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Long-term response of weed control intensity on Scots pine survival, growth and nutrition on former arable land

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Abstract The effects of post-planting weed control intensity on the cover and composition of ground vegetation, and on growth, survival and foliar nutrient concentrations of 4-year old bare-rooted Scots pine (*Pinus sylvestris* L.) seedlings were studied over a 15-year period with experimentation on former arable land. Weed control treatments with terbuthylazine and glyphosate were carried out 1–3 times during successive years, either as overall or as spot applications. The vegetation cover and the shading effect of vegetation decreased with increasing weed control intensity. The more intensive the weed control was, the better was the afforestation result in terms of tree seedling growth and survival. Overall application repeated three times increased seedling survival by 79 percentage points, and their final height, breast height, diameter, and stand volume after 15 years were increased by 183, 19, 15, and 822%, respectively. Weed control did not affect the foliage nutrient concentrations, except for magnesium. However, increase in weed control intensity was reflected in larger needle size 5 years after planting.

Keywords Scots pine · Afforestation · Weed control · Foliar weight · Nutrient concentration

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Introduction

Afforestation of former arable land is often challenging. Agricultural practices, e.g. fertilisation, liming and ploughing, have changed soil properties. In boreal and temperate regions, phosphorus and potassium concentrations of former agricultural lands have been reported to be higher than in surrounding pristine forests 20–70 years or even 150 years after afforestation (Koerner et al. 1997; Falkengren-Grerup et al. 2006; Hytönen and Wall 1997; Ritter et al. 2003; Wall and Hytönen 2005). Agricultural soils can also contain large banks of viable seeds (Paatela and Erviö 1971; Törmälä 1982; Kiirikki 1993). Development of ground vegetation after soil preparation is rapid, and competition for water, nutrients and light between tree seedlings and weeds can be extremely severe, often resulting in afforestation failure. Several studies report that increase in vegetation cover on former arable land also increases the risk of vole damage (Ferm et al. 1994; Nordborg and Nilsson 2003; Hytönen and Jylhä 2005). Consequently, weed control is one of the most important silvicultural practices to be carried out when establishing a forest plantation on former arable land.

When competition from ground vegetation is intense, its reduction is important especially at the initial phase, and competition should be reduced and held back for at least two or three post-planting growing seasons (Lund-Høie 1984; Hytönen and Jylhä 2005, 2008; Jylhä and Hytönen 2006). A single application of the most effective herbicides can reduce competition over a 3-year period on former arable land (Hytönen and Jylhä 2005; Jylhä and Hytönen 2006). Recently, however, many soil-active herbicides with long efficacy have been withdrawn from the market, and repeated herbicide applications are not recommended in practical forestry in Finland. Currently, only glyphosate