Optimization of Nutrients Release Parameters in Synthesized Hydrogel Minerals Anchored Material for Growth of Selected Plants in Embu County, Kenya

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ABSTRACT

Soil is the natural basis for plants growth as it not only provides support, water and minerals, but also helps to aerate the roots for proper development. However, due to the ever-growing population, available land is becoming a challenge. Urbanization also leads to insufficient surface for food production, as the arable land is used for settlement. This has further been exacerbated by erratic climatic conditions. Due to such limitations, this has compelled other options to be considered. Such options are growing of plants in soilless media that include hydroponic crop production and growing plants in sand, gravel or other liquids where the requisite nutrients are added. These methods allow a more efficient use of water and fertilizers, as well as better control of climate and pest factors. Despite the success in hydroponic production, there are challenges in that there is need for air circulation in the nutrient rich solution, plant support mechanism and disposal of the high concentrated nutrient solution into the environment after use putting a stress to the already stressed natural resource. Due to such limitations, there is a need therefore to come up with a method that will address such challenges. However, growth and propagation of plants for food crop can be made possible in soilless media if suitable conditions are provided. The objective of the study was to synthesize a solid phase nutrient anchored substrate material for growth of selected plants watered by hydrogels of bio origin. The substrate material was synthesized and then characterized using Fourier Transform Infra-Red (FTIR) and Nuclear Magnetic Resonance (NMR) to confirm the modification. Suitable minerals were then anchored by complexation in the substrate material and this was confirmed by X-ray Photoelectronic Spectroscopy (XPS). The release parameter and concentrations of the minerals was investigated using Differential Pulse Anodic Stripping Voltammetry (DPASV) and Flame Atomic Absorption Spectroscopy (FAAS) respectively. The substrate material was watered using hydrogels synthesized by modification of biomass. The modified biomaterials were characterized using Thermo Gravimetric Analysis (TGA), UV –Vis and FTIR spectroscopy. It was observed that mineral released increased with decrease in pH and at a pH value of 5.5, 90% of the nutrients were available for plant uptake. It was found that complexation of Fe2+ had a stability constant of 1.99×1014M-1 . This implies that the nonbiodegradable material has a potential application as a media for plants growth. The swelling ability of the hydrogels was investigated. It was found that the modified biomaterials had superabsorbent properties as the some had a capable of holding 30 times by mass content of water within 5 minutes of exposure. The plant growth media plus each respective hydrogels were then used for the growth of some selected plants (Spinacia oleracea L., Solanum tuberosam L. and Carica papaya). The modified biomaterials had a retention capacity of 90 % for the first 4 weeks of application. It was also observed that growth analysis using the leaf area index were higher on plants grown in 10 g plant growth substrate media watered by 50 g of the celluloseurea and cow dung-urea gels which were found to have an average growth rate of 0.045/wk. This growth was made possible by adequate aeration provided by volume variations of the gel and support provided by the solid particles of the soilless media. The hydrogel watered substrate was done in potted plants as well as in artificial gardens to grow vegetables rich in nutrients and the findings extrapolated for growth of some selected plants in an arid area. Therefore the synthesized materials have a potential application for the growth of crops in arid areas.

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