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CORRECTING THE SOIL pH USING A METALLURGICAL WASTE

EUGENIA GAMENT, MARIANA MARINESCU
[1]*National Research Institute for Soil Science, Agrochemistry and Environmental Protection, Bucharest*
e-mail: eugeniagament@yahoo.com

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ABSTRACT

Soil acidity is among the important environmental factors which can influence plant growth and can seriously limit crop production. Therefore, liming acid soils is basic to maintain an optimal pH. Soil pH has a large influence on the availability of plants nutrients. The steel slag can be used as an amendment for an acid soil considering the high contents of CaO and MgO. The paper presents the preliminary obtained data regarding the use of steel slag resulted as a metallurgical waste from a Romanian steel refinery and its effect on the soil pH. The physical and chemical characteristics of the acid soil are presented. The effects of the steel slag applied at different rates on soil pH have been investigated in the laboratory experiment.

INTRODUCTION

Liming an acid soil to an optimal range is the first step in creating the favorable soil conditions for productive plant growth (Gament et. all., 2012).

Various factors over time cause changes in soil pH. The upper soil layer can be acidified by applications of nitrogen fertilizers and manure. If the soil acidity increases it is necessary to neutralize the acidity by adding lime to the soil. Soil acidity is among the important environmental factors which can influence plant growth and can seriously limit crop production. Therefore, liming acid soils is basic to have good soil and crop management.

Several negative problems can cause toxicity for the plants such as the availability of aluminium and manganese if the pH decreases bellow 5.5. For most agronomic crops, a range of soil pH between 6.0 and 7.0 is recommended. At this pH range the activity of Al and Mn is reduced (Beegle & Dwight, 1995).

The steel slag can be considered a material capable of neutralizing soil acidity and increasing soil pH.

MATERIAL AND METHOD

To determine how much steel slag is needed to neutralize the soil acidity we selected the acid soil to set up the experiment in the laboratory.

An important consideration in the laboratory experiment management should be the physical and chemical characteristics of the soil, the characteristics of the steel slag and the doses applied.

The source of the steel slag is a romanian steel refinery.

The soil material has been taken from Moara Domneasca area, close to Bucharest.

The research was carried out during a period of 30 days. The experiment has been set up in the laboratory and the treatment consisted in 4 rates of steel slag: 0%, 1%, 4% and 8%; 3 replicates and no mineral or organic fertilizers applied and no other factors of influence (water, aeration, etc.).

The aim of the experiment was to evaluate if the time, in the laboratory conditions, can influence the pH value of the acid soil amended with steel slag in order to choose the optimal treatment for the next step of the field experiment; to know the length of time that it takes for steel slag to change soil pH in the laboratory conditions.

Using the same rates of steel slag for 3 periods of time to compare between them we studied the soil reaction evolution after 5 days, 10 days and 30 days from the starting day of the treatment application.

The study's results are only a part of a national research project, it is the first step to evaluate the effects of the steel slag application on chemical characteristics of an acid soil.

For chemical characterization of the soil material and steel slag, some typical soil and steel slag analyses have been determined (pH, N, C, P, K, CaO and MgO, heavy metals, ANP – Amendment Neutralizing Power, etc.) (Treadwell & Zurcher, 1939; Metodologie, 1981; Metode, 1984; Metode, 1986).

RESULTS AND DISCUSSIONS

The soil taken from Moara Domneasca area, close to Bucharest belongs of the silt loam medium texture group class, silt-loam subclass (SL), according to Soil Taxonomy Romanian System (STRS, 2003) (Table 1).

From the particle –size distribution consideration, the soil includes 0.7% coarse sand (2.0-0.2 mm), 35.7% fine sand (0.2-0.02 mm), 33.6% silt (0.02-0.002 mm) and 30.0% clay (< 0.002 mm). These values are the mean of 5 replicates of the soil material.

Table 1

Particle - size distribution in the soil material taken from Moara Domneasca area (n=5), in mm, % from mineral size (g/g)

	Coarse sand (2,0 – 0,2mm) %g/g	**Fine sand** (0,2 – 0,02mm) %g/g	**Silt** (0,02 – 0,002mm) %g/g	**Clay** <0,002 mm %g/g	**Symbol - subclasse texture**
x	0,7	35,7	33,6	30,0	**Silt – Loam** (SL) texture subclasse (Romanian Soil Taxonomy System, 2003)
SD	0	2,058	1,033	2,721	-
CV	0	5,760	3,070	9,070	-
S_E	0	0,920	0,462	1,217	-

x-Mean; SD-Standard Deviation; CV-Coefficient of Variation; S_E-Standard Error

Some chemical indicators of the soil material are presented in Table 2 and Table 3.

Table 2

Some chemical characteristics of the soil material taken from Moara Domneasca area (n=5)

	pH (H_2O)	**Corg** %	**Hms** %	**Nt** %	**P^*_{AL}** $mg \cdot kg^{-1}$	**K_{AL}** $mg \cdot kg^{-1}$
x	5,62	1,03	1,77	0,182	62	337
SD	0,065	0,046	0,514	0,010	3,193	24,339
CV	1,160	4,447	29,040	5,490	5,150	7,220
S_E	0,029	0,021	0,230	0,004	1,428	10,885

*Value corrected according to pH;
x-Mean; SD-Standard Deviation; CV-Coefficient of Variation; S_E-Standard Error

Table 3

Heavy metals contents of the soil material taken from Moara Domneasca area (n=5)

	Cd mg·kg^{-1}	Cu mg·kg^{-1}	Co mg·kg^{-1}	Cr mg·kg^{-1}	Mn mg·kg^{-1}	Ni mg·kg^{-1}	Pb mg·kg^{-1}	Zn mg·kg^{-1}	Fe %
x	0,32	22	5,49	15,5	505	35	19	60	1,94
SD	0,082	1,949	1,222	2,333	34,502	1,732	0,7746	4,4497	0,0447
CV	25,63	8,86	22,26	15,05	6,83	4,95	4,08	7,42	2,30
S_E	0,0367	0,8716	0,5465	1,0434	15,4302	0,7746	0,3464	1,9900	0,0021

x-Mean; SD-Standard Deviation; CV-Coefficient of Variation; S_E-Standard Error

The soil material has a medium acid soil reaction (pH=5.62), a low content of organic carbon (1.03%); classified in the middle class of total nitrogen (0.182%) and with a high content of available phosphorus (P_{AL}=62 mg·kg^{-1}) and very high of available potassium content (K_{AL}=337 mg·kg^{-1}); normal contents of heavy metals. (Metodologia, 1987).

The Cation Exchange Properties and some other indicators characterization of the soil material will be part of the next step of the researches, the soil being in the mezobasic class with a Base-Cation Saturation Ratio, expressed as % from CEC (Cation Exchange Capacity), of 75%, bellow the normal range (80-85%).

Also, the chemical steel slag (LF) characterization will be presented in the next step of the researches. For the present study it is important to mention that the reaction of steel slag is alkaline with a pH=11.96.

The evolution of soil reaction at 4 rates of steel slag and 3 time periods considered from the beginning of the application of the treatment is presented in Figure 1.

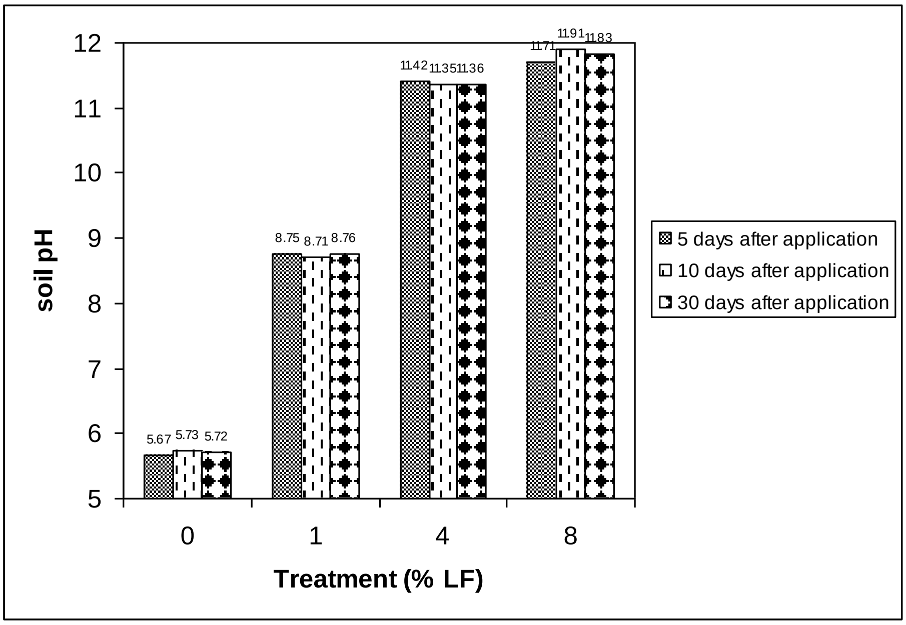

Figure 1 The effect of steel slag LF application on the soil pH and the soil pH evolution in time

The first conclusion was that the time did not influence the pH value. The values were close to each other for each period (5 days, 10 days, 30 days). There is no connection considering this conclusion and the changes in time of the agrochemical indicators of soils and also with the best time to apply the steel slag in the field.

On the other hand, the pH value very statistically significant increased for all treatments compared with control. At 1% steel slag (V1) the pH value increased above 8 for each period of time.

For most agronomic crops, a range of pH between 6.0 and 7.0 is recommended.

RECOMMENDATIONS

- ❖ The doses required for the next step to study the influence of steel slag application on the cation exchange properties and the experimental field application will be up to 1%;
- ❖ There is an upper limit as concern the amount of steel slag that can be applied considering the optimal pH value for crop growth (6.0 to 7.0); do not add an excessive amount of steel slag that the soil pH raises above 8;
- ❖ The steel slag will be applied in microdoses to maintain an optimal soil pH to avoid the negative effects of soil acidity and to improve crop production.

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