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Germination Studies in *Ochradenus baccatus* Delile., *Peganum harmala* L. and *Gynandriris sisyrinchium* Parl.

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ABSTRACT

The arid eco-systems of the world can support plants with minimum water requirements that are drought and salt tolerant, for use in landscaping and gardening projects. Conservation of native plants are possible by utilizing aesthetically appealing native plants in urban landscape projects instead of water-thirsty exotic plants. In this study, efforts were made to standardize the techniques for mass propagation of *Ochradenus baccatus, Peganum harmala* and *Gynandriris sisyrinchium*. The treatments included exposure (10 or 20 days) to dry heat (50°C) to mimic the desert environment and various concentrations of gibberellic acid (0, 500, 750 and 1000 ppm GA_3) either in combination or individual. There were twelve treatments, which were replicated thrice in a completely randomized design. Each replication contained 20 seeds. The data were analyzed using R procedure of Analysis of Variance (ANOVA) and Dunkan's Multiple Range Test. Highest germination (100%) was obtained when the seeds of *Ochradenus baccatus* were pre treated with dry heat for 10 days followed by treatment with 750 ppm GA_3. Treatment combination of dry heat (10 days) and 500 ppm GA_3 was effective for enhancing germination (64.7%) in *Gynandriris sisyrinchium*. No pre treatments were needed for the germination of *Peganum harmala*.

Key words: Urban landscape, native plants, mass propagation, conservation, *Ochradenus baccatus, Peganum harmala, Gynandriris sisyrinchium*

INTRODUCTION

Semi arid regions of the world are most susceptible to land degradation and desertification with serious implications for sustainable use of the natural environment (Kassas, 1995; Brown, 2003). The arid eco-systems of the world can support plants with minimum water requirements that are drought and salt tolerant, for use in afforestation, landscaping and gardening projects, as drought has always been a normal recurrent event in arid and semi-arid lands (Le Houerou, 1996). Kuwait has a typical desert climate with extreme temperatures, minimal and variable rainfall, intense sunshine and frequently occurring dust storms. The climate is characterized by extremely hot summers, with daytime temperature exceeding 50°C and winter, cooler and at times wet, with temperature sometimes falling below 4°C (Food and Agriculture Organization of the United Nations., 2008). The rainy season extends from October to May. The mean annual rainfall is 113 mm (Omar *et al*., 2007). The total conventional freshwater resources available in Kuwait are six million cubic meter per year, while the total water demand has exceeded 350 million m^3 year

in 2000 (Hamoda, 2001). Native soil in Kuwait is mostly sandy in texture with high infiltration rate and is calcareous in nature (Omar *et al*., 2007).

The native vegetation of Kuwait includes scant perennial woody shrubs, herbs and spring ephemerals (Sudhersan *et al*., 2003). As in other arid and semiarid countries, annuals are the most dominant species (256 species) followed by herbaceous perennials (83 species), shrubs and under shrubs (34 species) and tree (one) species (Omar and Bhat, 2008). Kuwait's native vegetation is of enormous scientific value as it represents a transition between semi-desert and desert vegetation and it is highly tolerant to harsh environmental conditions such as extreme temperatures, drought and salinity. Several native desert plants are being threatened and are facing danger of extinction due to anthropogenic causes (Sudhersan *et al*., 2003). Such perennial native plant genotypes need to be preserved and propagated on a large scale for the rehabilitation and restoration of Kuwait's desert ecosystem (Sudhersan *et al*., 2003). Restoration and re-vegetation programs are necessary to reverse the negative trends of ecosystem degradation and to conserve the biodiversity of these important ecosystems. Conservation of native plants are possible by their utilization in urban landscape, as indigenous plant species have evolved and adapted to the local harsh climatic conditions over the years and they are more likely to function adequately under the local climate as opposed to exotic plants.

Xeriscape is a water-efficient-landscape concept to replace traditional landscape practices. This concept mainly focuses on the usage of aesthetically appealing native plants in urban landscape projects instead of water-thirsty exotic plants (California Department of Resources Recycling and Recovery-Calrecycle, 2003). Unfortunately, efficient propagation and establishment techniques that are crucial for both conservation of native plants and large-scale use in landscape programs are currently unavailable (AboEl-Nil, 1997). *Ochradenus baccatus, Peganum harmala* and *Gynandriris sisyrinchium* were selected for this study due to their ability to tolerate extreme adverse conditions in addition to their possible potential use in urban landscaping (AboEl-Nil, 1997; Sudhersan *et al*., 2003).

Ochradenus baccatus is a perennial large shrub found in sandy, stony areas. It is a dense shrub, approximately two meters tall, with grey-green linear leaves (Fig. 1). It blooms in yellow flowers, appearing in spring (December to March), followed by whitish berries containing black seeds (Omar *et al*., 2007). Stems are greenish in color and help the leaves in conducting photosynthesis especially when leaves are weakened and shriveled under severe drought environments (Abdulfatih, 2004).

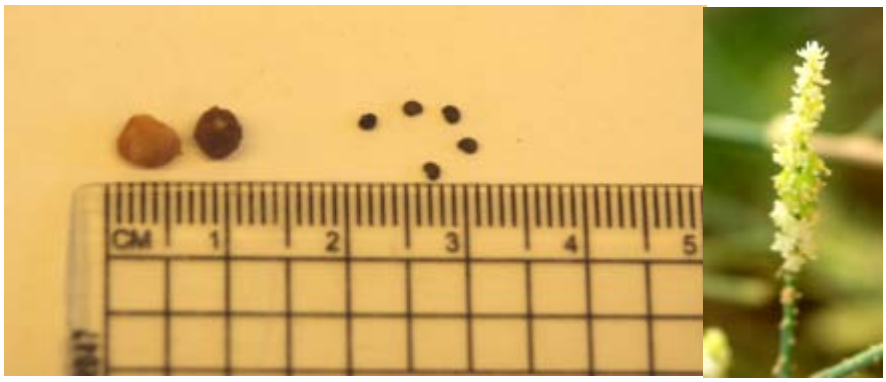

Fig. 1: Seeds and flower of *Ochradenus baccatus*

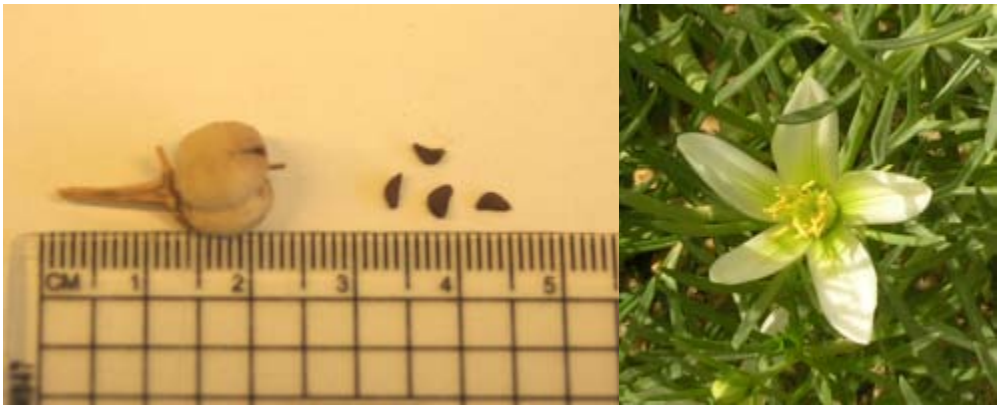

Fig. 2: Seeds and flower of *Peganum harmala*

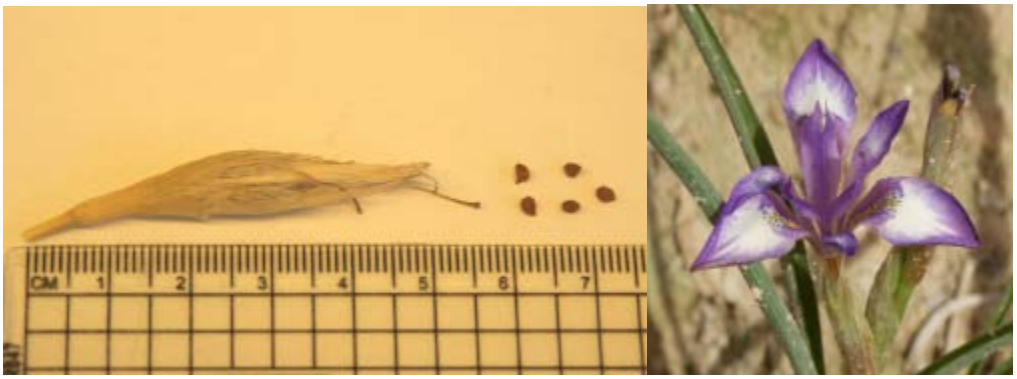

Fig. 3: Seeds and flower of *Gynandriris sisyrinchium*

Peganum harmala is a perennial herbaceous, glabrous plant (Mahmoudian *et al.*, 2002). It is a leafy shrub about 40 cm high with yellowish-white flowers about two cm across (Fig. 2). Its stems are woody at the base and multi-branched (Omar *et al.*, 2007). The leaves are dark-green linear and alternately spaced. They have a strong deterrent odor when rumpled (Mahmoudian *et al.*, 2002). The seeds are formed in small capsules. This is a beautiful plant and it is worth using as an addition to the garden (Omar *et al.*, 2007).

Gynandriris sisyrinchium is a perennial herb with a corm. It has several long, narrow channeled leaves. The deep lilac blue flowers with a white to yellow throat appear during January, February and March (Fig. 3). The bulbs are currently found in protected areas such as Sulaibiya Field Station (Omar *et al.*, 2007).

MATERIALS AND METHODS

Seeds: Seeds used in this study were obtained from seed bank of Kuwait Institute for Scientific Research (KISR) in November 2007. These seeds of *Ochradenus baccatus*, *Peganum harmala* and *Gynandriris sisyrinchium* were collected from Kuwait desert in 2007, 2006 and 2005, respectively. Viability was determined using Triphenyl Tetrazolium Chloride Test as recommended by the International Seed Testing Association (1999). Seeds were soaked in distilled water overnight and

they were excised to expose the embryo and were then soaked in 0.1% 2, 3, 5-TTC solution in Petri dishes, covered with aluminum foil and kept for 24 h at room temperature (25°C). These seeds were washed thoroughly with distilled water to remove excess stain and were then examined under the microscope. A total of 100 seeds (four replicates of 25 seeds each) were used for the test.

Germination studies: The experiments were carried out in the Plant Physiology Laboratory at Kuwait Institute for Scientific Research (KISR).

The experiment was conducted during 23.3.08 to 27.4.08 for *Ochradenus baccatus*, 12.11.08 to 8.1.08 for *Peganum harmala* and 23.3.08 to 29.6.08 for *Gynandriris sisyrinchium*. Seeds stored at room temperature were kept in an oven at 50°C for 10 days or 20 days and treated with various concentrations of gibberellic acid (GA_3) for 24 h. Treatments included exposure to dry heat at 50°C for 10 or 20 days and/or pre-sowing soaking in GA_3 solution (0, 500, 750 or 1,000 ppm) for 24 h. There were twelve treatments, which were replicated thrice in a completely randomized design. Each replication contained 20 seeds. The control seeds were not subjected to either heat or GA_3 treatment. The total germination was calculated when no more seeds germinated. Pre-treated seeds were sown in agricultural soil medium in Petri dishes and maintained in laboratory conditions at 25°C. The data were analyzed using R analysis procedure of Analysis of Variance (ANOVA) and Dunkan's Multiple Range Test to ascertain the significant differences among treatments (Little and Hill, 1978; Crawley, 2005).

RESULTS AND DISCUSSION

Viability of seeds used in this study was found to be 100%.

***Ochradenus baccatus*:** Hundred percent of seeds germinated when they were exposed to a duration of 10 days dry heat followed by treatment with 750 ppm GA_3. Pre-treatment with 500 ppm (99%) and 1000 ppm (97%) GA_3 also enhanced the germination percentage. Seeds sown without any treatment (Control) resulted in 74% germination percentage (Table 1). When the seeds were exposed to 10 days dry heat, combinations of GA_3 at concentrations of 500 and 750 ppm increased the germination whereas higher concentration of GA_3 (1000 ppm) displayed a diminishing effect. In contrast, exposure to an extended duration (20 days) of dry heat resulted in a decrease in germination irrespective of GA_3 concentration. Pre-treatment with various isolated concentrations (500, 750 and 1000 ppm) of GA_3 also enhanced the germination (99, 95 and 97%). The improvement in germination by pre-treatment was significant at $p<0.001$ level.

***Peganum harmala*:** Untreated seeds (Control) of *Peganum harmala* (Table 1) resulted in the highest germination of 96%. The next best result was obtained by treating the seeds with 750 ppm GA_3 (93%). Heat treatment (irrespective of the duration) either alone or with various concentrations of GA_3 impeded the germination percentage. When the seeds were exposed to dry heat alone, drastic reduction in germination was noticed. No dormancy was observed in this species. The variation in results was significant at $p<0.001$ level.

***Gynandriris sisyrinchium*:** A combination of 10 days heat treatment followed by soaking in 500 ppm of GA_3 for 24 h produced the highest (64.7%) germination (Table 1). The next best treatment (45.3%) was the treatment combination of dry heat treatment for 10 days and 750 ppm GA_3. In untreated seeds the germination percentage was 5.3%. Pre-treating with dry heat for ten

Table 1: Effect of dry heat (50°C) treatment and various concentratious of GA_3 on germination of *Ochradenus baccatus, Peganum harmala and Gynandriris sisyrinchium* seeds

		Germination (%)[i]		
Dry heat (days)	GA_3 (ppm)	*Ochradenus baccatus*	*Peganum harmala*	*Gynandriris sisyrinchium*
10	500	95.3e±2.0[ii]	42.7d±3.6	64.7f±7.9
10	750	100.0e±0.0	60.7e±11.9	45.3ef±8.7
10	1000	89.3de±5.7	78.7f±3.4	38.0def±6.4
10	0	86.7de±4.1	18.7ab±1.3	41.3ef±4.8
20	500	28.7a±7.4	24.7abc±5.6	22.0bcd±2.9
20	750	65.3bc±8.1	36.67cd±3.2	16.7abcd±2.4
20	1000	54.0b±7.6	32.0bcd±3.6	28.0def±1.7
20	0	61.3bc±7.7	10.0a±2.4	24.7cde±1.7
0	500	99.0e±1.0	85.0fg±5.5	7.0ab±4.4
0	750	95.0e±2.7	93.0fg±3.4	11.0abc±3.3
0	1000	97.0e±2.0	85.0fg±4.2	12.0abc±5.6
0	0	74.0cd±4.9	96.0g±1.9	5.3a±1.7
Significance[iii]		***	***	***

Seeds with 2 mm or longer radicle or shoot are cousidered as germinated[ii]; The means followed by the same letter are not statistically different at $p \leq 0.01$; [iii]Data were analyzed using R analysis of variance procedure; *** = Significant at $p \leq 0.001$ levels

days exhibited superior effect on germination than dry heat treatment for 20 days. In dry heat GA_3 combination treatments, when the GA_3 concentration was increased beyond 500 ppm, the germination percentage started to decline. Meanwhile, when the seeds were exposed to extended duration of dry heat (20 days), a negative effect on germination was observed. The improvement in germination by pre-treatment was significant at $p<0.001$ level.

Previous studies by Zaman (1999) on seed germination of selected desert plants of Kuwait indicated a wide variation in germination and seedling establishment. Zaman *et al.* (2003) stated that pre-sowing exposure of seeds to high temperature (50°C) for 10 or 20 days enhanced germination in *Eragrsotis curvula, Cenchrus ciliaris* and *Atriplex lantiformis* whereas it reduced germination of *Salvia apiana, Juncus acutus, Lotus cornicolatus, Linaria macrocanna* and *Pennisetum rupelii*. Some species did not respond to high temperature treatment. Tissue culture technology was developed for *Rhanterium epapposum, Ochradenus baccatus, Nitraria retusa* and *Lycium shawii* because of their potential for use in urban landscaping and in desert revegetation (Sudhersan *et al.*, 2003). As mentioned, various studies have been performed at KISR on native plant propagation; however, this is the pioneer research on germination of *Ochradenus baccatus, Peganum harmala* and *Gynandriris sisyrinchium*. Literature study indicated that there are no previously published reports on mass propagation of these species making it difficult to compare the results of the present study. Additionally, no reliable data are available about seed germination, growth and fruiting of *Peganum harmala* in domesticated or natural settings (Khawar *et al.*, 2005).

CONCLUSION

The germination study showed that, to propagate *Ochradenus baccatus* in a short period of time, pre-treatment with 500, 750 and 1000 ppm was found to be effective. Whereas, to attain highest germination (100%), pre-treating the seeds of *Ochradenus baccatus* with dry heat (10 days) followed by treatment with 750 ppm GA_3 was desirable. Treatment combination of dry heat

(10 days) and 500 ppm GA_3 was effective for enhancing germination (64.7%) in Gynandriris sisyrinchium. No pre treatments are needed for the germination of Peganum harmala. The findings of this study are crucial as this is the first attempt to standardize the propagation techniques of these species to facilitate its use in xeriscaping and desert rehabilitation.

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