Wild radish and toad rush control in Cadiz French serradella pastures

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Summary Plots were planted with Cadiz French serradella (*Ornithopus sativus*) in winter and were infested with wild radish (*Raphanus raphanistrum*) and toad rush (*Juncus bufonius*). Eight herbicides (bromoxynil plus diflufenican, diflufenican plus MCPA, flumetsulam, haloxyfop, imazamox, imazethapyr, MCPA amine and pyraflufen) were applied with a logarithmic sprayer, applying one half to five times the typical label rate, in early spring when the Cadiz French serradella was at the 4-6 leaf stage, the wild radish was at the 4 leaf to bolting stage and the toad rush was at the 2 leaf to tillering stage.

The herbicide tolerance of Cadiz French serradella and the efficacy on the weeds were measured by visually estimating the difference in biomass between treated and untreated areas, 4 and 8 weeks after treatment. The ED_{10} for Cadiz French serradella was approximately 300+30, 20+200, 60, >1040, 120, >350, 640 and 18 g a.i. ha^{-1} respectively for the herbicides above. Dose response curves for the pasture and weeds were fitted to determine the safest products for controlling the weeds present. Imazethapyr provided selective post emergence control of wild radish with an ED_{90} of 270 g a.i. ha^{-1} and toad rush with an ED_{90} of 50 g a.i. ha^{-1}. Imazamox and bromoxynil plus diflufenican also provided selective control of wild radish but with a lower margin of safety. More than 80 g a.i. ha^{-1} of flumetsulam was required for control of large wild radish.

Keywords bromoxynil, Cadiz, diflufenican, flumetsulam, French serradella, haloxyfop, imazamox, imazethapyr, *Juncus bufonius*, legume, MCPA amine, *Ornithopus sativus*, pasture, pyraflufen, *Raphanus raphanistrum*, serradella, toad rush, wild radish.

INTRODUCTION

Cadiz French serradella (*Ornithopus sativus* Brot.) is an annual pasture legume for which only three herbicides (bromoxynil, flumetsulam and imazamox) are registered for post-emergence control of wild radish (*Raphanus raphanistrum* L.) and only one (imazethapyr) for toad rush (*Juncus bufonius* L.) control (Moore and Moore 2010). These are all registered for control of young weeds with less than 3-4 leaves (Moore and Moore 2010). Staggered germination of the wild radish and toad rush often results in a wide range of plant sizes when spraying is delayed to control late emerging seedlings. Surviving weeds compete with pastures reducing their productivity and wild radish pods are difficult to remove from harvested serradella pods.

Haloxyfop is registered in Australia for use in other legume pastures but not serradella and provides control of grasses and some *Erodium* species. The other seven herbicides are also registered in various leguminous crops or pastures and have activity on wild radish or other closely related weeds. Imazethapyr is registered for pre and post emergence use in serradella for control of toad rush but is only registered for pre-emergence control of wild radish. The use of registered products is required for most quality assurance programs.

The aim of this experiment was to determine if various products commonly used in legumes had potential for registration for weed control in young French serradella. This was done using a logarithmic sprayer to apply a wide and continuous range of doses of eight herbicides and comparing the dose response curves of the weeds with those of Cadiz French serradella. The products with the greatest efficacy and selectivity could then be determined.

MATERIALS AND METHODS

Cadiz French serradella was sown at 20 kg/ha in 20 m by 1.3 m plots on 18 June 2009 at Mt Barker Research Station, Western Australia, on a sand over gravel over clay soil in the 600 mm winter predominant rainfall zone. Weeds emerged from the existing seed bank of the experimental site.

Treatments were applied in 217 L ha^{-1} water on 9 September 2009 when the Cadiz French serradella was at the 4-6 leaf stage, the wild radish at the 4-8 leaf to bolting stage and the toad rush at the 2 leaf to tillering stage. A logarithmic sprayer was used to apply three replicates of the herbicides shown in Table 1. The logarithmic sprayer applies the high rate at the beginning of the plot and the rate drops

logarithmically along the length of the plot to one tenth of the high rate at the end of the plot. The high rate corresponds to approximately 5 times the label rate and the low rate about half of the label rate. The plots were visually rated for biomass by comparing treated areas with unsprayed controls on 6 October and 2 November 2009 to estimate the weed control and pasture damage. The scores were combined for analysis using the DRC (dose response curve) package in the R statistical program (Ritz and Streibig 2005).

Table 1. Herbicides and the maximum rate of product applied.

Active ingredient	Product	High rate product ha^{-1}
Bromoxynil 250g L^{-1} + diflufenican 25g L^{-1}	Jaguar™	5000 mL
Diflufenican 25g L^{-1} + MCPA 250g L^{-1}	Tigrex™	5000 mL
Flumetsulam 800g kg^{-1}	Broadstrike™	100
Haloxyfop 520g L^{-1}	Verdict™ 520	2000 mL
Imazamox 700g kg^{-1}	Raptor™	250 g
Imazethapyr 700g kg^{-1}	Spinnaker™ 700 WDG	500 g
MCPA amine 500g L^{-1}	MCPA amine 500™	5000 mL
Pyraflufen-ethyl 20 g L^{-1}	Ecopar™	2000 mL

RESULTS

Imazethapyr as Spinnaker™ provided highly selective and good control of toad rush at low rates and good control of wild radish at high rates. The ED_{90} (effective dose for 90% control) for wild radish was 386 ± 100 g product ha^{-1} and for toad rush was 68 ± 6 g product ha^{-1}. Cadiz French serradella tolerated the highest rate tested with no significant reduction in growth ($P < 0.05$) (Figure 1).

Bromoxynil plus diflufenican as Jaguar™ provided reasonably selective control of wild radish in Cadiz French serradella. Rates around 1000 mL product ha^{-1} provided high levels of control of wild radish with acceptable damage to Cadiz. Lower rates provided less wild radish control, whilst at higher rates, damage to Cadiz French serradella increased rapidly. The dose response curve for toad rush was very similar to Cadiz (Figure 2). The ED_{90} for wild radish was 786 ± 122 mL product ha^{-1} and for toad rush was 5164 ± 1110 mL product ha^{-1}. The ED_{10} (effective dose for 10% control) for Cadiz French serradella was 1190 ± 275 mL product ha^{-1}.

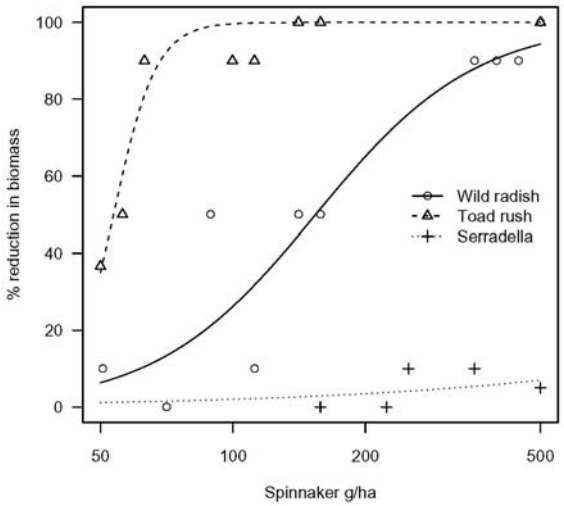

Figure 1. The response of wild radish, toad rush and Cadiz French serradella to various doses of imazethapyr as Spinnaker™.

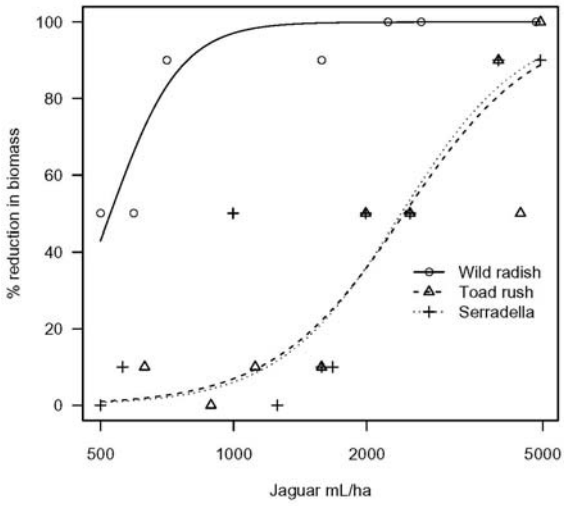

Figure 2. The response of wild radish, toad rush and Cadiz French serradella to various doses of bromoxynil plus diflufenican as Jaguar™.

Imazamox as Raptor™ provided good control of toad rush and suppression of wild radish at high rates. The ED_{90} for toad rush was 98 ± 16 g product ha^{-1}. The ED_{90} for wild radish was beyond the range of rates tested and estimated to be 430 ± 197 g product ha^{-1}. Cadiz French serradella growth had a trend toward reduced biomass at high rates of imazamox but this was not significant at $P < 0.05$ (Figure 3).

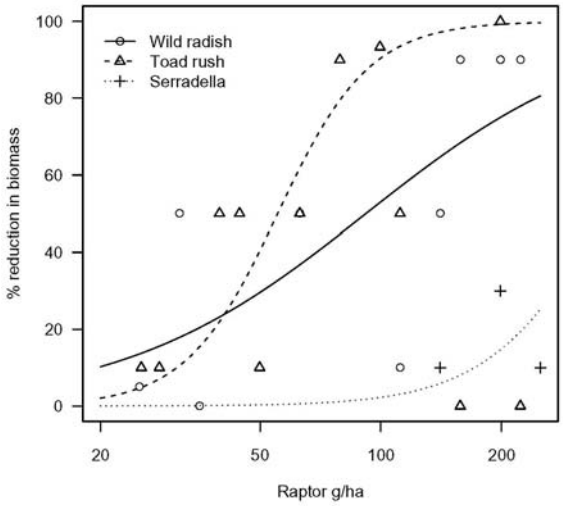

Figure 3. The response of wild radish, toad rush and Cadiz French serradella to various doses of imazamox as Raptor™.

Flumetsulam as Broadstrike™ only provided suppression of wild radish and poor control of toad rush at the highest rates tested. There was a trend toward reduced growth of Cadiz French serradella at the highest rates tested but this was not significant at $P < 0.05$ (Figure 4). The ED_{90} for wild radish was beyond the range of rates tested and estimated to be 173 ± 65 g product ha^{-1}.

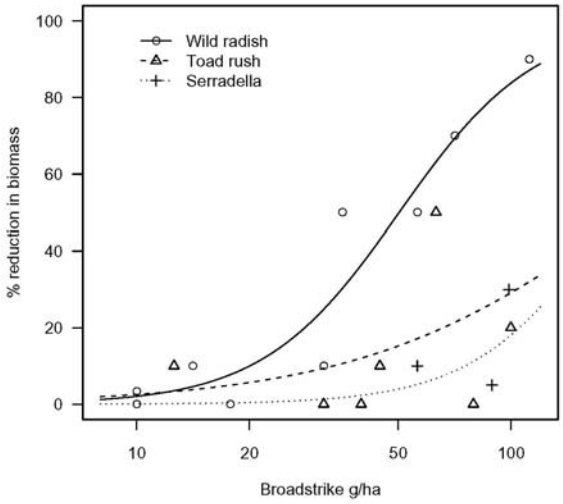

Figure 4. The response of wild radish, toad rush and Cadiz French serradella to various doses of flumetsulam as Broadstrike™.

Cadiz French serradella tolerated rates of diflufenican plus MCPA as Tigrex™ around 500 mL product ha^{-1} but was killed by rates above 1000 mL product ha^{-1}. Radish control was generally poor at the rates tolerated by Cadiz French serradella and toad rush control was poor at all rates tested (Figure 5). The ED_{90} for wild radish was 1273 ± 730 mL product ha^{-1}. The ED_{10} for Cadiz French serradella was 795 ± 160 mL product ha^{-1}.

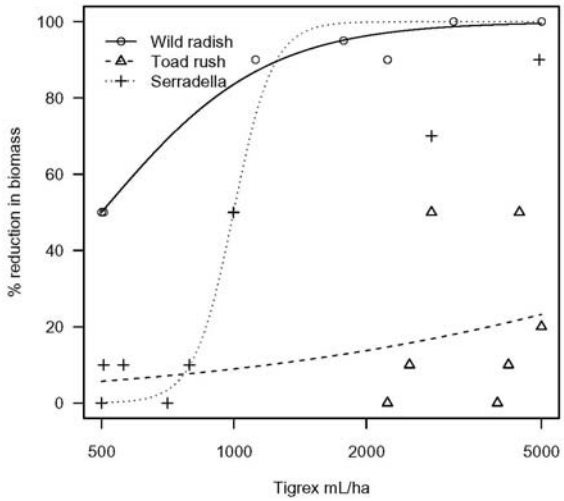

Figure 5. The response of wild radish, toad rush and Cadiz French serradella to various doses of diflufenican plus MCPA as Tigrex™.

Pyraflufen-ethyl as Ecopar™ and MCPA amine 500™ had no significant effect on toad rush ($P < 0.05$). For both products damage to Cadiz French serradella was significant at rates required for reasonable control of wild radish (Figures 6 and 7). The ED_{90} for wild radish was 1522 ± 268 mL product ha^{-1} for Ecopar and 2068 ± 1384 mL product ha^{-1} for MCPA amine 500™. The ED_{10} for Cadiz French serradella was 888 ± 191 mL product ha^{-1} for Ecopar™ and 1272 ± 1641 g product ha^{-1} for MCPA amine 500™.

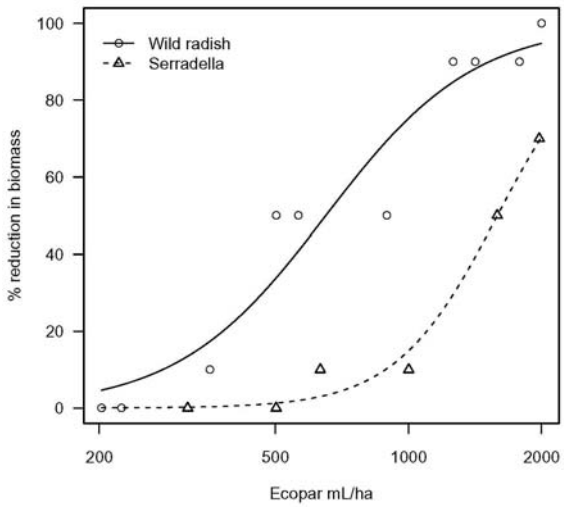

Figure 6. The response of wild radish and Cadiz French serradella to various doses of pyraflufen-ethyl as Ecopar™.

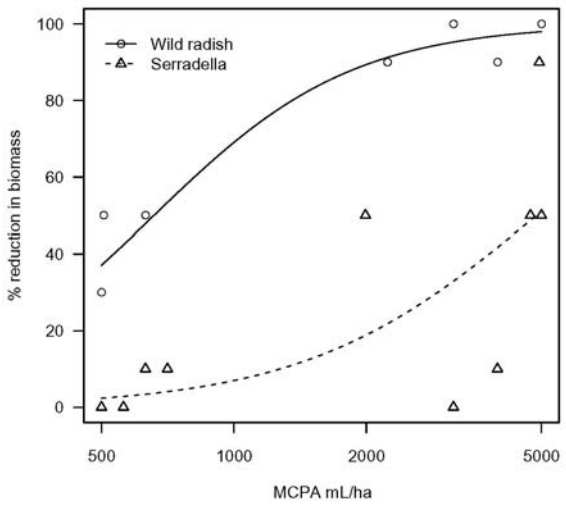

Figure 7. The response of wild radish and Cadiz French serradella to various doses of MCPA amine as MCPA amine 500™.

Cadiz French serradella, wild radish and toad rush all tolerated haloxyfop as Verdict 520™ at the highest rate tested of 2000 mL product ha^{-1}.

DISCUSSION

Imazethapyr provided the most selective control of wild radish and toad rush in Cadiz French serradella. Around 90% control of toad rush was obtained when this product was used very close to the label rate of 70 g Spinnaker™ ha^{-1}.

In Australia, Spinnaker™ is only registered for pre-emergence control of wild radish. Rates for post-emergence control of other young brassica weeds are between 70 and 140 g product ha^{-1} (Nufarm 2004). Around 400 g product ha^{-1} was required for greater than 90% control of the large wild radish in this trial. At these rates, pre-emergence control of late emerging radish is expected to be very good. As Cadiz French serradella tolerated at least 500 g product ha^{-1}, selective control of wild radish can be achieved. Herbicide carry-over into the following season may need to be considered, especially if cereals are to be planted. At current prices, 400 g product ha^{-1} for wild radish control will cost around $150 ha^{-1} so it is not likely to be widely adopted. In addition, this product will need to be registered for this application.

Jaguar™ is registered for wild radish control in clover and lucerne-based pastures at rates up to 1000 mL product ha^{-1}. This work indicates that Cadiz French serradella could be added to the label but double rates or overlaps may cause some damage.

Raptor™ is registered in serradella at 45 g ha^{-1} for suppression of wild radish at the cotyledon to 3 leaf stage. The larger 4 leaf to bolting wild radish in this trial required much higher rates. It is not registered for toad rush and double normal use rates were required to provide good control. This makes it expensive compared to Spinnaker™. About 50% control of toad rush was achieved at normal use rates of 40-50 g product ha^{-1}.

The other broad-leaved herbicides tested (Broadstrike™, Ecopar™, MCPA amine 500™ and Tigrex™) either had too little action on wild radish and toad rush or caused too much damage to Cadiz French serradella to be useful in this situation.

Verdict is registered for use in clover, medic and lucerne pastures but not serradella in Australia. Cadiz French serradella was tolerant at the highest rates tested. This will provide good control of a range of annual grasses and some *Erodium* species.

In conclusion; Spinnaker™ could be registered for post emergence control of wild radish up to the bolting stage in French serradella at rates around 400 g product ha^{-1}. French serradella could be added to the Jaguar™ and Verdict™ 520 labels and toad rush could be added to the Raptor™ label at rates around 100 g product ha^{-1}.

ACKNOWLEDGMENTS

Ross Ram and Daniel Kidd helped plant the trial. The Department of Agriculture and Food Pasture Program funded this work.

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