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Status of Zinc in the soils of Faridabad District, India

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ABSTRACT

Soil is the principal component of the ecosystem and contains minerals which are key required nutrients. Zinc (Zn) is one of such nutrients naturally present in soils at a concentration of 0.6-1.2ppm. However, various human activities have resulted in concentration variation. It has been speculated that these varied concentration leads to insufficient zinc in crops and estimated one third of the population is at risk of zinc deficiency, thus effectuating dire health implications such as impeding immune system and brain development. Zinc deficiency among the human population is prominently noticed among young kids. It affects them more as zinc deficiency impairs brain development and thus it can determine their early growth. Moreover one of the main dietary options is dairy products thus its necessary that fodder crops must contain enough zinc. Testing of soil for characterizing Zn availability provides information about concentration and soil conditions. The concentration of zinc in the soil is tested via Atomic absorption spectroscopy (AAS). This technique is employed to test for the concentration of heavy metals present at low concentration. After the testing, the results indicate varied concentration and significant statistical difference among samples. The concentration of some soil samples was below critical limit, which points that those specific spots require zinc supplements to improve the deficit noted.

Key words: *Soil, Zinc deficiency, AAS, Zinc concentration, Fodder crops*

Introduction

Soil is one of the foremost sources of nutrients for crops. These nutrients present in soil promote growth in plant, and insufficient nutrients will result in poor crop quality (Smith and Paul, 1990). Plants nutrients are characterized into macronutrients and micronutrients. Macronutrients are present in abundance and these are N, P, K, Ca, Mg and S while nutrients present in relatively small amounts the soil supplies Fe, Mn, B, Mb, Cu, Zn, Cl are micronutrients (Bünemann *et al.*, 2018).

Zinc, because of its concentration can be catalogued as trace element in soil and is considered one of the crucial micronutrient for normal healthy growth and development of crops. However, when the nutrients are inefficient yields of crops gets damaged (Alloway, 2008) Various plant enzymes are dependent on zinc for its metabolic reactions. Zinc is responsible for all the metabolic reactions by plant enzymes. It is known that zinc insufficient plants are deficient in carbohydrate, proteins and chlorophyll which is important for growth and maximum yield (Marschner, 1993). Zinc deficiency which ensues a low nutritional quality and decreased yield in plants is regarded to be far extensive and persistent trace element deficiency among all crops (Alloway, 2009).

Zinc deficiency in humans is one of the most prominent causes of health concern and one third of world's population suffers from it and among, them infants and kids under the age of 5 are mostly at the risk of low Zn intake and is considered as a consequential threat in humans. Zinc plays a decisive role in cellular differentiation, cell growth and metabolism. Deficiency in human affects physical growth, immune system functioning and reproductive health. These are due to various factors, one of which being low yielding zinc deficit soils mainly present in developing countries (Brown *et al*., 2002).

Studies have shown that milk is considered a good source of zinc, and since it plays a pivotal role in normal development, it must contain required nutrients and one of them being zinc. Daily recommended uptake for zinc range from 3 to 26 mg/day, conditional on age, gender, type of diet and various other factors.

It can be corroborated from the data that the majority of kids are dependent on dairy products, especially cow milk during their developmental stage. So, it is essential that these cattle must produce enough zinc in their milk and in order, cattle should be supplemented with enough zinc. Therefore it is essential that fodder crops contain enough zinc for the cattle to yield dairy with nutrients in it (Miller, 1970).

It has been studied that one of the leading reasons for zinc deficit is low total zinc content in soil and manure application (Singh *et al*., 1987). Biofortification is one such effective solution to this prominent problem and zinc fertilization is one of the processes which provides short term but potent approach. However, some studies have shown that crops lack zinc due to availability as inactive forms. These inactive forms render the proper uptake by plants leading the scantiness of zinc. Wherefore, it is inordinately central to understand and study rudimentary soil dynamics (Sakal *et al*., 1982). Zinc concentration present in soils can be determined via soil testing (Sahrawat and Wani, 2013). The soil samples were analyzed using Atomic absorption spectrophotometry (AAS). AAS is a spectro analytical instrumental technique employed for determining elemental metals using the absorption of light by free metallic ions. AAS method has been implemented in soil analysis. In this paper, the concentration of zinc at sundry agricultural spots of Faridabad, Haryana was calculated using AAS, and results were analyzed. The result obtained can be used to identify zinc insufficiency. Moreover, it accredits to envisage for future crop production so that preemptive measure can be taken (Shang and Bates, 1987). Furthermore, this data can be used to treat soil with a deficit amount of zinc by applying fertilizers rich in zinc or dispense Zinc solubilizing bacteria which can transmute inactive zinc to active forms making it easier to assimilate zinc by crops (Sindhu *et al*., 2019).

Materials and Methods

Study Area

Soil samples were collected from various agricultural locations of Faridabad, Haryana region. A number of 14 samples were cumulated.

Materials Required

Soil samples, Ziplock plastic bags, shovel, sieves, beakers, electronic weighing balance.

Instrumentation

AAS spectrum ZX press 8000

Chemicals required

70% HNO_3, 30% H_2O_2

Sample Collection

Samples were collected from various agricultural spots of Faridabad, Haryana, by using the shovel. For experiments sample was carried from spots to lab by using Ziploc bags. The sample was sieved in order to remove large grits, and further, it was placed in an oven at a temperature of 50 °C for 20 mins. The fine dried powder obtained was then digested for further analysis.

Sample Digestion

0.5 g of oven dried soil samples were mixed with 0.5 mL of water to prepare a slurry mixture, in order to alleviate test splash and to accelerate rapid reaction rate with acid. A beaker containing slurry mixture, 10 mL of conc HNO_3 was added, which was then covered with a watch glass. The acid digest was carried for about 2 hours at 1000c on a hot plate, followed by 15 mins of cooling. 3 mL of 30% H_2O_2 was added slowly to the mixture. For another, 1 hour heating was continuously provided with occasional stirring. The digest was cooled and then filtered through a glass funnel into a flask. The filtered digestate was diluted with deionized water to 50 ml in a volumetric flask and used directly for AAS analysis.

Instrumentation

AAS spectrum Z Xpress 8000, provided deuterium Zeeman background correction mode. A standard and a sample solution were aspirated in a nebulizer of the spectrophotometer. At least 3 absorbance values were, noted and the average of values was used for calculations.

Results

The result of study revealed that Zn is present in the soil at varied concentration. The concentration of zinc is below 1.5 ppm, and the permissible amount of zinc in the soil is between 0.6-1.2 ppm. Soils from two regions show higher concentration (S3 and S12). Further soils from four regions, namely (S4, S7, S9 and S12) have medium concentration. While the remaining 8 soil samples have less than 0.6 ppm indicating that the concentration level is low (Fig. 1). ANOVA results show that P-value <0.05 which shows that there is a significant difference in the means of soil samples.

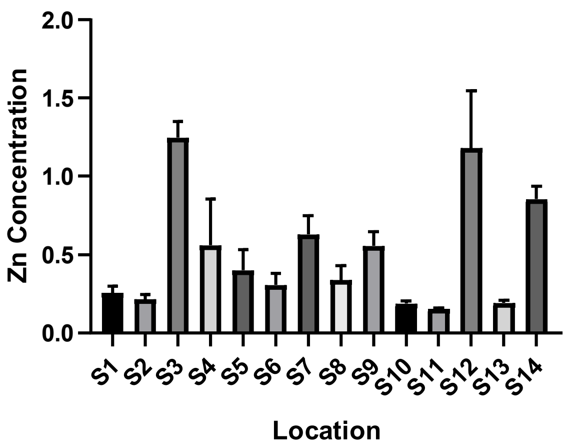

Fig. 1. Graph showing concentration of Zinc at various locations.

Discussion

The concentration of zinc in agricultural soils of Faridabad has been determined in this study. The samples analyzed using AAS were statistically significant, indicating variations in zinc concentrations. The results suggest that the concentration of Zinc in 57% of the soil samples were below the critical limit indicating a deficit in the soil thus recommends the need to provide supplements in the form of fertilizers. Gaur *et al.* (2018) also reported that about 49% of the soil samples in Agra District to be deficient in zinc in their study. Zinc deficient soils have also been reported by Singh *et al.* (2018). The concentration of zinc in soil depends upon a range of factors like pH of the soil, organic matter of the soil and presence of phosphate in the soil. At high pH, zinc solubility decreases and leading to zinc deficiency in soil (Rutkowska *et al*., 2015). Soils having high organic content tends to be zinc deficient. High phosphate content in the soil decreases the zinc concentration apparently due to the formation of insoluble complexes with zinc thus rendering it unavailable to the crops (Marschner, 1993).

In the present study, some regions were found to have high level of zinc concentration, which can be attributed due to their location in the vicinity of the industrial sites. This study is effective in planning the effective strategies for the management of zinc deficiency in different agroclimatic zones.

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