Research reports

Bulbil watsonia (*Watsonia bulbillifera* Mathews and Bolus) control with herbicides in Western Australia

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Summary
The herbicides 2,2-DPA and glyphosate are shown to have similar cost effectiveness for the control of bulbil watsonia. Annual applications, of 7.4 to 14.8 kg ha^{-1} a.i. of 2,2-DPA or 4.5 kg ha^{-1} a.i. of glyphosate, in September when bulbil watsonia was in the stem elongation stage provided high levels of control. Chlorsulfuron and metsulfuron were ineffective at similar costs of herbicide.

Introduction
Bulbil watsonia, (*Watsonia bulbillifera* Mathews and Bolus) from the Iridaceae family, is a tall, winter growing perennial weed of roadsides and wet areas that displaces native vegetation, is a fire hazard in summer and obstructs vision at road intersections. It reproduces by shallow underground corms and stem-borne cormels that are often spread by earth moving equipment or water. It has become a significant weed in the southern states of Australia and in New Zealand after its introduction from South Africa (Parsons and Cuthbertson, 1992).

Ideally, herbicides for the control of bulbil watsonia should be selective and not affect native roadside vegetation. High rates of 2,2-DPA control bulbil watsonia (Meadly, 1965). The rate required depends on the time of application (Parsons, 1992). The use of 2,2-DPA in orchards and vineyards indicates that it may not seriously affect established native trees and shrubs. Glyphosate provides short term control but infestations usually reappear in one or two years. It is not known whether this is due to corm recovery or cormel germination. As glyphosate is non-selective, labour-intensive hand spraying must be used to reduce damage to companion plants. The sulfonyl urea herbicides, chlorsulfuron and metsulfuron, are efficacious on similar species such as *Homeria* spp. (cape tulip) and *Romulea rosea* (L.) Eckl. (onion grass). They have also been used for selective weed control in remnant vegetation.

The objective of this study was to determine the efficacy of the above herbicides, at various times of application, so strategies for the control of bulbil watsonia could be formulated.

Materials and methods

Treatments
Four herbicides were applied at two rates (Table 1) and four times of application which were 17 July 1989, 13 September 1989, 6 November 1989 and 7 June 1990. One year after the first application, a repeat application was applied to half of each plot for the 2,2-DPA and glyphosate treatments for the July and September times of application.

Bulbil watsonia growth stages were early vegetative, late vegetative, stem elongation to flowering and post flowering to cormel production stages respectively, for the four times of application. Herbicides were applied in 1000 L ha^{-1} water plus 0.25% non-ionic wetting agent using a hand held spraying wand.

Table 1. Herbicides and rates used in the experiment.

Herbicide	Product	Rate g ha^{-1} a.i.	Rate Product ha^{-1}
2,2-DPA (Na salt)	Agripon	7400, 14 800	10, 20 kg
Glyphosate	Roundup CT	900, 4500	2, 10 L
Chlorsulfuron	Glean	15, 75	20, 100 g
Metsulfuron	Ally	6, 30	10, 50 g
Control			

A split plot design was used with times of application as subplots. Each treatment was replicated three times. Plots were 7 m × 7 m and extended from the edge of the road to the fence line. The site was waterlogged in winter on a sand over clay duplex soil carrying a very dense and old infestation of bulbil watsonia.

Measurements
EWRC ratings of control (Anon. 1979) were taken on 6 November 1989, 15 November 1990 and 11 September 1991. An EWRC rating of 4 or less is considered to be adequate control. The percentage of surviving plants flowering and producing cormels after a July or September treatment were recorded in November 1989. Flowering stalks were collected after maturity in December 1989 and the number and weight of cormels recorded on the top four nodes. Corms were retrieved from two 0.25 m^2 areas in various plots in December 1989 and 1990. Corms were sorted into three classes. The classes were:

1. "single" – single corms,
2. "multiple" – when more than one corm was enclosed in the fibrous leaf remnants and
3. "rotten" – when corms were of spongy consistency or decayed.

The weight of corms was recorded after removing all dead material surrounding the corm. They were then stored in open bags at room temperature and the number that sprouted was recorded in the July following retrieval.

On plots treated with glyphosate and 2,2-DPA and those with an EWRC rating of less than 5, the number of mature,

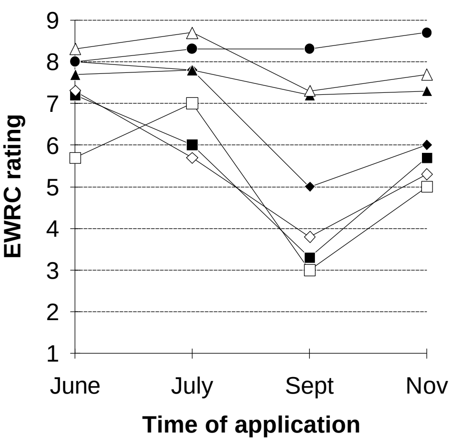

Figure 1. Watsonia control (EWRC rating) for rates and times of application of various herbicides. EWRC 1=complete kill; 9=no kill Assessed September 1991, 15–26 months after treatment, s.e.m.=0.50
2,2-DPA: ■ 7.4 kg ha^{-1} □ 14.8 kg ha^{-1}
Glyphosate: ◆ 0.9 kg ha^{-1} ◊ 4.5 kg ha^{-1}
Metsulfuron: ▲ 6 g ha^{-1} △ 30 g ha^{-1}
Chlorsulfuron: ● 75 g ha^{-1}

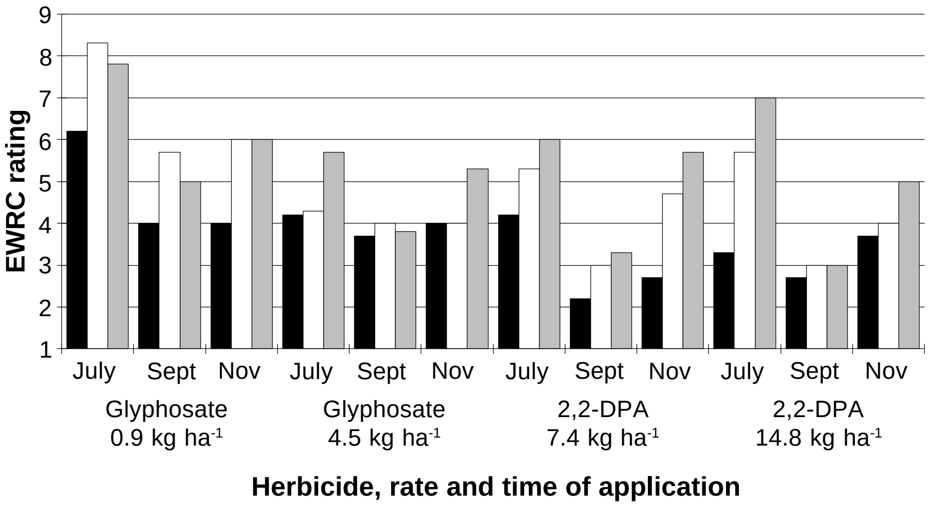

Figure 2. Watsonia control (EWRC rating) at various times after a single application of various herbicide treatments.
EWRC 1=complete kill; 9=no kill
■ : assessed June 1990 s.e.m.=0.408; □ : assessed November 1990 s.e.m.=0.428;
▒ : assessed September 1991 s.e.m.=0.504

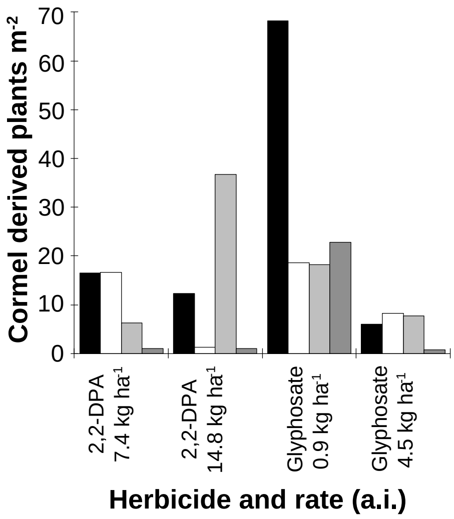

Figure 5. The effect of single and repeated treatments with 2,2-DPA or glyphosate, at various rates and times of applicaton, on cormel derived watsonia density.
Control=51.5 flowering stems m^{-2}
Assessed Sept 1991, s.e.m.=5.57
■ : sprayed July 1989
□ : sprayed July 1989, repeated July 1990
▒ : sprayed September 1989
▓ : sprayed September 1989, repeated September 1990

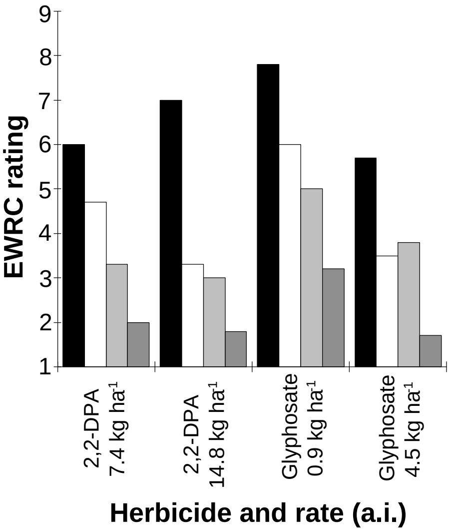

Figure 3. The effect of rates and times of application of 2,2-DPA and glyphosate on watsonia control.
EWRC 1=complete kill; 9=no kill
Assessed September 1991, s.e.m.=0.427
■ : sprayed July 1989
□ : sprayed July 1989, repeated July 1990
▒ : sprayed September 1989
▓ : sprayed September 1989, repeated September 1990

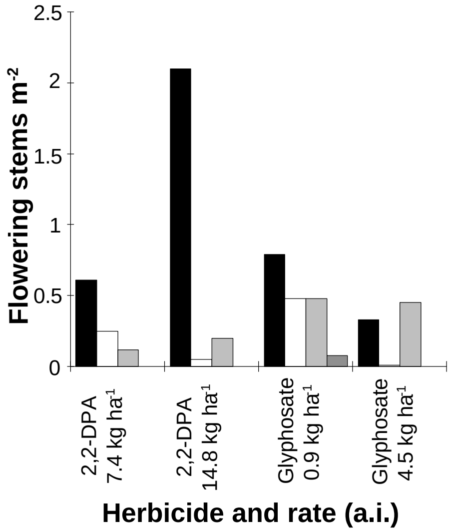

Figure 4. The effect of single and repeated treatments with 2,2-DPA or glyphosate, at various rates and times of application, on flowering stem density.
Control=7.3 flowering stems m^{-2}
Assessed September 1991, s.e.m.=0.19
■ : sprayed July 1989
□ : sprayed July 1989, repeated July 1990
▒ : sprayed September 1989
▓ : sprayed September 1989, repeated September 1990

young and flowering plants were recounted on 11 September 1991.

Results

Ratings

Single applications of 2,2-DPA and glyphosate provided the greatest reduction in above ground biomass when applied in September (Figure 1). Chlorsulfuron at 75 g ha^{-1} a.i. and metsulfuron at 6 g ha^{-1} a.i. were ineffective. Metsulfuron at 30 g ha^{-1} a.i. provided a reduction in biomass in the year of treatment but the watsonia stand recovered by the following season. Similarly, glyphosate applied in July or November initially gave the same biomass reductions as the September applications, but considerable recovery occurred over the following year. 2,2-DPA and high rates of glyphosate applied in September maintained control for 2 years after application (Figure 2). At low rates or other times of application, the level of control tended to decrease with time. 2,2-DPA applied in September was the most efficacious single application treatment. Control was not improved by doubling the rate of 2,2-DPA from 7.4–14.8 kg ha^{-1} a.i.

A low dose of 2,2-DPA or glyphosate that was repeated 1 year later was more efficacious than a single high dose (Figure 3). These herbicides were more effective when applied in September to the extent that a single application in September had an efficacy equal to or greater than repeated applications in July. Repeated applications in September of the high rate of glyphosate or either rate of 2,2-DPA provided high levels of control.

Counts

The number of flowering stems produced two seasons after the single application treatments was much greater for the high rate of 2,2-DPA applied in July than for other 2,2-DPA or glyphosate treatments (Figure 4). These stems produced 7 cormels per stem compared to 38 on the controls. Repeat treatments of the high rate of either herbicide at either time of application or the low rate in September reduced the number of flowering stems to very low levels (Figure 4) and prevented cormel production. Cormel formation was also prevented by single applications of glyphosate and metsulfuron in July and September and by the September, high rate, 2,2-DPA

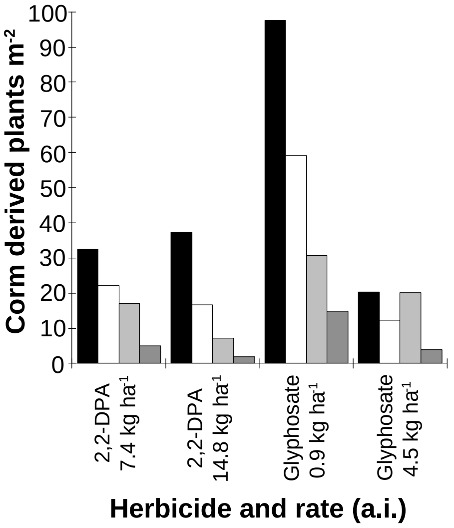

Figure 6. The effects of single and repeated treatments with 2,2-DPA or glyphosate, at various rates and times of application, on corm derived watsonia density.
Control=92 plants m^{-2}
Assessed Sept 1991, s.e.m.=7.40
■: sprayed July 1989
□: sprayed July 1989, repeated July 1990
□: sprayed September 1989
□: sprayed September 1989, repeated September 1990

treatments. Overall, 3% of the plants surviving single glyphosate treatments and 22% of the plants surviving single 2,2-DPA treatments produced at least one stem-borne cormel.

The number of plants germinating from cormels was kept to low levels by repeated September applications of glyphosate at the high rate or 2,2-DPA at either rate (Figure 5). Repeated applications of 2,2-DPA at the high rate in July were also effective. The density of plants germinating from underground corms followed a different pattern (Figure 6). Repeated applications were always more effective than single applications. The lowest number of plants were recorded from repeated September applications of the high rate of glyphosate or either rate of 2,2-DPA.

Corms
In the summer following treatment, the high rate of glyphosate provided 80 to 90% reduction in corm yield for July to November applications (Figure 7). September applications of the other herbicides were usually more effective in reducing corm yield than July or November timings.

When corm yield is considered over time, the high rate of glyphosate provided a 90% reduction in the year of application (Figure 8). 2,2-DPA was much slower in its action and corm yields were only reduced by 10 to 60% in the year of application. This reduction continued into the second year and, by the second summer after application, 2,2-DPA was providing similar levels of corm control to glyphosate. Repeat applications of glyphosate appeared to reduce corm yields more than repeated 2,2-DPA applications. However, this may be due to their differing speed of action as shown above.

Glyphosate, at the high rate, applied in September and the high rate repeated for the July application provided more than 95% reduction in corm density. Corm yield was closely correlated with corm density. Overall, 2,2-DPA reduced the number of surviving multiple corms more than glyphosate and this led to an apparent increase in the average weight of individual corms.

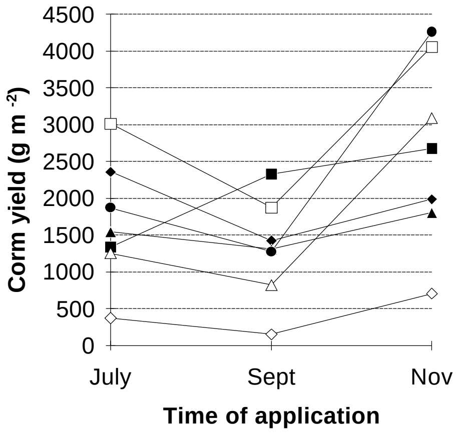

Figure 7. The effect of rates and times of application of 2,2-DPA or glyphosate on total corm yield.
Control=3440 ± 332 m^{-2}
Assessed December 1989, s.e.m.=471.6
2,2-DPA: ■ 7.4 kg ha^{-1} □ 14.8 kg ha^{-1}
Glyphosate: ◆ 0.9 kg ha^{-1} ◊ 4.5 kg ha^{-1}
Metsulfuron: ▲ 6 g ha^{-1} △ 30 g ha^{-1}
Chlorsulfuron: ● 75 g ha^{-1}

Corms appear to divide every 5–6 years resulting in the observed ratio of single to multiple corms in the control treatments of 4.6:1 and the average number of corm cases attached to single corms of 5.1.

Corms treated with 2,2-DPA had greater dormancy than those treated with glyphosate or untreated (Table 2). The dose of herbicide had no significant effect, but repeat applications and time of application of 2,2-DPA affected corm dormancy.

Discussion
This experiment has shown that the timing of application of 2,2-DPA and glyphosate will determine the cost of achieving bulbil watsonia control.

The cost effectiveness of glyphosate and 2,2-DPA is similar. Currently 10 kg

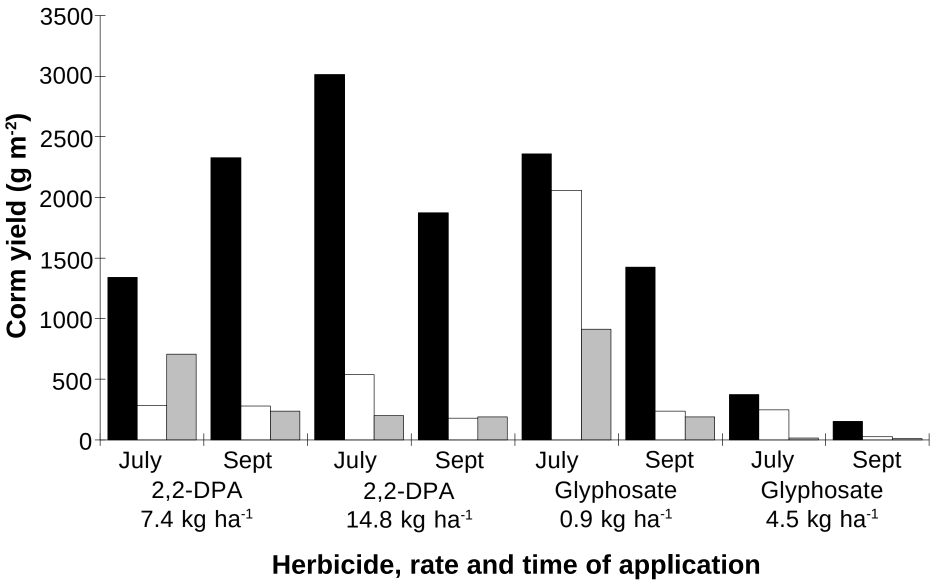

Figure 8. The effect of single or repeated treatments with 2,2-DPA or glyphosate, at various rates and times of application, on corm yields over time.
Control yield=3337 ± 235 g m^{-2}. Sprayed 1989, repeat treatments applied 1990
■: assessed Dec 1989 s.e.m.=471; □ : assessed Dec 1990 s.e.m.=320
□: assessed Dec 1990 (repeated treatments) s.e.m.=320

Table 2. The effect of glyphosate and 2,2-DPA on the dormancy of bulbil watsonia corms.

Herbicide	Time of application	% Dormant corms
Glyphosate	July 89	11 ab
Glyphosate	Sept 89	4 a
Glyphosate	July 89, 90	15 ab
Glyphosate	Sept 89, 90	23 bc
2,2-DPA	July 89	35 c
2,2-DPA	Sept 89	92 e
2,2-DPA	July 89, 90	71 d
2,2-DPA	Sept 89, 90	60 d
Control		1 a

(product) of 2,2-DPA (740 g kg^{-1}) is the same cost as 4 L (product) of glyphosate (450 g L^{-1}). When applied at the stem elongation stage of bulbil watsonia, and repeated annually, similar high levels of control are expected.

2,2-DPA is the preferred herbicide where bulbil watsonia is growing amongst desirable species because it is usually more selective than glyphosate for bulbil watsonia.

Annual applications at half rates or less were more effective than a single high-rate application. Whilst 2,2-DPA has residual action which controls cormels germinating in the year after application, the longevity of some cormels appears to exceed the persistence of the herbicide. Two years after a single application of 14.8 kg ha^{-1} a.i. of 2,2-DPA, a significant reinfestation from cormel germination can occur. Two annual applications at half rates prevented this situation.

The residual action of 2,2-DPA appeared to compensate for the production of some cormels by plants surviving treatment. Glyphosate almost totally prevented cormel formation on surviving plants. On balance, reinfestation by cormel-derived plants is likely to be less on 2,2-DPA treated areas.

Reports of the failure of glyphosate to control bulbil watsonia, which initiated this work, can probably be attributed to low rates, poor timing and lack of repeat sprays to prevent reinfestation from both corm and cormel-derived plants. In addition, the apparently good, but short lived, levels of control provided by application of glyphosate two months before or after the optimum timing have undoubtedly enticed people into mistiming applications.

The results of this experiment suggest that a more effective control strategy may be to use glyphosate in tank mixes with 2,2-DPA in order to prevent cormel formation on plants surviving the initial treatments and achieve a rapid decay of corms. Alternatively, using glyphosate as the initial spray and then 2,2-DPA as the repeat spray in the following seasons may be more effective than a single herbicide strategy. These strategies require evaluation.

Further work is required on the fate of corms, that are dormant due to treatment with 2,2-DPA, to determine if they are a potential source for reinfestation.

Acknowledgments

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