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Experimental Summary 1985

1. The ecology of skeleton weed (Chondrilla juncea L.) in Western Australia

2. Afghan thistle (Solanum hoplopetalum) ecology

3. Reproductive biology of Gorteria personata

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1. THE ECOLOGY OF SKELETON WEED (*Chondrilla juncea* L.) IN WESTERN AUSTRALIA

1.1 Seed production and water use in the glasshouse (84PE18, 3764EX)

Objectives

a) To compare seed production, seed viability and water use of droughted and non-droughted skeleton weed, in relation to the performance of field-grown plants.

b) To compare the performance of the two forms of skeleton weed (Form A and Form C) that occur in Western Australia.

Results

In summer 1984/85, prolific flowering and seed production occurred in both Form A (narrow leaf) and Form C (broad leaf) skeleton weed plants growing in the glasshouse at South Perth. Form B (intermediate leaf) plants again did not flower. Plants of Forms A and C were subjected to simulated drought. Control plants were watered weekly and supplied with sufficient water to replace that used during the previous week, as determined by weight loss. Droughted plants were watered fortnightly and received half of the average amount of water used by the controls. Droughted plants therefore received, on average, a quarter as much water as the controls. The seed production results are summarised in Table 1.

Table 1: Seed production and quality characteristics for skeleton weed (*C. juncea*) during summer 1984/85, in South Perth (glasshouse) and at Badgingarra.

Form	Treatment	Total seeds per plant	Viable seeds per plant	Average viability (%)	Average dormancy (%)	100-seed weight (g)
Glasshouse						
A	Wet[a]	8,290	6,450	78	11.5	0.044
A	Dry[b]	1,890	1,580	84	6.0	0.046
C	Wet	2,750	2,370	86	2.7	0.051
C	Dry	1,480	1,220	82	3.7	0.036
Badgingarra						
A	Field[c]	8,430	6,230	74	11.0	0.048
C	Field	14,120	11,210	79	3.5	0.049

a Wet = well-watered control plants
b Dry = droughted plants
c Field = natural field conditions

There were significant differences between forms and treatments. Amongst the control plants, total seed numbers in Form A (8,290 seeds/plant) were nearly three times the total for Form C (2,750 seeds/plant). Droughting reduced seed numbers by 77% in Form A and 46% in Form C. Seed viability remained high throughout the period of seed production, averaging 80-85% in all plants, regardless of form or treatment. Primary seed dormancy was higher in Form A, averaging 11.5% amongst controls and 6.0% for droughted plants; in Form C the dormancy value was around 3%. The 100-seed weight was reduced significantly by droughting in Form C but not Form A.

Seed production in watered Form A plants was comparable to levels observed in the field, both in terms of seed numbers and quality characteristics. However, seed production by the Form C controls was substantially lower than for field-grown plants of this form, indicating that the glasshouse conditions were probably less suitable for Form C than for Form A. The watering regime followed in summer 1984/85 caused significant reductions in seed numbers, especially in Form A, but did not affect viability. There was a strong linear relationship between seed numbers and cumulative water use since the start of flowering in Form A and, to a lesser extent, in Form C.

1.2 Seed production and water use by field-grown skeleton weed (84BA17, 84BA18)

1. Seed Production

Seedlings of Forms A and C, planted at Badgingarra Research Station in winter 1984, bolted in late October and began flowering in late December. Seeds were collected fortnightly between January and late May 1985. Significant differences in seed production and quality were found between the two forms. Form C plants produced significantly more seed than Form A, of greater viability and with a lower level of primary seed dormancy (Table 1: $P < 0.001$ for these comparisons). Viable seed production in Form C was twice that for Form A, but 100-seed weight was the same for both forms.

Further differences were apparent in the time course of seed production. In Form C, seed production reached a peak in early March, then declined steadily. Form A exhibited a substantial depression during March, which resulted in a bimodal pattern of seed production with peaks in late February and early April. This pattern was matched by a drop in Form A seed viability in March. It is likely that these reductions in seed numbers and viability were the result of the extremely high temperatures during February, which affected Form A but not Form C.

Primary seed dormancy was initially high, around 15%, in both forms but then tended to decline over subsequent harvests. The level of dormancy was significantly higher in Form A at nearly every harvest. In Form C, primary dormancy was 6% or less after the first harvest. In both forms, 100-seed weight was lowest during March, around 0.035 g, with the highest values of 0.05 - 0.07 g at the start and end of the seed production period. Seed viability had a significant linear correlation with 100-seed weight in Form A but not Form C.

Total seed production was significantly correlated to flowering stem dry weight in Form A plants but not Form C. No meaningful correlations could be found between either cumulative rainfall or average maximum temperature for various fortnightly periods immediately prior to seed harvest and the various seed parameters. This indicated that seed production and quality were, overall, independent of rainfall and air temperature over the summer months.

2. Water Use at Badgingarra

Comparisons were made between changes in soil water storage at the four neutron moisture meter access tubes planted with C. juncea, and the four unplanted access tubes which served as controls.

Net depletion of soil moisture over the summer months (October - May) was greater beneath C. juncea than at the control tubes, with significant differences being found to a depth of 3.3 m. Evapotranspiration over this period at the C. juncea plots resulted in a soil moisture depletion of 93 mm from the top 4.1 m of soil, compared with 49 mm at the control tubes. Water loss at the control tubes was due entirely to soil evaporation, since there were no live plants to extract moisture. On this basis, total water use during summer by the six C. juncea plants at each access tube averaged 44 mm. Such low values of water use are indicative of highly conservative use of soil stored water by C. juncea during summer.

1.3 Seedling root growth (85PE54)

Seedlings of C. juncea were grown in Perspex-sided root observation boxes in growth cabinets at 20/10°C, 30/15°C and 35/20°C. High levels of mortality were observed at the two higher temperatures, with 70-90% of seedlings dead four weeks after the start of the experiment.

In general, Form C seedlings exhibited higher rates of root growth and a more vigorous development of the root system. Mean root extension rates were around 16 $mm.d^{-1}$ in Form C seedlings and 13 $mm.d^{-1}$ in Form A. Maximum growth rates were around 19 $mm.d^{-1}$ and 14 $mm.d^{-1}$, respectively.

Temperature did not affect root extension rates during the first 15 days of growth, but subsequently the highest growth rates were amongst the surviving seedlings in the hottest cabinet. These root growth rates, although high, would probably be insufficient to enable newly germinated seedlings to escape the drying of surface soils, following occasional summer rainfall that might permit germination and temporarily soak the soil.

2. AFGHAN THISTLE (Solanum hoplopetalum) ECOLOGY

2.1 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 2).

Table 2: Shoot survival in S. hoplopetalum at monthly intervals after emergence.

Time of emergence	Percentage survival after emergence			
	1 month	2 months	3 months	4 months
Late May	90	27	27	27
Late June	73	40	30	37
Late August	90	83	74	68

Shoots emerging in late May and June had a lower survival rate than those emerging in August. Mortality was greatest amongst the late May emergents. After the substantial losses over the first two months, there have been no further losses amongst the May and June emergents. However, there has been a steady rate of loss amongst the shoots that emerged in late August.

2.2 Regenerative ability of S. hoplopetalum (85PE51)

Roots and below-ground stems of S. hoplopetalum are being collected monthly from a site near Bolgart and incubated in darkness in a growth cabinet at 20/30°C. Other material from each collection is buried in the field at the time of collection for later measurement of regeneration.

Under laboratory conditions, regenerative ability is influenced by the type and size of the regenerating fragment, and also shows seasonal variation. In general, there is more regeneration from horizontal root fragments of 2-4 mm and 4-6 mm diameter, than from 0-2 mm diameter fragments. The greatest amount of regeneration is usually from tap root fragments, while the least is from stem fragments. Fragments produced either shoots or roots, but shoot production was up to 10 times more frequent than root production. Some root fragments showed great longevity and dormancy during incubation, surviving as long as three months without regenerating or rotting. In general, though, most regeneration took place within six weeks of collection and the remaining fragments rotted. Stem fragments usually rotted more rapidly than roots.

The highest levels of shoot regeneration were shown by the October and December 1985 collections. Root production was greatest amongst January and March 1985 collections. The results for 2-4 mm diameter root fragments, and for tap roots and stem fragments, are summarised in Table 3.

Table 3: Regeneration from Afghan thistle (S. hoplopetalum) root and stem fragments, six weeks after collection. Results are expressed as the percentage of fragments producing shoots or roots.

Date of collection	2-4 mm dia. roots		Tap roots		Stems	
	% shoots	% roots	% shoots	% roots	% shoots	% roots
19 Dec 84	0	10	-	-	-	-
17 Jan 85	0	70	0	0	-	-
14 Feb	0	0	-	-	-	-
14 Mar	0	20	-	-	-	-
11 Apr	0	0	-	-	-	-
22 May	0	10	0	30	-	-
25 June	10	10	14	-	-	-
31 July	6	0	-	-	12	0
28 Aug	28	6	32	6	4	0
23 Sept	18	0	67	0	6	0
21 Oct	62	8	50	30	44	8
18 Nov	10	6	55	9	12	0
16 Dec	52	10	-	-	26	2

These investigations are continuing. Results for fragments buried in the field are not yet available.

3. REPRODUCTIVE BIOLOGY OF Gorteria personata

Gorteria personata is an hispid, annual herb, in the family Asteraceae, that has become established in a number of townsite and roadside locations in the wheatbelt. The plant is of South African origin and is of concern because of its prolific production of spiny burrs around 1 cm in diameter. It is recorded as a weed only in Western Australia. There is no information available on its status as a weed or on any aspects of its biology.

As part of a preliminary investigation of this weed, the floral biology, burr characteristics and burr production were studied.

3.1 Floral biology

Each shoot of the many-branched plant is terminated by a flower (capitulum) that consists of a small number of florets of three kinds. The outermost are ligulate ray florets that are neuter, the outer disc florets are female and the inner disc florets are male. Seedlings collected at Meckering in late June 1985 began flowering in the glasshouse at South Perth in late August and early September.

The capitulum remains open for 4-7 days, during which time the disc florets open in succession and pollination occurs. It is not yet known whether self- or cross-pollination predominates. The capitulum then closes and development of the burr (i.e. the fruit) proceeds.

Development of mature, ripe burrs takes 5-7 weeks for the capitula that opened in early September and around four weeks for those opening in late October. Ripe burrs detach readily from the parent plant. Burr drop occurred continuously between mid October and early January, when the period of observation was terminated. Plants grown in the glasshouse reached a peak of burr production in late November, then declined, whereas those grown outside continued to produce large quantities of burrs until early January.

Burr production averaged 48 burrs per plant in the glasshouse and 63 burrs per plant outside. By early January the glasshouse plants were beginning to senesce and die, whereas those outside appeared capable of continued growth and burr production. Mean burr weight decreased from around 0.20 g in mid October to 0.06 g in January. The behaviour of plants in the field is not yet known, but these observations suggest that flowering and burr production will continue as long as the parent plants receive water.

3.2 Seed content of burrs

Burrs collected from the soil surface at Meckering were found to contain a maximum of four or five achenes (seeds). Old burrs often contained only one or two seeds, but retained the empty walls of others, indicating their loss through germination or decomposition. Seeds extracted from these burrs showed high viability levels (as shown by positive Tetrazolium chloride staining) but germination rates (at 15/25^{o}C) were low or zero. Thus, it appears that each burr contains four or five highly dormant seeds when released. Each burr has the potential to produce plants over a number of years. Germination requirements and dormancy characteristics are being investigated.