INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS APPLIED TO MULTIELEMENT DETERMINATION IN A VARIETY OF LETTUCE GROWN IN A CONTAMINATED SOIL AND TREATED WITH PHOSPHATE

Armelin, A. M. J.[1]; Trevizam, A. R.[2] ; Muraoka, T.[3];Silva, M. L.S.[2]; Saiki, M.[1]; Maihara, V.A.[1]

[1] Instituto de Pesquisas Energéticas e Nucleares, IPEN/CNEN-SP, São Paulo/SP, Brasil; [2] Universidade Estadual do Centro Oeste, (UNICENTRO), Guarapuava/PR, Brasil; [3] Centro de Energia Nuclear na Agricultura, (CENA/USP), Piracicaba/SP, Brasil.

marmelin@ipen.br

INTRODUCTION

- **Anthropogenic activities, those associated with industrial processes, mining, procedures normally used to improve the physical and chemical conditions of soil, such as application of fertilizers, limestone, pesticides have been the major source of inorganic elements enrichment in soils. Due to the possibility of elements to be at toxic levels to plants and reaching the food chain through the plants, the interest in the developing technologies for remediating contaminated sites has increased.**
- **The addition of substances capable of immobilizing the toxic element from the soil is a procedure that has been used for remediating contaminated sites. The function of these substances is to reduce the mobility and bioavalaibility of potentially toxic elements in the soil. The substances commonly used for this purpose are phosphates, limestone, Fe or Mn oxides, organic materials and zeolites.**
- **The objective of this study was evaluate the efficiency of phosphorus in reducing the availability of different elements in plant grown in contaminated soil treated with phosphorus. For this, five rates of phosphorus were applied in contaminated soil, growing lettuce plants and the concentrations of different elements absorbed by the lettuce were compared with those of control lettuce plants (no addition of phosphorus).**

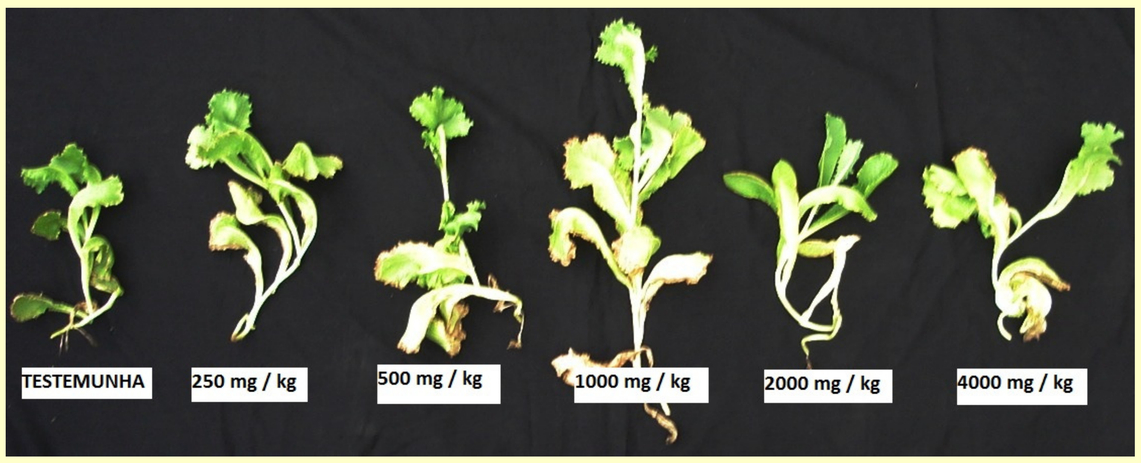

Figure shows the lettuce obtained and their treatment with phosphorus.

MATERIAL AND METHOD

- **Sample of 50 kg soil was collected in an area of 2 x 3 m from 0-20 cm depth, passed through 4mm mesh sieve and then homogenized.**
- **Lettuce plants were grown in pots containing 2 kg of soil. The trial was performed at green house with ventilation and humidification system.**
- **The experimental design was a randomized block, with 6 treatments (rates of phosphorus):0, 250, 500, 1000, 2000 and 4000 mg kg^{-1} of P.**
- **Lettuce leaves were collected at 70 days after transplanting, rinsed with deionized water, oven dried (at 65ºC), weighed and ground in agate mortar.**
- **Instrumental neutron activation analysis (INAA) followed by gamma-ray spectrometry was the analytical method used to determine element contents in lettuce leaves.**

RESULTS AND DISCUSSION

Element concentrations in lettuce leaves as a function of treatment with phosphorus (P *)

P *	Cl	Mg	K	Ca	Na	Mn	Zn	Fe	Br	Cd	Rb	Sb	Cr	Cs	Co	Sc	Th
mg kg^{-1}	mg g^{-1}	mg g^{-1}	mg g^{-1}	mg g^{-1}	mg g^{-1}	µg kg^{-1}	µg kg^{-1}	µg kg^{-1}	µg g^{-1}	µg g^{-1}	µg g^{-1}	µg kg^{-1}	µg g^{-1}	µg g^{-1}	µg kg^{-1}	µg kg^{-1}	µg kg^{-1}
0	22.8 A	5.2 **C**	96.1 **A**	30.3 **A**	4.2 **D**	42.7 **A**	836 **B**	423 **CD**	87.5 **A**	12.4**BC**	52.3 **C**	85.0 **A**	1.01 **B**	0.05 **C**	302 **B**	42.0 **D**	25.0 **B**
250	8.5 **D**	3.6 **D**	52.7 **C**	14.9 **D**	6.0 **CD**	13.9 **D**	346 **D**	168 **E**	62.0 **B**	4.0 **E**	81.0 **B**	30.3 **B**	0.58 **D**	2.36 **A**	76 **C**	85.0 **B**	24.0 **B**
500	10.3 **CD**	5.6 **BC**	71.6 **B**	16.5 **CD**	6.9 **BC**	19.9 **CD**	497 **CD**	338 **DE**	77.0 **AB**	6.1 **DE**	66.0 **BC**	44.3 **B**	0.84 **C**	0.97 **B**	252 **BC**	71.3 **BC**	44.3 **B**
1000	12.4 **C**	5.4 **BC**	74.9 **B**	20.4 **CD**	10.3 **A**	31.8 **B**	537 **C**	970 **A**	80.0 **AB**	9.5 **CD**	68.7 **BC**	71.7 **A**	2.45 **A**	0.34 **C**	980 **A**	112.3 **A**	143.0 **A**
2000	10.2 **CD**	6.4 **AB**	70.7 **B**	22.5 **BC**	8.8 **AB**	21.1 **C**	778 **B**	613 **B**	75.3 **AB**	16.9 **A**	105.3 **A**	82.3 **A**	1.13 **B**	0.27 **C**	1026 **A**	48.0 **CD**	35.7 **B**
4000	15.1 **B**	6.8 **A**	68.5 **B**	22.9 **B**	7.4 **BC**	37.6 **AB**	1228 **A**	564 **BC**	62.0 **B**	13.2 **B**	59.3 **C**	79.0 **A**	0.77 **C**	0.17 **C**	369 **B**	44.0 **D**	55.0 **B**

Mean values followed by same letter in column indicate no difefrence by Tukey test ($p<0.05$)

- **Each result, in Table, is the arithmetic mean of three pots, as experimental design. Variance analysis was applied to the values of Table, using Tukey test, $p<0.05$, to verify if there is difference among element concentrations in plants under different doses of phosphorus compared with the element concentrations in plant control.**
- **The Cl, Mg, K, Ca, Mn, Zn, Fe, Cd, Co and Cr contents were significantly decreased when the dose of 250 mg kg^{-1} (P) was applied.**
- **Phosphorus treatments increased the Rb, Cs and Sc concentrations in the leaves compared to the control.**
- **In literature there are many studies on the use of phosphate to reduce mobility, especially for elements such as Cd, Cu and Pb in areas with contaminated soils. In the case of this work, INAA is a useful tool because it allows the determination of some elements that are not routinely measured in this kind of study by other analytical methods.**

CONCLUSION

In general, the application of 250 mg kg^{-1} (P) was the most effective treatment to reduce the concentrations of essential and potentially toxic elements in lettuce leaves.

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