Agronomic Fortification of Rice and Wheat Grains for Improving Human Health

Hari Ram, V S Sohu, Kuldeep Singh, Ismail Cakmak, G S Buttar, GPS Sodhi, H S Gill, Indoo Bhagat, Parminder Singh, SS Dhaliwal, G S Mavi

Punjab Agricultural University Ludhiana, 141 004, India (hr_saharan@yahoo.com)

INTRODUCTION

India's food grain production improved after the introduction of high yielding dwarf fertilizer responsive varieties of wheat during 1966–68, progress in manufacture and consumption of fertilizers, and increases in the area under irrigation and development of rural infrastructure. Cereals, especially rice and wheat, constitute nearly two thirds of the energy needs of humans in India. Dwarf high yielding varieties of wheat, which ushered the green revolution in India, also led to the development of the rice–wheat cropping system, which presently occupies about 10 million ha in the Indo-Gangetic Plain (IGP) of north India and is spread over the states of Punjab, Haryana, Uttar Pradesh, Bihar and West Bengal (Prasad 2005). Zinc (Zn) has recently received global attention (Hotz *et al.,* 2004). Zinc soil and foliar fertilization is one of the aspects which have shown good responses for a number of crops including rice and wheat.

METHODS

The experiments were conducted at Bathinda, Patiala, Ferozepur, Gurdaspur, and Bhagatpur (Kapurthala) having soil Zn of 0.42, 0.80, 2.92, 0.56 and 0.82 ppm respectively. The experiments were conducted in a randomized complete block design with four replications. The rice experiment was conducted without Zn and with soil Zn (50 kg $ZnSO_4.7H_2O$ ha^{-1}) application. The wheat experiment was conducted with three treatments as 1) standard farm application (LS) recommended NPK without Zn, 2) LS + soil Zn (50 kg $ZnSO_4.7H_2O$ ha^{-1}) + foliar Zn (0.5% $ZnSO_4.7H_2O$), 3) LS + soil Zn + foliar $ZnSO_4$ along with Tilt 25EC (Propiconazole fungicide). Tilt is being used to control sheath blight in rice and yellow rust in wheat. The Zn solution was applied with 600 litres ha^{-1} in the evening hours. Except for fertilizer application, the crops were raised using best local agronomic practices.

RESULTS AND DISCUSSION

Rice: Application of Zn in soil significantly increased the grain yield (7.18%) of rice at all the locations irrespective of the Zn status of the soil (Table 1). It might be due to higher response of rice to Zn application. The Zn concentration in grain was also increased (14.8% higher) which was significantly higher than without Zn. Shivay *et al.* (2008) also reported higher grain Zn concentration in rice in Zn fertilized plots.

Wheat: The pooled grain yield of wheat was significantly higher with application of soil Zn + foliar Zn or soil Zn + foliar Zn along with Tilt (Propiconazole fungicide) over no Zn application; however, in locations of medium to high soil Zn status there was no increase (Table 2). The grain Zn was significantly increased (from 29.36 to 224% higher) with Zn application (soil + foliar) over no Zn application. These results might be due to translocation of Zn from leaf to the grain. Cakmak (2008) also reported higher Zn concentration in food grains after foliar application of Zn to crops.

CONCLUSIONS

Soil and foliar Zn application significantly improved grain Zn concentrations of rice and wheat. The increases in grain Zn were greater using foliar applications than soil applications alone. Foliar Zn can be combined with application of Tilt 25EC (Propiconazole fungicide).

Table 1. Effect of Zn application on performance of rice at various locations in Punjab.

Location	No Zn	+Soil Zn	LSD (p=0.05)	% increase/decrease over no Zn
		Grain yield (t ha^{-1})		
Rauni (Patiala)	5.12	5.47	0.25	+6.84
Kapurthala	2.87	3.17	0.14	+9.28
Ferozepur	4.08	4.30	0.10	+5.47
Pooled Mean	4.02	4.31	0.17	+7.18
		Grain Zn concentration (mg kg^{-1})		
Rauni (Patiala)	24.1	28.5	3.6	+18.3
Kapurthala	21.5	24.4	2.4	+13.5
Ferozepur	18.3	22.1	2.9	+20.8
Mean	21.3	25.0	3.0	+14.8

Table 2. Effect of Zn application on performance of wheat at various locations in Punjab.

Location	No Zn	Soil Zn + Foliar Zn	Soil Zn+ Foliar Zn+Tilt	LSD (p=0.05)	% increase/decrease	
					Soil+Foliar	Soil+Foliar+Tilt
			Grain yield (t ha^{-1})			
Rauni (Patiala)	4.80	5.10	4.91	NS	6.25	2.29
Bhagatpur	4.61	4.75	4.69	NS	3.04	1.74
Ferozepur	4.13	4.23	4.33	NS	2.42	4.84
Gurdaspur	4.54	4.73	4.95	0.2	4.19	9.03
Bathinda	4.40	4.78	4.89	0.3	8.64	11.14
Pooled Mean	4.50	4.72	4.75	0.1	4.94	5.74
			Grain Zn concentration (mg kg^{-1})			
Rauni (Patiala)	34.0	64.0	53.7	17.0	88	58
Bhagatpur	25.8	77.0	64.8	12.2	198	151
Ferozepur	48.7	63.0	65.3	NS	29	34
Gurdaspur	34.3	69.8	61.3	4.8	103	79
Bathinda	25.0	81.0	70.0	13.5	224	180
Pooled Mean	33.6	71.0	63.0	10.1	111	88

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