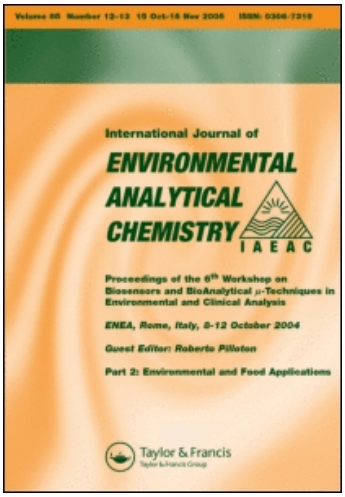

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J. Sippola[a]; R. Mäkeläkurtto[a]
[a] Agricultural Research Centre, Institute of Soils and Environment, Jokioinen, Finland

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DECREASING LEAD LEVELS IN CULTIVATED SOILS IN FINLAND

J. SIPPOLA and R. MÄKELÄ-KURTTO

Agricultural Research Centre, Institute of Soils and Environment, SF-31600 Jokioinen, Finland

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Soluble and total lead were determined in soils sampled in 1974 and 1987 using acid ammonium acetate-EDTA and aqua regia for extraction, respectively. The concentration of total lead decreased during the 13 years period from 7.9 to 7.6 mg/l soil corresponding to total amount of 15.8 and 15.2 kg/ha in the plough layer. The concentration of soluble lead decreased more than total lead and amounted to 8 % compared to 4 % in case of total lead. This favourable development is caused by introduction of unleaded petrol and hence decreased lead emissions from traffic. Speciation studies would be a useful tool to elucidate the pathways of lead deposited on soil.

KEY WORDS: Lead, total, soluble, soil.

INTRODUCTION

In Finland as in other countries, concern for environmental pollution has stimulated the use of unleaded petrol instead of leaded fuel types. As a result, the emissions of lead from traffic have decreased from 930 tonnes in 1973 to 160 tonnes at present[1].

A study on the chemical characteristics of Finnish agricultural soils indicated a clear decrease in the extractable lead content[2]. The mean concentration of acid ammonium acetate-EDTA extractable lead was 1.97 mg/l of soil in 1974 and 1.66 mg/l in 1987. This means a decrease in the soluble lead concentration by 16 % in 13 years or more than 1 % annually. However, lead is still deposited on soils and the total content still might increase as long as the leaching losses and plant uptake are lower than the deposition.

Generally, lead is adsorbed strongly in soil by organic matter and also plant uptake is relatively small. Therefore the residence time of lead in soil is relatively long and one would expect the total lead content in soil to change very slowly.

This study aims to investigate more closely the observed decrease in the soluble lead content of soil by determining the total lead in addition in some of the samples from the above study[2]. Information on the cycling of lead deposited on soil was looked for.

MATERIALS AND METHODS

A set of 36 soil samples was selected from sample material collected during early summer 1974 and 1987 in cultivated timothy fields in Finland[2]. The two sets of samples were taken at the same sites so that evaluation of lead content changes was considered to be possible. Samples were bulked from five subsamples taken from an area of 10 by 10 meters in different farmers' field plots. There was some difficulty in relocating the original sampling areas as indicated by relatively large differences in for example in the organic matter content of samples.

Soluble lead was extracted using acid ammonium acetate-EDTA (AAAc-EDTA) solution[3]. For total lead digests of soil with aqua regia were obtained by adding to 5 g of soil 37.5 ml HCl and 12.5 ml HNO_3 and boiling slowly under reflux for 2 h. Lead in extracts and digests was determined with an atomic absorption spectrometer using an air-acetylene flame.

RESULTS AND DISCUSSION

The results in Table 1 show that in 1974 the average total concentration of lead in cultivated soils was 7.9 mg/l soil, representing 15.8 kg/ha lead in a 20 cm plough layer. In 1987 the total lead concentration had decreased to 7.6 mg/l soil equalling to 15.2 kg/ha. Soil total lead content was thus reduced by 0.6 kg/ha during 13 years.

For all 32 of the selected soils the decrease in the concentration of soil soluble lead was 0.16 mg/l between 1974 and 1987. For the selected clay soils the decrease was 0.39, for the coarse textured soils 0.12 and for the organic soils 0.14.

Table 1 Changes in the lead concentration of 32 sites sampled in 1974 and again in 1987.

	Mean (s.e.)		*Change*	
	1974	*1987*	*mg/l*	*%*
Clay soils (n=4)				
AAAc-EDTA mg/l soil	2.28 (.58)	1.89 (.17)	-0.39	-17
Aqua regia mg/l soil	12.9 (1.5)	12.1 (.8)	-0.8	-6.8
Coarse textured mineral soils (n=18)				
AAAc-EDTA mg/l soil	1.53 (.19)	1.41 (.19)	-0.12	-7.8
Aqua regia mg/l soil	8.1 (.7)	7.8 (.6)	-0.3	-3.7
Organic soils (n=10)				
AAAc-EDTA mg/l soil	3.00 (.50)	2.86 (.37)	-0.14	-4.7
Aqua regia mg/l soil	5.4 (.4)	5.6 (.6)	+0.2	+3.7
All soils(n=32)				
AAAc-EDTA mg/l soil	2.08 (.23)	1.92 (.19)	-0.16	-7.7
Aqua regia mg/l soil	7.9 (.6)	7.6 (.5)	-0.3	-3.8

The relative decrease in the soil total lead concentration, 3.8 % is smaller than that in soluble lead, 7.7 %. The group of organic soils is an exception when the total lead content appears to increase and soluble lead content decreases like in other soil groups. The decrease in the lead concentration of clay soils is large taking into account the low permeability of these soils.

The estimated decrease in the soil lead content appears to be unexpected. Hovmand[4] has calculated that plant uptake of lead may be 2.5 g/ha in one year, he also estimated that leaching to groundwater and drainage accounts to a loss of 5 g/ha, corresponding to a total removal in the order of 7.5 g/ha. The lead removal suggested by the present study is much larger.

Friedland et al.[5] have reported lead decreases in forest soil organic surface layers in northeastern United States of the same order as presented in this study. Craig et al.[6] reported a clear downward shift of lead followed by accumulation in deeper layers in forest soils. These results show that in certain conditions relatively much lead may leach from the surface layer.

Friedland et al.[5] considered that reduced lead emissions from the automobile traffic were the major cause of lead decrease in the surface layer. Also in Finland the great decline in the use of leaded petrol is the most likely cause of this beneficial development. Other possible reasons for the decrease of the lead concentration may be dilution caused by the deepening of plough layer upon tillage, and slow erosion of the soil surface by water. However, the decrease appears to be surprisingly fast and speciation studies could be a very useful tool to study the fate of lead deposited on soil.

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