Effect of time of immersion in running and still water on the germination of silver-leaf nightshade

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SUMMARY

A laboratory experiment was conducted on fresh, mature seed of silver-leaf nightshade (*Solanum elaeagnifolium* Cav.). The effects of three times of immersion in both running and still water on the germination of the seed were investigated. Increasing the time of immersion in water significantly increased the germination of the seed. Running water increased germination more than still water 8 days after the commencement of germination, but there was no difference between running and still water after 50 days.

It is suggested that a mucilaginous substance around the seed may inhibit germination, either as a physical barrier to water imbibition, or as the carrier of a germination inhibiting chemical.

The implications of these results on the distribution and spread of silver-leaf nightshade in Western Australia are discussed.

INTRODUCTION

Silver-leaf nightshade (*Solanum elaeagnifolium* Cav.) is a deep-rooted, summer-growing perennial plant which infests over 27,000 ha in the cereal growing areas of New South Wales, Victoria and South Australia (Smith, 1975; Molnar and McKenzie, 1976; and Cuthbertson, Leys, and McMaster, 1976). It is also found to a lesser extent in Queensland and Western Australia (Meadly, 1974; Cuthbertson et al, 1976).

In Western Australia, silver-leaf nightshade is restricted to about 15 farming properties in the southern wheatbelt (latitude 32^0 -34^0 South) over an estimated 150 ha (Rutherford, unpublished report). Furthermore, as it has been recorded in that State for over 50 years, the rate of spread of silver-leaf nightshade has been relatively low. The same report indicates that all the infestations are closely associated with water-courses which flow after unseasonal summer rainfall. In fact, the appearance of new infestations appears to be closely related to the incidence of unusually wet summers. This conclusion is borne out by Molnar and McKenzie (1976) who state that in Victoria seedlings were abundant following unusually heavy rains (up to 75 mm) in February 1973.

Rootstocks of silver-leaf nightshade in Western Australia produce new shoots in September with flowering commencing in November, and mature berries appearing in early March (Rutherford, unpublished data). The above-ground parts of the plant are killed in autumn by the first frosts, but the dead stems with berries remain standing for several months. Approximately 50 seeds are contained in each berry held together by a mucilage, which becomes very hard when the berry is mature (Cuthbertson et al, 1976).

In Victoria, it has been experimentally shown that 80% germination of one-year-old seed of silver-leaf nightshade is possible under alternating temperatures of 15/30°C (McKenzie and Douglas, 1974). In these experiments all seed failed to germinate under constant temperatures of 20°C or 25°C. In the U.S.A., Bellue (1959) found that 29% of fresh seed germinated, 72% of 3 year-old seed, and 60% of 10 year-old seed.

In Western Australia, a maximum seed germination of 42% has been obtained with 12 hour alternating temperatures of 20/30°C (Rutherford, unpublished data). The seeds were subjected to constant fluorescent light (minimum 650 lux) while at 30°C.

The experiment described below was designed to test the hypothesis that subjecting the seed to various times of immersion in water causes an increase in the subsequent germination of the seed.

MATERIALS AND METHODS

Fresh, mature berries of silver-leaf nightshade were collected from a large, well-established infestation on a farm at Yealering, approximately 200 km south-east of Perth, W.A., on 5 March, 1977.

The following seven treatments were arranged in a completely randomized design.

Treatment	1 : Control	5 : 1 hour still water
	2 : 1 hour running water	6 : 24 hours still water
	3 : 24 hours running water	7 : 120 hours still water
	4 : 120 hours running water	

Each treatment consisted of 300 randomly selected seeds which were enclosed in a transparent, 2 cm diameter polythene tube, approximately 5 cm long. The open ends of the tube were sealed with a single layer of fibreglass fly-wire mesh held in place by elastic bands.

(a) Treatment 1 (Control) was stored dry on the laboratory bench.

(b) Running water (Treatments 2, 3, 4)

Three of the tubes containing seed were each placed in a polythene bag. The water treatment of each was commenced at a time which would ensure that they were all completed within about 30 minutes of one another. The bag was sealed to a tap with elastic bands and filled (about 500 ml) with water from the tap. To allow water to flow across the seeds the bag was punctured with eight small holes, and the tap adjusted to keep the bag full of water. The flow rate of water through the bag was measured at 17 ℓ/hour.

(c) Still water (Treatments 5, 6, 7)

The other three tubes containing seed were each placed in a polythene bag. When each running-water treatment was commenced the corresponding still-water treatment bag (e.g. T_4 and T_7 etc.) was filled with 500 ml of tap water, sealed with elastic bands, and left on the laboratory bench out of direct sunlight. Air temperature in the laboratory was within the range 15° to 25°C. As each treatment time expired, the seeds were removed from the tube and divided at random into three replicates of 100 seeds. Each replicate was germinated on a double layer of Whatman's No. 1 filter-paper moistened with distilled water. The germination cabinet was adjusted to give 12 hour alternating temperatures of 20°C to 30°C, with fluorescent light (minimum 650 lux) during the 30°C phase. All germination treatments were counted daily and the experiment was terminated after 50 days.

RESULTS

Analysis of variance of the 8 day and 50 day percentage germinations of the seven treatments indicated that there was a very highly significant ($P<0.001$) response to the treatment of seed by water (Tables 1, 2 and 3).

Effect of running vs still water

There was a significant ($P<0.05$) difference between the effect of running and still water after 8 days. At this stage, running water caused an increase in germination by a mean of 14% compared with still water. After 50 days, there was no significant difference between the running and still water treatments, the mean increase in germination under running water being only 3%.

Effect of time of immersion

There were very highly significant ($P<0.001$) differences in germination between the three times of immersion in water after both 8 and 50 days.

Increasing immersion from one hour to 24 hours caused a mean increase in germination percentage of 25% (8 days) and 9% (50 days). Immersion for 120 hours caused a mean increase in germination by a further 27% (8 days) and 12% (50 days).

DISCUSSION

The germination of silver-leaf nightshade can be significantly increased by subjecting the seed to relatively long periods of immersion in water. A possible cause for this may be that the seed is prevented from imbibing water readily. There are two possible ways by which this could occur.

It has been observed that the mucilaginous substance in which the seeds are embedded becomes very hard on maturity. This could present a physical barrier to the seed imbibing water. In this experiment, the longer the seeds were immersed in water, the greater was the subsequent germination. It is possible that the mucilage is partially water-soluble, and that it is gradually removed from the seed coat when immersed in water. Running water resulted in significantly better germination than still water after 8 days, reflecting the greater rates of mucilage removal by the turbulence of moving water, compared with a relatively slow rate of dispersion in still water. After 50 days, there was no significant difference between running and still water, as the water present in the germination dishes may have effectively dissolved any mucilage remaining on the seed.

The second possibility is that there may be a chemical germination inhibitor in the seed coat or mucilage which will prevent

Table 1. Level of significance associated with variation due to treatments, running and still water, times of immersion, and interactions, measured after eight days and at the end of the experiment (50 days)

Variation due to	8 days	50 days
Treatments	***	***
$T_2+T_3+T_4$ vs $T_5+T_6+T_7$	*	n.s.
T_2 vs T_3 vs T_4	***	**
T_5 vs T_6 vs T_7	***	***
T_2+T_5 vs T_3+T_6 vs T_4+T_7	***	***
T_2 vs T_5	*	n.s.
T_3 vs T_6	n.s.	n.s.
T_4 vs T_7	n.s.	n.s.

* $P<0.05$; ** $P<0.01$; *** $P<0.001$; n.s. not significant

Table 2. Percent germination (after 8 days) of silver-leaf nightshade seed (mean of three replications) subjected to three times of immersion in running and still water

Treatments		Mean germination after 8 days	
Main effect	Time of immersion (hours)	%	$\sqrt{\text{arcsin}}$ transformation
Control	0	3.33	10.401
Running water	1	18.00	24.485
	24	45.00	42.090
	120	69.66	56.630
Still water	1	4.66	12.032
	24	28.33	31.697
	120	57.66	49.602

L.S.D. between transformed treatment means (P=0.05) 12.363

Table 3. Germinations (after 50 days) of silver-leaf nightshade seed (mean of three replications) subjected to three times of immersion in running and still water

Treatments		Mean germination after 50 days	
Main effect	Time of immersion (hours)	%	$\sqrt{\text{arcsin}}$ transformation
Control	0	49.33	44.645
Running water	1	69.33	56.476
	24	78.67	62.493
	120	89.67	71.268
Still water	1	65.67	54.240
	24	74.67	59.828
	120	88.33	70.386

L.S.D. between transformed treatment means (P = 0.05) 6.95

germination until the inhibitor is removed by water. Evidence for such a process is shown by the fact that the different trends (Figure 1) which have arisen from the three times of immersion persisted even after 50 days of germination. The volume of water necessary to remove the chemical inhibitor must be greatly in excess of the amount present in the germination dishes over a 50 day period. This is supported by the observations that, in Western Australia, new infestations arise only after heavy, unseasonal summer rainfall which produces fast-running watercourses and local flooding. Under these weather conditions the combination of high alternating temperatures (McKenzie and Douglas, 1974; Rutherford, unpublished data) and large volumes of water would provide the necessary prerequisite for a high level of seed germination.

Thus the importance of the spread of silver-leaf nightshade by seed is likely to be of greater significance in areas which experience a higher incidence of summer rainfall than Western Australia.

The exact nature of the mucilage and its role in the germination of the seed are of importance and need further investigation. The factors which affect the survival of the seedling also needs further clarification as they would further define the conditions which favour the spread of silver-leaf nightshade.

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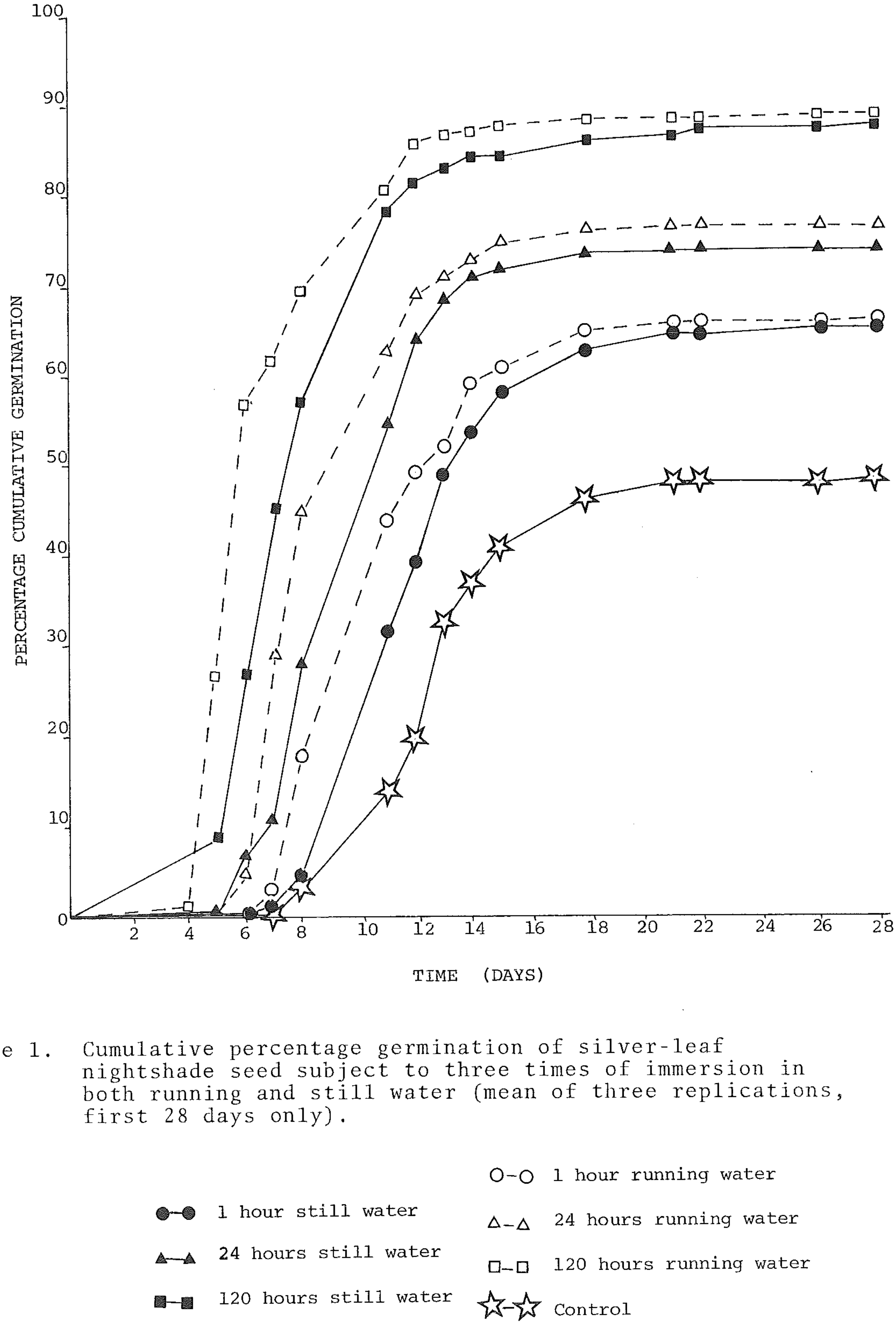

Figure 1. Cumulative percentage germination of silver-leaf nightshade seed subject to three times of immersion in both running and still water (mean of three replications, first 28 days only).