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RELATIONSHIP BETWEEN CATION SATURATION STATE INDEX AND HYDROGEN IONS IN SOIL

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A b s t r a c t. The dependence between cation saturation state index (CSS index) and hydrogen ions determined with various methods was estimated. It was determined that the dependencies between CSS index, and the concentration of hydrogen ions in soil solution and hydrogen ions in soil had the characterof function y=a/x and the dependence between CSS index and adsorbed hydrogen ions had the shape of function y=bx+c. The determined dependencies, and especially the function y=a/x, indicate the decrease of CSS index down to the value close to 1.0 and lower. It is connected with very quick increase in the amount of hydrogen ions in soil.

K e y w o r d s: cation saturation, hydrogen ions, soil solution

INTRODUCTION

The phenomenon of the occurence of exchangeable cations in soil is the most important property among many physical, chemical and biological soil characteristics. In the climate with larger amounts of rainfalls a lot attention is paid to hydrogen ions in soil solution as well as to the adsorbed ions on soil colloids [1,2].

From the agricultural point of view the proportions between adsorbed metallic cations and adsorbed hydrogen cations are important.

These relations are quantitatively expressed by cation saturation state index (CSS index), [5].

The determination of dependency between CSS indices and hydrogen ions determined with various methods can be of great practical importance.

METHODS

The research was carried out on 25 kinds of soil in the northern part of Lublin region. The detailed chemical and agricultural characteristics of these soils was presented in the author's earlier papers [3,4].

The concentration of hydrogen ions in soil solution was calculated on the basis of the measurement of soil reaction in water and 0.01 mol $CaCl_2/dm^3$ and was expressed in μmol H^+/dm^3. Hydrogen ions were determined quantitatively in 1 mol KCl/dm^3 and in 1 mol CH_3 $COONa/dm^3$ and expressed in mmol H^+/kg. Exchangeable cations K^+, Ca^{2+}, Mg^{2+} and Na^+ were determined in 1 mol CH_3COO NH_4/dm^3 of pH 7.

Cation saturation state index (CSS index) was calculated according to the assumptions presented elsewhere [5].

RESULTS

The measurement of pH as well as the determinations of ion amounts adsorbed on soil colloids constitute important agrochemical characteristics of soil. However, pH index as the minus exponent of power can be applied neither to the calculation of average values nor to the calculation of regression equations, this type of data cannot serve for the calculation of variance analysis and confidence half intervals.

If we want to work out statistically the data expressed with pH index we should calculate pH index to hydrogen ions concentration. That is why the dependence between CSS index and hydrogen ions, was presented in relation to hydrogen ion concentration in soil reaction on the basis of pH measurements in water (Fig. 1) and on the basis of the pH measurement in 0.01 mol $CaCl_2$ (Fig. 2), and also in relation to the amount of exchangeable hydrogen ions determined in 1 mol KCl (Fig. 3), as well as the adsorbed hydrogen ions on soil colloids determined in 1 mol CH_3COONa (Fig. 4).

The range of CSS index in the examined soils amounted from 0.11 to 5.34, on the average 1.38-0.57. The range of hydrogen ion concentration calculated on the basis of pH measurement in water amounted from 0.316 to 31.6 μmol H^+/dm^3, on the average 10.47 ±3.68.

The range of hydrogen ion concentration calculated on the basis of pH measurements in 0.01 mol $CaCl_2$ amounted from 0.631 to 159.0 μmol H^+/dm^3, on the average 42.2 ±17.08. The range of exchangeable hydrogen ion amount

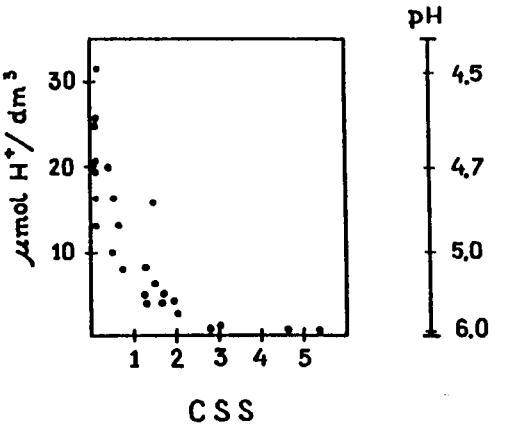

Fig. 1. Relationship between CSS index and hydrogen ion concentration in soil solution calculated on the basis of pH measurements in water. Regression equation y=4.953/x.

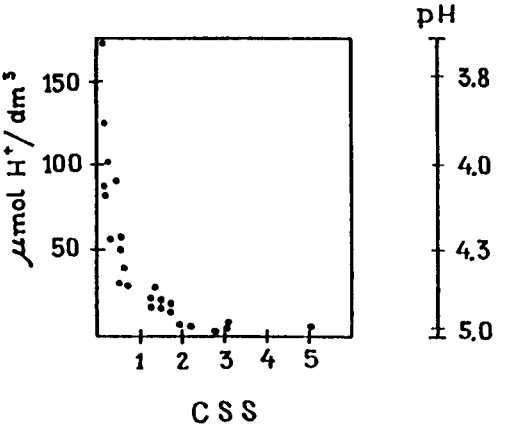

Fig. 2. Relationship between CSS index and hydrogen ion concentration in soil solution calculated on the basis of pH measurements in 0.01 mol $CaCl_2$. Regression equation y=17.114/x.

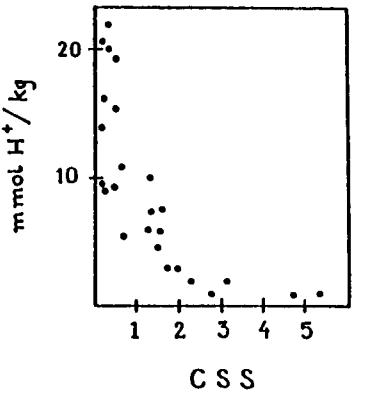

Fig. 3. Relationship between CSS index and the amount of exchangeable hydrogen ions in soil determined in 1 mol KCl. Regression equation y=5.381/x.

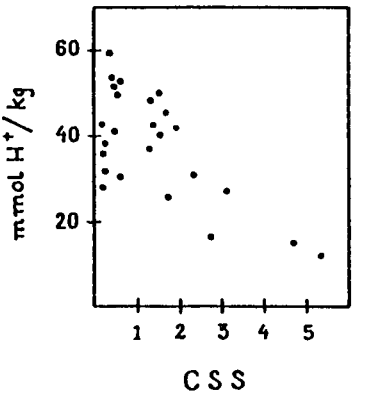

Fig. 4. Relationship between CSS index and the amount of adsorbed hydrogen ions in soil determined in 1 mol CH_3COONa. Correlation coefficient r=-0.681; regression coefficient b_{yx}=-6.067, b_{xy}=-0.076.

determined in 1 mol KCl amounted from 0.87 to 20.15 mmol H^+/kg, on the average 9.11 ±2.75. The range of hydrogen ion adsorbed on soil colloids determined in 1 mol CH_3COONa amounted from 12.0 to 59.0 mmol H^+/kg, on the average 37.9 ±5.11. Thus it can be concluded that the examined properties had a large range of values, which constituted the basis for the evaluation of dependence between CSS index and hydrogen ions in soil determined with various methods.

The dependence between CSS index and the concentration of hydrogen ions in soil calculated on the basis of pH mesurements in water is presented in Fig. 1. The dependence has distinct form of function y=a/x. On the basis of the experimental data the following regression equation was calculated: y=4.953/x.

The dependence between CSS index and hydrogen ions concentration in soil solution calculated on the basis of pH measurements in 0.01 mol $CaCl_2$ is presented in Fig. 2. On the basis of experimental data the regression equation was calculated, which has the following form: y=17.114/x.

The dependence between CSS index and the amount of exchangeable hydrogen ions in soil determined in 1 mol KCl has the form of regression equation y = 5.381/x. However, the dependence between CSS index and hydrogen ions adsorbed on soil colloids determined in 1 mol CH_3COONa has rather the form of equation y=bx+c, correlation coefficient r=-0.681 was significant at α=0.01. The value of regression coefficient amounted b_{yx}=-6.067, and b_{xy}=-0.076.

Thus, when the value of CSS index decreases, the hydrogen ion concentration increases in soil solution and also the amount of exchangeable and adsorbed ions in soil increases.

CONCLUSIONS

1. The evaluated relationship between CSS index and hydrogen ions in soil indicates that the increase in the CSS index value means the decrease in the hydrogen ion content in soil.

2. The dependence between the CSS index and the concentration of hydrogen ions and the amount of exchangeable hydrogen ions in soil had the form of function y=a/x, which indicates that when the value of CSS index decreases down to the value approximate to 1.0 and lower, the amount of hydrogen ions in soil rapidly increases.

3. The dependence between CSS index and hydrogen ions adsorbed in soil had the character of the following function y=bx+c at r=-0.681, and the values of regression coefficients amounted b_{yx}=-6.067, and b_{xy}=-0.076.

4. Further research should be held aiming at determining of quantitative dependencies between CSS index and hydrogen ions in soil, as well as recognizing the dependence between CSS index and other agrochemical characteristics of soil.

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ZALEŻNOŚĆ POMIĘDZY WSKAŹNIKIEM STANU WYSYCENIA KATIONAMI A JONAMI WODOROWYMI W GLEBIE

Oceniono zależność mędzy wskaźnikiem wysycenia kationami state CSS, a jonami wodorowymi określonymi różnymi metodami. Stwierdzono, że zależność między wskaźnikiem CSS, a stężeniem jonów wodorowych w roztworze glebowym i wymiennymi jonami wodorowymi w glebie miała charakter funkcji y=a/x, natomiast zależność między wskaźnikiem CSS, a zaadsorbowanymi jonami wodorowymi miała kształt funkcji y=bx+c. Oceniane zależności, zwłaszcza funkcja y=a/x wskazuje, że zmniejszenie wartości wskaźnika CSS do wartości bliskiej 1.0 i poniżej wiąże się z bardzo szybkim zwiększeniem ilości jonów wodorowych w glebie.

S l o w a k l u c z o w e: wskaźnik wysycenia kationami, jony wodorowe, roztwór glebowy.