Forest Ecology and Management 364 (2016) 165–172

Contents lists available at ScienceDirect

Forest Ecology and Management

journal homepage: www.elsevier.com/locate/foreco

The effect of birch removal on growth and quality of pedunculate oak in a 21-year-old mixed stand established by row planting

Mateusz Liziniewicz [a,*], Tadeusz Andrzejczyk [b], Stanisław Drozdowski [b]

[a] Swedish University of Agricultural Sciences, Southern Swedish Forest Research Centre, Box 49, Alnarp, Sweden
[b] Warsaw University of Life Sciences-SGGW, Faculty of Forestry, Department of Silviculture, Nowoursynowska 159/34, 02-776 Warszawa, Poland

A R T I C L E I N F O

Article history:
Received 28 October 2015
Received in revised form 7 January 2016
Accepted 11 January 2016
Available online 21 January 2016

Keywords:
Oak
Quercus
Competition
Mixed-stand
Birch
Betula

A B S T R A C T

We examined growth and quality parameters of young oaks growing with birch in a row-mixtures planted as two rows oak and one row birch, and subjected to different levels of birch removal. The experiment was established eleven years after planting. Three levels of birch removal were applied: removal of every second birch row (R50), removal of every second birch tree (T50) and complete removal of birch (R100) plus a control from which no birch were removed. This produced a total of five treatments with different competition situations i.e. birch density and spatial arrangement of oak and birch. The experiment was located in north-eastern Poland on a moderately fertile site. All analyzed growth and quality traits were significantly affected by the applied treatment in the 10-year period of the study except mean height and diameter of the thickest living branch. Total removal of birch resulted in the greatest values of growth parameters for oak. Oaks growing 3 m away from birches in the R50 treatment had similar growth parameters to those where all birches were removed. Oaks without birch competition were significantly larger in diameter at breast height (1.3 m) than those growing in competition with birch. Total removal of birch resulted in a greater mean of the thickest branch diameter; however, differences with other treatments were small. Our results demonstrate the negative effect of birch competition on oak, but also show that if birch is kept in a mixed-stand for a longer period it may enhance a stand's volume production.

© 2016 Elsevier B.V. All rights reserved.

1. Introduction

The traditional production of high-quality sessile oak (*Quercus petraea* (Matt.) Liebl.) and pedunculate oak (*Quercus robur* L.) that are two most important oak species in Europe is expensive because of the long rotation and intense silvicultural measures required. In central Europe, rotation ages for both species are between 140 and 250 years depending on thinning model (Burschel and Huss, 2003; Guericke et al., 2008). Typical silviculture measures in oak stands include weed and browsing control, numerous pre-commercial thinnings and thinnings (Evans, 1984; Spiecker, 1991). The tendency to develop epicormic shoots (Colin et al., 2010; Evans, 1982) requires often pruning to improve stem quality (Attocchi, 2013; Kerr and Harmer, 2001; Wignall and Browning, 1988) or planting understory of shade tolerant species e.g. hornbeam (*Carpinus betulus*) to prevent development of epicormic shoots (Burschel and Huss, 2003; Dieckert et al., 1982; Krahl-Urban, 1959). The production goal of oak management is to produce high quality timber mainly for floor, furniture and veneer industries. The commonly used parameters defining quality of oak logs are diameter, clear bole length, straightness, absence of rot, shake and cracks, annual ring width and epicormic branches (Attocchi, 2015). Both species have been found to be well adapted to warmer and more extreme climate that is predicted for the central Europe in the future (Bolte et al., 2009), thus, oaks ecological and economical role in forest management is likely to increase (Rigling et al., 2013; Schelhaas et al., 2015).

In order to improve the economic return, cheaper methods of establishment and managing stands (Andrzejczyk et al., 2015; Gockel, 1995; Kenk, 1993; Petersen, 2007; Saha et al., 2012) as well as shorter rotations of oak (Evans, 1984; Kerr, 1996; Kerr et al., 1992; Weaver and Spiecker, 1993) have been considered. An admixture of coniferous or fast growing broadleaved species in oak stands has been recommended as a method to improve both timber quality and stand productivity (Drössler et al., 2015; Evans, 1984). Both oaks species are light demanding (Krahl-Urban, 1959) but in a young age they tolerate shading (Welander and Ottosson, 1998; Zarzycki et al., 2002). They are highly susceptible for spring frost damages causing shoots dieback (Chaar and

* Corresponding author.
E-mail address: Mateusz.liziniewicz@slu.se (M. Liziniewicz).

http://dx.doi.org/10.1016/j.foreco.2016.01.011
0378-1127/© 2016 Elsevier B.V. All rights reserved.

Colin, 1999; Puchalski and Prusinkiewicz, 1990). Thus, in young oak stands, admixture species have been recommended to fulfill a protecting role against frost, and wind and solar radiation (Comeau and Heinemann, 2003; Leder, 1996; Petersen et al., 2009). The most common admixed species used in oak stands are Norway spruce (*Picea abies* L. Karst) (Andrzejczyk, 2007; Evans, 1984; Johansson, 2003; Kerr et al., 1992; Linden and Ekö, 2002) and Scots pine (*Pinus sylvestris* L.) (Andrzejczyk, 2007; Bergmann, 2003; Evans, 1984; Szymański, 1966). Recently, there has been an increased interest in central Europe regarding the use of silver birch (*Betula pendula*) as a temporary admixture with oak as it often regenerates naturally on clear-cuts (Ammer and Dingel, 1997; Bielak, 2010; Leder, 1996).

Silver birch as pioneer species, often regenerates naturally and grows fast when young, which increases the level of competition with the principal species (Cameron, 1996; Jaworski, 2012). Studies of how naturally regenerated birch influences the growth of oak have shown that the diameter-growth of oak decreased 1–2 years after the competition with birch first appeared. A decrease of height growth occurred several years later (Petersen et al., 2009; Wagner and Röker, 2000). von Lüpke (1991) and Petersen et al. (2009) found that diameter-growth was reduced even when the level of competition with birch was low, whereas height-growth was affected only by strong competition. Naturally regenerated birch is therefore usually removed from the oak stands during cleaning and pre-commercial thinning (Lockow, 2006; von Lüpke, 1991). However, Leder (1996) showed that it is possible to keep naturally regenerated birch in young oak stands if it is selectively removed during management operations.

Retaining birch in young oak stand established as monoculture in initial density between 6000 and 8000 seedlings ha^{-1} i.e. spacing of 1.5 × 1.1 m is difficult due to competition exerted on oak (Wagner and Röker, 2000). Keeping naturally regenerated birch is particularly possible in oak stands that have been established with wide initial spacings (Andrzejczyk et al., 2015; Kenk, 1993) or in group-planted oak stands (Petersen, 2007; Saha et al., 2012). In such stands, birch and other naturally regenerated species replace intraspecific oak competition. These trees have been found to have a positive impact on oak quality, namely by reduction of branch diameter size (Andrzejczyk et al., 2015) or acceleration of the natural pruning rate (Dong et al., 2007; Rock et al., 2004; Wagner and Röker, 2000).

The lower rates of diameter and height growth of oak growing under influence of naturally regenerated birch has revealed that birch removal is needed to keep growth parameters of oak at acceptable level (Wagner and Röker, 2000). Thus, keeping birch in oak stands established as traditional, closely-spaced monocultures e.g. planting density >6000 seedlings ha^{-1}, might be difficult. Andrzejczyk et al. (2015) found that planting oak with wide row spacing (3.0 m or 4.5 m) might lead to establishing stands mixed with birch. In a group-planting experiment**,** Rock et al. (2004) and Saha et al. (2014) found that only those birches growing close to oak need be removed in order to limit any negative influence on oak. Andrzejczyk et al. (2015) concluded that the time of removal should be carefully adjusted to the dynamics of the stand, while Stahl and Gauckler (2009) recommended removing birch only after it had fulfilled its role as a nurse crop, i.e. its role in protecting young oaks against frost.

In Poland, planting mixed stands of birch and oak are used in reforestation of agricultural areas. Such stands are usually established as row-mixtures with one or several rows of oak trees planted between rows of admixture species e.g. birch. In these situations, the birch, being a fast growing species, can be used to produce pulpwood in a relatively short time period of 15–20 years (Andrzejczyk, 2007; Dieckert et al., 1982). Andrzejczyk (2008) found that the spatial distribution and proximity of oak and birch established as row-mixture, has the strongest influence on growth and quality parameters 8–9 years after planting. Birch had a negative effect on oak height and diameter at breast height in all rows immediately adjacent to a birch row, but not on the middle row of a 3-row planting of oak. Consequently, a minimum distance of 3 m between oak and birch rows was recommended in order not to disturb DBH and height-growth of oak up to a height of 7 m or 8 m.

In the present study, we investigated how individual birch trees might be kept in an oak stand for at least 15–20 years without deteriorating any growth and quality parameters of the oak. We established the experiment in a 11-year-old oak stand planted in row-mixtures with birch growing as single rows interspersed with double rows of oak, with 1.5 m between rows. We examined the effect of different level of birch removal from the planted stand. The removal levels differed in their intensity and spatial pattern. The main hypothesis analyzed in this study was that the total removal of birch improves the height-growth and diameter-growth of the remaining oaks. The auxiliary hypothesis was that the removal of every second birch row makes it possible to keep birch as an admixture in an oak stand. The hypothesis was tested by comparing growth and quality traits e.g. diameter at breast height, mean height, top height, and the thickest branch diameter, one, two, six and ten years after birch removal.

2. Materials and methods

2.1. Study area

The material for this study was collected in an experiment in Krynki located in north-eastern Poland (53°19′N, 23°83′E, alt. 180 m a.s.l., Fig. 1). The climate of the area is under continental influence with a mean January temperature of −3.5 °C and mean annual precipitation of 600 mm. In the vegetation period from 1st May to the end of September, a mean temperature is 13.9 °C and rainfall 376 mm. The soil moisture class in the experimental stands was fresh and the soil type was luvisol (CILP, 2000).

The stand was planted in 1996 on abandoned agricultural land. Two-year-old, bare-rooted oak and silver birch seedlings were planted in row-mixtures: two rows oak and one row birch. The initial spacing was 1.5 m between rows regardless species and 0.8 m and 1.0 m between trees within a row for oak and birch respectively. Thus, the distance between birch rows were 4.5 m and two oak rows were planted in between; that was 5500 oaks ha^{-1} and 2200 birches ha^{-1}. Seedlings of both species were from local provenances. In spring 2003 a schematic removal of birch was conducted in which every other tree was removed in each birch row while oaks remained untouched.

2.2. Experimental design and treatments

In spring 2005, the experiment concerning birch removal was established. Three different treatments were applied *viz.* (*i*) removal of every second birch row (R50), (*ii*) removal of every second birch tree (T50), (*iii*) complete removal of birch (R100). There was also a control plot without birch removal (C). Because we assumed that growing conditions differed according to the distance between trees, for data analysis, the R50 treatment was divided into two separate sub-treatments *viz.* R50_1.5 – oaks growing at a distance of 1.5 m from birch, and R50_3.0 – oaks growing at a distance of 3.0 m from birch.

The experiment was designed as a randomized block with three blocks and four rectangular plots within each block (25 m × 22.5 m). Each plot comprised five rows of birch and ten rows of oak. The net-plot area was 0.056 ha for all plots. Each treatment was randomly assigned to one plot within each block.

Download English Version:

https://daneshyari.com/en/article/6542405

Download Persian Version:

https://daneshyari.com/article/6542405

Daneshyari.com