Carbonaceous microsphere-based superabsorbent polymer as filler for coating of NPK fertilizer : fabrication, properties, swelling, and nitrogen release characteristics

Tanveer Ahmed Khan[1], *Munirah Ezzah Tuan Zakaria*[2], *Hyun-Joong Kim*[1], *Suriati Ghazali*[2], *Saidatul Shima Jamari*[2]

[1] Lab. of Adhesion & Bio-Composites, Program in Environmental Materials Science, Research Institute of Agriculture and Life Sciences, Seoul National University, Seoul, 08826 Republic of Korea

[2] Faculty of Chemical and Natural Resource Engineering, University Malaysia Pahang, 26300 Kuantan, Pahang, Malaysia

ABSTRACT

Recently, the use of controlled release fertilizers in agriculture has resulted in huge benefits in plant growth and cultivation. Superabsorbent polymer (SAP)-coated fertilizers have the added advantage in retaining water in soil after irrigation and also reduce the nutrient release rate from soil in a controlled manner. This study aimed to produce a nitrogen–phosphorus–potassium (NPK) fertilizer coated with superabsorbent carbonaceous microspheres polymer (SPC) by inverse suspension polymerization method with water-retention and controlled release properties. Two sets of experiments were conducted: (1) three different weight percentages and (2) different materials. NPK coated with SPC showed increasing water-retention ability with respect to carbon microsphere percentages and retains >80% water at the 30th day of experiment compared with pure NPK and NPK coated with SAP. The slow release behavior of all samples was investigated by induced coupled plasma mass spectrometry spectrometry and results showed that NPK coated with SAP and SPC has a low release rate with <50% nutrient release compared with uncoated NPK at the 30th day. The release mechanism kinetics of NPK coated with SAP and SPC were studied based on the Kosmeyer–Peppas model. The mechanisms approached Fickian diffusion-controlled release as the n value for both samples was less than 0.5.

KEYWORDS

Controlled release fertilizer (CRF); Hydrothermal carbonization (HTC); Superabsorbent carbonaceous microsphere polymer (SPC); Superabsorbent polymer (SAP)

ACKNOWLEDGEMENTS

The authors express their thanks to the Ministry of Education Malaysia for financial assistance under the Fundamental Research Grant Scheme (FRGS/1/2014/TK04/UMP/02/7 or RDU140106) and Internal Research Grant Scheme (RDU1803104). The authors also thanks to Universiti Malaysia Pahang for the lab facilities and National Kenaf and Tobacco Board for the raw material to complete this research and Laboratory of Adhesion & Bio-Composites, Seoul National University, Seoul, Republic of Korea.