

Is Stand Density Really Important for Optimal Yield of Tree Plantations?

A Review on the Concepts of Competition, Shoot-Root Ratio, and Soil Conservation

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ABSTRACT

Tree plantations are commonly managed as to optimize their production of stemwood. To this end, planting more trees per hectare readily seems like a good way of growing more wood. However, as density increases, so does competition between individual trees since resources are limited. It has been known for some time that too dense a stand potentially leads to a reduction in shoot growth and even the death of weaker individuals. Recent studies shed new light on this phenomenon by suggesting that root competition between neighbouring plants induces further investment on root development in excess of what is necessary for regular nutrient requirements. This excess allocation to roots would even have a detrimental effect on shoot growth and reproduction of the competing individuals, which has been compared to a "Tragedy of the Commons". Such an unfavourable consequence of root competition certainly raises doubts about the effects of stand density in tree plantations. Therefore, we herein propose a literature review on the subject of plant biomass allocation patterns at different densities. Our analysis of 19 studies revealed that plant response varied: shoot:root ratios could either increase, decrease, or remain constant at higher density. From what is actually known about plant competition and resource allocation strategies, we suggest that observed effects of density can be explained by other variables, namely plant size and soil fertility. We then discuss how these findings could contribute to achieve optimal stand density in a tree plantation, and what implications stand density has in regards to the conservation of soil nutrients.

Keywords: root competition, shoot: root ratio, stand density, Tragedy of the commons, tree plantations