Foliar application of ZnO Nanoparticle for Increacing Adaptability of *Kochia indica* in saline habitats

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Abstract: In arid and semi-arid regions, water limitation is undoubtedly a critical environmental constraint hampering improving agriculture. Recently the progressing in nanoscience and nanotechnology has shifted from disk lab research technique into value added products helps to maximize plant tolerance against biotic and abiotic stress. Thus the present work was conducted to Study the effect of using nanoparticles of ZnO synthesized in increasing adaptability of *Kochia indica* against saline environments of South Sinai. Field experiment was carried out at the Model Farm of National Research Centre, El Tour, South Sinai to test the impact of foliar application with ZnO (20, 40 and 60 ppm) in addition to control treatment on some growth characters, photosynthetic pigments content, crude protein content, crude fiber, ash and some physiological aspectsas well as nutrients content of *Kochia indica*. Results obtained revealed that foliar application of ZnO nanoparticle improved growth, photosynthetic pigments content, crude protein and crude fiber. The best results were obtained from foliar application with40 ppm ZnO nanoparticle treatment. We can conclude that zinc nanoparticles can improve growth in salt affected soil soils.

Key words: *Kochia indica* · Zn nanoparticles · Growth · Physiological aspects · Saline habitats

INTRODUCTION

Soil salinity is one of the worst environmental problems around the world, irrigation practices, low rainfall and high transpiration rate. It is reported that about 20% irrigated and 7% of all land is salt affected, which accounts about 1000 million hectare of land [1]. Salinity tolerance is defined as the ability of plants to grow under salt stress conditions [2]. Furthermore, the salinity tolerance is identified the ability of plant cells to adjust osmotically and to accumulate organic solutes (proteins, sugar, amino acids, etc.).

Kochia as a halophyte plant receiving attention by many researchers because it represents a good alternative as a grazing or forage crop, it's a good plant for saline soils reclamation in arid regions. Several scientists reported that kochia is a prospective forage crop for salt-affected soil [3].

Recent sustainable agricultural strategy is associated with the program of increasing the cultivated lands, most of target area are suffered from rare of water and saline soil and water as well as harsh climatic.

They have also an inadvertent, detrimental impact on the environment and on ecosystem services, highlighting [4]. It is well documented that excessive and inappropriate use of fertilizers has increased nutrients and toxins in groundwater and surface waters, incurring health and water purification costs and decreasing fishery. Agricultural practices that degrade soil quality contribute to eutrophication of aquatic habitats and may necessitate the expense of increased fertilization, irrigation and energy to maintain productivity on degraded soils, they also kill beneficial insects and other wildlife [5, 6]. Intensive tillage, irrigation and fertilizer dressing have also caused more extensive damage to the carbon profile in soils than early agrarian practices did [7].

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During the last few decades, there has been a rapid growth of interest in the areas of nanoscience and nanotechnologies because of the realization that nanosized materials are effective in a multitude of agricultural [8].

Attempts to apply nanotechnology in agriculture began with the growing realization that conventional farming technologies would neither be able to increase productivity any further nor restore ecosystems damaged. Nanotechnology is an emerging technology, which can lead to a new revolution in every field of science [9]. Research in this field has gained momentum in the recent years by providing innovative solutions in different scientific disciplines [10]. Nanotechnology deals with nano particles that are atomic or molecular aggregates characterized by size less than 100nm. These are actually modified form of basic elements derived by altering their atomic as well as molecular properties of elements [11]. Nanoparticles gained considerable attraction because of their unusual and fascinating properties, with various applications, over their bulk counterparts. Zinc Oxide Nanoparticles. Zinc oxide is an inorganic compound with the molecular formula ZnO. It appears as a white powder and is nearly insoluble in water [12]. In this regard, Raliya and Tarafdar [13] stated that, ZnO NPs in lower concentration increased seed germination in wheat. They recorded improved plant biomass, root and shoot length, chlorophyll and protein synthesis and other growth parameters *Cyamopsis tetragonoloba* when exposed to ZnO NPs. Moreover, Burman *et al.*, [14] reported that foliar application of ZnO NP at 1.5 mg/L concentration increased biomass as compared to ZnSO4 in chickpea.

The objective of this work was to test the impact of some nano-concentration of ZnO treatments on growth, photosynthetic pigments content, crude content as well as some physiological aspects of *Kochia indica*.

MATERIAL AND METHODS

field experiment was carried out at the Model Farm of National Research Centre, El Tour, South Sinai to study the impact of foliar application of ZnO nanoparticles (control, 20, 40 and 60 ppm) on some growth characters, photosynthetic pigments content, crude protein content and some physiological aspects as well as nutrients content of *Kochia indica*. Zinc oxide (ZnO) NPs about 18 nm sizes were synthesized by mixing 10 ml of sodium hydroxide (NaOH) solution (4mM) to 0.1 ml of 0.5 M solution of 1- thioglycerol and to 10 ml of 10^{-3} M solution of zinc acetate [15]. The synthesized ZnONPs were dried in oven, suspended in water and then used for treatment.

Table 1: Chemical analyses of irrigated water of Abo Kalam well, El Tour. South Sinai.

pH		7.49
EC dS^{-1}		8.7
Soluble cations	K^+	0.5
Meq/L	Na^+	69.2
	Mg^{++}	11.9
	Ca^{++}	21.6
Soluble anions	SO4--	26.6
Meq/L	Cl-	74.2
	HCO3-	2.4
	CO--	-

Table 2: Mechanical and chemical analysis of the soil site.

Depth		00 – 30 cm	30 – 60 cm
Soil texture		Sandy soil	Sandy soil
pH		8.1	8.4
EC dS^{-1}		15.1	4.52
Soluble cations	K^+	0.4	0.24
Meq/L	Na^+	112.0	27.0
	Mg^{++}	28.8	5.5
	Ca^{++}	60.5	12.5
Soluble anions	$SO4^{-}$	61.0	10.64
Meq/L	Cl^-	139.0	31.0
	$HCO3^-$	2.7	3.6
	CO^-	-	-

Kochia indica seedlings was transplanted at 15th May 2015 and grown under drip irrigation system with saline water (EC : 8.7 dSm^{-1}), chemical analyses of water irrigation of Abo Kalam Well were done and results are presented in Table (1). Each experiment included 4 treatments Arranged in RCBD. Distance between plants was 1.5 x 1 mand the theoretical. No was 2800 plants /fed.The mechanical and chemical analyses of the soil was carried out by using the standard method described by [16], Table (2). Each plant was fertilized with 50 g calcium superphosphate (15.5% P_2O_5) and 30 g potassium sulphate (48.0 % K_2O) and 60 g urea (46.5% N) mixed with 500 g green manures (compost). Foliar application with ZnO nanoparticles was applied two times 30 days from transplantation and 30 days later. Three replicates from vegetative samples for each treatment were taken at 2ndSep 2015 to determine some growth characters i.e., plant height, number of branches, number of leaves, dry weight of leaves dry weight of whole plant and leaf area as well photosynthetic pigments content as [17].

Then plant with distilled water, then dried at 70°C using an aerated oven until constant weight. Dried thoroughly, then dried at 70° C to constant weight in an aerated oven to determine, proline (µg/g) according to [18], osmotic potential were obtained from the corresponding values of cell sap concentration tables given by [19] as well as values of succulence (ratio of fresh weight/dry weight) according to [20]. Soluble carbohydrates content were determined by the method described by [21]. The contents of sodium and potassium were determined in the digested material using Jenway flame photometer as described by [22]. K/Na ratio was also calculated for each treatment. crude fiber and ash were determined by standard analytical methods after [23]. Nitrogen was determined with micro Kjeldhal's apparatusaccording to the method described by [23]. Crude protein was calculated by multiplying nitrogen contents by 5.75.The obtained data were subjected to statistical analysis of variance described by [24].

RESULTS AND DISCUSSIONS

Effect of Foliar Application with Nanoparticles Size of ZnO on Some Growth Characters of *Kochia Indica*: Data registered in Table (3) showed that most of studied growth characters were significantly affected by foliar application of nanoparticles of ZnO all foliar treatments significantly affected the studied growth characters. The highest values for plant height, number of branches, leaf area, dry weight of shoot, dry weight of root as well as Shoot / root ratio were recorded in plants were sprayed with 40 ppm ZnO. Similar results were obtained by [25]. In the same concern ,Prasad *et al.,* [26] stated that, zinc oxide have potential to boost the yield and growth of food crops. Zinc oxide nanoscale treatment (25nm mean particle size) at 1000ppm concentration was used, which promoted seed germination and plant growth and these zinc oxide nanoparticles also proved to be effective in increasing stem and root growth in peanuts. In this concern, Naderi and Abedi [27] stated that, the increase in vegetative growth in plant be due to fundamental role of Zn in protecting and maintaining structural stability of cell membranes. Cakmak [28] added that Zn can be used in protein synthesis, membrane function, cell elongation as well as tolerance to environmental stresses. Prasad *et al*., [26] suggested that ZnO nanoparticles are absorbed by plants to a larger extent as compared to $ZnSO_4$. They also observed beneficial effects of nanoparticles in enhancing plant growth, development and yield in peanut at lower doses, but at higher concentrations ZnO nanoparticles were detrimental just as the bulk nutrients. Mahajan *et al*., [29] stated that, ZnONPs promoted the root and shoot length and root and shoot biomass.

Effect of Foliar Application with Nanoparticles ZnO on Photosynthetic Pigments Content of *Kochia Indica* Leaves: Data presented in Fig (1) revealed that foliar application with nanoparticles ZnO, positively affected photosynthetic pigments content, with superiority to 40 ppm concentration over all the other treatments. Similar results were obtained by [25]. Such increase in photosynthetic pigments content in the leaves of plants may be attributed to the enhancing effect of nanoparticles ZnO on chlorophyll accumulation through the useful importance of Zn on plant growth. In this regard, Raliya and Tarafdar [13] reported that ZnONPs induced a significant improvement in chlorophyll synthesis. SiO_2NPs improves photosynthetic rate by improving activity of carbonic anhydrase and synthesis of photosynthetic pigments [30].The exogenous application of TiO_2NPs improves net photosynthetic rate, conductance to water and transpiration rate in plants [31]. According to [32], metal nanoparticles can induce the efficiency of chemical energy production in photosynthetic systems.

Effect of foliar application with nanoparticles ZnO on some physiological aspects of *Kochia indica*: Data in Table (4) shows the effect of different treatments on some physiological aspects of *Kochia indica*. It is clear that all foliar treatments significantly affected all the studied characters as compared with control treatment. It is also

Table 3: Effect of foliar application with nanoparticles ZnO on some growth characters of *Kochia indica*

Treatments	Plant height (cm)	Number of branches / plant	Leaf area (cm^2)	Shoot dry weight (g)	Root dry weight (g)	Shoot / root ratio
Control	95.68	31.57	95.36	157.60	44.98	3.50
ZnO 20 ppm	101.54	35.25	100.87	179.57	47.65	3.77
ZnO 40 ppm	115.36	42.30	121.30	201.35	50.58	3.98
ZnO 60 ppm	108.39	39.65	112.60	185.94	48.65	3.82
LSD 5%	6.36	2.03	7.15	8.98	2.44	0.15

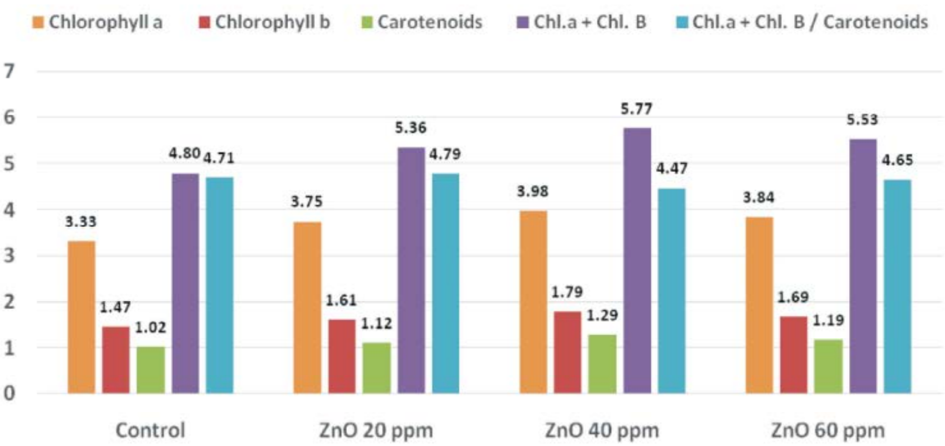

Fig. 1: Effect of foliar application with nanoparticles ZnO on photosynthetic pigments content of *Kochia indica*(LSD 5% =0.19)

Table 4: Effect of foliar application with nanoparticles ZnO on some physiological aspects of *Kochia indica*

Treatments	Osmotic potential values	Proline content µg/g dry wt.	Soluble carbohydrates%	Succulence	Crude protein %	Crude fiber %	Ash %
Control	7.06	344.58	45.98	3.19	7.68	21.35	27.68
ZnO 20 ppm	7.25	365.87	47.02	3.57	8.02	20.37	28.65
ZnO 40 ppm	8.02	402.36	48.23	3.75	8.87	22.02	28.87
ZnO 60 ppm	7.68	388.25	47.85	3.67	8.47	21.36	29.03
LSD 5%	0.41	18.25	2.81	0.15	0.44	NS	NS

Table 5: Effect of foliar application with nanoparticles ZnO on nutrients content of *Kochia indica*

Treatments	N %	P %	K %	Na %	K/Na	Zn ppm
Control	1.34	0.51	0.98	1.02	0.96	15.36
ZnO 20 ppm	1.39	0.55	1.03	0.96	1.07	16.58
ZnO 40 ppm	1.54	0.68	1.25	0.91	1.42	17.25
ZnO 60 ppm	1.47	0.60	1.12	0.88	1.23	17.99
LSD 5%	0.08	0.04	0.07	0.06	0.07	0.72

clear from the table that foliar application with 40 ppm ZnO recorded the highest values for Osmotic potential, Proline content and soluble carbohydrates %as well as succulence values,crude protein content and crude fiber in the plant leaves.On the other hand, the highest values for ash % were recorded under 60 ppm ZnO treatment. Similar results were obtained by [33]. In this regard, Helaly *et al*., [34] stated that, ZnO NPs induced proline synthesis and improved tolerance to abiotic stress.

Effect of Foliar Application with Nanoparticles ZnO on Nutrients Content of *Kochia Indica*: Data in Table (5) showed that, foliar application with ZnO nanoparticles, significantly affected content of N, P, K,Na and Zn as well as K/Na value as compared with control treatment. However, plants sprayed with40 ppm ZnO recorded the highest values of N, P and K as well as K/Na while plants sprayed with tap water (control) recorded higher contents of Na. On the other hand,plants sprayed with60 ppm ZnO recorded the highest values of Zn. Such result was confirmed by the findings of [35]. Such increase in K/Na ratio may be due to the enhancing effect of ZnO nanoparticles on absorption of more potassium and micronutrients.

CONCULOSION

The results show that *Kochia indica*is highly salt tolerant halophyte, foliar application with 40 ZnO nanopartícl esenhanced all studied growth characters as well as photosynthetic pigments content and crude protein as well as the physiological aspects of the plant. We can conclude that zinc nanoparticles can improve plant growth in such salt affected environment.

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