Effectiveness of spraying herbicides in the centre compared to all over rosettes of *Cirsium vulgare* and *Jacobaea vulgaris*

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Summary Spot-spraying of weeds in pasture can often result in considerable damage to pasture plants adjacent to the sprayed weed. A glasshouse experiment was conducted to determine whether herbicides are just as effective if applied only to the centre of a weed rosette compared with over the complete plant for *Cirsium vulgare* and *Jacobaea vulgaris*. Two herbicides commonly used for spot spraying pasture weeds in New Zealand were used, i.e. metsulfuron and a triclopyr/picloram mixture. Herbicides were applied either to the centre of rosettes (about 5% of leaf area) or the whole rosette using a hand-held sprayer. A range of rates, each applied at 5 mL per plant either in the centre or over the complete rosette, and an untreated control was used for each herbicide to obtain dose-response curves. There was generally no significant difference between applying either metsulfuron or the triclopyr/picloram mixture to the centre rather than all over *C. vulgare* or *J. vulgaris* rosettes. Thus, if farmers ensure they still apply the correct amount of active ingredient, applying it all to the centre of the weed should give the same level of control and presumably greatly reduce the area of pasture damaged around each weed.

Keywords Metsulfuron, triclopyr, picloram, herbicide damage, dosage rate, spot spraying.

INTRODUCTION

Jacobaea vulgaris Gaertn. (formerly *Senecio jacobaea* L, ragwort) and *Cirsium vulgare* (Savi) Ten.) (known as Scotch thistle in New Zealand and spear thistle in Australia) are considered two of the most important weeds of pastures in New Zealand (Bourdot and Kelly 1986, Bourdot *et al.* 1994, Seefeldt *et al*. 2005). These weeds are often spot-sprayed if they occur at low densities, but due to the practice of spraying weeds to run-off, pasture plants at or within the outer diameter of rosettes may receive a lethal herbicide dose. The bare ground resulting from the demise of the target weed plant and non-target pasture plants is likely to be colonised by opportunistic weeds of lower or no feed value (McConnaughay and Bazzaz 1987).

Metsulfuron and triclopyr/picloram are two commonly used herbicides for spot spraying in New Zealand but both these herbicides are very damaging to clovers and have a residual soil activity leading to pasture damage (Thompson 1974, Meeklah and Mitchell 1984, Popay *et al.* 1985).

It is prudent to minimise the non-target impacts of herbicides by more precise application to the centre of the target plant as compared to spraying to run-off. At the time this work was conducted, the label recommendation stated metsulfuron only needed to be applied to the centre of ragwort rosettes, and although the triclopyr/picloram label stated application to weeds could be made with a drench gun, this was suggested at a higher concentration than for spraying the complete plant (O'Connor 2004).

No study could be found that assessed how much more herbicide is required when applying it just to the centre of the weed. The objective of this work was to determine whether a greater amount of active ingredient is needed if applying metsulfuron or triclopyr/picloram mixes only to the centre of rosettes of *J. vulgaris* and *C. vulgare* compared with evenly over the complete plant.

MATERIALS AND METHODS

***Jacobaea vulgaris* experiment** *Jacobaea vulgaris* seeds were sown in cell trays with 18 cm^3 cells on 7 October 2005. After establishment in the trays, the seedlings were transplanted into 1.7 L planter bags on 31 October 2005. The potting mix used was a 4:1 mixture of bark and pumice with slow release fertiliser added. The plants were grown in a glasshouse for eight weeks before being transferred outside at the Plant Growth Unit of Massey University, Palmerston North. Water was applied to the plants using capillary matting wetted by means of drip hoses, occasionally supplemented by overhead watering.

Herbicides were applied on 11 April 2006 when plants were 26 weeks old with an average diameter of 15 cm. The herbicides used were a mixture of 100 g L^{-1} triclopyr and 50 g L^{-1} picloram as amine salts in the form of a soluble concentrate (Tordon Gold™) and metsulfuron in the form of a 200 g kg^{-1} water dispersible granule (Answer™). Herbicides were applied either to the centre of rosettes (about 5% of leaf area treated) or to the whole rosette using a small

hand-held sprayer. The application rate was 5 mL per plant for both treatments.

Six herbicide rates (all applied at 5 mL per plant) and an untreated control were used for each herbicide to obtain dose-response curves. These application rates were determined in an earlier trial in which plants were sprayed with many rates from ineffective to those causing 100% mortality in order to arrive at optimum rates for this current experiment. The metsulfuron rate ranged from 5.9 to 188 µg active ingredient (a.i.) per plant, with the highest rate being equivalent to 25% of the recommended label rate of 2.5 mL per plant of 7.5 g Answer in 5 L. However, as 5 mL per plant was applied, the concentration was adjusted accordingly. The triclopyr/picloram dosage rates ranged from 98/49 to 3120/1560 µg a.i. per plant with the highest rate being equivalent to 12.5% of the recommended rate of 5 mL per plant of 1:20 dilution for young plants (O'Connor 2004).

The experimental design was a completely randomised block design with a factorial arrangement of seven herbicide rates and the two application methods replicated ten times. The plants were assigned to blocks according to size.

Each plant was assigned a herbicide-injury score at regular intervals after treatment, initially weekly and then less regularly later. A score of 1 represented no visual herbicide effect while a score of 10 represented plants with no visual green leaf material. Most ragwort plants appeared to have died as observed by the absence of any green tissue material present at the June 2006 assessment and scoring was stopped. However, by mid-September new shoots had emerged at which point scoring resumed.

***Cirsium vulgare* experiment** *Cirsium vulgare* seeds were sown into cell trays with 18 cm^3 cells in March 2006. The seedlings were then transplanted into 2000 cm^3 PB3 planter bags. The plants were grown in a heated glasshouse (mean temperature of 12°C and 14°C in July and August respectively) and water was applied to the plants as described earlier for the ragwort experiment.

Herbicides were applied on 1 July 2006 when plants were 13 weeks old with an average diameter of 28 cm. Herbicides were applied either to the centre of the rosette (about 5% of leaf area treated) or the whole plant as described earlier. The application rate was 5 mL per plant for both application methods.

The same herbicides were used as for the *J. vulgaris* experiment. Eight herbicide rates and an untreated control were used for each herbicide to obtain dose-response curves. The metsulfuron rates ranged from 0.18 to 23.0 µg a.i. per plant. The highest rate was 3.1% of the recommended label rate of 2.5 mL per plant of 7.5 g Answer in 5 L (which was adjusted accordingly as we applied 5 mL per plant). The triclopyr/picloram rates ranged from 3.0/1.5 to 391/196 µg a.i. per plant. The highest rate was 1.6% of the recommended rate of 5 mL per plant of 1:20 ratio with water for young plants. Rates were selected based on earlier experiments to give a range of sub-lethal effects on plants. Visual assessments were made of foliar injury symptoms as for the ragwort experiment.

Statistical analysis A goodness of fit test (Kolmogorov-Smirnov) was applied to test the distribution of data using SAS. The scores were not normally distributed even after transformations so they were ranked and then subjected to a non-parametric analysis of variance followed by the multiple Bonferroni (Dunn) range test.

RESULTS

There was no significant difference ($P > 0.05$) in the amount of damage caused to *J. vulgaris* plants by any of the sub-toxic doses of either metsulfuron or the triclopyr/picloram mixture when applied to the middle 5% of the rosette compared with over the whole plant (Figure 1).

One consequence of using sub-toxic doses to compare the efficacy of the two methods of application is that regrowth commonly occurred from the root system of the treated plants even though all foliage had died back. Thus in order to correctly assess the effects of the herbicides, this regrowth was allowed to occur fully and so scores presented in Figure 1 are from the assessment made 29 weeks after treatment.

With the *C. vulgare* experiment, there was also very little difference found between applying either metsulfuron or the triclopyr/picloram mixture to the centre 5% of the plant compared with spraying the entire plant (Figure 2). Small but significant differences were found between the two methods of application at only one of the application rates for the triclopyr/picloram mix and at two of the application rates for metsulfuron. Unlike the situation with *J. vulgaris*, there was no regrowth from *C. vulgare* plants once complete necrosis of foliage had occurred.

DISCUSSION

A common misconception among farmers is that complete coverage of weeds must be achieved with herbicides to ensure a good kill of the weed. Although this may be true with contact herbicides, and also when spraying some woody species with translocated herbicides (Zimdahl 1999), herbaceous biennial species such as *J. vulgaris* and *C. vulgare* can be controlled

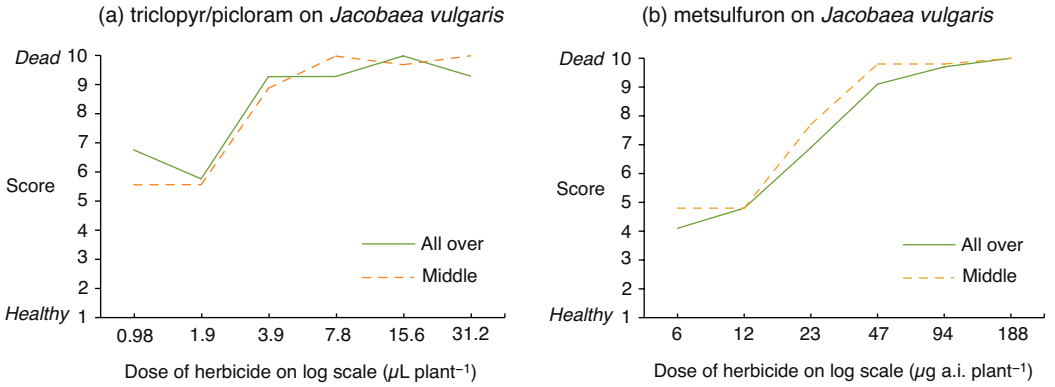

Figure 1. The effect of (a) triclopyr/picloram and (b) metsulfuron on the health score of *Jacobaea vulgaris* plants 29 weeks after being sprayed either in the middle 5% of the rosette (broken line) or over the whole plant (solid line). The lines do not differ from each other at P <0.05 for any dose.

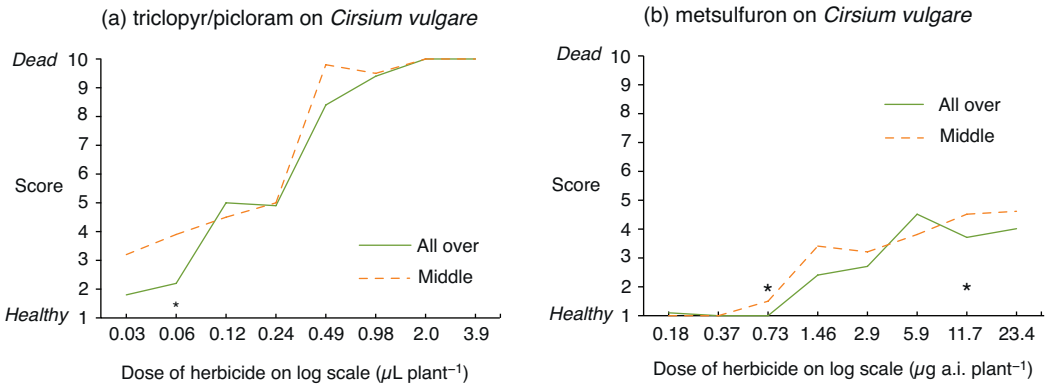

Figure 2. The effect of (a) triclopyr/picloram and (b) metsulfuron on the health score of *Cirsium vulgare* plants 20 weeks after being sprayed either in the middle 5% of the rosette (broken line) or over the whole plant (solid line). The lines only differ from each other at P <0.05 for doses with asterisks.

very well by translocated herbicides such as metsulfuron and triclopyr/picloram when only the centre part of the plant is sprayed.

Results from this work have shown that even as little as 5% cover of the weed when it is at the centre of the rosette can give equivalent levels of control to overall coverage, for the species and herbicides that we used. Obviously higher rates would be needed than were used in this work, as we needed sub-lethal effects to allow a comparison between the application techniques, which would not have been possible if all plants had died.

Although it was mentioned above that the highest rates used here were only a fraction of recommended rates, our plants were young when treated and growing at optimal rates, making them very susceptible to the herbicides (Rahman and James 1991, Shaner 1994). However, our results suggest there is no need to use higher concentrations of herbicide when applying it only to the centres than would be used to spray the entire plant, assuming the same volume of herbicide is applied per plant. This is likely to occur if drench guns are used for application, or the nozzle of a sprayer is held close to the centre of the plant. There might be some spillage of herbicide from the centre of the plant into the soil immediately by the roots, but all three active ingredients used in this work are readily absorbed by roots (Blair and Martin 1988, Cox 1998, Zimdahl 1999) so should still be absorbed by the weed.

By greatly reducing the diameter of the area sprayed with herbicide for each weed treated in pasture, much less clover damage will occur across a treated paddock. Also the size of the gap created in the pasture through damage by herbicides such as metsulfuron which can kill the grasses will also be greatly reduced. Moyo (2008) has shown that small patches of damaged pasture are recolonised by other pasture species much faster than large patches through lateral spread, and thus much less colonization by new weed seedlings occurs.

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