Effects of Root Trenching of Overstorey Norway-spruce (*Picea abies*) on Root Growth of Underplanted Beech (*Fagus sylvatica*) and Douglas fir (*Pseudotsuga menziesii*) Seedlings

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ABSTRACT

The impact of root competition by the overstorey Norway spruce on soil water potential and on root growth of the underplanted seedlings of beech and Douglas-fir over two growing seasons was investigated using a trenching experiment.
KEYWORDS: root trenching, *Fagus sylvatica, Pseudotsuga menziesii*, root growth response.

INTRODUCTION

The conversion of pure and even-aged stands of Norway spruce into mixed stands is a current silvicultural practice in many Europe countries, principally due to the predicted climate change. The most common conversion method is planting in advance of beech and other species under spruce shelterwood. Survival and growth of underplanted seedlings are often interpreted only as a function of light availability (Burschel and Huss 1964, Minotta and Pinzauti 1996), because differences in light intenstities are much more evident compared to those in soil moisture, and because "there are methodical difficulties in quantifing the below-ground impact of overstorey trees on underplanted seedlings" (Ammer, 2000). Coomes and Grubb (2000) pointed out the important role of root competition on seedlings growth, especially at less fertile and drier site. However, there are few studies about the relationship between the extent of root competition and soil moisture, and information about root trenching and its impact on the growth and root biomass allocation of underplanted seedlings is rare. The main objectives of the present study were: (1) to test the influence of overstorey spruce roots on soil water potential; and (2) to examine how the root component of underplanted seedlings is affected by root competition of the old spruce stand over two growing seasons.

METHODS

Two felling types (strip cutting and single tree selection cutting) were carried out in two pure Norway spruce stands (ca. 90 years old) located in the Solling Hills (Lower Saxony, Germany) and European beech and Douglas fir were planted underneath in 2004. A trenching experiment was conducted in spring 2007. Soil water potential was measured using mechanical tensiometers at a depth of 30 cm mineral soil in 2008. A suite of root attributes of underplanted seedlings was determined using WinRhizo software-package. The next section, "Results and Discussions", refers to three plots: (1) OZN- Otterbach (300m a.s.l.), single tree selection cutting, with mean basal area of 44 m^2 ha^{-1}, and 145 g m^{-2} fine root biomass of old Norway spruce; (2) NZN-

Neuhaus (500m a.s.l.), single tree selection cutting, 53 m^2 ha^{-1}, and 184 g m^{-2}; and (3) NS-Neuhaus, strip cutting, 34 m^2 ha^{-1}, and 136 g m^{-2}.

RESULTS AND DISCUSSION

The fine root biomass of the underplanted seedlings increased with soil water potential (Fig. 1A), that was significant higher in trenched plots than in control plots (Fig. 1B). This reflects the considerable effect of old Norway-spruce roots on soil moisture, and accords to findings of Ammer (2000). In the majority of the studied characteristics, the elimination of overstory Norway-spruce root competition induced a better root development of the planted seedlings. Significant differences between control and trenched plots were found in fine root biomass and root length for beech, fine root surface area and root volume per cubic meter of soil for Douglas-fir in NS, fine root density and specific root area (Fig. 1C) for Douglas-fir in NZN. Allocation of biomass to roots was lower in the variants with root trenching and higher in plots with the lowest environmental resources (NZN) (Fig. 1D) which is in agreement with Paz (2003).

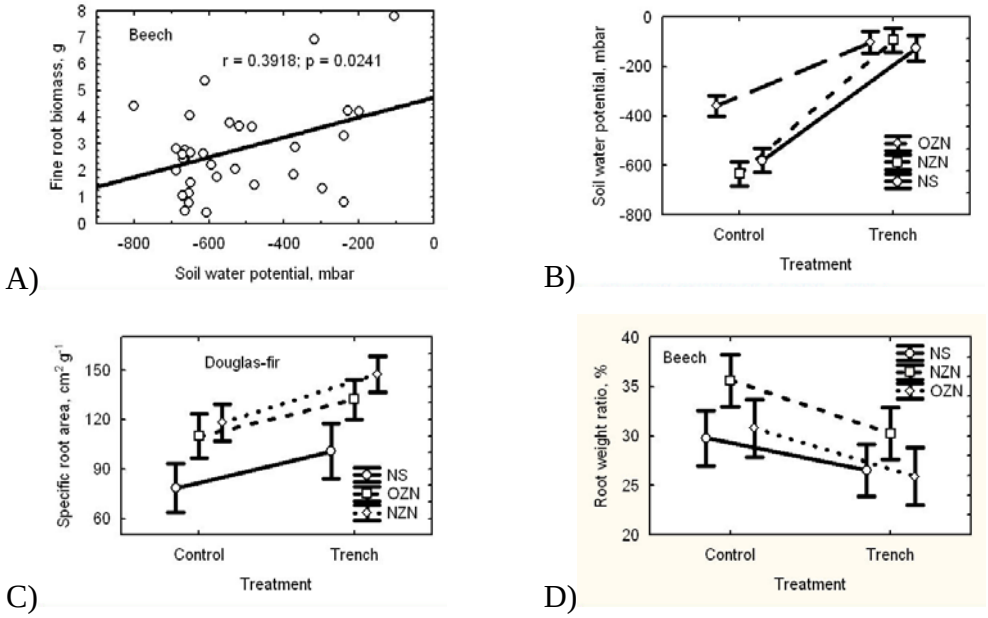

Figure 1. Relationship between seedlings root and soil water potential (A) and impact of root extent on soil water potential (B), specific root area (C) and root weight ratio (D).

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