تـأثير بعض الأمـلاح منفرداً ومـزدوجاً عـلى إنبات ونمو بادرات نبات العدس المر

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درست تـأثيرات كلوريـد الصوديـوم، كـبريتـات الصـوديـوم وكـبريتات المغنيسيـوم بصورة منفصلة أو مـزدوجة عـلى إنبات بذور نبات العدس المر ونمـو بادراتـه. ولقد وُجـد أن الأملاح الثلاثة عرقلت إنبات البذور ونمو البادرات بدرجات متفاوتة، ولكن عملية نمو البادرات كانت أكـثر حساسيـة للأمـلاح من عمليـة الإنبـات ويبـدو أن تـأثـير كـبريتـات المغنيسيـوم عـلى العمليتـين كان بسبب ارتفـاع الضغط الازمـوزي للمحلول، بينما كان تأثير كل من كلوريد الصوديوم وكبريتات المغنيسيـوم ناتجاً عن السمية الأيونية لهذين الملحـين. وظهر أيضـاً أن كلا من أيـون الصوديـوم والكلوريـد كـان أكـثر سمّيـة من أيـون المغنيسيوم والكبريتات. وعند دمج كبريتات المغنيسيوم مع كل من كلوريد الصوديوم وكبريتات الصوديوم زال التأثـير السّمي للملحـين الأخيرين كليـاً، في كـل من عمليتي الإنبـات ونمـو البادرات.

والأهم من هذا هو أن تأثير كبريتات المغنيسيوم مع كل من الملحين الأخرين وعلى كلتا العمليتين كان متدائباً.

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Germination and Seedling Development of *Achillea fragrantissima* as Affected by Storage Conditions, Temperature and Light

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ABSTRACT. *Achillea fragrantissima* (Forssk.) Sch. Bip. (Compositae) is a valuable perennial shrublet in the western desert of Iraq. Some of its germination requirements and subsequent seedling development were studied. Seeds, stored for more than three years at room temperature (fluctuations 18-40°C), and in a refrigerator (about 6°C), maintained their full germination capacity under both storage conditions. The seeds are light positive and little germination takes place in darkness. However, such light sensitivity is gradually lost with time. Germination is poor at low temperature (6°C) and best germination is at 15-20°C. Seeds hydrated for 0.5-6 hr and then dried for ten days under laboratory conditions maintained full germination capacity. When such seeds were rehydrated for another 3 hr and redried for ten days, for a second time, they also maintained high germination capacity.

Reseeding by native species is one of the possible ways to improve the plant cover and productivity of the degraded rangelands of Iraq. Consequently, the study of the ecophysiological characteristics of the key native range species would provide scientific bases for reseeding programmes and for the improvement and management of natural rangelands. *Achillea fragrantissima* (Compositae) is one of the important perennial shrublets, widely distributed in the desert regions of Iraq (Guest 1966).

In a series of studies involving several range species of Iraq, Al-Ani and Jawad (1971) and Al-Ani *et al.* (1971a and b) reported some valuable information on certain aspects of germination and nutrient composition of *A. fragrantissima*. The plant has a fairly good nutritive value and is palatable to sheep and camels.

The present investigation aimed at providing more detailed information on germination requirements and seedling development of *A. fragrantissima*.

Material and Methods

Seeds of *Achillea fragrantissima* were collected from the Rutba area in the western desert of Iraq, during December 1979. They were stored, after harvesting, either under laboratory conditions or in a refrigerator (temp. about 6°C), as described by Clor *et al.* (1976). The temperature under laboratory conditions ranged from 18-24°C during the winter and from 25-40°C during the summer.

Germination tests were carried out in 9 cm glass Petri dishes, lined with one layer of filter paper and moistened with 5 ml of distilled water, unless specified otherwise. The experimental unit consisted of three dishes, each containing 50 seeds. All germination tests were carried out in an incubator (Precision Model 806), with continuous fluorescent illumination. However, the effect of temperature on germination was studied under both continuous light and continuous darkness, as described by Al-Charchafchi and Jawad (1982). Germination counts were made usually at intervals of two days and for a period of 8 days. The emergence of the radicle was used as the criterion for germination.

Seedling vigour was judged by total length of the seedlings (from the tip of the radicle to the tips of the cotyledons) measured on the 9*th* day after the start of germination. The average total length of 30 seedlings per treatment, ten per Petri dish taken at random, was determined.

Results

1. *Seed Longevity and Effects of Storage Conditions*

Germination of seeds, stored for up to 40 months, under ordinary laboratory conditions and in a refrigerator, was tested periodically, at 20°C and under continuous illumination. The results are presented in Fig. 1. It is clear that the seeds maintained their viability for more than three years.

2. *Seed Longevity and Effects of Light on Germination*

Germination of the seeds, stored under laboratory conditions, was tested periodically under continuous illumination and continuous darkness. The results are shown in Table 1.

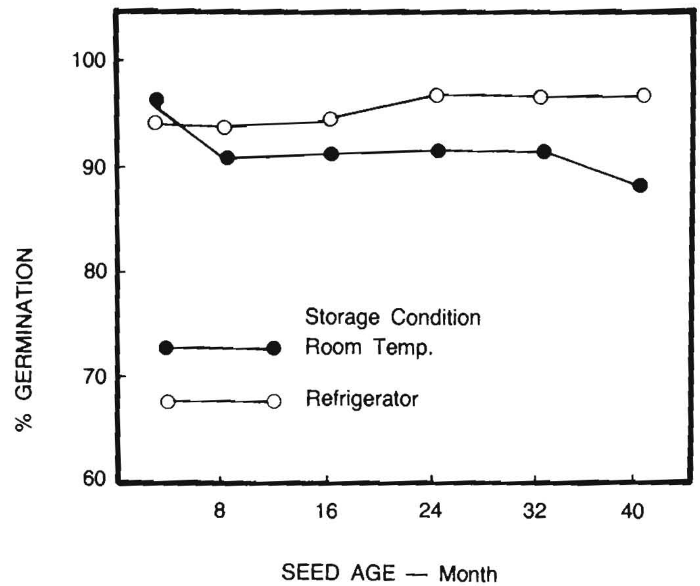

Fig. 1. Germination as affected by seed age and storage conditions.

Table 1. Effects of light conditions and time lapse on germination 20°C.

Seed age (Months)	Germination percentage with SE*	
	Continuous light	Continuous darkness
2	97 ± 2.3	30 ± 3.5
4	95 ± 2.5	56 ± 1.7
11	92 ± 2.7	78 ± 3.8
24	91 ± 0.7	90 ± 2.3
36	90 ± 2.7	93 ± 1.7

∗ SE signifies standard error.

It is evident that the seeds are light positive (germination favoured by light), and almost full germination is achieved under continuous illumination.

3. *Effects of Temperature and Light on Germination*

Germination of freshly collected seeds was tested at different temperatures and under continuous illumination and darkness. The results are presented in Table 2.

Table 2. Effects of light and temperature on germination of freshly collected seeds of *A. fragrantissima*.

Temp. (°C)	Germination percentage with SE	
	Continuous light	Continuous darkness
5	4.0 ± 2.3	1.3 ± 0.3
10	84.0 ± 9.6	41.3 ± 1.3
15	92.3 ± 1.3	33.3 ± 3.5
20	97.0 ± 2.3	29.3 ± 3.5

Germination under continuous light increase with increase of temperature and the highest germination percentage was obtained at 20°C. Equally, high germination percentage was obtained in the previous test at 20°C. On the other hand, germination was considerably inhibited in darkness, although some increase in germination percentage occurred as the temperature increased from 5 to 20°C.

Further Effects of Temperature and Light

The seeds that did not germinate under continuous light at 5°C, after being kept incubated for 9 days as described in the experiment above (Table 2), were further tested. These seeds were divided into two groups; one was kept under continuous light, and the other in darkness, all placed at 20°C. Germination percentages are shown in Table 3.

Table 3. Germination of seeds hydrated but not germinating for 9 days at 5°C and under continuous illumination and then placed at 20°C.

Days after start of germination at 20°C.	Germination percentage with SE	
	Continuous light	Continuous darkness
2	80.0 ± 4.0	41.4 ± 1.4
4	84.0 ± 0.0	55.3 ± 1.2
6	84.0 ± 0.0	63.6 ± 1.1
8	85.0 ± 1.3	65.3 ± 3.4

Seeds which remained hydrated for 9 days at 5°C maintained their high germination capacity when transferred to favourable temperature and light conditions. There was also a considerable and significant increase in germination percentage in darkness.

4. *Effect of Water on Germination and Seedling Growth*

To test the effect of water on germination and seedling grówth, different amounts of water, ranging from 1 to 5 ml, were added to each germination dish (50 seeds in each). Germination tests were carried out, as usual, at 20°C and under continuous illumination. The results are shown in Table 4.

Table 4. Germination percentage and seedling growth as affected by different amounts of water at 20°C and under continuous illumination.

Water quantity (ml)	Germination percentage with SE	Total seedling length (mm) with SE
1	75.0 ± 1.2	18.4 ± 1.2
2	83.0 ± 2.1	21.0 ± 0.8
3	95.0 ± 3.0	24.8 ± 0.3
4	95.0 ± 5.0	25.2 ± 2.2
5	89.0 ± 3.0	18.3 ± 0.6

Highest germination percentage and greatest total seedling length were obtained when 3 or 4 ml. of water was added to each Petri dish. But it is seen also that fairly good germination and seedling growth are obtained, even at the lowest water level.

5. *Effect of Hydration and Dehydration of Seeds on Germination and Seedling Development.*

To study the effect on germination and seedling development of limited water supply in arid regions and the possible exposure of the seeds to the conditions of hydration and dehydration, the following experiment was designed. Seeds hydrated for periods ranging from 0.5 to 6 hr were placed in germination Petri dishes in the usual manner, *i.e.* 50 seeds and 5 ml of water in each dish. Seeds were removed and placed in similar Petri dishes lined with dry filter paper. All these dishes were placed on a laboratory bench for 10 days. The redried seeds were then tested for germination and seedling growth under continuous light and at 20°C. The results are shown in Table 5.

Table 5. Effect of hydration and redrying of seeds on subsequent germination and seedling length (**A**, seeds stored at room temperature; **B**, seeds stored in refrigerator). Standard errors are shown.

Hydration period (hr)	Germination percentage after drying for 10 days		Total seedling length (mm)	
	A	B	A	B
0.0	92.0 ± 4.0	86.7 ± 4.8	21.3 ± 1.9	37.7 ± 3.5
0.5	84.0 ± 4.0	90.7 ± 3.5	25.3 ± 0.9	36.7 ± 2.7
1.0	90.7 ± 3.2	92.0 ± 2.1	30.9 ± 2.4	28.0 ± 3.3
2.0	88.0 ± 2.3	88.0 ± 2.6	30.9 ± 1.3	46.1 ± 2.9
4.0	89.3 ± 1.3	96.0 ± 2.3	29.2 ± 1.5	41.0 ± 1.3
6.0	94.7 ± 3.5	90.7 ± 2.7	23.2 ± 6.4	38.6 ± 2.9

Seeds hydrated for the various periods and dried maintained their high germination capacity.

Effect of Two Cycles of Hydration and Dehydration

In a further experiment, seeds were hydrated for 0.5 to 6.0 hr and redried for 10 days as outlined above. These seeds were then rehydrated for 3 hr and redried for another 10 days, and were tested for germination and seedling growth as usual. The results are shown in Table 6.

Table 6. Effect of a second cycle of hydration-dehydration on germination and seedling vigour (**A**, seeds stored at room temperature; **B**, seeds stored in refrigerator).

Hydration period (hr)	Germination percentage with SE after drying for 10 days, rehydration for 3 hr, then redrying for 10 days.		Total seedling length (mm) with SE	
	A	B	A	B
0.0	88.0 ± 2.3	93.3 ± 2.7	20.1 ± 0.7	39.9 ± 1.3
0.5	96.0 ± 2.3	88.0 ± 4.6	21.4 ± 2.2	39.3 ± 0.9
1.0	84.0 ± 2.3	89.3 ± 3.5	23.0 ± 1.8	41.1 ± 4.4
2.0	89.0 ± 3.5	91.3 ± 4.1	25.3 ± 2.2	37.8 ± 4.8
4.0	92.0 ± 4.0	81.3 ± 5.8	23.9 ± 2.0	35.9 ± 5.5
6.0	85.3 ± 7.1	88.0 ± 4.6	21.0 ± 1.3	36.5 ± 2.6

Even with two cycles of hydration and dehydration the seeds maintained their high germination capacity. Again, as reported above, better seedlings are developed from seeds stored at low temperature.

Discussion

The viability of the seeds of *Achillea fragrantissima* is maintained for more than three years when stored under laboratory conditions where the summer temperatures are usually high and the fluctuations in temperature are also large. This is certainly an ecological advantage of some survival value for the plant, especially when it is compared with some desert range shrublets in the same area, such as *Haloxylon salicornicum* (Moq.) Bunge and *Haloxylon articulatum* (Cav.) Bunge, in which the seeds lose their viability as the temperature increases during the first season (Clor *et al.* 1976 and Al-Charchafchi *et al.* 1983).

The seeds are also light positive when fresh, but this light sensitivity is gradually lost with age; thus full germination is obtained after two years of storage. The stimulation of germination by light is possibly due to the conversion of the inactive form of phytochrome (Pr) to the active form (Pfr) as discussed by Borthwick *et al.* (1954). This is also supported by the observation that light stimulation of germination increased as the temperature was increased above 5°C (to 10-20°C).

The observation that seeds which remained hydrated for 9 days at 5°C and maintained their high germination capacity when transferred to favourable temperature and light conditions is of definite ecological significance because seeds in nature might be exposed to such hydration conditions at low temperature. It is observed further that the germination percentage of such hydrated seeds increased significantly when placed in darkness at 20°C, indicating again that probably some conversion of Pr to the Pfr form of phytochrome did take place when the seeds were kept under continuous illumination at 5°C.

Our data indicate further that seeds of *Achillea fragrantissima* might germinate and fairly good seedlings might develop with a small quantity of available water, a feature that gives the plant better survival opportunities under limited water supply in an area considered as a subdesert with an annual rainfall of 75-150 mm.

Another significant finding in the present work is that seeds, hydrated for various periods and redried, maintained their high germination capacity and developed normal seedlings. Ecologically, this is very important because seeds in arid regions might be exposed to such hydration-dehydration conditions. Similar results were found with the seeds of *Haloxylon salicornicum* (Clor *et al.* 1974).

It may be mentioned in this connection that *A. fragrantissima* is usually found scattered on silty clay soils in wadi beds and open depressions where there is considerable run-off of rain water from the surrounding high ground (Guest 1966).

It is also observed that seedlings, developed from seeds stored at low temperature, were, in general, larger and more vigorous than seedlings developed from seeds stored at room temperature. This is possibly due to more available food material maintained in the seeds stored at low temperature. This is in agreement with what was found with the seeds of *Haloxylon salicornicum* (Clor *et al.* 1976). However, germination percentage of the two groups of the seeds was not significantly different.

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تـأثير الخـزن والضوء والحـرارة على إنبـات بذور نبات الكيصوم ونمو بادراته

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الكيصوم (من العائلة المركبة) أحـد نباتـات الرعي المهمـة في الصحراء الغربيـة من العراق، لهـذا درست بعض متطلبـات إنبات بذوره ونمو بادراته .

وجـد أن البذور تحتفظ بحيـويتها وقـابلياتهـا الإنبـاتيـة العـالية لفـترة تزيـد على ثـلاث سنوات، إذ خُـزنت في درجة حرارة الغرفة التي تتفاوت بـين ١٨ ـ ٤٠ درجة مئـوية، أو في ثلاجة تكون درجة حرارتها حوالي ٦ درجات مئوية .

إن بذور الكيصوم حساسة للضـوء، لذلـك فإن نسبـة إنباتها تكـون واطئة في الـظلام، ولكن تزول هـذه الحساسيـة تدريجياً مع الزمن وتقل نسبة الإنبات أيضاً في درجات الحرارة الـواطئة (٦ درجـات مئويـة)، ولكن تزداد هـذه النسبـة مـع ارتفـاع درجــة الحــرارة حتى تبلغ حــدهــا الأعــلى، مـن ١٥ ـ ٢٠ درجة مئوية . ويُمكن لبذور الكيصـوم أن تُنقع بـالماء لمـدة نصف ساعـة إلى ست سـاعـات ثم تجفف تحت ظـروف المختـبر لمدة عشرة أيـام ومع ذلـك تحتفظ بقابليـاتها الإنبـاتيـة العالية ويُمكن أن تُنقـع هذه البـذور نفسها للمـرة الثانيـة لمدة ثـلاث ساعـات وتجفف لمدة عشرة أيـام للمـرة الثـانيـة أيضـاً وتحتفظ كذلك بقابلياتها الإنباتية الجيدة .