The Forestry Authority
Forestry Commission

Research Information Note 245

Issued by the Research Division of the Forestry Authority

SITKA SPRUCE GENETIC GAIN TRIALS, by Steve J Lee

Summary

The concept of genetic gain trials and their objectives are introduced. A total of 15 Sitka spruce genetic gain trials were established across a range of site types in spring 1993. Data from these trials will yield valuable information about realised genetic gains relative to unimproved seed lots. Genetic gain trials will help to demonstrate to forest managers the financial benefits of planting genetically improved stock.

Introduction

1. *Predicted* gains from planting genetically improved Sitka spruce relative to unimproved Queen Charlotte Islands material have previously been stated by Lee (1991, 1992). Gains of 15% for final rotation volume and 7% for stem-form are predicted for planting stock raised from seed collected in progeny-tested clonal seed orchards. Predicted gains rise to 20% and 10% respectively for recent family mixtures produced by controlled pollination multiplied-up by vegetative propagation (Mason and Harper, 1987).

2. *Predicted* gains are estimated gains. They have not been measured directly but have been calculated, based on the estimated genetic values of the component clones derived from progeny tests (Lee, 1992).

3. Genetic gain can only be quoted as actual or *realised* following trials whereby the superiority of the improved material is assessed relative to unimproved origins. Such trials are referred to as genetic gain trials (GGTs).

Predicted gain from progeny tests

4. Since progeny tests are expensive to establish and assess they are planted on a minimum number of sites. Predicted gain calculations may, therefore, only accurately apply to a restricted range of sites. Conversely, improved seed lots can be expected to be planted across a range of site types.

5. Progeny tests usually consist of between one and twelve tree row plots replicated up to 30 times. Predicted gains in productivity per hectare have to be interpolated since inter-plot competition in the tests reduces their value beyond thicket stage.

6. Progeny tests do not demonstrate the realised gain that should be possible from a genetically improved seed lot; they just give an indication of the likely gain. Gain from an improved seed lot may be up to twice that seen in a progeny test in the case of open-pollinated families (Shelbourne, 1969; Lee, 1992).

7. Progeny tests usually have small plot sizes with a large number of replications. It is often very difficult to make visual comparisons between superior families and standard controls. They therefore have a low value in demonstrating the potential of planting genetically improved stock.

Demonstration of realised gains

8. Genetic gain trials need to present realised gains in a manner which reflects the realities of plantation management. GGTs are also needed by tree breeders, to allow a comparison between gains predicted on data from progeny tests and actual, realised gains.

9. The objectives of genetic gain trials are, therefore:

(i) to allow realised gains to be assessed on a per hectare basis up to end-of-rotation;

(ii) to demonstrate clearly the benefits of planting genetically improved stock over a range of site types;

(iii) to validate or allow modification to predicted gain.

10. To achieve these objectives, GGTs need to compare genetically improved and unimproved planting stock in large plot sizes over a range of sites. The comparative treatments should include improved material currently available and material likely to be commercially available in 10 years' time. In this way, it should be possible to release figures of realised gain around the time of commercial production.

The 1993 genetic gain trial programme

11. Fifteen Sitka spruce GGTs were planted in spring 1993 on either Forest Enterprise or privately owned land (see Figure 1). Eleven of the GGTs contain three replicates, one was replicated twice, whilst three are unreplicated demonstrations.

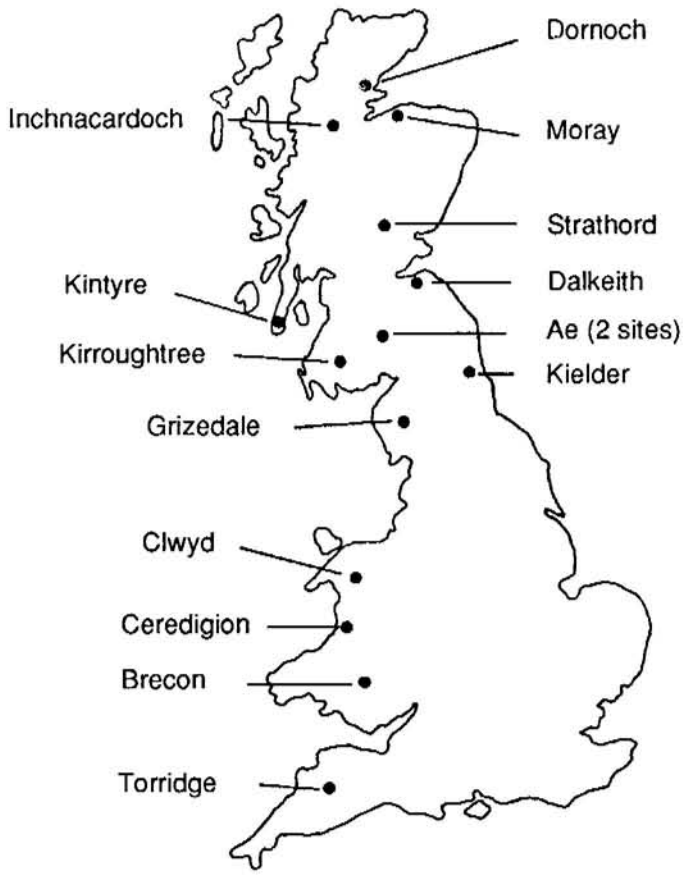

Figure 1. Map showing location of the 15 genetic gain trials planted in Britain, spring 1993.

12. Plot size was usually 225 trees (15x15) although occasionally this had to be reduced to 100 (10x10) or 120 (10x12). The unreplicated demonstration sites were either 500 or 1000 plant plots.

13. Two treatments were planted at all 15 sites. These were:

(i) unimproved Queen Charlotte Islands (QCI);

(ii) progeny-tested clonal seed orchard stock.

14. Other treatments varied with site, depending on geographic location and availability of trees (see Table 1).

    (i) Material from QCI seed stands and material expected to be commercially available in 10 years time were planted at most sites.

    (ii) Unimproved Washington and Oregon plots were included in sites on the western side of the country.

    (iii) Stock from the Northern Breeding Population, which is thought to be more suitable for exposed sites, was included at a number of Scottish locations.

Table 1. Genetic gain trials planted in Britain, spring 1993: details of treatments planted at each site

SITE	QCI	WSS	RSS	QCI SS	QCI SO	Veg. prop.	10 yrs	NBP	SPF#
Dornoch	*	*		*	*	*	*	*	*
Moray	*	*		*	*	*	*	*	*
Inchnacardoch	*	*	*	*	*	*	*	*	*
Strathord	*	*	*	*	*	*	*	*	*
Dalkeith	*				*				*
Ae(1)	*	*		*	*	*	*	*	
Ae(2)#	*				*	*	*		
Kintyre	*	*	*	*	*	*	*		
Kirroughtree	*	*	*		*	*	*		
Kielder	*	*		*	*	*	*		*
Grizedale#	*	*			*	*	*		
Clwyd	*	*	*	*	*	*	*		*
Ceredigion	*	*	*	*	*	*	*		
Brecon	*	*	*	*	*	*	*		*
Torridge#	*	*	*		*			*	

Key:

QCI	–	Unimproved QCI origin
WSS	–	Unimproved Washington origin
RSS	–	Unimproved Oregon origin
QCI SS	–	QCI seed stand
QCI SO	–	QCI tested clonal seed orchard
Veg. prop.	–	Rooted cuttings
10 yrs	–	Available in 10 years
NBP	–	Northern Breeding Population
SPF	–	Single-parent family blocks
#	–	Not replicated
*	–	Present at this site

15. Where space allowed, between two and ten half-hectare, single-parent family blocks were also planted. These are blocks in which all the trees are siblings of each other; they have a common mother but different fathers. The variation for vigour and straightness should be lower in these

blocks, relative to the other treatments, and should yield valuable information relating to the dynamics of stands with a narrow genetic variation.

16. All the GGTs will be maintained by their respective owners although periodic assessments will be carried out by Research staff to monitor the relative performance of treatments.

Future plans

17. The 1993 series of GGTs will meet all their stated objectives for contemporary planting stock. The GGTs will help forest managers to select the most profitable planting stock.

18. Consideration will be given to the establishment of a new series of GGTs when a new production population is created with *significantly improved* predicted gain relative to contemporary material.

19. It is intended that a GGT will be established on all major Sitka spruce site types.

Acknowledgement

Tree Improvement Branch would like to acknowledge the co-operation of Forest Enterprise and Eagle Star Life Assurance Company Limited in providing land for genetic gain trials. The co-operation of staff at Wykeham Nursery, all Forest Enterprise sites, Bidwells (Perth) and Silviculture (North and South) Branches is also greatly appreciated.

References

LEE, S.J. (1991). *Potential gains from genetically improved Sitka spruce.* Research Information Note 190. Forestry Commission, Edinburgh.

LEE, S.J. (1992). Likely increases in volume and revenue from planting genetically improved Sitka spruce. *In:* D.A. ROOK, ed. *Super Sitka for the 90s.* Forestry Commission Bulletin 103. HMSO, London.

MASON, W.L. and HARPER, W.C.G. (1987). *Forest use of improved Sitka spruce cuttings.* Research Information Note 119. Forestry Commission, Edinburgh.

SHELBOURNE, C.J.A. (1969). *Tree breeding methods.* Forest Research Institute Technical Paper 55. New Zealand Forest Service, Rotorua.

Issued by:
Research Publications Officer
The Forestry Authority, Research Division
Alice Holt Lodge, Wrecclesham
Farnham, Surrey GU10 4LH

February 1994

ISSN 0267 2375

Phototypeset and printed by: Forestry Commission, 231 Corstorphine Road, Edinburgh EH12 7AT