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The influence of rotation length on the biomass production and diversity of ground beetles (*Carabidae*) in poplar short rotation coppice

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ARTICLE INFO

Article history:
Received 18 September 2012
Received in revised form
7 February 2013
Accepted 11 February 2013
Available online 15 April 2013

Keywords:
Short rotation coppice
Biomass yield
Biodiversity
Poplar
Carabidae

ABSTRACT

Results are presented from the evaluation of biomass production and biodiversity in experimental poplar short rotation coppice grown under three different rotations: 1-, 3- and 6-year. The experiment was established in a 9-year-old plantation of poplar clone Max-4 (*Populus nigra* L. × *Populus maximowiczii* Henry) in the locality Peklov, Czech Republic. The following tree parameters were measured: tree height, stem diameter and number of stems per tree. Above-ground biomass was harvested in the winter months. Yields of fresh biomass were weighed and survival rates were counted to calculate yields of dry biomass per hectare. Biodiversity was evaluated using a selected group of biological indicators – beetles of the *Carabidae* family. Individual collections of beetles from pitfall traps were assessed and statistically evaluated. The *Carabidae* individuals were divided into ubiquitous, adaptable and rare groups according to their habitat requirements. The Simpson biodiversity index, evenness, and level of anthropogenic influence were calculated. Results showed the following: i) length of rotation influences all measured and calculated parameters including biodiversity; ii) the highest average dry biomass yield of 11.7 Mg ha^{-1} y^{-1} was found in the 6-year-rotation block; iii) rotation statistically significantly influenced ubiquitous ground beetles, which were 2.30× more abundant in the 6-year rotation than in the 3-year rotation.

1. Introduction

Previous research and experience showed that selected clones of poplar and willow in temperate climatic regions can be harvested repeatedly in very short rotations (2–5 years) for at least 15 years [1,2]. The probably oldest experimental poplar clone test (including Max-4) in Hannovesch Münden, Germany has been harvested in 2-year rotations for 32 years with average yields reaching 10 Mg ha^{-1} y^{-1} (Janssen A, personal communication at Fifth International Poplar Symposium, Orvieto, Italy 2010 September 20–25). The productivity and vitality of SRC (short rotation coppice) plantations depend mainly on good stump sprouting and high increments of stem height and diameter. Apart from the genetically coded characteristics of poplar and willow clones, other factors also contribute to good plantation growth. Such factors include

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0961-9534/$ – see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.biombioe.2013.02.012

site suitability, rotation length and quality of plantation establishment and cultivation. Careful selection of suitable sites for an SRC plantation can have equal or even higher importance than the selection of a particular poplar (willow) clone for productivity and vitality of SRCs [2].

Fast growth and sprouting after harvests are essential for early establishment of a canopy that creates a specific stand climate and conditions important for plantation growth (weed suppression, litter-humus creation). In comparison to annual crop fields or grasslands, SRCs typically have lower temperatures and higher air humidity at ground level below the closed tree canopy [3]. It was documented that SRC can create suitable conditions for quite different biota than those adapted to an intensively cultivated agricultural landscape with dominating annual crops [4], thus increasing the opportunity for higher biodiversity.

In this study, ground beetles have been selected for biodiversity evaluation in the experimental SRC. In various ecological studies these beetles were used as a model group, mainly because of their specific response to different ecosystems and changes in environment [5–8]. Beetle occurrence depends on many abiotic and biotic factors, e.g., humidity and vegetation character, temperature, geologic substrate, migration ability, predation and anthropogenic influences. Species diversity and abundance significantly aid in maintaining the material and energy-exchange-cycle balance in local ecosystems [9]. Hůrka [10,11], divided the ground beetle family according to the wide range in ecological valence and the intensity of anthropogenic influence: ubiquitous U (in his literature mentioned as eurytopic), adaptable A and stenotopic R (rare) groups.

This study aimed to test a hypothesis that the SRC rotation length influences not only a plantation's production and biometric parameters, but also its biodiversity. More specifically, plantations with longer rotation periods may be more suitable for "adaptable" organisms (adapted to certain narrow and stable conditions) and those with shorter rotations are more suitable for "ubiquitous" organisms that are in terms of anthropogenic influence more flexible.

2. Methodology

2.1. *Locality and experimental (SRC) plantation*

The Peklov experimental plantation located approximately 2 km east of Kladno, a town in Central Bohemia (50°7′27.919″N, 14°9′33.555″E) belongs to a drier, slightly warmer temperate climatic region (MT4) of the Czech Republic with mean daily temperature between 7 °C and 8.5 °C and annual precipitation between 450 and 550 mm (Figs. 1. and 2).

The plantation site is in a flat location at an altitude of 375 m. The soil profile has brown acidic soils and slightly gley forms found on marls and hard to medium-hard marlstones with good hydrologic conditions, fairly supplied with nutrients for poplar culture (see Table 1). Ground water level is about 2 m deep. The field was weedy before the plantation was established and therefore, the soil was deep ploughed and harrowed two weeks before cuttings were planted.

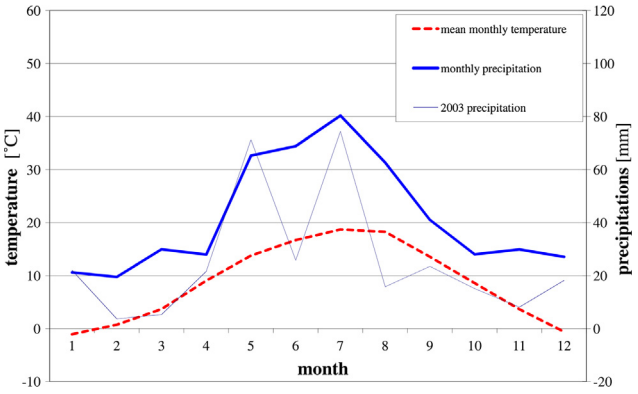

Fig. 1 – Climadiagram (1994–2010) of the nearest meteorological station Praha-Ruzyně.

The 247 m × 37 m Peklov SRC plantation was planted manually between March 20 and April 15, 1994. Total area of the plantation is 0.91 ha including hedges, which is similar to typical Czech poplar SRCs used for production of firewood and/or woodchips. A single-row planting scheme was chosen (0.5 × 1.5 m), which is equal to the theoretical number of 13,333 plants per hectare. Poplar clone Max–4 (*Populus nigra* L. × *Populus maximowiczii* Henry) was used.

Rows were weeded manually and a glycophosphate herbicide applied in between the rows only in the first year of plantation growth. The plantation has not been watered nor fertilized since its establishment. Such "low-input" agronomy is widely used in well growing plantations of poplar clone 'Max-4' in the Czech Republics on suitable sites, with sufficient nutrient concentrations and favorable hydrological conditions. This clone usually creates a dense tree canopy two years after each harvest. This dense tree canopy strongly suppresses the growth of the grass layer (weeds).

The plantation had been used for commercial purposes during the first 9 years (1994–2002). The whole plantation (identical to current blocks A–D) was harvested in non-–regular rotations twice in a 2-year and once in a 5-year rotation depending on biomass demand from the local farm stables' wood boiler. The plantation's owner had tested different harvesting technologies on the whole SRC during this period. The owner has allowed our department to use the SRC plantation for scientific purposes since the winter of 2002/2003. The plantation was then divided into four parts – blocks A, B, C, D, all with the same harvesting history (Fig. 3).

The area of experimental plantation evaluated in the presented experiment consists of three equal blocks A, B, C (50 × 30 m each) with poplar clone Max-4 (Fig. 3.). Block A is harvested every year, block B every 3 years and block C every 6 years. Block D represents an experiment with transformation of short rotation coppice to poplar ligniculture (Fig. 3.). Block E contains a clone test with more than 20 poplar genotypes, which was established in 2004 (one year later than the experimental plantation). It was never harvested. A field biotope is adjacent to Blocks A, B, C from the east and a fallow land from the south and partially also from the west.