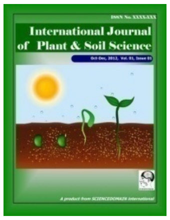

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Impact of Nitrogen Fertilizer and Zinc Foliar Application on Growth, Yield, Yield Attributes and Some Chemical Constituents of Groundnut

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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ABSTRACT

Two field trials were carried out at the Agricultural Production and Research Station, NRC, Egypt, during the two successive summer seasons 2012 and 2013, to study the effect of combination between nitrogen fertilizer and foliar zinc application on growth, yield attributes and chemical constituents of groundnut seeds. Different treatments show significant differences in the both growth samples however, 120N $kg.ha^{-1}$+1000 $mg.L^{-1}$ zinc surpassed in most studied characters with no significant difference between this treatment and treatment 120N $kg.ha^{-1}$+750$mg.L^{-1}$ zinc in all studied characters. Increasing foliar zinc application from 0 to 1000$mg.L^{-1}$ significantly increased all yield and yield attributes with the two nitrogen rates (60 and 120N $kg.ha^{-1}$). Increasing foliar zinc application from 500 to 1000$mg.L^{-1}$ with 60N $kg.ha^{-1}$ shows significant differences in most studied characters, except weight of $seeds.plant^{-1}$, 100-pod weight, 100-seed weight and pods $yield.ha^{-1}$. Increasing foliar zinc application from 750 to 1000$mg.L^{-1}$ with 120N $kg.ha^{-1}$ shows significant differences in most of studied characters, except weight of $seeds.plant^{-1}$, 100-pod weight and 100-seed weight. Significant differences between treatments in seed protein content, NP seed concentration and NK straw concentration.

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1. INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is considered one of the most important oilseed crops in the world. It contains about 50% oil, 25-30% protein, 20% carbohydrate and 5% fiber and ash which make a substantial contribution to human nutrition. The high-energy value, protein content, and minerals make groundnut a rich source of nutrition at a comparatively low price [1]. About two thirds of world production is crushed for oil and remaining one third is consumed as food, because its high price in the international commodity market. Most of the cultivated area in Egypt is poor sandy soil using high rates of NPK chemical fertilizers, especially nitrogen fertilizer however, one of the most important factors for crop growth and high yield with good quality. Nitrogen fertilizer caused an increase in photosynthesis rate, metabolites synthesized, meristematic activity and translocated assimilates to the seed. Increasing nitrogen fertilizer increased pod and seed yield, pod weight.plant^{-1}, 100-seed weight and 100-pod weight [2]. The highest seed yield was obtained by 80N kg.ha^{-1} [3]. Increasing nitrogen fertilizer increased pod and seed yield, pod weight.plant^{-1}, 100-seed weight and 100-pod weight [4]. The use of chemical fertilizers has been doubled during the last two decades. Thus the coincident application of some micronutrients especially zinc is frequently recommended for improving the use efficiency of chemical fertilizer to get high agricultural yield products with good quality.

Zinc is one of the most important nutrient required for plant growth. It plays as an activator of several enzymes in plants and is directly involved in the biosynthesis of growth substances such as auxin which produces more plant cells and more dry matter. Some investigators reported that foliar spraying with zinc could correct zinc deficiency, improve growth, yield and seed quality of groundnut. Application of zinc (1000ppm zinc sulphate) gave the highest seed and oil yields.ha^{-1} and protein percentage [5]. Furthermore, Application of foliar spray with Zn (2%) slightly improved peanut yield and its attributed as well as quality [6]. Soil and/or foliar applications of Zn may also increase grain Zn concentration and thus contribute to grain nutritional quality for human beings. Higher grain Zn concentration is also important for better seedling vigor and field establishment, particularly on Zn deficient soils [7]. The aim of this investigation is to study the effect of combination between nitrogen fertilizer and foliar zinc application on growth, yield, yield attributes and some chemical constituents of groundnut.

2. MATERIALS AND METHODS

Two filed experiments were carried out at the Agricultural Production and Research Station, National Research Centre, El Nubaria Province, El Behira Governorate, Egypt, during the two successive summer seasons 2012 and 2013, to study the effect of nitrogen fertilizer and foliar zinc application on growth, yield, yield attributes and some chemical constituents of groundnut. Physical and chemical properties of soil (0-30 depth) in the experimental site were as follows: sand 91.2%, silt 3.7%, clay 5.1%, P^H 7.3, organic matter 0.3%, $CaCO_3$, 1.4%, EC 0.3 ds.m^{-1}, soluble N 8.1g.kg^{-1} and available P 3.2g.kg^{-1}. Soil properties were measured as described by [8]. The randomized complete block design with three replicates was used, where the treatments consisted of two rates of nitrogen fertilizer (60 and 120N kg.ha^{-1} as ammonium sulfate, 20.6 %) and foliar zinc application which were added in four rates (0, 500, 750 and 1000mg.L^{-1} $ZnSO_4$ $7H_2O$). The experimental unit area was 10.5 m^2 consisting of five rows (3.5m long and 60 cm between rows). Seeds were sown on May 5th and 12th in the first and second seasons, respectively. The seeds (Giza 6 cultivar) were coated just before sowing with the bacteria inoculants, using Arabic gum (40%) as adhesive agent and were sown in hills 10 cm apart. Phosphorus fertilizer, as calcium superphosphate, 15.5% P_2O_5 at the rate 70 P_2O_5 kg.ha^{-1} and potassium fertilizer, as potassium sulfate 48% K_2O at the rate 100 K_2O kg.ha^{-1} were added during the seed bed preparation, while nitrogen fertilizer has been added to the soil in two rates of 60 and 120N kg.ha^{-1} as ammonium sulfate, 20.6% in four equal doses weekly starting from 15 days after sowing. Sprinkler irrigation was applied as plants needed. The proceeding winter crop was wheat in the both seasons. Groundnut was manually harvested on September 10th and 14th in the first and second season, respectively.

2.1 Data Collection and Analysis

Five guarded plants were taken at random from the second row of each plot at 75 and 90 days after sowing (DAS). Leaves and stems were oven dried at 70℃ until constant weight to estimate leaves, stem and total top dry weight.plant^{-1} as well as pods dry weight.plant^{-1}. At harvest, a random sample of 10 plants were taken from each 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, 100-pod weight. Plants on the middle two rows in each plot (4.2m^2) were harvested and their pods were air dried to calculate, pods, straw and seed yield.ha^{-1}. Oil %, NPK in seed and straw were determined according to the method described by [9] and the seed protein content was calculated by multiplying total nitrogen concentration by 6.25. Data were analyzed using an ANOVA randomized complete block design [10]. Since the trend was similar in both seasons, Bartlett's test was applied and the combined analysis of the two growing seasons was done. LSD ($P<0.05$) was used to compare means.

3. RESULTS AND DISCUSSION

3.1 Dry Matter Accumulation

Data presented in Table (1) show that leaves dry weight.plant^{-1}, stems dry weight.plant^{-1}, total top dry weight.plant^{-1} and pods dry weight/plant at 75 and 90 days after sowing where the different treatments show significant differences in the both growth samples however, the treatment 120 N kg.ha^{-1} + 1000mg.L^{-1} zinc surpassed the different treatments in most studied character with no significant difference with the treatment 120N kg.ha^{-1} + 750mg.L^{-1} zinc in all studied characters. Concerning the nitrogen level, 60 N kg.ha^{-1}, increasing of foliar zinc application from 500 to 1000mg.L^{-1} zinc foliar application show significant differences in leaves dry weight.plant^{-1}, stems dry weight.plant^{-1} and total top dry weight.plant^{-1}, while pods dry weight.plant^{-1} did not show significant differences between the two zinc foliar application levels while, in case of 120 N kg.ha^{-1}, increasing of foliar zinc application from 500 to 1000mg.L^{-1} show significant differences in most studied characters in both growth samples, except stems dry weight.plant^{-1} and pods dry weight.plant^{-1} (g) after 75 days after sowing. Zinc plays very important role in plant metabolism by influencing the activities of hydrogenase and carbonic anhydrase, stabilization of ribosomal fractions and synthesis of cytochrome [11]. Plant enzymes activated by Zn are involved in carbohydrate metabolism, maintenance of the integrity of cellular membranes, protein synthesis, regulation of auxin synthesis and pollen formation [12]. As zinc is required for the synthesis of tryptophan which is a precursor of IAA, it also has an active role in the production of an essential growth hormone auxin [13,14]. These results are in agreement with [15] reported that application of N levels up to 100 percent of the recommended doses of fertilizer gave significantly better effect on the growth parameters. Application of N gave the highest total dry matter.plant^{-1} [16].

Table 1. Effect of nitrogen fertilizer and foliar zinc application on dry matter (DM) accumulation in different plant parts (Leaves, L; Stems, S; Total top, Tt; and Pods, P) after 75 and 90 days after sowing (DAS) of groundnut (combined data of 2012 and 2013 seasons)

Fertilizer treatments		75 DAS				90 DAS			
N kg.ha^{-1}	$ZnSO_4$ mg.L^{-1}	LDM g.plant^{-1}	SDM g.plant^{-1}	TtDM g.plant^{-1}	PDM g.plant^{-1}	LDM g.plant^{-1}	SDM g.plant^{-1}	TtDM g.plant^{-1}	PDM g.plant^{-1}
60	0	28.64	28.01	56.67	13.07	49.36	49.28	98.66	31.77
	500	35.66	30.00	65.67	13.43	50.32	51.56	101.89	35.59
	750	35.03	30.33	65.38	14.15	52.46	51.61	104.08	35.18
	1000	37.97	30.41	68.39	14.14	56.99	54.59	111.60	37.54
120	0	27.67	31.56	58.13	15.94	57.86	59.27	117.14	37.27
	500	37.00	36.75	73.75	26.48	58.03	63.74	121.78	47.65
	750	45.37	31.82	77.19	24.96	63.71	61.74	125.46	40.36
	1000	46.63	33.77	80.07	25.11	66.44	62.02	128.47	42.83
LSD 5%		2.78	2.37	4.71	2.31	4.04	2.89	5.73	3.01

3.2 Yield and Yield Attributes

Yield and yield attributes (i.e., number of pods.plant^{-1}, weight of pods.plant^{-1}, number of seeds.plant^{-1}, weight of seeds.plant^{-1}, 100-pod weight, 100-seed weight, pod, seed and straw yield.ha^{-1}) as affected by experimental treatments are presented in Table (2) where it shows that significant differences in all studied characters. Regarding to 60 N kg.ha^{-1}, increasing foliar zinc application from 0 to 1000mg.L^{-1} significantly increase all yield and yield attributes where, the increment percentage in the yield reach to 11.21, 24.21 and 17.03% for pod, seed and straw yield.ha^{-1}, respectively. Increasing foliar zinc application from 500 to 1000mg.L^{-1} shows significantly differences in most studied characters except weight of seeds.plant^{-1}, 100-pod weight, 100-seed weight and pods yield.ha^{-1} where the increment percentage in the yield reach to 4.86, 12.85 and 8.20% for pod, seed and straw yield.ha^{-1}, respectively. Increasing foliar zinc application from 750 to 1000mg.L^{-1} did not show significant differences in most of studied characters, except number of pods. plant^{-1} and weight of pods.plant^{-1} however, the increment percentage in the yield reach to 4.16, 10.25 and 2.08% for pod, seed and straw yield.ha^{-1}, respectively.

Regarding to 120N kg.ha^{-1}, increasing foliar zinc application from 0 to 1000mg.L^{-1} significantly increased all yield and yield attributes where the increment percentage in the yield reach to 31.15, 25.68 and 19.24% for pod, seed and straw yield.ha^{-1}, respectively. Increasing foliar zinc application from 500 to 1000mg.L^{-1} shows significant differences in all studied characters where the increment percentage in the yield reach to 19.85, 12.18 and 11.49% for pod, seed and straw yield.ha^{-1}, respectively. Increasing foliar zinc application from 750 to 1000 mg.L^{-1} shows significant differences in most of studied characters, except weight of seeds.plant^{-1}, 100-pod weight and 100-seed weight however, 16.21, 11.54 and 4.05% for pod, seed and straw yield.ha^{-1}, respectively. The interactions resulting from the effects of N application helps to promote plant growth and, to a lesser extent, in changing the pH of the root environment since application of N promotes the growth of plants, it is possible to find positive interactions between increasing levels of Zn and N fertilizers [13]. These results are in harmony with those obtained by [17] who reported that increasing of zinc spraying rate increased seed yield, pod yield, 100-seed weight.

3.3 Chemical Constituents

Data presented in Table (3) illustrate seed oil and protein content, nitrogen, phosphorus and potassium seed content and nitrogen, phosphorus and potassium straw content where significant differences were observed between treatments, except seed oil content, potassium seed content and phosphorus straw content, where the treatment 120Nkg.ha^{-1} + 500mg.L^{-1} foliar zinc application surpassed in oil seed content, seed protein content and nitrogen seed content while, 120Nkg.ha^{-1}+ 1000mg.L^{-1} foliar zinc application surpassed in phosphorus seed content, phosphorus and potassium straw content. Zn is required for integrity of cellular membranes to preserve the structural orientation of macromolecules and ion transport systems. Its interaction with phospholipids and sulphydryl groups of membrane proteins contributes for the maintenance of membranes [18-20].

Table 2. Effect of nitrogen fertilizer and foliar zinc application on yield and yield attributes of groundnut (combined data of 2012 and 2013 seasons)

Fertilizer treatments		Pod.plant^{-1}		Seed.plant^{-1}		100-pod weight (g)	100-seed weight (g)	Yield. ha^{-1} (ton)		
N kg.ha^{-1}	$ZnSO_4$ mg.L^{-1}	Number	Weight (g)	Number	Weight (g)			Pod	Seed	Straw
60	0	24.76	33.42	42.55	28.44	171.32	74.97	3.489	2.434	6.894
	500	23.53	32.03	44.69	35.97	178.66	77.73	3.701	2.679	7.456
	750	30.58	32.58	46.39	36.22	179.56	78.78	3.726	2.742	7.904
	1000	33.15	35.34	47.80	37.43	181.64	80.20	3.881	3.024	8.068
120	0	24.64	35.82	47.28	38.84	172.68	77.04	3.676	2.785	8.088
	500	33.61	37.40	48.81	40.75	179.11	79.33	4.023	3.120	8.651
	750	35.02	39.99	56.80	41.64	184.37	81.57	4.149	3.138	9.270
	1000	38.07	47.40	61.29	43.71	185.81	83.04	4.821	2.434	9.645
LSD 5%		2.45	2.36	2.67	2.20	4.21	3.37	0.157	0.140	0.127

Table 3. Effect of nitrogen fertilizer and foliar zinc application on some chemical constituents of groundnut (combined data of 2012 and 2013 seasons)

Fertilizer treatments		Seed content		NPK in Seed			NPK in Straw		
N $kg.ha^{-1}$	$ZnSO_4$ $mg.L^{-1}$	Oil (%)	Protein (%)	N (%)	P (%)	K (%)	N (%)	P (%)	K (%)
60	0	47.30	24.255	3.881	0.865	0.724	1.949	0.256	1.160
	500	47.67	25.268	4.043	0.913	0.787	2.107	0.270	1.198
	750	47.35	24.055	3.849	0.856	0.735	1.891	0.250	1.151
	1000	47.81	24.693	3.951	0.885	0.783	1.961	0.261	1.172
120	0	47.75	23.449	3.752	0.949	0.836	2.114	0.275	1.223
	500	48.22	26.337	4.214	0.837	0.712	1.928	0.254	1.159
	750	47.81	24.399	3.904	0.879	0.774	2.068	0.266	1.178
	1000	47.85	26.116	4.179	0.942	0.821	2.111	0.277	1.248
LSD 5%		NS	1.44	0.23	0.055	NS	0.019	NS	0.011

4. CONCLUSION

Different treatments show significant differences in both growth samples. Increasing foliar zinc application from 0 to 1000$mg.L^{-1}$ significantly increased all yield and yield attributes with the two nitrogen rates (60 and 120 N $kg.ha^{-1}$). 1000 $mg.L^{-1}$+120N $kg.ha^{-1}$ shows significant differences in most of studied characters, except weight of $seeds.plant^{-1}$, 100-pod weight and 100-seed weight.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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