Options for Enhancing Grain Iron and Zinc Concentrations in Sorghum

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INTRODUCTION

Micronutrient malnutrition related iron (Fe) and zinc (Zn) deficiencies causes blindness and anemia in more than half of the women and pre-school children in South and Southeast Asia and sub-Saharan Africa. Sorghum is cultivated and consumed as a staple food in these areas. Growing high-yielding cultivars with micronutrient fertilization provides an attractive approach to improve grain micronutrient concentrations (Johnson *et al.,* 2005). ICRISAT Patancheru, India studied the effects of micronutrient fertilization on sorghum grain Fe and Zn concentrations and assessed the genetic variability for grain Fe and Zn concentrations in germplasm and commercial cultivars and the trait associations.

METHODS

For studying the effect of micronutrient fertilization on sorghum grain Fe and Zn concentrations, a set of selected 12 sorghum lines were grown with a combination of five different levels of micronutrients in a strip-plot design with three replications on a Vertisol and an Alfisol in the 2007 postrainy season. A total of 29 selected germplasm accessions were evaluated in a replicated (n=3) RCBD trial during the 2007 and 2008 postrainy seasons. To assess the variability in commercial sorghum cultivars, a total of 20 commercial sorghum cultivars (Set 1) were evaluated in a randomized block design (RBD) with three replications during the 2008 and 2009 postrainy seasons.

RESULTS AND DISCUSSION

Soil type did not have significant effect on grain Fe and Zn concentrations as indicated by the non-significant mean squares due to soil type. A non-significant variance due to micronutrient fertilization levels suggested poor evidence for the influence of soil micronutrient fertilization on grain Fe and Zn concentrations in any particular soil type. Numerically, while no pattern was observed for grain Fe concentration, grain Zn concentration seemed to be marginally higher when grown on the Alfisols (Table 1).

Over the two years, mean grain Fe concentration in core germplasm accessions ranged from 26 to 60 mg kg^{-1} and Zn concentrations from 21 to 57 mg kg^{-1} (Table 2). Twelve lines were significantly superior to both control lines for grain Fe concentration ranging from 48 to 61 mg kg^{-1}, while 27 accessions were superior for grain Zn concentration ranging from 32 to 57 mg kg^{-1}.

A significant positive correlation existed between grain Fe and Zn concentrations (r= 0.75) of the lines under evaluation. Both grain Fe (-0.36) and Zn (-0.46) concentrations showed small but significant negative associations with grain yield but numerically low indicating that genetic enhancement for grain Fe and Zn concentration does not have a yield penalty.

Variability in Commercial Cultivars

The mean grain Fe concentration among the set I genotypes ranged from 30 to 44 mg kg^{-1} and grain Zn concentration from 22 to 33 mg kg^{-1} (data not shown). The hybrids GK 4035 and Mahabeej 703 showed higher mean Fe concentrations over two years (data not shown) indicating their stability for this trait. A significant positive association was observed between the grain Fe and Zn concentrations (r=0.85).

Table 1: Sorghum grain Fe and Zn concentrations as influenced by soil micronutrient fertilization.

Micronutrient fertilization level	Fe ($mg\ kg^{-1}$)		Zn ($mg\ kg^{-1}$)	
	Alfisol	Vertisol	Alfisol	Vertisol
Control	45.9	39.7	29.4	28.2
Fe	44.5	46.3	34.2	27.3
S + B + Fe	44.7	43.9	34.4	27.4
S + B+ Zn	40.4	46.6	33.7	27.4
Zn	43.7	45.4	34.3	26.5
LSD (5%)	13.9		8.2	

Table 2. Mean performance of sorghum germplasm lines evaluated for grain Fe and Zn concentrations.

IS No./ Pedigree	Race	Origin	Days to 50% flowering	Grain Yield ($t\ ha^{-1}$)	Fe ($mg\ kg^{-1}$)	Zn ($mg\ kg^{-1}$)
5427	Durra	India	65	2.0	61	57
5514	Guinea-bicolor	India	68	1.4	56	45
55	Durra-caudatum	US	71	1.3	54	38
3760	Caudatum-bicolor	USSR	68	2.2	53	37
3283	Bicolor	US	66	1.9	50	42
Mean			71	2.26	46	37
SE +			0.96	0.26	3	3

CONCLUSIONS

Micronutrient application with Fe and Zn fertilizers and soil type has a limited effect on grain Fe and Zn concentrations when the soils are not deficient in these minerals. Promising germplasm accessions (IS 5427, IS 5514, IS 55, IS 3760 and IS 3283) identified from this study can be utilized as donors in crossing programs to increase the grain Fe and Zn concentrations. Simultaneous improvement of grain Fe and Zn concentrations in sorghum is possible. Hybrids NSH 703 and GK 4035 possessing high Fe and Zn concentrations identified in this study can be further tested and used in large- scale dissemination.

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REFERENCES

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