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Environmental rehabilitation of mining dumps

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Abstract

Mining exploitations, especially the surface ones, severely degrade the environment by removing large areas from agricultural and forestry use, micromorphological changes, hydrogeological and hydrographic changes, air, water and soil pollution, flora and fauna losses, microclimate changes, historical and archaeological sites damages, displacements of settlements and transport routes. Results obtained following the agrochemical experiments show that increasing the doses of fertilizers had positive effect on yields of all the tested crops.

This paper presents several experimental fertilizers: four liquid fertilizers associating humic substances extracted from lignite with a complex matrix containing macronutrients (nitrogen, phosphorus, and potassium) and trace elements (copper, zinc, iron, manganous, boron); two types of organo-mineral fertilizers with macronutrients on a lignite carrier; two types of organic fertilizers (containing cattle manure or compost obtained from cattle manure, lignite powder and potassium humates). These experimental fertilizers were tested - alone or associated with mineral fertilizers - on maize, sunflower and peas crops.

In all three experimental years, and for all three crops, the best yields were obtained for the variants fertilized with 40 t/ha compost + $N_{100}P_{80}K_{80}$. Thus, a 364% average yield increases were recorded for maize, 310% for sunflower and 156% for peas crop, compared to the control plot (unfertilized). For maize crop, the following yield increases have been recorded, comparing to the control plot: 165% for mineral fertilization ($N_{100}P_{80}K_80$); 253% for the variant with 40 t/ha cattle manure; 277% for the variant with 40 t/ha cattle manure + $N_{100}P_{80}K_{80}$; while the variant with 40 t/ha compost led to a 256% yield increase. Regarding the variants with organo-mineral fertilizers, yield increases between 196% and 229% were obtained, as compared to the control plot. Liquid fertilizers with humic substances extracted from lignite highlighted very significant yield increases (135-158%). Similar observations were recorded for sunflower and peas crops.

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Keywords: recultivation; sterile dump; mineral and organic fertilizers; liquid fertilizers; humic substances.

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1. Introduction

In the mining areas in Oltenia (Dolj, Gorj, Valcea, Mehedinti) 18443 ha were withdrawn from economic cycle, of which 13680 ha of agricultural land and 4763 hectares forest land, and by the end of the exploitation works will affect 26476 ha, of which 15490 ha agricultural lands and 10982 ha forest land (Cărăbiş, 2013).

The mining industry seriously affects the environment through: degradation of large areas of farmland and forestry lands, geomorphological changes, hydrogeological and hydrographical changes, water and air pollution, losses of flora and fauna, microclimate changes, dislocations of human settlements and communication routes, losses of historical and archaeological sites; impairment of social inhabitants (Munteanu, 1998; Ianc, 1999; Akala and Lal, 1999; Dumitru et al., 1999; Daniels et al., 1999; Corici, 2006; Pascovici, 2006, Dinucă and Târziu, 2015).

Serious environmental effects have imposed the development of research to combat these effects, for the rehabilitation of the affected areas.

Large affected areas led to the development of technologies for re-cultivation. Re-cultivation process comprises two distinct phases:

- Mining recultivation stage, to be carried out by the company which produced degradation. At this stage the following activites are done: selection operation, dumps selective arrangement, erosion prevention measures, levelment, creating access roads, etc.
- Biological recultivation stage, which is designed to increase fertility for dump materials, including amelioration measures, as well as specific crop technologies for dumps.

Re-cultivation has its own specific character for each area to be drawn into the economic circuit. The most important directions for the enhancement of degraded lands are as follows:

- Agricultural re-cultivation, which aims to cultivate these dumps with grain crops, fruit trees, vineyards, pastures and meadows, etc.
- Forestry re-cultivation, i.e. the establishment of forests with commercial or protection role, in order to restore the soil, biodiversity, hydrological regime, aesthetic and recreational function, climate, for fixing CO_2, oxygen production, water quality improvement, retaining pollutants, etc.;
- Sanitary-hygienic re-cultivation purposes, i.e. recreational areas, parks, grassing for environment protection, golf sport fields, tourist areas, etc.
- Build lakes with different purposes: reservoirs, lakes fisheries, lakes with regulatory role for hydrological regime, sport areas, etc.
- Re-cultivation in order to improve habitat for wildlife, enhancing the conditions for hunting and fishing, restoring biodiversity, etc.
- Arrangement of industrial sites and housing, etc.

Choosing the crops structure and fertilization system is of great importance in the efficiency of ecological rehabilitation of degraded lands by opencast mining, looking for to obtain agricultural yields similar to those achieved on neighbouring un-degraded lands in similar conditions of economic efficiency (Dumitru et al., 1999; Bendfeldt et al., 1999; Daniels et al., 1995; Tatomir et al., 2010; Mocanu et al., 2007; Dumitru et al., 2008; Călinoiu, 2013; Băbeanu, 1998; Becheriţiu, 2003; Blaga, 1981; Eger et al., 1999; Braia, 2004; Călinoiu, 1999; Cătinaş, 2012, Clapa, 2003, Craioveanu et al, 2002; Chisăliţă, 2001; Călin, 2012; Dinucă, 2015; Ianc, 1999; Munteanu, 1998; Negrea, 2007; Oprea, 2010; Pascovici, 2006; Popa, 2007; Roşculete, 2005).

The main features of materials from dumps which affects the production are as following: excessive texture (too sandy or too clayey), the excessive skeletal content, low content of humus, low contents of nitrogen, phosphorus, potassium, micronutrients, poor aero-hydric regime, reduced biological activity.

The presence of coal residues leads to better conditions for re-cultivation dumps. Charcoal from dumps consists of two parts: one part that can not be mineralized or is very slow mineralized, represented by derivatives of lignin and aromatic nucleus with a high degree of polymerization and from a mineralized part, represented by humic substances which, by microbial decomposition, can provide nitrogen for plants and soil microorganisms (Becherescu et al., 2008). The values of organic carbon content obtained by analysis from soil humus and that from coal are often misaddressed, despite they are different used by plants. Therefore, even dumps have high levels of organic carbon, they often have a low potential for crop production and require large doses of organic, organo-mineral or mineral fertilizers to achieve reasonable yields. The low level of nutrients in soluble form in the substrate