

# GERMINATION REQUIREMENTS OF THE SEEDS OF NATIVE TREES, SHRUBS AND VINES

COLIN J. BURROWS

I have been experimenting to find the conditions required for germination of the seeds of native woody plants, mostly from Canterbury. The object of these experiments is to discover how the seeds behave when placed in conditions simulating those that the seeds would experience in nature. I am gradually publishing research papers on this work (Burrows 1993), but thought that an explanation of the procedures and a summary of the kinds of results obtained could be useful to Society members now. On the whole I have had very good success rates for the seeds that I have tested (usually 90-100% germination success for my standard treatment).

## STEP-BY-STEP PROCEDURES

In nature, as soon as the fruit are ripe, the seeds of our native forest plants are likely to experience conditions that will stimulate them to begin the physiological processes that culminate in germination. Therefore experiments to test for appropriate germination conditions must begin at this time, with fresh seeds. The first step is to collect ripe fruit from a plant which is fruiting heavily. Within a few days of collection the seeds are then prepared for the various treatments by the following procedures:

1. Removal of the pericarps (fruit tissues, derived from the ovary, which surround the seeds) for all but one lot. For seeds in fleshy pericarps this simulates passage through a bird - it is known that most, if not all, native fleshy fruit are eaten by birds (Clout & Hay 1989; Burrows unpublished). Fleshy fruit are gently macerated on a sieve, then repeatedly soaked in water and decanted to float off the unwanted tissues. Dry fruit are either dehiscent or indehiscent. The seeds of the former normally are released from the fruit while still on the parent plant. They must be collected just before shedding. Indehiscent fruit are collected when ripe and broken open to remove the seeds. In nature loss of their investing pericarp tissue is by mechanical means such as battering or rubbing against other objects by the wind, or in streams so that the pericarp is cracked or abraded; or they may be gradually removed by microbial decay, on the plant or on the ground. The treatment where the pericarp is left surrounding the seeds simulates situations where whole fruit remain on the parent, or where fruit fall to the ground and decay releases the seeds.
2. The seed lots which have had the pericarp removed are soaked for 12 hours in tap water to ensure that they are imbibed and also to leach out possible inhibitory substances. This may be only partially effective (cf. Partridge 1990).

The cleaned seeds are then examined carefully under a stereomicroscope and diseased, damaged or empty individuals removed. In practice it was found that, for a few species, predatory insect larvae inside some seeds were not detected by this procedure.

3. One set of 25 seeds is tested with a vital stain, triphenyl tetrazolium chloride, which stains living embryos a distinct pink colour. This is a standard agronomic seed viability test, done by slicing the seeds longitudinally through the embryo and soaking them in the stain solution for 12 hours, in the dark. Dead seeds do not stain.
4. The rest of the seeds, and the batch still enclosed by pericarps, are placed in treatment conditions in an unheated, partially shaded glasshouse at the Plant and Microbial Sciences Department garden area, on the University of Canterbury campus.
  - (a) Standard. Four sets of 25 seeds, in plastic petri dishes with one sheet of filter paper, well supplied with tap water and exposed to the light received in the house. This treatment simulates conditions for seeds which lie on the ground under circumstances optimal for germination. In nature, of course, seeds are not in petri dishes, but it is necessary to do it this way to ensure that the seeds can be seen at all times. No attempt is made to ensure that there are sterile conditions.
  - (b) Dark. Two sets of 25 seeds, in petri dishes, as before, but wrapped in aluminium foil. This simulates conditions where seeds are buried by deep litter, or in the soil. They are checked in a darkened room, under a photographer's safe light.
  - (c) In fruit. Two sets of 25 seeds, in petri dishes as before. These are the seeds with the pericarp surrounding them.
  - (d) Soil. Two sets of 25 seeds, laid out in shallow grooves in a potting mix: fine gravel: vermiculite mixture, in small plastic meat dishes with drainage holes. The treatment approaches natural conditions more closely than for seeds in petri dishes, but it is difficult to see all of the seeds clearly.

All of these treatments are kept in the glasshouse and monitored regularly until all of the seeds have germinated, or are dead (at about 3 day intervals in summer, weekly in winter and monthly for the dark treatment). The glasshouse has an automatic watering system. The temperatures are similar to those outside, in the shade, in summer. In winter the glasshouse temperatures are like those outside but the minima are higher (at most, down to  $-4^{\circ}\text{C}$ ). This is close to the temperature range within forest. Shading is by a row of evergreen and deciduous trees; some direct sunlight is received and, again, this simulates conditions within forest. The shading also prevents the rapid drying out of petri dishes in summer.

The criteria of germination are either splitting of the seed coat, as the embryo swells, or emergence of radicles. Germinated seeds are removed and pricked out onto a soil mix in small meat dishes which are also kept in the glasshouse. Many of the young plants so produced have ended up in the plantings at Kaiapohia Pa.

## Results

Summarizing the results (which are indicated in Table 1):

1. Most species in the standard test show very high germination success (often higher than the percentage of viable seeds indicated by the tetrazolium test).
2. Seeds of the different species germinate at different rates, which are characteristic for the species. Most germinate within the first 9-10 months. Some germinate quickly in summer or autumn, while others are slower, germinating in autumn, winter or early spring. These latter fall into two main patterns; those which germinate over a short period, following a delay of a few to many months; those where there is a slow trickle of germination over many months. A few species have a bout of germination in the year that the seeds are first ripe; most germinate then but a few remain dormant until the following spring. A few species have appreciable amounts of germination only after 1, 2 or 3 years.
3. The seeds of most species germinate in the dark treatment. It remains to be established whether the conditions employed to store or monitor these seeds stimulate germination (i.e. if they were left enclosed, in the dark continuously, would they germinate?). Some of the germinated seed species kept in the dark treatment develop exceedingly long, etiolated hypocotyls. The potential for this appears to be an adaptation to cope with seed burial.
4. Seeds enclosed by fleshy pericarps in most cases have very low germination success (none at all for some species). Some germinate after a long period, when the pericarp is leached or decayed. Seeds enclosed by dry pericarps show variable behaviour; some germinate, others do not. This inhibition by the pericarp phenomenon is considered further in another article.
5. Seeds placed on the soil almost invariably have lower germination success than those observed in the standard treatment and some are slow to complete germination. Presumably hazards such as soil fungi, bacteria or collembola kill some of them. What slows the germination of others is not known.
6. Occasional drying out of petri dishes for a few days does not usually kill seeds or tiny seedlings, though it slows their growth.

Table 1 Germination Data for Canterbury Forest Plants

	Germination Pattern*	Number of Provenances Tested	Percentage Germination Success in Treatments				
			Standard	Dark	In Fruit	Soil	Tetrazolium
<u>Trees</u>							
<i>Alectryon excelsus</i>	2a	1	48	0	12**	64	92
<i>Aristotelia serrata</i>	4	2	98	86	12	90**	88
<i>Carpodetus serratus</i>	2a	1	100	4	0	35	88
<i>Cordyline australis</i>	2a	1	92	92	0†	88	100
<i>Fuchsia excorticata</i>	1	2	98	84	12	72	100
<i>Griselinia littoralis</i>	1	1	86	86	2**	72	100
<i>Hedycarya arborea</i>	3	2	100	92	4	80	100
<i>Meliccytus ramiflorus</i>	1	2	99	100	62**	82	92
<i>Myoporum laetum</i>	5a	2	74	6	0	84	100
<i>Paratrophis microphylla</i>	3	1	98	98	10	96**	100
<i>Pennantia corymbosa</i>	2b	2	98	96	24	76**	88
<i>Pittosporum eugenioides</i>	2b	2	96	not done $\Delta$	not done	88	84
<i>P. tenuifolium</i>	2b	2	80	86	0	72**	100
<i>Plagianthus regius</i>	2b	2	100	0	74	72	96
<i>Pseudopanax arboreum</i>	2a	2	100	74	0	96**	84
<i>P. crassifolius</i>	2a	1	100	not done	20	90	100
<i>Rhopalostylis sapida</i>	2c	1	95	0	2	95	80
<i>Schefflera digitata</i>	2a	2	98	84	60**	54	80
<u>Vines</u>							
<i>Calystegia tuguriorum</i> ††	5b	1	11	12	2	8	100
<i>Clematis foetida</i>	2b	1	89	not done	not done	26	100
<i>Muehlenbeckia australis</i>	2b	1	97	not done	36	78	92
<i>Parsonsia heterophylla</i>	5b	1	85	36	not done	50	96
<i>Ripogonum scandens</i>	3	2	98	82	0	98	100
<i>Rubus cissoides</i>	3	1	76	58	24	46	84
<i>Tetrapathaea tetrandra</i>	2a	1	98	92	0†	80	96
<u>Shrubs</u>							
<i>Coprosma lucida</i>	2a	2	95	0	0	86**	68
<i>C. robusta</i>	2a	2	90	96	74**	98	96
<i>C. rotundifolia</i> $\Delta\Delta$	?	1	1	48	24	10	100
<i>Coriaria arborea</i>	1	2	100	98	98	96	84
<i>Dodonaea viscosa</i>	3	1	98	60	14	76	95
<i>Macropiper excelsum</i>	1	2	100	96	2†	86	56
<i>Melicope simplex</i>	6a	1	81	2	not done	0	76
<i>Myrsine divaricata</i> ††	5a	1	51	28	22	40	92
<i>Myrtus obcordata</i>	2a	1	100	100	90	96	100
<i>Pseudowintera colorata</i>	5a	1	96	96	0	82**	92
<i>Solanum laciniatum</i>	2a	1	91	not done	not done	not done	76
<i>Urtica ferox</i> $\Delta\Delta$	5a	1	67	not done	not done	8	84

\*Patterns are: 1. all germinate within 6 weeks; 2. all germinate over a short period (a) within 2-5 months (b) within 6-9 months (c) within 10-12 months; 3. all germinate, gradually, within 6-12 months; 4. most seeds germinate as for 2a or b but a small proportion remains dormant and they germinate after 10-12 months; 5. a few seeds germinate, sporadically, in the first 10 months but the rest germinate ((a) over a short period (b) gradually), in a second and/or a subsequent year; 6. No germination occurs in the first year, but then germination ensues ((a) over a short period (b) gradually), in a second and/or a subsequent year.

\*\* Markedly slower than the standard treatment.

† Overrun by moulds.

†† This experiment begun in 1989, is not complete yet.

$\Delta$  Not done, in most cases means that there was a mishap to the treatment.

$\Delta\Delta$  This experiment was run for only one year.

## CONCLUSIONS

The high germination success rates; lack of long germination delays for most seed species; ability of many seed species to germinate in autumn and winter and apparent ability to germinate in the dark, are outstanding features for the seeds that have been tested. Within forest, where most seeds of these woody species are deposited there should be, if conditions are moist, a correspondingly high potential for the occurrence of abundant seedlings at times when moisture stress is least likely to affect both germination and establishment of seedlings. Frequent observation shows that each autumn, winter and spring, bare ground in mixed forest on Banks Peninsula is carpeted with little seedlings. Most of these disappear in summer probably mainly because of the normally dry conditions. Some may be removed by predatory insects, mice, rabbits etc. and experiments are needed to determine exactly what are the causes of their attrition.

## REFERENCES

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