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Efficacy of graminicides on grass weed species of forestry

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Abstract

Good crop selectivity makes the use of graminicides an attractive proposition for use in tree establishment. However when compared to the agricultural situations upon which most graminicide recommendations are currently based, regenerating woodlands usually contain larger specimens of a wider range of grass weed species. For this reason, five field experiments were set up to investigate the relative susceptibility of young and established plants of 29 grass weed species and *Juncus effusus* to the graminicides cycloxydim, fluazifop-*p*-butyl and propaquizafop in comparison with glyphosate and propyzamide. Graminicide applications were made 6, 12 and 18 months after establishing small plants in early autumn. Generally, a wider range of grass species appeared to be susceptible, and at later growth stages, than currently recommended by manufacturers.

Cycloxydim was the most effective graminicide on perennial grasses giving good long term control of *Anthoxanthum oderatum*, *Cynosurus cristatus*, *Dactylis glomerata*, *Festuca arundinacea*, *Lolium perenne*, *Molinia caerulea*, *Phleum pratense* and *Poa trivialis* at all application dates and *Agrostis gigantea*, *Agrostis stolonifera*, *Arrhenathrum elatius* in spring only.

Fluazifop-*p*-butyl was the most effective on *Festuca pratensis*. Autumn applications of cycloxydim and fluazifop-*p*-butyl controlled *Holcus lanatus* and cycloxydim controlled *Agrostis capillaris*, *Deschampsia caespitosa* and *Nardus stricta.*

Propaquizafop was the most effective graminicide on *Elytrigia repens. Festuca longifolia*, *Festuca ovina*, *Festuca rubra* ssp. *rubra* and *J. effusus* were not susceptible to these herbicides.

The graminicides were generally very effective on annual species except *Poa annua*, although cycloxydim gave poorer control of older plants of *Anisantha sterilis* and *Anisantha diandra* and propaquizafop of *Apera spica-venti*. Possible factors affecting susceptibility of grass species to these herbicides are reviewed.

Keywords: Herbicide efficacy; Cycloxydim; Fluazifop-*p*-butyl; Propaquizafop; Glyphosate; Propyzamide; Grass species; *Juncus effusus*; Forestry

1. Introduction

Grass weeds can be a serious problem in forestry, farm woodland and amenity tree plantings, affecting the establishment and growth of newly- planted trees (Davies, 1987; Willoughby and Dewar, 1995). In lowland forestry and new farm woodlands, grass species that are significant weeds in agricultural crops will also compete with young trees. In upland forestry, species such as *Holcus mollis* L. (creeping soft grass) and *Molinia caerulea* L. Moench (purple moor grass) are important competitors.

Since its introduction into British forestry in the 1960's, atrazine has been used widely to selectively control most grass species without damaging young trees (Willoughby and Dewar, 1995). Control using selective rather than broad spectrum herbicides is attractive, as overall applications are cheaper to apply and offer less risk of damage than using directed sprays of more broad spectrum products. However, following review under EU Directive 91/414, in most European countries atrazine will be withdrawn from use by 2005, although 'essential use' provisions will allow a temporary extension of use until 2007 in the UK (Whitehead, 2005; UK Pesticide Safety Directorate, pers. comm.). Propyzamide, a selective soil-acting herbicide, is recommended as a post tree planting winter grass control treatment, but being dependent on

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rainfall and low winter temperatures, it is not always completely effective (Willoughby and Dewar, 1995). The broad-spectrum herbicide glyphosate is commonly used as a directed spray around young trees during establishment, and as an overall spray on some conifer species in autumn and winter (Willoughby and Dewar, 1995). However, whilst potentially very effective, glyphosate misapplication often causes long-term damage to trees (McCavish, 1980). Therefore it would be desirable to identify alternative foliar-acting herbicides that could effectively control a wide range of grass species without damaging young trees, as an alternative to the use of atrazine.

Foliar-acting graminicides, which are selective on broad-leaved crops, have been in use in agriculture for about 20 years (Plowman et al., 1980; Zwink et al., 1985; Bocion et al., 1987). Cycloxydim and propaquizafop are approved for use in forestry situations in the UK, and together with fluazifop-*p*-butyl, they also have approval for use in farm woodland establishment on land previously under arable cultivation or improved grassland (Willoughby and Clay, 1996).

Product labels for these herbicides list the major grass weed species that were found to be susceptible in manufacturers' trials (BASF, 2002; MAKHTESHIM-AGAN, 2002; SYNGENTA, 2001). All three herbicides are said to control young plants of *Alopecurus myosuroides* Huds., *Avena* spp. (wild oats), *Lolium perenne* L. (rye grass) and volunteer cereals. Control of the rhizomatous perennial grasses *Agrostis stolonifera* L. (creeping bent) and *Elytrigia repens* (L.) Nevski (couch grass) with higher doses is claimed where rhizomes are fragmented by earlier cultivation; follow up treatment with a lower dose may be necessary. Cycloxydim and fluazifop-*p*-butyl also have recommendations for the control of *Agrostis capillaris* L. (common bent), *Anisantha sterilis* (L.) Nevski (barren brome) and *L. multiflorum* Lam. (Italian rye grass), cycloxydim for *Apera spica-venti* (L.) P. Beauv. (loose silky bent), *Arrhenathrum elatius* (L.) J. and C. Presl. (false oat grass), *Bromus hordeacus* L. (soft brome) and *Phalaris canariensis* L. (canary grass), and propaquizafop for *Poa annua* L. (annual meadow grass) up to the three leaves unfolded growth stage.

Some species are listed as resistant to these graminicides on product labels: *Festuca ovina* L. (sheep's fescue) and *Festuca rubra* L. (red fescue) to all three herbicides, *P. annua* to cycloxydim and fluazifop-*p*-butyl, *Poa pratensis* L. (smooth meadow grass) moderately resistant to cycloxydim, *Cynosurus cristatus* L. (crested dog's tail), *Festuca longifolia* Thuill. (hard fescue) and *Festuca filiformis* Pourr. (fine-leaved sheep's fescue) resistant to fluazifop-*p*-butyl.

For the establishment of trees in forestry and farm woodland situations in the UK, additional grass species to those listed on product labels can be a problem. Grass species are often targeted at more advanced growth stages, as they can persist for up to 15 years after planting because of a lack of natural suppression by the tree crop. There is therefore a need to determine the potential efficacy of graminicides on a wider range of grass species, and at more advanced growth stages than currently recommended, to assist managers with product selection.

The wider literature does provide some examples of research on a wider range of target species. With *E. repens*, Moyer and Schaalje (1993) and Piskorz and Leska (1999) found propaquizafop gave better control than cycloxydim or fluazifop-*p*-butyl, whereas Hallgren (1996) reported cycloxydim as giving better control than propaquizafop. Poor growing conditions at the time of treatment and lack of rhizome fragmentation can reduce graminicide efficacy on this species (SYNGENTA, 2001). Clay et al. (1990) found that five applications of fluazifop-butyl over 3 years were required to eliminate *E. repens* in a perennial crop.

There is some information reported on the control of other species. In trials in W. Europe, cycloxydim was found to give control of *Anisantha tectorum* (L.) Nevski (drooping brome), *F. arundinacea* Schreb. (tall fescue), *Phalaris minor* Retz. (lesser canary grass) and *P. pratensis* whereas *Poa trivialis* L. (rough meadow grass) was resistant (de Vleeschauer et al., 1992). Cycloxydim and fluazifop-*p*-butyl effectively controlled *Agrostis gigantea* Roth. (black bent) (Peck and Rieley, 1985). Cycloxydim gave better control of *Deschampsia flexuosa* (wavy hair grass) than fluazifop-*p*-butyl (Dixon et al., 2005a) and of *M. caerulea* compared with propaquizafop (Milligan et al., 2003). In work in the USA with fluazifop-*p*-butyl, Brewster and Spinney (1989) tested 31 species of seedling grasses and found all susceptible except *F. rubra*, *Vulpia myuros* (L.) C.C. Gmel. (rat's tail fescue) and *P. annua*; Foy and Witt (1992) also found *Dactylis glomerata* L. (cocksfoot) susceptible.

Despite these findings, there is still little information on a wide range of commonly occurring grass species that may become serious weeds amongst young trees in the UK. Therefore, five field experiments were set up to investigate the relative efficacy of three selective graminicides compared with standard treatments of glyphosate or propyzamide, on pure stands of 29 grass species plus *Juncus effusus* L. Many reports of efficacy of graminicides only assess response 4–6 weeks after application, so in this work, growth of the grasses up to 6 months after application was assessed to determine the potential for the longer-term control necessary in young tree crops. Combinations of cycloxydim and propaquizafop were included in some experiments to assess any potential changes in efficacy that might result from the use of mixtures of graminicides.

2. Materials and methods

The experiments were sited in a field at Failand near Bristol, UK (51°27′ N, 2°41′ W). Soil type according to Mackney et al. (1983) was a typical brown earth, Newbiggin Association, and had a pH of 5.8 and an organic matter content of 3.3%. Twenty seven grass species plus *J. effusus* were grown from seed obtained from Herbiseed Ltd., sown in June and/or July under cool glass and hardened off prior to planting during the autumn.