

## GROWING WALNUT IN MIXED STANDS

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### SUMMARY

Walnuts in Britain are usually grown in pure stands or as individual trees, rather than in mixed plantations. Research conducted in the USA and Italy has indicated that walnuts can benefit from being planted in mixed stands, particularly with nitrogen-fixing species. Advantages may include increased growth rates and improvement of tree form, combined with protection from frost damage and reduced weed competition. Three field trials were established in southern England during spring 2000, to test the effects of growing walnut (*Juglans regia*) with a number of companion species, under the auspices of the British and Irish Hardwoods Improvement Programme.

### *Introduction*

As the producer of a potentially highly valuable timber, walnut is a desirable species for the British forester and landowner but is beset with a number of problems. Historically, walnuts have been selected for fruit-producing qualities: consequently, most trees have poor phenotypes for timber production. The species is also highly susceptible to damage from late-spring frosts.

The production of high-quality hardwood ideally combines the use of suitable genotypes with the most effective silvicultural techniques. In the late 1990s, a breeding strategy for the common walnut (*Juglans regia*) was initiated, which aims to develop improved genotypes (Hemery, 1998; Anon, 1999; Hemery, 2000). However, silvicultural methods for walnut timber production in Britain remain poorly tested.

### *Walnut Silviculture*

Walnut is a light-demanding species and has the largest crown diameter, in relation to any given stem diameter, of the main timber-producing species used in British forestry (Hemery, 2000). The usual recommendation is that walnut is planted at wide spacings, due to its intolerance of shading, unless the accompanying nurse species is maintained carefully (MacDonald *et al*, 1957; Evans, 1984). Evans (1984) states that it may also be grown in plantation conditions where the trees should be planted at wide spacing with 625 to 1,100 trees/ha (3-4 m spacing), aiming for a final crop density of 40 to 70/ha (12-15 m spacing). Becquey (1997) recommends a planting spacing of 10-12 m for the common walnut (*Juglans regia*) but, importantly, emphasises the importance of the genotype at this density.

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There is, however, increasing evidence that walnut may benefit when planted with suitable nurse or companion trees and shrubs. In the USA, Schlesinger and Williams (1984) tested black walnut (*Juglans nigra*) in mixtures with black locust (*Robinia pseudoacacia*), autumn-olive or oleaster (*Elaeagnus umbellata*) and alder (*Alnus glutinosa*). These species were chosen for their nitrogen-fixing capabilities because many hardwood trees, including *J. nigra*, have shown improved growth when grown with N-fixing species (Finn, 1953). *Elaeagnus umbellata* is a fast-growing, multi-stemmed, wide-spreading (3.6-5.5 m) shrub reaching 6-9 m in height, which is tolerant of exposure and will grow in most soil types (Bean, 1950).

Schlesinger and Williams (1984) found that all four of the nurse species increased walnut height growth but that the treatment effect was site dependent. Walnuts interplanted with *Elaeagnus* resulted in height gains of 56 to 351 per cent over non-nursed walnuts. The dense canopy afforded by the *Elaeagnus* nurse effectively reduced weed competition. The rapid growth of the *Robinia* necessitated severe control of its height by coppicing or ring-barking. There was high mortality of the alder nurse after five years, allegedly due to an allelopathic reaction with the walnut.



Twelve-year-old trial plots of walnut in central Italy testing growth and form in mixed stands. Walnuts planted without nurses (right) are noticeably shorter than walnuts planted with nurses *Alnus cordata* and *Robinia pseudoacacia* (left). Walnut stem straightness and branching habit were also markedly poorer in the pure plantations, which accentuated the role of genetics in the trees' architecture.



Walnut (*Juglans regia*) planted in a mixture with *Alnus cordata* (left and right) and *Elaeagnus* (central foreground) in central Italy. The walnut (centre) has grown above the surrounding nurses and shows excellent apical dominance and a light branching habit.

Friedrich and Dawson (1984) analysed soil nitrogen concentration under N-fixing crops with *Juglans nigra* in southern Illinois. Concentrations were highest under nurse crops of *Robinia pseudoacacia* and *Elaeagnus umbellata*, with decreased amounts under *Alnus glutinosa* and lower still under clover (*Lespedeza striata*). Campbell and Dawson (1989) calculated projections of growth which showed average stem diameters (dbh) of 28 cm in 31 years for walnut interplanted with the *Elaeagnus*. They projected that 40 years of growth would be required for the walnut to achieve 28 cm dbh with an alder nurse or 80 years for those planted with no nurse.

There are additional benefits of planting walnuts in mixtures. Campbell and Dawson (1989) suggested that requirements for corrective pruning of walnut trees could be reduced with the use of a suitable nurse. Using nurses may help control walnut anthracnose, *Mycosphaerella* spp, by inhibiting the bacterium's spore movement from infected walnut leaf litter (Kessler, 1985). Li *et al* (1967) proposed that *Alnus rubra* might have potential in the biological control of root pathogens such as *Poria weirii* and the honey fungus (*Armillaria mellea*). *Alnus* spp fix atmospheric nitrogen in nitrate rather than ammonium or amine

forms: the root pathogens cannot use nitrate nitrogen, unlike antagonist organisms such as *Streptomyces* spp which thrive on it (Li *et al*, 1967).

In central Italy, mixed plantations with *Juglans nigra* established in 1985 (see photo on page 32) have also demonstrated impressive growth (Buresti and Frattegiani, 1994). The first plantations with *J. regia* were established more recently (see photo above), using nurses of cherry (*Prunus avium*), *Elaeagnus angustifolia*, Italian alder (*Alnus cordata*) and *Robinia pseudoacacia* (Buresti, 1995). Six-year results indicated that walnut increased in height by 48 per cent and in stem diameter by 36 per cent when planted with cherry (non N-fixing), compared with those walnuts with no nurse (Buresti, 1995). However, walnuts with N-fixing nurses were 76 per cent taller and with average dbh 42 per cent greater than pure-grown walnuts (Buresti, 1995).

### Walnut Silviculture Trials

Research has been initiated, under the auspices of the British and Irish Hardwoods Improvement Programme, with the aim of investigating planting mixtures which promote the growth of walnut (*Juglans regia*) in England, in terms of stem quality and

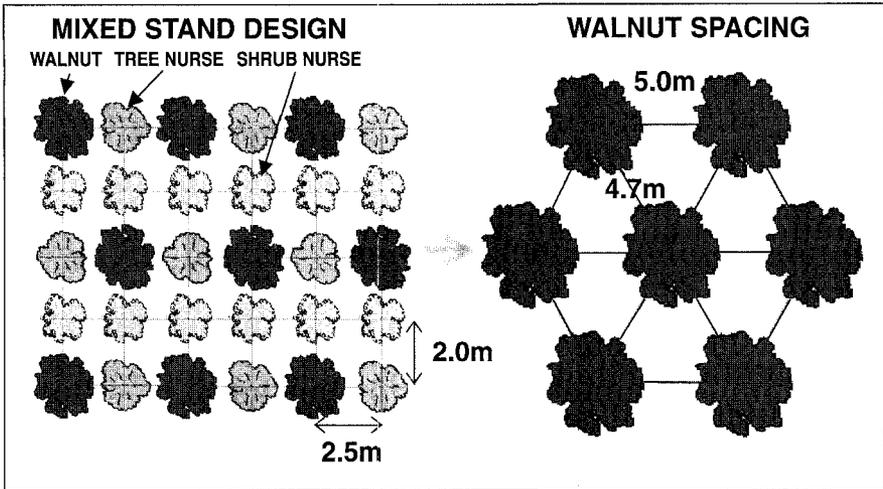


Figure 1. Mixed stand design adopted in the walnut silviculture trials. Walnut (*Juglans regia*) with tree nurses (*Alnus cordata*, *Betula pendula*, *Prunus avium*, *Thuja plicata*) and shrub nurses (*Corylus avellana*, *Elaeagnus umbellata*, *Sambucus nigra*).

vigour, leading to a reduction in rotation time. Three field trials were established in southern England during spring 2000. The planting design used in the trials is based on similar schemes used in Italy (Buresti, *pers comm* [1]) but was adapted by using a closer spacing and alternative species more suited to the British climate.

The walnuts were planted in a triangular pattern at about  $5 \times 5$  m (Figure 1). At this spacing, based on a predicted crown diameter:stem diameter relationship for walnut (Hemery, 2000) and a stem diameter increment of 1 cm/year, the onset of crown competition between walnuts would begin 15 to 20 years after planting. The tree nurse was planted at similar spacing between the walnuts in an alternative triangular pattern (Figure 1). Shrub nurses, where included, were planted in alternate rows, effectively surrounding the walnuts. Total plant density, if both tree and shrub nurses are included, is 2,000 plants/ha ( $2.5 \times 2.0$  m spacing); with the number of plants per ha being 400 walnuts, 400 tree nurses and 1,200 shrub nurses.

Nurse species were selected for inclusion in the trial based on their compatibility with walnut in terms of having similar site requirements (altitude/exposure and soil pH, texture and drainage) and growth (tree architecture, vigour and longevity). Additionally, the potential for commercial utilisation of the nurse was considered, alongside its ability to fix soil nitrogen and to suppress weeds. The main role of the tree nurses will be: to promote walnut height growth and good stem architecture (straight stem, light branching); to improve soil fertility (N-fixing capability); and to create a long-term microclimate. The shrub nurses will ideally provide a ground-level microclimate and, therefore, protection from early-spring frosts, in combination with weed suppression and N-fixation (Table 1).

All tree nurses are likely to need thinning between years 15 and 20, although the

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Table 1. Nurse species included in the walnut silviculture trials, planted in spring 2000, and the criteria for their inclusion.

Suitability is indicated as ✓✓ – high, ✓ – moderate, × – poor and ? – unknown.

species	compatibility			N-fixing	weed suppressing	economic value
	architecture	vigour	longevity			
trees						
<i>Alnus cordata</i>	✓✓	✓✓	✓✓	✓	✓	✓
<i>Betula pendula</i>	✓✓	✓✓	✓✓	×	✓	✓
<i>Prunus avium</i>	✓	✓	×	×	✓	✓✓
<i>Thuja plicata</i>	✓✓	×	✓✓	×	✓	✓
shrubs						
<i>Corylus avellana</i>	✓	✓	✓	×	✓	×
<i>Elaeagnus umbellata</i>	✓✓	✓✓	✓	✓	✓✓	?
<i>Sambucus nigra</i>	✓✓	✓✓	✓	×	✓✓	×

*Alnus* and *Betula* will probably be outgrown by the walnut. Combining *Prunus avium* with walnut was considered a worthwhile treatment as it is a vigorous species like walnut, although it is likely to be more competitive than the other tree nurses. *Thuja plicata* was included to test the benefits of all-year-round shelter, as provided by an evergreen conifer nurse.

The trials, each about 1 ha in area, were planted in spring 2000 on contrasting sites in East Sussex, Oxfordshire and Devon. The trials include all combinations of the nurses (a total of 17 treatments): with tree nurses only (four), tree plus shrub nurses (12) and a pure walnut treatment (one). The trials are of a randomised complete block (RCB) design, comprising 17 plots in each block (replicate) and two blocks per site. The plots of pure walnut were not incorporated on the Devon site due to limited area.

The walnuts were measured at planting time and will be monitored annually until the expected conclusion of the trials in 15 to 20 years. Assessments of tree form, including stem straightness and branching habit, will be made. Additional data will be collected on the competition dynamics between the walnuts and nurses; and knowledge gained on the suitability of *Elaeagnus* for inclusion in forest planting in Britain.

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