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Controlled release glass fertilizer based on phosphosilicate as a promising alternative to traditional fertilizers

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Glass fertilizers (GF) emerge as an alternative to traditional fertilizers, due to their advantages, such as the possibility of incorporating several nutrients into their structure and the ability to control their dissolution through compositional adjustments. By varying the concentrations of glass-forming agents, such as P_2O_5 and SiO_2, materials with controlled dissolution can be obtained [1-2]. In this work, glassy fertilizers were developed based on the P_2O_5-SiO_2-CaO-K_2O compositional system, to obtain a controlled release of available nutrients from the matrix. The GFs were synthesized by the traditional melt-quenching method and characterized by Raman, FTIR, DSC, SEM-EDS and ^{31}P NMR. From the characterization data, it was observed that the increase in SiO_2 in the glassy network "depolymerizes" the main phosphate network. The dissolution was conducted in vitro in two solvents: deionized water and citric acid/sodium citrate buffer solution, pH 4.7. It was observed that the components contained in the glass are released gradually and in a controlled manner throughout the experiment (measured by ICP-OES), and this release depends on the compositional system. After the dissolution tests, the GF was analyzed, and changes in the structure of the exposed grains were noted, indicating that Qn units with increasingly smaller n values remain in the matrix, suggesting the release of [PO_4] and [SiO_4] units from the glass network (Raman, FTIR and ^{31}P NMR). The application of GF in situ in a test forage plant revealed that the compositions produced have a positive impact on the dry mass production of the plant when compared to the control group. Thus, this work demonstrates the obtaining of materials with different properties and the potential to minimize the impacts caused by conventional fertilizers, considering their capacity for compositional modulation and controlled release, opening new opportunities in the development of materials for agriculture.

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References
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