Biology and management of matricaria (*Oncosiphon piluliferum*)

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Key messages

Matricaria seed survives well when buried at 2-10cm. Darkness inhibited germination under laboratory conditions. Seed is likely to survive in the soil for several years if buried.

Cost effective herbicide options are available for control of matricaria in both sub-clover and medic pastures, with glyphosate, paraquat + atrazine, Jaguar® and bromoxynil providing good control.

A number of highly effective options are available for the herbicide management of matricaria depending on the farming system; apply treatments either to small plants (six to eight leaves, 8cm rosette) or during the early flowering stages (bud formation with few yellow buttons) for seed set control. Both glyphosate and paraquat can be used for seed set control.

Aims

Since appearing in the eastern wheat-belt in the late 1960s, matricaria has spread widely in that region and is now a serious weed. Matricaria is spreading into neighbouring regions (e.g. the Northern agricultural region) where the farming systems and seasonal conditions are similar and is considered an emerging threat (Michael et al 2011).

Effective management of matricaria in pastures is often poor as stock have a tendency to avoid grazing it and there are limited herbicide options available. This, plus the reduction in cultivation during crop establishment is thought to have favoured weed build-up. There are some herbicide options available for cereal crops, where herbicide efficacy is helped by crop competition.

This project investigates the biology of matricaria, triggers for germination, and management options with a focus on the pasture phase.

Biology

There are two species of matricaria in WA and they can be distinguished by their flower heads. Columba Daisy *Oncosiphon suffruticosum* (more 'club' shaped flower heads) and Globe Chamomile *Oncosiphon piluliferum* (rounder, globe shaped flower heads).

Both species of matricaria are erect annual herbs with bright yellow flowers and look very similar until the flowers start to form. They both have a strong smell, form dense stands and are considered unpalatable to grazing livestock (although not known to be toxic). Only one species, *O. piluliferum*, has been used in these studies as it is the most common in the region.

Plants produce many small seeds, averaging 3000 to 5000 seeds per plant. However, greater than 100000 seeds per plant have been recorded from ungrazed areas. Seeds are partially adapted for wind dispersal but many seeds remain in the head for long periods. Major spread is probably due to whole seed heads being broken off in strong wind and rolling away or by animal and vehicle movement (Parsons and Cuthbertson 1992). Seed retained in the head has been tested for viability and found to be 10% germinable after nine months intact on the plant (October to June in Mukinbudin) in field conditions (Alex Douglas unpublished).

Most seed will germinate in autumn. Seedlings form a rapidly growing rosette and plants usually develop a flowering stem, or stems, in August. Plants flower in September to November and usually die in early summer. A few plants may germinate in late winter/early spring and continue to grow and produce seed over the summer period providing conditions are favourable.

Factors affecting germination

Seeds from four matricaria populations were subjected to various conditions and the effect on germination assessed. All four populations had been collected during the same week in December 2017, with three of the collected populations growing within 25km of each other north of Merredin and the fourth population located in Mukinbudin. Two populations were collected from roadsides, Knungajin-Merredin Rd and Nangeenan Nth Rd, and the remaining two collected within paddocks adjacent to trial areas.

Five temperatures were assessed; constant 5°C, 15°C, 25°C, 35°C and 45°C. The test was conducted with an alternating 12 hour dark/light regime, for two weeks, with four replicates.

Matricaria germinated at 15 and 25 degrees only. No germinations were recorded for the samples kept at 5°C, 35°C and 45°C (Table 1). Matricaria is an autumn

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germinating species and this range of temperatures fits with autumn conditions. It is less likely that matricaria will germinate in the summer months to become a summer weed.

Table 1. Effect of temperature on germination (%), for seed from four populations of matricaria 2018.

Population	5°C	15°C	25°C	35°C	45°C
Knungajin-Merredin Rd	0.0	36.0c	23.3d	0.0	0.0
Nangeenan Nth Rd	0.0	12.7a	18.7b	0.0	0.0
McCartney Mukinbudin	0.0	24.7b	20.7c	0.0	0.0
Gray Merredin	0.0	24.7b	11.3a	0.0	0.0

Temperature treatment (P<.001) 5% Lsd 3.7. Population (P<.008) 5% Lsd 3.3. Values followed by the same letter are not significantly different.

Further samples of the seed were subjected to light and dark conditions (petri dishes wrapped in aluminium foil) and scarification (the seed was rubbed gently between two rubber mats for 10 seconds, before being placed in petri dishes). Samples were placed in cabinets with a 10/20°C 12 hour dark/light cycle, for two weeks (Table 2).

Table 2. Effect of light and dark conditions and scarification on germination (%) of seed from four populations of matricaria.

Population	Light	Dark	Scarification
Knungajin-Merredin Rd	49.3c	3.3a	51.3c
Nangeenan Nth Rd	41.3b	0.7a	40.0b
McCartney Mukinbudin	37.3b	0.0a	28.7a
Gray Merredin	29.3a	1.3a	36.7b

Population (P<.001) 5% Lsd 6.4, and treatment (P<.001) 5% Lsd 6.4. Values followed by the same letter are not significantly different.

Seeds kept in darkness showed much lower germination than those seeds exposed to light (up to 3.3% compared to up to 49.3%; Table 2). Scarification did not increase the level of germination under the standard conditions (light). Use of cultivation at crop establishment/fallow maintenance is unlikely to stimulate additional germination. The action of tillage may bury matricaria seed leading to increased longevity of the seed in the soil seed bank.

Depth of burial over time

A trial was established at Northam to determine the effect of depth of seed burial on the persistence of matricaria. Fifty seeds from three matricaria populations were placed in nylon bags and buried at different depths (0, 2, and 10cm) in June 2017. Bags were collected in September (3 months) and June 2018 (12 months), further collections are planned for 24 and 36 months.

Following collection, seeds were germinated by removing from the bags and placing in petri dishes with distilled water and gibberellic acid. Matricaria seeds were subjected to a 10/20°C dark/light temperature regime for a period of two weeks. The percent germination was calculated from total number of seeds initially placed in the bags at the time of burial. In the 0 and 2 cm depths a proportion of seeds had germinated and died/rotted prior to recovery these were included in calculating the per cent germination reported in Table 3.

Table 3. Germination (%) of matricaria seeds collected following burial at various depths for 3 and 12 months, for three populations of matricaria.

	Germination % after 3 month			Germination % after 12 month		
	0cm	2cm	10cm	0cm	2cm	10cm
Nangeenan/Connell	11.3a	48.0b	44.7b	6.0a	23.3ab	30.7abcd
Nangeenan/Fitzpatrick	4.7a	50.7b	37.3b	0.7a	60.7d	18.7ab
Nokaning	8.7a	47.3b	48.0b	2.7a	57.3cd	30.0abcd
Average Population	8.2a	50.9b	43.3b	3.1a	47.1bcd	26.4abc
	P<.001 5% Lsd (depth) 21.3			P<.05 5% Lsd (depth) 31.2		

Values followed by the same letter are not significantly different.

Fifty to sixty percent of matricaria seeds germinated buried at 2cm and 10cm compared with four to ten percent for those left on the soil surface (Table 3). This was consistent in both the three and 12 month collection times (Table 3). The longer buried seed remains able to germinate the more likely it is to persist in the soil seed bank. Seed longevity will influence the time required to manage field populations as recruitment from the soil seed bank will extend the time needed to reduce the population. There may also be implications for summer fallow management if cultivation is used

and the use of soil inversion at crop establishment as these practices will bury seed to depths where it can remain viable.

Data from work conducted in the late 1980s (Dodd and Lloyd 1988;1989) showed that matricaria seeds can remain viable in the soil seed bank for at least five years, indicating that the seeds, are capable of persisting for several years if buried.

There was no difference in the behaviour of the three populations for burial depth and length of time the seed was buried.

Management

Herbicide Experiment 1 – Herbicide application to large, flowering matricaria, Mukinbudin 2017

The trial area was selected in a stand of matricaria (*O. piluliferum*) that had germinated at the end of autumn from storm rains in a fallowed paddock in Mukinbudin. At the time of application the plants were already large and in many cases flowering. The paddock was being treated as a fallow by the grower. Treatments were applied on 1 June 2017 and the range of treatments had been selected following consultation with the grower and local agronomists. Plots were visually assessed at three and five weeks post application (Table 4).

Table 4. Visual assessment of matricaria for the Mukinbudin site three weeks post application. The level of biomass reduction was assessed for each treatment compared to the untreated control (% biomass reduction), Experiment 1.

Treatment* (rate/ha)	3 weeks post application	5 weeks post application
Untreated	0.0 a	0.0 a
Glyphosate 1.25L	42.5 b	60.0 b
Glyphosate 1.8L + 2,4-D LVE 500mL	50.0 bc	60.0 b
Glyphosate 1.8L + 2,4-D LVE 500mL + Hammer® 30 mL	50.0 bc	55.0 b
Glyphosate 2L	50.0 bc	50.0 b
Paraquat 2L + Hammer® 30mL	87.5 d	87.5 c
Paraquat 2L + Chlorsulfuron 20g	85.0 d	85.0 c
Bromoxynil 1.5L	10.0 a	10.0 a
Sharpen® 17g + Hasten 1%	55.0 c	55.0 b
Sharpen® 34g + Hasten 1%	57.5 c	57.5 b
P(<.001) 5%	11.3	13.4

*Product Formulation Strength; glyphosate 570 g ai/L, 2,4-D LVE 680 g ai/L. Paraquat 250 g ai/L, Bromoxynil 200 g ai/L, chlorsulfuron 750 g ai/kg, Hammer® (carfentrazone) 400 g ai/L, Sharpen® (saflufenacil) 700 g ai/kg. Values followed by the same letter are not significantly different.

Treatments containing paraquat provided the most effective control to large flowering matricaria in the trial, with up to 87.5 per cent control when mixed with Hammer®.

There was very little rain recorded at the site prior to treatment application and during the period between the two assessments. The effect of the herbicides may have been greater if there had been better growing conditions. Plants treated with glyphosate were less vigorous than the control and paraquat had burnt the plants off, however there was new growth at the base of the plants; plants treated with Sharpen® had flowers knocked off but there was green growth present.

Herbicide Experiment 2 – Control in medic pasture, Beacon 2018

A range of herbicides were applied to a stand of matricaria (*O. piluliferum*) growing in a vigorous medic pasture in Beacon WA. Treatments were applied on 18 July 2018 when the matricaria growth stage was 8-15 leaf, and the medic growth stage was 6-15 leaf. Treatment effects were assessed seven weeks post treatment, matricaria plant density was measured, and the level of matricaria control and suppression of medic growth was visually assessed (Table 5).

Paraquat (80 percent) and glyphosate (99 per cent) both provided excellent control of seedling matricaria in this trial.

The outstanding treatments were paraquat, paraquat plus atrazine, and glyphosate, giving between 80 and 99 per cent control compared to the untreated control, although there was also a reduction in medic growth. These treatments are relatively inexpensive and despite reducing medic density and growth for a short period post treatment, the pasture was able to recover and set seed prior to the end of the growing season. Jaguar® and Raptor® plus paraquat also provided acceptable control of matricaria but with substantially higher effects on medic growth.

Please note: Some of the treatments applied in Experiment 2 are not registered for use in medic pastures.

Table 5. Effect of a range of herbicides on matricaria plant density (plants/m²), control of matricaria (% biomass reduction compared to the untreated) and the suppression of medic plants (% biomass reduction compared to the untreated), seven weeks after application (AA), Experiment 2.

Treatment* (rate/ha)	Matricaria density (plants/m²) 7 weeks AA	Matricaria control (% relative to untreated control) 7 weeks AA	Medic suppression (% relative to untreated control) 7 weeks AA
Untreated	85.2 e	0 a	0 a
Jaguar® 1.1L	7.4 ab	70 cd	55 d
Ecopar® 150mL + MCPA 750mL	72.2 de	38 b	15 abc
Atrazine 556g + 0.4% BS1000	25.9 b	7 a	43 cd
Paraquat 500mL + 0.1% BS1000	7.4 ab	80 de	20 abc
Paraquat 500mL + atrazine 278g	3.7 a	92 de	3 ab
Raptor® 25g + 0.1% BS1000	48.1 c	0 a	10 ab
Raptor® 25g + Bromoxynil 200 1.4L	51.9 cd	50 bc	7 ab
Raptor® 25g + paraquat 500mL + 0.1% BS1000	9.3 ab	78 d	27 bcd
Glyphosate 400mL	1.9 a	99 e	7 ab
P (<0.001) 5% Lsd	21.3	23.6	28

*Product Formulation Strength; glyphosate 450 g ai/L, Jaguar® (bromoxynil 250 g ai/L and diflufenican 25 g ai/L), Ecopar® (pyraflufen-ethyl 20 g ai/L), atrazine 900 g ai/kg, paraquat 250 g ai/L, bromoxynil 200 g ai/L, Raptor®(imazamox 700 g ai/kg), MCPA 750 g ai/L

Values followed by the same letter are not significantly different.

Herbicide Experiment 3 – Control in sub-clover pasture, Moora 2018

Matricaria is spreading into areas of higher rainfall, compared to its common range in the eastern wheat-belt. Growers in these new areas are keen to control areas of the weed before they spread further. A subterranean clover pasture infested with matricaria (*O. piluliferum*) was selected to test a range of herbicides. Herbicides were applied at two times; Time 1 was sprayed on 10 July 2018 when the matricaria growth stage was at 9-10 leaves and the clover growth stage was at 6-8 leaves, Time 2 was sprayed on 30 July 2018 when matricaria was at 16-18 leaves (15 cm tall) and clover was with 8-10 leaves. The site was assessed on 6 September 2018 for matricaria density (plants/m²) and effect on clover (Table 6). There was no effect of time of application so only Time 1 is presented.

Table 6. The effect of a range of herbicides on matricaria plant density (plants/m²) and the suppression of sub-clover plants (% biomass reduction compared to the untreated), eight weeks after application (AA), Experiment 3.

Treatment (rate/ha)	**Matricaria Plant density (pl/m²) 8 weeks AA**	**Sub-clover suppression (% relative to untreated control) 8 weeks AA**
Untreated	35.5 bc	0
Ecopar® 500mL + MCPA amine 750mL	3.7 a	3.3
Bromoxynil 200 1.4L	7.4 a	0
Jaguar® 1.1L	0 a	8.3
Broadstrike® 25g + Bromoxynil 200 700mL + Uptake 0.5%	13.0 ab	3.3
Broadstrike® 25g + Bromoxynil MA 700mL + Uptake 0.5%	13.0 ab	3.3
Raptor® 45g + Hasten 0.5%	42.6 c	3.3
Raptor® 45g + Bromoxynil 200 1.4L	5.6 a	3.3
Paraquat 500mL + MCPA amine 500mL	9.3 a	0
P(<.005) 5% Lsd	25.4	ns

*Product Formulation Strength; Jaguar® (bromoxynil 250 g ai/L and diflufenican 25 g ai/L), Ecopar® (pyraflufen-ethyl 20 g ai/L), paraquat 250 g ai/L, bromoxynil 200 g ai/L, Raptor®(imazamox 700 g ai/kg), MCPA 750 g ai/L, Broadstrike® (flumetsulam 800 g ai/kg), Bromoxynil MA (bromoxynil 200 g ai/L plus MCPA 200 g ai/L).

Values followed by the same letter are not significantly different.

The best treatments were Ecopar® plus MCPA amine, Jaguar® and Raptor® plus Bromoxynil 200, these reduced matricaria density by 80 to 90 per cent. There was no effect of time of herbicide application at this site. Although it is a rule of thumb that herbicides will work better on smaller target plants.

The site received above average rainfall during the experimental period. The clover did not show any reduction in biomass due to the applied herbicides at the time of assessment, although chlorosis was observed on the plots treated with Jaguar®. The clover and grasses on the site provided considerable competition to the matricaria plants and this may have contributed to the lack of effect of time of herbicide application on matricaria control.

Experiment 4 – Seed set control of matricaria, Merredin 2017

Matricaria has been observed to build up population density during the pasture or fallow phases of the rotation. The areas where matricaria are most prevalent are in the eastern wheat-belt of WA where growing season rainfall is low and distribution often patchy. As a result of these conditions, stands of matricaria frequently reach the flowering stage before any treatment is considered. A seed set control experiment was conducted near Merredin to test time of application of a range of herbicides on flowering matricaria (*O. piluliferum*) plants.

There were three times of application: 23 August 2017 – 100% of plants with green flower buds (early bud formation) (Time 1); 13 September 2017 - 30% of plants with green buds and 70% of plants with yellow flower heads (no seed formed) (Time 2); 5 October 2017 - 100% of plants with yellow flower heads (no mature seed) (Time 3). Five herbicide treatments were applied at each of the three development stages.

Seed was harvested from mature plants in all plots. The seed samples were processed. Seed number per plant was recorded (Table 7).

Table 7. Seed number (seeds/plant) and the per cent germination (%) of that seed, following application of a range of herbicides at three times during flowering of matricaria, Experiment 4.

Treatment (rate/ha)	Seed number (seeds/plant)			Germination (%)		
	Time 1	Time 2	Time 3	Time 1	Time 2	Time 3
Untreated	5 903 b	12 712 c	16 019 d	25.3 b	27.4 c	32.6 d
Bromoxynil 2L	3 864 b	3 853 b	4 031 abc	19.1 b	17.5 b	17.1 c
Glyphosate* 1.25L	0 a	180 a	1 472 a	0 a	0.25 a	0.5 a
Glyphosate 2L	0 a	0 a	1 220 a	0 a	0 a	0.75 a
Glyphosate 1.25L + Ecopar® 400mL	0 a	0 a	3 269 ab	0 a	0 a	2.5 ab
Paraquat 2L	3 992 b	4 995 b	6 721 bc	25.5 b	10.6 b	9.2 bc
P(<.001) 5% Lsd (Treatment): Seed yield 3 414, Germination 8.0						

*Product Formulation Strength; glyphosate 570 g ai/L, Ecopar® (pyraflufen-ethyl 20 g ai/L), paraquat 250 g ai/L, bromoxynil 200 g ai/L.
Values, in the same column, followed by the same letter are not significantly different.

Seed was tested for germination. Fifty matricaria seed were placed in petri dishes, watered with distilled water then placed in a germination cabinet, there were four replicates (i.e. 200 seed tested for each plot). Samples were subjected to a 10/20°C 12 hour light/dark cycle and germination counted after 2 weeks. Following the initial distilled water germination count, gibberellic acid (0.1g in 500mL distilled water) was added to the petri dishes. Samples were returned to the incubator for a further ten days, and a final germination count was recorded (Table 7).

The glyphosate treatments applied at Time 1 and 2 were very effective at reducing seed set as they killed the plants outright. Herbicide applications at Time 3 dramatically reduced the number of seed set per plant compared to the untreated control.

Glyphosate treatments applied at Time 2 and 3 reduced the viability of the seed produced, by up to 99 per cent (Table 7). Treatment with glyphosate at 1.25L/ha and 2L/ha gave the most consistent results for both reduction in seed number and seed viability, with very little viable seed being set following these treatments.

Conclusion

Matricaria germinated between 10°C and 25°C and not at other temperatures. It is unlikely that matricaria will germinate in summer. Matricaria seed survives well when buried at 2-10cm, and darkness inhibits germination under laboratory conditions. Seed is likely to survive in the soil for several years if buried. There may be implications for summer fallow management if cultivation is used and the use of soil inversion at crop establishment as these practices will bury seed to depths where it can remain viable.

Results from field trials are showing that timing of herbicide application can be important. Selective herbicides should to be applied to small plants to be most effective and knockdown applications may work best when mixed with other

herbicides, to act as a ‘spike’. The best time for applications targeting seed set are before plants are fully flowering, seed viability can be reduced (by up to 99%) when non-selective herbicides are applied during the flowering stage.

References

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