COAT-IMPOSED DORMANCY CONTROLLING GERMINATION IN WILD RADISH AND FIDDLE DOCK SEEDS

A.H. CHEAM

Department of Agriculture
Jarrah Road, South Perth,
W.A. 6151, Australia

Summary. The coat-imposed dormancy in wild radish and fiddle dock seeds was demonstrated in a series of experiments.

Results indicated that in wild radish there were significant differences between the southern, central and northern radish populations of Western Australia. The southern population coming from a region where false-breaks are more common, retained the highest level of dormancy. The degree of dormancy also varied among the three basic forms of wild radish; the white and purple forms having significantly higher level of dormancy than the yellow form.

In fiddle dock, the husk-imposed dormancy was evident at most of the temperatures tested in both light and dark, but the effect was more pronounced in the dark than light. The order of dormancy of the different populations when tested in the dark was similar to that of wild radish, viz: southern > central > northern population. Light favoured germination in fiddle dock seed, with and without husk, irrespective of the germination temperature or the seed population.

The ecological and practical implications of the results are discussed.

INTRODUCTION

Wild radish (*Raphanus raphanistrum L.*) is a widespread species throughout the world. It is one of the most widespread and troublesome weeds of cereal crops in Western Australia and other Australian States. Its success as a weed in cereal crops may be largely attributed to its specific germination ecology, and the widespread occurrence is mainly due to its contamination in agricultural produce. Each fruit segment containing the seed is derived from the mature indehiscent pods. Piggin et. al. (1978) have suggested that the seed pod plays an important role in determining germination behaviour of wild radish. Perhaps the slow and varying rate of breakdown of seed pods in the field are mainly responsible for the sporadic germination of the seed.

Fiddle dock (*Rumex pulcher L.*) is less widely distributed in the world. It originated in the Mediterranean region (Rechinger, 1949) and is a serious weed in the South West region of Western Australia. At present, little is known about the factors controlling the pattern of germination of fiddle dock seed. Allen (1976) noted that fiddle dock seed germinated throughout the growing season. He stated that the apparent dormancy in the field is that dock seed tends not to germinate when enclosed in the fruiting valve but gave no experimental evidence for this.

Thus, the effect of the seed coat on the germination of wild radish and fiddle dock seed was investigated. The term seed coat is here taken to mean the structures surrounding the embryo and the structures responsible for imposing and maintaining dormancy in wild radish and fiddle dock seeds are the seed pod and the fruiting valve respectively.

MATERIALS AND METHODS

Wild radish

Experiment A:

The existence of the coat-imposed dormancy in radish seeds collected from three different sites.

Fully mature indehiscent pods of wild radish were collected from three regions of Western Australia in December, 1982. The Chapman collection represents the northern population, the Northam collection is the central population and the Mt. Barker collection is the southern population. The following treatments were imposed: (i) seed separated from the pod, (ii) seed with pod. The three by two factorial experiment was carried out in a randomized complete block design of eight replicates, each of 100 seeds and sown 1 cm deep in the field at South Perth. Emerged seedlings were counted and removed weekly.

Experiment B:

To determine whether there is any difference in the seed dormancy of the three basic forms of wild radish, yellow, white and purple types.

Seeds of the three forms were collected from Albany, in December 1982. However, seeds of the purple form collected from Chapman were also used because of insufficient seeds from Albany. The experiment was carried out in a randomized complete block design of eight replicates with 50 seeds (with pods) per replicate sown 1 cm deep in the field at South Perth in early June, 1983. Seedling emergence was recorded at fortnightly intervals till the end of winter.

In a separate experiment, seeds from South Perth were collected and tested for germination in the laboratory at 24/12^{o}C which corresponds to the daily variation in temperature near the surface of moist soil in Western Australia in mid-autumn.

Fiddle dock

The influence of the seed covering (fruiting valve) on the dormancy of fiddle dock seed was investigated over a range of fluctuating temperatures in light and darkness in the laboratory.

Seeds of fiddle dock were collected from dense populations growing at Chapman, Northam and Mt. Barker in January, 1984. Some of the freshly collected seeds were gently rubbed free from the fruiting valves. Seeds with and without fruiting valves were then subjected to germination tests at a range of fluctuating (12 hr. high; 12 hr. low) temperatures in germination cabinets. The light treatment was 12 hours per day during the high temperature period. The dark treatment was continuous darkness. There were four replicates of 50 seeds for each treatment.

Figure 1

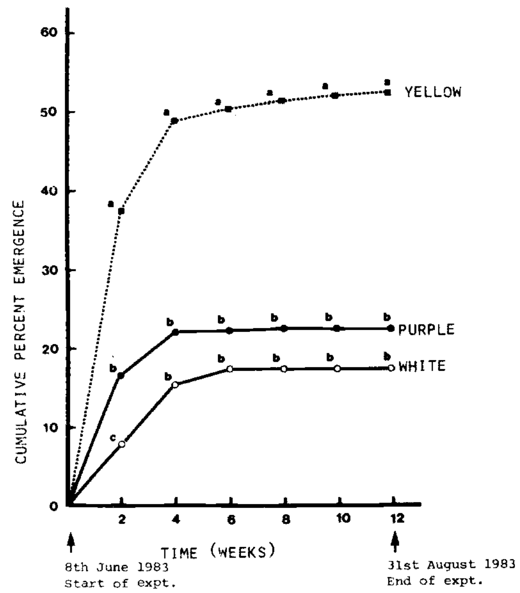

Figure 1. Cumulative percent emergence of seedlings of different forms of wild radish at fortnightly intervals. Any two means not marked with the same letter at a particular week are significantly different at 0.05 level of probability.

Similar results were obtained when seeds collected from the different forms grown under the same field conditions in South Perth were germinated in the laboratory (Table 2). Under the laboratory conditions, where moisture was non-limiting and the other germination conditions were optimum, over 90% of seeds in the decoated treatment germinated, indicating that the main dormancy mechanism is related to the seed pod.

Table 2: Cumulative percent germination of seeds of different forms of wild radish four weeks after sowing.

Form	Seed type		Mean
	Naked seed	Seed with pod	
Yellow	98.0 (83.1)	74.0 (59.5)	86.0 (71.3)
White	93.5 (75.4)	40.0 (39.1)	66.8 (57.2)
Purple	94.5 (76.6)	32.5 (34.6)	63.5 (55.6)
Mean	95.3 (78.4)	48.8 (44.4)	

LSD 0.05 : Form = 5.0; seed type = 4.1; form x seed type = 7.1

RESULTS AND DISCUSSION

Wild radish:

Experiment A:

Removal of the seed pod significantly increased emergence of wild radish (Table 1).

Table 1: Cumulative emergence of wild radish four weeks after sowing

Collection	Seed type		Mean
	Naked seed	Seed with pod	
Mt. Barker	53.7	14.6	34.2
Northam	77.2	41.7	59.5
Chapman	77.5	56.4	67.0
Mean	69.5	37.6	

LSD 0.05 - Collection = 5.5, seed type = 4.5, collection x seed type = 7.8.

The Mt. Barker collection, representative of genotypes from the south, where false-breaks are more common, retained considerably more dormancy than did the northern and central collections. The overall differences in dormancy recorded for the three different sites could be due to the proportions of the seed of the different forms of wild radish in the bulked sample of the respective collection if it is assumed that the different forms have different levels of seed dormancy.

Experiment B:

The field results shown in Figure 1 confirmed that there are differences between the three forms as seeds of the yellow form gave a significantly higher percentage of seedlings than the white and purple forms.

Transformed (inverse sine) values given in degrees used for statistical analysis are shown in brackets.

The exact mechanism by which the seed pod imposes dormancy in wild radish was not investigated. The only experimental work investigating the mechanism was undertaken by Mekenian and Willemsen (1975) using leaching experiments. They suggested the presence of a non-leachable chemical inhibitor in the pod which is gradually broken down during after-ripening. Mechanical restriction by the pod was also suggested as a contributing factor. It is suspected that it is the variation in both or either factor in the seed pod of the three different forms of wild radish that is responsible for the different degrees of dormancy in their seeds.

The pod-imposed dormancy characteristics of wild radish in relation to its field occurrence can be summarized as follows: Under natural field conditions, wild radish seeds are dispersed during summer in the form of intact fruits lying on the soil surface. Over the hot summer months some of the pods would fracture into segments and a very small percentage of the seeds maybe released as isolated seeds. Also, during this time, the chemical and mechanical restriction imposed by the pod decreases, resulting in a certain proportion of nondormant seeds ready for germination as soon as there is sufficient moisture in the soil at the start of the growing season. Thus the amount of germination following the break of the season would depend on the number of seeds released from the pod and the degree of after-ripening occurring in seeds with pods in the field. However, because the number of seeds released from the pod between dispersal and the oncome of the germinating rain is very minimal, it is to be expected that the establishment of wild radish at any time of the growing season also depends on the germination of seeds resident in the soil produced by plants occurring in previous seasons.

Fiddle dock:

Seeds with fruiting valve (hereafter referred to as husk), showed significantly greater dormancy than seeds without husk at most of the temperatures tested in both light and dark, especially for the Northam and Mt. Barker collections (Table 3).

Table 3: Per cent germination of fiddle dock seeds, with and without husks, over a range of fluctuating temperatures four weeks after sowing in the light and dark.

	15/5°		20/5°		20/10°		24/12°		25/15°		30/20°	
	Light	Dark	Light	Dark	Light	Dark	Light	Dark	Light	Dark	Light	Dark
(a) Chapman Seed												
No Husk	99.5	69.5	98.5	38	99.5	29	96.5	5	98.5	7.5	97	0
With Husk	92	25.5	98	28	89.5	28	86.5	14	94	5.5	27.5	0
LSD 0.05 = 10.38 = 16.13 = 11.27 = 6.20 = 4.73 = 24.06												
(b) Northam seed												
No Husk	36	29.5	39	25.5	42	29.5	38	19	32	30	36	1.5
With Husk	20.5	7.5	25.5	5	32	16.5	22.5	7.5	26.5	7.5	18	0
LSD 0.05 = 6.79 = 9.97 = 11.85 = 8.92 = 12.50 = 8.66												
(c) Mt. Barker seed												
No Husk	85.5	67.5	89	46	90.5	78	70.5	2.5	87.5	22	74.5	25
With Husk	81.5	1	83.5	1.5	82.5	4.5	86.5	1.5	85	6	40	12
LSD 0.05 = 10.27 = 12.97 = 6.43 = 5.41 = 13.54 = 28.82												

The husk-imposed dormancy was more pronounced in the dark than in the light at five of the temperature regimes tested except for the 30/20° C temperature. Therefore, burial of the with-husk seed resulting from trampling by stock for example, would favour the survival of dock at most times of the year. The order of dormancy of the different populations when tested in the dark was as follows: Mt. Barker > Northam > Chapman population.

Light favoured germination in both seed type, with and without husk, irrespective of the germination temperature or the seed collection. The reasons for this behaviour are not at present clear. However, it has been suggested that intact light-requiring seeds are stimulated to germinate when a certain ratio of the active (Pfr) and inactive (Pr) forms of phytochrome (P) is established within the embryo by the combined action of the red and far-red components of white light (Bewley and Black, 1982). Since the light has to pass through the structures enclosing the embryo, it is conceivable that these could act as a filter, altering the proportion of red and far-red radiation reaching the sensitive embryo. Working on this theory, it appears that the husk of the Northam seed was the most effective as a light filter resulting in a poorer germination of seeds with husk when exposed to light especially at the lower temperature regimes.

In fiddle dock as in the case of wild radish, there is evidence to suggest that a chemical inhibitor in the husk is involved. For example, when the intact seed with husk is germinated in the laboratory, the embryo swells sufficiently to rupture the testa without radicle protrusion passing the husk. In addition, under field conditions, flooding seems to favour germination which is probably related to the leaching of the inhibitor from the husk.

Summarizing the wild radish and fiddle dock results there are several practical implications to be considered. The greater dormancy of the purple and white forms of wild radish would mean that they have a greater likelihood of avoiding chemical sprays. One would expect a gradual build-up of the white and purple forms of wild radish as a result of continuous early spraying in crops. Any reported resistance of wild radish to chemical sprays may in fact be due to this avoidance phenomenon rather than due to actual chemical resistance. A delay in sowing to enable more weed killing cultivations may lessen the weed problem.

With dock, because the husk imposed dormancy is quite significant especially in the dark, the obvious practical implication is not to allow stock into the dock-infested paddock during the earlier part of the season because trampling by them would result in seed burial. Grazing of the infested paddock is to take place only after most of the surface-lying seeds have germinated.

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