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Editorial: Carbon sequestration in forest plantation ecosystems

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Editorial on the Research Topic
Carbon sequestration in forest plantation ecosystems

Global forests sequester 662 Pg C in plant biomass and soils (FAO, 2020) and play an important role in mitigating the increasing atmospheric CO_2 concentration. Planted forests, accounting for 7% of the world's forests, make a great contribution to forest carbon (C) sink (Pugh et al., 2019). For instance, the planted forests supplied more than 80% of the C sink in Chinese forests (Fang et al., 2014). Therefore, promoting C sequestration in planted forests is vital to enhancing the forest C sink. However, the mechanisms of C sequestration in planted forests are not well understood.

Although tree traits have been well demonstrated to influence the C accumulation of plant biomass (Poorter et al., 2015), their impacts on soil organic carbon (SOC) are inconclusive and may be related to the climatic and soil conditions (Vesterdal et al., 2013; Chen et al., 2021; Augusto and Boča, 2022). The effects of vegetation type and plant functional groups on ecosystem C storage, especially SOC dynamics, are extremely complicated and require more and further studies. Moreover, soil microorganisms directly influence SOC mineralization and participate in SOC formation by microbial necromass such as amino sugars and glomalin-related soil protein (Condron et al., 2010). The increased microbial necromass C facilitates SOC sequestration during reforestation from croplands (Zhang et al., 2023). Furthermore, soil physicochemical properties such as soil available nitrogen can affect SOC stocks through altering organic matter decomposition (Eastman et al., 2021; Lu et al., 2021).

Establishing planted forests often increases the C storage of terrestrial ecosystems (Zhang et al., 2020). However, poorly planned and executed afforestation could actually increase CO_2 emissions (Di Sacco et al., 2021). In light of forest C sink, some traditional forestry practices should be reconsidered. This Research Topic aims to gather novel research findings or comprehensive perspectives in the field of C sequestration in planted forests. We emphasized the role of forest management practices in soil C cycling, the impact of vegetation type and stand age on ecosystem C storage and distribution, and the regulatory mechanisms of vertical SOC distribution.

Recently published work has indicated that specific forest management strategies can enhance C sequestration capacity and SOC storage (Ameray et al., 2021). Understory plants are a crucial component of forest ecosystems, but they are traditionally removed to reduce competition with cultivated trees for nutrients and water in planted forests (Giuggiola et al., 2018; Zhang et al., 2022). To prevent or alleviate soil acidification, lime application is considered as a common forestry practice in humid tropics and subtropics (Xue et al., 2010; Homan et al., 2016). For example, Liu J. et al. found that both understory removal and lime application inhibited total soil respiration, the presence of understory plants can counteract the increase in heterotrophic respiration induced by lime application. Huang et al. evaluated the effects of vegetation type on ecosystem C storage and distribution in subtropical planted forests. They found that the ecosystem C density of the *Schima superba* plantation was higher than that of the slash pine and *Masson* pine plantations. The differences stemmed from plant biomass C density, not SOC storage. The broad-leaved planted forests may have higher ecosystem C storage in subtropical regions. Xanthopoulos et al. quantified the C stocks in a *Robinia pseudoacacia* L. (black locust) planted forest and examined the effect of stand age at the largest lignite center in Greece. They discovered that litterfall started early in the growing season and together with fine roots, fueled SOC. SOC accrual declined with age, referring to the accumulation of SOC derived from black locust. Above- and below-ground biomass C increased linearly with age. This finding furthers our understanding of C accumulation in restoration planted forests at degraded post-mining sites.

Biological and abiotic factors in the soil environment can alter SOC distribution and C sequestration potential (Jobbágy and Jackson, 2000; Chen et al., 2019; Dong et al., 2021). SOC concentration is generally inversely related to soil depth with an immense amount of SOC storage and turnover occurring in the topsoil (Cusack and Turner, 2021). This pattern results largely from terrestrial plant litter distribution and root density along the soil profile. Patterns in the vertical distribution of SOC are key to assessing soil C sequestration potential (Lorenz and Lal, 2005). Liu B. et al. sampled 18 soil profiles at one meter depth to investigate the vertical distribution and controlling factors of SOC at different soil depths in poplar plantations in eastern China. They found that SOC concentration was co-regulated by soil physiochemical and microbial properties at the site level with soil chemical and microbial properties dominant in the topsoil and subsoil, respectively. This study highlights the dominance of microbial community in regulating SOC in the subsoil and advances our understanding of the variation in mechanisms regulating SOC along the soil profile.

Collectively, the findings from these studies highlight the importance of tree species in the C accumulation of plant biomass. They also show that understory plants mediate SOC dynamics and that the regulation mechanisms of SOC differ between topsoil and subsoil. Continuous research is necessary to gain more insights into the C sequestration mechanisms of tree functional traits on SOC sequestration, the impact of forest management strategies on ecosystem C density, and the influence of stand age on C sink of mature forests. These knowledge is vital to improving our ability to manage planted forests since maintaining and enhancing the C sink function could help mitigate the rising atmospheric CO_2 concentration.

Author contributions

YC: Conceptualization, Funding acquisition, Project administration, Supervision, Writing – original draft, Writing – review & editing. BZ: Formal analysis, Writing – original draft. YZ: Writing – original draft. JW: Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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