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EVOLUTION OF MAIZE BIOMASS IN A CRUDE OIL POLLUTED SOIL ACCORDING TO THE TREATMENT APPLIED

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Abstract

There are many hydrocarbon-contaminated sites today due to the 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. The aim of this study is to develop and test artificially an improved technology for bioremediation of crude oil polluted soils. The soil artificially polluted with crude oil will be treated with a natural biodegradable product and bacterial inoculum. The plant used in the greenhouse experiment is maize. The paper presents the resulted obtained in two experimental years regarding the following parameters of plants growth: the number of plants/pot, the plant height, the leaves number and the biomass. It will be shown the influence of crude oil on plant growth in a soil treated with a natural biodegradable product. According with the results obtained, this method could be used in field for rehabilitation and reuse in agriculture of polluted soils with crude oil.

INTRODUCTION

The most important classes of organic pollutants in the environment are mineral oil constituents and halogenated products of petrochemicals. Therefore, the capacities of aerobic microorganisms are of particular relevance for the biodegradation of such compounds and very good described with reference to the degradation of aliphatic and aromatic hydrocarbons [5].

Moreover, low biodegradability and bioavailability of the contaminants may limit the biodegradation in a contaminated site. During remediation 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 [5].

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 [1].

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 [3, 4]. Although hydrocarbons biodegradation around rhizosphere are known, still have not been clarified the mechanisms that influence the microorganisms growth and activity [2, 6].

MATERIAL AND METHODS

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.

The experimental variants were:

- ✓ 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 + 1 kg ECOSOL/m^2 polluted soil;
- ✓ V_5, polluted soil with 5% crude oil + 1 kg ECOSOL/m^2 polluted soil + bacterial inoculum;
- ✓ V_6, polluted soil with 5% crude oil + 2 kg ECOSOL/m^2 polluted soil;
- ✓ V_7, polluted soil with 5% crude oil + 2 kg ECOSOL/m^2 polluted soil + bacterial inoculum;
- ✓ V_8, polluted soil with 10% crude oil + 2 kg ECOSOL/m^2 polluted soil;
- ✓ V_9, polluted soil with 10% crude oil + 2 kg ECOSOL/m^2 polluted soil + bacterial inoculum;
- ✓ V_{10}, polluted soil with 10% crude oil + 4 kg ECOSOL/m^2 polluted soil;
- ✓ V_{11}, polluted soil with 10% crude oil + 4 kg ECOSOL/m^2 polluted soil + bacterial inoculum.

Sowing was done in April in every experimental year, at 8-10 cm depth with a total of 5 seeds in each pot. In the first experimental year with plant, 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, because of the pollution

degree. In the second experimental year with plant, the first seedlings have sprung in control, with a delay in pots with soil polluted with 5% crude oil and 10% crude oil.

During 5 month of experiment in every year, soil was kept clean by weeds and in an optimal state of moisture (approximately corresponding with water capacity in field).

RESULTS AND DISCUSSION

Tables 1 and 2 present the characteristcs of plants 5 months after seedling, in the first and second experimental years with plant.

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

In the second experimental year with plant, in the pots were the soil was polluted with 5% and 10% crude oil the plants rise up with delay, the differences between the treatments can be observed compared with the first experimental year with plant.

The number of plant/pot, the height of plants, the number of leaves and the biomass are increasing with the applied treatments.

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.

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.

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.

Table 1

Evolution of plants in experimental variants according to applied treatment in the first year with plant

No.	Experimental variant	Plants/plot (number)	Height (cm)	Leaves (number)	Biomass (g)
1	V_1, control (unpolluted soil)	5	139	12	106.33
2	V_2, polluted soil with 5% crude oil	4	62	8	5.83
3	V_3, polluted soil with 10% crude oil	-	-	-	-
4	V_4, polluted soil with 5% crude oil + 1 kg ECOSOL/m^2 polluted soil	5	43	7	5.17
5	V_5, polluted soil with 5% crude oil + 1 kg ECOSOL/m^2 polluted soil + bacterial inoculum	4	38	8	5.17
6	V_6, polluted soil with 5% crude oil + 2 kg ECOSOL/m^2 polluted soil	5	62	8	6.67
7	V_7, polluted soil with 5% crude oil + 2 kg ECOSOL/m^2 polluted soil + bacterial inoculum	5	55	8	6.50
8	V_8, polluted soil with 10% crude oil + 1 kg ECOSOL/m^2 polluted soil	-	-	-	-
9	V_9, polluted soil with 10% crude oil + 1 kg ECOSOL/m^2 polluted soil + bacterial inoculum	-	-	-	-
10	V_{10}, polluted soil with 10% crude oil + 4 kg ECOSOL/m^2 polluted soil	-	-	-	-
11	V_{11}, polluted soil with 10% crude oil + 4 kg ECOSOL/m^2 polluted soil + bacterial inoculum	-	-	-	-

Table 2

Evolution of plants in experimental variants according to applied treatment in the second year with plant

No.	Experimental variant	Plants/plot (number)	Height (cm)	Leaves (number)	Biomass (g)
1	V_1, control (unpolluted soil)	5	122	14	177.35
2	V_2, polluted soil with 5% crude oil	5	56	8	28.76
3	V_3, polluted soil with 10% crude oil	5	80	9	77.19
4	V_4, polluted soil with 5% crude oil + 1 kg ECOSOL/m^2 polluted soil	5	66	8	45.57
5	V_5, polluted soil with 5% crude oil + 1 kg ECOSOL/m^2 polluted soil + bacterial inoculum	5	89	9	68.76
6	V_6, polluted soil with 5% crude oil + 2 kg ECOSOL/m^2 polluted soil	5	83	8	64.22
7	V_7, polluted soil with 5% crude oil + 2 kg ECOSOL/m^2 polluted soil + bacterial inoculum	5	114	9	109.09
8	V_8, polluted soil with 10% crude oil + 1 kg ECOSOL/m^2 polluted soil	5	83	8	62.23
9	V_9, polluted soil with 10% crude oil + 1 kg ECOSOL/m^2 polluted soil + bacterial inoculum	5	88	8	109.13
10	V_{10}, polluted soil with 10% crude oil + 4 kg ECOSOL/m^2 polluted soil	5	79	8	71.50
11	V_{11}, polluted soil with 10% crude oil + 4 kg ECOSOL/m^2 polluted soil + bacterial inoculum	5	87	8	67.81

CONCLUSIONS

1. In the first experimental year, in the pots where the soil was polluted with 5% crude oil 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.
2. In the second experimental year, in the pots were the soil was polluted with 5% and 10% crude oil the plants rise up with delay, the differences between the treatments can be observed compared with the first experimental year with plant.
3. 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 applied and the pots with soil polluted with 10% crude oil have no value because the plants did not rise up.

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