# The Influence of Total Chromium Soil Content on the Maize Zinc Levels, in a Polluted Area

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## Abstract
Chromium compounds are highly toxic to plants and are detrimental to their growth and development. Cr is toxic to most higher plants at 100 μMKg$^{-1}$ dry weight, while Zn is an essential plant nutrient. The essentiality of Zn in plants was first shown in maize. The aim of this paper was to determine the influence of Cr contamined soils on the accumulation of Zn in maize (*Zea mays L.*) grains, sampled from Tarnaveni area (Mures County, Romania), a well known industrial center. The heavy metals contents in soils and maize were determined by flame atomic absorption spectrometry using a ContrAA 300 spectrophotometer with high resolution continuum source. In soil, Cr contents ranged from 9.7 ppm to 80.73 ppm and Zn from 21.77 to 99.87 ppm. In corn, the values for Cr are between 0.081 to 0,11 ppm and for Zn between 44.74 to 132.66 ppm. Mathematical modeling indicates that chromium in the soil might be the one which is determining the evolution of zinc corn content.

## Introduction
Zinc is an essential plant nutrient. The essentiality of Zn in plants was first shown in maize [12]. Zinc deficiency is one of the most widespread micronutrient deficiencies in plants and causes severe reductions in crop production [5].
Chromium compounds are highly toxic to plants and are detrimental to their growth and development. Although some crops are not affected by low Cr concentration ($3.8 \times 10^{-4}$ μM) [9,10], Cr is toxic to most higher plants at 100 μMKg$^{-1}$ dry weight [6].
Soil pH is influencing the accumulation of chromium in plants, observation confirmed by various literature data[2].
Barcelo et al. found high correlation between chlorophyll pigments and Fe and Zn uptake in Cr-stressed plants [1].
The accessibility of metals for plants depends on soil reaction, mineral colloids, soil humidity, microbiological activity and organic matter content [16]. Literature contains numerous data on the distribution of minerals in plants from spontaneous flora or cultivated in different geographical areas, as well as a series of mineral analysis techniques [3,4,7].
The aim of this paper was to determine the influence of Cr contaminated soils on the accumulation of Zn in maize (*Zea mays L.*) grains, sampled from Tarnaveni area (Mures County, Romania), a well known industrial center.

## Experimental
The prelevations points are located in a polluted area (Tărnaveni- Mures County, Romania).
Soil and maize samples were collected from four familiarly farms located in the studied area. From each prelevation points (PP) were collected soil (0-40 cm depth) and maize samples. Determination of pH has been accomplished in watery suspension in report with the soil: water of 1:2.5.

The heavy metals contents in soils and maize were determined by flame atomic absorption spectrometry using a ContrAA 300 spectrophotometer with high resolution continuum source (Analytik Jena, Germany).

The FAAS determination of minerals, in the analysed samples needed two working steps: mineralisation through calcination followed by the solubilisation of the inorganic matter in nitric acid 0.5 N up to 50 ml. The solutions obtained were used for total metal content determinations [11]**.**

*Statistical analysis***.**

*Cluster analysis* permits to form groups of related variables (similar to what is done in factor analysis), in such a way that objects in the same group (called a cluster) are more similar to each other than to those in other groups (clusters) [14]. Cluster analysis was performed using PAST (version 2.14), [8].

*Principal Components Analysis* (PCA) is a mathematical model that permits to identify patterns in data by expressing the data to highlight their similarities and differences [8].

**Results and discussion**

The pH level of soil, in studied area, registered values between 7.67 and 8.73.
The results were expressed in ppm ($mgKg^{-1}$ dry weight).
Regarding the heavy metals contents in soil, Cr ranged from 9.7 ppm to 80.73 ppm and Zn from 21.77 to 99.87 ppm.
In corn, the values for Cr are between 0.081 to 0.11 ppm and for Zn between 44.74 to 132.66 ppm. Each value is an average of 3 replicates.
According to Table 1 (the maximum admitted concentrations for soils), in the sensitive areas revealed to be exceeded for Cr (30 ppm) in 3 sites.
The soil levels of Zn do not exceed the reference value (100 ppm) in the sensitive area.

**Table 1:** Romanian guideline on the admitted concentrations of Cr and Zn in soil [19]

| Element | RVS(ppm) | ALVS(ppm) | AITV(ppm) |
|---|---|---|---|
| Cr | 30 | 100 | 600 |
| Zn | 100 | 300 | 1500 |

***Legend:*** *RSV = Reference value in the sensitive area, ALVS = Alert level value in the sensitive area, AITV = Area intervention threshold value*

Further, mathematical modeling indicates that chromium in the soil might be the one which is determining the evolution of zinc corn content, in all four locations (Figure 1 and 2).
Spatial interpolation map (Figure 3) highlights that the level of Zn in corn depends on the total chromium soil content for all the analyzed samples.
Our research is in accord with other studies [8] who found high correlation between Zn uptake in Cr-stressed plants.

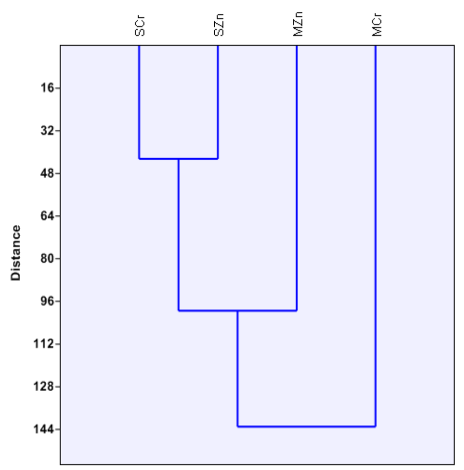


**Figure 1.** Clusters representation for chromium and zinc content of studied areas samples

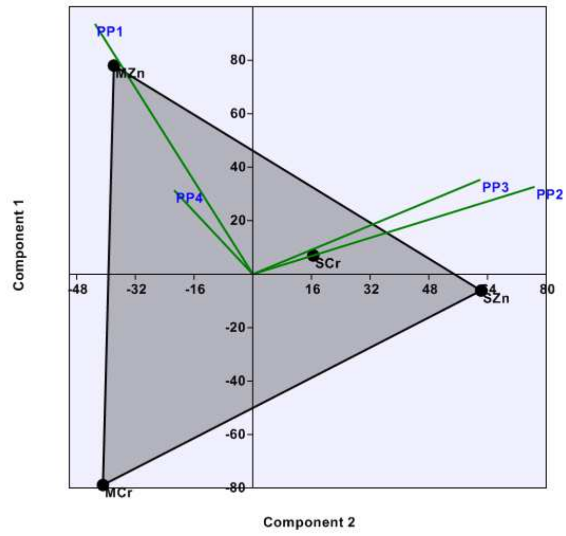


**Figure 2.** Scatter representation of PCA using PC1 axis

***Legend:*** *SCr=Cr contents in soil, SZn=Zn contents in soil, MCr=Cr contents in maize, MZn=Zn contents in maize;*

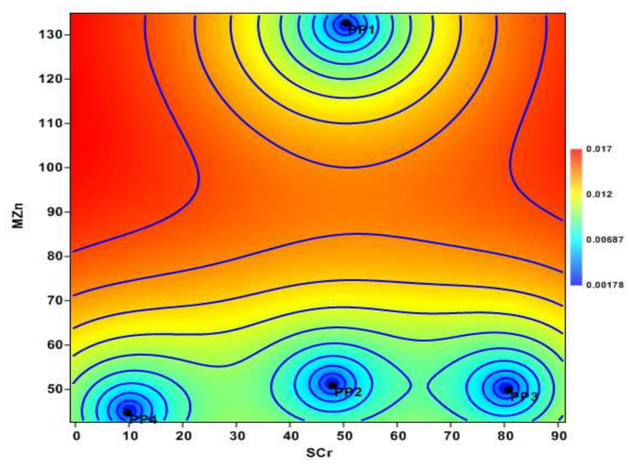


**Figure 3.** Spatial interpolation of soil and maize samples data

## Conclusions

In soil, sampled from Tarnaveni area, Cr ranged from 9.7 ppm to 80.73 ppm and Zn from 21.77 to 99.87 ppm.

In corn, the values for Cr were between 0.081 to 0,11 ppm and for Zn between 44.74 to 132.66 ppm.

Mathematical modeling indicates that chromium in the soil might be the one which is determining the evolution of zinc corn content.

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