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Impact of Salinity and Zinc on the Post Harvest Availability of Cationic Micronutrients

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Abstract The plants of wheat were raised in the earthen pots containing dune sand, at four salinity levels (EC_e 4, 8 and 12 dS m^{-1}), each dominated by chloride ($Cl:SO_4 = 7:3$) and sulfate ($Cl:SO_4 = 3:7$) salts separately under natural conditions of screen house. Each EC_e treatment including non-saline control was established at four levels of zinc (0, 5, 10 and 15 mg kg^{-1} soil) with the objective to study the change in availability of cationic micronutrients after the harvesting of wheat. Under salinity there was a considerably decrease in Zn, Cu, Fe and Mn content and increase in sodium and chloride content in post harvest analysis of soil samples. The adverse effect of saline environment was ameliorated by Zn applications and for that optimum dose of Zn application in both type of salinity was 15 mg kg^{-1} soil. In the absence of Zn, there was the less availability of these cationic micronutrients. The data revealed that soil cationic micronutrients like Cu, Fe and Mn have positive correlation with the increasing application of Zn.

Keywords Chloride, Salinity, Sulfate, Zinc.

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Introduction

Salinity stress is one of the major constraints of the arid and semi-arid areas on production of the agricultural products. In such circumstances, besides imposing certain management applications, proper nutrition has an important role to play in improving plant conditions.The increasing frequency of dry periods in many regions of the world and the problems associated with salinity in irrigated areas frequently result in the consecutive occurrence of drought and salinity on cultivated land. About 50% of irrigated land in the world, which has at least twice the productivity of rainfed land and may produce one-third of the world's food, is affected by salinization [1]. In arid and semiarid regions, low precipitation coupled with the in adequately of canal water, compel farmer to rely on the ground water for supplemental irrigation. Saline soils all over the world contains Ca^{2+}, Mg^{2+}, Na^{+} as the major cations and CI- and SO_4^{2-} as anions. Salinity influences the physiological and biochemical processes, which ultimately cause reduction in plant growth and productivity [2]. Bukvic et al. [3] observed that the main factors which affect the amount of zinc in soil are pH, carbonate content, organic matter, soil texture and interaction between zinc and other microelements. Available copper and manganese decreased with increase in the levels of salinity.

Total contents were higher in fine textured soil than in coarse-textured soils. Concentration of micronutrients in the surface layer was low. Organic carbon, pH, clay, silt and calcium carbonate exerted strong influence on the distribution of micronutrients. DTPA extractable Zn, Cu, Mn and Fe increased with increasing organic carbon but decreased with increase in pH and calcium carbonate content [4]. Salt affected soils of iran results of the last decade showed that at the present time, among micronutrients, zinc (Zn) deficiency is the most detrimental to effective crop yield [5]. This study was taken up to evaluate the post harvest availability of cationic micronutrients like Zn, Cu, Fe and Mn in relation to different application of Zn.

Materials and Methods

A pot experiment was conducted using sandy soil *(Typic torripsamments)* of pH (1:2) (8.39), EC_e (1:2) (0.37 dS m^{-1}), organic carbon (0.14), Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-} and SO_4^{2-} were 2.50, 1.50, 0.66, 10.00 and 1.20 me L^{-1}, respectively under screen house conditions in the Department of Soil Science, CCS Haryana Agricultural University, Hisar ($29^0$46´ and $75^0$46´ at an elevation of 215.2 m above MSL).This region has semi-arid climate. The crop was grown on Cl-dominated ($CI:SO_4$=7:3) and SO_4- dominated ($Cl:SO_4$ = 3:7) soils at four EC_e levels (4, 8 and 12 dS m^{-1}) and compare with the non saline soil. Each salinity treatment including non-saline was having four levels of Zn, i.e. 0, 5, 10 and 15 mg kg^{-1} soil. Nutrients were applied as basal dose of N, P and K @ 130, 50 ppm, respectively, in the form of $(NH_4)_2SO_4$, KH_2PO_4 and KCI. Zinc, copper, manganese and iron were applied 10, 5, 10 and 15 ppm each, through $ZnSO_4$, $CuSO_4$, $MnSO_4$ and $FeSO_4$ respectively, in solution form. Ten seeds were sown for uniform germination in the first week of December. Before the sowing, each salinity treatment was equilibrate for ten days. After complete germination four plants pot^{-1} retained for physiological maturity. After the harvesting of plants soil samples were taken for the post harvesting analysis of cationic micronutrients availability, DTPA extractable Zn, Cu, Fe and Mn (µg pot^{-1}) of soil samples were determined by atomic absorption spectrophotometer [6]. Each treatment was replicated thrice with completely randomized design. Data were analyzed by using ANOVA to test for significance of main effects and interactions and tested at 5% levels of critical difference.

Results and Discussion

DTPA extractable Zn in post harvest soil sample

The results (Table 1) revealed that the mean DTPA estractable zinc decreased with increasing salinity levels both in chloride and sulfate dominated salinity. The mean DTPA extractable zinc decreased from 3.00 to 2.40 and 2.88 to 2.20 µg pot^{-1} in chloride and sulfate dominated salinity, respectively, as the salinity levels increased from 4 to 12 dS m^{-1}. The mean DTPA extractable zinc increased significantly with increased in applied zinc levels from 0 to 15 ppm in soil irrespective of types and levels of salinity. The mean DTPA extractable zinc increased from 0.42 to 5.35 and 0.35 to 5.26 µg pot^{-1} in both chloride and sulfate dominated salinity, respectively. The DTPA extractable zinc in soil decreased with increasing levels of both types of salinities. The per cent decrease in mean available zinc was 20.0 and 23.6 in chloride and sulfate domi-

Table 1. Post harvest DTPA extractable zinc (µg pot^{-1}) in soils at affected by both zinc and salinity levels.

Zn levels	Chloride salinity (dS m^{-1})					Zn levels	Sulfate salinity (dS m^{-1})				
(ppm)	0	4	8	12	Mean	(ppm)	0	4	8	12	Mean
Zn_0	0.63	0.49	0.37	0.20	0.42	Zn_0	0.63	0.34	0.24	0.17	0.35
Zn_5	2.29	2.17	2.11	2.00	2.14	Zn_5	2.29	2.11	1.77	1.49	1.92
Zn_{10}	4.07	3.86	3.49	2.31	3.43	Zn_{10}	4.07	3.71	3.35	2.17	3.33
Zn_{15}	5.63	5.50	5.20	5.09	5.35	Zn_{15}	5.63	5.37	5.04	4.98	5.26
Mean	3.16	3.00	2.79	2.40		Mean	3.16	2.88	2.60	2.20	

CD (5%)	CD (5%)
Chloride = 0.28	Sulfate - 0.178
Zinc= 0.28	Zinc = 0.178
Chloride × Zinc = 0.56	Sulfate × Zinc = 0.36

Table 2. Post harvest DTPA extractable copper (µg pot^{-1}) in soils as affected by both zinc and salinity levels.

Zn levels (ppm)	Chloride salinity (dS m^{-1}) 0	4	8	12	Mean	Zn levels (ppm)	Sulfate salinity (ds m^{-1}) 0	4	8	12	Mean
Zn_0	0.67	0.65	0.6	0.46	0.59	Zn0	0.67	0.62	0.59	0.43	0.58
Zn_5	0.73	0.71	0.68	0.58	0.68	Zn5	0.73	0.67	0.51	0.44	0.59
Zn_{10}	0.77	0.77	0.73	0.61	0.72	Zn10	0.77	0.76	0.69	0.57	0.70
Zn_{15}	0.86	0.8	0.67	0.64	0.74	Zn15	0.86	0.82	0.63	0.57	0.72
Mean	0.76	0.73	0.67	0.57		Mean	0.76	0.72	0.60	0.50	

CD (5%)
Chloride = 0.08
Zinc = 0.08
Chloride × Zinc = -

CD (5%)
Sulfate = 0.06
Zinc = 0.06
Sulfate × Zinc = -

nated salinity, respectively, as the salinity levels increased from 4 to 12 dS m^{-1}. The interaction of zinc and types of salinity was significant. Similar results were obtained [7] and concluded that DTPA extractable micronutrient levels in study area (Fe, Zn and Mn) were found to be deficient in all salt affected soil class to growth of plant, whereas, Cu was medium in non-saline, non-sodic soil and saline soil of both (Vertisols and Fulvisols) soil types but deficient in saline sodic soil and sodic soil of Fluvisols was more as per the rating described by Lindsay and Norvell [6].

DTPA extractable copper

DTPA extractable copper (µg pot^{-1}) in soil as affected by types of salinity and zinc levels after wheat harvesting is presented in Table 2. The data presented that in the absence of zinc and salinities, the mean DTPA extractable copper was 0.67 µg pot^{-1}. The mean available copper increased from 0.67 to 0.86 µg pot^{-1} with the increasing application of Zn from 0 to 15 ppm soil in the absence of applied salinities. This indicated that the mean DTPA extractable copper increased with the application of Zn. The results also revealed that mean DTPA extractable copper decreased with increasing salinity levels both in chloride and sulfate dominated salinity. The mean DTPA extractable copper decreased from 0.73 to 0.57 µg pot^{-1} (21.9%) and 0.72 to 0.50 µg pot^{-1} (30.6%) in chloride and sulfate dominated salinity, respectively, as the salinity level increased. The mean DTPA extractable copper increased significantly with increase in applied zinc levels in soil from 0 to 15 ppm, irrespective of types and levels of salinity. Mean DTPA extractable copper increased from 0.59 to 0.74 and 0.58 to 0.72 µg pot^{-1} in chloride and sulfate dominated salinity, respectively. The per cent increased in mean available copper was 25.4 and 24.1 in chloride and sulfate dominated salinity, respectively, as the zinc levels increased from 0 to 15 ppm.

Table 3. Post harvest DTPA extractable iron (µg pot^{-1}) in soils as influenced by both zinc and salinity levels.

Zn levels (ppm)	Chloride salinity (dS m^{-1}) 0	4	8	12	Mean	Zn levels (ppm)	Sulfate salinity (dS m^{-1}) 0	4	8	12	Mean
Zn_0	2.69	2.65	2.52	2.50	2.59	Zn_0	2.69	2.58	2.26	2.18	2.43
Zn_5	2.72	2.68	2.64	2.61	2.66	Zn_5	2.72	2.58	2.48	2.46	2.56
Zn_{10}	2.76	2.71	2.71	2.68	2.72	Zn_{10}	2.76	2.63	2.50	2.48	2.59
Zn_{15}	3.05	2.78	2.75	2.71	2.82	Zn_{15}	3.05	2.71	2.64	2.50	2.72
Mean	2.81	2.71	2.66	2.62		Mean	2.81	2.63	2.47	2.40	

CD (5%)
Chloride = 0.08
Zinc = 0.08
Chloride × Zinc = -

CD (5%)
Sulfate = 0.10
Zinc = 0.10
Sulfate × Zinc = -

Table 4. Post harvest DTPA extractable manganese (mg pot^{-1}) in soils as influenced by both zinc and salinity levels.

Zn levels (ppm)	Chloride salinity (dS m^{-1}) 0	4	8	12	Mean	Zn levels (ppm)	Sulfate salinity (dS m^{-1}) 0	4	8	12	Mean
Zn_0	8.60	7.85	7.71	7.05	7.80	Zn_0	8.60	7.67	7.25	6.78	7.57
Zn_5	8.87	7.89	7.88	7.55	8.05	Zn_5	8.87	7.79	7.75	7.34	7.94
Zn_{10}	9.04	8.46	8.09	8.06	8.41	Zn_{10}	9.04	7.97	7.81	7.41	8.06
Zn_{15}	9.60	8.80	8.38	8.07	8.71	Zn_{15}	9.60	7.98	7.92	7.75	8.31
Mean	9.03	8.25	8.02	7.68		Mean	9.03	7.85	7.68	7.32	

CD (5%): Chloride = 0.59; Zinc = 0.59; Chloride × Zinc = -

CD (5%): Sulfate = 0.68; Zinc = -; Sulfate × Zinc = -

DTPA extractable iron

The mean DTPA extractable iron (Table 3) increased from 2.69 to 3.05 µg pot^{-1} with the increasing application of Zn from 0 to 15 ppm soil in the absence of applied salinities. This indicated that the mean DTPA extractable iron increased with the application of Zn. The results revealed that the mean DTPA extractable iron decreased with increasing salinities levels both in chloride and sulfate dominated salinity. The mean DTPA extractable copper decreased from 2.71 to 2.62 µg pot^{-1} and 2.63 to 2.40 µg pot^{-1} in chloride and sulfate dominated salinity, respectively, as the salinity levels increased from 4 to 12 dS m^{-1}. The mean DTPA extractable iron increased with increase in applied zinc levels in soil irrespective of levels of salinity. Mean DTPA extractable iron increased from 2.59 to 2.82 µg pot^{-1} and 2.43 to 2.72 µg pot^{-1} in chloride and sulfate dominated salinity, respectively. The DTPA extractable iron in soil decreased with increasing levels of both types of salinity. The per cent decrease in mean available iron was 3.3 and 8.7 in chloride and sulfate dominated salinity, respectively, as the salinity levels increased from 4 to 12 dS m^{-1}. El-Fouly et al. [8] revealed that uptake and availability of micronutrients reduced with an increasing NaCl concentration while K, Ca, P, N as well as K/Na, Mg/Na ratios, Fe, Mn, Zn and Cu also decreased as salinity levels increased. Available iron also decreased with increase in the levels of salinity.

DTPA extractable manganese

The mean DTPA extractable manganese (Table 4) increased from 8.60 to 9.60 µg pot^{-1} with the increasing application of Zn from 0 to 15 ppm in soil. This indicated that the mean DTPA extractable manganese increased with the application of Zn. Results revealed that the mean DTPA extractable manganese decreased with increasing salinities levels both in chlorides as well as sulfate salinity. The mean DTPA extractable manganese decreased from 8.25 to 7.68 µg pot^{-1} and 7.85 to 7.32 µg pot^{-1} in chloride and sulfate salinity, respectively, as the salinity levels increased from 4 to 12 dS m^{-1}. The mean available manganese increased significantly with increase in applied zinc levels in soil irrespective of types and levels of salinity. Mean available manganese increased from 7.80 to 8.71 µg pot^{-1} and 7.57 to 8.31 µg pot^{-1} in chloride and sulfate dominated salinity, respectively, as the Zn levels increased from 0 to 15 ppm. The per cent increased in mean available manganese was 11.7 and 9.8 in chloride and sulfate dominated salinity, respectively, as the zinc levels increase from 0 to 15 ppm. The results are in good agreement with those obtained by El-Arquan et al. [9] who observed that the amount of nutrient elements significantly decreased by increasing salinity.

Conclusion

On the basis of the present investigation it could be concluded that there was decrease in micronutrients like Zn, Cu, Fe and Mn availability in the post harvest soil samples with increasing the soil salinity which affect the crop production. All above mentioned micronutrients availability increased with increasing application of Zn . Therefore, the present study suggested that the increasing application of zinc 15 ppm which was optimum mitigates the adverse effect of both types of salinity and increased availability of other micronutrient availability.

References

1. Hillel D (2000) Salinity management for sustainable irrigation. The World Bank, Washington, DC.
2. Sairam RK, Veerbhadra Rao K, Srivastava GC (2002) Differential responses of wheat to long term salinity stress in relation to oxidative stress, antioxidant activity and osmotic concentration. Pl Sci 163 : 1037—1046.
3. Bukvic G, Antunovic M, Popovic S, Rastija M (2003) Effect of P and Zn fertilization on biomass yield and its uptake by maize lines (*Zea mays* L.). Pl Soil Environ 49 : 505—510.
4. Sharma BD, Kumara R, Singh B, Sethia M (2009) Micronutrients distribution in salt-affected soils of the Punjab in relation to soil properties. Arch of Agron and Soil Sci 55 : 367—377.
5. Mohammad JM (2008) The effect of micronutrients in ensuring efficient use of macronutrients. Turky J Agric 32 : 215—220.
6. Lindsay WL, Norvell WA (1978) Development of DTPA soil test for zinc, iron, manganese and copper. Soil Sci Soc Am J 42 : 421—428.
7. Worku A, Bedadi B, Mohammed M (2016) Assessment on the status of some micronutrients of salt affected soils in amibara area, Central Rift Valley of Ethiopia. Academia J Agric Res 4 : 534—542.
8. El-Fouly MM, Mobarak ZM, Salama ZA (2011) Micronutrients (Fe, Mn, Zn) foliar spray for increasing salinity tolerance in wheat (*Triticum aestivum* L.). Afr J Pl Sci 5 : 314—322.
9. El-Arquan MY, El-Hamdi KhH, Seleem EM, El-antawy IM (2002) Nutrient uptake of sugar beet as affected by NPK fertilization and soil salinity levels. Egypt J Soil Sci 42 : 783—797.