Evaluating the extent of serrated tussock (Nassella trichotoma) resistance to the herbicide, Flupropionate in Australia.

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Summary Identification of a population of Nassella trichotoma resistant to the herbicide flupropionate just north-west of Melbourne has previously prompted a mail survey of 5000 land managers impacted by N. trichotoma across Australia. Out of 400 respondents, 9 reported N. trichotoma resistance to flupropionate and 6 reported resistance to glyphosate. Follow up testing of suspected properties has now confirmed 3 properties with N. trichotoma resistance to flupropionate. This study has also developed a relatively quick seed bioassay technique for testing for resistance. The extent of N. trichotoma resistance to flupropionate identified in this survey flags serious concern about its future viability as a management tool. This study emphasises the importance of promoting integrated management of N. trichotoma to help combat resistance.

Keywords: Serrated tussock, resistance, flupropionate

INTRODUCTION

Serrated tussock (Nassella trichotoma) (Nees) Hack, ex Arechav.) is a Weed of National Significance (Thorp and Lynch 2000) causing huge agricultural and environmental impacts to Australia (McLaren et al. 1998). The potential distribution of serrated tussock based on its current infestations in Australia has been estimated at 32 million ha with substantial areas of New South Wales, Victoria and Tasmania at risk of invasion (McLaren et al. 1998).

The only registered herbicides for control of serrated tussock in pastures are flupropionate, glyphosate and 2,2-DPA. Flupropionate is widely regarded as the most selective and effective herbicide for controlling serrated tussock (Campbell and Vere 1995). It is classified by as a Group 1 herbicide that inhibits plant lipid synthesis and is regarded as a relatively low risk herbicide for resistance (Cropphie Australia 2007). Flupropionate is a soil active herbicide that can have a residual activity and can prevent serrated tussock from regrowing for three to five years (Campbell and Vere 1995).

Flupropionate resistance has been identified in a population of serrated tussock in Victoria with serrated tussock surviving application rates as high as 8 L ha⁻¹, which is four times the recommended rate used for controlling this species (Noble 2002). A national serrated tussock resistance survey was undertaken by the Victorian Department of Primary Industries during 2004 to determine the extent of resistance in Australia (McLaren et al. 2006). This paper reports an assessment of 3 of 9 suspected flupropionate resistant serrated tussock populations identified from the 2004 survey compared to a known flupropionate susceptible population.

Petri dish seed bioassay techniques are commonly used to screen weed seeds for herbicide resistance (Beckie et al. 2000). We developed a sensitive Petri dish bioassay based on serrated tussock shoot growth for detecting differences in the response of serrated tussock to flupropionate.

MATERIALS AND METHODS

Serrated tussock seed collections were made from a known flupropionate resistant population from Diggers Rest, Victoria (37°39' 144°41''), a known susceptible population from St Albans Victoria, (37°45' 144°47'') and from suspected flupropionate resistant populations in the Rowsey Valley, Victoria (37°41' 144°21'') and in Armidale, NSW (30°32' 151°36'). The known and suspected resistant populations all had histories of 6-8 applications of flupropionate over a long period (15 to 20 years). Seed from the Diggers Rest site was obtained from known resistant glasshouse grown plants. At each of the other locations, seed was collected from 10-20 individual serrated tussock plants. For each site, the seed was then bulked together and the most viable seed was selected by choosing well-formed seeds that were firm when squeezed with moderate pressure with tweezers. For each treatment, 30 seeds were placed onto a 9 cm diameter Schleicher & Schuell no. 5703 filter paper inside a plastic Petri dish. 5.0 ml of treatment flupropionate solution was applied to the seeds in each Petri dish. Individual flupropionate treatments
Figure 1. Mean ± Standard error shoot length (% of untreated control) affected by fluropionate concentration for four seed collections of serrated tussock after 18 days germination in petri dishes. Arrows were used to calculate treatment GR50s (dose required to give a 50% reduction in shoot growth).

were applied to the seeds at concentrations of 0, 6.6, 16.4, 41.0, 102.4, 256, 640, 1600 and 4000 mg L⁻¹. Each treatment was replicated three times. After application the Petri dishes were placed in a germination cabinet at 25/15 °C (12/12 hr light/dark) and had their locations rotated at random every 4 days. Petri dishes were checked daily for hydration and 5ml of distilled water was applied to all Petri dishes on day 12. However, 5 of the 108 Petri dishes did dry out and these were excluded from the analysis. Shoot length was measured 18 days after treatment application. Only germinated seedlings were measured for their height and included in the analysis. Fluropionate-stunted serrated tussock seedlings did not regrow and died.

RESULTS
In comparison to the untreated controls, germinated seedlings from St Albans were significantly shorter (susceptible) than those from Diggers Rest, Rowsley Valley and Armidale (resistant) when treated with fluropionate at rates from 6.6 mg L⁻¹ to 256 mg L⁻¹ (Figure 1). The differences in shoot length between resistant and susceptible populations were greatest between fluropionate concentrations of 16 and 40 mg L⁻¹ (Figure 1). The GR50 (dose required to give a 50% reduction in shoot growth) for the susceptible St Albans serrated tussock seedlings was approximately 4.7 mg L⁻¹ compared with 280 mg L⁻¹ for Diggers Rest, 370 mg L⁻¹ for Rowsley Valley and 500 mg L⁻¹ for Armidale seedlings respectively (Figure 1). These are 64, 69 and 105 times the GR50 fluropionate dose for the susceptible St Albans seedlings (Figure 1). In comparison to the untreated seed, germination of fluropionate-treated seed across all treatments declined by 5.5% (Rowsley Valley), 12.7% (Diggers Rest), 1.9% (Ardadale) and 26.9% (St Albans) (Table 1).

Table 1. Effect of fluropionate serrated tussock seed germination compared across locations.

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<thead>
<tr>
<th>LOCATION</th>
<th>% Seed Germination</th>
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<tbody>
<tr>
<td></td>
<td>Untreated</td>
</tr>
<tr>
<td>Rowsley Valley</td>
<td>94.4</td>
</tr>
<tr>
<td>Diggers Rest</td>
<td>83.3</td>
</tr>
<tr>
<td>Armidale</td>
<td>46.6</td>
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<tr>
<td>St Albans</td>
<td>53.3</td>
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DISCUSSION
This study has confirmed that there are now at least three properties in Australia with serrated tussock resistant to flupropionate. This is of serious concern as flupropionate is widely regarded as the most effective and selective herbicide for serrated tussock control (Campbell and Vere 1995). Herbicides that have long soil residual and season-long control of germinating weeds characteristically increase selection pressure and the likelihood of resistance (Warwick 1991). Flupropionate has these characteristics, with a single flupropionate application preventing serrated tussock regrowing for three to five years (Campbell and Vere 1995). We propose that the continued use of flupropionate over a long time period (15-20 years) has resulted in flupropionate resistance developing independently at the Diggers Rest, Rowsley Valley and Armidale locations.

The Petri dish bioassay technique used in this trial showed that flupropionate-resistant serrated tussock seed from Diggers Rest, Rowsley Valley and Armidale could be reliably differentiated from susceptible seed from St Albans at concentrations from 16 mg L\(^{-1}\) to 102 mg L\(^{-1}\) in 18 days. This is far quicker than conventional testing of mature plants, as flupropionate is slow acting and treated plants may not respond for 3 to 12 months (Parsons 1992).

It is critical that land managers do not rely solely on one herbicide type to control serrated tussock. Land managers need to consider mechanical control, cropping, pasture rehabilitation, grazing management and strategic use of herbicides to try and reduce the likelihood of resistance. The findings of this study reinforce the need to practice integrated weed management to control serrated tussock. The implications of serrated tussock herbicide resistance is its increased dominance as a weed, increased costs for land managers, more herbicide usage and higher environmental pollution as a consequence. It is now appropriate to undertake serrated tussock flupropionate-resistance paddock surveys around the properties identified in this study to determine the extent of resistance and take appropriate remedial actions.

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REFERENCES


