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Soil respiration, glomalin content, and enzymatic activity response to straw application in a wheat-maize rotation system

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Abstract
Purpose Straw residue has been widely applied in the North China Plain agroecosystems due to their positive roles in soil fertility improvement, sustainable production, and climate change mitigation. However, little is known about how straw application alters soil respiration by influencing soil biochemical properties in this region. This is the first study to evaluate the role of soil enzyme activity and glomalin content in the response of soil respiration to straw application at different growth stages in a wheat-maize rotation system.
Materials and methods Field experiment was conducted in a wheat-maize rotation system and it contained two treatments: straw residue removal (CK) and straw residues application (SR). Soil respiration, moisture, and temperature were measured using LI-8100 at different growth stages during wheat and maize (2013–2015) growing seasons. From 2013 to 2014, soil sample (0–20 cm) was collected at different growth stages during wheat and maize growing seasons and transported to the laboratory. Glomalin content and soil enzyme activity were analyzed by using Bradford and enzyme-labeled meter method, respectively. In addition, we determined soil chemical properties such as soil organic carbon (SOC), soil total N content (TN), ammonium N (NH_4^+-N), and nitrate N (NO_3^--N) concentrations.
Results and discussion SR significantly increased soil respiration and this promotion effect became more significant after 4-year straw application. Soil respiration exhibited significant seasonal variation and was significantly increased by soil temperature with Q_{10} ranging from 1.73 to 2.14 for CK and from 1.51 to 2.28 for SR. Both soil temperature and moisture accounted for 70–72% of the seasonal variation in soil respiration. SR significantly increased easily extractable glomalin-related soil protein during 2013–2014 wheat growing season except jointing stage. In addition, positive and significant effect of SR on activities of β-glucosidase and cellobiohydrolase was observed at initial and vigorous growth stages. Straw application significantly increased TN, but did not significantly influence SOC, NH_4^+-N, and NO_3^--N concentrations.
Conclusions Our study demonstrated that straw application increased soil respiration by stimulating soil enzyme activities and improving easily extractable glomalin-related soil protein. Straw application is recommended as an agricultural management in the North China Plain because of its role in improving biochemical properties. To improve soil biochemical parameters with a relative low soil respiration rate, further information is necessary about the optimum amount of straw application.

Keywords Glomalin · Seasonal variation · Soil enzymatic activities · Soil respiration · Straw residues

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