The biology and control of chincherinchee (*Ornithogalum thyrsoides* Jacq.)

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Summary Chincherinchee (*Ornithogalum thyrsoides* Jacq.) is a bulbous ornamental that has invaded significant areas in the Tambellup area of Western Australia. It is tolerant to a wide range of herbicides. Imazapyr has provided good control followed by metsulfuron, Grazon™, Garlon™ and 2,4-D ester. A community based 'Weed Action Group' has organised control on the roadsides and river reserves. Sheep deaths have been recorded following grazing of the green leaves in early winter. A summary of the biology, the characteristics of the local infestation and data on chemical control trials are reported.

Keywords 2,4-D, chincherinchee, chlorsulfuron, control, herbicides, imazapyr, metsulfuron, *Ornithogalum thyrsoides*, picloram, toxicity, triclopyr, weed.

INTRODUCTION

Chincherinchee (*Ornithogalum thyrsoides* Jacq.) is a bulbous ornamental that has invaded significant areas in the Tambellup (34° 03'S, 117° 39'E) area of Western Australia (WA). It is a fleshy, succulent, dark green, hairless plant with 3–6 flat or concave, strap-like, basal leaves about 15 cm long by 3 cm wide. The flowering head is held well above the leaves by a simple, cylindrical stem about 30 cm tall. It has a cluster of 11–70 flowers that is initially conical and compact then elongates with age. The flowers are white with darker centres giving rise to one of its common names, 'Black-eyed Susan'.

It has a perennial, globular bulb about 2 cm in diameter and normally produces one or occasionally two bulbils in the field. Bhardwaj *et al.* (2001) report bulb sizes from 3.11–5.86 g with the large bulbs producing 5.2 bulbets per bulb or five times more than the small bulbs. In WA, bulb fresh weights ranged from 1.6–9.9 g in June or about 5 t ha^{-1} of bulb in a typical stand and up to 20 t ha^{-1} in thick patches. Leaf cuttings can produce bulbs along the cut surface (Littlejohn *et al.* 2000) but this is rare in the field. Weedy varieties are usually diploid (2n=12) but this has not been checked in local populations. The diploids tend to reproduce by seed and bulbs as is seen in the Tambellup populations, whereas the ornamental varieties often have a higher ploidy level and tend to reproduce mainly by bulbs. The bulbs have a low potassium and a high nitrogen content. Adequate soil potassium is important for early growth but the overall requirement for potassium and phosphorous is low and they need little soil nitrogen early in the season (Claassens and Beusichem 1990).

Wallwork *et al.* (1992) found Barley Rust on the closely related Star of Bethlehem (*O. umbellatum*) in South Australia.

Life cycle In field situations, near Tambellup, seeds germinate from autumn to spring and form a small bulb in the first year. Leaves die off over summer with the onset of summer drought. New leaves emerge in the following autumn after rain and the old bulb is exhausted. A new bulb forms in spring. The leaves die off again in summer. This process is repeated until the bulb attains a size of 1–2 cm diameter. It then produces a flowering stem in spring and flowers appear in September to October. The leaves have usually withered by the time the plant flowers in WA. The flowering date is delayed as the storage temperature of the bulb over summer increases up to 30°C (Jansen *et al.* 1997). The bulbs can be stored for six months at 35°C without detrimental effects on growth or flowering (Jansen *et al.* 1992). It produces about 500 seeds per plant.

Water appears to be an important vector for spread as the local infestation extends along water courses and appears to have moved about 15 km down the Wadjekanup River from a primary infestation over a period of several decades. Wind blowing the flower heads around is the most likely form of local spread outside water flows. Flower heads or seeds caught in vehicles could explain most medium distance spread around the Tambellup area. Intentional planting of the bulbs at farmhouses, schools and cemeteries is almost certainly the source of introduction and means of long distance dispersal.

Originally from South Africa, it has naturalised in Indonesia, New South Wales, Victoria and South Australia (Lazarides *et al.* 1997). In WA and according to herbarium records (Florabase 2002), it is naturalised only in Tambellup, but it is known to occur in gardens across the south west of the state. Elsewhere in the temperate world it is grown commercially for flower and pot plant production and it can be seriously affected by Ornithogalum Mosaic Virus (Villiers *et al.* 2000). This virus does not appear to be present in WA field infestations.

In WA, the major infestation is located in the 500 mm annual rainfall zone near Tambellup, which has a Mediterranean climate. There are 25 ha in a dense stand and about 200 ha as scattered clumps or isolated plants covering a 10 km radius around the main infestation. The worst infestations are on winter waterlogged areas and watercourses and it spreads readily from these areas. In drier sites it is usually associated with intentional planting and rarely spreads more than 10–20 metres.

All parts of the plant are toxic, including the seeds. Sheep losses have been recorded in WA at the start of the feed season in autumn and early winter after the new chincherinchee leaves have emerged and when other natural feed is scarce. As paddock feed becomes more abundant, problems decrease and there have been no stock toxicity reports in spring, or in summer after the chincherinchee tops have dried. Sheep deaths usually occur several days after exposure to the green infestation.

Little work has been done on the herbicidal control of chincherinchee. No detrimental effects on growth, development or flowering were observed on the related *O. umbellatum* by Skroch *et al.* (1994) and Skroch *et al.* (1988) when pre-emergence benfluralin, bensulide, chlorthal-dimethyl, dithiopyr, isoxaben, metolachlor, napropamide, pendimethalin, sethoxydim, fluazifop, metolachlor + simazine or isoxaben + oryzalin were applied. Oxyfluorfen and oxadiazon damaged foliage and reduced bulb number. Soil solarisation gave no control (Linke 1994).

A range of herbicides applied at three times was tested to determine strategies for control.

MATERIALS AND METHODS

Three experiments investigating herbicidal control were conducted at different stages of the weed's life cycle. The first was sprayed on 10/11/98 when the chincherinchee was at the full to late flowering stage with some immature seed and the new bulb attached, and when the soil was dry but the plants did not appear stressed.

The second experiment was sprayed on 22/7/99 when the chincherinchee was from the emerging to 3–5 leaf, 15 cm leaf length stage. Bulbs were 1 to 20 mm diameter with larger bulbs up to 5 cm deep. The third experiment was sprayed on 23/9/00 at the beginning of stem elongation.

All experiments were sprayed with a logarithmic sprayer, which applied 217 L ha^{-1} water with 0.25% Pulse Penetrant™ over two replicates and a plot size of 5 m wide by 20 m long. All herbicide rates are quoted in mL or g of product ha^{-1} and active ingredients are shown in Table 1.

Table 1. Product names, active ingredients and times of application of herbicides evaluated.

Product name	Active ingredient	Time of application
Ally™	Metsulfuron 600 g kg^{-1}	11/98, 7/99
Amitrole™ T	Amitrole 250 g L^{-1}	11/98, 7/99
Arsenal™	Imazapyr 250 g L^{-1}	7/99
Barrel™	MCPA240 g L^{-1} + Bromoxynil 140 g L^{-1} + Dicamba 40 g L^{-1}	11/98, 7/99
Basta™	Gluphosinate 200g L^{-1}	11/98, 7/99
Broadstrike + Diurex	Flumetsulam 800 g kg^{-1} + Diuron 900 g kg^{-1}	7/99
Broadstrike™	Flumetsulam 800 g kg^{-1}	7/99
Brodal™	Diflufenican 500 g L^{-1}	11/98, 7/99
Diurex	Diuron 900 g kg^{-1}	7/99
Garlon™	Triclopyr 600 g L^{-1}	11/98, 7/99
Glean™	Chlorsulfuron 750 g kg^{-1}	11/98, 7/99
Goal™	Oxyfluorfen	11/98
Grazon™	Triclopyr 300 g L^{-1} + Picloram 100 g L^{-1}	11/98, 7/99
Igran™	Terbutryn 500 g L^{-1}	11/98, 7/99
Lexone™ DF	Metribuzin 750 g kg^{-1}	11/98, 7/99
Logran™	Triasulfuron 750 g kg^{-1}	11/98, 7/99
Lontrel™	Clopyralid 300 g L^{-1}	11/98, 7/99
Propon™	2,2-DPA 740 g kg^{-1}	11/98, 7/99
Raptor™	Imazamox 700 g kg^{-1}	9/00
Spinnaker™	Imazethapyr 240 g L^{-1}	9/00
Spray.Seed™	Paraquat 135 g L^{-1} + Diquat 115 g L^{-1}	11/98, 7/99
Various	2,4-D ester 800 g L^{-1}	11/98, 7/99
Various	Dicamba 200 g L^{-1}	11/98, 7/99
Various	Glyphosate 450 g L^{-1}	11/98, 7/99

RESULTS

Experiment 1 When applied in November and assessed eight months later, Grazon™ at 10 L ha^{-1} provided control of small plants and a 75% reduction of large plants. The following products provided less than 50% control; 2,4-D ester 800 g L^{-1} at 5 L ha^{-1}, dicamba 200 g L^{-1} at 5 L ha^{-1}, Garlon™ at 10 L ha^{-1}, Barrel™ at 5 L ha^{-1}, Lontrel™ at 2.5 L ha^{-1}, Igran™ at 2.5 L ha^{-1}, Lexone™ DF 750 at 1 kg ha^{-1}, Brodal™ at 1 L ha^{-1}, amitrole 250 g L^{-1} at 10 L ha^{-1}, Basta™ at 10 L ha^{-1}, 2,2-DPA 740 g kg^{-1} at 25 kg ha^{-1}, Spray.Seed™ at 10 L ha^{-1}, Ally™ at 100 g ha^{-1}, Glean™ at 100 g ha^{-1}, Logran™ at 200 g ha^{-1}, glyphosate 450 g L^{-1} at 10 L ha^{-1} and Goal™ at 1 L ha^{-1}.

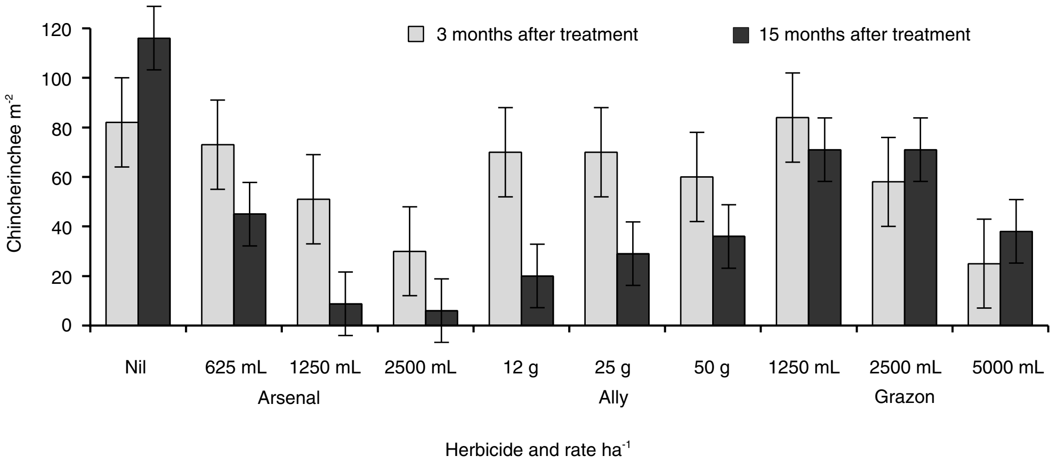

Figure 1. The effect of various rates of three herbicides on the control of chincherinchee.

Experiment 2 July applications of Arsenal™, Ally™ and Grazon™ provided the largest reductions in plant numbers, and the reduction was greater in the season after application for Arsenal™ and Ally™ (Figure 1). Control levels with Arsenal™ reached a maximum at 1.25 L ha^{-1} in the season following application. There was little response to the rate of application of Ally™. Control increased with increasing rates of Grazon™ indicating that higher rates than those tested may be required for higher levels of control (Figure 1). 2,4-D ester, Garlon™ and Glean™ provided useful suppression with maximum reductions in plant numbers being 72%, 70% and 52% respectively and dependent on rate and time of assessment (Table 2).

The following treatments provided less than 50% control – dicamba 200 g L^{-1} at 5 L ha^{-1}, Barrel™ at 5 L ha^{-1}, Lontrel™ at 2.5 L ha^{-1}, Igran™ at 2.5 L ha^{-1}, Lexone™ DF 750 at 1 kg ha^{-1}, Brodal™ at 1 L ha^{-1}, amitrole 250 g L^{-1} at 10 L ha^{-1}, Basta™ at 10 L ha^{-1}, 2,2-DPA 750 g kg^{-1} at 10 kg ha^{-1}, Spray.Seed™ at 10 L ha^{-1}, Logran™ at 200 g ha^{-1}, glyphosate 450 g L^{-1} at 10 L ha^{-1}, Broadstrike™ at 200 g ha^{-1}, Broadstrike™ + Diurex™ at 200 g + 400 g ha^{-1} and Diurex™ at 1 kg ha^{-1}.

Experiment 3 Raptor™ at 250 g ha^{-1} provided 50% control and up to 60% control at 500 g ha^{-1}. Spinnaker™ at rates up to 5 L ha^{-1} provided less than 50% control when assessed 10 months after treatment.

DISCUSSION

Chincherinchee is highly tolerant of most common herbicides but has shown some sensitivity to group B (sulfonylurea and imadazolinone) and group I (hormone) herbicides. Arsenal™ at rates greater than 1.25 L ha^{-1} applied in July provided a 90% reduction in chincherinchee density in the season after application. Ally™ did not significantly reduce the density in the season of application but had reduced it by 80% in the following season. There was little response to the rate of Ally™ over the range of application rates from 5 g ha^{-1} to 50 g ha^{-1}. Grazon™ provided up to 60% control at 5 L ha^{-1} with the higher rates providing better control than lower rates.

Arsenal™ severely affects pasture production in the year of application and Ally™ and Grazon™ severely reduce the legume component of the pasture. Ally™ is around one tenth of the cost of the other

Table 2. Chincherinchee density, 3 and 15 months after treatment (MAT).

Herbicide	Rate g or mL ha^{-1}	Plants m^{-2} 3 MAT	15 MAT
Nil		82	116
2,4-D ester	625	73	33
2,4-D ester	1250	64	48
2,4-D ester	2500	77	50
Garlon™	1250	71	89
Garlon™	2500	57	63
Garlon™	5000	25	70
Glean™	12.5	86	80
Glean™	25	83	65
Glean™	50	55	56
LSD		53	36

herbicides for similar levels of control. Further work is required to determine the optimum time of application of herbicides, the necessity for adjuvants and the best strategies for control or eradication. With current knowledge and herbicides prices the preferred control strategies would include;

1) For pastures – application of 10 g ha^{-1} of Ally™ plus 0.25% Pulse Penetrant™ in winter each year plus supplemental nitrogen to maintain pasture growth.
2) For non productive areas – annual applications of 1 L ha^{-1} of Arsenal™ in winter.
3) For crops – planting of imadazolinone tolerant crops and treating with Arsenal™ or imazapyr based products, or planting to Wheat, Triticale or Barley and applying 10 g ha^{-1} of Ally™ in winter.

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