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ORIGINAL RESEARCH

Utilization of waste lignin to prepare controlled-slow release urea

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Abstract

Purpose The present work reports an economically attractive improvement in the area of producing particulate slow release nitrogen fertilizer using lignin as a waste effluent of pulp and paper manufacturing process.

Methods An improved coating of modified lignin was applied on the surfaces of the individual urea particles. The Kraft and Sulfite black liquors obtained from two different paper pulping units and were used as sources of sulfate and sulfite lignin, respectively. Chemical modification of extracted lignin was performed through acetylation reaction by acetic acid/sodium metabisulfite to increase its hydrophobicity character. In a separate experiment, a thin layer of synthesized acetylated lignin was coated on granular urea by fluidized-bed technique. The nitrogen release of synthesized fertilizer in the water and soil was examined by the Kjeldahl method.

Results The analysis of FTIR spectra indicated the changes in the functional groups of acetylated lignin. Petrographic photography and scanning electron microscopy (SEM) analyses demonstrated a uniform and homogeneous covering of the urea surface. The 7 day nitrogen release rate of urea coated by acetylated lignin in soil was obtained 36.3 and 45.3 % for Kraft and Sulfite lignin, respectively, whereas this value was 59 % for sulfur coated urea.

Conclusions Using industrial wastewater as source of lignin gives satisfactory results for industrial applications and yields a quality green fertilizer product with reduced operation difficulties while considerably preserving the environment.

Keywords Controlled release fertilizer · Fluidized-bed coating · Kraft and sulfite liquor · Modified lignin coated urea

Abbreviations

CRF	Controlled-release fertilizers
FTIR	Fourier transform infrared
SCU	Sulfur coated urea
SEM	Scanning electron microscopy

Introduction

The fertilizer industry faces a permanent challenge to improve the efficiency of its products. An ideal fertilizer should have at least three characteristics, including the needs for single application throughout the entire growing season; a high rate of return to the production input; and minimum detrimental effects on soil, water, and atmospheric environments (Shoji and Gandeza 1992; Trenkel 1997). Nitrogen is typically the most important nutrient in crop production in the world and used in the greatest amounts. Among the nitrogen fertilizers, the most widely used one is urea because of its high nitrogen content. Unfortunately, due to its high water-solubility, it leads to ground water contamination particularly by nitrates through leaching processes. In addition, its rapid hydrolysis in soils results in a great quantity of nitrogen (30–50 %) running off and only a fraction is really absorbed by plants (Salman 1988; Malhi et al. 2001; Devassine et al. 2002; Ni et al. 2009; Da Rosa and dos Santos Rocha 2010). One possible way to reduce nitrogen losses and environmental

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