Utilization of Waste Materials to Produce Silica Micro and Nanoparticles as a Slow Release Fertilizer

P.M.G.W.G. Rajapaksha[1], M. Thomas[2], M.Y.U. Ganehenege[3*]

[1]*Department of Environmental and Industrial Sciences, University of Peradeniya, Peradeniya, 20400, Sri Lanka*
[2] *Department of Mechanical Engineering, The Pennsylvania State University, Pennsylvania, 16802, USA.*
[3]*Department of Chemistry, University of Peradeniya, Peradeniya, 20400 , Sri Lanka.*
[*]*myug@sci.pdn.ac.lk*

Silica nanoparticles (*SNPs*) are considered as suitable delivery materials considering their unique characteristics. Mesoporocity, large surface area, size variation and manipulative chemical and physical qualities such as hydrophilic or phobic nature, electrostatic charge are some of the important features. *SNPs* are modified as nanofertilizers, as they can be either controlled release or engineered materials for various functions. However, their physiochemical properties including particle size, pore size, shape and morphology, specific surface area and surface charge, and functionalization can highly affect their adsorption and desorption capacities. In plants, silica is used for both mechanical/physical protection and increased pest tolerance. In this study, silica was selected as the base material to incorporate urea as a nanofertilizer. Silica was extracted from rice husk and coal fly ash under optimized conditions. Six types of silica particles in the size range of 80-400 nm were synthesized from extracted silica using modified template free sol-gel and precipitation methods. Among the six, four were in nanoscale with the particle size <100 nm. The percentage ratio of synthesized silica particles: base material mass ranges from 8 – 48%, based on both the nature of synthesis procedure and the silica source. 1 mg of silica particles revealed 20 mg of urea sorption capacity after simple immersion. In comparison with commercially available urea granules, urea desorption behavior was studied using colorimetric absorption of Urea-Ehrlich's reagent complex at 425 nm. Variation of production efficiency was observed based on the method and the material. Among the six types of urea adsorbed silica, not only *SNPs*, but also the silica particles in the 200 nm- 400 nm range showed slow releasing behavior for consecutive 8 day-period regardless of their particle sizes. This may be due to the effect of specific pore sizes, shapes, morphology, specific surface charge and surface area of these particles.

Keywords: Silica micro and nanoparticles, Nanofertilizers, Urea adsorption, Slow release fertilizer