Seed Germination of *Cycas revoluta*[1]

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Abstract

Cycas revoluta seeds commonly take from a few months to a year or more to germinate and germination percentages are normally quite low. In an effort to improve germination, several seed treatments were tested. Seeds germinated better in dark than in the light. Removal of the pulp from seeds increased percent germination as compared to seeds with the pulp intact. Treatment of seeds for 0.5, 1.0, 1.5 or 2 hr with concentrated sulfuric acid increased seed germination. The application of gibberellic acid at concentrations of 500, 1000 or 5000 ppm did not affect germination as compared to controls. Seeds stored at room temperature for 6 months germinated more readily than seeds planted immediately. It is suggested that seeds stored at room temperature and scarified with concentrated sulfuric acid for 1 hr will exhibit improved germination.

Index words: Cycad, propagation, scarification, GA

Introduction

Germination of *Cycas revoluta* seed occurs sporadically over extended periods of time. Seeds sown in flats start to germinate in a few months and continue to germinate for periods of a year or more. During this time the seedlings require constant attention to assure that they are watered properly. Over watering inevitably results in rotting of seeds. Erratic germination and the slow growth of the resultant plants increase the cost of production of cycads. Consequently, few growers propagate and grow cycads, resulting in a scarcity of this plant material.

Seeds of many temperate nursery crops respond to various treatments including depulping, scarification, stratification, exposure to light or dark, and treatment with gibberellic acid (GA) (7). Even seeds of tropical plants may require some type of seed treatment to enhance germination (6). One method used to screen seed from both temperate and tropical plants for viability is to place the seeds in water and discard those seeds that float, as these are normally considered nonviable. This method is not always reliable with cycads (3). Thus, selected seed treatments were evaluated as a means of enhancing of *C. revoluta* seed germination.

Materials and Methods

Seeds were depulped by soaking overnight in water (1) and the pulp mechanically removed with a blender, with the blades masked. Cracked seeds were discarded. Seeds were planted in 17 × 12 × 6 cm (7 × 5 × 2.5 in) plastic flats containing coarse vermiculite. Seeds were oriented on their side so that 75% of the seed was beneath the surface of the vermiculite. Seeds were germinated in the greenhouse at daytime average temperatures of about 25°C (77°F) from October to March and about 30°C (86°F) from April to September. Flats were watered as necessary. Germination was evaluated at the end of 9 months. Seeds with a radicle length of 1 cm (⅜ in) or greater were considered to have germinated. Eight replications of 5 seeds per flat were used for all experiments.

In order to determine the effect of light on germination, seeds with the pulp intact were germinated in the light or wrapped in 3 layers of black cloth. Black cloth was removed in order to water the seeds and then replaced.

The effect of scarification was determined by depulping the seeds then submerging them in concentrated sulfuric acid for 0.5, 1.0, 1.5 or 2 hr. The container with the acid and seeds was cooled by placing the container in a cold, running water bath. Control treatments consisted of seeds planted with and without the pulp. Seeds were germinated in the dark as previously described.

The third experiment was designed to determine the effect of GA. Seeds were depulped, cracked with a wooden mallet and submerged in solutions of 0, 500, 1000 or 5000 ppm GA_3 for 12 hr. The seeds were germinated in the dark under greenhouse conditions as previously described.

Seeds with the pulp intact were stored dry, at room temperature (25 ± 2°C, 77 ± 3°F) for 6 months. At the end of the storage the seeds were depulped and the seed coat was cracked with a wooden mallet. Seeds were germinated in the dark as previously described except that germination was evaluated after 3 months rather than 9 months.

Results and Discussion

The exclusion of light during germination more than doubled seed germination (Table 1). Germination for both treatments was completed after 6 months with the exception of one additional seed that germinated in the dark. Although temperature may be a factor in the dark treatment, results of a preliminary study indicate that increasing the germination temperature above 30°C (86°F) does not improve germination. Based on the results of this experiment, seeds in all future studies were germinated in the dark.

Depulping cycad seeds resulted in an increased germination (Table 2), possibly indicating the presence of an inhibitor in the sarcotesta or pulp. In addition, acid scarification increased seed germination with the greatest percent germination occurring at 1.5 hr (Table 2) indicating that the sclerotesta or hard seed coat poses a barrier to germination.

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Table 1. **Effect of light and dark on germination of cycad seed with pulp intact after 9 months.**

Treatment	Germination (%)
Light	7.5 a[z]
Dark	20.0 b

[z]Significant treatment effect determined by Fisher's F-Test, 5% level.

Table 2. **Effect of depulping and acid scarification on cycad seed germination in the dark after 9 months.**

Treatment (hr)	Germination (%)
Control (with pulp)	17.5
Control (depulped)	45.0
0.5	60.0
1.0	55.0
1.5	62.5
2.0	47.5
	q[z]

[z]Significant quadratic (q) relation determined by regression, 5% level.

Other studies have noted increased *Cycas* and *Zamia* seed germination following scarification by acid or mechanical means (5, 8, 9). It should be possible to use any method of seed scarification that breaks the integrity of the sclerotesta without damaging the embryo to improve germination.

GA treatments did not affect cycad seed germination (Table 3). Seeds were cracked prior to treatment with GA so that absorption of the treatment solution should not have been a limiting factor. These results conflict with studies published for other cycads including *Zamia* (1, 5). This disparity may be due to the length of time the seeds had been in storage or the conditions of storage. Many cycad seeds are shipped by boat for great distances under variable conditions. Additionally, seed may be stored at various temperatures and durations after shipping. These differences in storage can affect viability and germination vigour.

The effect of storage on germination is supported by the results of the final experiment were seeds stored at 25°C (77°F) for 6 months germinated 36% in three months. Seeds in the other experiments showed very little germination by this time. This percentage is comparable to that obtained for depulped seeds after 9 months. Thus it appears that age of the seed, regardless of whether it is planted or stored dry, is a major factor determining the germination of cycad seed. Storage at temperatures of 18° to 25°C (65° to 77°F) has also been suggested by other authors (5).

Table 3. **Effect of GA soak on depulped cycad seed germination in the dark after 9 months.**

Treatment (ppm)	Germination (%)
0	50.0
500	42.5
1000	32.5
5000	30.0
	NS[z]

[z]No significant differences (NS) as determined by Fisher's F-Test, 5% level.

Due to the variability and length of time required for cycad seed germination, tissue culture may be a viable alternative to produce more uniform plants at a lower cost. Preliminary studies indicate that it is possible to successfully culture immature *C. revoluta* embryos on a modified Murashige and Skoog medium (4). Culture of megagametophytes has previously been reported (2).

Significance to the Nursery Industry

The results of this study indicate that germination of cycad seed in the dark improves germination. The pulp appears to contain an inhibitor to germination. Removal of the pulp and scarification resulted in the best germination. Treatment with concentrated sulfuric acid for 1 or 1.5 hr can be used for scarification. GA did not affect seed germination, contrary to some other studies. It is suggested that storage conditions and length of time in storage can greatly affect cycad seed germination.

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