutrition of groundnut to enhance its productivity. The foliar application

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of micronutrients is still the mostly effective way to get better nutrition in plants (El-Metwally et al., 2018). In recent past, Iron is essential for the maintenance of chloroplast structure and function and it plays a significant role in basic biological processes such as photosynthesis, chlorophyll synthesis, respiration, nitrogen fixation, uptake mechanisms (Kim & Rees, 1992). Zinc has specific and essential physiological function in plant metabolism and protein synthesis and biosynthesis of growth substance such as auxin (Aravind & Prasad, 2004). Manganese is important element for synthesis many enzymes in plant (Millaleo et al., 2010).

This work aim to assessing the response of two groundnut varieties Giza 6 and Sohag 110 to different micronutrients levels beside their effects on groundnut growth, yield attributes, yield and micronutrients content at peanut seed and straw moreover fatty acids composition.

Materials and Methods

Experimental design and treatments

A field experiment was carried out at Arab El-awamer Research Station Farm, Oil Crops Department, Assiut Governorate, Agriculture Research Center (ARC), Egypt, during the summer of 2019 and 2020 seasons to study the evaluation of micronutrients levels on two groundnut varieties. The experiment was conducted out in a randomized complete blocks design (RCBD) using split plot design with three replications. The plot size was 10.5m^2. Seeds of two groundnut varieties Giza 6 (V1) and Sohag 110 (V2) were sown in hills 15cm apart and thinning at 21 day after planting to secure one plant/hill. Recommended doses of NPK were applied as the following: Super phosphate (15.5% P_2O_5) was added before sowing at a rate 71.43kg/ha. Ammonium nitrate (33.5% N) was added at a rate 142.86kg ha^{-1} divided into two doses. Potassium sulphate (48% K_2O) was used at a rate 57.14kg ha^{-1}. Four different foliar spraying levels of micronutrients combined between iron (EDTA, 6%), zinc (EDTA, 8%), and Manganese (EDTA, 13%) were applied twice at 30 and 60 days after sowing and allocated horizontally in split plot as the following:

1- M0 (control spraying with water).

2- M1 (100ppm of each Fe, Zn and Mn).

3- M2 (300ppm of each Fe, Zn and Mn).

4- M3 (500ppm of each Fe, Zn and Mn).

Experimental soil

Soil composite samples were collected before sowing at 30 cm of depth and analyzed in Agriculture Research Center (Table 1). The soil texture was determined according to Piper (1950). The water saturation capacity, total calcium carbonate, organic matter, electrical conductivity, soil pH, soluble cations, soluble anions, total nitrogen, available phosphorus and potassium were measured according to Jackson (1973). The diethylenetriaminepenta acetic acid extracting (0.005M DTPA, 0.1 TEA (triethanolamine), and 0.01 M $CaCl_2$, adjusted to pH 7.3) solution (Lindsay & Norvel, 1978) was employed to extract Fe, Mn, Zn and Cu as a potential indicator of plant-available micronutrients from soil samples.

TABLE 1. Soil physico-chemical properties

Soil Property	Value
Soil texture	Sandy
Saturation percent (%)	26
Total $CaCO_3$ (g kg^{-1} soil)	280
Organic matter (g kg^{-1} soil)	3.8
EC (dS m^{-1})	1.3
pH (1:2.5 water suspension)	7.70
Soluble cations(mmol$_c$ L^{-1}):	
Ca^{++}	6.06
Mg^{++}	4.33
Na^+	1.88
K^+	0.17
Soluble anions (mmol$_c$ L^{-1}) :	
CO_3^- HCO_3^-	3.30
Cl^-	4.24
SO_4^{--}	4.89
Macronutrients (mgkg^{-1} soil):	
Total N	100
Available P	4.78
Available K	46
DTPA-extractable (mg kg^{-1} soil):	
Fe	0.622
Mn	0.356
Zn	0.142
Cu	0.042

* Each value represents the mean of three replications

Measured traits

At harvest five randomly plant were taken from each plot plant height (cm), number of pods per plant, pods weight per plant (g), seeds weight per plant (g) and 100-seed weight were determine. Pods yield was determined per experimental unit then seed yield in kg ha^{-1} was calculated. Oil percentage (%) in groundnut seeds was estimated by extraction using Soxhlet apparatus and petroleum ether (bp 40-60°C) as solvent according to AOAC (1995). Oil yield in kg ha^{-1} was estimated by the multiplication of oil percentage by seed yield in kg ha^{-1}. Shelling percentage (%) was estimated from seeds from 100 pods /100 pods weight (g) *100.

Plant analysis

Total Fe, Mn and Zn in straw and seeds of groundnut in second season were determined by using a nitric-perchloric acids mixture (HNO_3 + $HClO_4$) according to the procedure of Tedesco et al. (1995).

Fatty acids composition

Fatty acids composition was determined in the second season of the experiment. Fatty acid methyl esters were prepared from total lipid by using rapid method according to the method of ISO 12966-2 (2017). Fatty acid methyl esters were injected into (HP 6890 series GC) apparatus provided with a DB-23 column (60m x 0.32mm x 25um). Carrier gas was N2 with flow rate 1.5 ml/min, splitting ratio of 1:50. The injector temperature was 250°C and that of Flame lonization Detector (FID) was 280°C. The temperature setting was as follows: 150 C to 210°C at 5°C /min, and then held at 210°C for 25min. Peaks were identified by comparing the retention times obtained with stander methyl esters.

Statistical Analysis

All data were statistically analyzed according to technique of analysis of variance (ANOVA) for the split- plot design with three replications by means of "Genstat" computer software package according to Gomez & Gomez (1984) and least significant differences (L.S.D.) test was used to compare treatment means at 5% level of probability.

Results and Discussion

Growth, yield attributes and yield

Varity effect

Data in Table 2 showed that there was a significant difference between two varieties [Giza 6 (V1) and Sohag 110 (V2)] Sohag 110 variety surpassed Giza 6 in the most studied traits. It had the highest mean values of plant height 37.5 and 31.02cm, number of pods plant^{-1} 31.94 and 29.28, number of nodules plant^{-1} 96.4 and 121.7, straw weight plant^{-1} 52.48g at first season, pod weight per plant 34.68 and 46.95g, seed weight plant^{-1} 22.3 and 31g, shelling percentage 61.38% and 69.71%, 100 - seed weight 87.29 and 86.3g, pod yield of 3308.8 and 3336.4kg ha^{-1}, oil percentage 50.56% and 50.63% and oil yield of 1438.1 and 1459.3kg ha^{-1} in the first and second season respectively. This may be due to genetic factors formed by the varieties used moreover the interaction between varieties and environment. These finding are in a good line with Seadh et al. (2017), Abdel-Motagally et al. (2016) and Mohammed et al. (2018) showed highly significant difference among groundnut genotype-by-season interaction for most of the traits studied.

Effect of micronutrients levels

Data in Table 3 highlighted that all studied traits were affected significantly by applied micronutrients Zn+Fe+Mn at level 300ppm (M2). It was superior to all other treatments in this respect and registered the highest mean value of all studied yield and yield attributes. This treatment recorded 41.67 and 33.32cm plant height, 37.99 and 36.44, number of pods plant^{-1}, 109.8 and 162 number of nodules plant^{-1}, 56.2 and 100.61g straw weight plant^{-1}, 40.4 and 50.26g pod weight plant^{-1}, 25.13 and 39.72g seed weight plant^{-1}, 59.75% and 78.82% shelling percentage 82.06 and 81.79g 100 seed weight in the first and second season respectively. Consequently the highest mean value of groundnut seed yield and oil yield were obtained from treatment M2 (3809.1 and 3997.4 for pod yield kg ha^{-1}, 51.542% and 52.2% for oil seed percentage, 1718.8 and 1848.3 for oil yield kg ha^{-1}). This may be due the importance of micronutrient for improving crop production, hence zinc is involved in various enzymatic process which helps in catalyzing reaction for improving crop growth (Arabhanvi et al., 2015). Iron is a component of cytochrome oxidase, chlorophyll and several enzyme systems (Gyana & Sunita, 2015). Manganese serves as a cofactor in most of the enzymes that activate phosphorylation processes (Millaleo et al., 2010). Moreover applied micronutrients at optimum level and provide balance nutrition of Zn, Fe and Mn that cause better crop growth (Damor et al., 2019). These finding are in a good line with Singh & Chaudhari (1997), Meena et al. (2007), Patel et al. (2008), and Shete et al. (2018). On the other hand the depressing effect of 500ppm of Zn, Fe and Mn may be due to antagonistic interaction between Zn, Fe and Mn with other nutrients in the soil, this result are in harmony with Gobarah et al. (2006) and

Noman et al. (2016) who recorded that by applied 5.0kg Zn ha^{-1} significantly influenced on all growth parameters and yield of groundnut, while increase in Zn level beyond 5.0kg to be 7.5kg Zn ha^{-1} resulted in adverse effect on growth parameters, yield attributes and yield this can be explained on the basis of law of variable returns. So at 7.5kg Zn ha^{-1}, Zn becomes excessive in relation to other inputs which had antagonistic effect on different parameters due to negative interaction with other nutrients in the soil.

Interaction effect of varieties and micronutrient levels

For the interaction effect, the presented data in Table 4 showed that the interaction between varieties and micronutrient levels significantly affected on most groundnut growth, yield and yield attributes in both growing seasons. Thus, the highest mean values of plant height (40.33 and 35.4cm) were obtained from the interaction between V1 × M2 and V2 × M2 in first and second season respectively. Number of pods $plant^{-1}$ and number of nodules $plant^{-1}$ were significantly affected by the interaction between V2 × M2 (300ppm of Zn+Fe+Mn × Sohag 110 variety) in second season only which recorded 39.7g and 178.2 respectively. On the other hand, dry weight $plant^{-1}$ reacted significantly to the interaction between 300ppm micronutrient level and Sohag 110 variety (V2) in first season only which recorded 61.44g. The highest mean value of pods weight $plant^{-1}$ 43.71 and 52.67g, seed weight $plant^{-1}$ 27.59 and 44.4g, 100 seed weight 90.23 and 90.85g, pod yield 4025.2 and 4162.9kg ha^{-1}, oil percentage 51.677 and 52.34%, oil yield 1841.9 and 1940.2kg ha^{-1} were obtained by interaction between V2 × M2 (300ppm micronutrient on Sohag 110 variety) in the first and second seasons respectively. The improvement in yield parameters might be due to owing to applied micronutrients at optimum level which lead to significant increase in growth finally leading to development of superior yield attributes. The finding of Sisodiya et al. (2017) and Rajitha et al. (2018) are in agreement with the present investigation.

Zinc, Iron and Manganese contents at groundnut seeds and straw

Variety effect

Data presented in Fig.1 revealed significant effect of variety on Fe, Zn and Mn contents in seed and straw. Giza 6 (V1) recorded the highest value of Fe content in seed and straw, respectively (177.1 and 173.1ppm), while Sohag 110 (V2) revealed the highest value of Zn content in seed (49.65ppm) and there was non-significant effect among two verities on Zn content at straw and Mn content at seed, V1 recorded the highest amount of Mn content at straw (128.61ppm). this may be due to genotype behavior and their interaction with environment condition and applied nutrient these finding are in a good line with Mahrous et al. (2015), El- Far et al. (2016), and Abd El-Moneem & Said (2018).

Effect of micronutrients level

There is a significant effect of different micronutrient level on Fe, Zn and Mn content in seed and straw (Figs. 2 and 3). Maximum concentration were recorded by application of 500 ppm of Zn+Fe+Mn (M3), this treatment recorded 184.8 and 185.6ppm Fe content in seed and straw, 50.99 and 35.34ppm Zn content in seed and straw, 136.9ppm Mn content in straw while there was non-significant effect of micronutrient levels on Mn content at groundnut seed. This might be attributed to greater absorption of Fe, Zn and Mn by the crop owing to higher availability in soil and due to addition of micronutrient with higher concentration. The results corroborate the findings of Arunachalam et al. (2013), Abdel-Motagally et al. (2016), Damor et al. (2019), and Nandi et al. (2020).

Interaction effect of varieties and micronutrient levels

The results indicated that the interaction between varieties and micronutrients levels had a significant influence on Fe, Zn and Mn content in groundnut seed and straw compared to the control (Figs. 4 and 5). The highest mean values of Fe content in seeds and straw 187.9 and 188.5ppm were obtained by application of 500ppm Zn+Fe+Mn (M3) on Giza 6 variety (V1), while maximum Zn content in seeds and straw 53.9 and 35.03ppm were obtained by applied M3 treatment on Sohag 110 variety (V2), the highest Mn content in straw 139.3ppm were obtained by applied M3 treatment on V1, while there was non-significant effect among different micronutrient levels and varieties on Mn content of groundnut seed. This is to be logic since the same trend was observed among two varieties and also when increase the amount of micronutrient level as mentioned before consequently increase the amount of micronutrient content at groundnut seed and straw. These findings are in agreement with those obtained by Singh et al. (1990) reported that the concentration of S, Zn and Fe in leaves and stems of groundnut and their uptake increased significantly due to addition of different iron and sulphur source (Patel et al., 2008; Abdel-Motagally et al., 2016).

TABLE 2. Effect of varietal differences on growth, yield attributes and yield of groundnut in 2019 and 2020 seasons

Treatment	Plant height (cm)	Number of pods plant^{-1}	Number of nodules plant^{-1}	Straw weight (g plant^{-1})	Pods weight (g plant^{-1})	Seed weight (g plant^{-1})	Shelling%	100 seed weight (g)	Pod yield (kg ha^{-1})	Oil %	Oil yield (kg ha^{-1})
2019 season											
V_1	34.00	26.83	74.20	47.51	32.03	20.21	56.52	71.9	3014.8	49.91	1265.5
V_2	37.50	31.94	96.40	52.48	34.68	22.30	61.38	87.29	3308.8	50.56	1438.1
F test	*	*	*	*	*	*	*	**	*	*	*
2020 season											
V_1	28.36	27.52	100.5	81.69	39.60	28.01	73.00	69.23	3166.4	49.70	1355.2
V_2	31.02	29.28	121.7	74.62	46.95	31.00	69.71	86.30	3336.4	50.63	1459.3
F test	*	*	**	*	**	*	*	*	*	*	*

V1: Giza 6; V2: Sohag 110; * and ** significant and highly significant at 0.05 and 0.01 probability levels, respectively.

TABLE 3. Effect of Fe, Zn and Mn levels on growth, yield attributes and yield of groundnut in 2019 and 2020 seasons

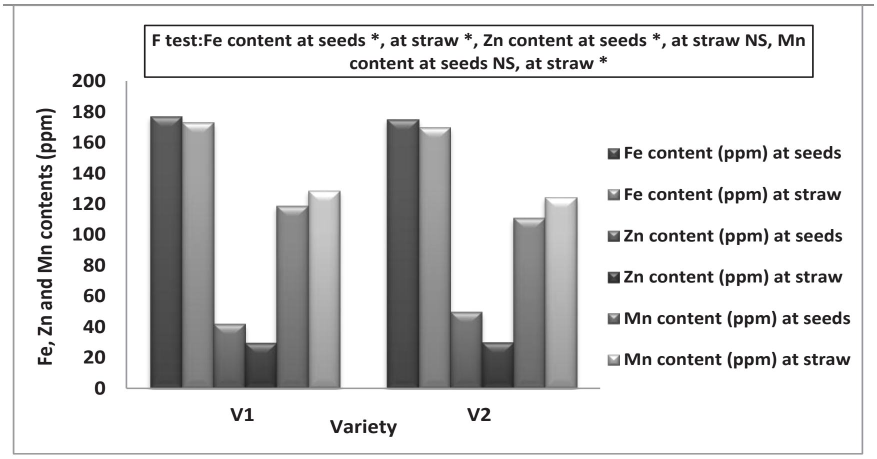
Treatment	Plant height (cm)	Number of pods plant^{-1}	Number of nodules plant^{-1}	Straw weight (g plant^{-1})	Pods weight (g plant^{-1})	Seed weight (g plant^{-1})	Shelling%	100 seed weight (g)	Pod yield (kg ha^{-1})	Oil %	Oil yield (kg ha^{-1})
2019 season											
M0	31.67	21.39	58.00	38.88	24.54	15.96	56.04	76.83	2261.0	48.84	868.80
M1	34.50	27.24	75.40	48.75	32.35	20.50	62.43	78.87	3070.7	50.67	1314.1
M2	41.67	37.99	109.80	56.20	40.40	25.13	59.75	82.06	3809.1	51.54	1718.8
M3	35.17	30.92	98.10	56.17	36.13	23.43	57.57	80.63	3506.4	49.88	1507.6
$LSD_{0.05}$	**0.889**	**1.349**	**11.630**	**2.319**	**3.218**	**1.484**	**2.980**	**1.811**	**113.8**	**0.452**	**54.33**
2020 season											
M0	25.36	19.52	68.00	48.57	29.84	14.70	59.40	73.19	2233.6	48.11	845.00
M1	29.53	26.19	86.00	76.78	45.74	32.46	77.66	75.70	3285.5	49.92	1413.8
M2	33.32	36.44	162.0	100.61	50.26	39.72	78.82	81.79	3997.4	52.20	1848.3
M3	30.56	31.45	128.5	86.66	47.26	31.14	69.54	80.37	3488.8	50.44	1521.9
$LSD_{0.05}$	**1.718**	**2.676**	**6.570**	**5.803**	**2.813**	**2.129**	**4.358**	**1.653**	**112.4**	**0.666**	**48.71**

M0: Control; M1:100ppm of each Fe, Zn and Mn; M2: 300ppm of each Fe, Zn and Mn; M3: 500ppm of each Fe, Zn and Mn; LSD: Revised least significant difference.

TABLE 4. The interaction effect between groundnut varieties and micronutrients Fe, Zn and Mn levels on growth, yield attributes and yield during 2019 and 2020

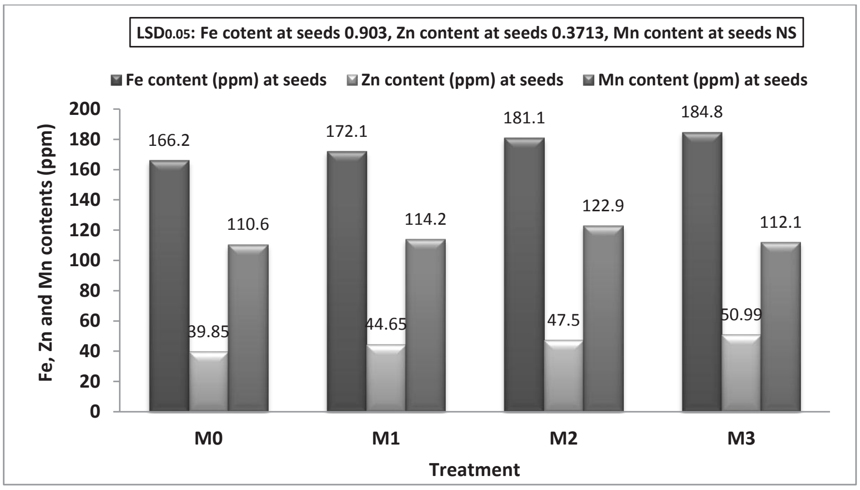
Variety	Treatment	Plant height (cm)	Number of pods plant^{-1}	Number of nodules plant^{-1}	Straw weight (g plant^{-1})	Pods weight (g plant^{-1})	Seed weight (g plant^{-1})	Shelling%	100 seed weight (g)	Pod yield (kg ha^{-1})	Oil %	Oil yield (kg ha^{-1})
2019 season												
V1	M0	30.33	17.67	62.80	40.08	25.56	15.15	51.07	70.77	2223.8	47.93	827.90
	M1	32.67	24.00	67.30	47.12	29.52	19.22	61.82	71.68	2937.6	50.47	1236.7
	M2	40.33	34.67	111.1	50.96	37.09	22.67	58.42	73.88	3593.1	51.41	1595.7
	M3	32.67	27.67	98.80	51.90	35.96	23.82	54.77	71.27	3304.8	49.82	1401.4
V2	M0	33.00	21.00	63.50	37.67	23.52	16.78	61.02	82.89	2298.1	49.74	905.00
	M1	36.33	27.67	83.80	50.38	35.18	21.78	63.04	86.05	3203.8	50.87	1391.7
	M2	43.00	38.00	121.5	61.44	43.71	27.59	61.08	90.23	4025.2	51.68	1841.9
	M3	37.67	31.00	105.8	60.45	36.30	23.04	60.38	89.99	3708.1	49.94	1613.8
	$LSD_{0.05}$	**1.249**	**NS**	**NS**	**3.875**	**3.954**	**1.862**	**4.233**	**2.345**	**145.5**	**0.691**	**67.26**
2020 season												
V1	M0	25.30	21.82	57.40	56.82	23.71	14.44	64.36	65.30	2250.7	47.26	842.62
	M1	26.41	25.90	76.80	85.48	43.08	31.37	78.44	68.23	3166.7	49.29	1345.2
	M2	31.22	33.13	145.7	99.74	47.85	35.00	76.55	72.74	3832.1	52.06	1756.4
	M3	30.51	29.23	122.2	90.72	43.77	31.23	72.64	70.66	3416.0	50.19	1476.4
V2	M0	25.41	17.23	78.60	40.32	35.97	14.96	54.44	81.08	2216.2	48.97	847.14
	M1	32.64	26.48	95.30	75.08	48.41	33.55	76.89	83.17	3404.5	50.54	1482.6
	M2	35.41	39.75	178.2	87.48	52.67	44.44	81.08	90.85	4162.9	52.34	1940.2
	M3	30.60	33.67	134.7	82.60	50.74	31.04	66.43	90.08	3561.9	50.69	1567.3
	$LSD_{0.05}$	**2.355**	**3.296**	**10.48**	**NS**	**3.651**	**2.88**	**5.502**	**2.713**	**162.1**	**0.839**	**71.91**

V1: Giza 6; V2: Sohag 110; M0: Control; M1:100ppm of each Fe, Zn and Mn; M2: 300ppm of each Fe, Zn and Mn; M3: 500ppm of each Fe, Zn and Mn; NS: Non-significant.



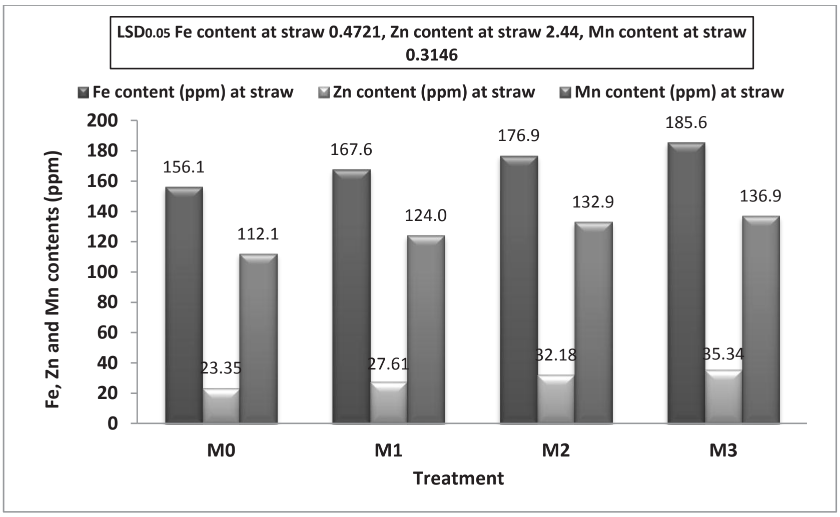
V1: Giza 6; V2: Sohag 110; *: significant; NS: Non-significant.

Fig. 1. Fe, Zn and Mn contents (ppm) in two groundnut varieties at seeds and straw



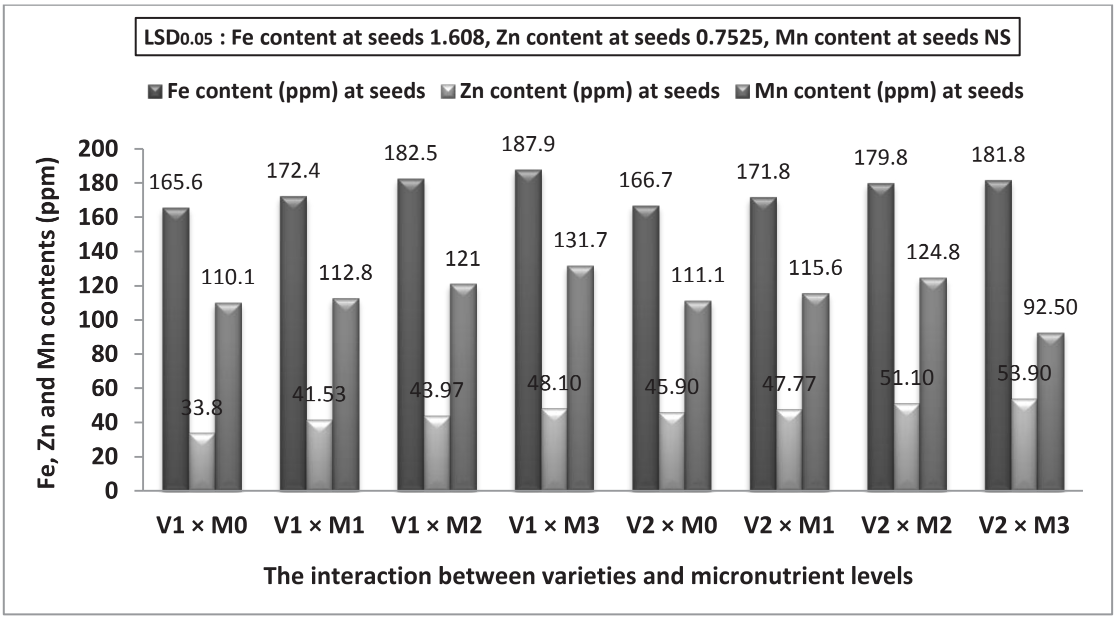
M0: Control; M1:100ppm of each Fe, Zn and Mn; M2: 300of each Fe, Zn and Mn; M3: 500ppm of each Fe, Zn and Mn; NS: Non-significant.

Fig. 2. Effect of micronutrient levels on Fe, Zn, and Mn contents at groundnut seeds



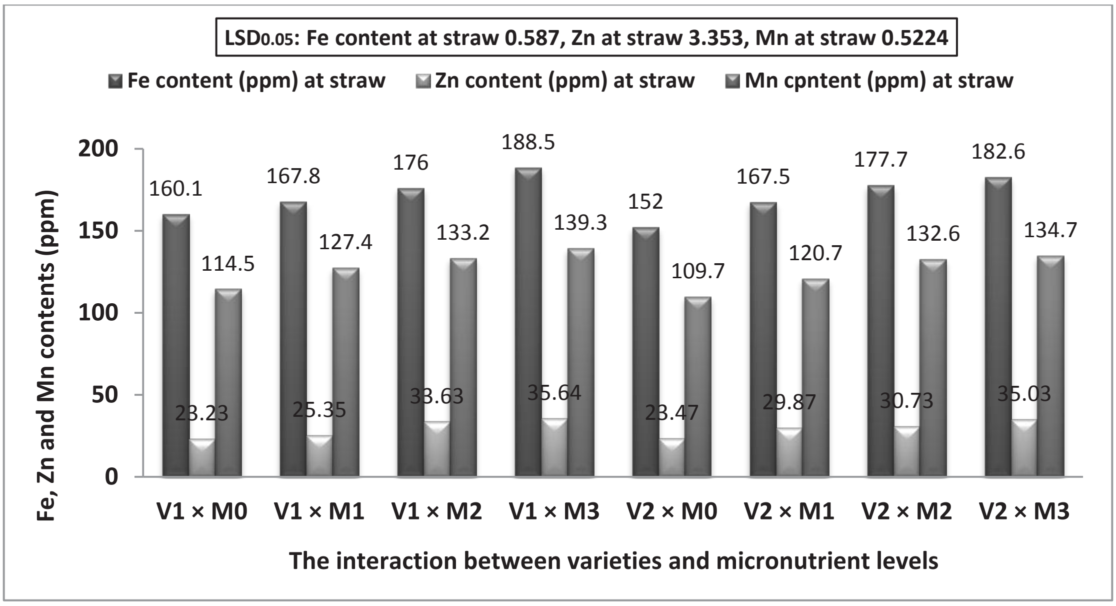
M0: control; M1:100ppm of each Fe, Zn and Mn; M2: 300of each Fe, Zn and Mn; M3: 500ppm of each Fe, Zn and Mn

Fig. 3. Effect of micronutrient levels on Fe, Zn and Mn contents at groundnut straw



V1: Giza 6; V2: Sohag 110; M0: control; M1:100ppm of each Fe, Zn and Mn; M2: 300ppm of each Fe, Zn and Mn; M3: 500ppm of each Fe, Zn and Mn; NS: Non-significant.

Fig. 4. Effect of the interaction between varieties and micronutrient levels on Fe, Zn and Mn contents measured in groundnut seeds



V1: Giza 6; V2: Sohag 110; M0: control; M1:100ppm of each Fe, Zn and Mn; M2: 300ppm of each Fe, Zn and Mn; M3: 500ppm of each Fe, Zn and Mn.

Fig. 5. Effect of the interaction between varieties and micronutrient levels on Fe, Zn and Mn contents measured in groundnut straw

Effect of micronutrients on unsaturated fatty acids

Results of the effect of the varieties with micronutrients on unsaturated fatty acids interaction are presented in Table 5. The results clearly showed that the rate of 300ppm foliar application with micronutrients was recorded the maximum value with all unsaturated fatty acids (Palmitoleic (C16:1), Heptadecenoic acid (C17:1), Oleic acid (C18:1), Linoleic acid (C18:2), Linolenic acid (C18:3) and Eicoaaenoic acid (C20:1) were produced by the commercial variety Giza 6 (V1) with values of 0.106, 0.086, 40.27, 37.88, 0.058 and 1.167mg g^{-1}, respectively .The maximum value of the mentioned trait (0.99, 0.112, 49.12, 30.35, 0.050 and 1.170mg g^{-1}) achieved by the interaction of promising groundnut line Sohage 110 (V2) under 300ppm (M2) foliar application with micronutrients on all unsaturated fatty acids and its components compared with the control treatment. These result are in harmony with Sabra et al. (2020) recorded that the unsaturated fatty acids significantly affected by micronutrient foliar application treatment and groundnut cultivars while the highest value of oleic fatty acid recorded 51.44% with Gregory cultivar by the treatment Zn + Mn + B foliar application treatment. The highest concentration of unsaturated fatty acids was found in Oleic acid (C18:1) followed by Linoleic acid (C18:2) while the low concentration of unsaturated fatty acids was observed by Linolenic acid (C18:3) in V1 and V2.

Effect of micronutrients on saturated fatty acids

The commercial variety Giza 6 (V1) with concentrations 300ppm (M2) foliar application with micronutrients showed the highest relative value to those of saturated fatty acids (0.038, 12.59, 0.114, 2.814, 1.295, 2.795 and 1.657mg g^{-1}) Myristic acid (C14:0), Palmitic acid (C16:0), Margarinic acid (C17:0),Stearic acid (C18:0), Arachidic acid (C20:0), Behenic acid (C22:0) and Ligoceric acid (C24:0) ,respectively (Table 6).

These results are in agreement with the results of promising peanut line Sohage 110 (V2) whose recorded the maximum value of saturated fatty acids 0.035,10.76,0.128,4.668,1.730,2.592 and 1.541mg g^{-1}) Myristic acid (C14:0), Palmitic acid (C16:0), Margarinic acid (C17:0),Stearic acid (C18:0), Arachidic acid (C20:0), Behenic acid (C22:0) and Ligoceric acid (C24:0) ,respectively ,with the micronutrients 300ppm.

Palmitic acid (C16:0) was the highest concentration of saturated fatty acids .While Myristic acid (C14:0) and Margarinic acid (C17:0) were the low concentration in all oils,on the other side Stearic acid (C18:0), Arachidic acid (C20:0), Behenic acid (C22:0) and Ligoceric acid (C24:0) were recorded the moderate concentration of saturated fatty. These finding are in harmony with Sabra et al. (2020) who illustrated that the saturated fatty acids affected slightly by micronutrient foliar application treatment and groundnut cultivars.

Effect of micronutrients on saturated and unsaturated fatty acids parameters:

The results showed that 300ppm (M2) foliar application with micronutrients was highest relative to those of all saturated fatty acids parameters except MUFA/PUFA ratio parameter compared with the control treatment with two genotypes V1 and V2.

Total unsaturated the super wise of all saturated fatty acids parameters, MUFA(Mono-unsaturated fatty acids) and PUFA(Poly-unsaturated fatty acids) and Total saturated were the moderate of saturated fatty acids parameters, while S/U ratio (Saturated/Unsaturated ratio) and MUFA/PUFA ratio (Mono-unsaturated fatty acids/ Poly-unsaturated fatty acids ratio) were recorded the lowest value of all saturated fatty acids parameters.

TABLE 5. Effect of foliar application with micronutrients on unsaturated fatty acids

Variety	Treatment	Palmitoleic (C16:1)	Heptadecenoic acid (C17:1)	Oleic acid (C18:1)	Linoleic acid (C18:2)	Linolenic acid (C18:3)	Eicoaaenoic acid (C20:1)
V1	M0	0.083	0.063	39.25	36.77	0.041	1.029
	M1	0.086	0.081	39.47	36.80	0.050	1.106
	M2	0.106	0.086	40.27	37.88	0.058	1.167
	M3	0.104	0.071	39.64	37.11	0.051	1.117
V2	M0	0.089	0.055	47.20	29.00	0.041	0.921
	M1	0.093	0.095	48.23	29.64	0.042	1.150
	M2	0.099	0.112	49.12	30.35	0.050	1.170
	M3	0.094	0.069	48.47	29.51	0.048	1.163

V1: Giza 6; V2: Sohag 110; M0: Control; M1:100ppm of each Fe, Zn and Mn; M2: 300ppm of each Fe, Zn and Mn; M3: 500ppm of each Fe, Zn and Mn.

TABLE 6. Effect of foliar application with micronutrients on saturated fatty acids

Variety	Treatment	Myristic acid (C14:0)	Palmitic acid (C16:0)	Margarinic acid (C17:0)	Stearic acid (C18:0)	Arachidic acid (C20:0)	Behenic acid (C22:0)	Ligoceric acid (C24:0)
V1	M0	0.030	11.70	0.094	2.545	1.260	2.529	1.377
	M1	0.032	11.98	0.113	2.634	1.287	2.599	1.501
	M2	0.038	12.59	0.114	2.814	1.295	2.795	1.657
	M3	0.037	12.33	0.098	2.670	1.278	2.696	1.579
V2	M0	0.032	10.66	0.090	3.186	1.499	2.308	1.333
	M1	0.034	10.74	0.102	3.364	1.603	2.527	1.407
	M2	0.035	10.76	0.128	4.668	1.730	2.592	1.541
	M3	0.034	10.71	0.125	3.589	1.513	2.511	1.471

V1: Giza 6; V2: Sohag 110; M0: Control; M1:100ppm of each Fe, Zn and Mn; M2: 300ppm of each Fe, Zn and Mn; M3: 500ppm of each Fe, Zn and Mn.

TABLE 7. Effect of foliar application with micronutrients on saturated and unsaturated fatty acids parameters

Variety	Treatment	Total saturated	Total unsaturated	S/U ratio	MUFA	PUFA	MUFA/PUFA ratio
V1	M0	19.54	77.24	0.253	39.33	36.81	1.07
	M1	20.14	77.58	0.260	39.56	36.85	1.07
	M2	21.30	79.57	0.268	40.38	37.94	1.07
	M3	20.69	78.09	0.265	39.74	37.16	1.07
V2	M0	19.11	77.31	0.247	47.29	29.04	1.63
	M1	19.78	79.25	0.249	48.32	29.68	1.63
	M2	21.45	80.90	0.265	49.22	30.40	1.62
	M3	19.95	79.18	0.252	48.56	29.56	1.64

V1: Giza 6; V2: Sohag 110; M0: Control; M1:100ppm of each Fe, Zn and Mn; M2: 300ppm of each Fe, Zn and Mn; M3: 500ppm of each Fe, Zn and Mn; S/U ratio: Saturated/Unsaturated ratio, MUFA: Mono-unsaturated fatty acids, PUFA: Poly-unsaturated fatty acids, MUFA/ PUFA: Mono-unsaturated fatty acids/ Poly-unsaturated fatty acids ratio.

Conclusion

In conclusion, difference among two groundnut varieties Sohag110 variety surpassed Giza6 in the most studied traits. Micronutrient foliar spray (Fe, Zn and Mn) at 300ppm could be considered a convenient strategy for improving groundnut growth, yield, yield attributes The contribution of groundnut two varieties interaction with different micronutrient levels, indicating the predominate influence of the most groundnut growth, yield and yield attributes. Highest pod yield 4025.2 and 4162.9kg ha^{-1} was recorded by interaction between V2 × M2 (300ppm micronutrient on Sohag 110 variety). Micronutrient foliar spray (Fe, Zn and Mn) at 500ppm resulted in marked improvement in Fe, Zn and Mn contents. Favorable effect of (Fe, Zn and Mn) at 300ppm was also significant on saturated and unsaturated fatty acid.

References

Abd El-Moneem, A.M.A., Said, M.T. (2018) Response of some peanut genotypes to phosphorus fertilization levels under new valley conditions. *Assiut Journal of Agricultural Sciences*, **49**(1), 1-9.

Abdel-Motagally, F.M.F., Mahmoud, M.W.Sh., Ahmed, E.M. (2016) Response of two peanut varieties to foliar spray of some micronutrients and sulphur application under East of El-Ewinat conditions.*Assiut Journal of Agricultural Sciences,* **47**(1), 14-30.

AOAC (1995) "*Association of Official Analytical Chemists*". 16th Ed., A.O.A.C International, Washington, USA, 1141p.

Arabhanvi, F., Pujar, A.M., Hulihalli U.K. (2015) Micronutrients and productivity of oilseed crops - A review. *Agricultural Reviews*, **36**(4), 245-248.

Aravind, P., Prasad, M.N.V. (2004) Zinc protects chloroplasts and associated photochemical functions in cadmium exposed *Ceratophyllum demersum* L., a freshwater macrophyte. *Plant Science,* **166**(5), 1321-1327.

Arunachalam, P., Kannan, P., Prabhaharan, J., Prabukumar, G., Kavitha, Z. (2013) Response of groundnut (*Arachis hypogaea*L.) genotypes to soil fertilization of micronutrients in alfisol conditions. *Electronic Journal of Plant Breeding,* **4**(1), 1043-1049.

Chaiyadee, S., Jogloy, S., Songsri, P., Singkham, N., Vorasoot, N., Sawatsitang, P., Holbrook, C.C., Patanothai, A. (2013) Soil moisture affects fatty acids and oil quality parameters in peanut. *International Journal of Plant Production*, **7**(1), 81-96.

Damor, V.C., Patel, J.M., Chaudhary, P.P. (2019) Effect of Fe and Zn enriched organics on yield, quality and nutrient uptake by summer groundnut *International Journal of Chemical Studies,* **7**(5), 1998-2003.

El- Far, I.A., Ali, E.A., El-Sawyand, W.A., Mohamed, A.H. (2016) Evaluation of some peanut genotypes under two planting methods and different fertilization levels. *Assiut Journal of Agricultural Sciences,* **47**(6-2), 311-324.

El-Metwally, I.M., Doaa, M.R., Abo-Basha, Abd El-Aziz, M.E. (2018) Response of peanut plants to different foliar applications of nano- iron, manganese and zinc under sandy soil conditions. *Middle East Journal of Applied Science,* **8**(2), 474-482.

Gobarah, M.E., Mohamed, M.H., Tawfik, M.M. (2006) Effect of phosphorus fertilizer and foliar spraying with zinc on growth, yield and quality of groundnut under reclaimed sandy soils. *Journal Applied Science Research*, **2**(8), 491-496.

Gomez, K.A., Gomez, A.A. (1984) "*Statistical Procedure for Agricultural Research*". 2nd ed, John Wiley and Sons, New York, USA.

Gyana, R.R., Sunita, S. (2015) Role of iron in plant growth and metabolism. *Reviews In Agricultural Science,* **3**(1), 1-24.

ISO 12966-2.first edition (2017) Animal and vegetable fats oils Gas chromatography of fatty acid methyl esters.

Jackson, M.L. (1973) "*Soil Chemical Analysis*". Prentice-Hall of India Private Limited, New Delhi.

Kim, J., Rees, D.C. (1992) Structural models for the metal centers in the nitrogenase molybdenum-iron protein. *Science*, **257**(5077), 1677-1682.

Lindsay, W.L., Norvel, W.A. (1978) Development of a DTPA soil test for zinc, iron, manganese, and copper. *Soil Science Society of America Journal,* **42**, 421-428.

Mahrous, N.M., Safina, S.A., Abo Taleb, H.H., El-Behlak, S.M. (2015) Integrated use of organic, inorganic and bio fertilizers on yield and quality of two peanut (*Arachis hypogaea* L.) cultivars grown in a sandy saline soil. *American-Eurasian Journal of Agricultural & Environmental Sciences*, **15**(6), 1067-1074.

Meena, S., Malarkodi, M., Senthilvalavan, P. (2007) Secondary and micronutrients for groundnut – A review. *Agricultural Reviews*, **28**(4), 295-300.

Millaleo, R., Reyes, D.M., Ivanov, A.G., Mora, M.L., Alberdi, M. (2010) Manganese as essential and toxic element for plants transport, accumulation and resistance mechanisms. *Journal of Soil Science and Plant Nutrition*, **10**, 470-481.

Mohammed, K.E., Afutu, E., Odong, T.L., Okello, D.K., Nuwamanya, E. (2018) Assessment of groundnut (*Arachis hypogaea L.)* genotypes for yield and resistance to late leaf spot and rosette diseases. *Journal of Experimental Agriculture International,* **21**(5), 1-13.

Nandi, R., Reja, H., Chatterjee, N., Bag, A.G., Hazra, G.C. (2020) Effect of Zn and B on the growth and nutrient uptake in groundnut. *Current Journal of*

Applied Science and Technology, **39**(1), 1-10.

Noman, H.M., Rana, D.S., Choudhary, A.K., Rajpoot, S., Paul, T. (2016) Sulphur and Zn management in groundnut (*Arachis hypogaea*)-wheat (*Triticum aestivum*) cropping system: Direct effects on system productivity and residual effects on yield, energetics and Zn biofortification in wheat. *Indian Journal of Agricultural Sciences,* **86**(4), 441–447.

Patel, K.C., Patel, K.P., Kandoria, H.K., Jetani, K.L., Ramani, V.P. (2008) Yield and uptake of micronutrients by groundnut [*Arachis hypogea* (L.)] as influenced by foliar application of seaweed liquid fertilizer under rainfed condition of Jamkhambhaliya, Saurashtra region. *Asian Journal of Soil Science*, **3**(2), 252-256.

Piper, C.S. (1950) "*Soil and Plant Analysis*".1st ed. Inter Science Publishers. Inc. New York, pp. 30-229.

Rajitha, G., Reddy, M.S., Babu, P.V.R., Maheshwari, P.U. (2018) Influence of secondary and micronutrients on yield and yield components in groundnut (*Arachis hypogaea* L.). *International Journal of Current Microbiology and Applied Sciences,* **7**(9), 309-316.

Sabra, D.M., El-Bagoury, O.H., El Habasha, S.F., Fergani, M.A., Mekki, B.B., El-Housini, E.A., Abou-Hadid, A.F. (2020) Effect of some micronutrients foliar application on chemical characters of two groundnut cultivars. *Plant Archives,* **20**(1), 1367-1376.

Seadh, S.E., Abido, W.A.E., Abd El-Al, A.N., Ibrahim, Z.A.A. (2017) Effect of NPK-Levels on productivity and seed quality of some groundnut genotypes under newly reclaimed sandy soils condition. *Journal of Plant Production*, **8**(5), 605-609.

Shete, S.A., Bulbule, A.V., Patil, D.S., Pawar, R.B. (2018) Effect of foliar nutrition on growth and uptake of macro and micronutrients of Kharif Groundnut (*Arachis hypogaea* L.). *International Journal of Current Microbiology and Applied Sciences,* **7**(10), 1193-1200.

Singh, A.L. (1999) Mineral nutrition of groundnut. *Advances in Plant Physiology*, **2**, 161-200.

Singh, A.L., Chaudhari, V. (1997) Sulphur and micronutrient nutrition of groundnut in a calcareous soil. *Journal of Agronomy and Crop Science,* **179**(2), 107-114.

Singh, A.L., Joshi, Y.C., VidyaChaudhari, Zala, P.V. (1990) Effect of different sources of iron and sulphur on leaf chlorosis,nutrient uptake and yield of groundnut. *Fertilizer Research*, **24**, 85-96.

Sisodiya, R.R., Babaria, N.B., Parmar, T.N., Parmar, K.B. (2017) Effect of sources and levels of sulphur on yield and micronutrient (Fe, Mn, Zn and Cu) absorption by groundnut (*Arachis hypogaea*L.). International Journal of Agriculture Sciences, **9**(32), 4465-4467.

Tedesco, M.J., Gianello, C., Bissani, C.A., Bohnen, H. Volkweiss, S.J. (1995) "*Analysis of Soil, Plants and Other Materials*". Technical Bulletin No. 5, 2nd ed., Federal University of Rio Grande doSul.

تأثير الرش الورقي لبعض معدلات من العناصر الصغري علي النمو والمحصول والصفات المحصوليه ومحتوي العناصر الصغري وكذلك الاحماض الدهنيه في صنفين من الفول السوداني

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اقيمت التجربه بمحطه عرب العوامر البحثيه بقسم بحوث المحاصيل الزيتية – محافظه اسيوط خلال موسمي 2019-2020 لتقييم استجابه صنفين من الفول السوداني (جيزه 6 و سوهاج 110) للرش الورقي بمعدلات مختلفه من العناصر الصغري (الحديد والمنجنيز والزنك)، التجربه مزروعه بتربه جيريه رملية، استخدم لذلك تصميم القطاعات كاملة العشوائية باستخدام ترتيب القطاعات المنشقة في ثلاث مكررات حيث تم التوزيع العشوائي لصنفي الفول السوداني (جيزه 6 وسوهاج 110) في القطاعات الرئيسيه بينما تم توزيع الاربع مستويات من العناصر الصغري في القطاعات المنشقه، النتائج اوضحت أنه يوجد فروق معنويه بين صنفي الفول السوداني وأن الصنف سوهاج 110 يتفوق علي الصنف جيزه 6 في معظم الصفات المدروسه خلال الموسمين وكذلك الرش الورقي بالعناصر الصغري له تاثير معنوي وبالاخص التركيز 300 جزء في المليون والذي كان متفوق علي باقي المعدلات في الموسمين، كما أثر التفاعل بين الأصناف ومعدلات العناصر الصغري تأثيراً معنوياً على جميع مكونات محصول دوار الشمس في موسمي النمو، حيث تم الحصول على أعلى متوسطات لقيم محصول البذور(4025.2 و4162.9 كجم للهكتار-1) ومحصول الزيت (1841.9 و1940.2 كجم للهكتار)-1 من التفاعل بين (v2×m2) (300 جزء في المليون علي الصنف سوهاج 110). بينما التركيز 500 جزء من المليون للعناصر الصغري سجل اعلى معدل من تركيز الحديد والمنجنيز والزنك في كل من البذور والقش. الاحماض الدهنيه المشبعه والغير مشبعه سجلت اعلى معدل لها عند اضافه التركيز 300 جزء في المليون من العناصر الصغري .