

Studies on the development of root systems in young forest stands of deciduous trees in naturally-afforested agricultural lands

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ABSTRACT

The article summarises study data on accumulation of the biomass of 10 – year birch and 12 – year grey alder stands in above-ground and root biomass. The research goal was to determine the volume of birch and grey alder biomass and its characteristic components: the biomass of the above-ground part – the biomass of the stem and branches, as well as the biomass of roots: the mass of coarse roots and fine roots. An analysis was carried out on the number of active root tips, root length, volume and total root mass, as well as its influence on the development of the above-ground part of the aforementioned tree species.

The biomass of fresh roots (stump part + coarse roots) and the above – ground part (stem mass + branch mass) of 10-year birch stands was determined – respectively 24.7 t ha⁻¹ and 55.65 t ha⁻¹, while in 12-year grey alder stands it was respectively 52.12 and 131.6 t ha⁻¹. The morphological parameters of fine roots in birch stands per 1 ha are the following: biomass – 5.431 t ha⁻¹, root length – 3,169 km ha⁻¹, root volume – 8.11 m³ ha⁻¹ in air – dry condition. The morphological parameters of fine roots in grey alder stands per 1 ha are the following: biomass – 12.5 t ha⁻¹, root length – 7.29 km ha⁻¹, root volume – 18.65 m³ ha⁻¹ in air – dry condition.

The studies show that 2.28 times more biomass can be accumulated in 10-year grey alder stands in comparison with birch stands of the same age.

KEYWORDS: birch, grey alder, root morphology, fine roots biomass, length of roots, roots volume.

INTRODUCTION

In Latvia, with changes in the agrarian economy, large areas of agricultural land were left unmanaged, and at present more than 310 thousand ha of these lands have been afforested or become afforested naturally, mainly with birch and grey alder (data of the Statistical Bureau, 2007; Forest Database of the State Forest Service, 2007). The majority of these young forest stands have now reached the age of 10 – 15, and significant accumulation of biomass and carbon has begun both in the above – ground part – in the stem and branches – and in roots – coarse roots and fine roots.

The study on the amount of biomass in young birch and grey alder stands will allow to predict the amount of energy wood, as well as to calculate the accumulation of carbon both in above – and under – ground biomass. Until now, little research has been done in Latvia on the development of birch and grey alder root systems (Gaitnieks, 2007; Daugaviete, 2008).

MATERIALS AND METHODS

To achieve the goal, three circular trial plots (100 m²) were created in each of two 10 – year birch and 10 – year grey alder stands. After evaluating the dendrometrical measurements (tree height, m, and breast height diameter, cm), one sample tree corresponding to the average characteristics of the stand was selected in each trial plot. These trees were cut and dug out. The cut sample trees (3 from each stand) were divided by their parts – the above ground part: the stem, branches and stump, and the root part – coarse roots and fine roots. The biomass of the

above-ground part and coarse roots was determined with the weighing method. The samples of fine roots were obtained with an Eijkelkamp soil drill, by taking soil samples at a depth of 0-10, 10-20, 20-30, 30-40 and 40-50 cm and analysing them by using the software Win RHIZO 2002 C (Regent instrument^R).

RESULTS AND DISCUSSION

The results of the above-ground biomass study show that in a plantation of 10 – year silver birch (*Betula pendula* Roth.) in agricultural land, the average height of trees is between 6.3 and 6.8 m, the average diameter at breast height (DBH) – 6.1 cm, the average volume: 0.0173 – 0.0214 m³, which make for a yield of 43-53 m³·ha⁻¹.

In a naturally-developed stand of 12 – year grey alder in agricultural land, the average height of trees is between 7.0 and 10.0 m, the average diameter at breast height (DBH): 6.2 – 6.3 cm, the average volume: 0.0108 – 0.0250 m³, which make for a yield of 67 – 79 m³·ha⁻¹.

The mass of above-ground tree parts in a 10-year birch plantation has the following distribution: mass of stem, fresh harvested – 42.5 t·ha⁻¹; mass of branches – 13.3 t·ha⁻¹, mass of stump – 8.4 t·ha⁻¹, which makes for, respectively, 66%; 20% and 14% of the above – ground biomass of the whole birch stand (number of trees – 2500 trees·ha⁻¹).

The mass of above – ground tree parts in a 12 – year grey alder stand has the following distribution: mass of stem, fresh harvested – 90.7 t·ha⁻¹; mass of branches – 56.6 t·ha⁻¹; mass of stump – 35.9 t·ha⁻¹, which makes for, respectively, 49.5%; 30.9% and 19.6% of the above – ground biomass of the whole grey alder stand (number of trees – 4200 trees·ha⁻¹).

In the aforementioned stands, the under-ground biomass has been divided by parts: coarse roots (>2 mm) and fine roots (<2 mm).

The biomass of coarse roots in 10-year birch stands is 10.1 t·ha⁻¹, while in 12-year grey alder stands it is 28.0 t·ha⁻¹.

The biomass of fine roots in birch stands per 1 ha is 5.431 t·ha⁻¹, the length of roots – 3.169 km·ha⁻¹, the volume of roots – 8.11 m³·ha⁻¹ in air-dry condition, while in grey alder stands the biomass of fine roots is 12.5 t·ha⁻¹, the length of roots – 7.29 km·ha⁻¹, the volume of roots – 18.65 m³·ha⁻¹ in air-dry condition.

To calculate the accumulated carbon, data obtained with element analyser MACRO CHNS were used, and they show that the wood, roots and leaves of birch in completely dry condition contain, on average, 50.5% carbon, while those of grey alder contain 49.9% carbon.

The amount of carbon accumulated in the above-ground biomass of a 10-year birch stand on average is 21.2 t·ha⁻¹, but in roots – 7.35 t·ha⁻¹, while in a 12-year grey alder stand these amounts are, respectively, 45.8 t·ha⁻¹ and 10.1 t·ha⁻¹.

According to findings of scientists (Gaitnieks, 2007; Daugaviete, 2008), the amount of carbon accumulated in root biomass in the boreal forest zone makes for, on average, 12-25% of the total amount of carbon accumulated per 1 ha. Our study data confirm that the amount of carbon accumulated in roots compared to that in the above-ground biomass in a 10-year birch stand makes up 24%, but in a 12-year grey alder stand – 22%.

CONCLUSION

The studies show that 2.28 times more biomass can be accumulated in 10-year grey alder stands in comparison with birch stands of the same age.

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