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THE EVOLUTION OF PLANT BIOMASS IN SOIL POLLUTED WITH CRUDE OIL IN DIFFERENT EXPERIMENTAL VARIANTS

MARIANA MARINESCU, ANCA LACATUSU, EUGENIA GAMENT, D.M. MOTELICA, M. MARINESCU

National Research Institute for Soil Science, Agrochemistry and Environmental Protection, Bucharest, Romania,

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.) (Metode de Analiza Chimica a Solului, 1986; Metodologie de analiza agrochimica a solurilor in vederea stabilirii necesarului de amendamente si ingrasaminte, 1981; Metode de analize agrochimice si control al calitatii amendamentelor calcaroase si a ingrasamintelor chimice produse industrial, 1984; Treadwell & Zurcher, 1939).

RESULTS AND DISCUSSIONS

Soil polluted with 5 and 10% crude oil by volume , was treated with Ecosol in uninoculated and inoculated with bacteria options selected . At the end of the first year of testing the polluted ground material was allowed to stand over the winter , when not applied watering or aerating and mixing procedures . Storage temperature was close to the house exterior environment of vegetation . The seeding was carried out in April of the second at a depth of 8-10 cm of 5 grains per pot . The first seedlings have emerged in late March and 5% crude oil contaminated vessels (Figure 5.60) . In vessels with 10% oil polluted plants sprang not at all excessive concentration of pollutant exerting a very severe phytotoxic effect , preventing total germination . The soil was kept in an optimal state of moisture (approximately corresponding to the capacity of the water in the field). The beneficial effects of the treatments were emphasized in the development of corn plants , which grew only 5% oil polluted variants , developing best in version v7 with 100 g Ecosol and inoculated with selected bacteria .

In the third year experimental soil was homogenized before reorganization experience . Sowing was performed in April , at a depth of 8-10 cm with a total of 5 beans in each pot. As expected , the first seedlings have emerged in control . Unlike in the previous experiment , although the delay corn plants have emerged and vessels contaminated with oil at both concentrations. Figure 5.62 shows the experimental variations in appearance, two months after emergence , where you can see the huge difference of force and size between plants affected by pollution of developed oil and a clean soil . Comparison between experimental variants show a better development of corn plants in polluted soil variations and inoculated with 5% oil , the same observing and variants of polluted soil inoculated with 10% oil . Inoculation of soil polluted with bacteria appears to confer enhanced plant vigor of maize in combination with soil conditioning with 0.5 % and 1 % Ecosol .

Figure 1 shows the corn plants in the flowering period clearly illustrates the beneficial effects of the application of bioremediation technology by two major technological links, soil conditioning product Ecosol and inoculated with bacteria selected on plant development. Thus, it can be seen clearly maintain phytotoxic effects of oil in the variants V2 and V3 be subject to natural attenuation, even at two and a half from pollution. The solution V2, contaminated with 5% crude corn plants have reached the stage of flowering, while in the variant V3 oil contaminated with 10% of the plants could not flourish. At both doses of pollution ECOSOL application in lower doses (0.25% and 0.5%) as the only link technology has not exercised sufficient protection from pollutants so that plants can grow.

Doubling the dose of Ecosol (0.5% and 1%) added to the existing corn plants could flourish in conditions of soil pollution with 10% oil. Obviously, the more developed plants and flowers of maize variants in which the two technological, soil conditioning Ecosol and inoculated with selected bacteria, they act synergistically.

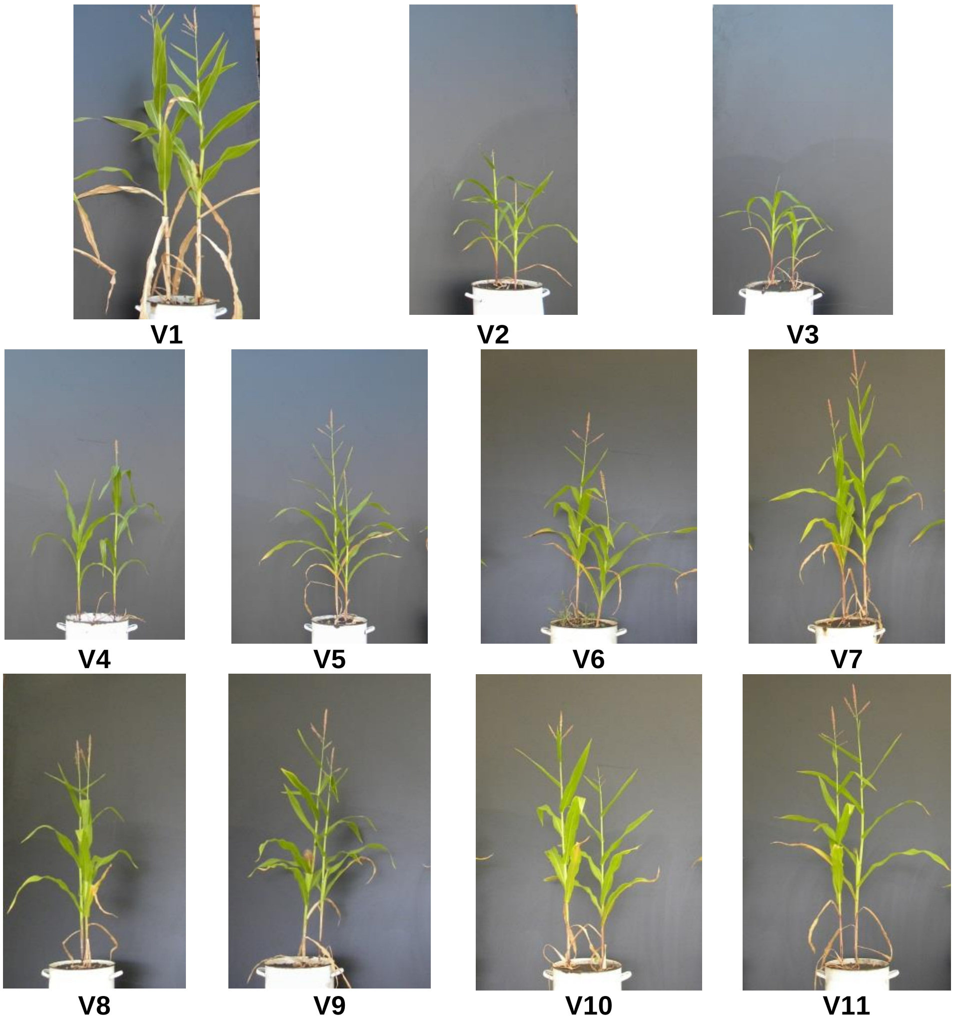

Figure 1 Maize plants after four months from seedling of each experimental variant in the third experimental year

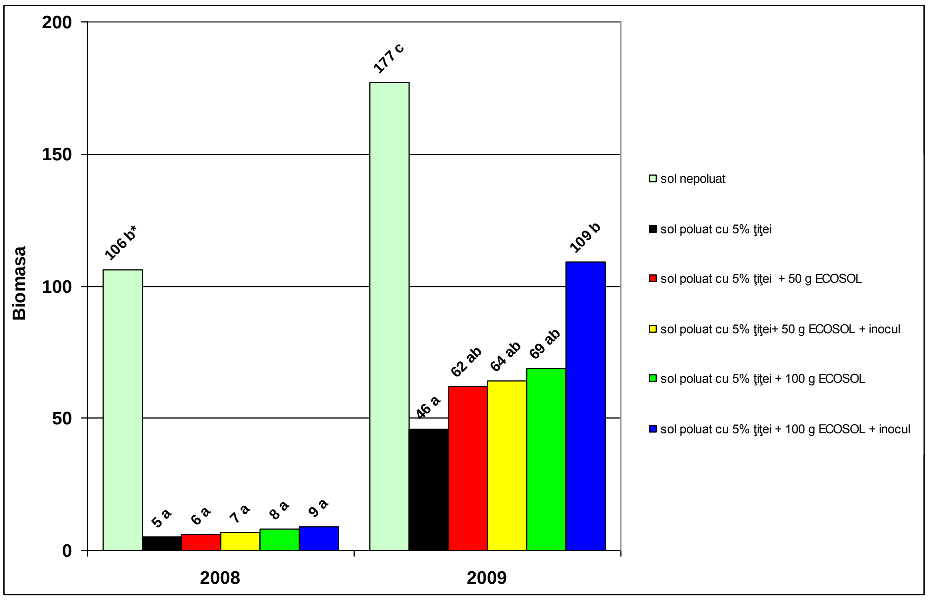

Figure 2. The evolution of plant biomass in soil polluted with 5% crude oil in different experimental variants – analysis of variance

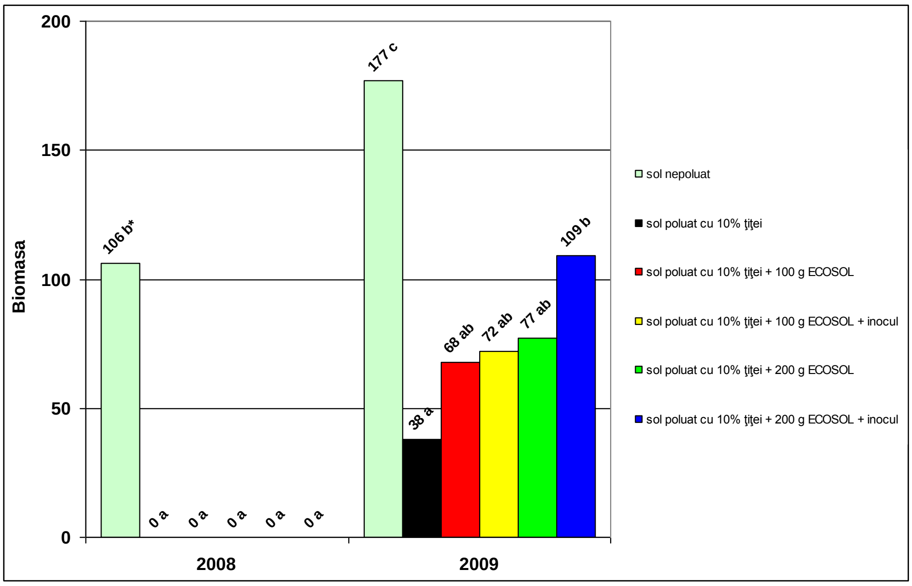

Figure 3. The evolution of plant biomass in soil polluted with 10% crude oil in different experimental variants – analysis of variance

CONCLUSIONS

The benefit effects of treatments applied were found in maize plants growth in the second experimental year, which could grow only in the variants polluted with 5% crude oil, the better option and inoculated with 0.5% (100 g/pot) Ecosol with selected bacteria.

In the first experimental year with plants, in polluted pots with excessive concentrations of 10% crude oil exercised very severe phytotoxic effect, preventing total germination.

In the second experimental year with plant, although late, maize plants have sprung up into pots polluted with crude oil at both concentrations, the difference in size between the enormous force and plants affected by crude oil pollution and growed on a clean soil being very visible.

Inoculation with selected bacteria of soil polluted in combination with conditioning the soil with 0.5% and 1% Ecosol has a benefic effect on plant vigor of maize. Obviously, the best growth and flourished maize plants in variants in which the two acted synergistically technological measures.

Biomass plants in bioremediation variants was significantly higher than that of plants in natural attenuation variants, and the experimental variants considered optimal in the soil was conditioned with higher Ecosol doses and inoculated with selected bacteria, plant biomass was significantly higher compared with other experimental variants bioremediation. The data were correlated clearly with the dynamics of soil pollutant disappearance.

BIBLIOGRAPHY

1. **Beegle D. B., Lingenfelter D. D.**, 1995 - *Soil Acidity and Aglime, College of Agricultural Sciences*, Cooperative Extension, Agronomy, Facts 3, The Pennsylvania State University.

2. **Gament Eugenia**, 2012, Steel Slag - *Amendment for Acidic Soils*, Annals of the University of Craiova, Agriculture, Montanology, Cadastre Series, vol. 42, No. 2/2012, ISSN CD-ROM 2066-950x.

3. **Treadwell W. D., Zurcher M.**, 1939, Helv. Chim. Acta, 22: 1371-80.

4. *** 1981, *Metodologie de analiza agrochimica a solurilor in vederea stabilirii necesarului de amendamente si ingrasaminte*, Vol. II, ICPA, No.13, Metode. Rapoarte. Indrumari. Bucuresti.

5. *** 1986, *Metode de Analiza Chimica a Solului*, Min. Agriculturii, ICPA Bucuresti.

6. *** 1987, *Metodologia Elaborarii Studiilor Pedologice*, Partea III, Indicatori Ecopedologici, ICPA, Bucuresti, Nr. 20C.

7. *** 1984, *Metode de analize agrochimice si control al calitatii amendamentelor calcaroase si a ingrasamintelor chimice produse industrial*, No. 19, Metode. Rapoarte. Indrumari., Bucuresti

8. *** 2003, *Romanian Soil Taxonomy System*, Ed. ESTFALIA, Bucuresti, ISBN 973-85841-7-5.