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# 兴安落叶松林生物量、地表枯落物量及土壤有机碳储量随林分生长的变化差异

# Differences in biomass, litter layer mass and SOC storage changing with tree growth in *Larix gmelinii* plantations in Northeast China

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**中文摘要**:

有关生物量碳随林分生长变化研究较多,而相关土壤有机碳储量随林分生长变化研究较少且结论争议较大。通过对二者随林分生长变化差异的比较,旨在探讨是否可以通过简单林分生长指标来判断土壤有机碳的变化规律。对兴安落叶松人工林分布区内139个样地的生物量与土壤碳动态研究结果表明:(1)林龄是指示生物量碳累积的可靠参数。兴安落叶松个体大小(胸径、树高和单株生物量)随着林龄的增大不断增加,相关性显著($P$<0.001),而林分生物量密度随林龄的增大呈线性上升($R^2$=0.2-0.6,$P$<0.001)。(2)地表凋落物量与林龄表现显著的二次曲线相关,前37a上升而后开始下降。地表凋落物量与林木大小、生物量密度均相关显著($R^2$=0.14-0.82,$P$<0.001),但与树高相关性最高,显示树高变化对于评价地表枯落物生物量可能更有效。(3)林龄、林木大小和林分生物量密度均与土壤不同层碳存在相类似的相关关系。深层土壤有机碳(>40cm)与林龄显著负相关($P$<0.05),表层土壤有机碳有增加趋势 ($P$>0.05),这使得0-40 cm与40-80 cm土壤有机碳储量比值随林龄增加而显著增加($P$<0.01);与此类似,林木平均大小也与深层土壤有机碳显著负相关($P$<0.05),而表层与深层有机碳储量比值随林木大小(胸径与树高)的增大也呈显著上升趋势($P$<0.05);但同时考虑林木个体大小和林分密度的林分生物量密度(地上和地下),并没有发现明显的显著相关关系。这些结果说明,评价土壤有机碳变化的指标中,林龄、树高和胸径可能更优于较为复杂的生物量密度等指标。考虑到深层土壤较表层具有更长期的稳定性,这种表层与深层土壤有机碳比值的增加,意味着土壤碳有向表层积聚而深层减少的趋势,这可能使得土壤有机碳更容易受外界环境变化(如火灾等)的影响。落叶松人工林群落碳储量随林龄增加的变化规律明显,除了占主要部分的生物量碳之外,土壤碳累积值得关注,这一发现对于以固碳增汇为目标的碳汇林建设具有指导意义。

English Summary:

In despite of many researches on relations between biomass carbon and tree growth, the similar soil organic carbon (SOC) relations were rarely surveyed and conclusions are also controversial to date. Through the clarification of these growth-related differences between biomass and SOC, we tried to explore some simple indicators for identifying the changes of SOC during forest development. An investigation was carried out on the biomass, aboveground litter mass and SOC dynamics of 139 chronosequence plots of larch plantation forests in Northeast China. Our results showed that: 1) Tree age was a credible parameter to describe biomass carbon changes. Significant linear correlations between larch body size (DBH: diameter at breast height, tree height and plant biomass) and tree age were observed ($P$<0.001). Similarly, significant increases in stand biomass density (biomass per one unit area of soil) with tree age were also observed ($R^2$=0.35-0.6, $P$<0.001); 2) Surface litter mass was quadratically related with tree age, i.e., obvious escalation before the age of 37, but decrease thereafter was observed ($P$<0.05). Other growth parameters, such as *DBH*, tree height, tree size as well as biomass density were linearly correlated with the litter mass above soil surface ($R^2$=0.14-0.82, $P$<0.001), and the best correlation was found in tree height. Thus, tree height should be the optimal parameter to evaluate the changes of litter mass in larch plantations; 3) Various parameters of tree age, tree size and biomass density had rather similar relations with SOC storage in different soil layers. In general, SOC in deep soils (>40 cm) was negatively correlated with plantation age, while positive mounting SOC was found in the surface soil (but without statistical significance ($P$>0.05)). This contrary changes made the SOC ratio between 0-40 cm and 40-80 cm increased significantly with plantation age ($P$<0.01). Similarly, the tree size parameters were significantly negatively correlated with deep SOC ($P$<0.05) and the ratio between surface and deep soil SOC also displayed a significant upward trend with increasing DBH and tree height ($P$<0.05). However, stand biomass density (above and below ground), which has taken the individual tree size and tree density into account, did not significantly correlated with the SOC changes ($P$>0.05). These results suggested that the simple parameters of stand age, tree height and DBH are even better than some sophisticated parameters (e.g. biomass density) for evaluating the change of SOC (both vertical distribution and absolute storage). Owing to the fact that SOC in deep soil is more stable than that in surface, the increase of SOC ratio indicates that more SOC may accumulate in surface layer, and this will be a risk of soil carbon return atmosphere(for example in a fire). In all, carbon storage changes during the development of larch plantation forests is obvious both aboveground and belowground. Besides the main part of biomass carbon, soil carbon is also remarkable and should be carefully considered in carbon budget studies. This discovery is of a guiding significance for the afforestation of carbon sink larch forests in northeastern China.