Mini Seedlings – A New Forest Regeneration System

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Introduction

Swedish forest tree nurseries produce approximately 300–350 million seedlings annually for outplanting. Most seedlings (80%) are containerised i.e. they are produced in small containers or pots that are filled with a growing media. The most common growing media is peat. The volume of the containers vary between 45 and 150 ml and seedlings are grown at densities of about 300 – 900 seedlings m^{-2}. The seedlings when outplanted are usually 1–3 years old.

Large seedlings cause high costs when they are raised in the nursery due to the long growing time at low densities. Also, costs for handling, transportation and planting normally increase with the size of the seedling. Large seedlings also put strain on the environment as the need for energy, fertilization and pesticides are high.

One of the largest problems in Swedish forestry is the damage caused by the large pine weevil (*Hylobius abietis* L.) in conifer reforestation areas. The adult weevil gnaws the stem bark of conifer seedlings and may often cause severe plant mortality (Eidmann 1969). The first years after planting are critical (Långström 1982) and to make a normal seedling survive the pine weevil, the seedlings must either be protected by mechanical or chemical means (insecticides) (Pettersson 2004). In the future synthetic pyrethroides and other insecticides will probably be prohibited. Therefore alternatives to chemical protection of seedlings need to be found. By postponing planting until 2–3 years after clear cutting the risk for pine weevil attacks are normally reduced (Örlander et al. 1997), but the delayed planting may cause other problems such as production losses and problems with competition from vegetation.

Studies have shown that the pine weevil prefers planted seedlings before small naturally generated or seeded seedlings (Trädgårdh 1939, Selander et al.1990, Selander and Immonen 1992). This knowledge was the main reason for the start of a project with the aim of testing very young seedlings (mini seedlings) in field trials (Gyldberg and Lindström 1999). Other arguments for testing mini seedlings was the known fact that short growth in the nursery could reduce risks for root deformation and instability of the tree when outplanted (Rune 2003) as well as the potential of reducing forest regeneration costs.

Mini Seedlings – A New Cultivation System

The mini seedling is grown for only 8–12 weeks in small containers, 10–20 ml, at a density of 1500–2000 m^{-2}. The seedling is quite small when outplanted, only 4–6 cm high. Using this short cultivation time, roots have small possibilities of armouring the substrate. Therefore, suitable cultivation systems for mini seedlings include a reinforcement of the substrate either by encasing the growing media in a net or by the use of binding agents.

There are numerous advantages and possible potentials with mini seedlings. As a result of the short cultivation period the need of fertilizers and pesticides in the nursery will be reduced which makes the system environmentally friendly. The nurseries will also be able to deliver seedlings continuously for planting and fulfil orders at short notice. The need for greenhouse and storage space will be reduced which will lower production costs. Also the need of over wintering seedlings will be reduced. This considerably lowers the risk for seedling losses. The small size of the seedling enables transportation, handling and planting to become more efficient.

Field Experiences

Numerous field trials in central Sweden show that mini seedlings are attacked by pine weevil to a lesser extent than normal sized 1-year-old containerized seedlings (Lindström et al. 2000, 2002, 2004). The difference in pine weevil attacks between the plant types is very large after 1 year but is reduced in the second year, when mini seedlings have grown into a size that is more preferred by the pine weevils (Figure 1). However, the attacks on the mini seedlings in the second year are still lower than for the normal sized reference seedlings. Due to less injury from the pine weevil, survival rates are the same and in some cases even better for the mini seedlings than for normal sized reference seedlings (Lindström et al. 2004).

Results also indicate that the mini system can be used both for Scots pine (*Pinus sylvestris* L.) and Norway spruce (*Picea abies* (L.) Karst.). So far experiences from five years of field testing indicate that insecticide treatment is not needed for mini seedlings before planting and that planting can be done one or two years earlier after the final felling than with conventional sized seedlings.

Shoot growth during the first year is usually small for the mini seedling. The mini seedling seems to give priority to root growth during the first year of establishment. This may partly explain the limited shoot growth. During the second year however the growth is comparable to a conventional seedling. Results from 2–3 years old field trials indicate that the initial difference in height will remain for at least a few years (Lindström et al. 2004).

There are also results indicating that less radical soil scarification is needed for the mini seedling (Gyldberg and Lindström 1999). However, the mini seedling should be planted in mineral soil or in a mixture of mineral soil and humus in order to obtain high survival and growth. Planting in mounds or in humus will cause high risks for water stress.

Field storage experiments have shown that mini seedlings dry out faster than conventional seedlings. Therefore precautions have to be taken to protect the seedlings at field storage. The use of protective blankets increases the time of safe field storage (Lindström et al. 2004).

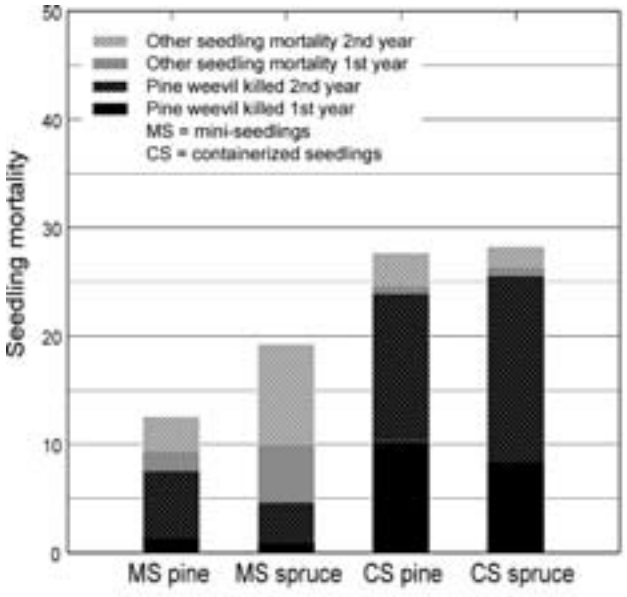

Figure 1. *Mean seedling mortality during the first and second year after outplanting for three field experiments in central Sweden. The experiments were planted in early summer in 2001, 2002, and 2003. Mini seedlings were approximately 10 weeks old and had a height of approximately 5 cm at the time of planting and the containerized seedlings were 1-year-old seedlings, with a height of 10-15 cm. N = 300*

Nursery Experiences

The cultivation period as well as the treatments in the nursery is important for the mini seedling vitality and potential of good field establishment. Both pine and spruce are positively affected by a 2–3 week outdoor hardening phase after the greenhouse period. Long night treatment of pine in late spring/early summer has also improved field establishment.

The time when late sown mini seedlings are safely stored occurs a few weeks later than for conventional older seedlings. Root freezing tolerance develops slowly in young pine and spruce. For spruce this is the case also for the shoot freezing tolerance. Since the hardening processes are a bit slower for mini seedlings it is extra important to test storability before seedlings are put into storage (Lindström et al. 2004).

Future Development and Research

The mini seedling system is presently being implemented in Swedish forest companies and small scale enterprises. The system is still under development and further work is needed to find optimal solutions on practical aspects of nursery and planting techniques.

Further research is needed to better understand the reasons for the limited pine weevil attacks on mini seedlings and at what developmental stage a seedling becomes attractive to pine weevils. There is also a need to identify at what site indexes the mini seedling can be used with success. Suitable fallow period, planting time and selection of scarification method are other urgent research areas to deal with before the mini seedling concept can be launched in a large scale.

References

Eidmann, H. 1969. Rüsselkäferschäden an verschiedenen Nahrungsflanzen. Anz. Schädlingsk. 42: 22-26.

Gyldberg, B. and Lindström, A. 1999. Kan små skogsplantor ge billigare och bättre föryngringar? [In Swedish.] Plantaktuellt 4: 1-2.

Lindström, A., Hellqvist, C., Gyldberg, B. and Håkansson, L. 2000. Odlingssystem för små skogsplantor. [In Swedish.] Högskolan Dalarna, Avdelningen för Skog och Träteknik. Stencil nr 17. 13 pp.

Lindström, A., Hellqvist, C. and Håkansson, L. 2002. Resultat från fältförsök med miniplantor 2002 samt återinventering av äldre försök. [In Swedish.] Högskolan Dalarna, Institutionen för matematik, naturvetenskap och teknik. Stencil nr 29. 17 pp.

Lindström, A., Hellqvist, C., Håkansson, L. and Stattin, E. 2004. Resultat från fältförsök med miniplantor 2003 samt återinventering av äldre försök. [In Swedish.] Högskolan Dalarna, Institutionen för matematik, naturvetenskap och teknik. Stencil nr 36. 22 pp.

Långström, B. 1982. Abundance and seasonal activity of adult *Hylobius* – weevils in reforestation areas during first years after final felling. Commun. Inst. For. Fenn. 106: 1 – 23.

Örlander, G., Nilsson, U. and Nordlander, G. 1997. Pine weevil abundance on clear-cuttings of different ages: A 6-year study using pitfall traps. Scand. J. For. Res. 12: 225-240.

Petersson, M. 2004. Regeneration methods to reduce pine weevil damage to conifer seedlings. Doctoral diss. Southern Swedish Forest Research Centre, SLU. Acta Universitatis Agriculturae Sueciae. Silvestria 330.

Rune, G. 2003. Instability in plantations of container grown Scots pine and consequences on stem form and wood properties. Doctoral thesis. Acta Universitatis Agriculturae Sueciae, Silvestria 281.

Selander, J. and Immonen, A. 1992. Effect of fertilization and watering of Scots pine seedlings on the feeding preference of the pine weevil (*Hylobius abietis* L.). Silva Fenn. 26(2): 75-84.

Selander, J., Immonen, A. and Raukko, P. 1990. Resistance of naturally regenerated and nursery-raised Scots pine seedlings to the large pine weevil [In Finnish with English summary]. Folia For. 766. 19 pp.

Trägårdh, I. 1939. Sveriges skogsinsekter. [In Swedish.] Gebers förlag. 508 pp.