Susceptibility of woodland plants to herbicide drift

by F.L. Dixon, D.V. Clay and I. Willoughby

SUMMARY: The susceptibility of three woodland plant species to two commonly used herbicides at a range of doses was investigated. Glyphosate was found to be more damaging than propyzamide at the low doses that might be encountered in drift situations. Lamiastrum galeobdolon and Primula vulgaris were severely affected at one sixteenth of the normal dose rate of glyphosate (equivalent to 0.3 litres ha^{-1} Roundup). Methods for minimising the risk of drift are discussed.

Introduction

Herbicides are used in forestry to control weeds that compete with young trees for resources. Without weed control, transplants or naturally-regenerated seedlings will suffer death or substantially reduced growth.

The Forestry Commission currently recommends maintaining a minimum 1m wide-weed free spot or band around trees until they are established (Davies, 1987). Given a lack of information on the relative competitiveness of different weed species to trees in UK conditions, it is recommended that all vegetation is controlled within the weed-free spots.

Many lowland woodlands subject to regeneration have a fairly impoverished ground-flora, dominated by aggressive species such as bramble (*Rubus fruticosus L.*), bracken (*Pteridum aquilinum L.*) and grasses (Harmer et al, 1997). However, in some cases, for example in well-managed ancient semi-natural woodlands, there may be a rich and diverse ground flora present. This may mean that to establish or regenerate trees, otherwise desirable vegetation may be viewed as weeds, and subject to control.

Outside the weed-free spots or bands, vegetation will be left untreated, which once trees are established, would probably recolonise the treated areas.

However, drift of broad-spectrum herbicides into the untreated areas could damage desirable plants. In agriculture, buffer zones of between 6 – 20m around the edges of fields have been suggested to protect plants in hedgerows and adjacent field margins (Marrs et al, 1993). Obviously, this is impractical when spot spraying trees in woodland, and in many cases may not be necessary.

Most applications in forestry are made with knapsack sprayers at conventional volumes, where drift is unlikely to extend over 1m if spraying is restricted to occasions when windspeeds are less than the 6.5 km $hour^{-1}$ permitted (MAFF, 1998). Tractor-mounted sprayers are primarily used for pre-planting applications following clearfell, but they are unlikely to be used when regenerating ancient semi-natural woodland. The potential risk of drift from tractor-mounted sprayers will depend on the herbicide used, sprayer type, nozzle type, spray pressure, volume rate and environmental conditions.

Pesticide Safety Directorate guidelines suggest that with certain low drift sprayers, buffer zones around water courses can be reduced to 1m (MAFF, 1999). Certain CDA and low drift systems used in forestry offer reduced potential for drift, and wind speeds may be lower in woodlands. Given good working practices, risk of drift in normal spraying operations in forestry situation is probably low.

Previous work by English Nature showed that 10% of spray doses applied with conventional hydraulic equipment travelled up to 2m, 5% up to 7m, and 1% up to 40m from the source (Williams et al, 1987). This would equate to around one twentieth of the dose applied to target vegetation travelling up to 7m. Therefore, even if conventional tractor-mounted hydraulic sprayers were to be used within sensitive forests, the concentrations reaching non-target vegetation may be so low as to not cause concern.

However, even very low rates of broad-spectrum herbicides could lead to indirect changes in plant communities, where vigorous, less susceptible species suppress the more susceptible ones, leading to a loss of species and reduction in floral diversity (Marrs & Frost, 1995).

Experiments were therefore set up to study the susceptibility of three herbaceous woodland species

(*Lamiastrum galeobdolon L.* – Yellow archangel, *Primula vulgaris* Huds. – Primrose and *Viola riviniana* Reichenb. – Dogs violet), to two commonly-used forestry herbicides, glyphosate and propyamide.

The species were chosen as examples of desirable woodland plants that might be susceptible to applications of low rates of herbicide (Davis, 1990). *V. riviniana* is a valuable food plant for butterflies (Thomas, 1986) whilst *L. galeobdolon* and *P. vulgaris* form a very visual and attractive element of certain native woodland types (Rodwell & Patterson, 1994).

Glyphosate and propyzamide were applied at a range of doses from one sixteenth of the normal recommended rate to full recommended rate, which might simulate the possible doses resulting from drift occurring after inappropriate spraying, particularly from conventional tractor-mounted sprayers.

Methods

Lamiastrum galeobdolon, *Primula vulgaris* and *Viola riviniana* plants were transplanted from 3 x 3cm modules in June 1995 into 9 cm diameter pots containing a compost mixture of three parts loam, two parts peat and one part grit with added Osmocote fertilizer.

The plants were grown outside for 1 month under overhead sprinklers before being re-potted into 15cm diameter pots. Half of the plants from each species were potted up using the same compost mixture as before whilst a mixture of seven parts loam to three parts grit was used for the remainder. Peat-free compost was used on this half so as to reduce any inactivation of the residual herbicide – propyzamide. Osmocote fertilizer was added to all pots. All pots were then connected to a trickle irrigation system.

On 17 August 1995 the plants grown in a loam + peat compost were sprayed with glyphosate (360 g litre^{-1} SL; Roundup; Monsanto (UK) Ltd) at 0.11, 0.22, 0.45, 0.9 and 1.8 kg a.e. ha^{-1}.

On 29 November 1995 the plants growing in the peat-free compost were sprayed with propyzamide (400 g litre^{-1} SC; Kerb Flo; Pbi Agrochemicals Ltd) at 0.093, 0.187, 0.375, 0.75 and 1.5 kg a.e ha^{-1}.

The highest dose of both herbicides was set at the maximum normal recommended rate, which was equivalent to 5.0 litres ha^{-1} Roundup and 3.75 litres ha^{-1} Kerb Flo. Both herbicides were applied using a laboratory track sprayer fitted with an 80015E Flat Fan Nozzle; the glyphosate was sprayed at 210kPa in a spray volume of 230 litres ha^{-1}, whilst the propyzamide was sprayed at 280 kPa in 333 litres ha^{-1} (see Table 1 for plant size at application).

There were six replicates of each treatment, except for *V. riviniana* sprayed with propyzamide, where there were only four replicates. After spraying plants were set out in randomized blocks outside, with species and herbicides kept separate.

Plants were transferred to an unheated glasshouse with netted sides in December 1995 to protect them from severe winter weather and watered sparingly by hand. In April 1996 they were moved back outside and watered using trickle irrigation. Plant health was assessed at regular intervals and in July 1996 plants were harvested and shoot fresh weights recorded.

Results

In general, glyphosate was the more damaging herbicide, causing reductions in growth at the lower doses and some plant death at the highest dose. Herbicide treatments had no effect on the flowering of less damaged plants, except for the higher doses of

Table 1. Size of plants at application.

Species	17 August 1995	29 November 1995
L. galeobdolon	Well established with trailing shoots 30 - 40 cm long.	Large trailing plants with shoots up to 50 cm long, no exposed soil visible.
P. vularis	Well established, 5 - 10 cm diameter.	Compact rosettes variable in size, 9 - 23 cm diameter.
V. riviniana	Healthy green plants 10 - 15 cm diameter.	Rosettes, 9 - 20 cm diameter.

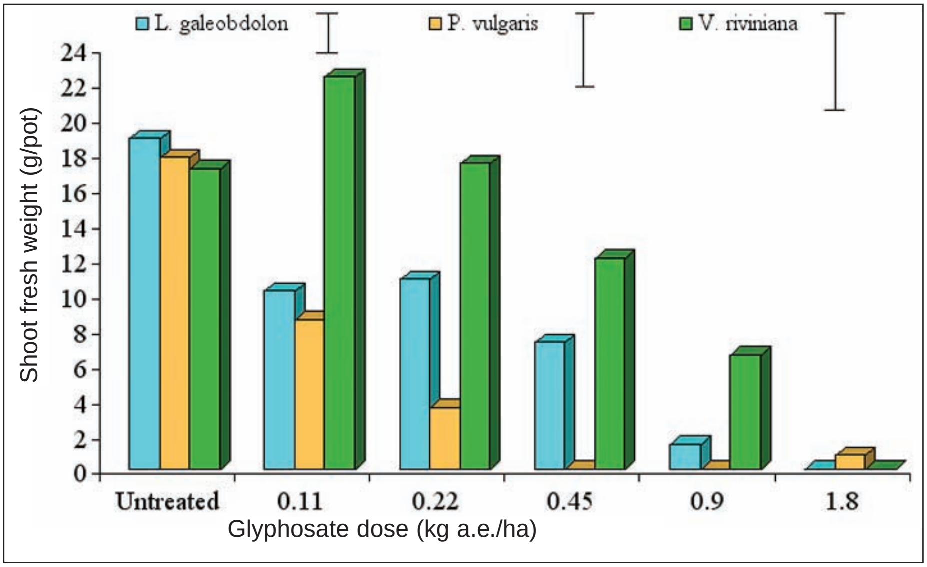

Figure 1. The effect of glyphosate on shoot fresh weights 11 months after treatment. (Standard error of differences of means shown beside species key.)

propyzamide, which prevented flowering of *V. riviniana*.

L. galeobdolon and *P. vulgaris* were particularly sensitive to glyphosate and even at the lowest dose (one sixteenth of the normal recommended rate) applications resulted in very severe reductions in growth (Figure 1). *L. galeobdolon* was killed by the highest dose (recommended rate), whilst a quarter of the normal recommended rate and above killed *P. vulgaris*. Growth of *V. riviniana* however was unaffected by the lower doses and only moderately affected by the middle dose (quarter normal rate). Higher doses were more damaging with the recommended dose resulting in plant death.

L. galeobdolon was largely unaffected by propyzamide although the lower doses resulted in some initial damage (data not shown); long-term growth of *P. vulgaris* and *V. riviniana* was only consistently severely reduced by the highest dose (Figure 2).

Discussion

The results suggest that the methodology used is an effective way of detecting differences in herbicide susceptibility of woodland species, providing that the plants are sprayed at the correct time and growth stage and that growing conditions are realistic.

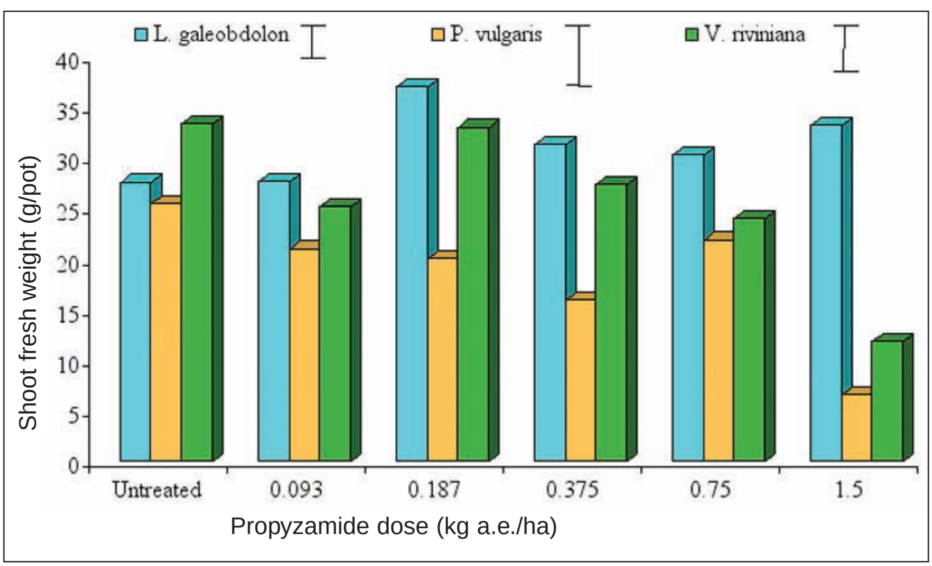

Figure 2. The effect of propyzamide on shoot fresh weights 8 months after treatment. (Standard error of differences of means shown beside species key.)

From this experiment it is possible to see the large differences in response of different species to different herbicides.

Generally we can conclude that drift from glyphosate is likely to be much more damaging than that from propyzamide, since the lower doses of propyzamide, which might be comparable to those encountered from drift (less than quarter dose), (William et al, 1987) appeared to


Yellow archangel, *Lamiastrum galeobdolon*.


Dog violet, *Viola sp*.


Primrose, *Primula vulgaris*.

have no long-term effect on any of the species.

However the lowest dose of glyphosate caused severe reductions in the growth of two of the species tested (*L. galeobdolon* and *P. vulgaris*) and at a quarter rate killed *P. vulgaris*.

This result is consistent with findings from the Natural Environment Research Council (Davis, 1990). Davis reports *L. galeobdolon* growing between 5 and 8m, and *P. vulgaris* 10m away from the source of an application of glyphosate at 2.2 kg a.e. ha^{-1} made with a tractor-mounted sprayer, were not damaged, whilst those growing closer than 5m were damaged.

If we extrapolate from the findings of Williams et al., (1987), this might lead us to expect that the dose received by those plants between 5 and 10m away from the source of application, made with a conventional tractor-mounted hydraulic sprayer, was approximately one twentieth or less than the original dose (0.11 kg a.e. ha^{-1}). This is comparable to the lowest dose in this experiment, which also caused severe reductions in growth of these two species.

While propyzamide applications are unlikely to cause damage to non-target plants by spray drift, they can give damage by lateral movement in soil; leaching of this herbicide down slopes can occur when heavy rain follows treatment.

This experimental series had relatively modest aims; to investigate the effect of low doses of glyphosate and propyzamide on certain desirable woodland species. No attempt was made to address issues such as actual amount of drift possible from different types of applicator, or the effects on complex communities of different plant species, or the effects of other, more selective products.

However, it did indicate that very low doses of glyphosate could cause severe reductions in the growth of *Lamiastrum galeobdolon*, *Primula vulgaris* and *Viola riviniana*.

There is no evidence that such damage is routinely occurring as a result of spot or band-sprays from hand-held sprayers. However, this research does act as a reminder that the use of herbicides in woodland areas where desirable non-target species are present needs to be carried out with extreme care.

Methods for reducing the risk of drift include:-

- Use of hand held sprayers.
- Use of low drift applicators (e.g. dribble bars, weedwipers, certain CDA applicators).
- Use of nozzles giving larger, more uniform droplet sizes at lower pressure with higher volume rates. This needs to be balanced against the risk of runoff.
- Use of more selective herbicides such as graminicides to control grasses only (Willoughby & Clay, 1999). These have no adverse effects on broad-leaved species.
- Avoiding spraying herbicides subject to volatilisation in hot weather.

- Use of dye markers with herbicide applications to identify any drift (Willoughby, 2001).
- For soil-acting herbicides such as propyzamide use of lower volume rates and avoidance of applications in very wet weather.

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