Management of flaxleaf fleabane (*Conyza bonariensis*) in lucerne pastures

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Summary Pasture has been an integral component to the success of mixed farming systems in southern Australia. However, heavy infestation of fleabane in pasture paddocks has become common in southern NSW. Currently no registered products are available for fleabane control in lucerne based pastures, thereby representing a real challenge to control fleabane in pastures. The present study showed that most treatments applied in early July did not achieve commercially acceptable control on small fleabane. Addition of suitable Group C herbicides such as atrazine and simazine to Paraquat provided excellent control on small fleabane and on subsequent emergences. These mixtures gave better control on fleabane when compared to the standalone treatment of atrazine or simazine.

Another trial in lucerne pastures to target mature fleabane after grazing in early December showed that only a few double-knock treatments gave excellent control of fleabane. These included 2,4-DB ± flumetsulam (or ± a Group C herbicides) followed by 7 days later Paraquat ± atrazine (or simazine). Grazing by itself is not effective, as it only delayed the growth and development of fleabane. The fleabane regrowth after grazing requires follow-up herbicide applications, otherwise the fleabane will flourish as a result of little competition.

This research indicates that effective fleabane control should target small fleabane using residual herbicides in winter. Alternatively, mature fleabane should be grazed by sheep and followed by herbicide applications. However, it should be noted that many herbicide treatments caused significant damage to the pasture species.

Keywords Fleabane, *Conyza bonariensis*, chemical control, lucerne pasture.

INTRODUCTION

Flaxleaf fleabane (*C. bonariensis*) is native to South America. Its introduction into Australia can be traced back to 1840s (Wu 2007). It has recently emerged as a difficult-to-control weed in southeastern states of Australia. It was first identified as a major crop weed in northern New South Wales and southern Queensland, but it has now widely spread into southern states. It severely infests cropping areas, roadsides and other non-agricultural lands. A number of factors have contributed to its rapid spread, including reduced cultivation as a result of wide adoption of no-till farming systems, reduced use of effective pre-emergence herbicides, ineffective post-emergent herbicides as well as the unique protective leaf structures of mature fleabane plants which restrict foliar herbicide uptake.

The weed produces more than 110 000 seeds per plant and has a pappus on the seed, which enables it to be disseminated long distances by high intensity summer storms, through a combination of strong wind and surface run-off, and through the water movement in irrigation channels and waterways. The wind-blown seed suggests that the spread of fleabane across an agricultural landscape could be very rapid (Wu 2007). Another reason for its rapid spread is that there is no dormancy requirement of the seed to germinate (Wu *et al*. 2007). Once seed drops onto the soil surface, emergence occurs if climatic conditions are favourable.

Previous research efforts have been concentrated on improved herbicide control efficacy in cereal crops and fallows (Wu *et al.* 2008, Wu *et al.* 2010, Werth *et al*. 2011). Little information is available on effective herbicide control on fleabane in degraded lucerne pastures. Although fleabane plants can be grazed by sheep, its re-growth characteristic makes the grazing option ineffective. The aim of this study was to identify effective herbicide control options on seedling fleabane and on mature fleabane in lucerne-based pastures.

MATERIALS AND METHODS

Two experiments were conducted in degraded lucerne pastures in 2011 in southern NSW. The first site was selected due to the high levels of mature fleabane in the summer of 2010/2011. Thirty five herbicide treatments were applied on 1st July 2011 to evaluate their effectiveness on small fleabane in winter. The second experiment was conducted in December 2011 on a lucerne pasture site which had a high level of basal fleabane population of 60 plants m^{-2}. The site was heavily grazed one week prior to spraying. Twenty-five treatments were sprayed on 2nd December 2011. Among them, 11 treatments had a second application either in one or three weeks as a 'double-knock'. Fleabane visual rating was assessed over time.

Design and statistical analysis The experiments were designed as a randomised complete block with three replications. ANOVA was conducted using Genstat.

RESULTS AND DISCUSSION

Most treatments did not achieve acceptable control (>90%) (Table 1). Paraquat (1.6 L ha^{-1}) mixing with atrazine (1.5 kg ha^{-1}), diuron (1.5 kg ha^{-1}) or simazine (1.5 kg ha^{-1}) were the only three treatments showing excellent residual control on seedling fleabane and subsequent emergences. These mixtures gave better control on fleabane when compared to the standalone treatment of atrazine, diuron or simazine. However, only Paraquat (1.6 L ha^{-1}) mixing with atrazine (1.5 kg ha^{-1}) continued to show excellent residual activity,

Table 1. Control efficacy of herbicides on seedling fleabane and their damage on pasture species (visual rating, % control).

	Fleabane			Luc[b]	Sub[b]	Chi[b]
Treatment	53D[a]	104D[a]	164D[a]		28 D[a]	
25 g Flumetsulam	37.3	23.3	70	0	0	0
50 g Flumetsulam	47.3	36.7	63	0	0	0
25 g Flumetsulam + 1k g simazine 900DF	85	70	73	0	0	0
25 g Flumetsulam + 1.5 L 2,4-DB	70	33.3	75	0	0	43.3
25 g Flumetsulam + 500 g Diuron 900 DF	50	20	47	0	53.3	33.3
25 g Flumetsulam + 1.5 L Bromoxynil	45	33.3	70	0	0	30
200ml Paraquat + 1 kg Simazine 900DF + 500 mL Jaguar	75	76.7	52	10	46.7	46.7
2 L Bromoxynil	45	20	37	0	0	30
500 mL Velocity	15	13.3	33	36.7	70	46.7
300 mL Starane	10	10	17	13.3	83.3	43.3
50 g Raptor	60	0	47	0	0	30
100 g Spinnaker 700WDG	5	13.3	37	6.7	13.3	26.7
1 L Jaguar	30	16.7	60	16.7	16.7	36.7
2.5 L 2,4-DB + 2% Liase	68	36.7	40	3.3	0	33.3
1.6 L Paraquat + 1 kg Simazine 900 DF	95	98.3	75	20	73.3	70
400 mL Ecopar + 2 L 2,4-DB	50	13.3	33	10	26.7	30
400 mL Ecopar + 500ml Igran 500F	15	0	0	10	23.3	20
400ml Ecopar + 1 kg Terbyne 750WG	15	0	3	10	20	13.3
1.5 L Alliance	50	0	47	56.7	76.7	70
2.8 L Amitrole	3.3	0	7	76.7	83.3	73.3
100 g Gallery 75DF	0	0	13	0	3.3	3.3
1 kg Terbyne 750WG	25	0	40	0	0	0
1 kg Prometryn 900DF	15	0	13	0	0	0
100 g Balance	72.7	43.3	43	43.3	36.7	70
2.5 L Boxer Gold	7.3	0	40	0	26.7	13.3
118 g Sakura	3.3	0	10	0	0	0
1.5 kg Simazine 900DF	90	73.3	55	0	50	16.7
1.5 kg Atrazine 900DF	89	73.3	45	6.7	96.7	20
1.5 kg Diuron 900DF	58.3	13.3	22	0	96.7	26.7
750 mL Outlook	40	0	53	0	16.7	13.3
3 L Stomp Xtra	3.3	0	17	0	0	0
1.6 L Paraquat + 1.5 kg Diuron 900DF	95	86.7	62	23.3	88.3	46.7
1.6 L Paraquat + 1.5 kg Atrazine	95	100	93	20	93.3	63.3
20 g Lontrel 750 SG + 500 mL MCPA amine	15	23.3	73	70	16.7	66.7
LSD (P = 0.05)	17.0	8.7	37.7	7.4	10.9	13.3

Note: a – Days after treatment; b – "Luc" for lucerne, "Sub" for subclover and "Chi" for chicory.

achieving 93% control of fleabane at 164 days after treatment.

Many herbicide treatments, however, caused significant damages to the pasture species (Table 1). There were four treatments causing damages to lucerne by more than 40%, including Amitrole®, Alliance, Balance® and the mix of Lontrel® 750 SG and MCPA amine. Subclover and chicory were more sensitive to the herbicide treatments than lucerne. Subclover was highly sensitive to those treatments containing atrazine, diuron, simazine, Amitrole, Alliance, Velocity® or Starane® Advanced.

In the second trial, mature fleabane was grazed one week prior to the herbicide application. Seven double-knock treatments were highly effective on fleabane (Table 2). 2,4-DB mixing either with flumetsulam or a Group C herbicide (atrazine, simazine or metribuzin) achieved 87–93% control. Other three effective treatments included (Simazine + Paraquat) followed by 1 week later (Simazine + Paraquat), (Starane Advance + Atrazine) followed by 1 week later Paraquat, and (Paraquat + Atrazine) followed by 3 weeks later Paraquat.

All the herbicide treatments applied once only on 8th December 2012 did not provide satisfactory results, giving only 40–65% control, although some of these one-off applications contained herbicide mixtures. Three double-knock treatments using Paraquat or Paraquat-based Alliance were also less effective, only achieving 77–85% control on the mature fleabane.

There were three treatment caused significant damage on lucerne, ranging from 37% to 57%. These included (1.5 kg Simazine + 2 L Paraquat) followed by 1 week later (1.5 kg Simazine + 2 L Paraquat), 2 L Paraquat followed by 3 weeks later 2 L Paraquat, and (2 L Paraquat + 1.5 kg Atrazine) followed by 3 weeks later 2 L Paraquat. It seems that the spraying

Table 2. Control efficacy of herbicides on mature fleabane and their damage on lucerne (visual rating, % control).

Treatment	32D[a]	56D[a]	102D[a]	Lucerne
2 L Paraquat	23	20.0	40.0	
2 L Spray.Seed	27	26.7	58.3	
1.5 kg Atrazine	3	36.7	53.3	
1.5 kg Simazine	20	46.7	63.3	
1.0 kg Metribuzin	20	68.3	65.0	
50 g Flumetsulam	73	51.7	63.3	25.0
1.5 kg Simazine + 2 L Paraquat	27	71.7	75.0	
1.5 kg Simazine + 2 L Spray.Seed	13	61.7	61.7	
1.0 kg Metribuzin + 2 L Paraquat	37	36.7	60.0	
Atrazine (1500 g) + 2 L Paraquat	43	71.7	65.0	
50 g Flumetsulam + 1.5 kg Atrazine	27	58.3	65.0	
25 g Flumetsulam + 2.5 L 2,4-DB	73	73.3	83.3	
25 g Flumetsulam + 2.5 L 2,4-DB ➜ 1 week later 1.5 kg Simazine + 2 L Paraquat	98	91.7	93.3	
2 L Paraquat ➜ 1 week later 4 L Alliance	20	60.0	76.7	
1.5 kg Simazine + 2 L Paraquat ➜ 1 week later 1.5 kg Simazine + 2 L Paraquat	80	88.3	91.7	36.7
800 mL Starane Advance + 1.5 kg Atrazine ➜ 1 week later 2 L Paraquat	97	86.7	93.3	
2.5 L 2,4-DB + 1.5kg Atrazine ➜ 1 week later 2 L Paraquat	95	93.3	93.3	
2.5 L 2,4-DB + 1.5 kg Simazine ➜ 1 week later 2 L Paraquat	90	88.3	86.7	
2.5 L 2,4-DB + 1.5 kg Metribuzin ➜ 1 week later 2 L Paraquat	88	90.0	93.3	
2 L Paraquat ➜ 1 week later 2 L Paraquat	33	58.3	85.0	
2 L Paraquat ➜ 3 weeks later 2 L Paraquat	33	73.3	85.0	56.7
2 L Paraquat + 1.5 kg Atrazine ➜ 1 week later 2 L Paraquat	33	75.0	80.0	
2 L Paraquat) + 1.5 kg Atrazine ➜ 3 weeks later 2 L Paraquat	87	93.3	95.0	36.7
LSD (P = 0.05)	22.6	26.0	18.2	na

Note: a – Days after treatment.

window for the double-knock application should be ideally practiced within a week after the first application. The second application, if sprayed too late, could cause substantial damage to lucerne despite of being recently grazed.

CONCLUSION

Our preliminary testing showed that fleabane plants contained 8.3 (MJ kg^{-1} DM) metabolisable energy, 8.7% water soluble carbohydrates and 12–17% crude protein depending on the fleabane growth stages. Sheep can easily graze fleabane. However, grazing by sheep is only an effective option in suppressing the fleabane growth and delay the onset of flowering and seedset. Grazing by itself will not kill fleabane plants. It is critical to apply herbicides after grazing or forage cut, otherwise fleabane can regrow quickly and respond with many more aggressive stems as a result of little competition. The most effective management is to combine grazing followed by the double knock approach.

Herbicide control efficacy depends highly on the timing of application, the use of herbicide mixtures, sequential application as well as the strategic use of residual herbicides. Limited herbicide options are available for fleabane control in lucerne based pastures. A system approach, targeting crops, pastures, fallows, fenceline and roadside, is needed to effectively manage the fleabane. Any missing link could mean the control failure, as the air-borne seeds of this weed might cause re-infestation and infestation to new areas.

With the development of fleabane populations resistant to glyphosate in northern New South Wales and southern Queensland (Walker et al. 2011), it is imperative to adopt an integrated approach, incorporating chemical and non-chemical control options to manage this weed. Fleabane is a poor competitor. Improved crop or pasture competition and the use of tactical tillage are effective non-chemical options in reducing fleabane populations (Wu 2007).

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REFERENCE

Walker, S., Bell. K., Robinson, G. and Widderick. M. (2011). Flaxleaf fleabane (*Conyza bonariensis*) populations have developed glyphosate resistance in north-east Australian cropping fields. *Crop Protection* 30, 311-317.

Werth, J., Walker, S., Boucher, L. and Robinson, G. (2010). Applying the double knock technique to control *Conyza bonariensis*. *Weed Biology and Management 10, 1-8.*

Wu, H. (2007). The biology of Australian weeds. 49. *Conyza bonariensis* (L.) Cronquist. *Plant Protection Quarterly* 22, 122-131.

Wu, H., Walker, S., Rollin, M.J., Tan, D.K.Y. and Werth, G. (2007). Germination, persistence and emergence of flaxleaf fleabane (*Conyza bonariensis* L. Cronq.). *Weed Biology and Management* 7, 192-199.

Wu, H., Walker, S. and Robinson, G. (2008). Control of flaxleaf fleabane (*Conyza Bonariensis* L. Cronq.) in winter fallows. *Plant Protection Quarterly* 23, 162-165.

Wu, H., Walker, S. and Robinson, G. (2010). Control of flaxleaf fleabane (*Conyza Bonariensis* L. Cronq.) in wheat and sorghum. *Weed Technology* 24, 102-107.