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Evolution of plant colonization in acid and alkaline mine tailing ponds after amendments and microorganisms application

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Intense mining activities in the past were carried out in Cartagena-La Unión mining district, SE Spain, and caused excessive accumulation of toxic metals in tailing ponds which poses a high environmental and ecological risk. One of the remediation options gaining considerable interest in recent years is the in situ immobilization of metals. A corresponding reduction in the plant-available metal fraction allows re-vegetation and ecosystem restoration of the heavily contaminated sites. In addition, the use of microorganisms to improve the soil condition is a new tool used to increase spontaneous plant colonization. The aim of this research was to assess the effect of amendments (pig manure, sewage sludge, and lime) and microorganisms on plant cover establishment, as a consequence of metal immobilization and the improvement of soil properties.

The study was carried out in two mine ponds (acid and alkaline). Twenty seven square field plots, each one consisting of 4 m2, were located in each pond. Four different doses of microorganism (0 ml, 20 ml, 100 ml and 200 ml of microorganism solution in each plot) and one dose of pig manure (5 kg per plot), sewage sludge (4 kg per plot) and lime (22 kg per plot) were used. Organic amendment doses were calculated according to European nitrogen legislations, and lime dose was calculated according with the potential acid production through total sulphur oxidation. Three replicates of each treatment (organic amendment + lime + microorganism dose 0, 1, 2, or 3) and control soil (with no amendments) were carried out. Plots were left to the semi-arid climate conditions after the addition of amendments to simulate real potential applications of the results. Identification of plant species and biodiversity was determined on each plot, after 2, 4, 6 and 8 months of amendment addition.

The results showed that, in those plots without application of microorganism, 8 months after applications the number of species and individuals of each species that were be able to colonize sewage sludge amended plots (Acid tailing pond: Piptaterum mileaceum(2) and Fagonia Cretica(1); and alkaline tailing pond: Zygophylum fabago(14)) were less than those found in pig manure amended plots (Acid tailing pond: Piptaterum mileaceum(11), Sonchus tenerrimus(4) Dittrichia viscosa(2) and Fagonia cretica(2); and alkaline tailing pond: Zygophylum fabago(31) and Piptaterum mileaceum(9)). Higher number of species and individuals of plant found in pig manure–amended plots compared to sludge could be related to the highest contents of seeds of pig manure and a higher and easier release of nutrients under Mediterranean climate. In relation to the effect of the microorganism's doses in spontaneous plants colonization, there is an increase in the number of species and individuals when the dose of microorganism was increased for both organic amendments, especially in pig manure amendment plots. Eight months after amendments application and in plots with dose 3 of microorganism, a maximum of 4 species (Sonchus tenerremus(2), Malva silvestris(2), Piptaterum mileaceum(7), and Dittrichia viscose(1)) and 2 species (Zygophylum fabago(4) and Piptaterum mileaceum(1)) in the plots amended with sewage sludge were found in acid and alkaline ponds respectively; and 7 species (Sonchus tenerrimus(3), Malva silvestres(1), Piptaterum mileaceum(23), Dittrichia viscosa(4), Fagonia cretica(8), Polypogon monspeliensis(1) and Diplotaxis lagascana(1)) and 5 species (Zygophylum fabago(80), Malva silvestres(4), Piptaterum mileaceum(19), Diplotaxis Lagascana(1) and Sonchus tenerrimus(1)) in the plots amended with pig manure in acid and alkaline ponds respectively.

Key words: amendment, microorganism, tailing ponds, plant colonization