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Response of Peanut to Nitrogen Fertilizer Levels and Foliar Zinc Spraying Rates in Newly Reclaimed Sandy Soils

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ABSTRACT

Two field experiments were conducted at the Farm of the Faculty of Agriculture, Demo, Fayoum University, Egypt, during 2014 and 2015 summer growing seasons to study the effect of three nitrogen levels *i.e.*, 15, 30 and 45 kg N fad^{-1} (fad=4200 m^2) and foliar spraying with zinc rates *i. e.* (Zero, Water as a control), 50, 0.75 and 1.00 g Zn L^{-1} on yield and its attributes of peanuts (variety Giza 6). The experimental design was a split - plot in RCBD with three replications, where nitrogen levels and foliar spraying of zinc rates were allocated in the main and sub plots, respectively.1- The adopted either N levels or Zn foliar application rates and their interactions significantly influenced all measured parameters in 1st and 2nd seasons. Increasing N levels up to 45 kg N fad^{-1} significantly increased most measured characteristics namely, seed, straw and pod yields, number of pods $plant^{-1}$, weight of pods $plant^{-1}$, number of seeds $plant^{-1}$, weight of seeds $plant^{-1}$, weight of 100 pods and weight of 100 seed, seed oil yield, N%, protein %, and protein yield of groundnut in1st and 2nd seasons. On the contrary, seed oil % and N- use Efficiency traits exhibited different trend, where the values significantly decreased with increasing N levels. 2-The assessed Zn foliar application rates, up to 1.00 g L^{-1} resulted in gradual significant increases for the abovementioned characteristics.3-Regarding the interaction effect, it is obvious that most peanut traits under study e.g. yield, yield attributes and quality exhibited higher values due to the interaction of 45 $KNfed^{-1}$ level and foliar Zn application at 1.00 gL^{-1} rate. Due to the mentioned interaction, pod yield (t fed^{-1}) and seed oil (%) parameters, as an average of both seasons, amounted to 2.51 t fed^{-1} and 47.89%, respectively. Likely, number of seed $plant^{-1}$ exhibited similar trend with value comprised to 58.00 in 1st season. In addition, number of pod $plant^{-1}$, seed yield (t fed^{-1}), seed oil yield (t fed^{-1}) and seed protein % with values reached to 34.67, 1.58, 0.76 and 26.10%, respectively, in 2nd season. 4- Positive and highly significant correlations were obtained between oil yield ton fed^{-1} and seed yield ton fed^{-1}, r = 0.995** and 0.992**. Negative and highly significant correlations were obtained between seed yield ton fed^{-1} and seed oil % equals - 0.539** and - 0.691**, respectively, in 1st and 2nd seasons.

Keywords: Peanut, N fertilization, foliar zinc application, stepwise, correlation, seed yield, yield attributes, oil and protein yields.

INTRODUCTION

Peanut (*Arachis hypogaea* L.) is considered as successful crop in newly reclaimed sandy soils, and the crop has a high content of edible oil. The newly reclaimed soil are suffer shortages in nutrient elements which required for acceptable crop outputs. Peanut is fundamental summer oil seed crop and food grain legume. It is a useful provenance of rich in energy (567 calories/100 grams) and contains health benefiting nutrients, minerals, antioxidants and vitamins that are basis for optimum health. The peanut oil composes enough rates of mono-unsaturated fatty acids (MUFA), particularly oleic acid, which helps lower LDL or "bad cholesterol" and increase HDL or "good cholesterol" level in the blood. The seeds of peanuts are an excellent source of vitamin E (α tocopherol) which containing about 8 g/100 grams. Vitamin E is a strong lipid soluble antioxidant which helps maintain the integrity of cell membrane of mucus membranes and skin by protecting from harmful oxygen free radicals. Additionally, 100 grams of peanuts provide about 85% of niacin, which contribute to brain health and blood flow to brain.

Nitrogen is a fundamental element of many components of plant, like chlorophyll, proteins, enzymes, hormones and vitamins. It increment the photosynthesis rate and assimilates translocation to the seed. Tiwari and Dhakar (1997), Barik *et al.* (1998), Gohari and Niyaki (2010), Bozorgi *et al.* (2011), Ziaeidoustan *et al.*(2013) and El Habbasha *et al.*(2014) showed that applying higher level of N -fertilization produced the greatest values of pod and seed yields, pod weight $plant^{-1}$, seed index, 100–pod weight and seed oil yield. In Egypt, Farag, Iman and Zahran(2014) reported that increasing N fertilization to 60 Kg N fad^{-1} comparing with 30 Kg N fad^{-1}, significantly increased Pod, straw and seed yields. The authors added that the yield attributes e.g. number of pods $plant^{-1}$, Pod weight $plant^{-1}$ seed weight $plant^{-1}$, weight of 100 seeds, seed oil content %, oil yield (Kg fad^{-1}) and Protein content (%) exhibited similar trend.

Zinc element is one of the most substantial nutrients required for plant development as an activator of various enzymes is directly participatory in the biosynthesis of growth material like for auxin, which promotes production of more plant cells and biomass that will be stored in the plant organs especially in seeds. Moreover, Zinc appeared in six enzyme categories e.g. oxidoreductases, transferases, hydrolases, lyases, isomerases and ligases (Auld, 2001). Additionally, Zn is required for chlorophyll production, pollen function and germination (Cakmak, 2008). Zinc's action in cell membrane integrity will also be researched particularly for root cells along with its function in suppressing free radical damage to cells (Cakmak, 2000). Reduction of crop yield due to zinc shortage ranged from 13.3 to 20 % (Singh *et al.*, 2004). Zinc shortage is a prevalent characteristic in much climatic regions, especially in newly reclaimed soil and it cause sharp lowering in yields of peanuts plants. A few researchers noted that zinc element as foliar spraying could repair zinc shortage, increase development, yield of peanuts plants. Darwish *et al.*, (2002) reported that applying of Zn (1000 mg L^{-1} as Zn sulphate) produce the highest values of seed and oil yield as well as protein %. Moreover, Ali and Mowafy (2003) reported that using of Zinc 2% as foliar spraying slightly improved peanut yield and its attributes as well as quality. El Habbasha *et al.*, (2013) reported that applying of Zinc as foliar spraying increased the number of pods and seeds plant^{-1}, weight of pods and seeds plant^{-1}, seed index, yields of pods, seeds and oil, as well as N use efficiency compared to control treatment. Recently, Irmak *et al.* (2016) reported gradual increases in peanut yield were noticed due to increasing foliar Zn application rate. The authors added that increasing Zn rate up to one kg ha^{-1} resulted in higher values of seed oil and protein contents%.

The aim of the present study was to investigate the influences of nitrogen fertilizer levels and foliar application with zinc on yield, yield attributes and quality traits of peanut grown in newly reclaimed sandy soils at Fayoum Governorate, Egypt.

MATERIALS AND METHODS

Two field trials were carried out in the Farm of the Faculty of Agriculture, Demo (29°17` N; 30°53` E), Fayoum University, Egypt, during the two successive summer seasons 2014 and 2015, to study the effect of nitrogen fertilizer levels and foliar application with zinc on yield and its components and quality of peanuts. Particle size distribution and some chemical properties of the experimental soil, were determined according to Wilde *et al.* (1985), and presented in Table 1. The experimental unit area was 10.5 m^2 consisting of five ridges, 3.5 m long and 60 cm apart. Peanut seeds were sown on April 15th and 11th in the first and second seasons, respectively.

The peanut seeds (Giza 6 CV) were inoculated just before planting with the specific rhizobium bacteria inoculants and sown in hills 10 cm apart. The experimental design was split-plots design in RCBD with three replicates, where nitrogen fertilizer levels (15, 30 and 45 kg N fad^{-1}, (one faddan = 4200 m^2) were assigned to the main plots, and zinc as foliar application at 0.50, 0.75 and 1.00 g L^{-1} rates comparing with water as control were distributed in the sub-plots. The rates of zinc foliar spraying were applied twice at (30 and 50 days after planting) at 400 L fad^{-1} rate using a hand sprayer. Chelated zinc (EDTA)) form was used. Phosphorus fertilizer, as calcium superphosphate (15.5 % P_2O_5) at 250 kg fad^{-1} rate, potassium fertilizer as potassium sulfate, 48 % K_2O at 24kg k_2O fad^{-1} rate and organic fertilizer at 20 m^{3}fad^{-1} rate were incorporated into the soil surface during seed bed preparation.The assessed nitrogen doses were added as ammonium sulfate (20.6 %N) in three equal doses at 15, 30 and 45 days after planting. Surface irrigation was adopted as recommended. The preceding winter crops were faba bean and sugar beet in the first and the second seasons, respectively.

Peanut was manually harvested on September 25th and 28th in the first and second seasons, respectively. At harvest, a random sample of ten plants were taken from each sub plot to determine number of pods plant^{-1}, weight of pods plant^{-1}, number of seeds plant^{-1}, weight of seeds plant^{-1}, 100-seed weight and 100-pod weight. Plants on the middle two rows in each sub plot were harvested and dried to calculate, pods, straw and seed yield fad^{-1}. Nitrogen use efficiency was calculated (kg seeds kg N^{-1}) according to Moll *et al.*, (1982). Samples, each of 50 g seeds, were grinded into fine powder and stored in brown glass bottles for chemical analysis. Seed oil and N%, were determined according to the methods described by A.O.A.C. (1990), and the seed protein % was calculated by multiplying total nitrogen % by 6.25. Seed oil and protein yields per faddan was calculated by multiplying seed oil and N% by seed yield fad^{-1}. All obtained data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the spilt- plot design as outlined by Gomez and Gomez (1984), using MSTAT statistical package (MSTAT- C). Least Significant Difference (LSD, at 5% level of probability) was used to test the differences between treatments mean.

Table 1. Particle size distribution and some chemical properties of the experimental soil in 2014 and 2015 seasons.

Season		2014	2015
Sand%		66.5	76.1
Silt%		12.4	10.8
Clay%		21.1	13.1
Textural class		**Sandy clay Loam**	**Sandy Loam**
CaCO3%		7.10	5.20
Cations	Na^+	69.80	65.70
	K^+	2.82	1.40
	Mg^{+2}	25.00	11.18
meqL^{-1}	Ca^{+2}	30.88	60.62
Anions	$SO4^{-2}$	28.60	33.40
	CL^-	92.40	94.50
	$HCO3^-$	7.50	11.0
	$CO3^{-2}$	-	-
Organic Matter %		1.47	0.70
ECe, dSm^{-1} at 25 ºC		5.89	5.33
pH at 25 Cº		7.63	7.87
Micronutrients (ppm)	Fe	6.86	4.29
	Mn	4.21	3.57
	Cu	1.46	0.69
	Zn	1.10	0.29

Nitrogen use efficiency is GwlNs in which *Gw* is grain weight and Ns is N supply expressed in the same units (e.g., glplant).

RESULTS AND DISCUSSION

A- Effect of nitrogen fertilizer levels and foliar Zn application rates

1. Seed, Straw and Pod yields of groundnut

It is clear that the results in the first and second seasons exhibited similar trends, so the discussion will performed on the two seasons mean. Data in Table 2 revealed that the adopted treatments significantly influenced seed, straw and pod yields of groundnut in1st and 2nd seasons. Increasing N level to 45 kg N fad^{-1} resulted in gradual increase in seed, straw, and pod yields amounted to (28.07and 12.31%), (30.12 and 14.10%) and (30.29 and 16.33 %), respectively, comparing with 15 and 30 kgNfed^{-1} rates. These findings are attributable nitrogen rule as fundamental factor to producing higher growth of vegetative and reproductive organs of peanuts and enhancing photosynthesis level which increasing seed yield of peanuts. These results are in agreement with those obtained by (Tiwari and Dhakar, (1997), Barik *et al.* (1998), Gohari and Niyaki (2010), Ziaeidoustan *et al.* (2013) and El-Habbasha et al. (2013) found that increasing N levels from 30 to 40 kg N fad^{-1} significantly increased pod, seed and straw yields. In addition, Farag, Iman and Zahran (2014) reported that the maximum groundnut seed yield was attained with the highest N level.

The tested foliar Zn application rates exhibited similar trend, where the highest seed, straw, and pod yields values (1.39and 4.09 and 2.15 t fed$^{-1,}$, respectively, as the mean 1st and 2nd seasons, which were recorded with the highest rate of foliar Zn rate i.e.1.0 g Zn L^{-1}. The seed, straw and pod yields fad^{-1} tended to reduction by (15.93, 8.59 and 4.51%), (9.07, 6.96 and 2.61%) and (16.85, 9.69 and 5.39%) with Zero, 0.5 and 0.75 g Zn L^{-1} foliar application rates, comparing with 1.0 gZnL^{-1}. In this sense, Irmak et al. (2016) reported gradual increases in Peanut yield (NC-7 variety) due to increasing foliar Zn application rate. In addition, El Habbasha *et al.* (2013), El Habbasha *et al.* (2014) and El Habbasha (2015) found that increasing level of zinc produced higher groundnut pod and seed yields.

Table 2. Effect of N levels and foliar Zinc application rates on Seed, Straw and Pod yields of groundnut in 2014 and 2015 seasons

Treatments	Seed yield (t fed^{-1})		Straw yield (t fed^{-1})		Pod yield (t fed^{-1})	
N fertilization level	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
15 kg N fad^{-1}	1.14	1.13	3.40	3.43	1.77	1.73
30 kg N fad^{-1}	1.29	1.31	3.98	3.81	1.94	1.98
45 kg N fad^{-1}	1.42	1.49	4.49	4.41	2.21	2.34
LSD 0.05	0.05**	0.08**	0.07**	0.06**	0.13**	0.06**
Foliar Zn application rate						
Zero g Zn L^{-1}	1.18	1.22	3.78	3.72	1.82	1.86
0.50 g Zn L^{-1}	1.26	1.29	3.90	3.82	1.94	1.97
0.75 g Zn L^{-1}	1.31	1.34	4.03	3.94	2.02	2.05
1.0 g Zn L^{-1}	1.38	1.39	4.12	4.05	2.11	2.18
LSD 0.05	0.03**	0.02**	0.09**	0.03**	0.04**	0.05**

*** P < 0.05; **P < 0.01 and ns – non-significant**

2-Yield attributes

Data in Table 3 showed that either the adopted N fertilization levels or foliar Zn application rates significantly influenced the yield attributes in 1st and 2nd seasons of study. A gradual increase in the values of yield attributes e.g. number of pods plant^{-1}, weight of pods plant^{-1}, number of seeds plant^{-1} weight of seeds plant^{-1}, weight of 100 pod and weight of 100 seed were observed with increasing the N level, and such findings were true in both seasons. As the two seasons mean, the increases in the above mentioned yield attributes due to 45 kg N fad^{-1} level were (20.78and 10.45%), (15.22 and 8.69%) and (14.67 and 9.56 %), (16.94 and 6.34%), (10.15 and 2.52%) and (11.79 and 4.53 %) respectively, comparable with 15 and 30 kgNfed^{-1} rates. The present results are in parallel with those of El-Habbasha et al. (2013) who found that increasing N levels from 30 to 40 kg N fad^{-1} significantly increased number of pods/plant, weight of pods/plant, weight of seeds/ plant, 100-seed weight. Additionally, Farag, and Zahran(2014) reported that increasing N fertilization to 60 Kg N fad^{-1} significantly increased the yield attributes of peanut e.g. number of pods/ plant, pod weight/ plant and seed weight/ plant and weight of 100 seeds, as compared with 30 Kg N fad^{-1},.

Table 3. Effect of nitrogen levels and foliar zinc application rates on peanut yield attributes in 2014 and 2015 seasons.

Treatments	Number of pods plant^{-1}		Weight of pods plant^{-1} (g)		Number of Seedsplant^{-1}		Weight of Seeds plant^{-1} (g)		Weight of 100 pod (g)		Weight of 100 seeds (g)	
	2014	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
N fertilization level												
15 kg N fad^{-1}	26.17	24.75	36.75	36.83	42.42	45.00	31.25	30.75	165.88	163.08	73.28	73.26
30 kg N fad^{-1}	28.42	27.25	38.83	39.17	46.42	47.75	34.50	33.67	173.85	174.68	77.68	79.03
45 kg N fad-1	31.58	29.92	41.92	42.75	51.17	52.00	36.50	36.00	180.93	181.43	80.86	82.96
LSD 0.05	0.64**	2.50*	2.59*	1.67**	1.48**	1.88**	0.80**	2.64*	4.71**	4.15**	3.05**	2.33**
Foliar Zn application rate												
Zero Zn L^{-1}	25.67	24.22	35.89	37.11	41.22	41.89	30.67	30.22	168.46	166.29	73.23	74.38
0.50 g Zn L^{-1}	27.33	26.44	38.00	38.78	44.67	47.00	33.44	32.78	172.30	171.70	75.72	77.41
0.75 g Zn L^{-1}	29.44	28.22	40.22	40.44	48.44	50.56	35.22	34.44	175.26	175.70	78.93	80.21
1.0 g Zn L^{-1}	32.44	30.33	42.56	42.00	52.33	53.56	37.00	36.44	178.19	178.54	81.33	81.67
LSD 0.05	0.80**	0.67**	1.02**	0.58**	0.63**	0.86**	0.60**	0.65**	1.26**	2.54**	1.23**	0.70**

P < 0.05; **P < 0.01 and ns – non-significant

Similarly, the highest values of the above mentioned yield attributes were recorded with the highest rate of foliar Zn application rate *i.e.*1.0 g Zn L^{-1}. with Zero, 0.50 and 0.75 g Zn L^{-1} rates, yield attributes tended to reduce by (26.37,13.70 and10.19%), (18.58 ,12.00 and 5.82%) , (26.95,17.15 and8.03 %) , (20.64, 10.65 and 5.05%) , (5.75,3.42 and 1.67%) and (11.06,7.41 and3.04 %), respectively, comparable with 1.00 $gZnL^{-1}$ rate in 1st season. The corresponding reduction values amounted to (25.23, 14.71and 7.48%), (13.18, 8.30 and3.86%), (27.86, 13.96 and 5.93%), (27.86, 13.96 and 5.9 3%), (20.58, 11.17 and 5.81%), (7.37, 3.98 and 1.62%) and (1.82, 5.50 and3.04 %), respectively, comparing with 1.00 $gZnL^{-1}$ rate in 2nd season. The obtained results are in parallel with those of Ali and Mowafy (2003) who reported that using of Zinc at 2% as foliar spraying slightly improved peanut yield and its attributes as well as quality. Additionally, El Habbasha *et al*. (2013) reported that applying of Zinc as foliar spraying achieved the highest number of pods and seeds $plant^{-1}$, weight of pods and seeds $plant^{-1}$.

3- Seed oil%, seed oil yield, N%, protein %, protein yield and N- use Efficiency

Data in Table 4 revealed that peanut seed oil%, seed oil yield, N%, protein %, protein yield and N- use Efficiency were significantly influenced due to the adopted treatments in the two seasons. Increasing N level resulted in a gradual reduction in peanut seed oil%, where the reduction with 30 and 45 kg $Nfed^{-1}$ rates amounted to 1.83 and 3.56%, comparable with 15kg $Nfed^{-1}$ rate. El Habbasha *et al*. (2013) previously reported that seed oil% was slightly reduced under 40 kg $Nfed^{-1}$ rate, comparing with 30kg $Nfed^{-1}$one. Similarly, N- use Efficiency exhibited the same trend, where the value tended to reduction with 30 and 45 kg $Nfed^{-1}$ rates by 42.67 and 57.04%, respectively, compared with15kg $Nfed^{-1}$ rate. In connection, Hossain *et al*. (2007) and El Habbasha *et al*. (2013) noted that N use efficiency tended to reduction with increased the level of nitrogen fertilizer. Seed oil yield revealed an opposite trend, where the value was increased under 30 and 45 kg $Nfed^{-1}$ rates by 12.50 and 25.00%, respectively, comparing with 15 kg $Nfed^{-1}$ rate. Higher seed oil yield under 30 and 45 kg $Nfed^{-1}$ rates are attributable to higher seed yield with 30 and 45 kg $Nfed^{-1}$ rates. With respect to seed N%, seed protein% and protein yield, such traits tended to increase with N level increasing, and reached to (2.08, 4.94%) , (2.20 and 4.78 %) and (18.91 and 34.31%) under 30 and 45 kg $Nfed^{-1}$ levels, respectively, higher than with 15 kg $Nfed^{-1}$ rate. El-Habbasha (2015) stated that peanut N and protein% were slightly increased with increasing N rate.

Data in Table 4 revealed that the highest foliar Zn application rate e.g. 1.0 g Zn L^{-1} rate exhibited higher figures of seed oil (%), seed oil yield (t fad^{-1}), N%, seed protein%, protein yield, $kgfed^{-1}$ and N- use efficiency (kg seeds/kg N), compared with the other foliar Zn application rates. The increases in seed oil (%) and seed oil yield (t fad^{-1})traits, under 1.0 g Zn L^{-1} rate, reached to (1.37, 0.97 and 0.41%), (19.30, 7.94 and4.62), respectively, compared with Zero , 0.50 and 0.75 g Zn L^{-1} rates. With respect to N%, seed protein%, protein yield ($kgfed^{-1}$) and N- use efficiency (kg seeds/kg N), the increases comprised (6.58, 3.32 and 0.99%), (6.84, 3.43 and 1.56), (23.27, 9.46 and 7.41%) and (15.68, 8.63 and 4.23), compared with the other foliar Zn application rates in the same above order. El-Habbasha (2015) reported that the highest peanut seed N and protein % were noticed with 750 mgL^{-1} rate, comparable with zero, 500 and 1000 mgL^{-1} rates.

Table 4. Effect of N levels and foliar zinc application rates on peanut seed oil%, seed oil yield, N%, protein %, protein yield and N- use Efficiency in 2014 and 2015 seasons.

Treatments	Seed Oil (%)		Seed Oil yield (t fad^{-1})		N %		seed protein%		Protein yield, $kgfed^{-1}$		N- use Efficiency (kg seeds kg N^{-1})	
N fertilization level												
	2014	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
15 kg N fad^{-1}	49.05	49.91	0.56	0.56	3.86	3.83	24.13	23.96	275.08	270.75	75.78	75.00
30 kg N fad^{-1}	48.49	48.70	0.62	0.64	3.94	3.92	24.65	24.51	317.99	321.08	42.83	43.61
45 kg N fad^{-1}	47.72	47.73	0.68	0.71	4.04	4.03	25.25	25.14	358.55	374.58	31.63	33.15
LSD 0.05	0.33**	0.39**	0.01**	0.02**	0.23**	0.23**	0.30**	0.37**	6.44**	3.30**	3.03**	2.87**
Foliar Zn application rate												
Zero Zn L^{-1}	48.13	48.40	0.57	0.59	3.78	3.81	23.60	23.80	278.48	290.36	46.05	46.91
0.50 g Zn L^{-1}	48.29	48.63	0.61	0.62	3.95	3.88	24.68	24.28	310.97	313.21	49.16	49.84
0.75 g Zn L^{-1}	48.51	48.97	0.64	0.65	4.01	3.97	25.04	24.81	328.02	324.81	51.42	51.75
1.0 g Zn L^{-1}	48.74	49.12	0.67	0.68	4.06	4.03	25.39	25.24	350.38	350.84	53.69	53.84
LSD 0.05	0.08**	0.25**	0.01**	0.01**	0.26**	0.24**	0.22**	0.20**	24.20**	22.30**	1.43**	0.84**

*** P < 0.05; **P < 0.01 and ns – non-significant**

B- Effect of interaction between nitrogen fertilizer levels and zinc foliar application rates on yield and yield attributes:

Data in Table 5 clear out that Pod yield (t fed^{-1}) trait was highly significant affected in the two season of study, and the highest values i. e. 2.41 and 3.60 $tfed^{-1}$ were recorded under 45 kg $Nfed^{-1}$ level as interacted with foliar Zn application at 1.00 gL^{-1} rate. Number of seed $plant^{-1}$ was significantly influenced in 1st season, whereas in 2nd season the influence was significant. The highest values e.g. 56.00 and 57.67 were obtained due to the interaction of 45 kg $Nfed^{-1}$ level and foliar Zn application at 1.00 gL^{-1} rate. Additionally, in 2nd t season, Number of pod $plant^{-1}$ trait was highly significant influenced, and Weight of 100 seed (g) trait was significantly affected. The highest values (34.67 and 85.30 g were reported with 45 kg $Nfed^{-1}$ level and foliar Zn application at 1.00 gL^{-1} rate interaction.

Table 5. Effect of the interaction between nitrogen fertilizer levels and foliar zinc application and yield attributes of peanut in 2014 and 2015 seasons.

N fertilization rate (kgfed^{-1})	Foliar Zn application (gL^{-1})	Number of pod plant^{-1} 2014	Number of pod plant^{-1} 2015	Weight of pod plant^{-1}(g) 2014	Weight of pod plant^{-1}(g) 2015	Number of Seed plant^{-1} 2014	Number of Seed plant^{-1} 2015	Weight of Seed plant^{-1}(g) 2014	Weight of Seed plant^{-1}(g) 2015	Weight of 100 pod (g) 2014	Weight of 100 pod (g) 2015	Weight of 100 seed (g) 2014	Weight of 100 seed (g) 2015	Pod yield (t fed^{-1}) 2014	Pod yield (t fed^{-1}) 2015
	Zero	22.67	22.00	33.67	34.33	38.00	38.00	27.33	27.67	160.07	153.87	69.20	69.13	1.60	1.62
	0.50	24.67	24.00	35.33	36.00	40.33	44.67	30.33	30.33	163.93	161.90	72.23	71.40	1.75	1.70
15	0.75	27.00	25.67	38.00	38.00	43.67	47.33	32.67	31.33	167.83	166.60	74.83	75.33	1.83	1.75
	1.00	30.33	27.33	40.00	39.00	47.67	50.00	34.67	33.67	171.67	169.93	76.83	77.17	1.88	1.85
	Zero	26.00	25.00	35.67	36.67	41.33	42.00	31.33	30.33	169.27	168.93	74.23	74.53	1.86	1.87
	0.50	27.00	27.00	37.67	38.33	45.00	46.67	34.00	33.33	172.83	173.43	76.33	78.33	1.92	1.95
30	0.75	28.67	28.00	39.33	39.67	48.00	49.33	35.67	35.00	175.47	177.00	78.47	80.73	1.95	2.00
	1.00	32.00	29.00	42.67	42.00	51.33	53.00	37.00	36.00	177.83	179.33	81.70	82.53	2.04	2.10
	Zero	28.33	25.67	38.33	40.3 3	44.33	45.67	33.33	32.67	176.03	176.07	76.27	79.47	2.01	2.10
	0.50	30.33	28.33	41.00	42.00	48.67	49.67	36.00	34.67	180.13	179.77	78.60	82.50	2.14	2.26
45	0.75	32.67	31.00	43.33	43.67	53.67	55.00	37.33	37.00	182.47	183.50	83.50	84.57	2.27	2.41
	1.00	35.00	34.67	45.00	45.00	58.00	57.67	39.33	39.67	185.07	186.37	85.47	85.30	2.41	2.60
LSD,05		ns	1.16**	ns	ns	1.09**	1.49*	ns	ns	ns	ns	ns	1.21*	0.07**	0.0**

*** P < 0.05; **P < 0.01 and ns – non-significant**

Data in Table 6 revealed that seed oil (%) was highly significant affected in 1st and 2nd seasons. The highest figures e.g. 49.57 and 50.84% were obtained as 15 kg Nfed^{-1} level interacted with foliar Zn application at 1.00 gL^{-1} rate, respectively, in 1st and 2nd seasons. Seed yield (t fed^{-1}), seed oil yield (t fed^{-1}) and seed protein% traits were highly significant influenced in 2nd season. The highest values of seed yield (1.58 t fed^{-1}), seed oil yield (0.76t fed^{-1}) and seed protein (26.10%) were recorded due to interaction of 45 kg Nfed^{-1} level and foliar Zn application at 1.00 gL^{-1} rate, whereas, the highest value of N use Efficiency (kg seeds/kg N) e.g. (80.67) were obtained with 15 kg Nfed^{-1} level and foliar Zn application at 1.00 gL^{-1} rate. Seed yield (t fed^{-1}), N use Efficiency (kg seeds/kg N), seed Oil yield (t fed^{-1}) seed protein % traits were significantly affected in 1st season. The highest figures were attained due to interaction 45 kg Nfed^{-1} level and foliar Zn application at 1.00 gL^{-1} rate, except N use Efficiency (kg seeds/kg N), where the highest value was noticed due to 15 kg Nfed^{-1} level and foliar Zn application at 1.00 gL^{-1} rate interaction. In addition, straw yield was significantly influenced in 2nd season, and the highest value (4.58 t fed^{-1}) resulted from interaction of 45 kg Nfed^{-1} level and foliar Zn application at 1.00 gL^{-1} rate.

It obvious that most peanut traits e.g. yield, yield attributes and quality as well under study exhibited higher values due to the interaction of 45 kg Nfed^{-1} level and foliar Zn application at 1.00 gL^{-1} rate. In connection, El-Habbasha (2015) reported that increasing the level of nitrogen and foliar spraying with zinc had a good effect on improving growth and yield of peanut.

Table 6. Effect of the interaction between nitrogen fertilizer levels and zinc foliar application rates on yield and yield attributes of peanut in 2014 and 2015 seasons.

N fertilization rate (gfed^{-1})	Foliar Zn application (gL^{-1})	Seed yield (t fed^{-1}) 2014	Seed yield (t fed^{-1}) 2015	Straw yield (t fed^{-1}) 2014	Straw yield (t fed^{-1}) 2015	N use Efficiency (kg seeds kg N^{-1}) 2014	N use Efficiency (kg seeds kg N^{-1}) 2015	Oil (%) 2014	Oil (%) 2015	Seed Oil Yield (t fed^{-1}) 2014	Seed Oil Yield (t fed^{-1}) 2015	Seed protein % 2014	Seed protein % 2015
	Zero	1.03	1.03	3.20	3.30	68.67	68.67	48.69	49.10	0.50	0.51	23.41	23.53
	0.50	1.12	1.11	3.35	3.37	74.67	74.00	48.82	49.46	0.55	0.54	24.00	23.84
15	0.75	1.18	1.15	3.48	3.46	78.67	76.67	49.13	50.24	0.58	0.58	24.30	24.08
	1.0	1.22	1.21	3.58	3.58	81.33	80.67	49.57	50.84	0.61	0.62	24.82	24.40
	Zero	1.22	1.25	3.81	3.66	40.67	41.67	48.27	48.47	0.59	0.61	23.60	23.81
	0.50	1.27	1.29	3.88	3.72	42.33	43.00	48.42	48.71	0.61	0.63	24.71	24.22
30	0.75	1.30	1.33	4.06	3.87	43.33	44.33	48.60	48.87	0.63	0.65	25.00	24.77
	1.0	1.36	1.36	4.18	3.99	45.33	45.33	48.66	48.73	0.66	0.66	25.29	25.22
	Zero	1.29	1.37	4.34	4.20	28.66	30.44	47.45	47.62	0.61	0.66	23.78	24.07
	0.50	1.39	1.47	4.46	4.38	30.88	32.67	47.62	47.70	0.66	0.70	25.34	24.77
45	0.75	1.47	1.54	4.55	4.48	32.67	34.22	47.80	47.79	0.70	0.73	25.84	25.60
	1.0	1.55	1.58	4.61	4.58	34.44	35.11	47.99	47.79	0.75	0.76	26.06	26.10
LSD 0.05		0.05 *	0.03 **	ns	0.06 *	2.47 *	1.46 **	0.14**	0.43 **	0.02*	0.02 **	0.39 *	0.35 **

P < 0.05; **P < 0.01 and ns – non-significant

Yield analysis study

Correlation coefficient: The correlation coefficients in Table 7 between oil yield t fed^{-1} and each of number of pod and seed, weight of pod and seed plant^{-1} g, weight of 100 pod and seed g, pod and seed yield t fed^{-1} and oil % were computed in order to throw light on the relationship of effectual traits interest. Positive and highly significant ($P \leq 0.01$) correlations were obtained between oil yield t fed^{-1} and each of seed yield t fed^{-1} (r = 0.995** and 0.992**) and number of seed (r = 0.951** and 0.834**). Also, positive and highly significant correlation coefficient were seen between seed yield t fed^{-1} and pod yield t fed^{-1} in 1st season (r = 0.922** and 0.946**) as well as between pod yield t fed^{-1} and weight of 100 pod (r = 0.918** and 0.899**, in 1st and 2nd seasons, respectively. However, negative and highly significant correlations were obtained between seed yield t fed^{-1} and seed oil percentage (r = -0.539** and - 0.691**.

According to Stepwise results in data in Table 8 clarified that there are four traits *i.e.* seed yield, oil (%), pod yield and weight of seed p^{-1} in 2014 season and five ones *i.e.* seed yield, oil (%), weight of 100 seed, weight of pod p^{-1} and weight of 100 pod in 2015 season were significantly ($P \leq 0.001$) contributed to variation in oil yield per feddan.

Table 7. A matrix of simple correlation coefficient between oil yield and other important traits estimated in 2014 and 2015 season.

Character	Number of pod plant^{-1}		Weight of pod plant^{-1}(g)		Number of Seed plan^{-1}		Weight of Seed p^{-1}(g)		Weight of 100 pod(g)		Weight of 100 seed(g)		Pod yield (t fed^{-1})		Seed yield (t fed^{-1})		Oil (%)		Oil yield (t fed^{-1})	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Number of pod p^{-1}	1	1	.905**	.890**	.955**	.911**	.930**	.866**	.845**	.884**	.888**	.796**	.866**	.877**	.897**	.826**	-.293	-.393**	.916**	.850**
Weight of pod p^{-1} (g)			1	1	.936**	.907**	.902**	.908**	.842**	.914**	.885**	.901**	.884**	.919**	.868**	.916**	-.305	.539**	.883**	.924**
Number of Seed p^{-1}					1	1	.954**	.920**	.832**	.839**	.902**	.842**	.875**	.810**	.931**	.789**	-.301	-.241	.951**	.834**
Weight of Seed p^{-1} (g)							1	1	.874**	.837**	.922**	.872**	.847**	.843**	.925**	.839**	-.287	-.376*	.946**	.868**
Weight of 100 pod (g)									1	1	.929**	.914**	.918**	.899**	.896**	.921**	-.488**	-.555**	.891**	.930**
Weight of 100 seed (g)											1	1	.881**	.895**	.915**	.925**	-.310	-.496**	.932**	.944**
Pod yield (t fed^{-1})													1	1	.922**	.946**	-.558**	-.680**	.909**	.933**
Seed yield (t fed^{-1})															1	1	-.539**	-.691**	.995**	.992**
Oil (%)																	1	1	.450**	.593**
Oil yield (t fed^{-1})																			1	1

** Correlation coefficient is significant at $P \leq 0.01$

Table 8. Correlation coefficient (r), coefficient of determination (R^2) and standard error of the estimates (SEE) for predicting oil yield in 2014 and 2015 seasons.

Season	R	R^2	SEE	Sig.	Fitted equation
2014	1.00	1.00	0.000	***	Oil yield = -0.60 + 0.48 seed yield + 0.01 oil + -0.01pods yield + 0.001 seed wt. p^{-1}
2015	1.000	1.000	0.001	***	Oil yield = -0.61+0.48 seed yield + 0.01oil +0.01 wt. 100 seed+0.01 wt. pods p^{-1} + 0.01 wt.100 pods p^{-1}

CONCLUSION

Data showed that under newly reclaimed soil condition it could be recommended to apply the highest level of nitrogen fertilization (45 kg $Nfed^{-1}$ level) combined with foliar Zn application at 1.00 gL^{-1} rate to accomplish acceptable profit yield of peanuts pods, seed and oil yield as well.

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إستجابة الفول السودانى لمستويات السماد النيتروجين والرش الورقى بالزنك تحت ظروف الأراضي الرملية المستصلحة حديثا.

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تم تنفيذ تجربتان حقليتان في مزرعة كلية الزراعة بالفيوم بمنطقة دمو– جامعة الفيوم - مصر. خلال الموسم الصيفى لعامى 2014 و 2015 لدراسة تأثير مستويات السماد التسميد النيتروجينى والرش الورقى بالزنك و التفاعل بينهماعلى المحصول ومكوناتة للفول السودانى صنف جيزة 6. تم إستخدام القطع المنشقة مرة واحدة فى تصميم القطاعات كاملة العشوائية ذى ثلاثة مكررات فى الموسمين. حيث احتلت معاملة التسميد النيتروجينى (15 ،30 و45 كجم فدان$^{-1}$) القطع الرئيسية بينما وزعت معدلات للرش الورقى بعنصر الزنك (0، 0.5 ، 0.75 و 1 جرام لتر$^{-1}$) فى القطع الشقية. يمكن ايجاز اهم النتائج المتحصل عليها فيما يلي:1- أدت زيادة السماد النتروجيني والرش الورقي بالزنك الي زبادة معنوية في صفات المحصول مثل (وزن محصول البذور ، وزن الثمار ، وزن الفدان$^{-1}$) و مكوناتة (عدد الثمار/النبات ، وزن الثمار/النبات، وزن البذور/النبات ، وزن 100- ثمرة ،وزن 100- بذرة) و كذلك صفات الجودة (نسبة الزيت بالبذور %، محصول الزيت للفدان ، نسبة البروتين بالبذرة% ، محصول البروتين للفدان) . وعلي العكس ادت زيادة مستويات التسميد النتروجيني والرش الورقي بالزنك الي انخفاض معنوي في كفاءة استخدام النتروجين ومحتوي البذور من الزيت ، وذلك في موسمى الدراسة.2- تشير النتائج الي ان اعلى محصول من الثمار والبذور والزيت للفدان قد نتجت من استخدام المعدل الأعلي من التسميد النيتروجين (45 كجم فدان$^{-1}$) بالمقارنة بإستخدام المستوى الأقل (15 كجم فدان$^{-1}$) خلال موسمى الدراسة.3- اظهرت نتائج التفاعل بانة تم الحصول علي أعلي القيم لمحصول الثمار والبذور والزيت للفدان من أستخدام المستوي الأعلي للتسميد النيتروجينى (45 كجم فدان$^{-1}$) مع إستخدام المعدل الأعلي من الرش الورقى بالزنك (1 جرام لتر$^{-1}$).4- أظهرت النتائج المتحصل عليها وجود إرتباط إيجابى عالى المعنوية ((r = 0.992) بين محصول الزيت و محصول البذور في الموسم الثاني، في حين وجد إرتباط سلبى عالي المعنوية بين محصول الزيت و نسبة الزيت فى البذور (r = -0.539 و -0.691) في الموسم الاول و الثاني ، علي التوالي.