Establishment Practice

This Guidance Note is one of a series summarising information presented at a seminar on "Improved Conifer Timber Quality through Plant Selection and Silviculture", held in February 2009 as part of FC Scotland's Timber Development Programme. It provides an outline of a presentation given by Alan Harrison of Forest Research, covering key aspects of establishment practice that are important for producing good quality timber from conifer species. The presentation itself is available for download through the seminar web page.

Introduction

Good establishment practice is essential for the production of high quality timber from conifer species. Trees that are carefully handled, well-planted in a suitably prepared site and tended to ensure adequate nutrition and freedom from weed competition are more likely to establish quickly, enjoy rapid early growth, develop stable root architecture and be able to express their full genetic potential. This presentation focused on some key aspects of the establishment process and highlighted the detailed guidance and decision support tools that are available to inform forest managers' decision making.

Cultivation

Cultivation is used to improve conditions for tree growth and is a key element of successful and cost-effective establishment. Detailed guidance on cultivation can be found in Paterson and Mason (1999), from which much of the information summarised below is taken. Additional information relating to cultivation techniques, including guidance on machine selection and output, can be found in a Technical Development Branch Information Note on Forest Ground Preparation, (Forestry Commission, 2002a). Specific guidance on excavator mound spacing on restock sites can be found in Morgan and Ireland (2004).

The general aim of cultivation is to make improvements to the microsite for planting which result in:

- Enhanced survival and improved, uniform early growth;
- Reduced establishment costs;
- Good access and prepared planting sites on restocking sites with moderate or heavy brash.

A range of cultivation types can be used according to soil type and site conditions:

- No cultivation (band or spot herbicide, mulches, mechanical or hand weeding)
- Scarification (disc trenching, screefing)

- Subsurface treatments (moling, subsoiling, ripping)
- Mounding (continuous, excavator trench or hinge)
- Ploughing (deep, shallow, complete, agricultural)

The impacts of cultivation on site conditions include:

1. Improved soil temperature regime

Soil temperature has a strong influence on root growth and the uptake of water and nutrients by plants. Appropriate cultivation techniques have been shown to produce beneficial changes in the temperature regime on a wide range of soil types, promoting survival and early growth.

2. Reduced frost damage

Low air temperatures near the soil surface can cause frost damage to planted trees or regenerating seedlings especially in spring and autumn. Cultivated soil stores heat during the day that is released to the overlying air at night, thus raising night-time temperatures.

3. Reduced wetness of planting position

Cultivation can have a major influence on the wetness of the surface layer of soil and the planting position, although there is generally only a minor influence on the water-table in the deeper horizons of the soil. On wet soils the aim of cultivation is to provide a raised planting position to reduce the soil moisture content and increase oxygen levels, thus improving root development.

4. Faster nutrient mineralisation (especially N)

Cultivation stimulates biological activity in the soil, causing more rapid mineralization, particularly of nitrogen – this can promote plant growth. On soils that are low in nitrogen there is only a short-term improvement in nutrient availability. Shallow mixing of humus or peat with mineral soil appears to be the best way of maintaining the long-term nutrient status of the site. Humus should not be buried beyond the reach of juvenile root systems or at depths where organic turnover is slow. The mixing of topsoil and subsoil should be minimized.

5. Reduced soil compaction

Tree roots will not penetrate soil horizons that are compacted, with a bulk density greater than 1.0-1.6 g cm^{-3} in coarse textured soils or 1.2 g cm^{-3} in fine textured soils. The limitations on rooting depth due to dense horizons will restrict tree growth and anchorage. Cultivation can substantially improve root penetration and fine root development in dense soil horizons in coarse textured soils. These improvements are not found in wet clay soils however.

6. Reduced weed competition

Cultivation will create weed free planting positions, allowing the new plants a period of early growth free from competition for water, nutrients and light.

7. Imposes correct spacing and stocking onto site

Cultivation helps to establish formal organization on a site and allows obstacles to be moved where necessary. This facilitates the attainment of target stocking densities and spacing patterns, which are a key consideration for producing high quality timber from conifer species.

The effects described above generally result in improved survival, growth and uniformity of crop where an appropriate cultivation technique is used. Consideration must always be given, however, to the impact of different cultivation techniques on root symmetry and long term effects on stability. For example, the use of spaced ploughing can result in linear root development and subsequent windblow along plough furrows.

Environmental impacts must also be considered: ploughing on slopes can result in soil erosion and subsequent siltation of watercourses. Disturbance of organic soils will result in a loss of soil carbon.

Frost Tolerance

Electrolyte leakage testing has been used to determine frost hardiness of shoots and roots for different species (Morgan, 1999). As plants approach dormancy shoot frost tolerance falls more rapidly and to lower levels than root frost tolerance: it is root frost tolerance that is the determining factor in plant storage. Table 1 shows storage tolerance levels that are used in UK nurseries.

Freezer storage (-3 to -1^{o} C)	Freezer storage (-2 to -0^{o} C)	Freezer storage (0 to +2^{o} C)
Spruce	Scots pine	Douglas fir
Larch	Lodgepole pine	Noble fir
Birch	Ash	
Rowan		

Table 1: Recommended storage temperatures for bare root planting stock

Plant Lifting and Planting Periods

Predicted changes in seasonal temperatures that are forecast as a result of climate change are likely to have an impact on plant dormancy and consequently on recommended periods for lifting plants in the nursery and planting periods. The period of dormancy is likely to be shorter, with longer growing seasons enabling a wider planting window.

Planting Techniques

Poor planting techniques can cause significant problems for the future growth and quality of newly planted conifers. Careful planting is required to ensure that root systems develop properly thus ensuring healthy tree establishment and future stability. Permanent root architecture distortion and associated growth, stability and stem form problems can result from poor planting. Guidance on planting techniques can be found in Morgan (1999) and Forestry Commission (2002b).

Weed Control

Weeds affect establishment success by competing with trees for moisture, nutrients and light. Competitive vegetation can cause physical damage, severe growth suppression and death, particularly when trees are very young. On wet, infertile sites in the uplands, competition from weeds for nutrients or light tend to be the most important factors. On nutrient-rich lowland sites in drier areas, competition for moisture may be the most important factor. In all situations adequate weed control is important for establishment success, although the actual weed species present, their relative growth rates and hence the amount and nature of weeding operations that may be necessary will vary considerably depending on location.

Site fertility greatly influences the amount of weed growth that occurs. On infertile, upland gleys, podzols and peats, successful establishment can often be achieved with little weed control other than that resulting from pre-planting cultivation. On fertile lowland brown earths, or on agricultural land being converted back to woodland, weed growth is usually profuse and successful tree establishment is likely to require frequent weeding. The amount of weed control required to achieve management objectives is influenced by a variety of factors. Some, like site fertility, are difficult to manipulate but others such as choice of silvicultural system are under the manager's control.

Full guidance on weed control is contained in Willoughby *et al.* (2004), which sets out a structured procedure for assessing requirements using a core decision chain, aimed at minimising the cost and environmental impact of control measures. Further information can be

found through the online herbicide advisor system and in the Forestry Commission web pages relating to pesticides.

Establishment Management Information System

The Establishment Management Information System (EMIS) is a computer-based decision support system which provides guidance for managers by matching species to site factors and by highlighting the most appropriate silvicultural establishment strategies. It integrates key establishment factors in a simplified "walk-through", web-based decision support tool that gives recommendations for species choice, cultivation, plant quality specification, fertiliser application, wind risk and (for Sitka spruce) timber quality – based on location and some basic soil and site information provided by the user. The system allows multi-species comparisons, and since it is web-based it can be updated centrally with new information as it becomes available. EMIS can be accessed through the FR Decision Support Services portal – users are required to register, but the use of the software is free.

Conclusions

- To produce good quality timber from conifer species it is important to optimise the young trees' growing environment at each stage of the establishment process;
- Cultivation techniques that are appropriate to the site should be used to provide planting positions with an improved microsite that will promote survival, rapid early growth and future stand stability;
- Good quality plants should be sourced, with particular attention paid to their storage, handling and the timing of planting out, giving due regard to species differences in frost tolerance;
- Correct planting techniques should be used to promote good root development, early growth, future stem form and stability;
- Appropriate weed control should be used to ensure successful establishment and rapid early growth;
- A range of web-based decision support systems are available to allow users to access up-to-date guidance on best practice for conifer establishment.

References

Forestry Commission (2002a). Forest Ground Preparation. Technical Development Branch Information Note ODW 10:01. Forestry Commission, Dumfries.

Forestry Commission (2002b). Tree Planting. Technical Development Branch Information Note ODW 10:02. Forestry Commission, Dumfries.

Morgan, J. L. (1999) Forest Tree Seedlings – best practice in supply treatment and planting. Forestry Commission Bulletin 121. Forestry Commission, Edinburgh.

Morgan, S. and Ireland, D. (2004). Excavator mound spacing on restocking sites. *Forestry Commission Technical Note FCTN08*. Forestry Commission, Edinburgh.

Paterson, D. B. AND Mason, W. L. (1999). Cultivation of soils for forestry. Forestry Commission Bulletin 119. Forestry Commission, Edinburgh.

Willoughby , I. , Evans , H. , Gibbs , J. , Pepper , H., Gregory , S. and Dewar , J. et al. 2004c Reducing pesticide use in forestry . Forestry Commission Practice Guide No. 15 . Forestry Commission , Edinburgh .

Links to further information

Establishment Management Information System (EMIS): www.forestresearch.gov.uk/fr/HCOU-4U4JE4

FR Decision Support Systems Portal: www.eforestry.gov.uk/forestdss/

Herbicide Advisor online system: www.forestry.gov.uk/fr/ggae-5jqkfd

Pesticides information: http://www.forestry.gov.uk/pesticides