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Summer planting of *Picea abies* container-grown seedlings: Effects of planting date on survival, height growth and root egress

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Abstract

In order to make mechanized planting economically viable, the present spring planting period of Norway spruce (*Picea abies* (L.)) seedlings in Fennoscandia needs to be enlarged. To evaluate the possibilities of enlarging the planting period, seven field experiments were established in the course of 3 years, during which actively growing or short-day-treated seedlings were planted regularly from the beginning of July to the middle or end of September, depending on the experiment, and also the following spring. The survival of seedlings differed between experiments, but the planting date had an effect only in the experiment where seedlings were planted on a mounded site with no short-day treatment before planting. Seedlings planted after mid-July were more susceptible to damage from night frosts. Seedlings planted in July and early-August had greater root egress and growth in height after the planting in comparison to seedlings planted after mid-August and during the following spring. For plantings in July, actively growing seedlings can be used without negative effects on their field performance. In order to avoid possible frost damage, short-day treatment is recommended before planting for seedlings used in plantings performed in August and later in the autumn.

Keywords: Frost; drought; Height growth; Norway spruce; Pine weevil; Planting date; Root growth; Short-day treatment

1. Introduction

In Fennoscandia seedlings are conventionally planted as dormant during May and early-June. Nowadays, seedlings are increasingly planted by machine. To ensure that the investment in an expensive planting machine is economically viable, the operation time of a machine per year should be as long as possible. The planting period should be expanded from conventional spring planting to the summer months when seedlings are actively growing.

Rikala (1996) and Luoranen et al. (2003) showed that actively growing silver birch (*Betula pendula* Roth) container seedlings can be planted safely in July and those seedlings grow even better than seedlings planted at the dormant stage in autumn or the following spring. The rapid root egress and seasonal maximum soil temperatures existed at the time of planting (Luoranen et al., 2003) and had an apparent impact of the increased growth of seedlings planted in the middle of the summer. According to Heninger and White (1974), high soil temperatures (19–31 °C compared to 15 °C) promote the root and shoot growth of paper birch (*Betula papyrifera* March). Furthermore, findings with coniferous species have shown that root growth starts after the root zone temperature rises above 5 °C, increases rapidly at 12–17 °C and attains maximum values at 20 °C (Andersen et al., 1986; Lopushinsky and Max, 1990; Vapaavuori et al., 1992; Iivonen et al., 1999; Domisch et al., 2001).

We showed in a previous study that it is possible to extend the planting period of Norway spruce container seedlings to mid-June using seedlings intended for spring planting, either when they are stored outdoors and growing, or when they are frozen-stored and dormant (Luoranen et al., 2005). Numerous studies also exist concerning the planting of Norway spruce seedlings during the summer months (June–August). Heikinheimo (1941), in Finland, and Mork (1951), in Norway, have demonstrated that planting Norway spruce bare-root seedlings is possible, but drought in some years may markedly reduce the survival of seedlings. The roots of container seedlings are not as dry-sensitive as bare-root seedlings, and drought is not a particularly high risk (Helenius et al., 2002a).

In the 1970s experiments with either three or four planting dates during a season were conducted in Sweden, and no

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