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INFLUENCE OF SOIL ACIDIFICATION ON SOME SOIL CHEMICAL PROPERTIES (EXCHANGEABLE ALUMINIUM AND MOBILE PHOSPHORUS)

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Abstract

Emissions of dioxide and trioxide sulfur from Ampellum S.A caused acid precipitation in Zlatna area, wich affected the soil physical, chemical and biologic properties. In studies area dominated are Cambisol sand acid rain lead to increased total soil acidity, mobilization of aluminium ions, immobilization of soil phosphorus. The objectives of this study were therefore to investigate the influence of acidification on exchangeable aluminum and mobile phosphorus of soils from Zlatna area. Content in aluminum exchangeable was determined in soil sample with reaction below 5.8 and ranged from very low to high according to soil type. Exchangeable aluminum correlates significantly with soil reaction, degree of base saturation, hydrolytic acidity. Content in mobile phosphorus correlates significant with soil reaction and was lower compared with specific values of monitoring sites from the Alba County.

INTRODUCTION

In Zlatna area, because of Ampellum S.A activity was issued large quantities of SO_2, SO_3, heavy metal oxides and sulfates [12, 13]. Dioxide and trioxide sulfur in contact with rain water converts to sulfuric acid that leading to the formation of acid precipitation. Gaseous emissions (SO_2, NO_X) and fall-out of particles enriched in Pb, Zn, Cu and Cd cause acid precipitation and heavy metal contamination (Bartok, 1982, quoted by Williamson et al.).

Acid rain leads to increased total soil acidity. The main effects of increased acidity are: decreasing the cationic exchange capacity, mobilization of aluminum ions, degradation of primary minerals, reduced biological activity, changes in surface properties of minerals and soil solution, loss of alkaline cations: Ca^{2+}, Mg^{2+}, K^+, Na^+ [4]. As soil pH declines, the supply of most plant nutrients decreases while aluminum and a few micronutrients become more soluble and toxic to plants [7].

The pH of aqueous suspension below 5.8 shows that soil containing aluminum ion adsorbed, whose participation in soil adsorption complex grows with soil acidification [1].

In general, the toxic effect does not occur when the pH (H20) is greater than 5.5 (Mc. Cart and Kamprath, 1965, quoted by Davidescu & Davidescu), but increases strongly when it is less than 5.

MATERIAL AND METHODS

The content of the exchangeable aluminum of soil samples collected from the Zlatna area, which had a pH <5.8, was determined.

Soil reaction (pH) was determined by the potentiometric method, in water suspension (1:2.5). The values of the percentage base saturation ($V_{8.3}$, %) were determined through calculation, sum of exchangeable bases (SB, me/100 g soil) and hydrolytic acidity (HA) by Kappen procedure, and the total cationic exchange capacity through calculation.

Exchangeable aluminum by Sokolov method and the Ca by Schollenberger, Dreibelbis, Cernescu method. The available phosphorus contents were determined by Egner-Riehm-Domingo procedure, by extraction the ammonium lactate acetate.

RESULTS AND DISCUSSION

Most of soil samples with pH<5.8 belong to Dystric Cambisols, Regosols, Luvisols, Podzols, Erodisols.

Exchangeable aluminum was in the range of extremely low-high, mean (2.1 me/100 g soil) belongs to the moderate class. In the medium-high classes are found 50% of the values of the exchangeable aluminum (Table 1).

The highest values were recorded in the sites belonging to a Leptic-dystric Regosols and Umbric-entic Podzols on the whole soil profile. In the case of Dystric Cambisols, values of exchangeable aluminum range in the low-moderate classes, generally, on the whole profile. In the case of Luvisols, exchangeable aluminum varies from low to high classes and in some soils high values took place only in the upper horizons. In the most soil profiles, exchangeable Al content is moderate either on the soil surface or on the whole soil profile. Correlations of exchangeable aluminum content and chemical properties (soil reaction, hydrolytic acidity, sum of exchangeable bases, degree of base saturation) of studied soils are shown in Figures 1 and 2. The correlations were negative, highly significant with sum of exchangeable bases (r=-0.5440), degree of bus saturation (r=-0.683) and significant with soil reaction (r=-0.33). Between content of mobile Al^{3+} and degree of soil base saturation of soils there is a strong correlation in both A and B horizon. Also, they showed that the highest values of mobile Aluminum (4-7 me/100 g soil) were found at the degree of saturation below 10-15% and lowest values (0.1-0.2 me/100 g soil) at the degree of saturation of 75-80% [6]. Very significantly positive correlation was established with hydrolytic acidity (r=0.793).

Table 1

Statistical parameters of soil exchangeable Al and Pm from Zlatna area

Statistical parameter	Al^{3+}, me/100 g soil	Pm, mg/kg (0-50 cm)
Number of samples	74	30
Minimum	0,04	1,2
25th percentile	0,89	4,8
Median	1,98	5,0
Mean	2,09	8,1
75th percentile	2,88	7,4
90th percentile	4,04	11,8
Maximum	5,87	56,7
Coefficient of variation	66	120

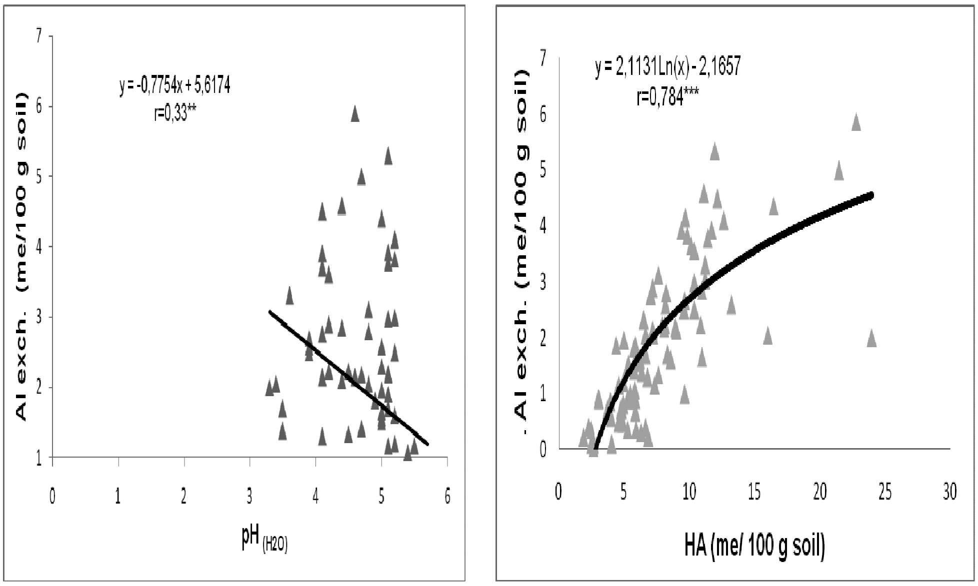

Fig. 1. Relationships of exchangeable Aluminium with soil reaction (pH $_{H2O}$) and hydrolitic acidity (HA)

The incoming strong acids mobilize aluminum in the soil minerals and aluminum displaces Ca and other cations from the exchange complex [2]. In the soils studied, between aluminum and Ca content of the adsorption complex has established a very significant negative exponential relationship (r =- 0.625) (Figure 3).

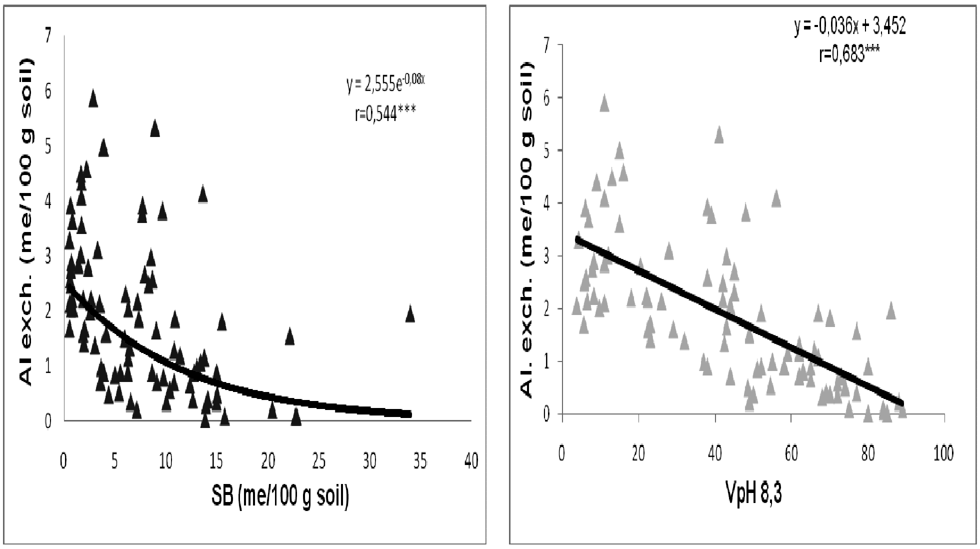

Fig. 2. Relationships of exchangeable Aluminium with sum of exchangeable bases (SB) and degree of base saturation (V, %)

Indirect action of aluminum is shown by immobilization of soil phosphorus and by inhibiting the negative influence of microbiological activity and increase soil acidity [10].

Solubility and accessibility of inorganic phosphorus compounds depend on many factors, including soil reaction that has an important role [11].

In the moderate and strong acid, as in the neutral and alkaline concentration the content of phosphorus in the soil solution is reduced, due to fixation in inaccessible forms. In acid soils, phosphorus is retained as iron and aluminum phosphate [7, 8].

Phosphorus content of soil range in the studied area, at the depth of 0-50 cm, from extremely low (1.2 mg/kg) to high (56.7 mg/kg), and the average is 8.1 mg/kg. Over 75% of the class values are very low and only 10% of values exceed the value of 12 mg/kg Pm (Table 1).

Determined values are much lower than the values Pm of agricultural monitoring sites from Alba County, which range from 3.6 mg/kg to 99 mg/kg, and the average of Pm, at the depth of 0-50 cm, was 14 mg/kg [9].

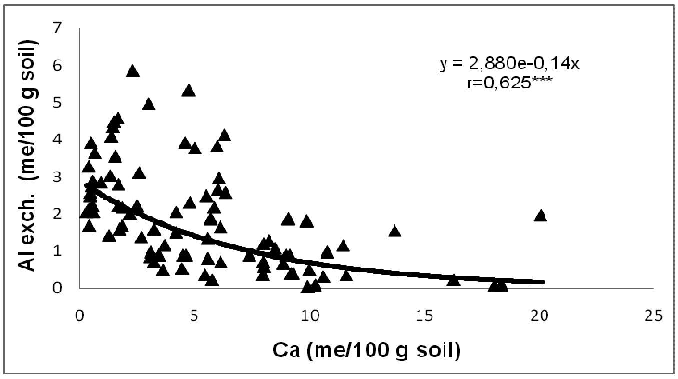

Fig. 3. Relationships of exchangeable Aluminium with Ca

Values of pH below 4 the contents of mobile phosphorus decreased dramatically (1-17 mg/kg P) [5].

Very significant exponential relationship was established between mobile phosphorus and values of soil reaction, in the studied area (Figure 4).

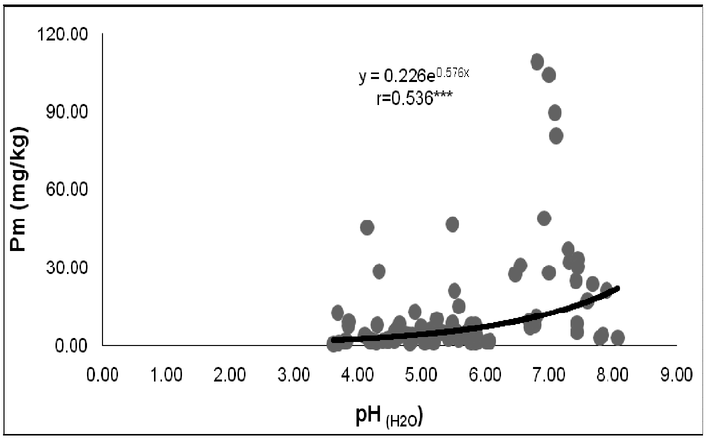

Fig. 4. Relationships of Pm with soil reaction (pH_{H2O})

CONCLUSIONS

1. Exchangeable aluminium was in the range of extremely low-high, mean belongs to the moderate class.
2. In most soil profiles, exchangeable Al content is moderate either in the upper horizons or on the whole soil profile.

3. The coefficient of correlation of exchangeable aluminium with some soil chemical properties decreased in the order: HA>V>Ca>SB>pH.
4. Phosphorus content of soils range in the studied area, at the depth of 0-50 cm, from extremely low to high and is much lower than the Pm values of agricultural monitoring sites.

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