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ABSTRACT

Phosphate fertilizers are a potential source of trace elements (TE) in agricultural systems. Such TE may pose a risk to human health if they are transferred to edible parts of plants. The ability of plants to transfer TE to edible parts is estimated by the ratio of TE concentrations on the plant over their concentrations in the soil, i.e., by the plant uptake factor (PUF), which is an essential parameter for risk assessments, since the food chain represents an important route of exposure of TE to humans. This study evaluated PUFs of Cd, Pb, and As for corn and soybeans grown in soils with records of a long-term application of high doses of phosphate (P) fertilizers in Brazil. The PUF for soybeans and corn cultivated in Mato Grosso State decreased in the following order: Cd>Pb>As, which is in agreement with the fact that Cd is the least and As the most retained of the studied TEs in oxidic soils. The PUF of Cd for corn cultivated in Minas Gerais State did not show differences among cultivars. Soil P content did not affect the PUF of Cd for corn cultivated in soils receiving different doses of P fertilization in the Brazilian Central Plateau. The results for As and Pb are in agreement, whereas those for Cd are greater than data reported in the literature for both crops, which are responsible for half of the Brazilian fertilizer demand.

INTRODUCTION

Phosphorus (P) is the macronutrient most limiting to crop growth because of their retention in tropical soils. However, phosphate fertilizers can be sources of toxic trace-elements (TE) soil contamination (Laegreid et al., 1999), which can be transfer to plants and than to edible parts.

The TE transfer from soil to plant tissue can be characterized by plant uptake factor (PUF), which is define as the ratio of the element concentration in plant tissue to that in soils. The PUF reflects the realities of crop production and is applied standardize the assessments of human exposure to trace element from croplands (Chen et al., 2009).

OBJECTIVE

The aim of this study is evaluate PUFs of Cd, Pb and As for corn and soybeans grown in soils with records of a long-term application of high doses of phosphate (P) fertilizers in Brazil.

MATERIALS & METHODS

Soybeans



→ Mato Grosso State, Brazil → high phosphate fertilizers rate

Crop Rotation: S: Soybean; S/M: Soybean/Millet; S/B: Soybean/Brachiaria; S/S: Soybean/Sunnhemp; S/C+B: Soybean/Corn+Brachiaria; S/C: Soybean/Corn

Corn



→ Brazilian Central Plateau → soils receiving different doses of P fertilization



→ Minas Gerais State, Brazil → Clones: EXP0053Y; DKB393YG; DKB177; DKB240Y; DKB240YG; DKB390YG; DKB185YG; DKB455; DKB175; DKB245; EXP0035Y; EXP00587; 2B707HX; DKB399.

Analysis → USEPA 3051A extraction method. → AAS; Certified Reference Material: BCR® - 482 (IRMM); IRMM 804; BCR® - 142R (IRMM); SRM 2710a Montana Soil I (NIST).

RESULTS

Table 1. Certified value, determined concentration and As, Cd and Pb recovery on certified materials.

	Certified Value	Determined concentration*	Mean recovery
	-----mg kg ⁻¹ -----		%
As	BCR® - 482	0.85±0.07	0.76
	BCR® - 142R	---	---
	SRM 2710a	1540±10	1196
Cd	BCR® - 482	0.56±0.02	0.46
	BCR® - 142R	0.5±0.01	0.22
Pb	BCR® - 482	40.9±1.4	38.3
	BCR® - 142R	25.7±1.6	20.8

* mean of 7 measurements of standard reference material samples.

Table 2. PUF of As, Cd and Pb in soybean grains cultivated under crop rotation in Mato Grosso State, Brazil

Crop Rotation - Soybean	PUF		
	As	Cd	Pb
Soybean	0.004±0.002	0.17±0.09	0.010±0.004
Soybean/Millet	0.004±0.001	0.08±0.05	0.012±0.003
Soybean/Brachiaria	0.006±0.001	0.13±0.03	0.012±0.003
Soybean/Sunnhemp	0.005±0.001	0.16±0.05	0.009±0.002
Soybean/Corn+Brachiaria	0.006±0.002	0.41±0.25	0.010±0.003
Soybean/Corn	0.003±0.001	0.16±0.10	0.010±0.001
Mean	0.005±0.001	0.18±0.11	0.011±0.001

Table 3. PUF of Cd in corn grains clones cultivated in Minas Gerais State, Brazil.

Corn Clones	PUF Cd
EXP 0053Y	0.24±0.12
DKB393YG	0.27±0.17
DKB177	0.11±0.02
DKB240Y	0.16±0.03
DKB240YG	0.25±0.17
DKB390YG	0.23±0.16
DKB185YG	0.08±0.05
DKB455	0.12±0.05
DKB175	0.07±0.04
DKB245	0.11±0.05
EXP0035Y	0.15±0.07
EXP00587	0.10±0.08
2B707HX	0.18±0.1
DKB399	0.15±0.1
Mean	0.16±0.06

Table 4. PUF of Cd in corn grains cultivated in soils receiving different doses of P fertilization in the Brazilian Central Plateau

P ₂ O ₅ rate kg/ha/year	PUF Cd
0	0.28±0.05
50	0.28±0.15
80	0.32±0.06
100	0.18±0.08
Mean	0.26±0.09

Table 5. PUF of As, Cd and Pb in grains, soybean and corn crops reported in the literature.

	PUF			Reference
	As	Cd	Pb	
Grains	0.03	0.12	0.05	Guilherme et al., 2011
Grains	0.02	0.09	0.01	CDFA, 2002
Grains	0.02	0.22	0.08	Chen et al., 2009
Soybean	----	0.39	0.004	Chen et al., 2009
Corn	----	0.15	0.003	Chen et al., 2009

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