1983

Ecology of skeleton weed (Chondrilla juncea) in WA. Population studies on pennyroyal (Mentha pulegium).

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Experimental Summary 1983

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

2. Population studies on pennyroyal (Mentha pulegium)

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1. The ecology of skeleton weed

1.1 Determination of forms

Objectives

To determine what forms of skeleton weed are present in Western Australia and to map their respective distribution.

Experimental

Indices of leaf shape of rosette leaves of young plants were obtained and compared with those from an original study which described forms found in eastern Australia. The technique of starch gel electrophoresis was used to determine characteristics of enzymes extracted from seedlings of both Western Australian collections and collections of known identity from Canberra.

Results

It was not possible to determine the identities of Western Australian collections on the basis of rosette leaf shape alone. Isozyme characteristics of local collections, however, were identical to those of the broad-leafed and narrow-leafed forms of skeleton weed from the Canberra collections. The locations for collections of each form are given in Table 1.1.

Table 1.1. Locations of different forms of skeleton weed in Western Australia

Form	
Broad-leafed	Narrow-leafed
Cunderdin	Chapman Valley
Tammin	Eradu
Narembeen (2 sites)	East Badgingarra
	Moorine Rock

Comments

The broad-leafed form appears to be confined to the central and eastern portions of the wheatbelt, whilst the narrow-leafed form is present in both the northern and eastern portions. The apparent abundance of the broad-leafed form in the Narembeen Shire is cause for concern, as little is available in the way of biological control for this form.

1.2 Seed viability

Objectives

To determine the level of viability of seeds produced by field-grown plants during summer and autumn months.

Experimental

Mature seed was collected periodically from plants enclosed in nylon mesh bags and was tested for germinability in the laboratory.

Results

Table 1.2. Viability of seed produced at three field sites. Figures are for collections of seed from individual plants except where noted

Site	Date of first flowering	Date of collection	Rainfall between sampling dates (mm)	% Germination
East Chapman+	2/12/82	29/12/92	0	95.0a
				94.0a
				92.0a
				90.0ab
				88.0b
East Badgingarra	14/12/82	30/12/82	0	74.0*cd
		26/ 1/83	0	73.8cd
				71.9d
		3/ 3/83	3.0	0e
				0e
		28/ 4/83	39.9	68.1d
				67.5d
		25/5/83	20.4	71.2d
				69.9d
Narembeen	15/12/82	4/ 1/83	0	95.0*a
		27/ 1/83	0	88.1*b
		8/ 3/83	8.0	88.8b
				85.0bc
				82.5c

\+ Plants removed after one collection.

* Collections in which seeds from more than one plant were bulked.

Means followed by the same letter do not differ significantly at 5% level

Contrasting types of behaviour of flowering plants are shown in Table 1.2. Whereas at Narembeen plants produced viable seeds until the end of February in the absence of appreciable rainfall, at East Badgingarra the production of viable seeds was interrupted during February, but resumed following further rainfall.

1.3 Fate of buried seeds

Objectives

To determine how many seeds germinate following summer rainfall and of these what proportion survives.

Experimental

Viable seeds were buried in containers and placed on Research Stations at Chapman Valley, Merredin and Esperance Downs during the last week of February 1983. The fate of seedlings was followed and in June 1983 all seed material was retrieved and its fate determined.

Results

The proportions of seed populations which germinated following seed burial are given in Table 1.3. Most of the buried seeds germinated even if less than 10 mm of rain fell at any one time. Seeds survived only at Merredin (2% alive after burial at 4 cm). The remainder of the seed populations lost viability before germination could occur. Main effects of depth of burial and site were highly significant ($p < 0.001$).

Table 1.3. Proportion of seeds germinating following burial at field sites

Depth of burial (cm)	Research Stations		
	Chapman	Merredin	Esperance Downs
1	0.779ab	0.734a	0.863bc
2	0.809ab	0.788ab	0.819b
4	0.931c	0.805ab	0.890bc

Symbols as in Table 1.2

At Esperance Downs less than 1% of the total seeds buried gave rise to seedlings which survived to the end of the trial. No seedlings survived elsehwere.

Comments

Due to a virtual lack of seed dormancy, seeds of skeleton weed will germinate following unseasonal rainfall and seedling survival is very low in the absence of follow-up rain. Seeds which are buried will germinate more readily than those which are on the soil surface, particularly if evaporative demand is high following rainfall.

2. Population studies on pennyroyal

2.1 Seed production

Objectives

To quantify seed production in three sites and to describe relationships between this and plant density.

Experimental

Twenty 30 x 30 cm quadrats of seeding material were harvested in sites close to Denmark (D), Mt Barker (MB) and Frankland (F). Estimates were made of seed production based upon morphological parameters determined previously and independent measures of seed fill/viability.

Results

Table 2.1. Seed production of pennyroyal populations at three sites

Site	Inflorescence density (no. m^{-2})	Seed production (no. m^{-2})	Relationship between seed production (y) and inflorescence density (x)
Denmark	284a	177,000a	y = 351x + 7,160 a
Mount Barker	233b	73,300b	y = 160x + 3,610 b
Frankland	657c	289,000c	y = 309x + 8,590 a
Combined	391	180,000	y = 381x + 2,870

Means in a column followed by the same letter do not differ significantly at the 5% level

Comments

Seed production was linearly related to inflorescence density at all three sites. Seed production was highest at F and lowest at MB. At the latter site there was a relatively small increase in seed production with increasing inflorescence density.

2.2 Buried seed banks

Objectives

To determine the size of seed banks in areas under different management regimes and to obtain preliminary information on the dynamics of numbers of buried seeds in particular sites.

Experimental

In 1982 soil cores 6.5 cm deep were obtained in the same sites (D, MB and F) where seed production had been measured. Seeds were then extracted in the laboratory. During 1983, in addition to resampling these sites, an additional nine sites were sampled. Sites were selected on the basis of whether populations occurred within pastures or were found outside. These latter populations were designated "ruderal".

Results

Table 2.2. Sizes of seed banks of pennyroyal in pasture and ruderal situations

Site	Year of sampling	No. seeds m^{-2}
	Pasture populations	
Denmark	1982	91,700b
	1983	56,200c
West Denmark	1983	176,000a
Karri Heights	1983	55,000c
Narrikup (1)	1983	119,000b
Frankland River	1983	109,000b
	Ruderal populations	
Mt Barker (1)	1982	2,110fg
	1983	1,770fg
Frankland	1982	5,350fg
	1983	3,631fg
William Bay	1983	19,100d
East Denmark	1983	13,800e
Narrikup (2)	1983	3,010fg
Denbarker	1983	7,130f
Mt Barker (2)	1983	777g

Symbols as in Table 2.1

Comments

Sizes of seed banks were generally an order of magnitude larger in pasture as compared to ruderal populations. Although data for seed production for all sites are not available, one possible factor which may account for such large differences between the two groups of sites may be soil disturbance due to trampling by animals. Pennyroyal seeds are very small (0.07 mg) and as such would be easily buried. Seeds generally will not germinate unless exposed to light, and therefore accumulate in the soil. A significant reduction in seed bank size occurred at Denmark between 1982 and 1983, during which period this site had been fenced off in order to exclude cattle.

2.3 Seedling emergence and survival

Objectives

To establish when seedling establishment occurs on a seasonal basis.

Experimental

Seedlings were marked within ten 20 x 20 cm permanent quadrats at D, MB and F. At fortnightly intervals, the numbers of surviving seedlings were noted and new seedlings were marked. Each new group of seedlings is known as a "cohort".

Results

Table 2.3. Demographic data for pennyroyal seedling populations. Study commenced at time of emergence of first cohort (17 April, 1983) and terminated on 14 December, 1983

Site	Number of cohorts	Total number of seedlings emerged	Peak emergence date	Peak emergence density (no. m^{-2})	Number of cohorts represented at end of study
Denmark	12	1,447	19 May	1,128	4
Mt Barker	11	751	4 May	390	9
Frankland	5	361	19 October	482	2

Comments

Emergence was fairly continuous throughout the study at D and MB. This is in agreement with germination studies which have indicated a very broad temperature response. The smaller number of cohorts at F was presumably due to drier conditions at this site; pennyroyal seeds will germinate at any time of the year given adequate moisture and exposure to light.

The majority of cohorts at MB were still represented at the beginning of summer, compared to only one third of the cohorts at D. This was presumably due to competitive effects, for the D population was located in a paddock and the MB population was ruderal. There were indications that seedlings which emerged earliest lived longest. Germination occurred under water and seedlings were able to survive inundation. This aspect of the species' ecology is believed to be critical to its success in seasonally inundated sites.

2.4 Genetic differences between populations

Objectives

To determine how genetically distinct are different populations of pennyroyal.

Experimental

Counts of chromosome numbers were made from flower bud material collected at D, MB and F.

Morphological parameters were compared for field-grown plants and those which had been transplanted from D, MB and F sites to experimental plots at South Perth.

Results

All populations demonstrated chromosome numbers of 2n = 20.

Table 2.4. Inflorescence characteristics of pennyroyal collections grown in field sites and experimental plots

Conditions of growth	Site of collection Denmark	Mt Barker	Frankland
(a) Number of flowers per main stem node			
Field-grown	62.0ab	65.4a	46.4d
Plot-grown	60.6b	52.4c	43.2d
(b) Number of flowers per axillary node			
Field-grown	53.4a	48.3b	40.7c
Plot-grown	54.8a	41.6c	39.4c

Symbols as in Table 2.1

Comments

Chromosome counts have indicated the absence of polyploid forms in the three sites. For inflorescence characters, at least, there are genetically determined differences between collections, with collections from D and F being particularly distinct. MB plants demonstrated considerable plasticity with respect to the attributes under examination. Further studies will assess the genetic contribution to differences in germination behaviour which exist between collections of seed from these populations.