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Integrated management of organic wastes for remediation of massive tailings storage facilities under semiarid mediterranean climate type: efficacy of organic pork residues as study case

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Remediation of large surface areas of massive mine wastes, such as tailings storage facilities (TSFs) is challenging, particularly when no topsoils have been stored for the mine closure stage. Worldwide, it has been demonstrated that the use of organic wastes as substrate amendments for remediation of hard rock mine wastes is a useful alternative to topsoils material. In the case of semi-arid climate conditions of north-central Chile, the copper mining industry has generated massive TSF (between 400 ha and 3,000 ha) which needs now to be properly closed according to recently established mine closure regulations. However, in most of the cases, there have been no topsoils savage that facilitate the initial stage of the site remediation. Industrial organic wastes (i.e. biosolids) are found in the area, but their availability is normally below the demand needed for remediation of TSFs and salt content is normally elevated, thus posing salinization risks to the substrate and negative plant growth. We focused on a large organic waste producing industry, the pork industry, whose growth has been restricted due to the limited possibilities for using pig slurries as amendments for croplands in north-central Chile and the strong odor generated, resulting in conflicts with local communities.
Incorporation of pig slurries as amendments to post-operative TSFs has been scarcely evaluated at international level (i.e. Spain) and no evaluation at all exists for the solid organic fraction generated from pig slurry treatment plants (PSTP). In the present study, we evaluated the efficacy of both pig slurries (PS) and the solid fraction of PSTP (SF-PSTP) as tailings amendment for creating good plant productivity on TSFs located under semi-arid Mediterranean climate conditions in north-central Chile. A short-term greenhouse study was developed. Copper mine tailings were mixed either with PS (0, 40, 80, and 120 m3 ha-1) or SF-PSTP (0, 25, 50 and 75 t ha-1), distributed in 3 L pots, and seeded with Lolium perenne. Experimental pots were kept under controlled conditions and irrigated up to 70% field water capacity for 42 days. After this period, chemical characteristics of the substrate and productive plant variables were determined and contrasted.
Results showed that both pig wastes evaluated had significant (positive) and dose-dependent effects on plant productivity (both aerial and root biomass), but an increase in copper and zinc contents in aerial tissues occurred. Metal increments in aerial plant tissues were, however, below plant toxicity thresholds and represent no risk for cattle consumption. Application of any pork waste to mine tailings increased organic matter and macronutrient contents, besides raising pH. No substrate salinization was detected under the evaluated doses. These promising results show that organic pork residues are useful amendments for remediation of TSFs in north-central Chile. Furthermore, a twofold solution for environmental problems generated by two very relevant industrial sectors of the country is thus possible. Further studies are, however needed.
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