Chemical control of onion grass (*Romulea rosea*) in native pastures

Zhongnan Nie[1], Reto Zollinger[1], Aggie Stevenson[2] and Bruce Knee[2]

[1]Department of Primary Industries, Private Bag 105, Hamilton, Vic 3300. Email zhongnan.nie@dpi.vic.gov.au reto.zollinger@dpi.vic.gov.au
[2]Glenelg Hopkins Catchment Management Authority, 79 French Street, Hamilton Vic 3300. Email: a.stevenson@ghcma.vic.gov.au b.knee@ghcma.vic.gov.au

Abstract
Onion grass (*Romulea rosea*) is a weed that prevails in native pastures of southern Australia and imposes a significant threat to the productivity, sustainability and biodiversity of the grazing systems. This paper reports the results of a glasshouse experiment followed by a paddock-scale demonstration of onion grass control in western Victoria. Five herbicides were tested in the glasshouse experiment: glyphosate, imazamox, MCPA, dicamba and metsulfuron methyl. Compared with the control, all herbicides except MCPA significantly ($P < 0.01$) reduced the plant population density of onion grass, with glyphosate and metsulfuron methyl being the most effective (80 – 86% reduction). Glyphosate also eliminated all native grasses whereas metsulfuron methyl significantly ($P < 0.01$) improved the cover of native grasses. All herbicides except MCPA reduced ($P < 0.05$) the number of seed pods. Imazamox and metsulfuron methyl were the most effective in reducing the number of corms of onion grass in the soil. Based on the results from this and previous experiments, a demonstration site was established and showed that application of metsulfuron methyl mixed with MCPA at 7 weeks after onion grass plant emergence was effective in onion grass and broadleaf weed control promoting native grass growth and proportion in native pastures.

Key Words
Weed control, selective herbicides, corms, perennial herb

Introduction
Onion grass (*Romulea rosea*) is a perennial herb that looks like a grass, grows like an annual, and can spread rapidly on farm land. It prevails in native pastures of southern Australia and imposes a significant threat to their composition and ecological and agronomic performance. Nie and Zollinger (2011) found that onion grass density reached 4790 plants/m^2 in spring in a native pasture under continuous grazing. Its ability to spread both through seed and corms (Eddy and Smith 1975) makes the weed difficult to control because there is currently no effective technique to get rid of both seed and corms in the soil. Under grazed conditions, grazing animals can play a significant role in dispersing onion grass seed. For instance, over 500 viable onion grass seeds were dispersed by a sheep per day (Eddy and Smith 1975).

For improved pastures or crops onion grass is often sprayed with non-selective herbicides such as glyphosate, followed by establishment of new pastures or crops (Smith 1978). This process cannot be applied to native pastures since resowing of native pastures on a large scale is currently not practical due to limitations on seed availability, establishment cost and technology (Nie and Mitchell 2006). Therefore, a series of glasshouse experiments was conducted to develop new techniques to control onion grass in native pastures. This paper reports the results of an experiment on screening a range of herbicides. Key findings from this and other experiments were then applied in a paddock-scale demonstration site to show the effectiveness of the new techniques in onion grass control for native pastures.

Methods
A glasshouse experiment was conducted at the Department of Primary Industries (DPI) Hamilton Centre from May 2008 to March 2009. Turf sods that were visually assessed as uniform in pasture and onion grass population were collected from an onion grass infested native pasture paddock on DPI Hamilton farm in mid May 2008. The sods were trimmed and placed into 13.5 cm x 13.5 cm square pots (15.2 cm deep) with voids filled with sand. The pots were then arranged with 5 herbicide treatments and a control (no herbicide applied) in a randomised complete block (RCB) design. The herbicide treatments were: 1) glyphosate (Active Ingredient (AI) 360 g/L) at 5 ml/L water plus 2 ml/L non-ionic surfactant; 2) imazamox (AI 700 g/kg) at 0.5 g/L water plus 10 ml/L non-ionic surfactant; 3) MCPA (AI 500 g/L) at 10 ml/L water; 4) dicamba (AI 500 g/L) at 6 ml/L water plus 6 ml/litre non-ionic surfactant; and 5) metsulfuron methyl (AI 600 g/kg) at 0.14 g/L water plus 1 ml/L non-ionic surfactant. Pots were sprayed with the herbicide treatments on 16 June 2008, within 6 – 8 weeks after onion grass plants emerged.

Onion grass plant density (plants/m^2) was estimated by counting the number of live onion grass plants per pot on 12 August 2008. Onion grass pod density was estimated by counting the number of onion grass pods per pot on 5 December 2008. Native grass cover was scored as 0 (none), 1 (<25% of surface cover), 2 (25% to <50% of surface cover), 3 (50% to <75% of surface cover), 4 (75% to <100% of surface cover) and 5 (100% cover) on 17 March 2009. Onion grass corm density was measured by taking two 2.1 cm diameter and 10 cm deep cores randomly per pot in January 2009. The samples were then washed and corms were counted to estimate corm density (corms/m^2) and dried at 100°C for 48 hours to calculate corm weight (mg/corm). All data were analysed by analysis of variance (ANOVA) using a RCB model of the General ANOVA in GenStat (Genstat Committee, 2009).

Based on the results from the research including this glasshouse experiment, two paddocks were selected on a commercial farm (37°32'S; 143°14'E) near Mawallok, Victoria, to demonstrate how native pastures can be improved through effective weed control. One paddock (Innovation paddock; 17 ha) was used to apply the weed control technique and the other (Control paddock; 15 ha) as control. The two paddocks were adjacent to each other with soil texture of light clay, soil pH of 5.5 (water) and Olsen P of 5 and 6 mg/kg for the Innovation and Control respectively. The long-term average annual rainfall (1970 – 2011) was 594 mm. On 14 June 2011 (approximately 7 weeks after onion grass emergence), the Innovation paddock was boom sprayed with metsulfuron methyl at 15 g/ha (AI 600g/kg) and MCPA at 1.49 L/ha (AI 570g/L) plus non-ionic surfactant at 140 mL/ha.

Pastures in the paddocks were monitored before and after the spray (30 March – 18 October 2011). Herbage mass was measured by placing seven 0.9 m^2 square cages in each paddock. Measurements commenced on 30 March 2011 with pastures cut to ground level and cages then placed on the trimmed area to monitor pasture growth to the next harvest. Herbage samples were taken by cutting a 0.1 m^2 quadrat from each cage and bulked across the paddock. Cages were moved to a new trimmed area at each harvest. Herbage samples were dried at 100°C for 48 hours to calculate DM production (kg/ha). At each of the herbage harvests, botanical composition was assessed by taking 50 toe cuts across each paddock. The herbage samples were bulked, fully mixed and about a quarter of the samples dissected into native perennial grasses, exotic perennial grasses , annual grasses, legumes, onion grass, capeweed (*Arctotheca calendula*), erodium (*Erodium botrys*), other broadleaf weeds and moss. The sub-samples were then processed as for herbage mass samples to calculate the composition of each species category.

Results and discussion

For the glasshouse experiment, approximately 8 weeks after the spray, the onion grass density was reduced ($P < 0.01$) by over 70% for dicamba and imazamox treatments and over 80% for glyphosate and metsulfuron methyl treatments, compared with the control (Table 1). Under these four treatments there was also a decline ($P < 0.05$) in seed pod density with most treatments (except dicamba) having no seed pods produced. Suppression of onion grass plant and pod density by most of the herbicide treatments did not translate to a promotion of native grass growth except for metsulfuron methyl that increased native grass cover score ($P < 0.01$) from 1.0 to 1.8 in the following autumn.

Onion grass has two ways to multiply and spread, one is through seed production and the other through corm development (Eddy and Smith 1975). Unlike many other weed species, control of the plant and seed will not get rid of onion grass if onion grass corms in the soil are not affected. There was significant ($P < 0.01$) difference in onion grass corm density between the herbicide treatments 7 months after the spray (Table 1). Imazamox and metsulfuron methyl reduced the corm density by over 90% and glyphosate by 80% whereas MCPA and dicamba had no effect on onion grass corms. This result implies that MCPA and dicamba are not effective in onion grass control due to their inability to kill onion grass corms. Overall, metsulfuron methyl was the most effective treatment in reducing onion grass plant density, seed production and corm development, which led to increased composition and herbage production of native grasses in the following autumn. There was no significant difference in mean corm dry matter (DM) weight between treatments due to large within-treatment variation.

Table 1. The densities of plant (plants/m^2), seed pod (pods/m^2) and corm (corms/m^2) of onion grass, mean onion grass corm weight (g DM/corm) and native grass cover (0-5) under a range of herbicide treatments.

Treatment	Plant density	Seed pod	Corm	Corm weight	Native grass cover
Glyphosate	576^{a}	0^{a}	1243^{a}	48	0.3^{a}
Imazamox	1193^{a}	0^{a}	276^{a}	55	1.3^{cd}
MCPA	3868^{b}	521^{bc}	6770^{b}	108	0.5^{ab}
Dicamba	1139^{a}	69^{ab}	6079^{b}	114	1.0^{bc}
Metsulfuron methyl	837^{a}	0^{a}	414^{a}	36	1.8^{d}
Control	4143^{b}	768^{c}	6079^{b}	91	1.0^{bc}
s.e.m.	315.1**	173.2*	1302.5**	21.6	0.25**

*P < 0.05; **P < 0.01; means with different superscripts are significantly different.

For the field demonstration, there were similar patterns in DM change between the Innovation and Control treatments over time (prior to herbicide spray, 8 and 18 weeks after the spray) for exotic perennial grasses and annual grasses (Figure 1). Initially (pre-spray), the DM accumulation of exotic perennial grasses was 279 and 357 kg/ha for the Innovation and Control treatments, respectively. This dropped by 55 – 64% in winter for both treatments due to lower growth rate of the exotic perennial species and competition of other species such as onion grass and broadleaf weeds. The DM accumulation of exotic perennial grasses then increased over the late winter and spring period with increasing temperature. Annual grasses showed a similar pattern except for the autumn harvest which had low DM production because annual grasses were in the early stage of germination and establishment in autumn.

There were large differences in the change of DM production of native grasses, onion grass and broadleaf weeds from May 2011 (prior to herbicide treatment) to August 2011 (8 weeks after the spray) and October 2011 (18 weeks after the spray) between the Innovation and Control paddocks (Figure 1). Native grass DM accumulation in the Innovation paddock remained unchanged in winter compared with the autumn harvest, but increased dramatically to 666 kg/ha in spring. In contrast, native grass DM accumulation in the Control paddock declined from 287 kg/ha in May 2011 to 188 kg/ha in August and 171 kg/ha in October 2011. This decline was largely attributed to strong competition from other species (e.g. onion grass and broadleaf weeds) over the winter and spring period. It was clearly shown that the growth and DM accumulation of onion grass and broadleaf weed increased in the Control paddock in winter and spring whereas the Innovation paddock had much lower onion grass and broadleaf weed accumulation than the Control paddock in winter, and by spring these two species categories almost disappeared in the Innovation paddock.

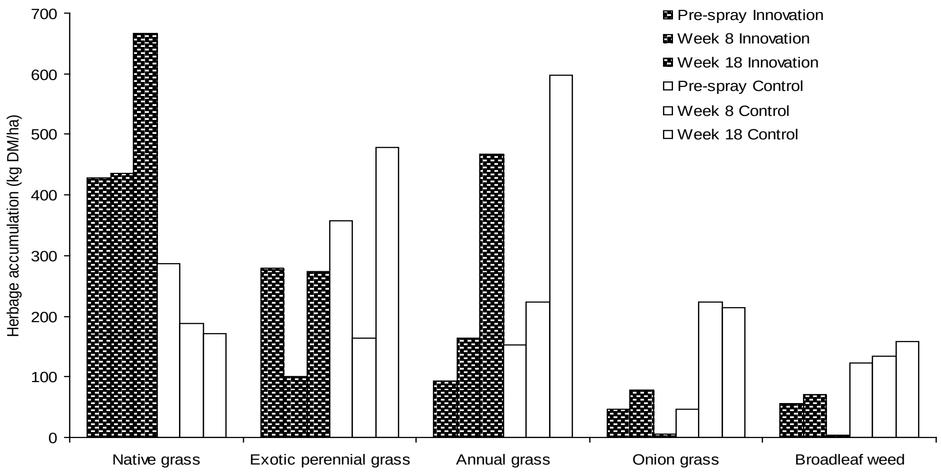

Figure 1. Changes in herbage accumulation (kg DM/ha) of native grasses, exotic perennial grasses, annual grasses, onion grass and broadleaf weeds under the Innovation (dark bars) and Control (white bars) treatments from May 2011 (prior to herbicide treatment) to August 2011 (8 weeks after the spray) and October 2011 (18 weeks after the spray)(left to right).

Further species/categories in the pasture were monitored as a proportion of pasture mass (Figure 2). Like DM production, the species that had the biggest change in the composition before and after the spray were native grasses, onion grass and broadleaf weeds including capeweed and erodium. For instance, the native grass composition in May 2011 was 47% for the Innovation paddock and 29% for the Control paddock. However, after the spray the native grass composition in the Innovation paddock remained at about 50% in August and October 2011 whereas the Control paddock declined to 20% in August and 10% in October. This was again due to stronger competition from other species such as onion grass in the Control paddock. Before the spray the onion grass composition was around 5% for both Innovation and Control paddock (Figure 2). However, the onion grass composition in the Innovation paddock was 9% and 0.4% in August and October 2011, compared to 23% and 13% in the same periods for the Control paddock. A similar trend was observed for other broadleaf weeds.

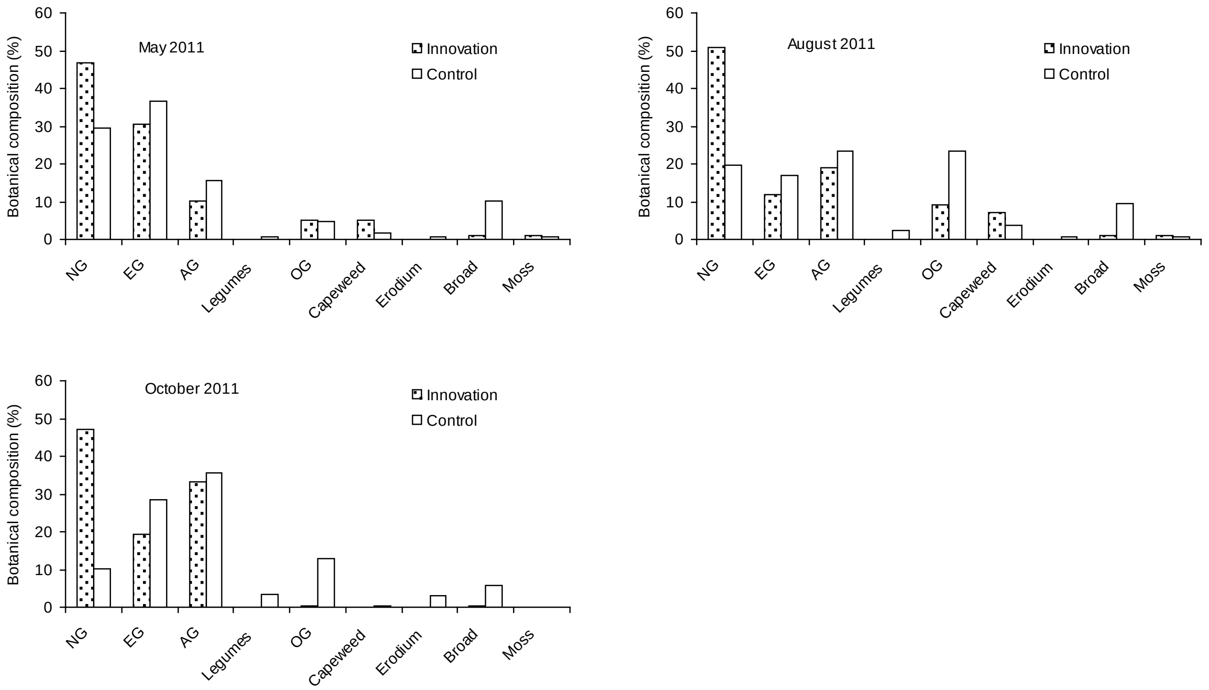

Figure 2. Botanical composition (%) of native perennial grasses (NG), exotic perennial grasses (EG), annual grasses (AG), legumes, onion grass (OG), capeweed, erodium, other broadleaf weeds (Broad) and moss in Innovation and Control paddocks from May 2011 (before herbicide spray) to October 2011, 5 months after the spray.

Conclusion

Effective control of onion grass is desirable for native pastures in southern Australia. While some herbicides may play a role in reducing onion grass plant, seed or corm density, few can achieve all three without detrimental effects on native grasses. Application of metsulfuron methyl mixed with MCPA at 6 – 8 weeks after onion grass emergence has proven to be the most effective technique in onion grass and broadleaf weed control, dramatically promoting native grass composition and yield in native pastures.

Acknowledgement

We thank the farm managers, Troy and Emma Smith, and the Mitchell Family, for their generous support, cooperation and allowing the use of their land. This work has been funded by the Glenelg-Hopkins Catchment Management Authority, Caring for our Country and Department of Primary Industries Victoria.

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