The role of soil reconstruction and soil amendments in forest reclamation

Jana Bockstette

Abstract

The physical and chemical properties associated with different soil materials are arguably the most important factor affecting early seedling growth and survival as they determine the amount of rooting space, nutrients and water available to planted seedlings. The likelihood of successful reforestation after severe anthropogenic disturbances, such as those caused by surface mining, depend heavily on the quality and quantity of available soil materials, which are likely to differ significantly from site to site. In some cases, there may be an opportunity to salvage high quality soil materials as part of the ongoing mining operations and later use these materials to construct a suitable growing medium for reforestation. In other cases, such materials may not be readily available in which case externally sourced soil amendments may offer a way to improve soil conditions to the point where planted seedlings can be supplied with sufficient water and nutrients to ensure successful establishment. However, given the variety of available soil materials and amendments, as well the varying requirements associated with different tree species, it is important to understand how and when to use these materials in forest land reclamation. For my thesis, I conducted two field experiments to test the effects of (1) different soil materials and placement techniques and (2) different soil amendments on soil properties as well as growth and establishment of three important boreal forest species, trembling aspen (*Populus tremuloides* Michx.), jack pine (*Pinus banksiana* Lamb.) and white spruce (*Picea glauca* (Moench) Voss.). The results of my first study revealed that the topsoil material type (e.g.

peat from a lowland and forest floor material (FFM) from an upland forest site) and application thickness (e.g. 30 cm peat vs. 10 cm peat) were the main drivers for the observed differences in seedling growth, while subsoil layer and total capping thickness had only limited effects on seedling growth at this early stage (three years) of reforestation. The persistently low soil temperature associated with the 30 cm peat thickness was likely the main cause for poor seedling growth performance as low soil temperatures can interfere with physiological function such as root growth and water and nutrient uptake. Due to different nutrient requirements and differences in nutrient availabilities among soil materials all planted species revealed nutrient deficiencies on both topsoil material types, although the form of nutrient deficiency varied by species. In my second study I found that fertilization with a slow release fertilizer increased seedling height after three growing seasons. However, neither the addition of biochar to the soil nor the combination of biochar and fertilizer resulted in the expected beneficial effects on seedling growth. The addition of biochar reduced the amount of plant available nitrate, while it marginally increased soil moisture and thus might have contributed to the lower observed seedling mortality. In combination, my experiments showed that adding salvaged soil materials with a high organic matter content or organic matter rich soil amendments can be a tool to improve soil conditions and thus promote the successful establishment of planted tree seedlings. However, my findings also highlight the need to understand the different requirements associated with different tree species and the respective physical and chemical soil properties associated with each material so that they can be applied in adequate amounts to ensure fast seedling growth and low mortality.