Combining Zn, P and Organic Amendments in Sorghum Production and Grain Quality in the Sahel

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INTRODUCTION

In many developing countries, low Zn supply is limiting crop yield and human health. The bioavailability of Zn to humans decreases when phytate: Zn molar ratios are too high. In the Sahel, major research emphasis has been on yield and macronutrients so far, though Buerkert et al. 1998 already focussed on possible interactions with the nutritional quality of cereals. Considering the nutritional quality of sorghum grains and potential micronutrient limitations to crop productivity, a field study was conducted in Burkina Faso to examine the effects of Zn fertilization in conjunction with organic amendments and P fertilizer application on Sorghum (*Sorghum bicolor* (L.) Moench) production.

METHODS

Experiments were carried out in farm fields in the Soudano-Sahelian Zone in Burkina Faso in 2002, 2003 and 2004. Annual rainfall was between 400 and 700 mm with a cropping season of 4 months (June – September). Soils have poor structure and a low inherent mineral and organic matter content**.** Sorghum is the main crop in the area because of its adaptation to erratic climatic and low soil fertility conditions**.**

Treatments in all three years included four combinations of two levels of Zn fertilizer (no Zn and 3.5 kg Zn ha^{-1}) and two levels of P fertilizer (no P and 37.5 kg P ha^{-1}). The four fertilizer treatments were always combined with an organic amendment of 15 t compost ha^{-1}, because no grain can be produced on these poor soils without it. Plots were cultivated using the traditional planting pits or 'zaï'. Organic manure and inorganic fertilizers were applied before planting during the preparation of the pits. At maturity the grains were separated from the panicles, and the emptied panicles were mixed with stem and leaves. The samples were pre-dried in direct sun light and subsequently oven-dried at 60^{o}C for 48 hours. Sorghum grain samples were analyzed for Zn content and IP-6 phytate (IP-6) mass fractions (MF).

RESULTS AND DISCUSSION

Effects of inorganic Zn and P application were significant ($P<0.05$) and consistent (Table 1). The increase obtained by both inorganic fertilizer applications depended on the cropping season and sampling period. In general, Zn application had a much smaller effect on sorghum yield than P application, but both effects were highly significant in all three field seasons. Grain-Zn yields and grain-Zn content and IP6 MF increased with Zn or P application.

The IP6: Zn molar ratio decreased with Zn application and increased with P application, resulting in comparable ratios when no fertilizer was applied and when both fertilizers were applied. A large inter-annual variability was observed for grain-Zn yield and grain-Zn content and IP6-MFs, and for the IP6: Zn ratio.

Table 1. Sorghum grain yield, Zn concentration and IP6: Zn molar ratio as affected by Zn and P fertilizer in three years on farm experiments.

		Grain yield			Grain Zn concentration			Grain IP6: Zn ratio		
		kg ha^{-1}			mg kg^{-1}					
		-	+	LSD	-	+	LSD	-	+	LSD
2002	*Zn*	1340	1450	*	23.8	58.1	**	18.8	13.3	**
	P	1190	1680	**	32.6	49.3	**	13.7	18.7	**
2003	Zn	1010	1230	*	16.8	19.8	**	*22.8*	*17.3*	**
	P	920	1320	**	17.6	19.0		15.9	23.3	*
2004	Zn	900	1150	*	26.5	57.4	**	10.4	6.3	*
	P	810	1240	**	35.8	48.2	*	6.5	10.2	*

***** significant at p<0.05**, **** significant at P<0.01

The P application improved crop yield due to low available P in the soil as found in other studies in the Sahel (Bationo et al. 1998). Sorghum grain-Zn concentration increased with both Zn and P fertilisation in most of the treatments. This might be the consequence of the positive impact of these fertilizers on Zn uptake which continued after flowering (Traore 2006). Increased grain-Zn concentrations were always accompanied by an enhanced total P crop uptake and higher grain IP6 concentrations, though this effect was stronger when P fertilizer was applied. The combined application of Zn and P fertilizers kept the IP6: Zn ratio roughly at the same level as obtained when no fertilizers were applied but at much higher yield levels and grain-Zn MFs. The food quality of such grains can be further improved by degrading phytate prior to consumption using appropriate food processing methods.

CONCLUSIONS

The observed positive effects of Zn fertilizers on sorghum production indicate that the introduction of Zn fertilizers or at least Zn-enriched P fertilizers could be beneficial in the area.

Organic amendments associated with P and Zn fertilizers are good treatment options for higher crop yield and reasonable grain quality. The IP6 in the sorghum grain produced under such conditions should be degraded to IP-3 or lower saturated IP forms prior to consumption for higher Zn bioavailabilities.

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