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Effect of Zinc Application on Maize Grown on Alluvial Soils

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ABSTRACT

A field test was done at the Experimental Station Farm, Faculty of Agriculture, Mansoura University, during 2015 season to think about the impact of zinc application on development, yield and its component of maize (Zea mays L.) single Cross half and half 168 (SC 168) developed in alluvial soil. The trial was done in a total randomized block outline with three duplicates. The acquired outcomes demonstrated that the best treatment was utilizing $ZnSO_4.H_2O$ as a foliar splash (0.75 g L^{-1}) Zn_4. That is, on account of developing a plant, the seeds can be utilized for Zn_2. On account of developing plant to get the leaves of the plant as a green plant (silage), Zn_3 can be utilized.

INTRODUCTION

Maize (Zea mays L.) is considered as one of the third most essential key grain nourishment edits after wheat and rice in Egypt and over the all world and its aggregate yield are more when contrasted with other oat crops (FAO, 2011). Maize is perceived as the "brilliant nourishment" in view of its high grain yield and sustenance esteem, a crucial wellspring of starches and assumes an imperative job in the day by day calorie admission of people. It is alluded to as the grain without bounds for its significant healthful certainties in human eating routine (Enyisi *et al.,* 2014). Maize is very essential in the world agricultural economy and used as a staple food for humans, as a feed for animals whether new, silage or grains and a common ingredient for industrial products such as starch, glucose and dextrose (Nuss and Tanumihardjo, 2010). Recently, it is an imperative wellspring of day by day human sustenance in view of blending its flour with wheat flour by 20 % for making bread to lessen the hole among generation and utilization of wheat. Hence, an incredible consideration ought to be paid to raise maize efficiency either by boosting yield per unit zone or either by expanding developed zone so as to diminish the hole between its generation and utilization.

Zinc is an essential element for human health, animals and higher plants and its significance in farming is progressively being perceived especially, in developing countries (Anthony *et al.,* 2002 and Genc *et al*., 2006). Alkaline soils with an apparently sufficient Zn level (>1 mg kg^{-1}) may show reduced Zn availability to crops due to (a) Zn partiality towards adsorption/obsession with the mud minerals adsorption locales, and (b) the high pH of soil (pH 8.0), which may have helped in the arrangement of inaccessible types of Zn as hydroxides. Zn has a greater affinity for adsorption on clay and also it tends to make unavailable zinc hydroxides due to increased pH (Khattak & Pulford, 1999). Zn deficiency persists in our soils and leads to create problem in many physiological processes to function normally thus, limits maize (Zea mays L.) yields in around the world (Alloway 2009). Maize is one of the products touchiest to Zn insufficiency; Zn lack obstructs maize development, bringing about diminished grain yield and quality (Behera *et al.,* 2015 and Mattiello *et al.,* 2015).

Although Zn is required in a critical small concentration, its availability is critical for several key physiological functions in plants including growth regulation, photosynthesis, respiration and sugar formation, fertility and seed production, and defense mechanisms against disease. Zinc is a vital part of different chemicals that are in charge of numerous metabolic responses in plants. Zinc is likewise assumes various jobs in essential biochemical procedures, for example, catalyst catalysis or actuation, protein blend, quality articulation, starch and axing digestion, chlorophyll creation, dust development, cytochrome and nucleotide amalgamation, support of film trustworthiness, and vitality dispersal (Alloway, 2009). Zn Critical nutrient deficiency levels defined physiologically in plants are typically expressed in terms of nutrient concentration in plant tissue e.g. 15-20 mg Zn/kg dry weight of plant tissue (Dobermann and Fairhurst, 2000). Its deficiency adversely affects these functions such as diminishes the photosynthetic rate, chlorophyll content, action of carbonic anhydrase, and protein biosynthesis (Cakmak, 2008; Kaya and Higgs, 2002; Fu *et al.,* 2016). in this manner bringing about lower yield and as often as possible in low quality harvest items (Tahir *et al.,* 2009). Hence, utilization of Zn compost might be a vital measure for enhancing the yield and nature of maize. People devouring yields developed on Zn lacking soils may experience the ill effects of Zn inadequacy which is the most across the board wholesome confusion, next only to iron, vitamin 'A' and iodine. Nearly, 49% of the global population does not meet their daily-recommended intake of 15 mg day^{-1} of zinc for an adult. Zn acts as a co-factor for the activity of more than 200 enzymes and is required for many biological processes such as normal development and function of the immune system, neuro-sensory functions, reproductive health and brain function (Meunier *et al.,* 2005). Zn is likewise a basic component controlling human intestinal Fe ingestion, and adequate amount of Zn alongside Fe in human body is urgent for treating iron lack sickliness (Graham *et al.,* 2012). Zn deficiency is one of the leading risk factors associated with diseases for example, impedance in physical improvement, hindering in youngsters, helplessness to irresistible sicknesses, expanded dreariness and mortality, and poor immune system and brain function and retarded growth contributing to the death of 8,00,000 people each year (Hotz & Brown, 2004; Cakmak, 2008). Expanding the Zn content in nourishment products might be a decent technique to beat its lack in assortment of individuals in creating nations. Numerous scientists attempted to chalk out different systems of its better supplementation, which notwithstanding; Zn application to soil as ZnSO4, Zn chelates, soil and foliar shower with various Zn mixes (Khan *et al.,* 2008; Maqsood *et al.,* 2009). Understanding the significance of Zn in plant and human nourishment and the issues related with its accessibility to plants in soluble soils, Zinc sulfate is the most usually Zn source utilized (Alloway 2009). In any case, these granulated Zn materials, when blended into the dirt, just treat little zones inside the dirt mass. The volume of soil treated with granular materials is typically deficient to supply the prerequisites of the developing corn plant (Brown and Krantz 1966).

Due to lower availability of soil applied zinc to plants consequent to its conversion to less soluble forms, chelated zinc was suggested to enhance the availability of applied zinc to plants and soil. In the present study, sources of zinc which is used include inorganic compound like, zinc sulfate and engineered chelate is delivered by joining a chelating specialist with a metal cation. Routinely, the utilization of inorganic Zn manures and manufactured chelates give roads to lighten Zn-insufficiency related issues both in human sustenance and harvest creation. It is smarter to expand the Zn content in grains, the staple nourishment in many creating nations, through Zn preparation.

Zinc sulfate ($ZnSO_4$) is the most well-known wellspring of Zn utilized compost worldwide and utilized in edit generation it is accessible in both crystalline mono hydrate and carbohydrate shapes. The most widely recognized engineered cheating operator utilized is ethylene Di-amine tetra acidic corrosive (EDTA) is extremely steady. Engineered ch-elate is famously reasonable for blending with concentrated compost answers for soil, fertilization, hydroponic applications and foliage splashes to amend Zn inefficiencies. Yet, their generally low zinc content implies that rehashed applications might be required for direct to serious zinc insufficiency. More Zn is expected to adjust inefficiencies on maize than on rice or sorghum. Zinc sulfate mono hydrate is the most stable frame in warm atmospheres and is 100% water solvent. The viability of Zn composts relies upon a few elements including water-dis solvable Zn content in the manure, soil pH, technique for application, and soil physical properties. Foliar treatment is a broadly utilized practice to remedy healthful lacks in plants caused by ill-advised supply of supplements to roots. The principle advantages of foliar splashing are that it can have up to a 90% effectiveness rate of take-up as inverse to 10 % proficiency from soil applications. Furthermore, foliar preparation turns out to be specifically accessible in the plants since they are 100% water-dissolvable. Malakouti (2008) indicated that Malakouti (2008) indicated that by providing plants with miniaturized scale supplements, either through soil application, foliar shower, or seed treatment enhanced yield, quality and full scale supplement utilize proficiency was enhanced up to half. The other extraordinary thing is that foliar showering fortifies the plants to make oozes in the roots, which energize microorganisms to work harder, and in this way builds supplement take-up from the dirt. What's more, foliar splashes upgrade flavors, sweetness, mineral thickness and yield of harvests (Seadh *et al.,* 2013).

Yosefi *et al.,* (2011) showed that micronutrient foliar application essentially influences plant stature, hail leaf length, grain, and characteristic yield, in any case the effect of small scale supplement foliar application on width of standard leaf, estimation of stem, number of segments per ear, number of grain per ear and weight of grain was not colossal. Salem and El-Gizawy (2012) showed that foliar splashing with micronutrients gave the most elevated estimations of, 100-grain weight, ears plant^{-1}, grains ear^{-1}, and grain yield. Hammad et al., (2012) announced that foliar use of chelated zinc expanded grain yield, 100-grain weight, grain oil, and protein substance and also seed substance of N, K, and Zn in maize plant. Aduloju and Abdulmalik (2013) showed that levels of Zn as $ZnSO_4$ (0, 15, 30 and 45 kg Zn/ha) had significant effects on maize root, shoot dry weight, Zn and P content. Ghanbari *et al.,* (2013) indicated that under water deficit stress using zinc sulfate fertilizer improved ear weight, dry weight and grain yield of maize. Puga *et al.,* (2013) indicated that Zn soil application resulted in higher Zn accumulation in the shoots and grains of maize as well as Zn uptake by plants, compared to Zn foliar application. Eteng *et al.,* (2014) showed that the application of Zn at rate of 8 kg Zn/ha to the soil significantly increased maize, grain yield dry matter production and nutrients concentration and uptake of maize.

The point of this work was to think about the impact of a few sources and strategies for Zn application on development, yield and its component organization of maize (Zea mays L.), single cross 168 (SC168) in Egypt under alluvial soil conditions.

MATERIALS AND METHODS

Keeping in mind the end goal to assess the impact of various sources and techniques for zinc application on development, yield and its components synthesis of maize (Zea mays L.) single cross 168 (SC168). The proposed research study was conducted during the cropping season of 2015 on a sandy clay-loam soil at the Experimental Station Farm, Faculty of Agricultural, Mansoura University, Dakhlia, Egypt, under field conditions for physical chemical examination, soil tests were taken before sowing of product from a profundity of 30 cm is introduced is presented in (Table 1). The experiment was laid out in randomized complete block design (RCBD) consisting of five treatments (Table 2) and replicated three times.

Table 1. Some physical and chemical properties of soil in present experiment site.

Particle size distribution %				Texture class	OM, g kg^{-1}	$CaCO_3$, g kg^{-1}	S.P %	Available (mgkg^{-1})			
C. Sand	F. Sand	Silt	Clay					N	P	K	Zn
3.98	19.82	52.55	32.65	**Sandy clay loam**	0.166	0.372	57.5	43.8	5.98	159.7	0.79

pH*	EC** dS m^{-1}	Soluble ions conc, meq/100g soil***							
		Cations				Anions			
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{-}	HCO_3^{-}	Cl^{-}	SO_4^{--}
8.12	1.05	1.58	1.26	5.3	1.3	nd	1.48	4.5	3.47

C. sand: Coarse sand, F. sand: Fine sand, S.P: Saturation percentage, * Soil pH was determined in soil suspension (1:2.5).
**** Soil Electrical Conductivity (EC) was determined in soil (1:5) extract, nd: note detected**
***** Soluble ions were determined in (1:2.5) soil water suspensions.**

The test field was furrowed twice, developed, compaction, ridging, leveled and after that detached into the test units (4 m^2). The region of each plot was 2 x 2 for each reproduce; planting was done at a dispersing of 20 cm x 70 cm. Maize grains (Zea mays L.), single cross 168 (SC168) were hand sown in inclines 25 cm isolated at the rate of 2-3 grains/slant using dry sowing method (After) on one side of the edge in the midst of the second multi day stretch of May 2015 season. Lessening technique was finished after ten extensive stretches of item advancement to one plant for each grade before the basic water structure the chief water framework was associated following 21 days from sowing and the going with water frameworks were associated at 15 days between times in the midst of the creating season. Nitrogen, phosphorus and potassium manure were connected at rate of 120, 100, 50 kg nourished 1, as ammonium nitrate (35.5 % N), calcium super phosphate (15.5 % P_2O_5) and potassium (48 % K_2O), K and P and half dosage of N were individually full measurements of the connected at sowing before the primary water system for all medications. While nitrogen compost was included communicated in three equivalent extents, previously the first, second and third water systems to stay at knee stature arrange for edit. All other agrarian practices have stayed typical and uniform for all medications. Zinc (Zn) as soil and foliar application were associated as zinc sulfate ($ZnSO_4$. H_2O) and zinc-EDTA to investigate the efficiency of two Zn sources and two application procedures as showed up in the going with table.

Table 2. Details of Zn treatments as soli and foliar application on maize crop during experiment.

Treatment no.	Treatments	Sources	Zn Content (%)
Zn_0	Control (No Zn)	-	-
Zn_1	Zn-EDTA as soil application (10 kg fed^{-1})	Synthetic Chelate "Zn chelate"	(Zn 14%)
Zn_2	Zn-EDTA as foliar spray (0.75 g L^{-1})	Na_2 Zn EDTA	(Zn 14%)
Zn_3	$ZnSO_4H_2O$ as soil application (25 kg fed^{-1})	Inorganic Zn sulfate monohydrate	(Zn 36%)
Zn_4	$ZnSO_4H_2O$ as foliar spray (0.75 g L^{-1})	$ZnSO_4$ H_2O	(Zn 36%)

Soil expansion of Zn sulfate and Zn-EDTA were made by banding it in lines just before maize planting. For foliar applications, the two past sources were utilized in this present examination as takes after; Zn sulfate and Zn-EDTA, The volume of the 200-liter nourished 1 paper arrangement was section of land and was splashed by manual sprayer (for test pots) until the point when the immersion point the morning and associated foliar twice times in light of change physiological depiction of maize following 30 days vegetative (V6) organize and following 50 days tuft development (VT), sulking (R1) stages from sowing, individually. Tween-20 was utilized as a lotion with a centralization of 0.02%. Zn composts were showered with rucksack hand sprayer.

Soil sample Analysis

The delegate soil surface example (0-30 cm) was taken from the test site before planting and arranged to decide some concoction and physical properties as appeared in Table 1.

- Soil particle size distribution of the studied soil by standard international pipette method and Saturation ratio is determined by Klute, (1986).
- (pH) Soil was estimated in 1: 2.5 soil water suspension, natural issue content, calcium carbonate as well as soluble cations and soil composites (1:5) were described by Jackson, (1967).
- Electrical conductivity (EC) in soil (1:5) was measured by EC meter by method of US Salinity Lab, (1954).
- Available N, P & P were determined as mentioned by Bremner and Mulvany, (1982), and Olsen and Sommers, (1982) respectively.
- Available micronutrient content was determinate in the soil; DTPA-extractable of Zinc was analyzed using the atomic absorption spectrophotometer according to Lindsay and Norvell, (1978).

Samples of plants were taken from each piece at 120 days after seeding (at the harvest stage) to measure the following growth parameters such as plant height (cm), 100-grains weight (g), Harvest index per cent, number of grain rows ear^{-1}, grain yield (kg fed^{-1}), number of grains ear^{-1}, grains weight ear^{-1}(g), and biological yield (Kg Fed^{-1}).

Characters studied included biological yield (Kg Fed^{-1}) and harvest index (%), were determined according to method described by El Naim *et al.,* (2010). Harvest index was calculated using the formula as shown under:

Uptake element = % Element * dry weight of grains.

Protein= %N*6.25

Plant Analysis

A leaf flanking the ear of the plant was taken from aimlessly picked plants of each plot for plant examination. For compound examination, at gather precedents of grain were taken from each plot of the test. The examples stove dried at 70oC for 72 hrs and smashed by the electric processor and sieved.

Plant tests were secured in polythene sacks for supplement examination. Dried materials were dried and 0.2 g of the maize grain test was prepared using 5.0 cm^3 of the mix of (1:1) as delineated by Peterburgski (1986). Signify N was controlled by scaled down scale Kjeldahl procedure as cleared up by Hesse (1971). Mean P was settled colorimetric accomplice using spectrophotometer as determined by Olsen and Sommers, (1982). K was registered by using fire photometer as depicted by Jackson (1967). Protein content was resolved in the dry grain by increasing the N focus by 5.7 as indicated by AOAC (2007). Indicate zinc obsession in maize grain and straw models was managed by wet-absorption using atomic maintenance spectrometer (ASS) system technique as portrayed Chapman and Pratt, (1961). The Zn take-up was computed by the rate Zn in grain and straw increased by the individual grain and strow yield. Zinc utilize productivity (ZUE) was computed utilizing the accompanying equation of Craswell, (1987).

Statistical analysis

The information were investigated measurably as indicated by the ANOVA system and the slightest huge contrast strategy (L.S.D) for the design of the complete random block (RCBD) as published by Gomez and Gomez (1984) through Co-STATE Computer.

RESULTS AND DISCUSSION

Ear weight (g)

Data of ear weight presented in Table 3 show that ear weight was non-significantly affected by Zn application techniques. The highest ear weight (350.27 g) was detected in treatment Zn_2 while the lowest ear weight (201.57 g) was noticed in control Zn_0. The foliar application of Zn 0.75 g/L as Zn-EDTA showed maximum ear weight than the addition of Zn to soil 10 kg fed^{-1} as Zn-EDTA. While, the application of Zn Kg fed^{-1} to soil as $ZnSO_4.H_2O$ treatment recorded higher ear weight (309.03 g) than the foliar application of Zn 0.75 g/L as Zn-EDTA which recorded the low ear weight. Similar findings were reported by Khasragi and Yarnia, (2014) who noticed greater ear weight by adding Zn to soil and foliar ways. The increased in ear weight is due to Zn add to soil and foliar supply (Drissi *et al.,* 2015).

Table 3. Some vegetative growth, yield and yield components of maize as affected by zinc application during 2015 season.

Treatment	Plant height (cm)	Ear weight (g)	Number of rows ear^{-1}	Number of grains ear^{-1}	Weight of 100 tab
Zn_0	193.3^{b}	201.57^{a}	14.33^{a}	399.00^{a}	21.57^{a}
Zn_1	205^{b}	265.6^{a}	14.33^{a}	309.33^{a}	21.99^{a}
Zn_2	221.3^{ab}	350.27^{a}	14.00^{a}	382.67^{a}	22.61^{a}
Zn_3	239.3^{a}	271.87^{a}	12.66^{a}	500.67^{a}	22.86^{a}
Zn_4	203.3^{b}	309.03^{a}	13.33^{a}	540.67^{a}	22.71^{a}
F.Test	*	NS	NS	NS	NS
LSD at 5%	22.414	107.83	1.94	200.66	31.17

Plant Height:

Results showed that the height of maize plant at harvest stage was significantly influenced by methods of Zn application (Table 3). The maximum plant height was 239.3 cm with 25 kg fed^{-1} soil application as $ZnSO_4H_2O$ followed by 0.75 g L^{-1} foliar application as Zn-EDTA whereas minimum plant height 239.3 cm was noted in control. The expansion in plant tallness might be because of zinc is associated with various physiological procedures of plant development and digestion, advanced development and required for the blend of tryptophan, which is an antecedent of IAA, this metal likewise has a functioning job in the creation of auxin, a basic development hormone, Marschner (1995).

Number of rows ear^{-1}:

Data presented in Table (3) showed that Zn as soil addition and foliar application on had no significant effect on number of rows. The maximum value of number of rows (14.33) with 25 kg fed^{-1} while control which recorded the minimum value, (12.66) with Zinc-sulphate as soil application.

Number of grains ear^{-1}:

Table (3) showed that number of grains ear^{-1} of maize plant at harvest stage was not affected significantly. The maximum value of number of grains ear^{-1} 540.67 with zinc-sulphate as foliar application at the rate of 0.75 g/Liter (Zn_4), while the minimum value was 309.33 with zinc-EDTA as foliar application (Zn_2). These results were found similar with the findings of Bakyt and Sade (2002).

100-grain weight (g):

Results showed that the 1000-grain weight at harvest stage was not significantly influenced by methods of Zn application (Table 3). The maximum value of 100-grain weight was 22.86a g with zinc-sulphate as soil application at rate of 25 kg fed^{-1} (Zn_3) while the minimum value was 21.57 g with control. These results were similar with the findings of Hariss *et al.*, (2007).

Grain yield:

Figure 1 show the grain yield (kg fed^{-1}) of maize plant. The maximum value of grain yield is 2742.24 with Zinc-sulphate as foliar application (Zn_4) while minimum value was 1993.16 with control (Zn_0). The treatments were significant. These results were found to be similar with Aref, (2007).

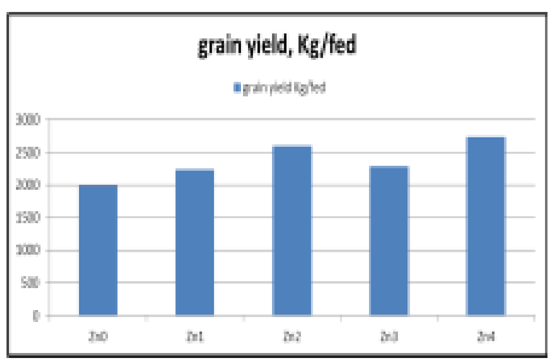

Fig.1. yield component of maize as affected by zinc application during 2015 season

Crude protein:

Figures 2 show that crude protein at harvesting was affected by Zn as soil addition and foliar application. This effect was not significant. The maximum value in harvesting stage 17.52 at Zn_3but the minimum value was 14.72% with control. Our outcomes are in accordance with those of Amer *et al.,* (1980) who reported that maize cultivar yielded the highest percentage of protein content, lysine, potassium and calcium in responses to Zn application. Fecenko and Lozek (1998) revealed that unrefined protein content in maize grain was expanded by 0.91 % by the application of 1.5-3 kg ha^1.

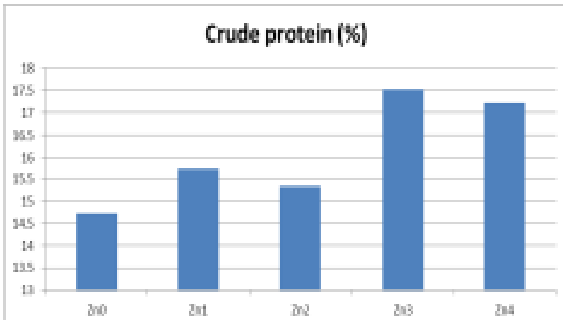

Fig .2. Effect of zinc application on crude protein at harvesting stage of maize plant.

Data presented in Table 4 show the effect of Zn application on % N, N uptake, %P, P uptake, %K and K uptake at flag leaf of maize plant during season 2015. Concerning different sources and methods of zinc fertilization treatments effect on maize plant, it was seen that medicines had high huge impact on % N and % K, while N uptake and K uptake were affected significantly but %P and P uptake did not affect significantly. The maximum value in % N was 2.98% with Zn_3 and the minimum value 2.51 with control. The maximum value in N uptake 125.27with Zn_2 and the minimum value was 67.53 kg fed^{-1} with control. These outcomes are of concurrence with those detailed by Belay *et al.,* (2002). The maximum value in P % was 45% with Zn_0 and the minimum value was 0.43% with Zn_4. The maximum value in P uptake 18.57 kg fed^{-1} with Zn_4 and the minimum value was 12.00 kg fed^{-1} with Zn_4. These outcomes are in concurrence with those announced by Ranade-Malvi, (2011). The maximum value in % K 2.13 with Zn_3 and the minimum value was 1.61 % with control. The maximum value in P uptake was 86.39 g fed^{-1} with Zn_4 and the minimum value was 42.88 kg fed^{-1} with control. These outcomes are in concurrence with those announced by Rasul (2010).

Table 4. Effect of zinc application on nitrogen, phosphorus and potassium concentration and uptake grains at flag leave stage.

Treatment	flag leave					
	Nitrogen		Phosphorus		Potassium	
	%N	N uptake (kg fed^{-1})	%P	P uptake (kg fed^{-1})	%K	K uptake (kg fed^{-1})
Zn_0	2.51^d	67.53^a	0.45^a	12.00^a	1.61^e	42.88^a
Zn_1	2.66^c	96.15^a	0.39^a	14.07^a	1.82^c	65.73^a
Zn_2	2.62^c	125.27^{ab}	0.39^a	18.54^a	1.72^d	82.43^a
Zn_3	2.98^a	108.09^{ab}	0.40^a	14.68^a	2.13^a	77.33^{ab}
Zn_4	2.84^b	120.14^b	0.43^a	18.57^a	2.04^b	86.39^b
Significant	**	*	NS	NS	**	*
LSD5%	0.060	35.66	0.045	6.95	0.83	25.79

Data presented in table 5 show that the effect of N %, N uptake, P%, P uptake, K% and K uptake at tasseling stages and harvesting stage of maize plant during season 2015. Concerning different sources and methods of zinc fertilizer treatments effect on maize plant, it was observed that treatments had high significant effect on % N,%P and % K at tasseling and harvesting stages, while N uptake, K uptake tasseling stage and harvesting stages were significant but P uptake tasseling stages and harvesting stages was not significant. The maximum value in % N was 2.57with Zn_3 at tasseling stage and 2.80 with Zn_3 at harvesting stage and the minimum value 2.13 with control at tasseling stage and 2.36 with control at harvesting stage. The maximum value in N uptake 106.43 with Zn_4 at tasseling stage and was 117.36 with Zn_2at harvesting stage and the minimum value 56.82 with control at tasseling stage, but was 62.88 with control at harvesting stage. These results are in agreement with those reported by Belay *et al.,* (2002). The maximum value in % P 40 with control at tasseling stage and 0.45with control at harvesting stage and the minimum value was 0.35 with Zn_4 at tasseling stage and 0.39 with Zn_4 at harvesting stage. The maximum value in P uptake was 16.37 kg fed^{-1} with control at tasseling stage and 12.133 with Zn_2 at harvesting stage and the minimum value 10.66 with Zn_2 at tasseling stage but 154.59 with control at harvesting stage. These results are in agreement with those reported by Ranade-Malvi, 2011. The maximum value in % K was 1.78% with Zn_3 at tasseling stage and 1.87% with Zn_3 at harvesting stage and the minimum value was 0.35% with Zn_4 at tasseling stage and 0.39% with Zn_4 at harvesting stage. The maximum value in K uptake was 71.47 kg fed^{-1} with Zn_4 at tasseling stage and 76.224 kg fed^{-1} with Zn_2 at harvesting stage and the minimum value was 34.59 kg fed^{-1} with control at tasseling stage, but it was 39.799 with control at harvesting stage. These results are in agreement with those reported by Rasul (2010).

Table 5. Chemical constituents and uptake grains of maize as affected by zinc application treatments during 2015 season.

Treatment	At tasseling stage						At harvesting stage					
	%N	N Uptake (Kg fed^{-1})	%P	P Uptake (Kg fed^{-1})	%K	K Uptake (Kg fed^{-1})	%N	N Uptake (Kg fed^{-1})	%P	P Uptake (Kg fed^{-1})	%K	K Uptake (Kg fed^{1})
Zn_0	2.13^{d}	56.82^{a}	0.40^{a}	16.37^{a}	1.30^{e}	34.59^{a}	2.36^{c}	62.88^{a}	0.45^{a}	18.716^{a}	1.48^{c}	39.799^{a}
Zn_1	2.30^{b}	82.71^{a}	0.36^{b}	13.15^{a}	1.50^{c}	54.03^{a}	2.51^{b}	90.87^{a}	0.42^{b}	15.058^{a}	1.68^{b}	60.513^{a}
Zn_2	2.20^{c}	105.36^{ab}	0.34^{d}	10.66^{a}	1.38^{d}	66.02^{a}	2.45^{b}	117.36^{ab}	0.40^{d}	12.133^{a}	1.60^{bc}	76.224^{a}
Zn_3	2.57^{a}	93.34^{ab}	0.36^{b}	12.99^{a}	1.78^{a}	64.42^{ab}	2.80^{a}	101.78^{ab}	0.41^{c}	14.921^{a}	1.87^{a}	68.015^{ab}
Zn_4	2.52^{a}	106.43^{b}	0.35^{c}	14.89^{a}	1.69^{b}	71.47^{b}	2.75^{a}	116.68^{b}	0.39^{e}	16.958^{a}	1.73^{b}	72.551^{b}
F.Test	**	*	**	Ns	**	*	**	*	**	NS	**	*
LSD5%	0.057	29.68	0.006	5.005	0.06	25.79	0.07	34.39	0.006	5.54	0.125	20.95

Table 6: show content of Zn mg kg^{-1} and Zn uptake g fed^{-1} at flag leave, tasseling and harvesting stages of maize plant during season 2015. Concerning different sources and methods of zinc fertilization treatments effect on maize plant, it was observed that treatments affected significantly Zn mg kg^{-1} at tasseling and harvesting stage, while significant with Zn mg kg^{-1} at flag leave, Zn uptake at tasseling stage and Zn uptake at harvesting stages was affected significantly but Zn uptake at flag leave was non-significant. The maximum value in Zn mg kg^{-1} at flag leave stage was 22.30 g fed^{-1} with Zn_3, while it was 20.44 gfed^{-1} at tasseling stage and 21.61 with Zn_2 at harvesting stage and The minimum value in Zn uptake at flag leave was 1.25 g fed^{-1} with Zn_2, while at tasseling stage it was1.16 g fed^{-1} with Zn2 and 1.22 g fed^{-1} with Zn2 at harvesting stage. These outcomes are in concurrence with those revealed by Bukvić *et al.,* (2003).

Table 6. Zinc concentration and uptake grains of maize plant at different growth 2015 season :

Treatment	flag leave		At tasseling stage		At harvesting stage	
	Zn, mg kg^{-1}	Zn uptake, g fed^{-1}	Zn, mg kg^{-1}	Zn uptake, g fed^{-1}	Zn, mg kg^{-1}	ZnUptake, g fed^{-1}
Zn_0	19.24^{b}	0.65^{a}	17.83^{e}	0.61^{a}	19.04^{e}	0.65^{a}
Zn_1	20.86^{a}	1.04^{a}	19.28^{d}	0.96^{ab}	20.42^{d}	1.01^{ab}
Zn_2	22.01^{a}	1.25^{a}	20.44^{a}	1.16^{ab}	21.61^{a}	1.22^{ab}
Zn_3	22.30^{a}	1.20^{a}	19.68^{c}	1.05^{ab}	20.81^{c}	1.11^{ab}
Zn_4	21.69^{a}	1.14^{a}	20.05^{b}	1.06^{b}	21.25^{b}	1.12^{b}
Significant	*	NS	**	*	**	*
LSD5%	1.59	0.42	0.196	0.34	0.209	0.37

CONCLUSION

In conclusion, $ZnSO_4H_2O$ as foliar spray (0.75 g L^{-1}) appears to be the best form and rate. The application of zinc to the soil increases the uptake of zinc by maize plants, compared to the application of other forms to the plant in grains or leaves.

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تأثير التسميد بالزنك على الذرة الشامية تحت ظروف الأراضي الطميية

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أجريت تجربه ميدانية فى المزرعة التجريبية بكلية الزراعة جامعة المنصورة خلال موسم 2015 لدراسة تأثير المصادر المختلفة و طرق الإضافة المختلفة من الزنك على نمو ومحصول ومكونات نبات الذرة الشامية صنف ذرة هجين فردى 168 المنزرع في الأراضي الرسوبية النهرية و نفذت التجربة في تصميم كامل العشوائية مع ثلاث مكررات وأ ظهرت النتائج أن أفضل معاملة هي كبريتات الزنك المضافة رشا علي النبات بمعدل 0.75 جم/لتر . وذلك في حالة زراعة محصول الذرة بهدف الحصول علي الحبوب و أيضا في حالة زراعة محصول الذرة للحصول علي المحصول الأخضر (السيلاج) تكون المعاملة 25 كجم/فدان من كبريتات الزنك المضافة للتربة هي الأفضل.

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