Flaxleaf fleabane – the next glyphosate resistant weed?

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Summary Flaxleaf fleabane (*Conyza bonariensis* L. Cronquist) is the most difficult-to-control weed for many grain growers in southern Queensland and northern New South Wales, particularly in conservation tillage systems. The weed is not controlled effectively by glyphosate alone. Whilst some sections of the grains industry believe that the weed was never controlled well with glyphosate, others state that the weed has become increasingly more difficult to kill with this herbicide.

To test whether this weed had developed resistance to glyphosate, seeds were collected randomly from flaxleaf fleabane populations throughout southern Queensland as part of a national survey. Their seedlings, which were grown under glasshouse conditions, were sprayed with six doses of glyphosate, up to 12 L ha^{-1} of Glyphosate CT (450 g L^{-1} product). All flaxleaf fleabane populations from cropping paddocks, where glyphosate is commonly used, had significantly greater biomass than the populations from non-cropping situations, without a history of glyphosate use. Therefore, repeated use of glyphosate for fallow weed control appears to have resulted in reduced susceptibility of flaxleaf fleabane to this important herbicide.

Keywords Flaxleaf fleabane, glyphosate, herbicide resistance.

INTRODUCTION

Flaxleaf fleabane (*Conyza bonariensis* L. Cronquist) has become the most difficult-to-control weed for many grain growers in southern Queensland and northern New South Wales (Walker *et al*. 2004, Wu *et al.* 2007), and more recently a problem in other cropping regions of Australia (Addison 2007).

The increase in this weed's abundance in the northern grain region was thought to be favoured by a number of factors: widespread adoption of zero tillage; the trend towards using glyphosate alone in fallows; reduction in use of chlorsulfuron herbicide in wheat; reduced crop competition with introduction of skip rows in sorghum and low wheat population densities; and weed control not specifically targeting fleabane (Walker *et al.* 2004).

A preliminary study indicated that a population may have developed resistance to glyphosate in the Goondiwindi region (Rollin and Tan 2004). This is a somewhat controversial issue, as some agreed that the weed has become more difficult to control with glyphosate over time, whereas others considered that fleabane has always been difficult to control with glyphosate alone. As a fleabane species (*Conyza canadensis* L. Cronquist) is now confirmed as resistant to glyphosate extensively in North America (van Gessel 2001), the situation in Australia needs clarification.

This paper reports on the response of flaxleaf fleabane populations collected from cropping and non-agricultural situations in southern Queensland to glyphosate.

MATERIALS AND METHODS

Plant collection and identification Plants and seeds were collected from agricultural paddocks and non-cropping situations, randomly selected at approximately 20 km intervals throughout southern Queensland. Representative plant samples from each site were pressed and sent to two herbaria for identification. Seeds from a minimum of 25 plants were bulked together for each sampling site, and stored in paper bags in dark cool conditions.

Pot experiment Seeds from 34 fleabane populations were sown on the soil surface in 12 cm diameter pot in July 2006. Pots were maintained under ideal growing conditions in a glasshouse. Following emergence, each pot was thinned to three seedlings. When the majority of the seedlings were 5 cm in diameter with approximately 10 leaves, pots were sprayed with six doses of glyphosate: 0, 0.375, 0.75, 1.5, 3.0 and 12 L ha^{-1} of Glyphosate CT (450 g L^{-1} product). Herbicides were applied with a tractor-mounted boom fitted with TT 110-01 nozzles, operated at 2 bars pressure to deliver 73 L ha^{-1}.

Measurements and analysis Experimental design was full factorial (34 populations × 6 herbicide rates) with five replications. At three weeks after treatment application, surviving plants were sampled, dried and weighed. Analysis of variance was conducted on the shoot biomass data using Genstat (8th edition).

RESULTS AND DISCUSSION

Identification The majority of the populations were identified as flaxleaf fleabane (*Conyza bonariensis*), with four populations (Q37, Q40, Q44 and Q45) identified as tall fleabane (*C. sumatrensis* (Retz) E.H.Walker) (Table 1). No populations of the tall fleabane were found in cropping situations, but flaxleaf fleabane was found in a variety of cropping and non-agricultural situations. There were no *C. canadensis* populations, the main *Conyza* species found in North America, which has developed glyphosate resistance in extensive cropping areas.

Response to glyphosate Statistical analysis showed that there were highly significant effects of the glyphosate dose (P <0.001), and interestingly there was a highly significant interaction between dose and population (P <0.001).

The tall fleabane seedlings were highly susceptible to glyphosate, irrespective of habitat. Seedling biomass reduction was 98–99% for the 1.5 L ha^{-1} rate, and seedlings were completely killed at the 3.0 L ha^{-1} rate (data not presented).

The response of flaxleaf fleabane seedlings differed with habitat (Table 2). All flaxleaf fleabane populations collected from cropping situations responded similarly, with seedling biomass at 17–44% of the untreated following treatment with 1.5 L ha^{-1}, which is a commonly used field rate. These populations also survived the highest rate of 12 L ha^{-1}, although their biomass was greatly reduced (1–11% of untreated), as seen in a representative population (Q17) in Figure 1. The mean response of the 21 populations from cropping situations was 54, 41, 28, 15, and 5% of the untreated for the treatments of 0.375, 0.75, 1.5, 3.0 and 12 L ha^{-1} of Glyphosate CT respectively.

The flaxleaf fleabane population that was unlikely to have been exposed to any glyphosate for many years (Q21) was controlled by the field rate of 1.5 L ha^{-1}, with biomass 3% of the untreated (Table 2). This population came from the catchment area immediately adjacent to one of Toowoomba's dams, a grass area that was mowed but not sprayed, and was 10 km from the nearest cropping area.

The flaxleaf fleabane populations from permanent pasture (Q34), and some roadside situations (Q30, Q36, Q39) were highly susceptible, with biomass ranging from 1 to 9% following treatment with the 1.5 L ha^{-1} rate compared with the untreated (Table 2). These three roadside populations were 130–2000 m from the nearest cropping paddock. The mean response of these three populations from non-cropping situations was 22, 11, 4, 2, and 0% of the untreated for the treatments of 0.375, 0.75, 1.5, 3.0 and 12 L ha^{-1} of Glyphosate CT respectively.

The other three roadside collections (Q2, Q4, and Q15) were similar in their responses to those from cropping. These were all collected within 50 m of the nearest cropping areas. The mean response of these populations was 57, 41, 26, 17 and 9% of the untreated for the treatments of 0.375, 0.75, 1.5, 3.0 and 12 L ha^{-1} of Glyphosate CT respectively.

Thus, the overall response of the southern Queensland flaxleaf fleabane populations to glyphosate can be grouped into two categories, as seen with representative populations in Figure 1.

Table 1. Identification and habitat of fleabane populations sampled across southern Queensland.

Code	Species	Habitat
Q1	*C. bonariensis*	Cropping
Q2	*C. bonariensis*	Roadside
Q3	*C. bonariensis*	Cropping
Q4	*C. bonariensis*	Roadside
Q5	*C. bonariensis*	Cropping
Q8	*C. bonariensis*	Cropping
Q9	*C. bonariensis*	Cropping
Q13	*C. bonariensis*	Cropping
Q15	*C. bonariensis*	Roadside
Q16	*C. bonariensis*	Cropping
Q17	*C. bonariensis*	Cropping
Q18	*C. bonariensis*	Cropping
Q20	*C. bonariensis*	Cropping
Q21	*C. bonariensis*	Area near dam
Q22	*C. bonariensis*	Cropping
Q23	*C. bonariensis*	Cropping
Q24	*C. bonariensis*	Cropping
Q25	*C. bonariensis*	Cropping
Q26	*C. bonariensis*	Cropping
Q27	*C. bonariensis*	Cropping
Q28	*C. bonariensis*	Cropping
Q29	*C. bonariensis*	Natural area
Q30	*C. bonariensis*	Roadside
Q31	*C. bonariensis*	Cropping
Q33	*C. bonariensis*	Cropping
Q34	*C. bonariensis*	Pasture
Q36	*C. bonariensis*	Roadside
Q37	*C. sumatrensis*	Roadside
Q39	*C. bonariensis*	Roadside
Q40	*C. sumatrensis*	Roadside
Q42	*C. bonariensis*	Cropping
Q44	*C. sumatrensis*	Orchard
Q45	*C. sumatrensis*	House yard

Table 2. Flaxleaf fleabane seedling response to treatment to GlyphosateCT (450 g L^{-1}) applied at 1.5 and 3.0 L ha^{-1}. Full response of the four populations noted with an asterisk is presented in Figure 1.

Code	Habitat	Biomass (% untreated)	
		1.5 L ha^{-1}	3.0 L ha^{-1}
Q17*	Cropping	43.6	22.0
Q16	Cropping	32.6	23.6
Q27	Cropping	32.4	13.3
Q24	Cropping	32.3	10.8
Q42	Cropping	32.1	11.6
Q23	Cropping	31.8	11.3
Q28	Cropping	31.3	17.2
Q8	Cropping	30.3	15.2
Q5	Cropping	28.9	17.0
Q31	Cropping	28.8	15.2
Q4*	Roadside	28.4	11.1
Q26	Cropping	28.2	13.6
Q2	Roadside	27.9	21.2
Q33	Cropping	25.8	12.9
Q18	Cropping	25.4	10.6
Q3	Cropping	24.5	14.6
Q25	Cropping	24.3	15.7
Q13	Cropping	23.4	17.0
Q1	Cropping	22.4	16.2
Q15	Roadside	21.7	17.7
Q9	Cropping	21.0	14.9
Q22	Cropping	21.0	9.0
Q20	Cropping	17.4	10.5
Q29	Natural area	12.7	6.2
Q30	Roadside	9.4	3.8
Q21*	Area near dam	3.3	2.6
Q34	Pasture	3.2	0.9
Q39	Roadside	2.3	2.2
Q36*	Roadside	0.9	0
LSD	(P = 0.05)	13.0	

The first category includes all populations from cropping paddocks, plus those from roadside situations within close proximity of cropping areas. All these populations exhibited moderate tolerance to glyphosate, particularly at rates less than 3.0 L ha^{-1}. The populations from cropping paddocks are likely to have a long history of glyphosate use. Whilst those from the roadsides would not have been regularly sprayed with glyphosate, they were adjacent to cropping paddocks, and seeds may have originated from these paddocks and blown short distances to these roadsides.

The second group are those from non-cropping situations that are unlikely been exposed to regular spraying with glyphosate. These populations were effectively controlled with 1.5 L ha^{-1} of Glyphosate CT.

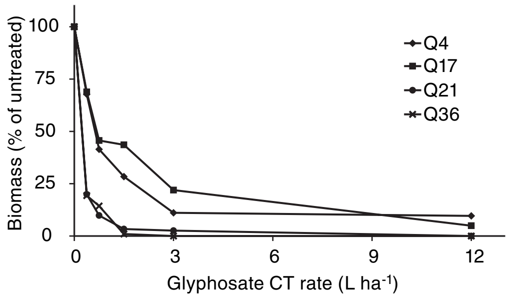

Figure 1. Response of selected flaxleaf fleabane populations to six doses of glyphosate, applied as Glyphosate CT (450 g L^{-1}). LSD = 13 ($P < 0.05$).

In summary, repeated use of glyphosate for fallow weed control in cropping areas of southern Queensland appears to have resulted in flaxleaf fleabane developing low levels of resistance to this important herbicide. Weed management strategies need to be adapted to take this into account for effective control of this problem weed.

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