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热塑性包膜尿素微观结构特征及养分释放机理研究

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Membrane microstructures and mechanism of thermoplastic coated urea

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摘要

采用扫描电镜、水中溶出法、饱和盐溶液蒸汽压法和土壤培养法，探讨了热塑性包膜尿素微观结构特性及养分释放机理。结果表明，热塑性包膜尿素膜表面光滑，膜上存在纤维状孔隙，膜厚度53.8～65.2 μm。氮素释放速率随温度的升高而增大，在25、30、40、50、60℃水中，尿素累积释放80%的时间分别为96、80、12、8、4 d。在不同培养温度条件下，氮素释放率与时间的关系可用一级动力学方程：$Nt=No(1-e^{-kt})$、Elovich方程：$Nt=a+blnt$和抛物线方程：$Nt=a+bt^{0.5}$表征；在25和40℃时，以一级动力学方程拟合效果最好。包膜尿素的氮素释放率随着水蒸气压差的增大而增加，并且随水分含量降低而降低。定量描述氮素养分释放的动力学方程中，以一级动力学方程更具有实效性。包膜控释肥料膜内外水蒸气压差是控制养分释放的主要因素。

关键词： 热塑性包膜尿素 微结构 机理 养分释放特征 热塑性包膜尿素 微结构 机理 养分释放特征

Abstract:

The nutrient release characteristic of Thermoplastic Coated Urea (PCU) is one of the most important indexes, indicating its quality. The aim of this study was to explore the membrane microstructures and mechanism of thermoplastic coated urea using electron scanning microscope (SEM), water dissolution, vapor pressure in saturated salt solution and soil extraction method. In addition mathematical models on nutrient release characteristics were developed based on the experimental results. The results indicated that the surface of thermoplastic coated urea was slick with small cracks and pores, but no large pores that permit a free circulation of the solution between the interior of grains and the exterior was observed. There were lots of fiber-network-like porosity in coating with the thickness of 53.8–65.2μm. The basic structure of coats was irregular sponginess and the pores were distributed randomly and interlaced, which forms the channels by which the water and nutrient can come into. In water dissolution method, nitrogen release rate increased with increasing incubation temperature and the nitrogen release time of PCU was 96, 80, 12, 8 and 4 d at the temperature of 25, 30, 40, 50 and 60℃, respectively. The higher the temperature, the faster the nutrients release rates. The dynamics of nitrogen release rate could be quantitatively described by three equations: the first-order kinetics equation ($Nt=No\ (1-e^{-kt})$), Elovich equation ($Nt=a+blnt$) and parabola equation ($Nt=a+bt^{0.5}$). However, the imitation of the first-order kinetics equation was the best at 25 and 40℃. Nitrogen release rate of coated urea increased with the increasing of differential water vapor pressure, and decreased with the increasing of soil water contents. The differential water vapor pressure between the inside and outside of PCU was the domain factor controlling the nutrient release.

Keywords:

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