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Results of tests on recultivation of hydrophobic light-gray forest soil contaminated with oil using liquid high-analysis organic fertilizer "BIOPLANT FLORA"

Rehabilitation of biological reproductivety of disturbed ecosystems is currently one of the critical tasks of inexhaustible environmental management. The most acute problem in this field is oil industry, causing various kinds of soil degradation – mechanical damage to soil profile integrity and structure of soil cover, contamination with various pollutants, that eventually results in decrease of biological productivity and harm to general environmental situation in the landscapes.

Since at this stage of oil industry development it is impossible to exclude its general effect on the environment, there is a necessity to develop methods and technologies on restoration of contaminated soils. Due to variety of edaphic-climatic conditions, physico-chemical properties of pollutants and recultivation measures costs, finding optimal and adaptable methods is rather urgent.

Recently biological method of contaminated soils recultivation became widespread. The method is based on application of various biopreparations containing microorganisms - oil destructors and biostimulants of native hydrocarbon-oxidizing microflora. (Kireyeva and others, 2001; Salanginas, 2003; Suleymanov and others, 2005).

The provided investigation results normally demonstrate that biological method application promote intensification of commercial (dehydrated and desalted) oil biodegradation on the relatively "fresh" contaminations in the conditions of model and microfield experiments. However, in case of recultivation of soils which have been long-contaminated with crude (high in magne-salt content) oil in situ of accidental spillages, various secondary pollution zones are likely to appear.

For example, previous research has demonstrated that in case of recultivation of light-gray forest soil with 30 years long contamination the content of oil products has decreased to sanitary limitations. However, concurrently with rapid destruction of oil, release of water-soluble salts (chloride sodium type) has been observed, that contributed to resalinization and alkalization of soils. Complex evaluation of recultivated soil condition has demonstrated that no effective restoration of soil fertility has occurred due to reservation and even intensification of unfavorable physico-chemical properties through time. (Gabbasova and others, 2002).

High water stability of agronomically valuable aggregates is also remarkable, since their water stability coefficient in the topsoil of the entire recultivated lot ranged from 0,8 to 0,8 and in some cases reached 1,0. It is known that some petroleum cuts (asphaltenes, naphtenic acids) form hydrophobic complexes entering into combination with various ions. (Chemistry …, 1994). Analysis of qualitative composition of residue bituminous substances in the light-gray forest soil has demonstrated predomination of heavy residues (resins, asphaltenes), which appealingly react with cations of soil-absorbing complex of soil and become irreversibly sorbed by organo-mineral colloids contributing to hydrophobization. Since hydrocarbon-oxidizing microorganisms affect mostly in water and are active only in the water and hydrocarbons contact zone (Киреева и др., 2001), the hydrophobic units have reduced the contacting surface area and, accordingly, appeared to be hard for microbiological destruction.

Monitoring has been conducted with view of further investigation of soil processes development at on the given plot. Ten years after complex investigation no visible changes have occurred. Same as before, the contaminated and recultivated plot could be outlined by complete absence of cultivated crop seeding (grain). The topsoil also remained structureless and diffused (by type of ash), hydrophobic properties persisted.

Further investigations have been conducted under the conditions of model experiment on soil samples gathered from plowing horizon of recultivated hydrophobic light-gray forest soil. Obviously measures aimed on reduction of hydrophobia are of critical importance.

At the present day the application of humic acids and humic acid-based preparations as fertility increasing agents for barren soils and for better effectiveness of nitrogen and phosphorous fertilizers, as well as for activation of growth processes in plants and microorganisms activity and soil biota is extended globally.

Preparations of this class bring along the acceleration of growth processes, as well as improving of plant’s stability against negative physical (heat, cold), chemical (salting, heavy metals, radionuclide) and biological (fungal, bacterial and viral diseases) effects. They are also successfully applied in the field of recultivation of soils contaminated with oil – as detoxifiers of oil products and stimulants of their biodegradation processes.

Liquid high analysis fertilizer “BIOPLANT FLORA” has been used for the experiment. After processing of soil (ample irrigation) it’s hydrophobic values have significantly reduced as a result of hydrophilic substances ability to cover hydrophobic units in the water systems, that is called “protective colloidal action” in biology (Уильямс В., Уильямс Х., 1976).

Evaluation of soils hydrophobia – hydrophilia has been carried out by putting the soil lot into tank with water and sedimentation for thirty minutes, with further drying and weighing of soil particles which gravitated to bottom or remained on water surface. Dispersion analysis has demonstrated significant difference of average (at $p < 0,05$) between the amount of settled particles ($t = 62,09$; $p = 0$) and those particles that remained on surface ($t = -45,00$; $p = 0$) soil samples gathered from plowing horizons of background non-contaminated soil (profile pit 14) and hydrophobic soil. It has also demonstrated absence of significant difference between exponents of background soil and hydrophobic soil that has been processed by organic fertilizer “BIOPLANT FLORA” for the settled particles ($t = -1,12$; $p = 0,29$) and those particles remaining on surface ($t = 1,43$; $p = 0,19$).

One of the criteria for the degree of soil rehabilitation is it’s biological productivity. Effectiveness of recultivation measures during the model experiment is estimated by seeding seeds of spring wheat “Saratovskaya 55”. As seen from the received data, germinating ability of seeds on recultivated soil has been 10% lower than on the background one, rootlet has been 44% shorter and 26% lighter (average data), yet, upon condition of absence of sprouts on hydrophobic soil, this result may be considered positive. (table 1; picture 1).

Thusly, recultivation measures, including processing of hydrophobic soil contaminated with oil with liquid high-analysis organic fertilizer “BIOPLANT FLORA” resulted in increase of it’s hydrophilia and rehabilitation of biologically productive function.

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Annexes

Picture 1. Germinating ability of seeds and morphological properties of “Saratovskaya 55” wheat (1 – non-contaminated background soil; 2- hydrophobic soil; hydrophobic soil processed with “BIOPLANT FLORA”)

Table 1. Statistical data of morphological properties “Saratovskaya 55” wheat sprouts

Wheat Morphological Properties	Soil	N	Mean	Min	Max	Variance	Std.Dev	Standard Error
Sprout Length	Non-contaminated background soil	49	4,361	1,0	7,0	2,907	1,705	0,243
	Hydrophobic Soil	50	0	0	0	0	0	0
	Hydrophobic soil processed with “BIOPLANT FLORA	43	2,895	0,6	5,4	1,657	1,287	0,196
Sprout Weight	Non-contaminated background soil	49	0,034	0,005	0,058	0,00019	0,014	0,002
	Hydrophobic Soil	50	0	0	0	0	0	0
	Hydrophobic soil processed with “BIOPLANT FLORA	43	0,025	0,004	0,043	0,00015	0,012	0,002

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