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Effects of mixing maize straw with soil and placement depths on decomposition rates and products at two cold sites in the mollisol region of China

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ABSTRACT

Crop straw is often retained on the ground as mulch or incorporated into soil through tillage practices. These straw management practices may affect straw decomposition rates and subsequently decomposition products due to mixing straw with soil, straw placement depths and experimental sites. Using litterbags containing maize (*Zea mays. L*) straw only (STO) or straw-soil mixture (SSM), this study aimed to determine the influence of mixing straw with soil and straw placement depths on decomposition rates and decomposition products, and to understand the relation of chemical composition of straw residues with straw decomposition rates. The litterbags were placed at three soil depths (0, 15 and 30 cm) in the fields at two cold sites (Hailun and Harbin), Northeast China, which had similar precipitations but different temperatures. During the 17-month experiment, the decomposition rate constants were higher by 60 %–160 % at a comparable depth in SSM than in STO. The mixing straw with soil was a more important factor in controlling straw decomposition rates than placement depths and experimental sites at the studied region. The relative abundances of O–alkyl C groups in straw residues decreased during the experimental period, even in the winter, while those of aromatic groups increased profoundly. The relative abundances of O–alkyl C groups in straw residues were lower by 0.4 %–6.9 % and those of aromatic groups were higher by 0 %–4.6 % in SSM than in STO. These findings suggest that the conventional litterbag method underestimated straw decomposition rates. Incorporating straw into soil could enhance maize straw decomposition and the formation of more stable soil organic matter (SOM) in the cold high-latitude studied region.

1. Introduction

Post-harvest crop straws amount to 5 million Mg worldwide (Cherubin et al., 2018). Traditionally, crop straws are preferably burnt in the field. However, the practice results in a serious environmental problem because of the immediate release of smoke and CO_2 to the atmosphere (Nguyen et al., 1994). Retention of crop straw in the field can replenish soil organic matter (SOM) and increase soil fertility (Moyin-Jesu, 2007; Chen et al., 2018). However, crop straw retention is often complained about the negative impact of accumulation of crop straw on crop growth and yields in the cold regions, where straw decomposition is considered slow due to low temperature (Chen et al., 2007). Straw accumulation can affect plant establishment, nutrient availability, soil temperature, water infiltration and evaporation, and disease and pest populations (Edwards et al., 2000; Johnson et al., 2004; Chen et al., 2007). Thus, a thorough understanding of the factors controlling the straw decomposition dynamics at different sites is a prerequisite to developing best management practices for crop residues.

Plant litter decomposition generally depends on the biochemical and physical properties of plant litters (Cornwell et al., 2008; Carvalho et al., 2009; Makkonen et al., 2012), and soil moisture and temperature (Thongjoo et al., 2015) as well as climates (Penner and Frank, 2019).

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