THE INFLUENCE OF MAIZE AND A NATURAL PRODUCT ON THE BIODEGRADATION OF OIL POLLUTED SOILS

Mariana MARINESCU, M. DUMITRU, Anca LĂCĂTUŞU, M. MARINESCU

National Research Development Institute for Soil Science, Agrochemistry and Environmental Protection, 61 Marasti Avenue, Bucharest, Romania
Corresponding author: Mariana Marinescu, e-mail:maramarinescu2003@yahoo.com

Abstract: *Soils are major support systems of human life and welfare. Pollution of soil is caused by the presence of contaminants or other alteration in the natural soil environment. There are many petroleum hydrocarbons polluted areas today due to incorrect use of oil products. The hydrocarbons biodegrading microorganisms occur in most environments where hydrocarbons may serve as organic carbon sources. Bioremediation is based on the use of microorganisms or microbial processes to degrade environmental pollutants, and offers several advantages over the conventional chemical and physical technologies as costs and negative impact on soil structure. This method can be a low cost effective and also an environmental friendly technology. Low biodegradability and bioavailability of the petroleum hydrocarbons may limit the biodegradation in polluted areas. Biodegradation is defined as the biologically catalyzed reduction in complexity of chemical compounds. During remediation the bioengineer can enhance the biodegradation by adjustment of optimal technological parameters. The aim of this study is to develop and test in a greenhouse experiment an improved technology for bioremediation of crude oil polluted soils. The soil artificial polluted with crude oil will be treated with a natural biodegradable product and bacterial inoculum. The plant used in the greenhouse experiment is maize. In this paper are presented the resulted obtained in the second experimental year regarding the following parameters regarding plants growth: the number of plant/pot, the height of plants, the number of leaves and the biomass. It will be shown the influence of crude oil on plant growth in a soil treated with a natural biodegradable product. Bioaugmentation is frequently used for the enhancement of the biodegradative capacities of polluted soils. According with the results obtained, this method will be used in field and the rehabilitation and reuse in agriculture of soil polluted with crude oil will be possible in a shortened time.*

Key words**:** *biodegradation, polluted soils, maize, a natural biodegradable product*

INTRODUCTION

There are many hydrocarbon-contaminated sites today due to incorrect use of oil products. The hydrocarbon-degrading microorganisms occur in most environments, where hydrocarbons may serve as organic carbon sources. Bioremediation, is based on the use of microorganisms or microbial processes to degrade environmental contaminants, and offers several advantages over the conventional chemical and physical technologies. It can be a cost effective, environmental friendly technology.

Crude oil is a complex mixture of hydrocarbons. It includes a saturate fraction, an aromatic fraction, asphaltenes, and resins (ATLAS, 1981). Due to this complexity, crude oil cannot be fully degraded by a single strain of microorganisms but its decomposition is achieved by microbial consortia and their broad enzymatic capacity (LEAHY AND COLWELL, 1990).

Moreover, low biodegradability and bioavailability of the contaminants may limit the biodegradation in a contaminated site. During remediation the bioengineer can enhance the biodegradation by adjustment of optimal technological parameters. The intensity of biodegradation is influenced by several environmental factors, such as quality, quantity and

activity of the indigenous microbial populations, levels of nutrients, aerobic conditions, pH, temperature, water content and other soil properties.

Phytoremediation of organics, like petroleum hydrocarbons, is applicable in case of non-phytotoxic contamination levels. Phytoremediation, the use of higher plants for decontamination of soil, water and sediments, is a cost-effective technique that, at the same time, is non-destructive and even has a rehabilitating effect on soil structure and ecology. (CUNNINGHAM et al., 1996).

Plants are designed to increase the activity of microorganisms in rhizosphere by optimizing the parameters of the environment, such as moisture, soil reaction. Further, roots growth involves the penetration of needed oxygen for contaminant/pollutant oxidation process (LIN AND MENDELSSOHN, 1998, JONER AND LEYVA, 2003).

Although hydrocarbons biodegradation around rhizosphere are known, still have not been clarified the mechanisms that influence the microorganisms growth and activity (WILTSE et al., 1998; HUTCHINSON et al., 2001).

Degradation processes occur around rhizosphere as a result of its effect, root exudates of organic compounds, which are increasing the density, diversity and activity of specific biodegrading microorganisms (CUNNNIGHAM et al., 1996; SICILIANO AND GERMIDA, 1998).

MATERIALS AND METHOD

The main objective of this research is testing the natural hydrocarbon absorbent named ECOSOL. To achieve data concerning the bioremediation of polluted soil with petroleum hydrocarbons was realized a greenhouse experiment. The soil used for this experiment was a cambic chernozems. This type of soil was chosen because of its currency in our country, also, for its physical, chemical and biological properties favorable to plant growth. The plant used in the experiment is maize.

The chemical characteristics of soil used in the experiment are:

- ✓ pH – 8.09;
- ✓ Organic carbon (%) – 2.99;
- ✓ Total nitrogen (%) – 0.279;
- ✓ C/N ratio – 12.5.
- ✓

The experimental variants are:

- ✓ V_1, control (unpolluted soil);
- ✓ V_2, polluted soil with 5% crude oil;
- ✓ V_3, polluted soil with 10% crude oil;
- ✓ V_4, polluted soil with 5% crude oil + 50 g ECOSOL;
- ✓ V_5, polluted soil with 5% crude oil + 50 g ECOSOL + bacterial inoculum;
- ✓ V_6, polluted soil with 5% crude oil + 100 g ECOSOL;
- ✓ V_7, polluted soil with 5% crude oil + 100 g ECOSOL + bacterial inoculum;
- ✓ V_8, polluted soil with 10% crude oil + 100 g ECOSOL;
- ✓ V_9, polluted soil with 10% crude oil + 100 g ECOSOL + bacterial inoculum;
- ✓ V_{10}, polluted soil with 10% crude oil + 200 g ECOSOL;
- ✓ V_{11}, polluted soil with 10% crude oil + 200 g ECOSOL + bacterial inoculum.

At the beginning of the experiment, the soil was contaminated/polluted with crude oil and conditioned with the natural hydrocarbon absorbent (ECOSOL). After 21 days from pollution, the soil was inoculated with bacteria. The bacterial inoculum was developed from microorganisms that occur naturally in the soil like *Pseudomonas*, *Mycobacterium*, *Arthrobacter globiformis* and *Bacillus megaterium*.

RESULTS AND DISCUSSION

The technology proposed for remediation has to be most appropriate to the natural processes and in the same time will become an available technology on market.

Sowing was done in April of the second experimental year, at 8-10 cm depth with a total of 5 seeds in each pot. The first seedlings have sprung in control, with a delay in pots with soil polluted with 5% crude oil and none in the pots with soil polluted 10% crude oil.

Until plants emergence, soil was kept clean by weeds and in an optimal state of moisture (approximately corresponding with water capacity in field).

Soil sampling (0-10 cm) for specific analysis was achieved every month until the end of experiments according to ICPA technology.

In figure 1-4 are presented the characteristcs of plants after 5 months from seedling, in the second experimental year of bioremediation and the first one when a plant was used in experiment.

The number of plant/pot, the height of plants, the number of leaves and the biomass are proportional with the treatment. As it can be observed the control presents values very high for all the parameters analysed, the pots with soil polluted with 5% crude oil have values lower then control and the pots with soil polluted with 10% crude oil have no value because the plants did not rise up.

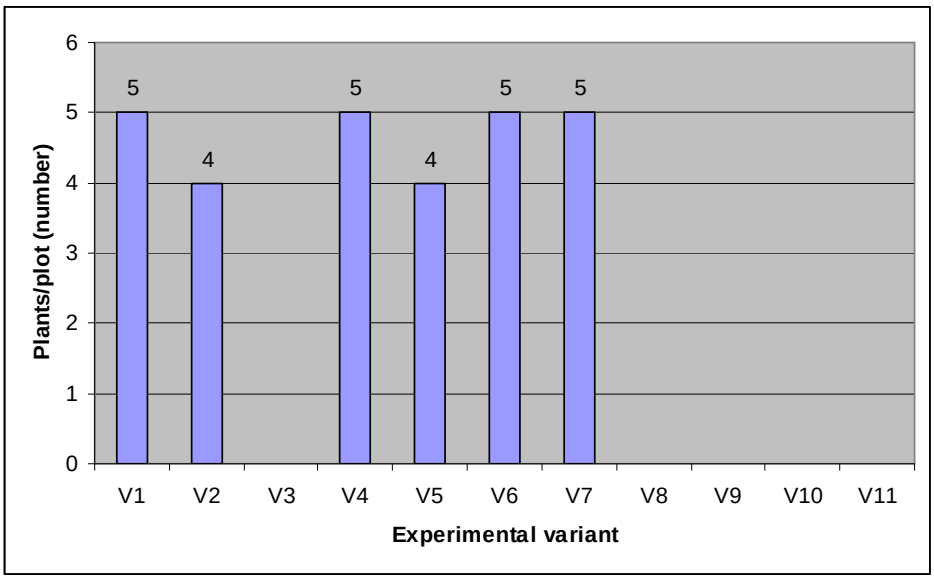

Figure 1 Evolution of plant/pot in all experimental variants (means of 3 repetitions) according with the applied treatment

From treatment point of view, can be analyzed all the parameters for the soil polluted with 5% crude oil. The number of plant/pot, the height of plants, the number of leaves and the biomass are increasing with the treatments applied.

Financial cost of this type of remediation is estimated through consultations among all partners involved in various stages of remediation chain.

The costs of monitoring and control stages of remediation are taken into account not only the intrinsic costs of remediation. It takes into account also the costs necessary to achieve the final balance of remediation.

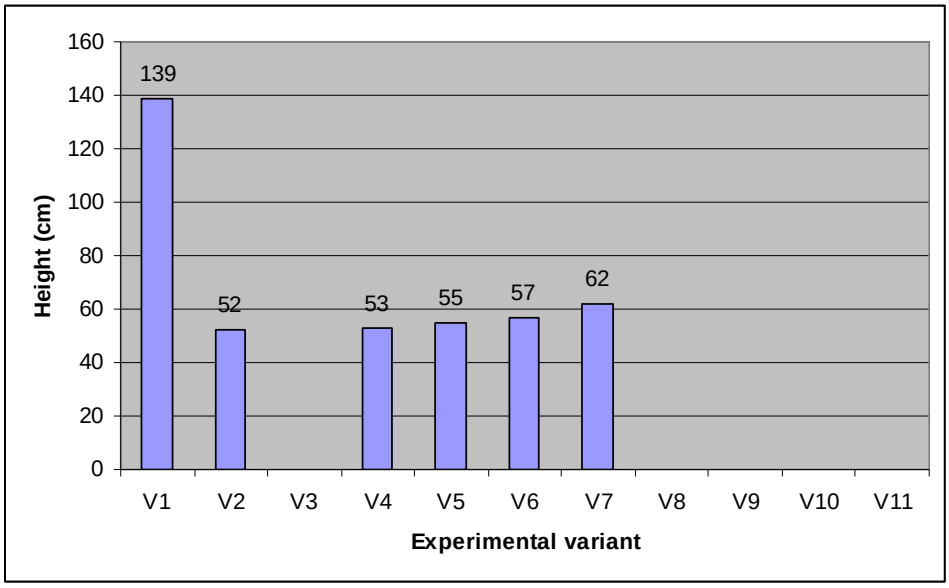

Figure 2 Evolution of plants height in all experimental variants (means of 3 repetitions) according with the applied treatment

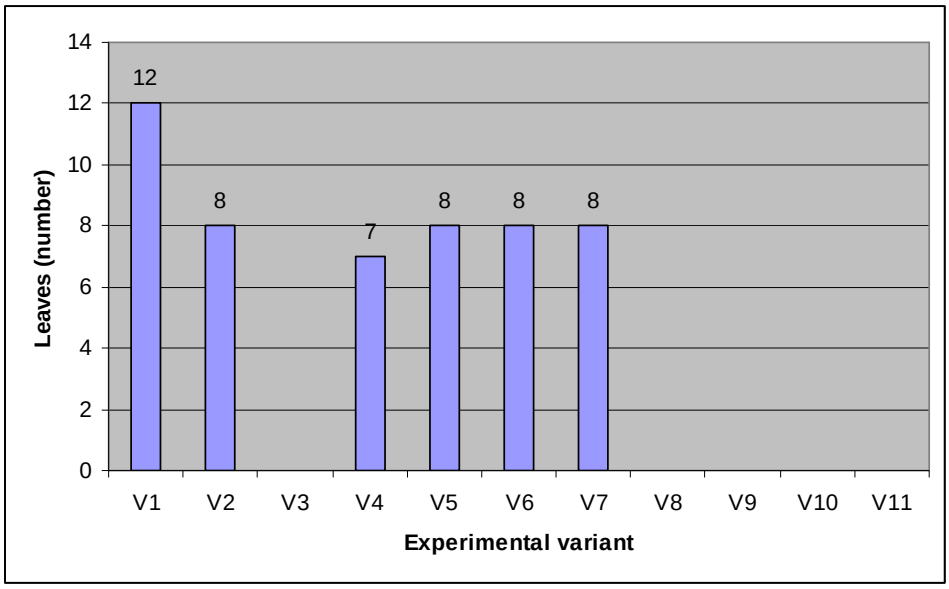

Figure 3 Evolution of plants leaves in all experimental variants (means of 3 repetitions) according with the applied treatment

It must be noted that estimates costs with adequate technology is difficult, because few cases can be determined with precision of remediation efficiency and time required to

achieve the objectives initially set. So it is preferable to a cost estimate for a certain period of time (weeks, months, quarters, etc.) Or mass per unit volume or area of environmental treaty.

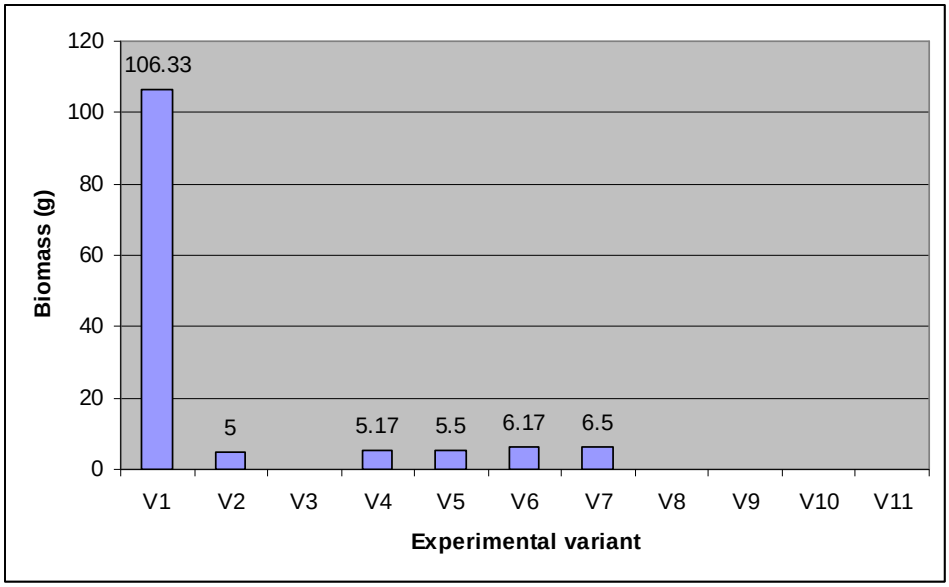

Figure 4 Evolution of plants biomass in all experimental variants (means of 3 repetitions) according with the applied treatment

There are two key elements that determine the size of the remediation costs for remediation method chosen from a technical standpoint: the required pollutant concentration at the end stage of the remediation work and diagnostic accuracy of pollution.

The cost of remediation evolving demands increase exponentially as the degree of pollution. Moreover, it was found that the incidence degree of accuracy and diagnostic phase is considerable detail on the cost of remediation. A significant reduction in total cost and the rehabilitation costs can be achieved by a relatively moderate increase in the cost of diagnosis. An investigation with high precision, it will be sufficient expenditure required to offset much lower cost of rehabilitation.

CONCLUSIONS

The experimental study leads to the following preliminary conclusions:

✓ In the pots were the soil was polluted with 5% the plants rise up with delay, the plant are at least two times lower than control, and differences between treatments can be observed after an experimental year.

✓ In all the pots where the soil was polluted with 10% crude oil, the plants haven't rise up even the treatment was applied.

✓ The number of plant/pot, the height of plants, the number of leaves and the biomas are proportional with the treatment. For all the parameters analysed the control presents values very high, the pots with soil polluted with 5% crude oil have values lower then control, proportionaly with the treatment apllied and the pots with soil polluted with 10% crude oil have no value because the plants did not rise up.

The experimental research will continue in Green House on the same polluted soil with plant cultivation to follow the growth and behaviour in function with total petroleum hydrocarbons concentrations, the treatment with ECOSOL and bacterial inoculum.

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