1986

The ecology of skeleton weed in Western Australia, Afghan thistle ecology, Biology of Gorteria personata.

J. Dodd

EXPERIMENTAL SUMMARY 1986

1. The ecology of skeleton weed in Western Australia
2. Afghan thistle ecology
3. Biology of _Gorteria personata_

J. Dodd
Weed Agronomy Branch
Plant Research Division
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1. THE ECOLOGY OF SKELETON WEED IN WESTERN AUSTRALIA

Seed production and water use by field grown plants (84BA17; 3764EX)

a) Flowering

Table 1. Performance of skeleton weed over three consecutive summers at Badgingarra

Season	Start of bolting		50% of plants bolting		Free seed first observed	
	Form A	Form C	Form A	Form C	Form A	Form C
1984/85	30 Oct.	25 Oct.	--- 1 Nov. ---		--- 9 Jan. ---	
1985/86	--- 18 Oct. ---		24 Oct.	19 Oct.	--- 7 Jan. ---	
1986/87	--- 30 Sept. ---		30 Sept.	20 Oct.	--- 6 Jan. ---	

The skeleton weed plants at Badgingarra, which are now in their third year, began bolting (i.e. elongation of the inflorescence stem) up to a month earlier in 1986 than in their first year. Results for the three seasons suggest that bolting occurs earlier as plants increase in age. Free, mature seeds were first released on approximately the same date each year, indicating a greater synchrony in the start of seeding (and thus flowering).

b) Inflorescence stem elongation

Once bolting has begun, inflorescence stems elongate rapidly in October and November. Both forms showed the same rates of elongation of around 2 cm/day during this period (Form A = 1.93 ± S.E. of 0.47 cm/day; Form C = 2.05 ± 0.27 cm/day). By the second week of December 1986, elongation had largely ceased in Form A, but was proceeding undiminished in Form C. The longest stems measured on December 9, 1986 were 96 ± 12 cm ($\bar{x}$ and S.E.) in Form A and 114 ± 8 cm in Form C. It is not known how much more growth would have occurred, because stems were either cut off at ground level on that date or were bagged for seed production studies.

c) Seed production

In 1985/86, only 1 plant of Form A and four of Form C survived a heavy attack of Rutherglen Bugs in December. Their seasonal seed totals and quality characteristics are summarised in Table 2. Fortnightly harvesting of ripe seed began on January 21 and continued until late May.

Table 2. Seed production by two-year old, field-grown skeleton weed at Badgingarra, during summer 1985/86. Figures in brackets are results for 1984/85

Form	No. plants	Stems per plant	Seed total per plant	Viable seed per plant	Percent viable seed	Percent dormant seed
A	1	2.7	18,560	12,900	70	6
	(6)	(1.0)	(8,430)	(6,090)	(71)	(11)
C	4	3.8	30,620	19,040	62	2
	(5)	(1.0)	(14,120)	(11,410)	(81)	(3)

As in the previous year, large numbers of seeds with high viability were produced. Form C had a higher seed yield per plant than Form A; however, seed yield per stem was similar in the two forms (Form A = 6,190 seeds/stem, Form C = 6,380). Seed viability was higher in Form A in 1985/86, in contrast to the previous year. Primary seed dormancy was, again, higher in Form A.

The time course of seed production in 1985/86 followed an erratic pattern in Form A, with maximum fortnightly seed yield in early February (5,000 seeds), followed by an irregular decline. Form C showed a bimodal pattern with peak fortnightly yields in early February (5,930 seeds) and mid April (5,225 seeds). Seed production in both forms lasted around 20 weeks. Heavy rain in late February (total = 76 mm) and between mid March and early April (26 mm) appeared to boost seed production in both forms, but did not affect seed viability or dormancy levels. Seed production data for 1986/87 are not yet available.

d) Water use at Badgingarra

Patterns of water use were measured to depths of 420 cm,using a neutron moisture meter. In 1984/85, during their first year of growth, skeleton weed plants extracted water to a depth of 330 cm in the deep yellow sand of the experimental site, and the amount of water used by skeleton weed between mid October and early February averaged 23 mm at each access tube (Table 3).

Table 3. Soil water depletion by skeleton weed at Badgingarra, measured to a depth of 420 cm, over the period mid October to early February.

Season	Planted tubes (mm)	Control tubes (mm)	Water used (mm)	Depth of extraction (cm)
1984/85	60	37	23	< 330
1985/86	56	62	-6	< 60 and > 300
1986/87	110	61	49	> 420

The results for 1985/86 were complicated by the Rutherglen Bug attack in December and are hard to interpret. Two apparent zones of depletion were recognised in 1985/86, namely the upper soil layers down to 60 cm, and from depths of 300 cm and greater. In 1986/87, the amount of water used was twice that for the comparable period in 1984/85 and extraction occurred uniformily down the profile to 420 cm and, presumably, to greater depths, as a result of continued growth of the tap root.

e) Daughter rosette production

Undisturbed skeleton weed plants produce daughter rosettes from buds on near-surface lateral roots. The progressive emergence of daughter rosettes was monitored at Badgingarra in 1985/86 (Table 4).

Table 4. Daughter rosette production by skeleton weed, Badgingarra, 1985/86

Form	Total rosettes	Rosettes per plant Mean	(Range)	Distance from parent plant (cm) Mean	Mostly	Max.
A (12 plants)	77	6.4	(2 - 10)	16.7	10 - 30	53
C (11 plants)	60	5.5	(2 - 9)	24.0	20 - 40	47

Daughter rosettes began to appear some distance from the root crown in mid October, and by late November there was an average of 1 daughter rosette per plant. All rosettes, both at the root crown and the daughter rosettes, were dead when scored in mid December, probably as a result of damage by Rutherglen bugs. Small numbers of daughter rosettes emerged in January and February. These represented new rosettes as well as regrowth of previous ones. Large numbers of new rosettes were recorded in March (47 from Form A plants, 42 from Form C), probably in response to the heavy late February rain. Further rosettes appeared in April (Form A = 17, Form C = 13), May (9, 5) and June (2, 2) but no more were recorded in July. All but a few daughter rosettes that emerged after January have persisted and are likely to become established as independent plants capable of flowering next summer: all rosettes that emerged this year remained vegetative. An analysis of daughter rosette production is given in Table 2.

Plants of both forms produced an average of 6 daughter rosettes per plant. Amongst Form A plants, most daughter rosettes emerged 10-30 cm from the parent plant, whereas in Form C, they tended to appear further from the parent plant, mostly 20-40 cm away. The maximum distance from the parent plant was 53 cm for Form A and 47 cm for Form C. These distances are in full agreement with several reports from south eastern Australia and, therefore, cast doubt on the contention that vegetatively produced daughter rosettes can be produced several metres from the parent plant. Vegetative reproduction by these undisturbed skeleton weed plants has therefore resulted in a 9-fold increase in rosette numbers during the second year of plant growth, due to the growth of 3 root crown rosettes and 6 daughter rosettes per plant.

2. AFGHAN THISTLE ECOLOGY

Winter rosette survival (84NO50; 3761EX)

Previous studies have established that the majority of *S. hoplopetalum* shoots emerge in August. The fate of earlier emergents was studied in winter 1985, by measuring the survival of shoots that appeared in late May, late June and late August, respectively. Results are shown below (Table 5).

Table 5. Percentage survival of Afghan thistle shoots emerging in late May, late June and late August 1985

Sampling date	Cohort 1 (marked May 22) n = 20	Cohort 2 (marked June 25) n = 30	Cohort 3 (marked August 28) n = 50
May 22, 1985	100	-	-
June 25	90	100	-
July 31	27	73	-
August 28	27	40	100
October 21	27	37	83
November 18	27	37	74
December 17	27	37	68
January 14, 1986	27	37	50
February 11	27	33	46
March 11	13	20	26
April 8	13	17	24
May 6	7	17	24
June 3	0	0	0

Shoots that emerged in May and June suffered high rates of mortality, losing up to 70% of shoots within 2 months of emergence, but the surviving shoots persisted until late summer (February) with few or no further deaths. The remaining shoots died during autumn and all were dead by early June 1986. Shoots of Cohort 3 that emerged in August and had the highest level of survival, but showed a fairly steady rate of mortality during summer and autumn. All were dead by early June.

In general, it was shown that survival of shoots was inversely related to their earliness of emergence.

Regenerative ability of stem and root segments (85PE51; 3761EX)

The regenerative ability of root and below-ground stem segments of Afghan thistle showed seasonal variation and was generally least in summer and autumn (November to May, inclusive). Nevertheless, regeneration could occur at any time of year (Table 6). In most cases, regeneration resulted initially in the production of new shoots on both stem and root fragments, although roots were formed first in a small proportion of cases. After producing shoots, regenerating fragments developed roots after a few weeks.

Table 6. Regeneration from Afghan thistle root (4-6 mm diameter) and stem segments, six weeks after collection

Date of collection	Roots Shoots (%)	Roots Roots (%)	Stems Shoots (%)	Stems Roots (%)	Carbohydrate content Roots (%)	Carbohydrate content Stems (%)
July 31, 1985	14	6	12	0	40.2	18.5
August 28	28	2	4	0	42.1	17.8
September 23	18	2	6	0	32.9	15.3
October 21	72	8	44	8	41.1	14.3
November 18	40	4	12	0	48.8	21.2
December 16	66	4	26	2	44.7	22.8
January 14, 1986	14	0	18	0	43.8	17.9
February 11	18	4	10	4	45.9	17.4
March 11	34	14	20	2	44.7	17.1
April 8	14	0	16	6	40.3	21.0
May 6	14	12	26	0	n.a.	n.a.
June 3	60	22	82	4	n.a.	n.a.
July 1	62	12	76	0	n.a.	n.a.
July 29	52	10	72	4	n.a.	n.a.

Seasonal variation in regenerative ability did not correspond with carbohydrate storage levels in the roots and below-ground stems (Table 6), which suggests that regeneration is influenced by some other seasonally varying factor(s), rather than carbohydrate reserves.

Regeneration from buried segments (85PE51; 3761EX)

Root and stem segments were excavated at Bolgart monthly from October 1985 to July 1986, cut into 4 cm segments and buried immediately.

Table 7. Regeneration from Afghan thistle root and below-ground stem segments, assessed in August 1986. Plant material was dug up, cut into 4 cm segments and immediately buried on the dates shown. Soil water contents are gravimetric values for those dates

	Roots		Stems		Soil water content at 20-30 cm (%)
	Regen. (%)	Dormant (%)	Regen. (%)	Dormant (%)	
October 21, 1985)					0.9
November 18)					0.6
December 17)					0.3
January 14, 1986)					0.6
February 11)					0.3
March 11	62	28	20	40	2.5
April 8	0	4	30	0	1.7
May 6	3	27	21	32	1.3
June 3	8	60	36	44	3.9
July 1	2	86	24	44	4.7
July 29	6	84	60	20	3.9

When scored in August 1986, all those buried between October and February (inclusive) were rotten and showed no signs of regeneration. Those buried from March onwards were regenerating. Except for the March collection, regeneration from root segments was much less than from stems (Table 7). In nearly all cases, only new shoots had been produced.

The death of the segments buried between October and February was due to the low moisture contents and, possibly, high temperatures of the soil over that period. The greater regenerative ability of stem segments after April corresponds with the period of renewed growth of adventitious shoots from the root system.

Under glasshouse conditions, a small proportion of segments found to be regenerating in August 1986 developed into established, flowering plants by December 1986.

3. REPRODUCTIVE BIOLOGY OF GORTERIA PERSONATA

Germination and establishment in the field (86MO3; 86NO8)

Natural populations of Gorteria were studied at Moora (2 sites) and Meckering (1) in 1986. The first germinations took place in late February/early March, following heavy rain in late February (Table 8). The peak of germination, however, was in late May, after which progressively fewer seedlings emerged. Germination had largely ceased by the end of July. All cohorts of seedlings showed high levels of survival (excepting those comprising small numbers of seedlings). Between 77 and 100 per cent of seedlings of the major cohorts survived until the end of October (Table 8). Senescence and death proceeded rapidly, and by November 11, all seedlings at all sites were dead.

Germination in autumn followed major rainfall events and, hence, the development of adequate soil moisture. Few germinations occurred from late April to mid May, during a dry period when soil moisture contents fell. The death of plants in early November showed no relation to plant age but, instead, corresponded with the soil moisture reaching low levels, equivalent to those of late summer and autumn.

Table 8. Germination and survival of Gorteria at Moora and Meckering, 1986

Cohort no.	Date emerged	No. of seedlings	% surviving to Oct. 29	Rain in previous 14 days (mm)
a) Stack St, Moora				
1	March 6	280	77	79
2	April 2	20	80	7
3	April 16	1	0	8
4	May 28	1,258	83	50
5	June 11	43	77	5
6	June 26	26	85	42
7	July 9	15	100	67
8	July 22	2	50	64
b) Melbourne St, Moora				
1	April 2	323	87	7
2	April 30	4	25	0
3	May 12	1	0	10
4	May 28	750	92	50
5	June 11	114	88	5
6	June 26	55	89	42
7	July 9	18	100	67
8	July 22	15	100	64
9	September 2	3	67	16
c) Meckering				
1	June 3	193	94	33
2	June 27	17	88	76
3	July 25	4	100	24
4	August 20	1	0	33

Life cycle (86MO3; 86NO8)

Despite the spread in dates of seedling emergence (mostly late February to late July), the date of first flowering fell mainly in September (Table 9). The earliest cohorts began flowering in late August/early September, some 5 or 6 months after germinating, whereas the later cohorts began flowering in mid or late September, after 1-3 months growth. By the end of September the majority of plants from all cohorts were flowering.

Ripe burrs were first recorded on October 14, some 4-8 weeks after the start of flowering. By the time of their death on November 11, plants ranged in age from 10 to 36 weeks (Table 9).

Table 9. Phenology of *Gorteria* at Moora and Meckering (cohort numbers and emergence dates as in Table 8)

Cohort no.	First flowering Date	Age (weeks)	% flowering on Sept. 30	Age at death on 11/11/1986 (weeks)
a) Stack St, Moora				
1	September 2	(26)	85	36
2	September 2	(22)	100	32
3	(Dead by June 26)		-	-
4	September 16	(16)	68	24
5	September 16	(14)	100	22
6	September 16	(12)	100	20
7	September 16	(10)	89	18
8	September 30	(10)	100	16
b) Melbourne St, Moora				
1	September 2	(22)	56	32
2	September 16	(20)	100	28
3	(Dead by July 22)		-	-
4	September 2	(12)	58	22
5	September 16	(14)	95	22
6	September 16	(12)	78	20
7	September 16	(10)	72	18
8	September 30	(10)	80	16
9	September 30	(4)	100	10
c) Meckering				
1	August 20	(11)	82	33
2	September 3	(10)	100	20
3	October 1	(10)	100	16
4	(Dead by Sept. 17)		-	-

Germination requirements (86PE7)

Seeds are highly dormant when the burrs are first shed. Fortnightly collection of burrs from the soil surface at the 3 study sites, has shown that loss of dormancy begins in late January (Table 10). These studies will continue until winter 1987.

Table 10. Loss of dormancy in burrs of <u>Gorteria</u>, collected from the soil surface at Moora (S = Stack St, M = Melbourne St) and Meckering

Date of collection	% germination at 14 days			% viable		
	S	M	Meck.	S	M	Meck.
November 11, 1986	0	0	-	89	95	99
November 25	0	0	-	79	88	-
December 9	0	0	0	99	93	94
January 6, 1987	0	0	0	98	95	94
January 20	3	5	6	98	91	93
February 4	6	8	3	97	98	99
February 17	3	15	21	n.a.	n.a.	n.a.

<u>Emergence and seedling root growth</u> (86PE7)

Burrs were planted in friable potting mix at South Perth on the surface, and at depths of 1, 2, 4 and 10 cm. Emergence was inversely related to planting depth, with no emergence from 10 cm.

Plant depth	% emergence at 28 days
Surface	75
1 cm	70
2	50
4	45
10	0

Seedling root growth was measured in perspex-sided observation chambers, at ambient temperatures, over a 30 day period in October/November 1986. The growth rate of the resulting tap root averaged 11.5 mm/day (n = 18) with values in the range 5.7 - 19.0 mm/day. These results were obtained in porous potting mix : lower values would be expected in the compacted loams characteristic of the study sites at Moora and Meckering.

<u>Effects of enclosing burrs</u> (86PE7)

Greater germination levels were achieved when burrs were set to germinate on the soil surface, rather than in petri dishes. To investigate this further, pots of burrs were established, each containing 20 burrs embedded at the soil surface. Half were covered with clear petri dish lids taped onto the pot, the remainder were left open. After 14 days, the cumulative totals of germinating burrs were compared and it was found that the uncovered pots had significantly more germinations.

	Treatment		
	Open	Covered	Significance
Average no. of burrs germinating (per 20 burrs)	12.2	1.8	***

The number of burrs germinating was also significantly higher amongst small (as opposed to large) burrs, and heat-treated (50°C for 14 days) burrs (P > 0.05 in each case).