Área: MAT

Castor oil-based polyurethane nanocomposites can increase the release control in granulated fertilizers by controlling nutrient diffusion

Ricardo Bortoletto-Santos* (PQ),[1] Marcela Pfeifer (IC),[2] Vinícius F. Majaron (IC),[2] Marisa G. da Silva (IC),[2] Wagner L. Polito (PQ),[3] Caue Ribeiro (PQ),[4] Sidney J.L. Ribeiro (PQ).[1]

ricbortolettosantos@hotmail.com

[1]Instituto de Química (UNESP); [2]Departamento de Química (UFSCar); [3]Instituto de Química de São Carlos (USP); [4] Laboratório Nacional de Nanotecnologia para o Agronegócio (Embrapa Instrumentação).

Keywords: *Controlled release, Castor oil, Polyurethane, Montmorillonite, Hydrotalcite, Fertilizer.*

Highlights

Small amounts of lamellar material are effective to control the N and P diffusion; PU-coatings modified with montmorillonite and hydrotalcite can delay the N and P release from urea and MAP.

Resumo/Abstract

Despite the indispensable use of agricultural fertilizers to achieve current levels of productivity, chemical nutrients have their effectiveness limited by problems such as ammonia (NH3) volatilization, leaching and/or soil immobilization. One strategy to minimize these problems is to protect the fertilizer with nutrient-release barrier materials. Thus, it is desirable that the formed polymer should have a homogeneous adhesive line on the granule surface and be able to control the diffusion of soluble nutrients through its structure, allowing the barrier to assume an active role and not just that of a physical obstacle, which release would occur by mechanical compromise (fracture) of the polymer. The permeation through a polymer can be significantly reduced by the presence of internal diffusional barriers such as finely dispersed nanoclays (in the nanocomposites form). Thus, we proposed a nanocomposite system based on castor oil-derived polyurethane (PU) for controlling the release of fertilizers by an ion-exchange mechanism. PU coatings modified with less than 5% (by weight) montmorillonite, a cation-exchange material, successfully retarded the nitrogen release from urea granules, with less than 50% of the nutrient released within 18 days of immersion, as confirmed by soil incubation experiments. The same profile was observed for the phosphate release from mono ammonium phosphate (MAP) granules coated with PU modified with hydrotalcite (less than 5% by weight), an anion-exchange material. The release times were proportional to the contents of the cation- or anion-exchange materials, which exhibited specific correlations with the kind of nutrient released (e.g., cationic or anionic), confirming the diffusion barrier promoted by the PU coating structures. Our results demonstrated that the use of PU nanocomposites can significantly reduce the coating thickness with improved nitrogen and phosphorus release control, opening a new field for the investigation of controlled-release fertilizers.

Agradecimentos/Acknowledgments

The authors are thankful for the financial support given by FAPESP (São Paulo State Research Foundation, grant#2016/10636-8, #2017/18673-2, #2018/10448-2, #2019/18036-8 and #2020/03259-9), CAPES (Coordination for the Improvement of Higher Education Personne, CAPES-Embrapa Program), CNPq (Brazilian National Council for Scientific and Technological Development), SISNANO/MCTI, FINEP, and Embrapa AgroNano research network. The authors also thank the National Nanotechnology Laboratory for Agribusiness (LNNA) for providing institutional support and facilities.