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Seed germination study on some threatened plants of Rajasthan desert

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Abstract
Seed germination is one of the most critical events subjected to environmental control in plant life. Fresh and one year old seeds of *Monsonia heliotropioides*, *Psoralea odorata* and *Seetzenia lanata* showed dormancy and 100% viability. In the present study, effect of mechanical scarification and various chemical treatments viz. Sulphuric acid (H_2SO_4), Ammonium nitrate (NH_4NO_3), Potassium nitrate (KNO_3), Gibberellic acid (GA) on seed germination were studied. Under control, fresh and one year old seeds of *Psoralea odorata* showed only 15% and 30% germination whereas *Monsonia heliotropioides* and *Seetzenia lanata* showed no germination. Mechanical scarification and chemical treatment enhanced germination percentage in *Psoralea odorata*. Seeds of *Seetzenia lanata* secreted mucilage and various treatments had no effect. A very poor germination was showed by *Monsonia heliotropioides* only under mechanical scarification.

Keywords: germination, mechanical scarification, dormancy, viability

Introduction

Seed germination is usually the most critical phase determining the success or failure of plant establishment. A seed may appear simple externally but has a very complex ecophysiology for resumption of growth, primarily its germination. A number of environmental factor together with the makeup of a seed affect germination phenomenon. For annual plants, which produce seed only once, seed germination response to environmental conditions is crucial for recruitment (Tobe *et al*., 2005) [18].

Seed germination can depend on certain environment factors among them temperature is of obvious important, equally significant in many cases are light, oxygen, carbon- dioxide and availability of water. The environmental control of seed germination is a complex process and seeds can only germinate when environmental stress does not exceed their limits of tolerance (Baskin and Baskin, 2014) [3]. In Indian arid zone plants, water acts as a master limiting factor for seed germination. The capacity of seed to germinate and the time at which it does so, are inevitably determined by a number of factors acting upon it (Bewely and Black, 1982) [4]. Sometimes the environment of particular region is disturbed directly or indirectly by man with undesirable activities, even then the seeds germinate and grow into the plants which in turn produce probably better seeds to suit the changed abode.

The delayed germination of seeds is of great survival value especially in arid zone of Rajasthan. Most of the arid zone plants have long seed dormancy period often running into several years mainly due to the presence of hard seed coat. The desert plants shows diversity in seed germination behavior especially under different temperature and light intensity range which are advantageous in arid environment where these factors have great fluctuation from day to day, season to season and year to year for a considerable period.

Material and Method

For the collection of seeds fully matured fruits of *Monsonia heliotropioides, Psoralea odorata* and *Seetzenia lanata* were collected. The collected fruits were kept in the blotting paper bags at room temperature for drying. The collected seeds were cleaned and stored in the glass bottles at room temperature. Viability of seeds was tested by the tetrazolium method of Porter *et al*. (1947) [14].

Seed germination study was performed in sterilized petriplates lined with a single layer of filter paper moistened with distilled water in continuous white light. Seeds were given the soaking treatment of different concentration of Sulphuric acid (H_2SO_4), Ammonium nitrate (NH_4NO_3), Potassium nitrate (KNO_3), Gibberellic acid (GA) and Mechanical Scarification. Five replicates each of 10 seeds along with control were maintained in all cases. Each experiment was repeated twice. The readings were recorded every day till no more germination occurred. Adequate moisture was maintained in petriplates by supplying distilled water at intervals for normal growth. Radical protrusion was the criterion for seed germination.

Result and Discussion

Survival and perpetuation of plants in any ecosystem particularly in desert are largely governed by setting viable seeds in enormous number and the ability of seeds to germinate at interval over long period. Some species have little whereas others have long seed viability. The fresh and one year old seeds of *Monsonia heliotropioides*, *Psoralea odorata* and *Seetzenia lanata s*howed dormancy and 100% viability. Freshly harvested and one year old seeds of *Psoralea odorata* showed 15% and 30% germination, respectively under control. Soaking treatment with different concentration of Conc. Sulphuric acid for different duration increased the germination percentage in both fresh and one year old seeds. Maximum germination was recorded when the seeds were treated with 10% sulphuric acid for ten minutes duration in case of fresh seeds and 2 minutes duration in case of one year old seeds, and it was 28% and 52%, respectively. Higher concentration reduced the germination and proved injurious to seeds. Steinbauer and Griegby (1959) [17] stated that Conc. sulphuric acid pre-treatment is the best method to overcome the resistance of seed coat for permeation of water and observed cent percent germination in *Convolvulus sepium*, *Polygonum persicaria* and *Abutilon theophrastii*. The pre-treatment of GA slightly enhanced the germination percentage in fresh as well as one year old seeds at all the concentration. Maximum germination was observed when seeds were soaked in 50 ppm GA for 24 hrs and it was 20% in fresh and 40% in one year old seeds.

NH_4NO_3 slightly increased germination percentage in both fresh and one year old seeds at 50 ppm concentration whereas at all other concentration the percentage of germination was reduced except 100 ppm in one year old seeds. Seeds soaked in 250 ppm KNO_3 for 24 hrs gave better results as compared with other concentration and the germination percentage was decreased at 500 ppm concentration. Mechanical scarification was proved to be the most effective among all treatments, and 70% and 90% germination were recorded in fresh and one year old seeds, respectively. It is clear from the present observation that storage of seeds under laboratory conditions promotes the germination percentage.

The seed germination in *Monsonia heliotropioides* was found to be extremely difficult in laboratory condition. Seeds did not germinated under control in both petriplates and pots. The soaking treatment with Conc. H_2SO_4, GA and Nitrate salts proved futile. The germination of seeds was observed only when the seeds were given the treatment of mechanical scarification and grown in pots filled with the soil collected from the natural habitat of plant. Mechanical scarification was done by rubbing of seeds on sand paper at 3-4 places on the seed coat or by scratching the seed coat at 2-3 places by needle. The percentage of seed germination was very low, it was 20% and 40% when the seeds were rubbed on sand paper while 30% and 60% under scratching with needle in fresh and one year old seeds, respectively. Seed germination was epigeal, although the seed coat remained inside the soil and remained attached with the lower part of hypocotyl.

Seeds of *Seetzenia lanata* did not germinate under control and various treatments. They secreted a large amount of mucilage with the contact of water, which formed a thick film around the seeds. When the seeds were rubbed on sand paper for mechanical scarification, thin and smooth seed coat was ruptured. Seed were given the treatment of acid scarification at different concentration of H_2SO_4 (5, 10, 25 and 50%) for 2 and 10 min. durations. It was observed that even treated seeds with 5% and 10% Conc. H_2SO_4, secreted mucilage. When the seeds were treated with 25% and 50% H_2SO_4, seed coat was decayed and germination was not observed.

Nature of the germination regulating mechanism itself interprets the survival value of a species. Seed coat inhibition has been the major cause of delayed seed germination and various methods have been suggested to overcome it. According to Pandya *et al*., (1991) [13] *Alysicarpus longifolius* and *A. monilifera* have seed dormancy imposed by both hard seed coat and pericarp, the latter possess some inhibitory substances. They found that seed dormancy in both the species was broken with the treatment of acid scarification. Vandana and Kasera (2006) [7] reported that increase in the duration of acid scarification at particular concentration enhanced the germination percentage in *Sida cordifolia*. In the present study, fresh as well as one year old seeds of *Psoralea odorata* exhibited seed coat dormancy. As only 15% and 30% germination was recorded in control, which improved when seeds were treated with certain concentration of H_2SO_4. It indicates that the seeds have hard and impermeable seed coats, a general characteristic of desert plants. Storage periods gradually made the seed coats permeable. Seed coat dormancy is of prime importance for the perpetuation of plant in arid region, where water stress is very common (Sen, 1977). Scarification and low pH solution treatment is the effective methods to remove dormancy caused by hard seed coat (Chaves *et al*., 2017) [5]

Natural occurring gibberellins affect more species and types of dormancy than other chemicals known to induce germination, suggesting a possible role in induction of germination (Amen, 1968) [1]. Promotive effect of GA on different weeds species have been reported by various workers (Bansal, 1978; Mishra, 1985; Kasera and Sen, 1987; Khandelwal, 1992) [2, 11, 7, 8,]. Kumar and Sinha (1992) treated the seeds of *Indigofera linnaei* and *I. linifolia* with different concentration of KNO_3, thiouria, GA_3, IAA and NAA solution with a view of breaking the dormancy and found that in former species KNO_3, NAA and IAA did not prove to be effective as against latter. Jha (1982) [6] and Mitra and Kushari (1982) [12] reported that ammonium nitrate was a very good agent to break seed coat dormancy in different plant species. In present investigation too, GA, NH_4NO_3 and KNO_3 improved the germination percentage in fresh and one year old seeds at certain concentration and their effect was more in one year old seeds.

The delayed germination in desert plant has great survival value. If all the seeds which are produced by a plant of arid ecosystem germinate promptly they would constitute a hit or miss method and wastage of precious propagation material. In arid environment, a seed is subjected to rigorous environmental conditions where an acute shortage of water is a primary limitation for the germination of seeds. Most of the arid zone plants have a long period of seed dormancy often running into several years. The lengths of the time for which seeds can remain viable are extremely variable and depend on characteristics of seeds, condition of soil or storage (Salisburry and Ross, 1986, Klingman and Ashton, 1982) [15, 9].

Table 1: Effect of the Soaking treatments of different chemicals and pretreatment of mechanical scarification on percentage germination of fresh (F) and one year old (O) seeds.

			Psoralea odorata Germination (%)		*Monsonia heliotropioides* (Germination (%)	
	Treatment		F	O	F	O
Control			15 ± 3.25	30 ± 3.16	-	-
H_2SO_4	5%	2 min	15 ± 3.57	35 ± 4.89	-	-
		10 min	15 ± 4.07	40 ± 5.68	-	-
	10%	2 min	18 ± 6.32	52 ± 5.89	-	-
		10 min	28 ± 5.81	38 ± 5.83	-	-
	25%	2 min	20 ± 3.29	12 ± 3.26	-	-
		10 min	10 ± 4.89	10 ± 3.16	-	-
	50%	2 min	00 ± 00	00 ± 00	-	-
		10 min	00 ± 00	00 ± 00	-	-
GA (24 Hrs.)	5 ppm		17 ± 3.25	32 ± 2.85	-	-
	10 ppm		18 ± 3.11	32 ± 4.42	-	-
	25 ppm		18 ± 2.35	34 ± 2.65	-	-
	50 ppm		20 ± 3.40	40 ± 4.80	-	-
	100 ppm		15 ± 2.85	34 ± 3.29	-	-
NH_4NO_3 (24 Hrs.)	50 ppm		18 ± 3.47	38 ± 3.74	-	-
	100 ppm		12 ± 2.44	36 ± 4.89	-	-
	250 ppm		08 ± 3.16	20 ± 5.09	-	-
	500 ppm		05 ± 2.00	12 ± 2.44	-	-
KNO_3 (24 Hrs.)	50 ppm		15 ± 3.74	30 ± 2.44	-	-
	100 ppm		15 ± 3.74	38 ± 2.52	-	-
	250 ppm		20 ± 3.16	44 ± 4.00	-	-
	500 ppm		10 ± 4.89	25 ± 4.89	-	-
Mechanical scarification			70 ± 5.86	90 ± 7.90	20 (30)*	40 (60)*

-- NIL F – Fresh seeds; O - One year old seeds ;* scratching by needle.

Fig 1: *Monsonia heliotropioides* - seedling growth showing root and shoot ratio

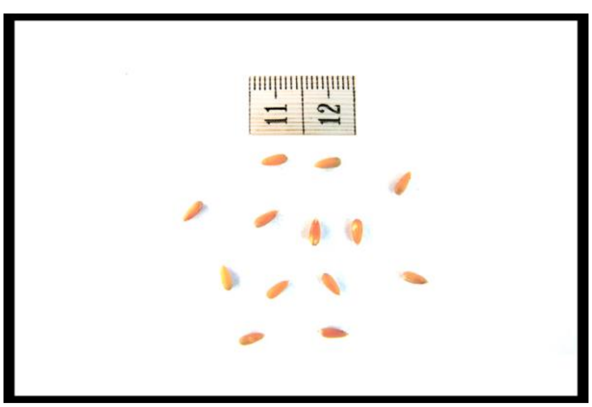

Fig 2: *Monsonia heliotropioides*- Seeds

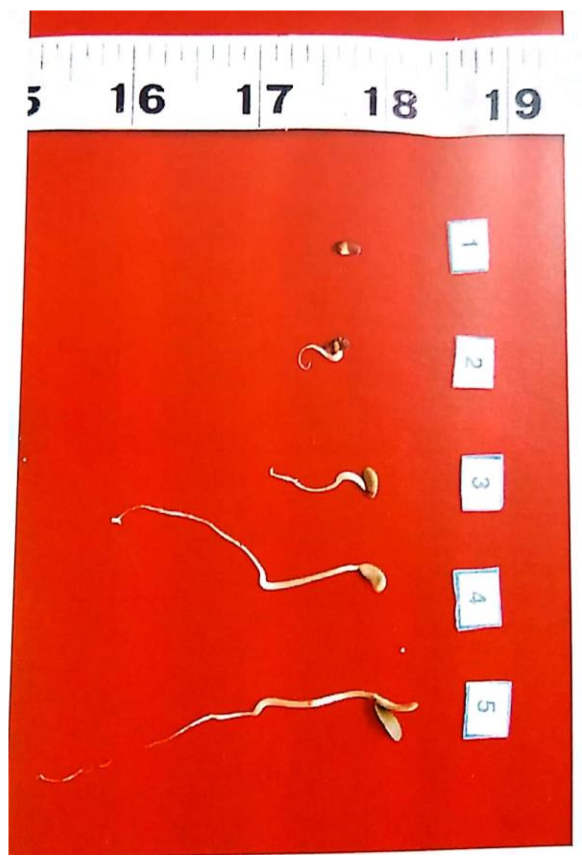

Fig 3: *Psoralea odorata*- Seedling growth showing root and shoot ratio

Fig 4: *Psoralea odorata*- Seeds

Fig 5: *Seetzenia lanata*-seeds

Conclusion

In present study, it was observed that *Monsonia heliotropioides* and *Psoralea odorata* showed 100% viability even after two years of storage. Higher seed production, viability and seedling growth are most important characteristic features to understand the ecophysiology and survival strategies in desert climate. Dormancy in general, helps plants to bridge unfavorable seasons and may be an extension of the system for stopping embryo growth during seed maturation. Dormant seeds represent a most important biological adaptation in the arid environment

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