1984

The ecology of skeleton weed .(Chondrilla juncea L.) in Western Australia , Afghan thistle (Solanum hoplopetalum) ecology

J. Dodd

Department of Agriculture,
Western Australia

Experimental Summary 1984

1. The ecology of skeleton weed (*Chondrilla juncea* L.) in Western Australia
2. Afghan thistle (*Solanum hoplopetalum*) ecology

J. Dodd
Weed Agronomy Branch
Plant Research Division

281

1. THE ECOLOGY OF SKELETON WEED (<u>Chondrilla juncea</u> L.) IN WESTERN AUSTRALIA.

1.1 <u>Seed production and water use in the glasshouse</u> (84PE18, File No. 3764EX).

<u>Objectives</u>

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 three forms of skeleton weed (Forms A, B & C) that occur in Australia.

<u>Results</u>

1. Seed Production and Viability

In summer 1983/84 prolific flowering and seed production occurred amongst Form A (narrow leaf) plants. Seed production in Form C (broad leaf) was limited to two plants which flowered late in the season for a short period. None of the Form B (intermediate-width leaf) plants flowered. In summer 1984/85 all plants of Form A and most of Form C flowered, but, again, none of Form B flowered. Seed production and viability in Form A during 1983/84 is summarised in Table 1. Results for the current flowering season are not yet available since seed production is still in progress.

Table 1: Viability and yield of seed from Form A (narrow leaf) skeleton weed plants, in response to simulated drought in summer 1983/84.

	Cumulative yield (seeds per plant)	Seed viability per cent (mean)	Total viable seeds (seeds per plant)	Seed production in peak fortnight (seeds per plant)	Period of peak production	Production > 50% of peak (weeks)
Droughted	1341	41.3	554	430	23 Feb - 24 March	4
Watered	8170	76.2	6226	2030	11 Feb - 23 March	6

The results (Table 1) showed that the droughted plants had substantially lower seed yields and seed viability. Over the harvest period, the droughted plants produced an average of approximately 1,300 seeds per plant, compared with 8,200 from the watered plants. The greatest number of seeds produced at any one harvest averaged 430 amongst droughted plants and 2030 amongst watered plants, and the period of peak production was shorter and later in droughted plants. On average, 41 per cent of the seed from droughted plants was viable, compared with 76 per cent from watered plants, therefore the total yield of viable seed was 550 seeds per droughted plant but 6,200 seeds per watered plant.

Water stress resulting from drought caused significant reduction in yield and viability of seed in skeleton weed. Drought reduced seed yield by 84 per cent and halved seed viability. Yet, despite the large reduction in water supply, droughted plants nevertheless maintained a relatively high level of seed viability amongst the limited number of seeds that were produced.

These results provide experimental evidence that drought can lead to reduced seed yield and viability, and may therefore account for some of the seed production results obtained from field-grown plants. The quality and quantity of seeds produced by field grown plants were generally similar to those of the watered glasshouse plants, which suggests that field grown plants were obtaining plentiful supplies of water during summer 1983/84.

2. Water Use

Water use by watered plants varied seasonally, but there were no consistent differences between the forms of skeleton weed. Maximum daily water use occurred in summer and autumn, particularly January, February and March, and corresponded to the period of highest air temperatures in the glasshouse. Water use rates over this period ranged from 5 to 8 $mm.d^{-1}$. The lowest rates, around 2 $mm.d^{-1}$, occurred in winter.

Droughted Form A plants had water use rates of 1 to 2 $mm.d^{-1}$ in summer and autumn, approximately one quarter the rate of watered plants. Water use in both treatments was proportional to the amount of water supplied (droughted = 500 ml/plant once a fortnight; watered = 500 ml/plant twice weekly. Watered: droughted = 4:1).

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

1. Seed production

Four-week old seedlings of skeleton weed (Forms A and C) were installed at Badgingarra Research Station during winter 1984. High rates of seedling mortality occurred after planting, which necessitated the planting of replacements on two occasions. This resulted in a mixed age population of seedlings planted between 25 May and 3 August 1984, most being from the latter date. Of the 23 surviving plants, 20 bolted and developed flowering stems. Bolting began in late October and was largely completed by late November (Table 2). Flowering began in late December.

Table 2: Progress of flowering stem production (bolting) in field-grown skeleton weed seedlings at BAR

	Number of plants		
	Form A (n = 12)	Form C (n = 11)	Total (n = 23)
25 October 1984	1	0	1
30 October 1984	3	2	5
2 November 1984	8	7	15
30 November 1984	9	7	16
5 December 1984	9	7	16
14 December 1984	9	8	17
9 January 1985	10	10	20

Flowering stems of selected plants were enclosed in nylon gauze bags in early December to allow for the fortnightly collection of seeds. The remaining stems were cut off at ground level. Flowering began in late December/early January with the first seeds ripening by 9 January 1985. Measurement of seed viability and production is in progress. Initial results indicate that seed production and viability levels are high.

2. Water Use

Measurement of soil water content by means of the neutron moisture meter began in late October 1984. Detectable differences in water content, attributable to water use by the skeleton weed plants, are only now (February 1985) beginning to be measured. It is anticipated that estimates of water use and depth of tap root penetration will be available after the end of the flowering season (April/May 1985).

1.3 Germination in relation to soil water content

Seeds of Forms A and C skeleton weed were set to germinate in closed containers with soils of different water contents. High levels of germination (> 50%) occurred at soil water contents greater than 0.06 $cm^3.cm^{-3}$ but none occurred in drier soil.

Table 3: Germination of skeleton weed in a sandy loam at different water contents

Volumetric water content, θ ($cm^3.cm^{-3}$)	Approx. soil water potential, (MPa)	Per cent germination Form A	Form C
0	< -10	0	0
.03	< -10	0	0
.07	-10	53.8	77.5
.10	-0.1	65.0	90.0
.18	-0.01	85.0	70.0

Germination in Form A increased to a maximum of 85 per cent at the highest water content (θ = 0.18 $cm^3.cm^{-3}$). Maximum germination in Form C was 90 per cent at a water content of 0.10 $cm^3.cm^{-3}$. The occurrence of high levels of germination at relatively low soil water contents, as demonstrated by these results, emphasises the ability of skeleton weed to germinate even after minor summer rainfall events which elevate soil moisture contents to a limited extent.

2. AFGHAN THISTLE (Solanum hoplopetalum) ECOLOGY

2.1 Water relations (84NO48; File No. 3761 EX)

Objectives

Xylem pressure potential (X.P.P.) and stomatal conductance in Afghan thistle have been monitored in two populations (Northam and Toodyay) during summer 1983/84 and spring and summer 1984/85. The aim of the study has been to monitor seasonal variation in environmentally-induced water stress and to relate water stress variation to the suitability for herbicide application.

Results

1. Dawn values of xylem presure potential (X.P.P.) in late summer 1984 (February, March and April) were relatively high (-0.2 to -0.5 MPa) and indicated that the plants were able to restore their water status overnight after the water deficit incurred during the previous day's transpiration.

Table 4: Seasonal variation of Xylem Pressure Potential (X.P.P.) and stomatal conductance in Afghan thistle. Stomatal conductance and minimum X.P.P. measured in early afternoon

	X.P.P. (MPa)		Stomatal conductance ($cm.s^{-1}$)	
Date	Dawn	Minimum	Young leaves	Old leaves
A. TOODYAY				
16 December 1983			0.95	0.81
19 January 1984		-1.90	0.88	0.49
16 February 1984	-0.48	-1.86		
22 March 1984	-0.18	-1.09	1.49	0.65
19 April 1984	-0.21	-1.03	0.77	0.63
11 October 1984		-0.53		
13 November 1984		-1.36	0.73	
19 December 1984		-1.55	0.74	0.31
17 January 1985		-1.45	0.28	0.28
14 February 1985		-1.95		
14 March 1985		-1.56	1.19	0.57
B. NORTHAM				
16 December 1983		-1.13	1.24	0.61
21 March 1984		-1.13	1.17	0.88
18 April 1984		-1.11	1.14	0.57
11 June 1984		-0.98	0.41	0.32
19 October 1984		-0.88	0.92	
20 November 1984			1.04	
18 December 1984		-1.38	0.92	0.59
16 January 1985		-1.11	0.66	0.51
15 February 1985		-1.42		
13 March 1985		-1.38	1.26	0.34

2. Daily minimum X.P.P. values in summer were also relatively high and were not below -2.0 MPa at Toodyay or -1.5 MPa at Northam. There values indicate that the plants maintained favourable water status during summer, despite low rainfall.

3. X.P.P. variation during the growing season was greater at the Toodyay site. This is probably a reflection of the soil types at the two sites: the Toodyay site has virtually pure sand of much lower water holding capacity than the heavy clay of the Northam site. There was greater soil water content variation measured at the Toodyay site.

4. The lowest daily minimum X.P.P. values at Toodyay were in January and February 1984 (-1.90 MPa and -1.86 MPa, respectively) and February 1985 (-1.95 MPa). The lowest X.P.P's recorded at Northam were -1.13 MPa in December 1983 and March 1984, and -1.42 MPa in February 1985.

5. Stomatal conductance measured at midday was of comparable magnitude at the two sites. Conductance values were high, especially those of the young leaves. The conductance of young, fully-expanded leaves was mostly in the range 0.8 to 1.2 $cm.s^{-1}$ while older leaves showed lower values between 0.3 and 0.8 $cm.s^{-1}$. There was no relationship between conductance and minimum X.P.P.

6. The stomatal conductance results are a further indication of the general lack of water stress in Afghan thistle over summer. High conductance values show that stomata remained open and would therefore permit high rates of transpiration.

7. There was no relationship between stomatal conductances and minimum X.P.P. at either site. This suggests that Afghan thistle did not develop sufficiently low X.P.P's to cause stomatal closure, even though this is widely recognised as a major physiological mechanism for stomatal control.

2.2 Growth in Afghan thistle (84NO50; File No. 3761 EX)

Objective

To monitor the seasonal progression of biomass accumulation and leaf area index.

Populations of Afghan thistle at Toodyay and Northam were sampled for above-ground biomass and leaf area index, using ten 30 x 30 cm quadrats per harvest. Samples were taken at monthly intervals during the 1983/84 and 1984/85 periods.

Results

1. At both sites, shoots emerged in August but remained too small to harvest until October. Between mid-October and mid-November biomass increased approximately four-fold, presumably as a response to increasing air and soil temperatures.

2. At Toodyay, after this period of rapid spring growth, biomass showed no further increase but remained around 55 g/0.9 m^2 (0.6 t/ha) during summer 1984/85. However, in the previous summer biomass was higher and fluctuated around 80 g/0.9 m^2 (0.9 t/ha). Above-ground parts were dead by June 1984 (Table 5).

3. At Northam, biomass continued to increase after November, but at a lower rate, reaching a maximum of 45 g/0.9 m^2 (0.5 t/ha) in January 1985. During the previous summer biomass remained around 70 g/0.9 m^2 (0.8 t/ha).

Table 5: Biomass and leaf area index of Afghan thistle at Toodyay

Date	LAI (live leaf area)	Biomass (dry wt.) g/0.9 m^2	t/ha	
18 January 1984	0.255	83.4	0.93	
15 February 1984	0.263	84.3	0.94	
14 March 1984	0.107	61.8	0.69	
19 April 1984	0.110	104.1	1.16	
22 June 1984	0	21.3	0.24	(Dead)
23 August 1984	Trace	Trace	Trace	(Too small to harvest)
11 October 1984	0.047	13.7	0.15	
13 November 1984	0.167	52.6	0.58	
19 December 1984	0.123	56.5	0.63	
17 January 1985	0.130	54.5	0.61	
15 February 1985	0.115	50.7	0.56	

4. The leaf area index of live foliage was greatest in November 1984 at both sites, with values of 0.167 at Toodyay and 0.09 at Northam. Live leaf area declined over the rest of summer.

5. In summer 1983/84, Afghan thistle responded to late summer rainfall by an increase in biomass, which was due largely to the growth of new leaves.

2.3 <u>Afghan thistle reproductive biology</u> (84NO49, 84NO63, 84PE19; File No. 3761 EX)

Objectives

To elucidate details of:-

i) Flower type variation
ii) Fruit setting frequency
iii) Length of flower life and of fruit development period

1. Flower type variation

A flowering plant of Afghan thistle can be found to possess three types of flowers, as follows:-

+ style = a complete, hermaphrodite flower
half style = functionally male but with a vestigial ovary and a short style
- style = male flower lacking the gynoecium.

The proportions of the flower types found on a particular plant vary geographically and seasonally. Their average percentage are 63%, 8% and 29%, respectively. This variation is related to position on the inflorescence, since the proximal two or three flowers on an inflorescence are + style hermaphrodites, while the distal 1 or 2 flowers are - style males. Occasional flowers of intermediate position are of the half style type. Thus the variation observed is due to the proportion of flowers on the various inflorescence positions that are open at any particular time.

2. Fruit setting frequency

Few fruits were found at Northam and Toodyay relative to the number of hermaphrodite flowers produced. Of 80 such flowers tagged at Toodyay in summer 1984/85, only one has set fruit, while seven out of 84 (9%) set fruit at Northam.

3. Length of flower life and of fruit development period

Observations on flowers of glasshouse plants revealed the following sequence of events during flowering.

Day 0	Bud ready to open
Day 1	Flower open, petals ruffled, reflexed and white
Day 2	Flower open, petals flat, white but turning blue later
Day 3	Flower closed, petals pale blue
Day 4+	Flower dies and falls off unless pollinated.

Both +style and -style flowers showed this pattern.

Fruit development in glasshouse plants is very slow. Four and a half months after pollination, half the tagged fruits were ripe, a quarter were green and immature while the rest were ripening. Similar rates of ripening have been observed in the field.