Management of Zinc in Soils and Crops for Sustainable Food Grain Production in Haryana State of India

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INTRODUCTION

Zinc (Zn) is an essential micronutrient for crops and its importance for sustainable food grain production cannot be overlooked. Haryana is a part of the Indo-Gangetic Plains and is one of the few states in India which has witnessed the success of the green revolution involving the rice-wheat cropping system. More than 150 million people support themselves by growing rice in rotation with wheat in the Indo-Gangetic Plains of India, Pakistan, Nepal and Bangladesh (RWC-CIMMYT 2003). There is a continuous decline in soil fertility and soils are not able to sustain the food grain production. The high productivity of rice-wheat systems are showing signs of fatigue. Increasing deficiency of micronutrients, mainly of Zn, has emerged as one of the major constraints in improving crop yields (Singh 2009). Deficiency of Zn is not only a problem in Haryana, India but also in the world where over half of all soils are deficient in available Zn (Cakmak 2008). In India, the extent of Zn deficiency is expected to increase to 63% by 2025 which could be a barrier in achieving the target of food grain production. Crops are generally low in Zn when grown on Zn-deficient soils and consequently poor grain Zn content can lead to Zn malnutrition in humans and animals.

METHODS

The work was conducted under the All India Co-ordinated Research Project on Micronutrients in Soils and Plants at Chaudhary Charan Singh, Haryana Agricultural University, Hisar, Haryana, during the past four decades. Studies were undertaken in laboratory, green-house and on farmers' fields covering all the districts of Haryana state, India. The soils were analysed for their initial available Zn content by extraction with DTPA solution (Lindsay and Norvell 1978). Zinc was determined in the filtrates by atomic absorption spectrophotometry. The physico-chemical properties were determined using standard methods of soil analysis (Jackson 1967).

RESULTS AND DISCUSSION

On the basis of 21,598 soil samples analysed, 54% of soils of the entire Haryana State were below critical levels in Zn and hence potentially deficient for crop production. Results of 1702 soil samples analysis during 1997-2008 revealed that deficiency of Zn is declining to the level of 19% due to regular application of Zn sulphate (Singh et al. 2009). The potential for Zn deficiency varies not only among different districts but also in different blocks within the same districts depending on the cropping system followed, soil characteristic and other management practices (Table 1). Low soil Zn was associated with low organic matter, calcareous pH and sandy texture. Visual symptoms of Zn deficiencies have been characterized in different crops. Soil maps of Zn status have been prepared for advisory purposes. Several studies on the Zn availability in different soils have shown DTPA-extractant to be a reliable soil test for determining critical level of Zn for a range of field crops (Singh 1992). The results showed that critical limits of Zn varied from soil to soil and crop to crop (Singh 1986). Spectacular responses of cereals, pulses, oilseeds and cash crops to Zn application have largely been observed on Zn deficient soils of Haryana (Singh 2009). A fast, simple and easy solution to correct Zn deficiency in soils and crops is application of Zn-containing fertilizers. An application of 25 kg of Zn sulphate per hectare as a basal application in Zn-deficient areas is recommended for correcting Zn deficiency. A large quantity of Zn sulphate has been sold in the Haryana State. Zinc sulphate has become a commonly used fertiliser along with urea and diammonium phosphate.

Table 1. Percent soil with Zn below the critical concentration of 0.6 mg Zn kg^{-1} dry soil in different districts of Haryana State.

District	% Zinc Deficiency	District	% Zinc Deficiency
Sirsa	22.7	Rewari	68.1
Fatehabad	13.6	Faridabad	69.0
Hisar	40.6	Sonepat	15.2
Bhiwani	66.9	Panipat	18.9
Jind	25.0	Karnal	3.10
Rohtak	20.6	Kurukeshtra	0.90
Jhajjar	15.8	Ambala	2.32
Gurgaon	17.2	Panchkula	1.31
Mewat	10.6	Yamunanagar	38.0
Mohindergarh	74.3	Kaithal	6.2

CONCLUSIONS

In Haryana State, the soils are alkaline in nature and are generally low in Zn and are often associated with low levels of soil organic matter. The increase in food grain production in the state has simultaneously increased the removal of Zn from soils. Continued emphasis on maximization of food grain production will result in further depletion of the soil's Zn reserves, if suitable management practices are not followed. There is a negative balance of Zn in the State which will continue to increase in future. Assuming a yield benefit of only few hundred kilogram per hectare due to Zn fertilization, especially Zn sulphate addition to deficient soils and in rice-wheat cropping system, a net benefit of several hundred crores of rupees has been accrued to the Haryana State exchequer over the last three and half decades.

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