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# Research Information Note 243

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## THE QUALITY OF SITKA SPRUCE AT THE TIME OF PLANTING, by Helen McKay

### Abstract

Sitka spruce planting stock was sampled at 23 sites across Scotland, northern England and Wales. Seven morphological and two physiological characteristics were compared to survival and increment after one growing season. Mean survival was high (90%) with a mean height increment of 15 cm and diameter growth of 2 mm. Survival was very highly correlated to root electrolyte leakage – low leakage values were associated with high survival. Height increment was positively related to the root:shoot ratio and root weight but not initial height or physiological measurements.

### Background

1. Morphological standards of nursery stock for forest use are described in British Standard 3936 Part 4: 1984. Bare-root stock of Sitka spruce should be greater than 15 cm in height. Plants of 15 cm should have a root collar diameter (RCD) greater than 2.5 mm, with an increase of 0.5 mm for every 5 cm increase in height. The root systems should contain fine fibrous rootlets, and should be proportional to the age and size of plant. However, BS 3936 does not define the proportion of fine root or the root:shoot ratio. Conditions for plant establishment are less favourable on restock than afforestation sites. The Forestry Commission has therefore increased the specifications on minimum RCDs of its own stock (Tabbush, 1988); for Sitka spruce of 15–25 cm height the minimum RCD is 3–4 mm, and for the 25–45 cm height class it is 4–6 mm. A minimum root:shoot ratio of 1:3 has been suggested by Tabbush (1988) and Aldhous (1989) but there is no published evidence to support this value.

2. There is no physiological standard set down in the British Standard. Root growth potential has been used to screen batches when physiological quality is in doubt but this test takes at least seven, and generally 14, days to complete. Recently, two rapid physiological tests have been reported – root moisture content (RMC) and root electrolyte leakage (REL). Tabbush (1987) found that survival of Sitka spruce decreased sharply when RMC fell below 250% as a result of exposure to wind and sun. Sharpe and Mason (1992) suggest that RMC is potentially a useful test, but that the critical value before survival decreased was lower (between 62 and 219%) when desiccation resulted from exposure during cold storage.

3. In an investigation of fine conifer roots after a period of cold storage, electrolyte leakage was found to be highly correlated with plant survival and height growth (McKay and Mason 1991; McKay, 1992). In these experiments, Sitka spruce with electrolyte leakage values of 15% and lower had survivals of greater than 90%. REL has also proved to be a useful research tool for quantifying damage due to desiccation, rough handling, freezing and excessive canopy storage. It is therefore a promising measure of the physiological quality of planting stock, but it is important to validate the test in commercial operations and compare its ability to detect plants of low viability with other rapid physiological tests and morphological measurements. The results of a preliminary experiment are described in this Note.

### Method

4. Samples of Sitka spruce were collected from a total of 23 sites across Wales, northern England and Scotland. The stock varied by source nursery (private and Forestry Commission), plant type and age (1u1, 1+1, 1½+1½ and cuttings), seed identity, provenance (the majority was of Queen Charlotte Islands seed origin but one sample of Oregon Sitka spruce was included), lifting date, storage history, insecticide treatment, site type and previous history, and planting date (25 January to 14 May). It was intended that the range of stock sampled was typical of the Sitka spruce being planted in 1991.

5. At each site 50 plants were collected (ten from each of five planting bags) and sent to the Forestry Authority's Northern Research Station for testing. Five plots of 20 trees were identified at the same planting site for survival, height increment and RCD measurements at the end of the first growing season. Browsing and insect damage was noted.

6. The following morphological measurements were made on each plant sample: shoot height, mean root collar diameter, and the dry weight of shoot, woody root and fine roots. From these we calculated total root and total plant weight and the ratios of fine root:woody root and total root:shoot.

7. Two rapid assessments of physiological quality were made on each plant: fine root electrolyte leakage and fine root moisture content.

**Results**

8. Morphological and physiological characteristics of the plants from each site are given in Table 1. For plants of a mean height of 28 cm, the mean diameter was in the lower end of the recommended range but was less than the Forestry Commission recommended diameter in seven samples. The mean root:shoot ratio was adequate but was below the recommended level in eight cases. The mean REL was low and individual levels were acceptable in all but one case. Mean RMC was close to the critical point given by Tabbush (1987); only nine of the 23 samples had satisfactory levels of moisture. However, if a lower threshold of 200% is used all but three samples had satisfactory RMC.

**Table 1. Morphological and physiological attributes at the time of planting and performance after one growing season of planting stock at 23 sites.**

| Height (cm) n = 50 | Diameter (mm) n = 50 | Shoot weight (g) n = 50 | Root weight (g) n = 50 | Total plant (g) n = 50 | Fine root: woody root n = 50 | Root:shoot n = 50 | Root moisture content (%) n = 50 | Root electrolyte leakage (%) n = 50 | Survival (%) n = 100 | Height increment (cm) n = 100 | RCD increment (mm) n = 100 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 | 4.4 | 5.1 | 1.9 | 6.9 | 0.9 | 0.39 | 215 | 11.7 | 82 | 5 | - |
| 26 | 4.6 | 5.2 | 1.7 | 6.9 | 0.9 | 0.33 | 185 | 11.6 | 85 | 4 | - |
| 20 | 3.8 | 2.4 | 1.4 | 3.7 | 1.7 | 0.58 | 243 | 11.8 | 100 | 23 | 1.7 |
| 19 | 3.7 | 2.8 | 1.4 | 4.2 | 2.3 | 0.50 | 292 | 11.6 | 98 | 22 | 1.6 |
| 31 | 4.4 | 5.5 | 2.3 | 7.7 | 2.0 | 0.40 | 318 | 11.5 | 95 | 22 | 1.2 |
| 31 | 4.6 | 5.1 | 2.2 | 7.4 | 2.2 | 0.44 | 301 | 10.9 | 100 | 28 | 1.7 |
| 33 | 5.0 | 5.8 | 2.1 | 7.9 | 1.5 | 0.39 | 315 | 9.5 | 96 | 31 | 2.2 |
| 30 | 5.1 | 6.5 | 2.8 | 9.3 | 1.0 | 0.45 | 218 | 51.1 | 0 | - | - |
| 22 | 4.5 | 5.2 | 1.7 | 6.9 | 0.9 | 0.37 | 213 | 9.5 | 98 | 34 | 2.1 |
| 37 | 5.9 | 10.6 | 3.1 | 13.7 | 0.6 | 0.30 | 214 | 11.8 | 94 | 34 | 1.4 |
| 39 | 6.0 | 10.5 | 3.3 | 13.8 | 0.5 | 0.31 | 187 | 11.9 | 99 | 6 | 1.8 |
| 30 | 3.8 | 3.5 | 1.1 | 4.6 | 1.1 | 0.29 | 205 | 9.6 | 96 | 5 | 3.3 |
| 27 | 4.7 | 3.6 | 1.4 | 5.0 | 1.0 | 0.39 | 246 | 11.4 | 87 | 7 | 0.0 |
| 34 | 4.0 | 3.8 | 1.2 | 4.9 | 1.7 | 0.29 | 260 | 16.8 | 97 | 8 | 3.1 |
| 29 | 4.1 | 3.4 | 1.2 | 4.6 | 0.9 | 0.34 | 255 | 13.8 | 95 | 7 | 0.0 |
| 30 | 4.6 | 3.8 | 1.2 | 5.0 | 0.6 | 0.31 | 245 | 13.9 | NA | NA | NA |
| 32 | 5.9 | 7.8 | 2.6 | 10.5 | 0.8 | 0.36 | 221 | 10.7 | NA | NA | NA |
| 29 | 4.5 | 4.5 | 1.5 | 6.0 | 0.9 | 0.35 | 225 | 13.4 | 100 | 31 | 2.4 |
| 28 | 4.9 | 6.5 | 2.7 | 9.1 | 2.1 | 0.41 | 324 | 8.7 | 86 | 6 | 1.0 |
| 20 | 3.1 | 2.4 | 0.7 | 3.1 | 2.7 | 0.27 | 269 | 9.6 | 99 | 7 | 1.5 |
| 29 | 3.7 | 3.5 | 1.1 | 4.6 | 0.9 | 0.30 | 232 | 10.5 | 98 | 5 | 3.3 |
| 30 | 4.1 | 4.0 | 1.2 | 5.2 | 1.1 | 0.32 | 199 | 8.8 | 99 | 5 | 2.6 |
| 19 | 4.1 | 2.8 | 1.0 | 3.8 | 1.2 | 0.36 | 282 | 13.2 | NA | NA | NA |
| 28 | 4.5 | 5.0 | 1.8 | 6.7 | 1.3 | 0.37 | 246 | 13.2 | 90 | 15.2 | 1.8 |

NA – data were not available

9. Overall, survival was high (90%) with a mean height increment of 15 cm and diameter growth of 2 mm. There was complete failure at one site; excluding this site increased the mean survival to 95%.

10. Survival was very highly correlated to root electrolyte leakage ($P < 0.0001$, $r = -0.94$) but not to root moisture content. Survival was not correlated to any of the morphological characteristics measured ($P < 0.1$). Height growth was not closely correlated to either physiological measure but it was positively related to measures of root size, i.e. root:shoot ratio and root weight, but correlation coefficients were low ($r = 0.38$ and 0.31 respectively). Diameter growth was not closely correlated to either morphological or physiological factors.

11. If the one site with poor survival was excluded from the analysis (leaving sites with 92–100% survival) none of the quality measurements was closely correlated to survival, but height increment was still related to root:shoot ratio and root weight.

### Discussion

12. The morphological criteria used in this survey were not sufficient to classify planting stock survival; the morphological characteristics of the batch which failed were satisfactory yet stock with inadequate diameter for height and poor root:shoot ratios did survive well. The physiological measure of fine root electrolyte leakage did identify the batch which failed and indicated satisfactory survival of the other stock. Measures of root size were reasonable indicators of potential height growth.

13. There are many morphological and physiological attributes which might be used as indices of potential performance (see Mason, 1991). This preliminary study confirms research experiments which suggest that REL is a useful physiological indicator. Further research is needed if quality standards are to be revised.

### Conclusion

14. Stock was generally of acceptable quality and survival was high.

15. The physiological measure, fine root electrolyte leakage, clearly identified the one batch of plants which failed.

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