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Viability of Venus flytrap (*Dionaea muscipula*) seeds: duration of viability and comparison of water versus conventional soil germination techniques

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Abstract: *Dionaea muscipula* seed viability beyond 140 days has not been systematically evaluated since Roberts and Oosting (1958), and no published study has compared water germination to conventional soil germination. Seeds of four age groups (2, 14, 26, and 38 months) were germinated using both methods; germination rates and time to germination were recorded weekly over 14 weeks. Seeds remained viable up to 14 months under both methods; seeds 26 months and older were nonviable. Soil germination yielded higher germination percentages (80% vs. 66% for 2-month seeds; 52% vs. 24% for 14-month seeds) and faster germination times. These results extend the known viability window beyond the 140-day threshold reported in 1958 and indicate that conventional soil germination is superior to water germination in both percentage and speed.

Introduction

The Venus flytrap (*Dionaea muscipula*) is a monotypic carnivorous plant native to coastal bogs in North and South Carolina, USA (Roberts & Oosting 1958). Widely cultivated by hobbyists and used for educational purposes, seed propagation is an important means of producing new plants, yet practical knowledge of seed viability under common storage conditions remains limited.

Roberts and Oosting (1958) found that germination of unstratified seed averaged 87% for seeds up to 40 days old, 56% for seeds 40–60 days old, approximately 2% for seeds 60–100 days old, and 0% after 140 days. More recently, Ballesteros *et al*. (2025) reported 0–2% germination in room-temperature-stored seeds approximately 19.2 months old. No other published studies have tested whether *Dionaea* seeds can remain viable beyond 140 days under standard, unrefrigerated conditions.

A novel germination technique—water germination, in which seeds are placed directly in distilled water rather than sown on a substrate—has been adopted by some hobbyist growers but has not been evaluated against conventional soil germination in any controlled study. It has been speculated that water germination might benefit older seeds by restoring internal moisture lost during storage.

The present study addresses both gaps. The primary objectives were: (1) to determine the upper limit of *Dionaea* seed viability under ambient storage conditions; and (2) to compare germination percentage and time to germination between water germination and conventional soil germination across seeds of varying ages.

Hypotheses

(1) Mean time to germination will increase with seed age, and the percentage of seeds failing to germinate will increase with age, with seeds becoming entirely nonviable at some point.

(2) Water germination may improve viability or reduce time to germination for older seeds, as seeds that have lost internal moisture during storage may benefit from direct water contact.

Materials and methods

Plant material

Dionaea muscipula seeds of four age groups were used: 2, 14, 26, and 38 months post-harvest. All seeds were from a single pot of an all-green *Dionaea* plant and stored under ambient conditions (19–23°C, 40–60% humidity, in sealed glassine envelopes) prior to the experiment. Seeds were not cold-stratified prior to use.

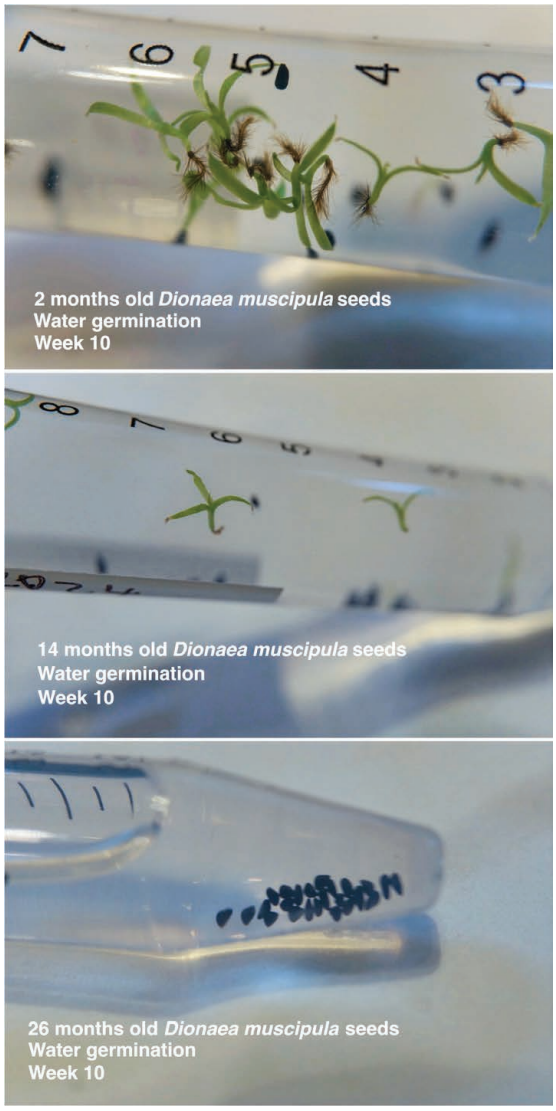

Figure 1. Water germinated *Dionaea* seeds of varying seed age.

Water germination

For water germination, 25 seeds were placed in a 15 mL sterile disposable conical tube filled with 10 mL of distilled water (Fig. 1). There are two tubes each containing 25 seeds (50 total) in each of four age groups—a total of eight tubes in the experiment (two tubes per age × four ages). Tubes were placed in a test tube rack on a south-facing window sill providing natural ambient light. Temperature was maintained at 19–23°C.

Conventional soil germination

For conventional soil germination, 25 seeds per age group were sown on the surface of peat-based medium (3 parts peat moss : 1 part silica sand : 1 part perlite) in individual plastic pots. Pots were bottom-watered with distilled water and covered with a humidity dome. Full-spectrum LED grow lights (380–800 nm) were set to a 12-hour photoperiod. Temperature was maintained at 19–23°C.

Data collection

The number of germinated seeds per tube or pot was recorded weekly. Germination was defined as emergence of the radicle or visible seedling growth. Observations continued for 14 weeks. Results are reported as percentage germination and mean and median time to germination in weeks.

Results

Seed age and viability

Venus flytrap seeds showed a clear age-dependent decline in viability (Table 1). Seeds 2 months old showed the highest germination rates under both methods; 14-month-old seeds germinated at substantially reduced rates. Seeds 26 and 38 months old showed 0% germination under both methods and were considered nonviable. These results indicate a viability window ending between 14 and 26 months under ambient storage conditions, extending the known threshold considerably beyond the 140 days (~4.7 months) reported by Roberts and Oosting (1958).

Comparison of germination methods

Conventional soil germination outperformed water germination in both percentage and speed across all viable seed age groups (Fig. 2). For 2-month-old seeds, soil germination achieved 80% (20/25 seeds; mean 4.8 weeks, median 3.0 weeks) compared to 66% (33/50 seeds; mean 8.0 weeks, median 9.0 weeks) via water germination. For 14-month-old seeds, soil germination achieved 52% (13/25 seeds; mean 6.5 weeks, median 6.0 weeks) compared to 24% (12/50 seeds; mean 9.4 weeks, median 10.0 weeks). Water germination technique did not result in germination in 26- or 38-month seed cohorts.

Table 1. Germination results for Venus flytrap seeds by age and germination method.

Seed Age (months)	Germination Method	Germination (%)	Weeks to Germination	
			mean	median
2	Water	66% (33/50)	8.0	9.0
2	Soil	80% (20/25)	4.8	3.0
14	Water	24% (12/50)	9.4	10.0
14	Soil	52% (13/25)	6.5	6.0
26	Water	0% (0/50)	N/A	N/A
26	Soil	0% (0/25)	N/A	N/A
38	Water	0% (0/50)*	N/A	N/A
38	Soil	0% (0/25)	N/A	N/A

*One tube of 38-month-old seeds (n = 25) was contaminated with fungus at week 3 and excluded from analysis.

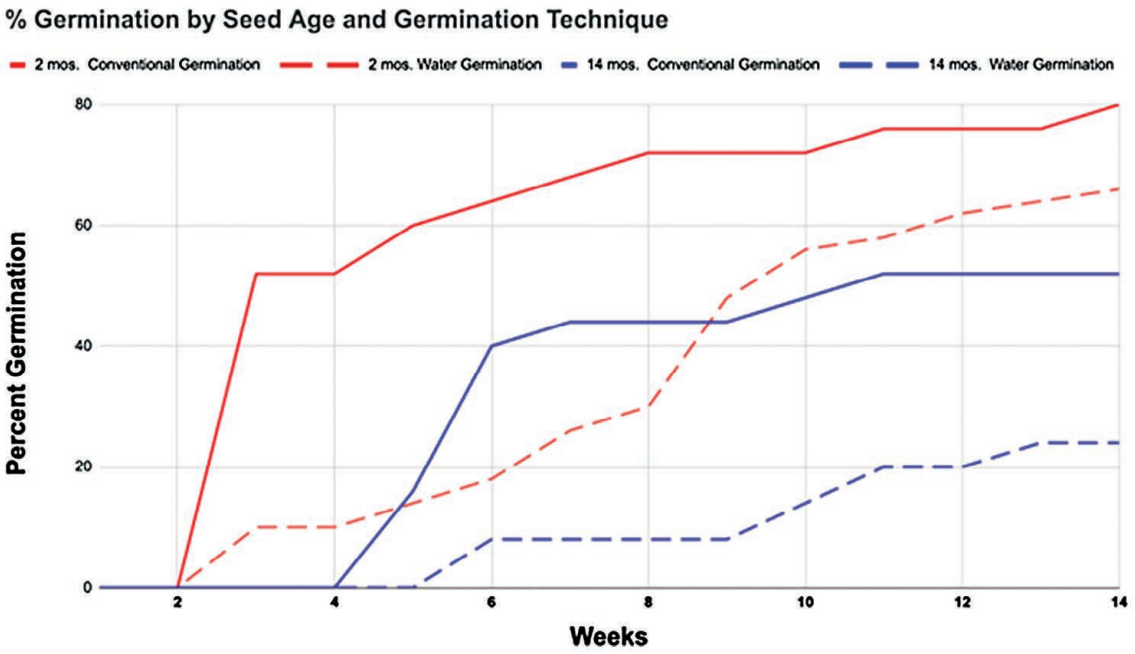

Figure 2. Percent germination by seed age and germination technique. Red lines represent 2-month-old seed; blue lines represent 14-month-old seed. Dashed lines represent water germination; solid lines represent soil germination.

Discussion

This study provides the first documented evidence of non-cold-stored *Dionaea* seed viability beyond 140 days since Roberts and Oosting (1958) and is the first controlled comparison of water germination versus conventional soil germination. Two key findings emerge.

First, Venus flytrap seeds retained viability at 14 months under ambient storage conditions, but no germination was observed in seeds 26 months or older, establishing a practical viability window of 14–26 months. This is broadly consistent with Ballesteros *et al*. (2025), who reported 0–2% germination in seeds approximately 19.2 months old under laboratory conditions. The reasons for the discrepancy with Roberts and Oosting (1958) are unclear but may reflect differences in storage conditions or seed source. Growers should treat unrefrigerated seeds stored beyond 26 months as nonviable.

Second, soil germination was clearly superior to water germination in both germination percentage and speed, by approximately 3–4 weeks across both viable age groups. Contrary to our hypothesis, water germination did not improve outcomes for older seeds. The inferior performance of water germination may reflect differences in light conditions (windowsill vs. LED), the absence of physical substrate support, or suboptimal oxygen availability in the water column. Future studies could control for light to isolate the effect of germination medium alone.

This study also demonstrates that cold stratification is not necessary for high germination rates with fresh seeds. Roberts and Oosting (1958) noted that cold stratification maintained high germination rates through nine months of cold storage. Ballesteros *et al*. (2025) applied 8 weeks of

cold stratification to seeds already 19.2 months old and observed only 0–2% germination. Whether refrigerated storage could extend viability beyond 14 months remains an open question.

Conclusions

Dionaea muscipula seeds stored at ambient temperature retain viability for up to 14 months; seeds 26 months and older are nonviable. Conventional soil germination on peat-based media is superior to water germination in both germination percentage and time to germination and is the recommended method for hobbyists and growers. Cold stratification is not necessary for germination of fresh seeds, though cold storage may extend long-term viability.

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