Balanced nutrient management: Effects on plant zinc

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Introduction

Participatory on-farm research on the diagnosis and management of nutrient disorders over the last decade by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and its partners has established that multi-nutrient deficiency is the norm rather than an exception. The results of analysis of a large number of soil samples from farmers' fields in the semi-arid tropical regions of India showed that generally the soils are low in organic carbon (C), indicating general poor soil health. Apart from deficiencies of the major nutrients nitrogen (N) and phosphorus (P), the deficiencies of secondary nutrient sulfur (S) and micronutrients especially zinc (Zn) and boron (B) are widespread and indeed revealing. The results from a large number of on-farm follow-up trials comparing soil test-based balanced nutrition with farmers' inputs showed that balanced plant nutrient management significantly increases crop productivity (Sahrawat and Wani 2013) and enhances grain and straw quality of crops (Sahrawat et al. 2008). Currently farmers use only sub-optimal amounts of major nutrients.

It follows from these results that application of major nutrients alone will have a small effect, if any, in increasing crop productivity as the average yield levels in the rainfed production systems with NPK application are low to very low. Therefore, balanced and integrated nutrient management strategy is a prerequisite for sustainable increase in crop productivity in rainfed areas of the semi-arid tropics (SAT) of India. The results on productivity gain under balanced nutrient management vary based on the seasonal rainfall and its distribution, but the yields with balanced nutrition are substantially higher and stable as compared to those with farmers' inputs (FI) (Sahrawat and Wani 2013).

The objective of this paper is to discuss the results on the effects of soil test-based balanced nutrient management strategy on plant (grain and straw) Zn status of various crops under diverse rainfed conditions in SAT of India. It is recognized that Zn deficiency is not only a problem for crop yield, but also an issue of human nutrition.

Methodology

The results from ICRISAT on-farm research trials in Andhra Pradesh are used to illustrate the effects of balanced nutrient management (FI + NP + SBZn) on crop grain and straw Zn contents as compared with FI treatment. As FI of even N and P are sub-optimum, hence application of additional N and P over and above FI were added in balanced nutrient management – N was applied at 60 kg N ha^{-1} for sorghum (*Sorghum bicolor*), maize (*Zea mays*) and castor (*Ricinus communis*) and 20 kg N ha^{-1} for groundnut (*Arachis hypogaea*), pigeonpea (*Cajanus cajan*) and mungbean (*Vigna radiata*); P was added at 30 kg P_2O_5 ha^{-1}; S was added at 30 kg S ha^{-1}, B at 0.5 kg B ha^{-1}, and Zn at 10 kg Zn ha^{-1}. Crops were grown in the rainy season under rainfed conditions (for details see Sahrawat and Wani 2013).

Data on extractable or available soil Zn from all the 30 districts of Karnataka were used to show the extent of Zn deficiency in Karnataka state. Extractable Zn (using DTPA as an extractant) in soil samples and Zn content in grain and straw samples were determined as described in Sahrawat and Wani (2013).

Results and discussion

Extractable Zn in soils of Karnataka. To illustrate the extent of Zn deficiency in soils of SAT of India, we have chosen results of soil analysis for DTPA-extractable Zn from Karnataka. Indeed, the results on the analysis of over 92000 soil samples from farmers' fields from all 30 districts of Karnataka (Fig. 1) showed that Zn deficiency (<0.75 mg Zn kg^{-1} soil) was widespread and varied with district. These results emphasize the importance of Zn deficiency in a range of crop production systems (Sahrawat and Wani 2013) and the need to include Zn in fertilization practices.

Plant Zn status as influenced by balanced nutrition. On-farm trials were conducted during 2003 and 2004 rainy season in the semi-arid region of Andhra Pradesh to determine the effects of balanced nutrient management

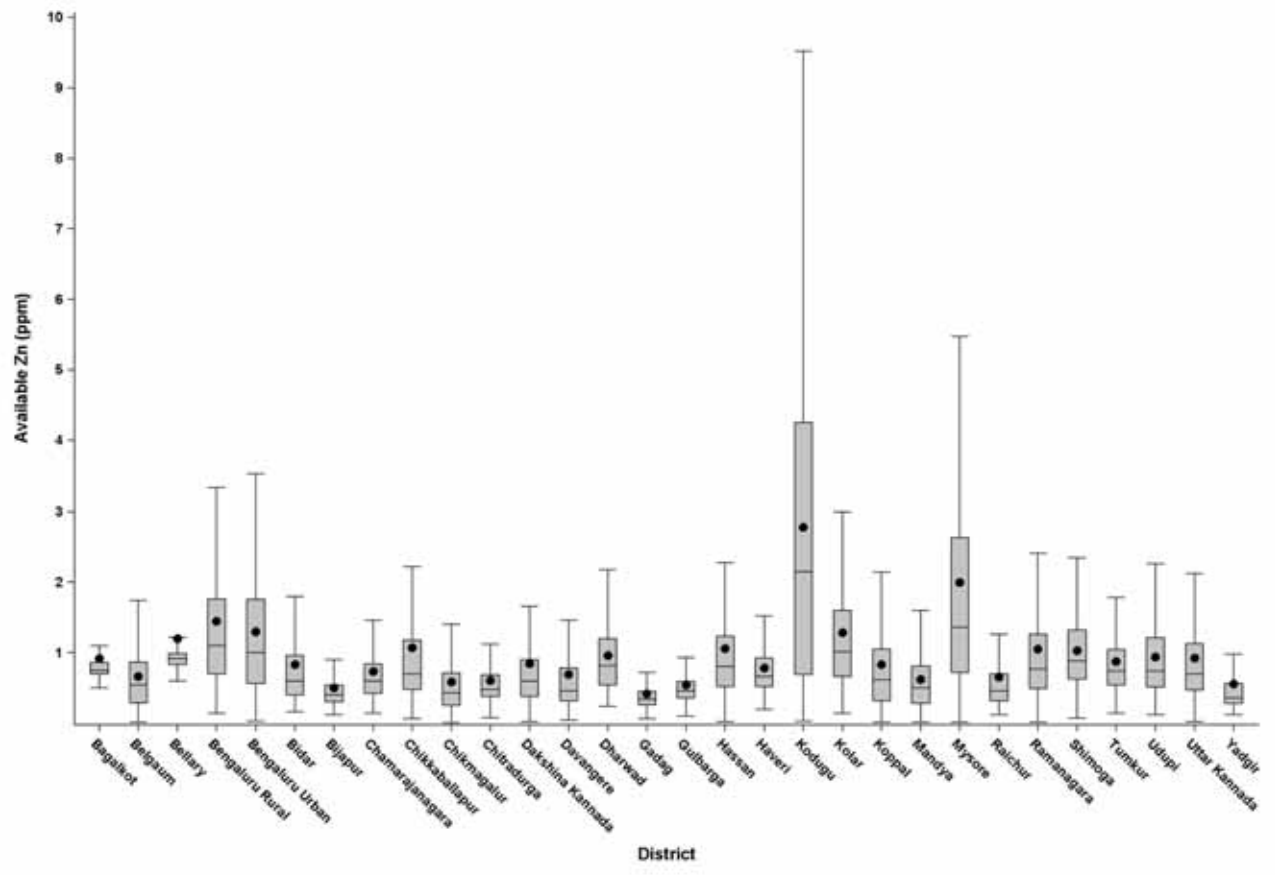

Figure 1. Zinc status of soils in 30 districts of Karnataka.

Table 1. Zinc concentration in grain and straw of different crops as affected by farmer's inputs (FI) and balanced nutrient (FI + SBZn + NP) management treatments in the semi-arid region of India.

		Zn content (mg kg^{-1})		
Crop	Grain/Straw	FI	FI + SBZn + NP	LSD (0.05)
2003 rainy season				
Sorghum	Grain	21	31	5.8
	Straw	22	31	5.7
Castor	Grain	40	43	3.7
	Straw	21	20	5.7
Pigeonpea	Grain	27	27	3.5
	Straw	14	13	1.7
2004 rainy season				
Maize	Grain	23	22	1.7
	Straw	18	20	4.0
Castor	Grain	34	40	4.0
	Straw	14	16	3.6
Groundnut	Seed	28	28	1.9
	Haulms	19	24	8.7
Mungbean	Grain	29	28	2.4
	Straw	16	18	3.3

and FI treatments on Zn concentration in grain and straw of selected field crops.

The results showed that balanced nutrition significantly increased Zn concentration in sorghum grain and straw during the 2003 rainy season; but the results relative to plant Zn status were statistically similar to FI treatment for castor and pigeonpea crops during the same season (Table 1). It is important to improve plant Zn status or at least maintain it as a result of dilution in pursuit of higher yields under the balanced nutrient management practice.

Similarly, the results from on-farm trials conducted in 2004 rainy season showed that grain or straw Zn concentration was statistically similar under balanced nutrient management and FI treatment for maize, groundnut and mungbean crops, except for castor seed Zn, which was significantly increased by balanced nutrition over FI (Table 1). However, the results on crop yields on these same sites showed that the grain and straw yields of crops were significantly increased during the two seasons under rainfed conditions (Rego et al. 2007).

Conclusions

Balanced nutrient management significantly increases yield of various crops over FI treatment in rainfed systems; and tends to increase plant grain and straw Zn concentration or maintain it. However, balanced nutrient management does not always result in increased Zn concentration in grain and/or straw of crops.

References

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