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Spatio-temporal distribution of enzyme activities with covered and mixed straw incorporation

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The rhizosphere and detritosphere are hotspots of soil enzyme-mediated microbial processes, but little is known about their spatiotemporal distribution and interaction, especially under various straw application strategies. Here, we used an *in situ* method (i.e. zymography) to investigate the distribution of enzyme activities in the maize rhizosphere and straw detritosphere after straw application (no straw, straw mulching and straw mixed). The surrounding of straw was considered as detritosphere. Furthermore, the root and shoot performance of maize and soil chemical properties were also monitored in the study. The plant height, shoot weight, and root surface density of straw mulching were 60.4%, 159.6%, and 19.2% higher than that of straw mixed ($p < 0.05$), which indicate straw mixed returning lead to a stronger competition between plant root and soil microorganism for nutrients. SOC, TN, DOC and DON in the topsoil of straw mulching returning were 97.2%, 27.0%, 186.7% and 175.0% higher than that of straw mixed, respectively ($p < 0.05$). Moreover, both straw mulching and mixed returning has a positive effect on soil surface enzyme activities. Higher enzyme activities in detritosphere was observed with straw mulching than straw mixed returning ($p < 0.05$). The higher enzyme activities in the rhizosphere of straw mulching on day 15 can be defined by the increase of C release caused by root growth. This in turn can promote the process of microbial and nutrient cycling, and enhance rhizosphere enzyme activity. These results revealed that straw mulching decreases nutrients competition between root and microorganism and increases the C- and N-acquiring enzyme activities in detritosphere.