THE USE OF THE AUTUMN OLIVE IN BRITISH FORESTRY

Autumn olive (*Elaeagnus umbellata* Thunb.) is a potential companion species for use in growing quality broadleaves in mixtures. **Jo Clark** and **Gabriel Hemery** describe its physiological and silvicultural characteristics, and its role as a successful nurse species.

The genus *Elaeagnus* (silverberry or oleaster) contains 45 species of flowering plants belonging to the family Elaeagnaceae (Mabberley, 1987). The vast majority of the species are native to temperate and subtropical regions of Asia. Autumn olive, *Elaeagnus umbellata* Thunb., is a large multi-stemmed shrub native to China, Korea and Japan, and was introduced to the UK in 1830 (Hillier Nurseries (Winchester) Ltd., 2004).

Bushy in appearance with a fast growth rate, it can reach a height and spread of 5m in six years (Allan & Steiner, 1965). The leaves and shoots are covered with tiny silvery to brownish scales, giving the shrub a whitish to grey brown colour from a distance. Leaves are alternate, simple, 3-10cm long, and 3-5cm wide. The flowers are small (1-2 cm long) silvery white with a four-lobed calyx and no petals. They appear in May and June, are hermaphrodite, fragrant and pollinated by bees and other insects.

The foliage and fleshy red fruit of the autumn olive *Elaeagnus umbellata* .

The bright red fruit is a fleshy drupe containing a single seed. The relatively large seeds ripen in September, are widely distributed by birds and have a high rate of germination (Eckardt & Sather, 1987).

Silviculture and propagation

Elaeagnus umbellata is a hardy shrub, tolerant of a wide range of soil types and conditions. It thrives on all but the most alkaline, shallow soils, with a pH range of 4.8-6.5 (Eckardt & Sather, 1987). It grows best in full sun or light shade although seedlings are shade intolerant.

Due to its compact habit, being as wide as it is tall, it provides excellent shelter from cold winds. It can withstand temperatures as low as minus 40°C and, once established, is very drought resistant (Eckardt & Sather, 1987).

It grows well on infertile soils because its root nodules house nitrogen-fixing actinomycetes. This symbiosis permits the fixation and subsequent utilization of atmospheric nitrogen (Torrey, 1978). Some of this nitrogen is utilised by the host plant but some can also be used by other plants growing nearby (Huxley, 1992). The species is notably resistant to honey fungus (Huxley, 1992).

Autumn olive is best grown from seed. Each shrub can produce 1-4kg of seed, with 40,000-80,000 seed per kg (Olsen, 1974). If planted as soon as they are ripe, the seeds should germinate by early spring, although they may take as long as 18 months. Stored seed can take even longer

to germinate. Cold stratification is required to break embryo dormancy (Eckardt & Sather, 1987). Fowler and Fowler (1987) report that 90% germination can be obtained in two weeks at 10/20ºC day/night temperatures after 16 weeks cold stratification at 5ºC. Semi-ripe cuttings with a heel can also be taken in July and August, although reproduction by seed is so easy that this is usually unnecessary. Plants can fruit in five to six years from seed.

Reclamation and environmental protection

Autumn olive has been cultivated for several purposes. In the United States, it has been planted in reclamation projects on opencast coal mine sites because it is tolerant of the low pH soil conditions often found on these sites (Fowler & Adkisson, 1980). It has also been suggested for use in stabilizing eroded soils in exposed coastal areas due to its salt spray tolerance (http://www.fs.fed.us/database/feis).

Fruit production

Several ornamental varieties have been produced. 'Cardinal' and 'Red Wing' are very good fruiting ornamental forms, whereas 'Jazbo' has been bred for its edible fruits, excellent in jam making.

The fruit are a rich source of vitamins and minerals especially vitamins A, C and E, flavanoids and other bioactive compounds (Matthews, 1994). It is also a good source of essential fatty acids, which is unusual for a fruit (http://www.pfaf.org). *Elaeagnus umbellata* has a high amount of lycopene, an antioxidant that has been shown to decrease the likelihood of prostate and other cancers and may even reverse their growth (e.g. Bowen, 2002). Lycopene (molecular formula: $C_{40}H_{56}$) is a bright red carotenoid pigment, found in tomatoes and other red fruits and is the most common carotenoid in the human body. It is one of the most potent carotenoid antioxidants, which can be absorbed more efficeintly by the body when processed (http://www.leffingwell.com/lycopene). Its name is derived from the tomato's species classification, *Solanum lycopersicum*.

Use as a forestry nurse

Many hardwood trees, including black walnut, *Juglans nigra* L., have shown improved growth when grown with N-fixing species, such as those in the *Elaeagnus* genus (Finn, 1953). Due to its compact habit and impressive growth rate, autumn olive has been used in plantations for companion planting with black walnut in the USA, and with *Juglans regia* L. in Italy (Hemery, 2001).

It is thought that autumn olive enhances walnut growth by increasing ecosystem nitrogen pools through its ability to fix atmospheric nitrogen and by decreasing herbaceous competition (Ponder, 1988). Field trials carried out in the USA have demonstrated that interplanting autumn olive with black walnut can increase seasonal soil nitrogen mineralization rates, increase black walnut leaf nitrogen concentration, and substantially improve black walnut growth and yield compared with growing black walnut alone (Paschke et al., 1989). Interplanting autumn olive may also indirectly enhance black walnut growth and yield by reducing incidence of leaf fungal diseases through interactions with microorganisms in the litter layer (Kessler, 1990).

The first British forestry planting with *Elaeagnus umbellata* was undertaken by the Northmoor Trust in field trials established to investigate the potential benefits of growing common walnut with a selection of nurse species including *E. umbellata* (Hemery, 2001). Early results from these trials indicate that walnut shows substantial increased growth and better form with the *E. umbellata* than with other nurse species after five years (unpublished data). Where *E. umbellata* crowds the walnuts, it also appears to enhance self pruning of the walnut trees. Vegetative competition is also greatly reduced.

In view of the benefits of establishing walnut with *Elaeagnus umbellata* it would be prudent, before recommending its widespread use in British forestry, to refer to the categorisation of this species as ‘invasive’ in the USA, where its planting is prohibited in four states (http://www.fs.fed.us/database/feis/plants/shrub/elaumb/all.html). It was introduced to the United

States for cultivation in 1830 (Allan & Steiner, 1965) and until recently was used to provide cover and food for wildlife. However, it has demonstrated an invasive tendency, colonising disturbed areas adjacent to the plantings where encroachment can be rapid due to the high production of seeds, high germination rate, and hardiness of the plants. Due to its nitrogen-fixing capabilities, it has the capacity to adversely affect the nitrogen cycle of native communities that may depend on infertile soils, and may also out-compete these species (Eckardt & Sather, 1987). Where control has been necessary in the USA, a stump treatment of glyphosate (10-20% dilution) is commonly applied after cutting in late August or September, as resprouting is normal after cutting back (Kuhns, 1986).

In Britain *Elaeagnus umbellata* has been cultivated in parks and gardens for nearly 200 years with no sign of the invasive tendencies experienced in the USA. To our knowledge, the *E. umbellata* planted across four experimental sites in Britain are the first forestry plantings in Britain. Within the closely monitored trials the shrub has been bearing fruit for the last four years with no evidence of regeneration, either vegetative or sexual. This may be due to the intolerance of seedlings to shade, or seed not being dispersed by native songbirds.

The walnut silviculture trial at the Northmoor Trust, Oxfordshire. The walnut being measured is in its sixth growing season (2.5m) and is surrounded by *Elaeagnus umbellata* and *Alnus cordata*.

Conclusions

Given the changes predicted for the British climate and their impact on trees and forests (Broadmeadow et al., 2005), the culture of hardwood trees with compatible nurse species may clearly provide benefits, particularly where the nurse is tolerant of dry conditions, as is the case with *Elaeagnus umbellata*.

Preserving soil moisture, improving micro-climate, and soil conservation are likely to become increasingly important factors during the lifetime of trees being planted today. In addition to these properties the saleable foliage of the species may be attractive to landowners looking for diversification and income generation while the crop trees in the mixed plantation mature. The clear benefits from the use of this species as a nurse in promoting increased vigour and early stem quality in the main crop, deserves the attention of foresters seeking to establish quality and sustainable hardwood plantations.

The non-native status of this and other forestry species, such as walnut, is likely to come under review in the light of our changing climate, and may be less of a barrier to adoption in future decades. Concerns about the unwanted spread of the species appear to be unwarranted in Britain but, nevertheless, a close watch needs to be kept of the autecology of *Elaeagnus umbellata* in the British forestry trials.

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