Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.6548

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **6 (3):** 154-158 (2018)

Review Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Zinc Deficiency in Soil of Rajasthan and its Management

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Received: 30.05.2018 | Revised: 23.06.2018 | Accepted: 27.06.2018

ABSTRACT

Zinc Deficiency in Soil of Rajasthan and its Management. In India, zinc (Zn) is now considered as fourth most important yield limiting nutrient in agricultural crops. Zn deficiency in Indian soils is likely to increase from 49 to 63% by 2025. meet out only 30 to 40% of zinc requirement meet out by soil and foliar application of zinc on crop plants while the remainder gets absorbed in clay colloids and become immobile and some parts may goes out to the environment due to soil and edaphic factors. Only a small amount of applied zinc is utilized by the crop plants. Studying the solublization and mobilization of zinc in soil and interaction with other nutrients in various types of soils are essential for the precise recommendation and use of zinc. The soils of Alwar and Jhalawar have 0.50 ppm of available zinc while in Bhilwara soils it was found in traces indicating that the soils of these places may show deficiency symptoms. Total Zn content of different soil groups of Rajasthan ranged from 34.8 to 79.6 ppm. Available zinc was not found to be correlated with pH. So it is necessary to reduces zinc loss in these regions by using well management practices. It can help for increasing zinc availability in Rajasthan region.

Key word: *Available zinc, FYM, Nutrient deficiency*

INTRODUCTION

Micronutrients are important in plant nutrition as the major nutrients, they simply occur in plants and soils in small concentration. Plants grown on micronutrient deficient soil can exhibit similar reductions in plant growth and yield. The deficiency of micronutrients has become a major constraint in production and sustainability.

Zinc is an integral part of many enzymes like: carbonic anhydrase, alcohol dehydrogenises, superoxide dismutase, RNA polymerase etc. It actively participates in N-metabolism and also activates the hormonal activities (Indole acetic acid). Mostly zinc deficiency has been observed in arid and semi-arid regions. Zinc ions adsorbed on soil complexes may easily be removed by leaching especially in sandy loam soils and adsorbed zinc is in equilibrium with the soil solution zinc.

Cite this article: Nagar, R., Meena, R. and Nagar, D., Zinc Deficiency in Soil of Rajasthan and its Management, *Int. J. Pure App. Biosci.* **6(3):** 154-158 (2018). doi: http://dx.doi.org/10.18782/2320-7051.6548

The amount of extracted zinc is increase with the increase in fineness of the soil texture. It has also been reported that organic matter plays a major role in controlling availability of zinc particularly in alkaline soil[1].

Singh[11] and Mehra[5] reported that availability of zinc increased significantly with increase in organic carbon because zinc forms soluble complexes (Chelates) with soil organic matter component. On the other hand, the availability of zinc reduced significantly with an increase in $CaCO_3$ and pH of soil. At high pH and $CaCO_3$ content, zinc forms insoluble compounds such as $Zn(OH)_2$ and $ZnCO_3$ which can reduce the availability of zinc.

Soil factors affecting availability of zinc:

Although genotypic factors are important in determining either tolerance or susceptibility of a crop cultivar to zinc deficiency, it is soil factors which are responsible for low available zinc supply. In general, the soils most commonly associated with zinc deficiency problems in plants mainly due to the factors such as neutral to alkaline in reaction, especially where the pH is above 7.4, high calcium carbonate ($CaCO_3$) content in top soil or in sub soil exposed by removal of the topsoil during field leveling or by erosion, coarse texture (sandy soil) with a low organic matter status, permanently or intermittently waterlogged soil, high available phosphate status, high bicarbonate or magnesium concentrations in soil or irrigation water and acidic soil of low zinc status developed on highly weathered parent material.

Calcareous soils with a high content of calcium carbonate (>15%) are typical soils of semi-arid and arid climates. Presence of calcium carbonate decreases the availability of zinc due to higher soil pH. Mostly salt affected soils are the saline soils (Solonchaks), sodic soils (Solonetz) and both mainly occur in arid and semi-arid regions. Saline soils contain high concentrations of soluble salts which restrict the types of crops which can be grown and reduces the availability of zinc. reported that poor availability of zinc caused by water logging can be due to a relatively high pH, zinc being present as the insoluble sulphide (ZnS) and elevated concentrations of ferrous, bicarbonate, and phosphate ions.

Interactions between zinc and other plant nutrients

There are inverse relationship between zinc and pH as the pH increases the availability of zinc decreased. High soil phosphate levels are one of the most common causes of zinc deficiency in crops by cations added with phosphate salts can inhibit zinc absorption from solution, H+ ions generated by phosphate salts inhibit zinc absorption from solution and phosphorus enhances the adsorption of zinc into soil constituents. Nitrogen appears to affect the zinc status of crops by both promoting plant growth and by changing the pH of the root environment. In many soils, nitrogen is the main factor that limiting growth. Several macronutrient including calcium (Ca), magnesium (Mg.), potassium (K) and sodium(Na) are known to inhibit the absorption of zinc by plant.

Interactions of zinc with other micronutrients

Loneragan[4] suggested that zinc interact with copper, iron, manganese and boron influence their concentration in plants by zinc-copper interactions occur due to copper and zinc sharing a common site for root absorption or copper nutrition affects the redistribution of zinc within plants. Iron-zinc interactions study resulted increasing zinc supplies to plants have been observed to increase the iron status, to decrease it and to have no effect on it.[3] reported that Zn application had adverse effect on Fe concentration and Fe uptake in plants.

Agronomic management to enhance zinc in soil

Soil application

Singh[10], reported that, an application of 10 kg of zinc in swell-shrink soils, 5 kg in zinc to alluvial red and lateritic soils per hectare was found optimum in ameliorating zinc deficiency.[9], Reported that, drip irrigation application was superior over the other soil and foliar Zn applications by precise application at appropriate times with desired concentration, uniform distribution, less damage to crop and soil and ultimately higher crop yield.[12] suggested that, the requirement and response to zinc application varies with the soil types. Application of 40 kg Zn ha^{-1} recorded high pod yield, protein content and zinc uptake by peanut, whereas application of 20 kg Zn ha^{-1} recorded the highest oil content and sulphur uptake in vertisol.

The soil application of 5, 1, 0.5 kg ha^{-1} Zn, B, and molybdenum (Mo), respectively along with NPK increased the crop yield to 30%[7]. Muthukumararaja and Sriramachandrasekharan[6] reported that increased in yield with zinc fertilization in zinc deficient soil. The soil application of 10 kg ha^{-1} Fe and 5 kg ha^{-1} Zn was recommended by All India Coordinated Research Project on micronutrients.

Zinc Fertilizers:

There are different forms and source of zinc available as listed in Table. The solubility of several zinc minerals decreases in the following order namely Zn $(OH)_2$ (amorphous) > $Zn(OH)_2$ > $ZnCO_3$ (smithsonite) > ZnO

Compound	Formula	Zn content (%)
Inorganic zinc fertilizers		
Zinc sulphate monohydrate	$ZnSO_4$. H_2O	36
Zinc sulphate heptahydrate	$ZnSO_4.7H_2O$	22
Zinc oxysulphate	$ZnSO_4$ ZnO	20-50
Basic zinc sulphate	$ZnSO_4.4Zn(OH)_2$	55
Ammoniated zinc sulphate	$Zn(NH_3)4SO_4$	10
Zinc oxide	ZnO	50-80
Zinc carbonate	$ZnCO_3$	50-56
Zinc chloride	$ZnCl_2$	50
Zinc nitrate	$Zn(NO_3)_2.3H_2O$	23
Chelated zinc fertilizers		
Disodium zinc EDTA	Na_2Zn EDTA	8-14
Sodium zinc EDTA	NaZn EDTA	9-13
Sodium zinc HEDTA	NaZnH EDTA	6-10
Zinc polyflavonoid	-	5-10
Zinc lignosulphonate	-	5-8

All of the Zn $(OH)_2$ minerals, ZnO and $ZnCO_3$ are about 105 times more soluble than soil zinc (adsorbed to solid surfaces) and would therefore makes highly suitable fertilizer sources of zinc.

Zinc forms soluble complexes with chloride, phosphate, nitrate and sulphate ions, but the neutral sulphate ($ZnSO_4$) and phosphate ($ZnHPO_4$) species are the most important and contribute to the total concentration of zinc in solution. The $ZnSO_4$ complex may increase the solubility of Zn_2+ in soils and accounts for the increased availability of zinc when acidifying fertilizers, such as ammonium sulphate [(NH_4 $(SO_4)_2$)] are used.

Application FYM enriched Zn observed improvement in the available zinc status of deficient soils is probably the result of an increase in soluble, organically-complexed forms of zinc. Low molecular weight organic acids namely, humic acid and fulvic acid form soluble complexes with zinc and contribute to the total soluble concentration in a soil. Barrow reported that organic ligands reduced the amounts of zinc adsorbed in soil and the effect was most pronounced with those ligands, including humic acids which complexes zinc strongly. Soluble forms of organically-complexes zinc can result in zinc becoming increasingly mobile and plant available in soils. In many cases, complexation of organic zinc with organic sources such as farmyard manure, and poultry manure at least 20 to 30 days. Application of enriched $ZnSO_4$ as a basal was found to be economically viable and sustainable. In case of severe deficiency of zinc foliar application of $ZnSO_4$ at 0.2 to 0.5%

is recommended to temporarily arrest the zinc deficiency.

Concerns and future directions:

Soil and foliar application of zinc meet out only 30 to 40% of zinc requirement of crop plants while the remainder the environment due to soil and edaphic factors. As only a small quantum of applied zinc is utilized by the crop plants. To reduce zinc malnutrition, the crop fortification is important aspect which not only enhances the zinc content in kernel but also increases the productivity of crop. Studying the solublization and mobilization of zinc in soil and interaction with other nutrients in various types of soils are essential for the precise recommendation and use of zinc. There is a need to develop the comprehensive nutrient management practices to be developed by taking into account of macro, micro and soil amendment (gypsum). Development of easy and economic, field-based biochemical test kits for assessing the zinc status of crops without relying on analytical laboratories is a key in the efficient use of zinc in agriculture near future. Better understanding of molecular and physiological mechanisms of zinc uptake, mobility and partitioning in peanut is required to design the suitable source, method of application and the stage of application. Investigation is needed on plant anatomical and rhizosphere changes responsible for the variability in absorption, translocation and uptake of zinc. At last to enrich micronutrient in food crops, the collaborative multidisciplinary research involving soil scientists, agronomists, plant breeders, human nutritionists and food technologists on the bio-fortification with zinc in a form which is bio-available to consumers is need of the hour. Further, the positive approach of government in their policies to enhance the micro-nutrients in stable food crops and their use in regular foods are very much desired to address the hidden hunger problem.

CONCLUSION

Zinc Deficiency in Soil of Rajasthan and its Management. The soils of Alwar. Jhalawar and Bhilwara appear to be deficient in available zinc. The soils of Alwar and Jhalawar have 0.50 ppm of available zinc while in Bhilwara soils it was found in traces indicating that the soils of these places may show zinc deficiency. Available zinc was not found to be correlated with pH. For reducing available zinc losses it is required to design the suitable source, method of application and the stage of zinc application .So it is necessary to reduces zinc loss in these regions by using well management practices. It can help for increasing zinc availability in Rajasthan region.

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