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Abstract

Ceramic Granules with Plant Biostimulant Effects Based on Silicon-Rich Biomaterials †

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Bentonite-based porous ceramics act as a slow release of adsorbed phosphate for plant growth [1]. Diatomaceous earth (DE) acts as a horticultural biostimulant with controlled release of soluble silicon [2], reduces the saline stress on plants, and restores land contaminated with salt [3]. In this study, various granules based on bentonite mixed with clay or DE enriched in biosilica extracted from reed were developed. Preliminary biotests for some of these formulations on tomato and pepper under greenhouse conditions were performed. Several types of granules were prepared: porous ceramic granules of bentonite (B) mixed with local (Bodoc) clay (A) moistened by spraying water and formulations such as bentonite, DE, and biosilica extracted from Giant Reed (*Arundo donax* L.). The granulation was carried out in a rotary granulator, up to the desired size of approximately 10 mm, at room temperature and then sintered at 960 °C. The density and absorption capacity of the granules were determined. Reed desilicification was carried out using an adapted microwave extraction method [4] with a laboratory microwave oven, at different times and powers. The extracted liquid was analyzed using Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES). The porous granules and the materials were characterized using Scanning Electron Microscopy-Energy Dispersive Spectroscopy (SEM-EDS), X-ray Diffraction (XRD) and Attenuated Total Reflectance-Fourier Transform Infrared Spectroscopy (ATR-FTIR). The biotests were performed on tomato and pepper under greenhouse conditions. The density of granules was 0.9 and 0.63 g/cm^3 and the absorption capacity was 60.04 and 71.77% for BA50 (B:A, 50:50 w/w) and BA60 (B:A, 60:40 w/w), respectively. The ATR-FTIR data of the granules BA50 and BA60 revealed some changes in the vibrational bands, such as relative intensities and shifts, compared to the raw materials (B, A). This indicated changes within and interactions between the raw materials. The calculated crystallinity indices (Cis) by area were between 60% and 94%, as determined by the XRD analysis, and the mineral composition of the granules was confirmed. The SEM images confirmed the porous characteristics of the granules and the EDS analysis identified Si and O as the main elements, but it also detected Al, Fe, and K. The extracted silicon content from reed was 0.135% (w/w), as found from the substrate

mass, and other elements such as Ca, Mg, P, Na, and K were also detected in significant amounts in the extracted sample. A statistically significant positive effect of the treatments with some of the ceramic granules on stomatal resistance was observed for both tomato and pepper crops. A series of ceramic granules based on silicon-rich materials were designed and successfully prepared. The XRD and ATR-FTIR results revealed changes due to the collapse of the primary materials and the structural rearrangement of the new materials. Preliminary biotests with some of the granules indicated promising results for the use of these ceramic granules in agriculture, including as biostimulants for plants. The other types of ceramic granules enriched in biosilica content are being tested.

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