Macro Benefits from Zinc, Boron and Sulphur Fertilization of Rainfed Systems in the Semi Arid Zone of India

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INTRODUCTION

Crop productivity in the rainfed semi arid tropics (SAT) of India is low due to water shortage and poor fertility status of the soils. Earlier research have shown that SAT soils are critically deficient in Zn, B and S in addition to N and P (Sahrawat et al., 2008; Wani et. al. 2009). For a sustainable increase in productivity and enhancing the resilience in rainfed systems, the issues related to soil fertility needs to be addressed. The objective of this communication is to show as to how balanced nutrition involving Zn, B and S can be used to enhance crop productivity on sustainable basis in the semi-arid regions of India.

METHODS

On-farm participatory research and development trials were conducted in the rainfed SAT regions/states of India during 2002 onwards to evaluate the effects of Zn, B and S applications on crop productivity. Response in initial trials formed the basis to conduct further multilocation evaluation trials with conjoint application of Zn plus B and S. The treatments were imposed on 2000 m^2 plots side by side. Farmers variety of crops and crop management were uniform in both the treatments. The treatments were: (i) Farmers practice (FP) of N and P application only and (ii) Balanced nutrition (BN) having in addition to FP, 10:0.5:30 kg Zn, B and S per ha through zinc sulphate, agribor and gypsum respectively.

For evaluating and improving the current generalized recommendations of adding 10:0.5:30 kg Zn, B and S per ha once in 2 to 3 years, a long term experiment was started at ICRISAT, Patancheru, India in 2007 with the application of Zn plus B and S once per year, once in 2 years, once in 3 years at 2 application rates (full and 50%) during the rainy season with soybean-sorghum and maize-chickpea cropping systems. The results were recorded on soybean and maize during the 2010 rainy season.

The data from on-farm and on-station trials was statistically analysed using the Genstat 13th statistical package to determine the least significant difference of means at 5% level (LSD 5%). Benefit to cost ratio (B:C ratio) was also worked out for comparative evaluation of BN over the FP.

RESULTS AND DISCUSSION

The results of trials conducted in Madhya Pradesh (MP) showed that chickpea grain yield increased over FP with the application of Zn (41%; 2.56 B:C ratio) and S (32%; 2.46 B:C ratio) during 2002 post rainy season (Fig. 1). The combined application of Zn along with S recorded the maximum increase (54%; 2.59 B:C ratio). In other 279 trials conducted in various districts of Rajasthan during the 2010 rainy season, conjoint application of Zn plus B and S increased crop yields by 10 to 50% as compared to the FP (Tables 1). Similar productivity improvements along with enhanced quality were recorded in different crops in MP (373 trials) and Andhra Pradesh (AP) (32 trials). Residual effects of Zn plus BS applied during 2009-10 post rainy were recorded in yield increases in 72 farmers fields in Rajasthan, M.P. and A.P. states during 2010 rainy season.

In on-station evaluation of application strategies, the Zn plus B and S increased soybean grain productivity over the only N and P by 24-37% when applied once per year, 18-24% when applied once in 2 years and 7% when applied once in 3 years (Table 2). Maximum productivity increase and net benefit were observed with 50% Zn plus B and S applied every year both in soybean and maize, which was a more effective fertilizer management strategy than the full dose once in 2 or 3 years.

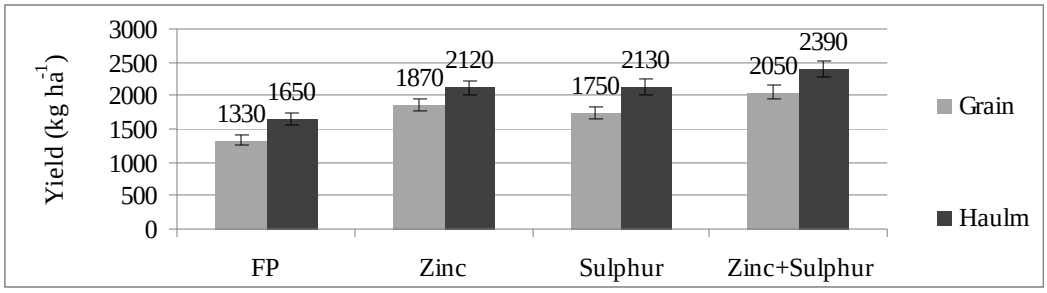

Fig. 1. Effects of Zn and S on chickpea yield in Guna, M.P., India during the 2002 post rainy season

Table 1. Effects of Zn, B and S on crop yield in Rajasthan, India during rainy season, 2010.

District	No. of trials	Crop	Grain yield (kg ha^{-1})		LSD (5%)	B:C ratio of adding ZnBS during 1st season itself
			FP	FP+ZnBS		
Banswara	75	Maize	1980	2450	118	1.97
Jhalawar	75	Soybean	1720	1890	38	1.21
Tonk	18	Maize	1730	2590	252	3.60
	8	Pearl millet	1200	1490	253	1.09
	15	Groundnut	760	930	90	1.71

Table 2. Effects of frequency and dose of Zn, B and S application on crop yield at ICRISAT, Patancheru, India during rainy season 2010.

Treatment	Soybean Grain yield (kg ha^{-1})			Maize Grain yield (kg ha^{-1})		
	ZnBS added once in a yr	ZnBS added once in 2 yr	ZnBS added once in 3 yr	ZnBS added once in a yr	ZnBS added once in 2 yr	ZnBS added once in 3 yr
Control	1880	2040	2210	610	860	610
NP	1970 (1.01)	2110 (0.78)	2410 (2.24)	2760 (8.71)	3440 (10.5)	2850 (9.08)
NP+ZnBS	2440 (2.44)	2620 (3.63)	2590 (2.38)	3950 (6.88)	4540 (10.1)	4470 (10.5)
NP+50% ZnBS	2700 (5.14)	2500 (3.70)	2220 (0.08)	5230 (12.6)	3900 (9.92)	3840 (10.5)
LSD (5%)	372	496	300	1335	706	1003

*Figures in the parentheses indicate B:C ratios over the control

Applied Zn, B and S increased rainfall use efficiency by enhancing the ability of plants to utilize water into productive transpiration. The fertilizer N use efficiency (NUE) increased significantly, indicating that deficiencies of Zn, B and S play a role in the current declining trend in NUE.

CONCLUSIONS

The application of Zn, B and S is needed along with N and P in the degraded SAT soils to harness crop productivity potential in rainfed systems. A better strategy is to apply (per hectare) 5 kg Zn, 0.25 kg B and 15 kg S each year than to add 10 kg Zn, 0.5 kg B and 30 kg S once in every 2 or 3 years.

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