Soil Use and Management

Soil Use and Management, June 2013, **29,** 182–190 doi: 10.1111/sum.12032

SHORT COMMUNICATION

Soil organic carbon sequestration under different fertilizer regimes in north and northeast China: RothC simulation

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Abstract

Soil organic carbon (SOC) modelling is a useful approach to assess the impact of nutrient management on carbon sequestration. RothC was parameterized and evaluated with two long-term experiments comparing different fertilizer treatments in north (Zhengzhou) and northeast (Gongzhuling) China. Four nutrient application treatments were used: no fertilizer (Control), mineral nitrogen–phosphorus–potassium fertilizers (NPK), NPK mineral fertilizer plus manure (NPKM), and NPK mineral fertilizer plus straw return (NPKS). The comparison between simulated and observed data showed that the model can adequately simulate SOC contents in the Control, NPK and NPKM treatments but overestimated in the NPKS treatment at both sites. By changing the value of decomposable plant material:resistant plant material (DPM:RPM) ratio from the default value to 3.35 for the NPKS treatment at the Zhengzhou site, dynamics of simulated SOC agreed with measured values. A pseudo-parameter, straw retention factor was introduced to adjust the amount of straw incorporated into soils. Using the inverse simulation method and the modified value of the ratio, the best-fitted value was 0.24 for the NPKS treatment at the Gongzhuling site. This result indicated that retaining straw on the soil surface makes less contribution to carbon sequestration than if it is incorporated. With this modification for straw, the model produced reasonable predictions for the two sites. The model was run for another 30 years with the modified parameter values and current average climatic conditions for different fertilizer treatments at both sites. The results suggested that the NPK application plus the addition of manure or straw would be better management practices for carbon sequestration.

Keywords: RothC simulation model, modelling, carbon sequestration, soil organic matter, long-term experiment

Introduction

Soil organic carbon (SOC) plays an important role in soil fertility and can contribute to the mitigation of climate change through the sequestering of carbon (C) in soils. However, the conversion from natural to agricultural ecosystems and unsustainable management of agricultural fields have caused a rapid and significant decline in SOC. It was estimated that the magnitude of SOC loss from croplands in the Midwestern United States was between 25 and 40 Mg C ha^{-1}, or about 30–50% of the antecedent level after about 50 yrs of cultivation (Lal, 2002). SOC depletion also happened in China, especially in the black soils in northeast China (Xin *et al.*, 2002) where the steppe meadow was converted into agricultural land during the 1950s and has been under cultivation ever since. Huang (2005) reported that for croplands of the same soil type, the SOC content in China was less than half of that in Europe. Of the five major cereal crop regions in China, the region with the greatest SOC content is in northeast China (only about 1.0–1.5%) and the region with the second smallest content is in north China (0.5–0.8%) (Pan & Zhao, 2005). It is

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Received February 2012; accepted after revision December 2012