Flaxleaf fleabane management in cropping systems of southern Australia

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Abstract
Flaxleaf fleabane (*C. bonariensis* (L.) Cronq.) has emerged as a difficult to control weed in southern Australia. Germination of fleabane in South Australia (SA) occurred between late August and early November, which is much later than that reported from southern QLD and NSW. Later germination of fleabane in SA means that is often not detected until after the crop has been harvested. Controlling fleabane in summer fallow has proven difficult with herbicide rates commonly used for weed control in summer fallow. Use of a double herbicide knock with glyphosate followed by paraquat has given consistently high levels of control where the first herbicide knock provided > 60% control by itself. High rates of glyphosate provided the greatest level of fleabane control, which is contrary to some results from the eastern states where glyphosate resistance is more common. Effective control of fleabane at two field sites during the summer fallow of 2012 conserved 45-71 mm soil water. As spring rainfall is becoming more erratic in southern Australia, it is extremely important to conserve soil water from summer rains by effectively controlling fleabane and other summer weeds.

Key words
Flaxleaf fleabane, summer fallow, weed management

Introduction
Flaxleaf fleabane (*C. bonariensis* (L.) Cronq.) has been a problematic weed in southern Queensland and northern New South Wales cropping regions for some time (Wu et al 2010). Over the last 10 years, it has emerged as a difficult to control weed in South Australia, Western Australia and Victoria. Fleabane has small seeds which germinate and establish close to the soil surface. Therefore, fleabane incidence tends to increase in no-till farming systems. Deep burial of seeds with cultivation maybe seen as a possible control option, however these seeds can remain viable, only to germinate when returned to the surface with later tillage (Wu et al 2007).

Fleabane is capable of large seed production with individual plants being able to produce up to 120,000 seeds (Wu et al 2007). These small light weight seeds can easily be dispersed over large areas by strong winds and water runoff assisted by a pappus on the seed, similar to sow thistle. Managing the seedbank of fleabane can be difficult as adjacent areas (i.e. neighbouring paddocks, roadsides and other non-cropped areas) are often a continual source for replenishment (Dauer et al 2007). As a result of high trichome density on the leaf surface, a thick cuticle and low stomatal density, fleabane has a natural tolerance to herbicide uptake (Procopio et al 2003). In addition control is made even more difficult as plants are often targeted after crop harvest by which time they have developed a large root system and spray conditions are often unsuitable for herbicide absorption.

The ecology of fleabane has been studied in the eastern states where it was found to have no innate dormancy and germination was mostly light and temperature dependant. Germination was shown to occur at temperatures between 10-25°C, however 20°C is optimal (Wu et al 2007). In eastern Australia 99% of fleabane plants emerge in late autumn, early and late winter, with less than 1% emerging mid spring (Wu et al 2007). This paper discusses the emergence pattern of fleabane in South Australia and its management in summer fallow.

Methods
Fleabane emergence
Fleabane emergence was monitored during 2012 in pots placed in the field at Roseworthy Campus, South Australia. Fleabane seed, collected in March 2012 from Bute SA, was spread on the surface of six trays of potting mix on 17 July and monitored until 14 December 2012, where moisture was not limiting. Fleabane census occurred regularly where plants were counted and removed.

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Field trials

Two field trials were conducted in early 2012, investigating fleabane management in summer fallow, the first at Bute on northern Yorke Peninsula and the second at Pinnaroo in South Australia's eastern Mallee region (Table 1.). The trials evaluated several herbicide mixtures with and without a second knock of paraquat. A knife roller was also evaluated. All treatments were replicated three times. Soil moisture, to a depth of 1.2m, was assessed in April 2012 at the end of summer fallow prior to subsequent crop being sown.

Results

South Australian fleabane was found to emerge as late as August to November, when moisture was not limiting (Fig. 1). Fleabane seedling emergence continued at a steady rate until the end of October.

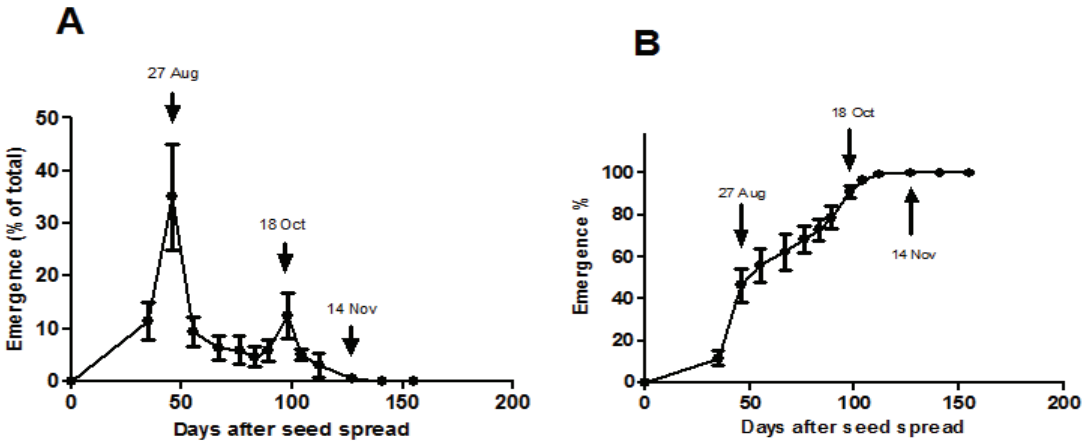

Figure 1. (A) Fleabane establishment in a pot study at Roseworthy starting from 17th of July 2012 when seed was spread. (B) demonstrates cumulative fleabane establishment as a percentage of total.

The 15 herbicide 1st knock treatments provided between 29 and 93% control of fleabane in summer fallow, which increased to 45-97% with the addition of the second knock of paraquat (Table 1). High levels (>90%) of fleabane control was achieved with glyphosate + 2,4-D amine + metsulfuron, or glyphosate + dicamba, or glyphosate + 2,4-D amine & picloram, when the second knock of paraquat was used. However, lower rates of glyphosate alone, glyphosate + clopyralid, or glyphosate + either carfentrazone or saflufenacil, gave inadequate weed control (<70%) even with the second knock (Table 1). High rates of glyphosate alone (≥3L/ha) provided good weed control even when the second knock was not used (Fig. 2A). Application of paraquat as a second knock was only effective when the initial herbicide application provided ≥60% control of fleabane (Fig. 2B). The use of a knife roller on the fleabane prior to first herbicide application provided no additional fleabane control (data not presented).

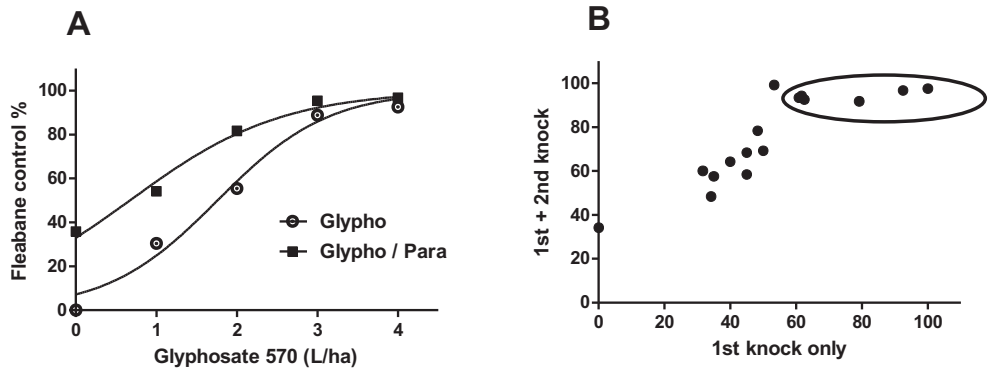

Figure 2. The response of fleabane to glyphosate alone and with additional application of 2.4L of paraquat (2nd knock) (A). (B) fleabane control of standalone herbicide treatment (1st knock) against control from both 1st and 2nd knock for each treatment across Bute and Pinnaroo trials.

Table 1. Effect of herbicide treatments on fleabane control from the final assessment (mid April 2012) for main herbicide treatment alone (1st knock) and with the addition of a subsequent paraquat application (+ 2nd knock). Data was pooled from Bute and Pinnaroo sites. Bute site: 1st knock 12 Jan, 2nd knock 9 Feb; Pinnaroo: 1st knock 1 Feb, 2nd knock 16 Feb.

Herbicide Treatment	**Fleabane control %**	
	1st knock alone	+ 2nd knock
Untreated	0	36
Glyphosate (570g/L) @ 1L / ha	30	54
Glyphosate (570g/L) @ 2L /ha	55	82
Glyphosate (570g/L) @ 3L / ha	89	95
Glyphosate (570g/L) @ 4L /ha *	93	97
Glyphosate (570g/L) @ 1L + 2,4-D amine (700g/L) @ 1.1L / ha	50	87
Glyphosate (570g/L) @ 1L + 2,4-D amine (700g/L) @ 1.1L / ha	50	84 **
Glyphosate (570g/L) @ 1L + Metsulfuron (600g/kg) @ 5g / ha	50	73
Glyphosate (570g/L) @ 1L + 2,4-D amine (700g/L) @ 1.1L + Metsulfuron (600g/kg) @ 5g / ha	57	91
Glyphosate (570g/L) @ 1L + Amitrole (250g/L) @ 2.8L / ha	63	80
Glyphosate (570g/L) @ 1L + Dicamba (500g/L) @ 0.5L / ha	46	69
Glyphosate (570g/L) @ 1L + Dicamba (500g/L) @ 1L / ha	58	91
Glyphosate (570g/L) @ 1L + Carfentrazone (400g/L) @ 45mL / ha	32	53
Glyphosate (570g/L) @ 1 L + Saflufenacil (700g/L) @ 18g / ha ***	29	45
Glyphosate (570g/L) @ 1L + 2,4-D amine & Picloram (300g/L & 75g/L) @ 0.7L / ha	50	97
Glyphosate (570g/L) @ 1L + Clopyralid (300g/L) @ 0.3L / ha	42	69
P<0.001 LSD = 10.934		

2nd knock herbicide application was Paraquat (250g/L)@ 2.4L / ha. The surfactant LI 700 @ 300mL / ha was used with all herbicide treatments except where indicated.

* Only at Bute site, ** 2nd knock was Fluroxypyr (400g) @ 400mL / ha, *** Bonza surfactant used instead of LI 700

The above treatments are for research purposes and some may not be registered

The best performing herbicide treatments provided significant gains in retained soil moisture compared to the untreated control, with 45 and 71mm of soil moisture retained for Bute and Pinnaroo, respectively (Fig. 3).

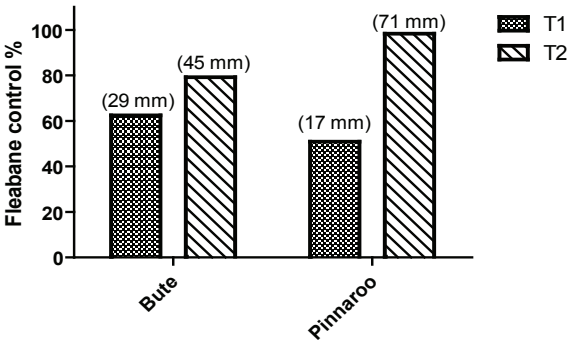

Figure 3. Fleabane control (%) at each site is displayed in the columns. Where T1 = glyphosate + 2,4-D amine + metsulfuron; T2 = glyphosate (3L/ha) as standalone treatment. Soil moisture was measured to a depth of 1.2m. Figures in brackets represent increase in soil moisture relative to the untreated control.

Discussion

In South Australia fleabane emerges through the late winter to late spring, which is later than that reported from the eastern states (Wu et al 2007). This later establishment of fleabane reduces the available options of

in-crop selective herbicides and allows the fleabane to take advantage of the crop's diminishing canopy cover late in the season. Often small fleabane seedlings go unnoticed by growers until after harvest, by which time the weed is well established. This is why the research reported here focussed on controlling fleabane in the summer fallow. There is no doubt fleabane control during summer is much more difficult due to unfavourable spray conditions and larger more established plants than earlier in the season. Previous research has shown that herbicide efficacy on fleabane decreases as the plant matures (Wu et al 2008). Future research needs to investigate the use of in-crop residual herbicides, late selective herbicides and crop-topping options to control fleabane before plants become established and difficult to control.

Herbicide control of fleabane in summer fallow could be achieved where the first-knock herbicide provided >60% control and was followed by the second-knock. In contrast to research from the eastern states, glyphosate alone when used at effective rates (≥3L/ha) provided good weed control by itself. However, reliance on glyphosate alone for fleabane control is not recommended because of confirmation of glyphosate resistance in SA, NSW and Qld (Malone et al 2012). Still glyphosate appears to be a useful tool in managing fleabane in the summer fallow. Increase in soil water from fleabane control over summer can significantly improve grain yields of winter crops.

Conclusion

The prevalence of fleabane appears to have steadily increased in many cropping districts in SA. Herbicide control of fleabane is difficult because it has a natural tolerance to herbicide uptake and plants usually have to be treated in summer when spray conditions are not favourable for herbicide activity. Field trials showed that fleabane control was significantly improved by the second knock of paraquat when the first herbicide knock provided >60% weed control. In contrast to the findings of previous studies in the eastern states, glyphosate alone can provide good control of fleabane.

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