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Biomass and Bioenergy 29 (2005) 10–21
BIOMASS & BIOENERGY
www.elsevier.com/locate/biombioe

Growth and production of a short rotation coppice culture of poplar. III. Second rotation results

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Received 30 September 2004; received in revised form 3 February 2005; accepted 14 February 2005
Available online 7 April 2005

Abstract

This study describes production and growth of the second rotation of 17 poplar (*Populus* spp.) clones in a short rotation coppice culture (SRC). In addition, the link with leaf characteristics was studied. In April 1996, an experimental field plantation with 10,000 cuttings ha^{-1} was established on a former waste disposal site. In December 1996, January 2001 and February 2004, all stools were coppiced. At the end of the second rotation (2001–2003), highest biomass production was found for *P. nigra* clone Wolterson with 9.7 $Mg\,ha^{-1}\,y^{-1}$. The best performers of the first rotation, i.e. *P. trichocarpa* × *P. deltoides* clones Hoogvorst and Hazendans, performed poorly in the second rotation, due to heavy rust infections. Two growth strategies were evident: Wolterson had a slow elimination of smaller shoots and had lots of smaller leaves; Hazendans and Hoogvorst had a rapid elimination of smaller shoots and had fewer, larger leaves. We conclude that shoot growth dynamics and leaf size were not the primary production determinants in our poplar SRC. But *Melampsora larici-populina* remained an important external determinant of biomass production.

Keywords: *Populus* Spp.; Short rotation coppice; Biomass production; Mortality; Leaf

1. Introduction

Short rotation forestry (SRF), i.e. fast-growing tree crops grown in carefully tended plantations for rotations shorter than 15 years [1,2], is limited to a few hectares of experimental plantations in Belgium (J.-M. Jossart, 2003, personal communication). Nevertheless, Belgium's Kyoto target is a 7.5% reduction of fossil fuel emissions by 2008–2012 compared to 1990. Energy crops have an important role to play [3], in particular SRF because of its numerous ecological benefits: it has a positive impact on biodiversity, on nutrient capture and on the carbon circulation in the soil-plant atmosphere system, especially on former agricultural land. Furthermore, they protect the soil from water and wind erosion [4–6]. However,

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0961-9534/$ - see front matter
doi:10.1016/j.biombioe.2005.02.005

free space is getting very scarce in Belgium. One option is to establish SRF plantations on set-aside land [3]: agricultural land offers optimal soil conditions. However, SRF is not yet profitable without subsidies. Under optimal conditions, small-plot yields achieved by poplar (*Populus* spp.) are in the order of 20–25 $Mg\,ha^{-1}\,y^{-1}$ in trials conducted in the USA (PNWS) [7–9]. Under less optimal conditions, annual yields of 10–15 $Mg\,ha^{-1}$ are more realistic [10]. Another option is to establish SRF plantations on marginal or slightly polluted land. Trees will stabilize the surface, prevent dust-blow, and reduce leaching and run-off of water. SRF on contaminated land provides therefore a means not only for stabilization and decontamination (e.g. heavy metal uptake) of a site, but also for some economic return from the land [5]. However, clones should be selected that grow well under less optimal conditions.

In Belgium, poplar and willow are most suitable for SRF. High biomass production is achieved by selecting clones with high growth vigor and disease resistance, and by applying certain agricultural techniques, such as site preparation, weed control and high planting density [1,2]. In addition, cultural management generally involves coppicing, i.e. the cutting of a tree at the base of its trunk to use the ability of the trees to regenerate from the cut stump, resulting in the emergence of new shoots from the stump and/or roots [11]. Coppicing is frequently applied at the end of the establishment year to promote sprouting of many shoots per cutting, which is supposed to increase final biomass production [1,2]. So far, poplar breeding has never focused on the creation of poplar clones specifically suited for a coppice system. Nevertheless, poplar performs rather well in coppice cultures [12]. However, current biomass yields are not high enough to be economically feasible. Therefore, further breeding is necessary to produce clones characterized by superior growth, and resistance to pests and diseases of leaf and stem.

In this study, a short rotation coppice culture (SRC) with different poplar clones provided the opportunity to study the relationship between biomass production and some anatomical parameters for a wide genotypic range. In addition, very few studies have quantified biomass productivity over more than one rotation cycle in SRC. Therefore, the objectives of this paper were:

1) to quantify the above-ground biomass productivity of 17 clones in a SRC at the end of the second rotation;
2) to study the link between biomass production and shoot growth dynamics;
3) to study the link between biomass production and leaf characteristics;
4) to study clonal differences in biomass distribution to leaves, stem and branches.

2. Materials and methods

2.1. Experimental set-up and plant material

In April 1996, a short rotation coppice plantation was established in an industrial area of Boom near Antwerp, Belgium (51°05′N, 04°22′E). The plantation is situated on an old household waste disposal site, which was covered with a 2-m-thick layer of sand, clay and mixed rubble. The soil was characterized by a high bulk density (heavy clay-loam), ranging between 1.22 and 1.62 $g\,cm^{-3}$, and by a high pH (7.3–8.1). The upper soil horizons contained between 0.8% and 1.8% organic matter. The nutrient and mineral reserves were extremely high in comparison with forest soils, but moderate in comparison with agricultural soils [12]. The site is situated at 5 m above sea level, and has a temperate climate with a mean temperature of 10 °C and a mean annual precipitation of 767 mm. Prior to planting, the area was leveled and cleaned of large stones, plastic, metal and other debris. A rotor tiller was used in the early spring of 1996 for final pre-planting soil preparation.

Seventeen poplar (*Populus*) clones, belonging to five different parentages were studied, i.e. *P. trichocarpa* T. & G. × *P. balsamifera* L. (T × B) clone Balsam Spire; *P. trichocarpa* × *P. deltoides* Marsh. (T × D) clones Beaupré, Boelare, Hazendans, Hoogvorst, Raspalje and Unal; *P. trichocarpa* (T) clones Columbia River, Fritzi Pauley and Trichobel; *P. deltoides* × *P. nigra* L. (D × N) clones Gaver, Gibecq and Primo; *P. deltoides* × *P. trichocarpa* (D × T) clones IBW1, IBW2 and