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Germination studies in *Horwoodia dicksoniae* Turril

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The use of native plants in urban landscape projects conserves natural plant diversity, imparts a natural appeal to the landscape, and requires less water and nutrients than do exotics. Desert annuals like *Horwoodia dicksoniae* Turril. have seeds with physiological dormancy. We studied the combined effects of dry heat (50°C) and GA_3 treatments on germination of *Horwoodia dicksoniae*. The results showed that the highest germination (88%) occurred when the seeds were subjected to a treatment combination consisting of exposure to dry heat (50°C) for 20 days followed by a treatment with 500 ppm GA_3 for 24 hrs. The next best treatment combination (86%) was the combination of 10 days dry heat (50°C) followed by a treatment with 1000 ppm GA_3 for 48 hours. This suggested that higher concentration of GA_3 could compensate for shorter exposure period to dry heat.

Keywords: Urban landscape; Greenery development; Conservation of native plants; *Horwoodia dicksoniae*

Introduction

Kuwait's climate is characterized by hot, dry summers with temperatures exceeding 45°C frequent sandstorms, and mild winters, with temperatures sometimes falling below 4°C [1]. The wet season extends from October to May. The mean annual rainfall is 113 mm [2]. The total conventional fresh water resources available in Kuwait are six million m^3/year, but the total water demand exceeded 350 million m^3/year in the year 2000 [3]. Perennial vegetation cover is sparse, usually less than 10% [4]. Several ornamental plant species have been introduced and evaluated for their performance under the local arid environmental conditions and some of these are currently being used in large-scale landscaping projects [5]. The number of ornamental plant species is insufficient, especially for accomplishing the comprehensive national greenery plan [6].

Although introduced ornamental plants are necessary in the urban and sub-urban landscape for diversity, they rely on high levels of nutrients and water. But the use of native plants in urban landscaping projects would conserve natural plant diversity and impart a fully natural appeal to the landscape. Native plants are easy to establish and less expensive than the exotic

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species in terms of water and nutrient requirement. As Kuwait's native plants are threatened in their natural habitat and are disappearing at an alarming rate, their use in landscape projects will help to conserve Kuwait's biodiversity and heritage [7].

Khuzamah (*Horwoodia dicksoniae* Turril. Family: Cruciferae) was selected for its aesthetic appeal, flower colour and potential to adapt to urban landscape conditions where several exotic species are used. It is a sweet-scented annual herb; named after Dame Violet Dickson who is locally known as Umm Saud. Khuzamah is a leafy plant with stems that are slightly hairy. It produces deep-lilac flowers and large, round and winged fruit (figure 1). It is abundant in sandy soil in Sulaibiya area in Kuwait [2].

During summer (June–August), most annual plants remain dormant in their seed form until the rainy season (October–May) in which the seeds start to germinate. When precipitation drops below the average and drought prevails for several years, annual plants remain dormant in the form of seeds until conditions improve. Some seeds develop hard seed coats to protect the embryo and endosperm from dehydration; others produce water–soluble inhibitors. These inhibitors prevent seed germination until an adequate amount of rainfall is received to leach out the inhibitors [2]. Many desert annuals, belonging to a diversity of plant families, have seeds with physiological dormancy (i.e. the embryo itself is incapable of developing), which is broken during the hot, dry season [8].

The temperature requirements for the loss of physiological dormancy in seeds of desert annuals are not well understood, with seeds of some species coming out of dormancy during storage at room temperatures, and others requiring considerably higher temperatures [8]. Seed germination rates under natural conditions are low. This can be improved by treating the seeds with sulphuric acid [9] or growth regulators prior to sowing. Results of the studies conducted during 1996–1998 by Zaman [10] for 14 desert plants indicated a wide variation in germination and seedling establishment.

The hard pericarp of *Horwoodia dicksoniae* fruit acts as a physical barrier for germination. Investigations on seed germination of *Horwoodia dicksoniae* after different durations of storage at 50°C resulted in a maximum of 9% germination after storage for 28 days [4]. Other factors affecting the breaking of dormancy in *Horwoodia dicksoniae* (e.g. pre-treatment with

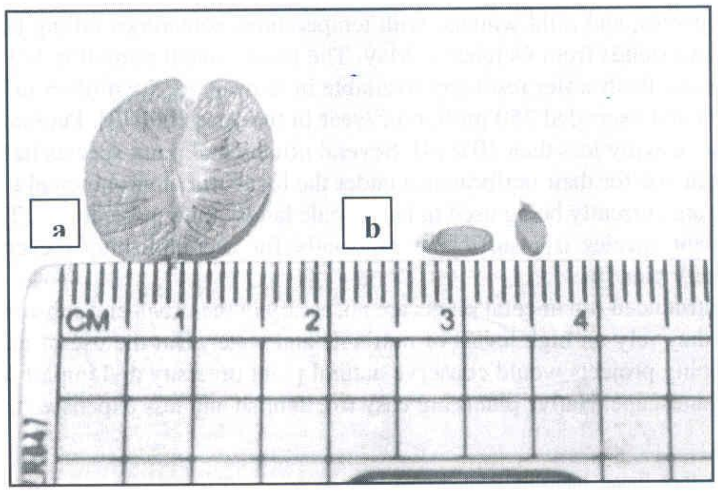

Figure 1. *Horwoodia dicksoniae* Turril. a) winged fruit; b) seeds.

GA_3, cold stratification) were not investigated. The objective of this study conducted during November 2007 to February 2008 was to test the effectiveness of various treatments in breaking the dormancy and improving germination of *Horwoodia dicksoniae* seeds.

Materials and methods

Seeds

Seeds used in this study were extracted manually from the winged fruit obtained from the seed bank of the Kuwait Instititute for Scientific Research (KISR) in November 2007. These fruits were collected from the Kuwait desert in 2006. Prior to their use in the experiment, seed viability was determined using Triphenyl Tetrazolium Chloride (TTC) Test [11]. In this test, viable embryos are stained pink due to the reduction of 2,3,5-TTC by respiratory activity in the cell. For this, 100 seeds (four replicates of 25 seeds each) were soaked in distilled water overnight, excised to expose the embryos, placed in a Petri dish, soaked in 0.1% TTC solution, covered in the Petri dish with aluminium foil and left for 24 hours at room temperature. Following the treatment, seeds were washed thoroughly with distilled water to remove excess stain and examined under the microscope.

Germination studies

In this experiment the combined effects of dry heat (50°C) exposure of seeds for 10 or 20 days and treatment with 0, 500, 750 or 1000 ppm GA_3 solution for 24 hrs prior to sowing on germination of *Horwoodia dicksoniae* were studied. For this the seeds from room temperature storage were kept in an oven at 50°C for 10 or 20 days, after which they were removed from the oven and treated with GA_3 for 24 hours. In the case of 1000 ppm the soaking was extended to 48 hr to ascertain if extended treatment had any positive effects. One batch of seed was soaked in 500, 750 or 1,000 ppm GA_3 without any heat treatment. The control seeds were not subjected to either heat or GA_3 treatment. The numbers of seeds with radicles that are at least 2 mm in length were recorded every day in each treatment and the total germination was calculated when no more seeds germinated. In all there were 15 treatments which were replicated five times in a randomized design. Each replication contained 30 seeds. The data were analysed using R analysis procedure of Analysis of Variance (ANOVA) and Dunkan's Multiple Range Test to ascertain the significant differences among treatments [12,13].

Results and discussion

Viability of seeds used in these studies was found to be 100%. The highest germination (88%) occurred when the seeds were subjected to a treatment combination consisting of exposure to dry heat (50°C) for 20 days and then treated with 500 ppm GA_3 for 24 hrs (table 1). The next best treatment combination (86%) was exposure to dry heat (50°C) for 10 days followed by a treatment with 1000 ppm GA_3 for 48 hrs. Dry heat exposure alone did not improve the germination (1.33%). In contrast, treatment of seeds with 500, 750 or 1000 ppm GA_3 alone resulted in 45, 49 and 51% of germination, respectively. It is interesting to note that germination increased with the increasing GA_3 concentrations in seeds that

Table 1. Effect of dry heat (50°C) exposure and GA3 on germination of *Horwoodia dicksoniae* Turril. seeds

	Germination (%)[a]				
	GA_3 treatment (ppm)				
	0	500	750	1000	1000
Heat treatment	24 h				48 h
RT	0.00 a[b]	45.00 bc ± 5.47	49.00 bc ± 5.17	51.00 bc ± 5.17	60.87 cd ± 1.86
50°C 10 Days	1.33 a ± 1.19	57.33 c ± 1.74	83.33 e ± 3.12	73.33 de ± 2.10	86.00 e ± 3.45
50°C 20 Days	2.00 a ± 0.73	88.00 e ± 3.23	80.66 e ± 1.46	50.66 bc ± 9.19	36.66 b ± 9.92

[a]Seeds with 2 mm or longer radicle or shoot are considered as germinated.
[b]The means followed by the same letter are not statistically different at p 0.001.

were exposed to dry heat for 10 days. In contrast, the germination was reduced at higher concentrations of GA_3 when dry heat exposure period was extended to 20 days. Untreated seeds (control) did not germinate at all. These results suggest that shorter exposure to dry heat can be compensated by treatment with higher concentrations of GA_3. The improvement in germination by dry heat and GA_3 was significant at $p < 0.001$ level compared to control.

The germination percentage of 88% in the present study is a clear improvement over the previous reports [4], where only 9% germination was recorded after storage at 50°C for 28 days. The fact that germinability of seeds was improved significantly when they were exposed to dry heat followed by soaking in GA_3 solution before sowing suggests that seed dormancy in this species may be due to the presence of high levels of germination inhibitors (physiological dormancy). High temperatures are known to degrade or inactivate these inhibitors [14]. GA_3 treatment further alters hormonal balance in favour of promoters to trigger germination process and shorten time needed for germination [15]. Results of this study are important as desert rehabilitation and biodiversity conservation is crucial to prevent the extinction of valuable native plants in Kuwait [7,2].

Conclusions

Desert plants like *Horwoodia dicksoniae* exhibit dormancy to adapt to the harsh environmental conditions in the desert. Effective dormancy breaking treatments are important to develop mass propagation techniques in native plants, which have hitherto not multiplied on a large scale. Exposure of seeds to dry heat (50°C) for 20 days followed by treatment with 500 ppm GA_3 was effective in breaking seeds dormancy and in significantly improving the germination in *Horwoodia dicksoniae*. The duration of heat exposure could be reduced to ten day if the seeds are subsequently treated with 1000 ppm GA_3.

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