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研究论文

北亚热带-南暖温带过渡区典型森林生态系统土壤呼吸及其组分分离

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摘要 阐明北亚热带-南暖温带过渡区典型森林生态系统土壤呼吸与其组分的碳排放速率及其对土壤水热变化的响应规律，本研究用壕沟断根法布设了土壤呼吸组分分离试验，并对土壤温湿度与呼吸速率进行了一年的观测。统计分析结果表明：土壤呼吸及其组分的呼吸速率在夏秋季较高、春冬季较低；土壤温度低于15 ℃时，呼吸速率的季节性变化主要受控于土壤温度；土壤温度高于15 ℃，而含水量低于0.20 kg•kg^{-1}时，含水量对呼吸速率有明显的抑制作用；当土壤温湿度分别高于15 ℃与0.20 kg•kg^{-1}，呼吸速率同时受到土壤温湿度的影响；土壤温湿度分别能解释呼吸速率季节性变化的80.36%~94.94%与7.20%~48.45%，温度的影响高于含水量；5种类型中土壤呼吸、自养与异养呼吸的Q_{10}值变化范围分别为2.30~2.44、2.49~2.82与2.09~2.35，每个类型中自养呼吸的温度敏感性均为最高，其次为土壤呼吸，异养呼吸最低；锐齿栎幼林、锐齿栎老林、华山松与短柄枹针阔混交林、千金榆与短柄枹阔叶混交林及栓皮栎林自养呼吸日贡献率的变化范围分别为35.19%~57.73%、28.73%~49.24%、28.67%~49.82%、24.24%~41.70%与30.07%~46.22%，土壤呼吸的年排放量分别为1105.15 gC•m^{-2}•a^{-1}、779.12 gC•m^{-2}•a^{-1}、821.23 gC•m^{-2}•a^{-1} 、912.19 gC•m^{-2}•a^{-1}与899.50 gC•m^{-2}•a^{-1}，其中自养呼吸的年贡献率分别为52.89%、39.77%、44.17%、38.15%与43.26%，若考虑断根样方内细根分解的影响，则自养呼吸的年贡献率分别为65.56%、47.95%、53.80%、46.83%与53.86%；5个林分间的土壤呼吸速率、异养呼吸速率没有显著差异（p>0.05），而自养呼吸速率存在显著差异（p<0.05），类型间活细根生物量的差异解释了自养呼吸速率差异的94.71%。

关键词 土壤呼吸 _ 自养呼吸 _ 异养呼吸 _ 土壤温度 _ 土壤含水量 _ 组分分离

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Soil respiration and its components partitioning in the typical forest ecosystems at the transitional area from the northern subtropics to warm temperate, China

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Abstract In order to ascertain the carbon emission rate and soil respiration response by its components to changing soil temperature and water content in the five typical forest stands at the transitional area from the northern subtropics to warm temperate, the root-excluded quadrates by trenching were set up to partition soil respiration components and the soil temperature, soil water content and respiration rate in each plot were simultaneously measured over the whole year experimen

t. The results indicate that respiration rates of the total soil respiration and its different components are higher in summer and autumn than that in spring and winter. The respiration rate is largely controlled by soil temperature when soil temperature is below 15 ℃, while it is clearly limited by soil water content when soil temperature is above 15 ℃ and soil water content is below 0.20 kg•kg^{-1}. However, it is simultaneously affected by both soil temperature and soil water content when soil temperature is above 15 ℃ and soil water content is above 0.20 kg•kg^{-1}. Soil temperature and soil water content can account for 80.36%-94.94% and 7.20%-48.45% of seasonal variation in respiration rates, respectively, suggesting that the effect of soil temperature on soil respiration is greater than that of soil water content. The Q_{10} values for autotrophic respiration, soil respiration and heterotrophic respiration are 2.49-2.82 , 2.30-2.44 and 2.09-2.35, respectively, in the five stands. The temperature sensitivity of autotrophic respiration is the highest, followed by soil respiration and the heterotrophic respiration is the lowest, regardless of stands. The contributions of daily autotrophic respiration in *Quercus aliena* var.*acuteserrata* young stand, *Quercus aliena* var.*acuteserrata* old stand, broadleaf/coniferous mixed stand, broadleaf mixed forest and Quercus variabilis stand are 35.19%-57.73%, 28.73%-49.24%, 28.67%-49.82%, 24.24%-41.70% and 30.07%-46.22%, respectively. Their annual amounts of carbon release through soil respiration are 1105.15, 779.12, 821.23, 912.19 gC •m^{-2}•a^{-1}and 899.50 gC•m^{-2}•a^{-1}, respectively. Their annual contribution percentages of autotrophic respiration are 52.89%, 39.77%, 44.17%, 38.15% and 43.26%, respectively, while if taking account of fine root decomposition in root-excluded quadrates, their annual contribution rates of autotrophic respiration increase to 65.56%, 47.95%, 53.80%, 46.83% and 53.86%, respectively. The statistical analysis indicates there is no significant differences in soil respiration rate and the heterotrophic respiration rate among the five stands (p>0.05), but the significant differences occur in the autotrophic respiration rate (p<0.05). The live fine root biomass accounts for 94.71%of the difference of autotrophic respiration rates among the five stands.

Key words soil respiration _ autotrophic respiration _ heterotrophic respiration _ soil temperature _ soil water content _ component partition

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