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ORIGINAL ARTICLE

Insecticides sprayed on seedlings of *Picea abies* during active growth: Damage to plants and effect on pine weevils in bioassay

JAANA LUORANEN & HELI VIIRI

Suonenjoki Research Station, Finnish Forest Research Institute, Suonenjoki, Finland

Abstract
In Finland, the planting period for Norway spruce [*Picea abies* (L.) Karst.] has lengthened from spring to summer so that seedlings are also planted during the active growing stage, not only when dormant. On many regeneration sites, there is a high risk of damage by the large pine weevil, *Hylobius abietis* L., and insecticide treatments are needed to protect seedlings against these weevils. However, all currently available insecticides have been tested and accepted for use only on seedlings that are not growing actively. In this study, actively growing Norway spruce seedlings were treated with three insecticides in mid-June, when the current year's shoot was about 7 cm and unlignified. At this stage of growth, GORI 920® (permethrin) damaged needles and reduced the following year's height growth. Decis Tab® (deltamethrin) and Karate Zeon® (lambda-cyhalothrin) caused no side-effects. All three products were also more or less effective in preventing feeding of pine weevils 1 yr after the treatments. Further studies are needed to investigate the possible harmful effects of insecticides in different stages of growth during the growing season.

Keywords: *Chemical control, deltamethrin, feeding, field performance, height growth, Hylobius abietis, lambda-cyhalothrin, Norway spruce, permethrin, pine weevil, survival.*

Introduction

Hylobius species feed on root collars and stems, and *Hylastes* species on root collars and roots of seedlings, causing extensive damage and thus creating problems for forestry. Currently, the most reliable way to protect seedlings from such damage is treatment with insecticide. On the European market, several active ingredients (a.i.) have been used for pine weevil control, e.g. alpha-cypermethrin, bensultap, deltamethrin, esfenvalerate, lambda-cyhalothrin and permethrin. In the Nordic countries the most widely used insecticide for protection of conifer seedlings against the pine weevil has been permethrin. In 1996 almost 80% of all the insecticides used in Finnish forest nurseries had permethrin as the active ingredient (Juntunen, 2001). In Finland, pine weevil insecticides are applied to seedlings in the nursery and are not reapplied on regeneration sites. In Sweden, permethrin has long been the only insecticide accepted for pine weevil control. In Denmark, however, several active ingredients were available in 1999: alpha-cypermethrin, esfenvalerate, lambda-cyhalothrin and permethrin (Fjelsted Pedersen & Ravn, 2000). Since 2004, permethrin is no longer registered within the European Union (EU) market. Furthermore, in Finland deltamethrin is the only insecticide available for chemical protection of seedlings against pine weevils (Anon. 2004). Chemical control of the pine weevil is an essential part of successful forest regeneration, while problems related to the application and installation of mechanical protection remain to be solved.

In southern Fennoscandia the abundance of pine weevils and the risk of seedling damage is high one to three growing seasons after final cutting (Långström, 1982; Nordenhem, 1989; Hagner & Jonsson, 1995). Although the abundance of pine weevils is greater early in the growing season than late in the season (Långström, 1982; Nordenhem, 1989), feeding by weevils continues throughout the growing season. Thus, seedlings planted in summer need protection against feeding both in the year of planting and

Correspondence: J. Luoranen, Suonenjoki Research Station, Finnish Forest Research Institute, Juntintie 154, FI-77600 Suonenjoki, Finland. E-mail: jaana.luoranen@metla.fi

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