Effects of Foliar Iron, Zinc Solutions and New CRU Fertilizers on Iron and Zinc Accumulation in Rice Grains

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INTRODUCTION

Rice (*Oryza sativa* L.) is the dominant staple food of almost half the world's population. However, it is a poor source of many essential micronutrients, especially of iron (Fe) and zinc (Zn). Several field experiments were carried out to examine the effects of spraying foliar Fe and Zn containing solutions or applying new CRU (Controlled Released Urea) fertilizers on Fe and Zn accumulation in rice grains in south China.

METHODS

Experiment 1: The experiment in 2009 was in a split plot design with three replicates, and the main treatment was four rice cultivars (T125, R7, *Zhenong 40, xiuyou-5)* and the sub-treatment was different Fe- and Zn-containing solutions (control, i.e. spray water, 1%, 0.1% (v/v), no nicotinamide, 0.3%, 0.5% $ZnSO_4.7H_2O$). Except for the control, all of the foliar solutions included complex amino acid, $FeSO_4.7H_2O$, urea, HBO_3 and ascorbic acid. The sprays were applied three times once every 5 days after anthesis, 700 ml different solutions were sprayed per plot every time.

Experiment 2: The experiment was laid out in a completely randomized design with three replicates in 2009 and 2010. The new CRU fertilizers used in the experiment were SPCU (Sulfur-Polyester Resin-Coated Urea, N 34%), PCU (Polyester Resin-Coated Urea, N42%). The application rates were 12 kg N hm^2 and 8.4 N hm^2. Tested CRU fertilizers were supplied by Shandong Kingenta Ecological Engineering Co., LTD.

RESULTS AND DISCUSSION

Table 1, Table 2 showed that foliar Fe, Zn-containing solutions could have obviously different effects on grain Fe, Zn concentrations of different rice cultivars and nicotinamide added to the Fe, Zn solutions could accelerate Fe accumulation in rice grains. A relatively low concentration of $ZnSO_4.7H_2O$ added to the sprays significantly increased the Zn accumulation in rice grains while no negative effects on Fe accumulation was observed.

Table 1. Effects of application of different foliar Fe, Zn solutions on on Fe, Zn concentrations in brown rice of different cultivars.

Cultivars	Fe	Zn
	mg kg^{-1} DW	mg kg^{-1} DW
Xiushui-2	16.1a	23.9a
Zhenong40	16.0a	24.0a
Xiuyou-5	12.0b	19.8ab
T125	11.2b	19.3b

Table 2. Effects of different Fe, Zn-containing solutions spray on Fe and Zn accumulation in brown rice.

Solutions	Fe mg kg^{-1} DW	Zn mg kg^{-1} DW
Control	10.2c	16.9b
1% nicotinamide	15.1b	19.9b
0.1 % nicotinamide	11.5c	19.4b
No nicotinamide	11.4c	20.0b
0.1% $ZnSO4.7H_2O$	15.9b	25.8a
0.5% $ZnSO4.7H_2O$	18.8a	28.5a

Table 3 showed that the two CRU fertilizers could significantly increase the yield of rice grain and may accelerate the Fe and Zn accumulation in brown rice. In 2009, SPCU 100% produced the highest yield and Fe concentration while PCU100% produced the highest Zn concentration. In 2010, PCU100% produced the highest yield and Fe concentration.

Table 3. Effects of two CRU fertilizers on grain yield, Fe and Zn accumulation in brown rice.

	2009 (Xiushui123)			2010 (Xiushui114)		
	Fe	Zn	Yield	Fe	Zn	Yield
Treatments	mg kg^{-1} DW	mg kg^{-1} DW	kg hm^{-2}	mg kg^{-1} DW	mg kg^{-1} DW	kg hm^{-2}
SPCU100%	6.9a	22.6b	436.4a	6.1c	20.7b	397.2ab
PCU100%	6.0b	25.4a	418.1b	6.7a	20.9b	405.4a
PU100%	5.7bc	22.7b	409.2b	7.1a	20.8b	382.8bc
SPCU70%	4.8de	21.6b	419.1b	6.7ab	22.3ab	383.4bc
PCU70%	4.2e	22.2b	412.1b	6.0c	19.9b	376.6c
PU70%	5.4cd	27.2a	385.9c	6.2bc	20.6b	373.5c
CK	4.8 f	21.4 b	369.1d	5.9c	19.5b	328.8d

CONCLUSIONS

The results showed that foliar Fe, Zn fertilizer may have different effects on grain Fe, Zn concentrations of different rice cultivars. Nicotinamide at suitable concentration added to the foliar solutions could improve the Fe accumulation in brown rice. CRU fertilizers could significantly improve the grain yields, while Fe and Zn concentrations in brown rice also increased.

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