Evaluating herbicides for the control of the invasive weed florestina (*Florestina tripteris* DC.)

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Summary Florestina (*Florestina tripteris* DC. Asteraceae) is an annual exotic weed that grows 15–60 cm high with grey-green leaves, small white flowers and sticky seeds. It is believed to have been accidentally introduced to Australia in 1964 in a consignment of buffel grass (*Cenchrus ciliaris*) seed from the USA. Florestina has since become naturalised near the townships of Tambo and Barcaldine in central western Queensland, Australia. In 2007, a chemical screening trial was undertaken on a cattle property near Barcaldine to evaluate the efficacy of 28 herbicide treatments (including a control). This trial resulted in a number of herbicides providing both high initial mortality of florestina plants and residual control of seedling recruitment for up to 205 days after treatment. The most effective herbicides identified were metsulfuron methyl (600 g kg^{-1}), triclopyr + picloram (300 g L^{-1} + 100 g L^{-1}), 2,4-D + picloram (300 g L^{-1} + 75 g L^{-1}) and 2,4-D amine + metsulfuron methyl (625 g L^{-1} + 600 g L^{-1}). Rate response trials of these most promising herbicides have been initiated to identify the optimum application rates that will provide not only high initial mortality, but also prolonged residual control of seedling recruitment.

Keywords *Florestina tripteris*, residual control, mortality.

INTRODUCTION

Florestina (*Florestina tripteris* DC. Asteraceae) is an annual exotic weed that grows 15–60 cm high with grey-green leaves, small white flowers and sticky seeds. Florestina is native to south-central Texas and Mexico and is believed to have been accidentally introduced to Australia in 1964 in a consignment of buffel grass (*Cenchrus ciliaris*) seed from the USA. It grows mostly along roadsides and in disturbed fields, occurring on various soils from near sea level to about 900 m (Turner 1963). The first Australian (Queensland Herbarium) record was collected in 1989 from Tambo and more recently from Barcaldine in 1993. Florestina seeds are easily spread by stock and machinery including vehicular traffic. Florestina is very similar in flower structure and growth habit to the Queensland-declared noxious weed parthenium (*Parthenium hysterophorus* L.), and the two can easily be confused. Like parthenium, florestina has the ability to survive dry conditions via a persistent seed bank, germinating quickly after rain and often completing a life cycle within 1 month (Sparks and Rodgers 2007).

The objective of this trial was to compliment previous herbicide research undertaken on florestina (Sparkes and Rodgers 2007) through further screening of a range of chemicals to identify methods for effective herbicide control of florestina.

MATERIALS AND METHODS

Site details The trial was undertaken at 'Kyneton Station' (23°48'S, 145°12'E), a cattle property located on the outskirts of Barcaldine along the Landsborough highway. The trial site predominantly consisted of pulled gidgee (*Acacia cambagei* R.T.Baker.), boree (*Acacia tephrina* Pedley.) and open woodland. The landform is flat to gently sloping undulating plains with gilgai (small depressions) development throughout. Soil type is primarily shrinking and expanding deep red, brown and grey cracking clay with scattered surface gravel or light stone cover. Groundcover consists of native and established introduced grass species, largely dominated by buffel grass (*Cenchrus ciliaris* L.), annual Flinders grass (*Iseilema vaginiflorum* Domin.) and a number of seasonal forbs.

Experimental design The chemical screening trial was set up on 12 March 2007 using a randomised complete block design with sufficient plots (experimental units) to incorporate 28 treatments and four replicates. At the time, conditions were fairly dry and florestina plants were mainly restricted to gilgais where moisture had remained higher due to ponding from previous rainfall. Plots (2 × 2 m) were strategically centred over the depressions and orientated so that two of their corners were in a north south direction. A survey peg was

positioned on each of these corners with the northern peg tagged to denote the plot number. To measure plant changes a 2 × 2 m quadrant (divided into four through the corners with rope) was put in the same position as the plot. Plants were counted in the first two quarters making note of the juvenile and adult plants present. If the combined total was not larger than twenty the next two quarters were counted. If the combined total was not greater than twenty the plot was excluded from the experiment. Each quadrant was counted by the same researcher at each subsequent visit.

Chemicals selected for screening had previous registrations for controlling other broadleaf (dicotyledonous) weeds using foliar spray applications. Similarly, rates were chosen for each chemical relative to rates used for other herbaceous broadleaf weeds, such as parthenium. In total, 16 chemicals were chosen (Table 1), and a number of these had varying rates recommended for different broadleaf weeds. The final number of chemical treatments was thus 28, which included a control. Treatment number 26 was on the expired Australian Pesticides and Veterinary Medicines Authority (APVMA) minor use permit for control of florestina in pasture, stock routes, roadsides and non-crop situations (PER9629). This treatment was a mixture comprising two chemicals, 2,4-D and metsulfuron methyl.

Spraying was to occur using a boom spray. However, because of the undulating nature of the site and the presence of pulled timber it was not suitable for this application technique. Instead, foliar spraying occurred using an Ag-murf pressurised sprayer. All herbicide mixtures were based on an application rate that equated to 1500 L ha^{-1} of mix. A spray adjuvant (paraffinic oil + alcohol alkloxylate (582 + 240 g L^{-1}) at 4.37 + 1.8 kg a.i. ha^{-1}; (Uptake) was added to all treatments.

Although some florestina plants were starting to wilt at the time of application (18 September 2007), plants were considered to be sufficiently healthy to proceed with the trial.

Assessments of herbicide treatments were undertaken 21, 35, 67, 74, 164, 205 and 276 days after treatment (DAT). To demonstrate the combined effects of each treatment on initial mortality and residual control we present the results of Florestina plant counts (number m^{-2}) undertaken 164, 205 and 276 DAT, following rainfall events of 436.7, 439.5 and 472 mm, (Natural Resources and Water 2009) respectively.

Data are presented as mean counts per square metre and were transformed ($\sqrt{X} + 0.5$) prior to statistical analysis and later back-transformed for presentation. GenStat Version 11.1.0.1575, 2008 was used for statistical analyses.

RESULTS

At 164 DAT the density of florestina was reduced (when compared to the control) most significantly using metsulfuron methyl, triclopyr + picloram, 2,4-D + picloram, clopyralid, imazapyr, 2,4-D amine + metsulfuron methyl, and aminopyralid + fluroxypyr at one or more of the application rates. At 205 DAT (Table 1) these herbicides continued to provide residual control, but by 276 DAT (data not shown) this effect had ceased with more than seventy florestina plants m^{-2} recorded in these treatments.

DISCUSSION

The chemical screening trial identified herbicides that are capable of causing high initial mortality as well as residual control to prevent new seedling establishment of florestina seedlings for several months. The herbicides approved for florestina control in the expired (APVMA) minor use permit (PER9629) (Treatment 26) provided excellent control of florestina but caused adverse effects (data not shown) on all pasture species present in treatment plots However, the residual activity of this treatment was not significantly different to that exhibited by the other better performing herbicides namely, metsulfuron methyl, 2,4-D + picloram, triclopyr + picloram, fluroxypyr + aminopyralid and clopyralid, which provided both high mortality and residual control. Sparkes and Rodgers (2007) also found that clopyralid, metsulfuron methyl and triclopyr + picloram gave good residual effects when compared to the untreated areas.

These herbicides all have the added advantage of being selective against broadleaf weeds and as such do not damage any grasses that may be present. This is highly pertinent, as florestina appears to be an opportunistic weed that prefers disturbed environments (Turner 1963). Therefore, maintaining a healthy pasture should help prevent the establishment and spread of florestina.

Imazapyr exhibited high mortality and residual effects on florestina, but it killed everything within treated plots including grasses. Some florestina seedlings were also observed emerging around areas of high organic matter such as dead grass crowns and manure. This resulted in the presence of a few very healthy florestina plants growing in the absence of competition from other species. Eventually these plants would produce seed and replenish the soil seed bank.

Based on the findings of this study, two rate response trials have been initiated to identify the most appropriate rates that will control not only the initial plants present within an infestation but also provide some residual control of seedling recruitment. Herbicides selected to progress to these trials

Table 1. Mean florestina plant counts (no. m^{-2}) at Barcaldine 164 and 205 days after various herbicide treatments. Data were transformed ($\sqrt{X + 0.5}$) prior to analysis. Plant counts within columns followed by the same letter are not significantly different ($P < 0.05$).

Treatment	Active ingredient [A]	Rate applied (g a.i. ha^{-1})	Plants m^{-2} 164 DAT	Plants m^{-2} [B] 205 DAT
1	metsulfuron methyl (600 g kg^{-1})	4.2	16.4 bcde	
2	metsulfuron methyl (600 g kg^{-1})	8.4	0.2 ab	0.7 [a]
3	metsulfuron methyl (600 g kg^{-1})	16.8	0.1 ab	3.9 [a]
4	glyphosate (360 g L^{-1})	540	188.5 j	
5	glyphosate (360 g L^{-1})	1080	77.5 gh	
6	triclopyr + picloram (300 g L^{-1} + 100 g L^{-1})	450 + 150	1.6 abcd	2.1 [a]
7	triclopyr + picloram (300 g L^{-1} + 100 g L^{-1})	900 + 300	0 a	0 [a]
8	2,4-D + picloram (300 g L^{-1} + 75 g L^{-1})	450 + 112.5	0.8 abc	0.4 [a]
9	2,4-D + picloram (300g L^{-1} + 75g L^{-1})	900 + 225	0.3 abc	0.6 [a]
10	2,4-D amine (625 g L^{-1})	1250	7.5 abcd	
11	2,4-D amine (625 g L^{-1})	2500	7.4 abcd	
12	clopyralid (300 g L^{-1})	93.75	18.6 bcde	
13	clopyralid (300 g L^{-1})	187.5	4.2 abcd	8.9 [a]
14	fluroxypyr (200 g L^{-1})	150	130.1 hij	
15	fluroxypyr (200 g L^{-1})	300	58.7 efg	
16	dichlorprop (600 g L^{-1})	1800	23.7 def	
17	dichlorprop (600 g L^{-1})	3600	20 cde	
18	imazapic (240 g L^{-1})	90	58.6 efg	
19	glufosinate-ammonium (200 g L^{-1})	500	79.4 gh	
20	glufosinate-ammonium (200 g L^{-1})	1000	94.3 ghi	
21	DSMA (220 g L^{-1})	750	23.6 def	
22	imazapyr (250 g L^{-1})	750	1.9 abcd	
23	chlorsulfuron (750 g kg^{-1})	15000	16.9 bcde	
24	MSMA (800 g L^{-1})	8000	161.6 ij	
25	Pine oil (680 g L^{-1})	204000	116.1 ghij	
26	2,4-D amine + metsulfuron methyl (625 g L^{-1} + 600 g kg^{-1})	1875 + 180	0.2 abc	0 [a]
27	aminopyralid + fluroxypyr (10 g L^{-1} + 140 g L^{-1})	40 + 560	2.6 abcd	4 [a]
28	Water		72.8 fgh	142.9 [b]

[A] All treatments include Uptake at 500 ml 100 L^{-1} as the wetting agent.
[B] Results shown are for residual active treatments only.

are metsulfuron methyl, 2,4-D + picloram, triclopyr + picloram, fluroxypyr + aminopyralid and clopyralid. In western Queensland florestina appears to be capable of germinating year round if there is adequate soil moisture and capable of setting flowers in as little as 1 month after germination. This makes an application of pre-emergent herbicides vital for the overall management of florestina. Further work to determine the soil seed bank size and longevity is required to aid the management of florestina.

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REFERENCES

Natural Resources and Water Enhanced Meteorological Datasets, SILO Data Drill http://www.nrw.qld.gov.au/silo (accessed 26 March 2009).

Sparkes, E.C. and Rodgers, M. (2007). Sticky florestina (*Florestina tripteris* DC. Prod.) herbicide screening for a recent invasive species in central-western Queensland. Proceedings of the 21st Asian-Pacific Weed Science Society Conference, eds B. Marambe, U.R. Sangakkara, W.A.J.M. De Costa and A.S.K. Abeysekara, pp. 463-8. (Colombo, Sri Lanka).

Turner, B.L. (1963). Taxonomy of florestina (Heleniaeae, Compositae). *Brittonia* 15, 27-46.