A New Tree Improvement Programme for Black Walnut in the United Kingdom

Karen Russell and Gabriel E. Hemery[1]

ABSTRACT—Black walnut is an introduced species in the United Kingdom (UK) and economically one of the more productive broadleaved species. Currently it is not widely planted in the UK as there is insufficient knowledge about the species among foresters and very little, if any, improved material is available. A research programme was initiated in 2001 to address both these issues. A range-wide seed collection from plus trees 20 US provenances and 10 European provenances and 2 European populations has been undertaken with a view to establishing two provenance/progeny trials. A collection of trees grafted from 63 individual plus trees has also been planted for assessment of form, vigour and disease resistance.

INTRODUCTION

Black walnut (*Juglans nigra* L.) was introduced to Britain from North America in the early 17th Century (Bean 1981) and was widely planted for its valuable timber. The species can produce high quality timber on a relatively short rotation of about 60 years and is consistently in great demand by end-users. During 2001 alone, UK imports of this valuable timber rose by 51% (Buckley 2002). Currently, the species is often disregarded by UK foresters because of its reputation as being site-demanding, usually of poor form and vulnerable to frost. No research has effectively addressed these problems in the UK.

The Forestry Commission established a series of black walnut provenance experiments between 1986 and 1987; a limited range of material from four provenances (Wisconsin, Southern Illinois, Ohio and Vermont) was tested (Kerr 1993). Insufficient seed was available for testing all material across four low-quality UK trial sites. A more comprehensive selection of material, selecting desirable, straight-stemmed and lightly-branched trees suitable to the climatic conditions of the UK should encourage a renewed interest in the species.

In 2001, Horticulture Research International (HRI) and the Northmoor Trust (NMT) initiated a new project for the improvement of black walnut in the UK to provide information and material. This is a collaborative project under the auspices of the British and Irish Hardwoods Improvement Programme (BIHIP) with sponsorship from the National Forest Company, the Department for Environment, Food and Rural Affairs (Defra) and the Forestry Commission.

Seed material was collected across the current natural US and introduced European ranges of the species and is being tested in a long-term provenance/progeny research programme. Field trials containing European and North American seedlots will be established during winter 2003 and winter 2004 with the aim of identifying superior black walnut trees that can act as seed trees or be cloned for timber production. A clonal collection of superior 'plus' trees has been established at HRI. This paper summarizes progress made to the autumn of 2003 and outlines expected outcomes from the research programme.

FIELD TRIAL METHODS

Selection of Seed Sources

Research institutes in 27 European countries were contacted to establish the importance of black walnut in their country and their interest and willingness to participate in the black walnut

[1]Woodland & Forestry Specialist (KR), Horticulture Research International, East Malling, Kent, ME19 6BJ, UK; and Forestry Research Manager (GEH), Northmoor Trust, Little Wittenham, Oxfordshire, OX14 4RA, UK. KR and GEH are corresponding authors, to contact call ++44 (0)1732 843833 or email Karen.Russell@hri.ac.uk or ++44 (0)1865 407792 or e-mail Gabriel.Hemery@NorthmoorTrust.co.uk. website: www.NorthmoorTrust.co.uk.

Citation for proceedings: Michler, C.H.; Pijut, P.M.; Van Sambeek, J.; Coggeshall, M.; Seifert, J.; Woeste, K.; Overton, R.; Ponder, F., Jr., eds. 2004. Black walnut in a new century, proceedings of the 6th Walnut Council research symposium; 2004 July 25-28; Lafayette, IN. Gen. Tech. Rep. NC-243. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station. 188 p.

improvement programme. Institutes that wished to participate then identified suitable stands and trees for seed collection. In the UK, individual landowners were targeted through the forestry press (Hemery and Russell 2002). Within the programme, provenance is defined *as a seed collection unit composed of a community of potentially interbreeding trees in an area subject to uniform environmental conditions* (adapted from Turnbull and Griffin 1986). In countries with scattered individual trees the term 'population' is used. Progeny refers to half-sib families.

During July 2001, the authors attended the annual meeting of the Walnut Council in Wisconsin, USA, and visited staff of the Hardwood Tree Improvement and Regeneration Centre (HTIRC) at Purdue University to encourage the search for North American provenances (Hemery 2002). HTIRC agreed to coordinate the identification and collection of seedlots from across the natural range of black walnut in the USA.

Seed Collection

Thirty-two provenances were targeted, 20 from the United States and 12 (including two populations) from Europe, each ideally comprising 20 half-sib progenies, or otherwise as bulked provenances/ populations. Twenty viable seeds from each of 20 mother trees of good or outstanding phenotypic character (Fig. 1) were required per provenance. The target number of seeds required per mother tree was 30 assuming a 60% germination rate (Brinkman 1974), giving approximately 600 seeds or approximately 7 kg of seed (cleaned weight) per provenance.

A minimum distance of 100 m was specified between mother trees within provenances and a wide geographic distribution among provenances within each country was requested of collaborators in each country. The identity of each mother tree was maintained for each. seedlot. The phenotypic characters of each mother tree was assessed and their environmental location recorded. Seeds were collected at seed fall during both 2002 and 2003. Where black walnut trees were scarce, a lower number of progenies or a bulked population collection was accepted.

The European seedlots were sent to HRI-East Malling where the seed was cleaned and sorted before distribution to a commercial nursery. The North American seedlots were cleaned and dispatched from HTIRC directly to Alba Trees plc, the UK nursery. After a minimum of 120 days of stratification, the seeds were sown into root-trainers of 400 cc volume and 17 cm depth and germinated

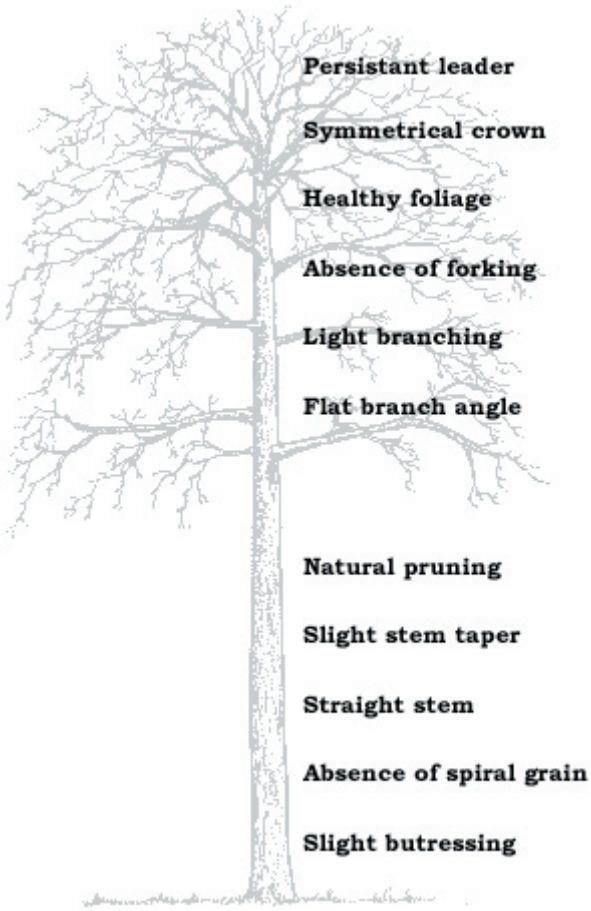

Figure 1.—The ideal black walnut plus-tree or 'ideotype'.

in a protected environment (polytunnel). One-year-old seedlings will be used in the establishment of the field trials.

Experimental Design

The main purpose of the field trials is to assess the suitability of provenances for timber production under UK conditions, with particular emphasis on selection for good form and late flushing. The trials will also provide a resource for genetic diversity studies. The trees will be planted out in combined provenance/progeny experiments at two sites during 2003 and 2004. Seedlots were received during 2 years, therefore, one UK progeny will be established at each field trial in both years as a control population.

Field trials will be established at two sites in central and southern England (Fig. 2). The central England site is at the National Forest at Lount in Derbyshire (52° 36' N/1° 25 W, soils pH 7.0, altitude 120 asl, annual precipitation 600 mm). The southern England site is at the Northmoor

Figure 2.—Distribution of European black walnut provenances sampled for UK trials.

Trust's Forest Research Centre in Oxfordshire. (51° 38' N/1° 12' W, soils pH 6.2 to 7.7, altitude 50 m asl, annual precipitation 570 mm). The proposed design combines both provenance and progeny assessments in a single experiment. Provenances will be distributed in non-contiguous multiple-tree plots. Progenies will be distributed as single-tree plots within a randomised complete block design, the replicate (block) size being dependent on the final number of progenies available (usually $\sqrt{n}$ progenies). The 30 provenances will provide 411 progenies for evaluation at each site, the remainder will consist of bulked population collections.

Plantation Design

Trees will be spaced at 2 x 2 m (2,500 trees ha^{-1}) and protected by 0.75 m tree shelters. The non-contiguous provenance plots will allow thinning whilst minimizing progeny losses. A study using molecular markers of the genetic diversity of genotypes within the trials is planned early in the life of the programme to minimise the impact of thinning.

RESULTS

Out of a total of 16 European countries who expressed interest in the research programme, seven provided seedlots. Four countries provided seedlots (number in brackets) during 2002: Austria (2), Czech Republic (3), Slovak Republic (2) and the UK (1). The seedlots from the UK were typically collected from individual trees, often distributed in parkland and only rarely in woodland and are termed a population.

In the autumn of 2003, seedlots were provided by France (1), Italy (2), Serbia and Montenegro (2), and additional seedlots were collected in the UK (1). The seedlot from France was collected from a seed orchard as was one seedlot from Italy. The second Italian seedlot was collected within a stand. The seedlots from Serbia and Montenegro and the UK (2002 and 2003) were from scattered individual trees and therefore treated as populations. A total of 10 European provenances and two populations have been collected (Fig. 2).

Seedlots were collected from 20 provenances across 13 States in eastern North America (Fig. 3): Alabama (1), Illinois (2), Indiana (3), Iowa (1), Kentucky (2), Maryland (2), Minnesota (1), North Carolina (1), Ohio (1), Pennsylvania (1), Tennessee (1), Wisconsin (3), and Missouri (1). The majority of the American seedlots were collected from trees within stands and the number of trees per stand from which seed was collected varied from 10 to 30.

Over 1,600 seedlings were raised in 2003 for establishment in the first phase of the provenance trials in winter 2003/04. The germination rates for the Austria and Czech Republic provenances were similar at 74% and 72% respectively; however for the UK population only 28% germinated as seed from some trees failed to germinate. One of the provenances from the Slovak Republic failed to germinate whereas the other had a germination rate of 39%. Some 20,000 seeds were stratified in winter 2003 and sown in spring 2004. The resulting seedlings will be planted out in the second phase of the provenance trial in winter 2004/05.

Figure 3.—Distribution of North American black walnut provenances sampled for UK trials.

CLONAL COLLECTIONS

Between 1997 and 2003, graftwood from superior black walnuts was supplied by INRA Bordeaux, France, and HTIRC, Indiana, USA, and collected by HRI from outstanding mature trees in the UK. The graftwood was propagated at HRI-East Malling on seedling rootstocks of common walnut (*Juglans regia* L.) using a 'hot pipe' technique developed for the propagation of difficult species (Toogood 1999). A total of 63 superior trees were successfully propagated (26 US, 25 UK, 12 Mainland Europe) and planted in the walnut collection at Bradbourne House, East Malling (Russell 2002) which also includes accessions of common walnut (fruit and timber selections) and interspecific timber selections. The accessions are being assessed for form, vigour, budbreak, and resistance to pests and diseases, including anthracnose.

FUTURE WORK

The provenance/progeny trials will be assessed for survival, flushing, vigour (height and diameter), form, and occurrence of anthracnose. Data will be analyzed and superior progenies and individuals will be selected to form the basis of the next stage of the improvement programme after 10 years. It is anticipated that clonal trials of plus trees and/or of seedling selections will be established in the future. In addition, it is hoped that a collaborative research programme on the genetic diversity of these collections can be initiated with HTIRC with the objectives of assessing the extent of diversity in black walnut represented in the programme and potentially providing information on origin of the European material.

ACKNOWLEDGMENTS

The programme has been supported in the UK by Jaguar Cars, The National Forest Company, Woodland Heritage, the East Malling Trust for Horticultural Research, the Northmoor Trust for Countryside Conservation, the Department for Environment, Food and Rural Affairs and the Forestry Commission. Our thanks go to the research institutes and individuals in Austria, Czech Republic, France, Italy, Slovak Republic, Serbia and Montenegro, and North America, particularly the HTIRC, who have provided seedlots and/or graftwood to date and to Alba Trees plc for raising the seedlings.

LITERATURE CITED

Bean, W.J. 1981. Trees and shrubs hardy in the British Isles. 8th ed. Revised, Vol. II D-M. London: John Murray. 476 p.

Buckley, M. 2002. Revivalist movement. Timber Trades Journal, 9th February: 14.

Brinkman, K.A. 1974. *Juglans* L., walnut. In: Seeds of woody plants in the United States. Agric. Handb. 450. Washington, DC: U.S. Department of Agriculture, Forest Service: 454-459.

Hemery, G.E. 2002. Walnut forestry tour of the mid-western United States. Woodland Heritage: 20-22.

Hemery, G.E.; Russell, K. 2002. Filling walnut's black hole. Forestry and British Timber. December: 22-23.

Kerr, G. 1993. Establishment and provenance of walnut in Britain. Forestry. 66: 381-393.

Russell, K. 2002. The Walnut collection at HRI-East Malling 2002. The Walnut Club Newsletter. Issue 3 (July 2002): 13-15.

Toogood, A., ed. 1999. The Royal Horticultural Society - propagating plants. London: Dorling Kindersley. 109 p.

Turnball, J.W.; Griffin, A.R. 1986. The concept of provenance and its relationship to infraspecific classification in forest trees. In: Styles, B.T., ed. Infraspecific classification of wild and cultivated plants. Oxford: Clarendon Press: 157-189.