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Analyses of Soil Cadmium and Copper Contents on a Region of Burgundy in France

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Abstract

The aim of present research was to know Cd availability. As a first report of this work, we present some results of analysing soil Cd and Cu contents on a part of Burgundy in France. Soil samples were collected from surface-ploughed layer in fields across the southern part of the Yonne district, Burgundy, France.

From the first extractable Cd content on a ratio (soil : EDTA =1:10), the soil Cd values on *Carixien* soil series decreased to a-third or to a-fourth of those Cd values on a lower ratio (soil : EDTA = 1:5). While the extractable Cd of the soil samples on *Sols marron* soil series decreased in a smaller extent. The changes of mixing ratio from 1:50 (soil : EDTA) to 1:10 and to 1:5 (soil : EDTA) had decreased the extractable Cu contents. But the range of the decrease was not so large as that of Cd contents. Soils on some soil series were a half (*Carixien*) or two-thirds level (*Domérien, Aubes*) when comparing the extractable Cu content on 1:5 ratio to the content on 1:50 ratio. The absorbance for Cu analyses of soils on *Carixien, Terres noires, Sols marron* soil series varied in larger extent (expressed on standard deviation for 6 values) than that of soils on *Domérien, Aubes* soil series.

(Key words : France, Soil, Cadmium, Copper, Analyses)

I. Introduction

The term 'heavy metal' is a broad one, covering metals of atomic weight higher than that of sodium and having a specific gravity in excess of 5.0 (Piotrowski and Coleman, 1980). Since cadmium(Cd) occurs in zinc(Zn), lead(Pb) and copper(Cu) ores, the mining and smelting of these metals, particularly Zn and Cu, are important sources of local environmental pollution by Cd (Piotrowski and Coleman, 1980).

Cadmium content of the surface soil can vary greatly (0.14~3.51 mg Cd /kg soil) depending on soil series and sampling site (Mench et al., 1997).

A field case study was undertaken across the southern part of the Yonne district, Burgundy, France (Mench et al., 1997). This area has various soil series with either low or high geochemical Cd content in the topsoil. After the work of Mench et al., we took the work of knowing the relation between soil weight, amount of an extracting reagent and extracted Cd, Cu contents from the soil

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in these soil series. The aim of present research was to know Cd availability (Etherington, 1982; Alloway, 1990). And the absorbance of the two mineral elements were determined by atomic absorption spectrophotometry (Arnaud, 1998). As a first report of this work, we present some results of analysing soil Cd and Cu contents on a region of Burgundy in France.

II. Materials and Methods

1. Materials

Soil samples were collected on 0.3 m^2 area with a spade from the 0 to 0.25 m surface-ploughed layer in fields at 15 sites across the southern part of the Yonne district, Burgundy, France (Mench et al., 1997). Soil samples were air-dried, 2 mm sieved and rehomogenized. And the soil samples from 5 soil series were used for the analyses of Cd and Cu contents. The name of the soils were as follows;

Dubloc, Bierry (*Domérien* soil series)

Vellerot, Rks, Brecy, Chaponne (*Carixien* soil series)

TN-4, S-41 (*Terres noires* soil series)

Chassigny, Vault de Lugny, Precy le Moult, Loiches (*Sols marron* soil series)

Nitry, Courtenay, Grimault (*Aubes* soil series)

2. Methods

Table 1. Soil Cd contents in five soil series from the Yonne district, Burgundy, France

(mg Cd/kg soil)

Soil series	Site	Extractable Cd[1]*	Extractable Cd[2]*	Extractable Cd[3]*
Domérien	Dubloc	0.3**	0.2±0.0	0.3±0.0
Domérien	Bierry	1.0±0.0	0.5±0.0	-
Carixien	Vellerot	2.0±1.4	0.5±0.0	-
Carixien	Chaponne	2.0±0.0	0.5±0.0	-
Carixien	Rks	1.5±0.7	0.5±0.0	-
Carixien	Brécy	2.0±0.0	0.7±0.3	-
Terres	TN 4	4.3±0.5***	3.7±0.3	-
noires	S 41	9.5±0.7	4.5±0.0	-
Sols	Chassigny	1.5±0.7	1.2±0.3	-
marron	Vault de Lugny	2.0±0.0***	1.0±0.0	-
marron	Precy le Moult	2.0±1.4	1.2±0.3	-
marron	Pré de Loiches	3.5±0.7	2.5±0.7	-
Aubes	Nitry	1.0±0.0	0.5±0.0	-
Aubes	Courtenay	1.5±0.7	0.5±0.0	0.6±0.0
Aubes	Grimault	1.0±0.0	0.5±0.0	0.6±0.0

[1] 2g of soil and 20 ml of 0.05 mol EDTA, agitated and filtrated on April 9~22, 1998.
[2] 6g of soil and 30 ml of 0.05 mol EDTA, experimented on May 12~June 9, 1998.
[3] 10g of soil and 30 ml of 0.05 mol EDTA for 3 samples, done on June 22~23, 1998.
* : mean ± standard deviation of 2 values.
** : single value.
*** : mean ± standard deviation of 3 values.

The method for extractions were by Lebourg (1996) and Ghestem (1997). The time for extraction was 24 hours. And the reagent for extraction was 0.05 M EDTA. (ethylene diamine tetraacetic acid) on the form of Na_2H_2EDTA. The soil was extracted in a polyethylene bottle (volume around 50 ml) by an agitator, then filtrated with a Millipore system (radius of membrane, $\varnothing$=0.45 μm). The weight of soil and amount of EDTA were 1 g and 50 ml, 2 g and 20 ml, 6 g and 30 ml, 10 g and 30 ml, respectively. The experiment was carried out on *Laboratoire de Chimie Analytique* of *Institut National Agronomique Paris-Grignon*(INA P-G) in France, during a period from March 24 to June 23, 1998.

The Cd and Cu contents of the extracted soil solution were determined by air-acetylene flame atomic absorption spectrophotometer(AAS) (model: VARIAN SPECTRAA 250 PLUS), and their wave lengths were 228.8 μm and 324.8 μm, respectively. Background correction was used for Cd analysis, but for Cu analysis the correction was not used (Pinta et al., 1979).

III. Results and Discussion

1. Soil Cd and Cu contents with several methods of mixing soil and EDTA reagent

Table 1 shows the soil Cd contents in five soil

Table 2. Soil Cu contents in five soil series from the Yonne district, Burgundy, France

(mg Cd/kg soil)

Soil series	Site	Extractable Cu[1]*	Extractable Cu[2]*	Extractable Cu[3]*	Extractable Cu[4]*
Domérien	Dubloc	5.2±0.3	3.0±0.0	2.5±0.0	2.5±0.2
Domérien	Bierry	7.2±0.3	5.5±0.7	5.0±0.0	-
Carixien	Vellerot	10.0±1.4	5.0±0.0	5.0±0.7	-
Carixien	Chaponne	11.2±1.0	6.0±0.0	4.7±0.3	-
Carixien	Rks	13.0±0.7	7.2±0.0	5.2±0.3	-
Carixien	Brécy	16.2±2.4	10.5±2.1	8.0±0.7	-
Terres	TN 4	12.2±0.3	11.6±1.1**	10.5±0.7	-
noires	S 41	14.2±0.3	16.5±3.1***	8.0±0.1	-
Sols	Chassigny	12.2±0.5***	11.5±0.7	10.7±0.3	-
marron	Vault de Lugny	8.0±0.7	7.0±1.0**	5.7±0.3	-
marron	Precy le Moult	9.7±0.3	8.0±1.4	7.0±0.0	-
marron	Pré de Loiches	11.7±0.3	10.0±0.0	10.0±1.4	-
Aubes	Nitry	7.0±0.0	6.0±0.0	4.7±0.3	-
Aubes	Courtenay	6.2±0.3	4.0±0.0	3.7±0.3	3.6±0.0
Aubes	Grimault	5.0±0.0	3.5±0.7	3.0±0.0	3.0±0.0

[1] 1g of soil and 50 ml of 0.05 mol EDTA, treated on March 24~27, 1998.
[2] 2g of soil and 20 ml of 0.05 mol EDTA, agitated and filtrated on April 9~22, 1998.
[3] 6g of soil and 30 ml of 0.05 mol EDTA, experimented on May 12~June 9, 1998.
[4] 10g of soil and 30 ml of 0.05 mol EDTA, for 3 samples, done on June 22~23, 1998.
* : mean ± standard deviation of 2 values.
** : mean ± standard deviation of 3 values.
*** : mean ± standard deviation of 4 values.

Table 3. The variance of the absorbance and the extractable copper content on the 15 French soil by an atomic absorption spectrometer[1)]

Soil series	Site	Absorbance			Mean absorbance[2)]	Mean absorbance[3)]
		1	2	3		
Domérien	Dubloc [4)]	0.079	0.080	0.074	0.077±0.003	0.075±0.004
	Dubloc	0.076	0.074	0.067	0.072±0.004	
Domérien	Bierry	0.088	0.087	0.089	0.088±0.001	0.087±0.001
	Bierry	0.088	0.087	0.086	0.087±0.001	
Carixien	Vellerot	0.093	0.092	0.093	0.092±0.0005	0.086±0.007
	Vellerot	0.084	0.079	0.077	0.080±0.003	
Carixien	Chaponne	0.083	0.084	0.083	0.083±0.0005	0.081±0.002
	Chaponne	0.080	0.080	0.079	0.079±0.0005	
Carixien	Rks	0.096	0.095	0.093	0.094±0.001	0.089±0.005
	Rks	0.087	0.085	0.083	0.085±0.002	
Carixien	Brécy	0.145	0.145	0.145	0.145±0.000	0.137±0.008
	Brécy	0.130	0.129	0.129	0.129±0.0005	
Terres	TN4	0.188	0.188	0.187	0.187±0.0005	0.177±0.011
noires	TN4	0.168	0.167	0.167	0.167±0.0005	
Terres	S41	0.134	0.134	0.135	0.134±0.0005	0.134±0.0005
noires	S41	0.135	0.134	0.135	0.134±0.0005	
Sols	Chassigny	0.184	0.184	0.183	0.183±0.0005	0.181±0.002
marron	Chassigny	0.180	0.179	0.178	0.179±0.001	
marron	Vault de	0.097	0.095	0.096	0.096±0.001	0.097±0.001
	Lugny	0.099	0.099	0.098	0.098±0.0005	
marron	Precy	0.119	0.118	0.118	0.118±0.0005	0.118±0.0006
	le Moult	0.118	0.118	0.117	0.117±0.0005	
marron	Pré de	0.187	0.189	0.189	0.188±0.001	0.168±0.021
	Loiches	0.150	0.148	0.148	0.148±0.001	
Aubes	Nitry	0.085	0.084	0.084	0.084±0.0005	0.081±0.003
	Nitry	0.078	0.078	0.078	0.078±0.000	
Aubes	Courte-	0.108	0.110	0.104	0.107±0.003	0.107±0.003
	Nay [4)]	0.113	0.107	0.103	0.107±0.005	
Aubes	Gri-	0.088	0.085	0.087	0.086±0.001	0.087±0.001
	Mault [4)]	0.090	0.088	0.089	0.089±0.001	

[1)] 6g of soil and 30 ml of 0.05 mol EDTA were mixed, agitated for 24 hours, filtrated on May 12~June 9, 1998.
[2)] mean ± standard deviation of 3 values.
[3)] mean ± standard deviation of 6 values.
[4)] 10g of soil and 30 ml of 0.05 mol EDTA were mixed, agitated for 24 hours. filtrated on June 22~23, 1998.

series (*Domérien, Carixien, Terres noires, Sols marron, Aubes*) from the Yonne district, Burgundy, France. The change of mixing ratio from 1:10 (2g soil and 20 ml EDTA) to 1:5 (6g soil and 30ml EDTA) lessened Cd contents. There were several factors who gave effect to the decision of Cd content by an atomic absorption spectrometer, for example, pH, concentration of EDTA, duration of extraction or ratio of weight/volume of solution (Ghestem, 1997).

From the first extractable Cd content on a ratio (soil : EDTA = 1:10), the soil Cd values on *Carixien* soil series decreased to a-third or to a-fourth of those Cd values on a lower ratio (soil : EDTA = 1:5). While the extractable Cd of the soil samples on *Sols marron* soil series decreased in a smaller extent.

Table 2 shows the soil Cu contents in five soil series from the Yonne district, Burgundy, France. The changes of mixing ratio from 1:50 (1g soil and 50 ml EDTA) to 1:10 (2g soil and 20 ml EDTA) and to 1:5 (6g soil and 30ml EDTA) had decreased the extractable Cu contents. But the range of the decrease was not so large as that of Cd contents as shown in Table 1. Soils on some soil series were a half (*Carixien*) or two-thirds level (*Domérien, Aubes*) when comparing the extractable Cu content on 1:5 ratio to the content on 1:50 ratio.

2. Utilization of the value of absorbance by an atomic absorption spectrometer(AAS) for soil Cu contents in the five soil series

Table 3 shows the variance of the absorbance and the extractable Cu content on the 15 French soil by an atomic absorption spectrometer. Pinta et al. (1979) wrote that there are some factors which have effect to the changes of absorbance of Cu, for example, temperature, associated anion, interaction with other minerals.

There were much resemblance between their absorbances for a same soil sample as shown in Table 3. The absorbance for Cu analyses of soils on *Carixien, Terres noires, Sols marron* soil series varied in larger extent(expressed on standard deviation for 6 values in Table 3) than that of soils on *Domérien, Aubes* soil series. Specially those variances of the soils on *Carixien* soil series changed much. From the fact it was suggested that the absorbance of the soils on *Carixien* soil series will vary much during the extraction. Therefore, it is necessary to continue a research with a method of speciation (Rutledge, 1996; Ghestem, 1997) or bio-dispensability (Lebourg, 1996) in order to know the heavy metals' availability (Mench et al., 1997).

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