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Interaction of oil-based polyurethane and nanoclay as a coating in urea granules reduces greenhouse gas emissions

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Despite the indispensable use of agricultural fertilizers to achieve current levels of productivity, chemical nutrients have their effectiveness limited by problems such as NH3 volatilization and soil immobilization. One strategy to minimize these problems is to protect the fertilizer with nutrient-release barrier materials. 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 polymer fracture. The permeation through a polymer can be significantly reduced by the presence of internal diffusional barriers such as finely dispersed nanoclays. 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% montmorillonite, a cation-exchange material, successfully retarded the N release from urea granules, with less than 50% of the nutrient released within 18 days of immersion, as confirmed by soil incubation experiments. The release times were proportional to the contents of the cation-exchange materials, which exhibited specific correlations with the nutrient released, confirming the diffusion barrier promoted by the PU coating structures. Moreover, the results showed that the combination between controlled release and nanoclay reduced the N2O and NH3 emissions in Palisade grass (Brachiaria brizantha). Our results demonstrated that the use of PU nanocomposites can significantly reduce the coating thickness with improved N-release control, opening a new field for the investigation of controlled-release fertilizers.