NATURAL PRODUCT HERBICIDES IN FORESTRY: what are the prospects?

What alternatives are there to synthetic pesticides? *Ian Willoughby and David Clay* look at whether natural product herbicides might play a role.

Used correctly, synthetic chemicals are often the cheapest way of killing weeds. Hardly surprising, then, that in the last few decades herbicides have become the weapon of choice for managers faced with establishing woodlands. More recently the pressure to reduce pesticide use has ratcheted up. A European Union review of active ingredients will almost certainly mean that over half of those pesticides currently available will eventually be withdrawn.

Voluntary certification schemes such as the UK Woodland Assurance Scheme require managers to reduce or eliminate the use of synthetic chemicals, and public pressure may persuade policymakers to call for further reductions in use. Herbicide use in forestry might be tiny compared to agriculture, but the pressure is on to make it even smaller.

THE GOOD NEWS

The good news is that, in theory, there are plenty of ways of achieving reductions. For example:

- Use of more active herbicides
- Use of dye markers to aid targeting
- Use of spot/band weed control
- Use of minimal necessary herbicide rates
- Use of larger transplants
- Cultivation
- Closer spacing
- Continuous cover forestry
- Use of mulches
- Mechanised weeding

THE BAD NEWS

The bad news is that many of the above approaches still require the use of some herbicides and, in practice, several of these techniques make up the good silvicultural practice that is already being routinely applied. Direct alternatives to the use of herbicides are not always practical, and are often much more expensive. If they weren't, most people would already be using them as a first resort.

A FUTURE APPROACH?

An alternative approach in the future might be through the development of control measures based on naturally occurring organisms. This could be from a variety of sources including, for example, plant pathogens, livestock, insects and growth-inhibiting substances.

- Mycoherbicides based on plant pathogens have been in use in North America on a small scale for the control of specific weeds for many years, but development and application to UK conditions is a long-term and expensive process, fraught with difficulties. The Forestry Commission's Research Agency, Forest Research, is currently reviewing the potential for the development of mycoherbicides for use against UK forest weeds.

- Insects have also been successfully used for the control of weeds such as ragwort in North America but the release of similar organisms in the UK seems unlikely to be approved in the near future.

- The use of livestock to provide pre-plant weed control can be effective, but it is a highly specialised operation, and is only practical on limited site types where specialist expertise exists. Also, after planting, weeds reinvade and need to be controlled by other methods.

- Some plant species contain growth-inhibiting substances; these can give some weed suppression when planted as ground-cover and then killed before planting a tree crop, but such systems have not led to significant reductions in herbicide use. Rather than using the intact agent, an alternative approach is to extract the growth inhibitor from the plant and apply that as a herbicide to plants or soil. This is sometimes referred to as a natural product herbicide.

- Some micro-organisms naturally produce chemicals with herbicidal properties. Such products are sometimes referred to as naturally synthesised herbicides.

- Citronella oil, a natural product herbicide, and Bilanafos a naturally synthesised herbicide, have been recently investigated.

CITRONELLA OIL – A NATURAL-PRODUCT HERBICIDE

Citronella oil has long been used as a food additive and insect repellent. It has been introduced recently by Barrier Biotech Ltd as 'Barrier H', a spot treatment for the control of ragwort in pasture and amenity grassland. It is produced by distillation from the Chinese grass, *Cymbopogon winteranius*. It is applied as a ready to use 22.9% emulsion in water, and is effective against ragwort seedlings at all times of the year. Larger plants may require re-treatment for complete control. Used as a spot spray, damage to surrounding grass is limited.

One feature of citronella oil is its rapid speed of action, small weeds being

p24 ▶

◀ p22

desiccated within two to three hours in warm weather (see photo). It is now being used for ragwort control by the Highways Agency, county councils, in countryside stewardship schemes and on SSSIs.

Recent (2001) Barrier Biotech trials have shown that citronella oil is effective against many species of seedling weeds, which suggests it may be useful as a pre-planting herbicide or as a directed spray between growing crops. Forest Research funded trials in 2001

The effect one week on after applying Barrier H at 2200 litres per hectare.

showed it can suppress many perennial weeds for 1 or 2 months (Fig 1).

Preliminary testing also showed that application to the basal 20 cm of dormant broadleaved species in February was not damaging; applications in May to trees in leaf caused death of sprayed shoots but no damage to upper parts of the trees. Directed applications to evergreen conifer species caused damage at both application dates.

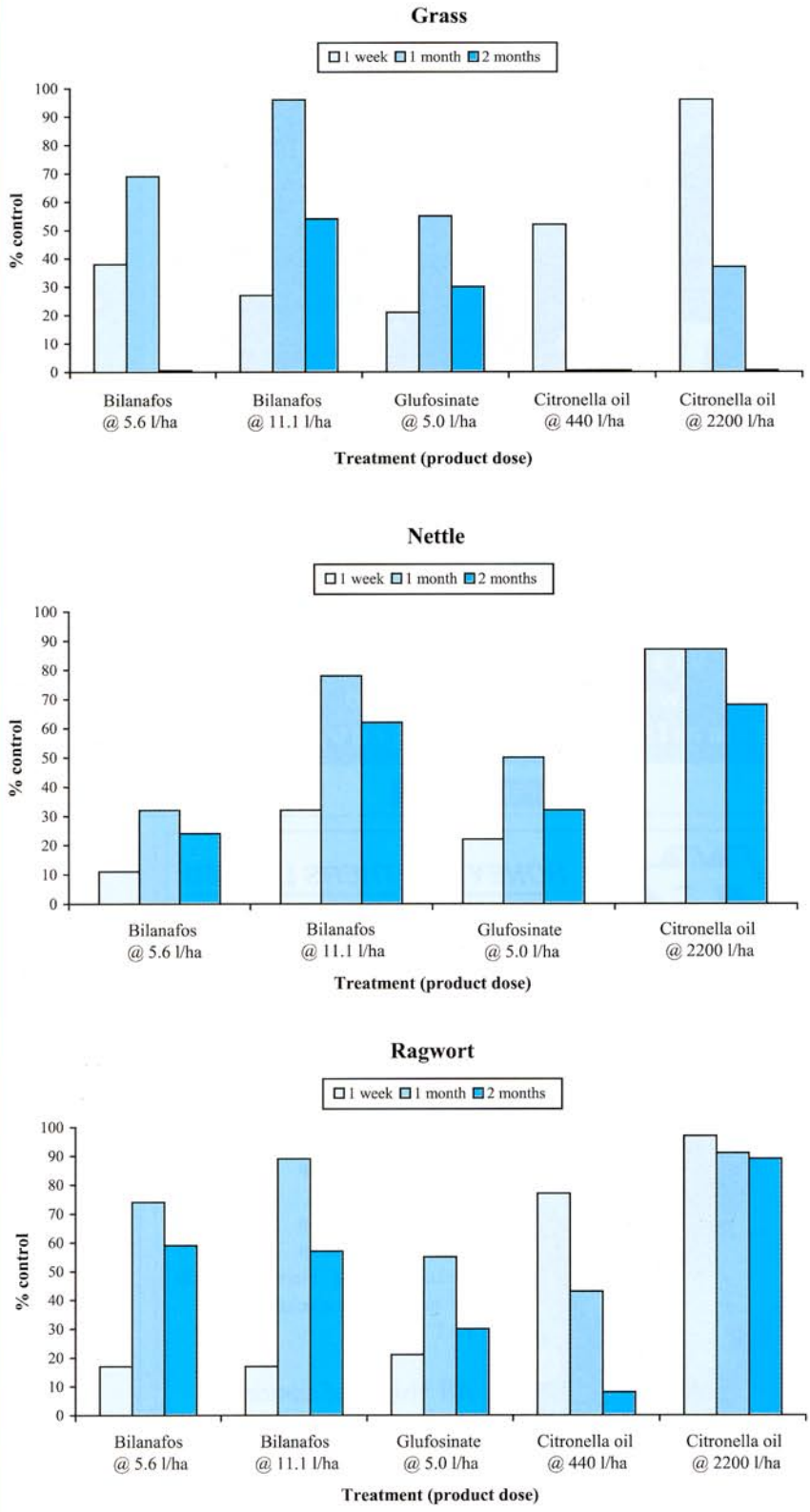
A note of caution: this product is not DEFRA Approved for uses other than ragwort control by spot treatment in grassland. At the doses needed for herbicidal action it may prove too expensive for wide-scale use. However it might conceivably find a niche in some 'organic' growing systems where a more expensive natural product treatment may be acceptable, even given the very high application rates required.

BILANAFOS – A NATURALLY-SYNTHESISED HERBICIDE

An alternative approach to non-synthetic herbicides is in the use of products synthesised by micro-organisms. Bilanafos (or bialaphos) is such a product, produced from *Streptomyces hygroscopicus*, and is in use in Japan under the trade name 'Meiji Herbiace'.

Bilanafos is a contact herbicide which is broken down in plants to phosphonotrycin, the same molecule as glufosinate, the active ingredient of the herbicide product 'Challenge'. Glufosinate is widely used in the UK as a crop desiccant and contact herbicide and has DEFRA Approval for use as a directed spray between trees from April to September. Forest Research-sponsored trials have shown that the dose of bilanafos needed for the control of weeds is similar to glufosinate (Fig 1).

Figure 1 Percentage control of grass, nettle and ragwort one week, one month and two months after application of the herbicides bilanafos, glufosinate ammonium and citronella oil.



Experiments have also shown that directed sprays to the base of trees of 10 species in May gave similar contact damage to glufosinate, with no damage in non-sprayed parts. Application in May to soil between trees did not lead to phytotoxic effects. Overall application of bilanafos to dormant broadleaved trees in January had no adverse effect on subsequent growth but conifer species were badly damaged. Currently, bilanafos has no approval for use in the UK.

SOME CONCLUSIONS

The results with citronella oil and bilanafos reported here show that natural product herbicides are capable of giving effective control of weeds in the establishment of forest trees. In the agrochemical industry, natural product herbicides have often been used to identify new target biochemical pathways for the development of synthetic pesticides.

However, there is a serious question mark over their adoption as alternatives to synthetic pesticides in the future. Natural product herbicides are not necessarily any less toxic than synthetically produced compounds (Barrier H has a lower acute toxicity than glyphosate, whereas bilanafos is considerably more toxic).

In many cases natural products have to date been subject to less rigorous environmental safety testing than synthetically produced compounds. None the less, as natural compounds already present in the environment and often readily degradable, they may be inherently more acceptable to some advocates of organic forestry (for example pyrethrum, an insecticide derived from the flowers of the plant *Tanacetum cinerariaefolium*, is permitted under some circumstances in organic agriculture).

As with synthetic pesticides, introduction of natural product herbicides into the UK would require a similar potentially time consuming and costly product registration process to be undertaken. The attitude of the public, non-governmental organisations and forest managers to such an approach is yet to be determined.

CONTACTS

Ian Willoughby, Silviculture & Seeds Research Branch, Forest Research, Alice Holt Lodge, Wrecclesham, Farnham, Surrey, GU10 4LH
Tel: 01420 22255

David Clay, Avon Vegetation Research Limited, PO Box 1033, Nailsea, Bristol.