HRI's Mission:

To direct, fund, promote and communicate horticultural research, which increases the quality and value of ornamental plants, improves the productivity and profitability of the nursery and landscape industry, and protects and enhances the environment.

Effect of Pericarp Removal, Gibberellic Acid Treatment, and Stratification on Seed Germination of *Abelia* ×*grandiflora*[1]

S.M. Scheiber[2] and Carol D. Robacker[3]
Department of Horticulture, University of Georgia
Griffin, GA 30223

Abstract

Seed germination within *Abelia* R. Br. spp. has been described as slow and inconsistent. An experiment was conducted with seeds of *Abelia* ×*grandiflora* (André) Rehd. (glossy abelia) to test procedures to increase germination percentage, uniformity and rate. The effect of pericarp removal was examined on seeds with no additional treatment, and on seeds that were stratified (moist-prechilled) for 60 days at 4C (39F) or immersed in 100 mg/liter gibberellic acid for 24 hr. Treatments were replicated five times with 15 seeds per replication. Seeds were sown on sphagnum peat, and germinated under mist in a greenhouse. Weekly germination counts were recorded for 8 weeks. Seeds with intact pericarps germinated at a significantly higher percentage than those without pericarps. Stratified seeds germinated in fewer days than the other treatments. The combination of stratified seeds with intact pericarps gave the best overall response, with final germination of 62% and a reduction in germination time to 14 days (to reach 90% final germination) as compared to 35 days for untreated seeds.

Index words: achene, GA_3, plant propagation.

Significance to the Nursery Industry

Abelia ×*grandiflora* (glossy abelia) is widely used in the landscape. Most new cultivars of *Abelia* ×*grandiflora* have arisen from sports of other cultivars, rather than through seedling selection, which would generate greater variability. Hybridization followed by selection among seedlings is needed to produce new cultivars with improved cold hardiness, novel foliage and flower colors, and compact form. Seed propagation is essential for breeding programs. Since only one seed is obtained per pollination in *Abelia*, numerous pollinations must be performed to obtain the large quantities of seeds needed. Germination is slow and nonuniform, and percentage germination is often low. This study demonstrated that stratification (moist-prechilling) for 60 days at 4C (39F) improved uniformity of germination and significantly reduced the time for seed germination.

Introduction

Abelia ×*grandiflora* is an important shrub in the nursery and landscape industries. It flowers from May to frost, has an abundance of pinkish-white flowers, and glossy semi-evergreen foliage (evergreen in mild climates) (1, 3, 7). However, the flowers are small and only mildly fragrant, and the plants are not hardy below –20C (–4C) or zone 6 (1, 3, 7). Nurseries and gardeners are interested in new *Abelia* cultivars with increased cold hardiness, richer pink-rose flower colors, unique foliage colors, and compact growth habits (4).

Abelia taxa are reproduced commercially by rooting semihardwood or hardwood cuttings. Seed production is considered undesirable because *Abelia* fruits mature over a long time period, and the seedlings are highly variable (5). Although sexual reproduction is undesirable from a commercial standpoint, seed propagation is essential for breeding and selection programs. Since only one seed is obtained per pollination in *Abelia* and most cultivars are self-incompatible, numerous pollinations must be performed to obtain the large quantities of seeds needed to conduct a breeding program. Increased germination percentages and uniformity are critical for the development of new cultivars. However, little information on seed germination requirements is available.

Our observations of nontreated open-pollinated seeds of *A. chinensis* R. Br. (Chinese abelia) indicated that germination was slow and nonuniform. Seeds sown in December 1997 did not begin to germinate until February 1998, with seedlings emerging sporadically over several weeks. Similar germination patterns were observed of seeds derived from interspecific crosses and germination percentages were ~ 50%.

Inhibition of seed germination can result from hardened seedcoats, embryo dormancy, or a combination of both factors termed double dormancy (2, 5). *Abelia* fruit is a one-seeded, leathery achene. The dry, indehiscent pericarp of the achene can mimic the function of a seedcoat and delay, reduce, or suppress germination. The pericarp can be a source of inhibitory compounds, prevent inhibitory compounds from leaving the embryo, interfere mechanically with radicle protrusion, or inhibit water imbibition or gas exchange (2). Removal or weakening of the pericarp has been shown to increase germination percentages and rates in *Rosa multiflora* Thunb. (Japanese rose) and *Anthemis cotula* L. (mayweed) (6, 17). Seeds with embryo dormancy are prevented from germinating even when environmental conditions are optimum for germination. The embryo must undergo an after-ripening period to induce the biochemical processes necessary for germination (2, 5, 11). Stratification and/or gibberellic acid (GA_3) treatments have proven useful for overcoming dormancy requirements. Incorporating 100 mg/liter (100 ppm) GA_3 into the germination medium of *Helianthus annuus* L. (wild sunflower) and *H. petiolaris* Nutt. (wild sunflower) overcame achene dormancy (13). Upfold and Van Staden (15) reported that achenes of *Tithonia rotundifolia* Mill. (Mexican sunflower) must undergo a 12-week after-ripening treatment for maximum germination to occur and that treatment

[1]Received for publication May 31, 2002; in revised form November 25, 2002.

[2]Graduate Student. Currently: Assistant Professor, Mid-Florida Research & Education Center, 2725 Binion Rd., Apopka, FL 32703.

[3]Associate Professor and corresponding author.

Table 1. Final germination percentages and nonlinear regression parameter estimates for germination of *Abelia* ×*grandiflora* from seeds with and without pericarps.

Treatment	β_0[z]	β_1[y]	β_2[x]	r^2
GA_3				
Seeds with pericarps	56.3a[w]	0.2a	38.0a	0.82
Seeds without pericarps	38.4b	0.4a	19.1b	0.86
Stratification				
Seeds with pericarps	62.5a	0.6a	15.4a	0.78
Seeds without pericarps	34.2b	0.5a	11.0b	0.31
Control				
Seeds with pericarps	56.1a	0.2a	37.8a	0.82
Seeds without pericarps	48.9a	0.3a	21.4b	0.81

[z]Final germination percentage.

[y]Relative rate of germination.

[x]Time (days) until 90% of final germination was reached.

[w]Parameter separation within pericarp treatment. Parameter separation determined by 95% asymptotic confidence intervals.

with GA_3 stimulates germination. Stratification promoted germination of dormant achenes of *Polygonom convolvulus* L. (Wild buckwheat), *Solidago* L. spp. (Goldenrod), and *Bidens laevis* L. (Bur-marigold) (8, 9, 16). In the present study, pericarp removal, GA_3 treatment, and stratification were tested as a means of increasing seed germination percentages and rates of *A*. ×*grandiflora*.

Materials and Methods

Seeds of self-pollinated *A*. ×*grandiflora* were collected from a stock plant maintained under greenhouse conditions at the Georgia Station, Griffin, GA, in December 1998, and were stored in paper envelopes at 22C (72F). Seeds of *A*. ×*grandiflora* are small, with ~ 9,500 seeds/28 g (1 oz). To test the effect of pericarp removal, the pericarps of one half of the seeds were removed with the aid of a stereomicroscope. Pericarps were removed from seeds immediately prior to any subsequent treatment. Seeds with pericarps and without pericarps were given either a stratification treatment, a GA_3 treatment, or no treatment. Seeds to be stratified were mixed with moist, milled sphagnum peat, sealed in polyethylene bags, and placed in the dark for 60 days at 4C (39F). GA_3-treated seeds were immersed in 100 mg/liter (100 ppm) GA_3 at 22C (72F) for 24 hr and were sown immediately following treatment. All seeds were sown in February 1999. Seeds were sown uncovered into flats filled with milled sphagnum peat, and germinated under mist (10 sec every 32 min) with bottom heat [22C (72F)] in the greenhouse. The experiment was conducted as a 2 × 3 factorial of pericarp removal and seed treatments (total treatments = 6). Due to the difficulty of obtaining a large quantity of seeds, each treatment consisted of five replicates with 15 seeds per replication. Treatments/replications were completely randomized on the mist bench. Weekly germination counts were recorded for 8 weeks. Seeds were considered germinated when the hypocotyl had emerged.

Statistical data were sorted by presence or absence of the pericarp and seed treatments and were modeled and analyzed using the following logistic growth function (12):

$$Y = \beta_0 / \{1 + [(1 - p) / p]\, e^{[-\beta_1(day - \beta_2)]}\}$$

where β_0 = asymptote of final germination percentage, β_1 = relative rate of germination, β_2 = time until asymptote of p is reached, and p = point where a predetermined value of maximal germination is obtained (90%). Significant differences among parameters were determined using 95% confidence intervals.

Results and Discussion

Seeds with pericarps had a significantly higher final germination percentage than those without pericarps for both the gibberellic acid (56% vs. 38%) and the stratification (62% vs. 34%) treatments . Presence of pericarp had no effect on final germination percentage of nontreated seeds (Table 1, Fig. 1). Rate of germination was similar for all treatments, though seeds without pericarps reached 90% of final germination in significantly fewer days than seeds with pericarps (Table 1, Fig.1). Apparently, the pericarp delayed germination, perhaps by serving as a barrier to imbibition.

The reduction in final germination percentage of seeds following pericarp removal may have been due to the vulnerability of the unprotected embryo to damage from the GA_3 and stratification treatments. Pericarps imitate the function

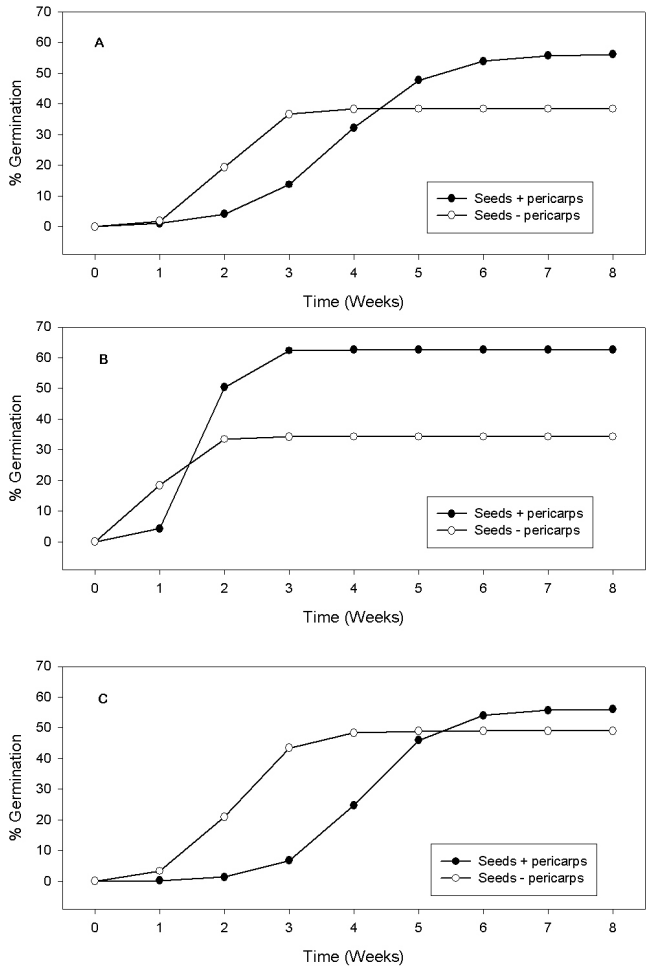

Fig. 1. Germination of *Abelia* ×*grandiflora* from seeds with and without pericarps following: A. immersion in gibberellic acid (GA_3) at 100 mg/liter (100 ppm) for 24 hr; B. stratification for 60 days at 4C (39F); and C. no treatment. Each point is a mean of 75 observations. Model parameter estimates are presented in Table 1.

Table 2. Final germination percentages and nonlinear regression parameter estimates for germination of *Abelia* ×*grandiflora* seeds with pericarps following immersion in gibberellic acid, stratification, and no treatment.

Treatment	β_0[z]	β_1[y]	β_2[x]	r^2
Gibberellic Acid (GA_3)	56.3a[w]	0.2a	37.4b	0.82
Stratification	62.5a	0.6a	15.4c	0.78
Nontreated (control)	56.1a	0.2a	37.8a	0.82

[z]Final germination percentage.

[y]Relative rate of germination.

[x]Time (days) until 90% of final germination was reached.

[w]Parameter separation among treatments of seeds with pericarps. Parameter separation determined by 95% asymptotic confidence intervals.

of a seedcoat by providing structural protection from interactions with the environment, pathogens, insects, and chemicals (2). Following the stratification treatment, fungal growth was observed on some of the seeds without pericarps. On the stratified seeds with pericarps, this was not observed. Removal of the pericarp may have allowed entry of microorganisms which damaged the embryo during stratification. In the gibberellic acid treatment, direct penetration of GA_3 to the unprotected embryo may have reduced the germination percentage due to a concentration effect. Shahi et al. (14) reported that *Cymbopogon martini* Stapf. (Palmarosa) and *Cenchrus ciliaris* L. (Buffelgrass) treated with 5 mg/liter (5 ppm) GA_3 germinated at 68% and 98%, respectively, but treatment with 20 mg/liter (20 ppm) GA_3 reduced germination relative to the control. 'Swingle' Citrumelo seeds immersed in 50 mg/liter (50 ppm) GA_3 increased germination percentages by 10% relative to the control, but immersion in 250 mg/liter (250 ppm) GA_3 reduced germination (10).

Stratified seeds with pericarps reached 90% maximum germination in fewer days than the GA_3-treated seeds or the nontreated seeds (Table 2, Fig. 2). Between days 7 and 14, germination of stratified seeds increased by 47%. By day 14, stratified seeds attained 90% of maximal germination or 51% germination compared to 1% and 0% germination for seeds receiving GA_3 or no treatment, respectively. For GA_3-treated seeds and nontreated seeds, 90% of maximal germination was not achieved until 35 days. No significant difference among treatments for final germination percentage or relative rate of germination was observed. Walck et al. (16) reported a similar decrease in time for initiation of germination for *Solidago altissima* L. (Tall Goldenrod), *S. nemoralis* Ait. (Gray Goldenrod), and *S. shortii* Torr. & Gray (Short's Goldenrod) achenes (seeds with pericarps) following a 12-week stratification period.

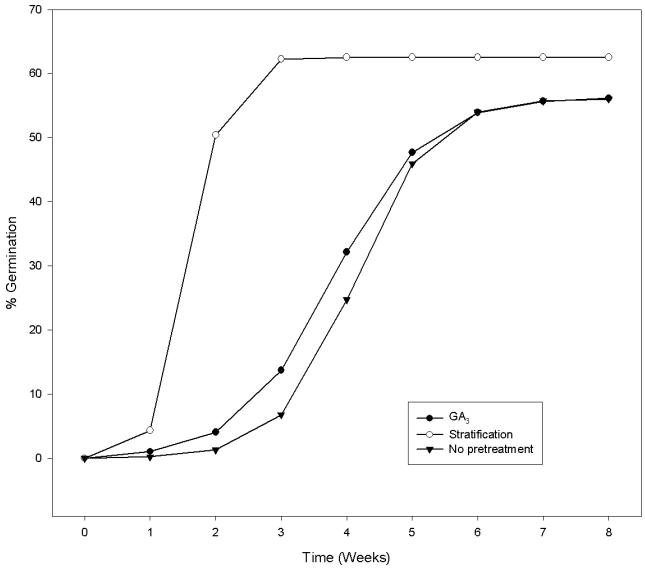

Fig. 2. Germination of *Abelia* ×*grandiflora* from seeds with pericarps subjected to stratification for 60 days at 4C (39F), immersion in 100 mg/liter gibberellic acid (GA_3) for 24 hr, or no treatment. Each point is a mean of 75 observations. Model parameter estimates are presented in Table 2.

The highest germination achieved in this study with *A.* ×*grandiflora* was 62%, indicating that 38% of the seeds did not germinate. Whether these seeds failed to germinate due to nonviability or some other factor was not determined. Additional studies to assess the viability of the seeds through use of tetrazolium staining and examination of dissected seeds with a stereomicroscope is needed. We have conducted such studies on seeds of interspecific hybrids of *Abelia*, and discovered that in about half of the seeds the embryo has aborted. Similar studies on seeds from crosses/selfs within *A.* ×*grandiflora* were not performed due to the inability to generate sufficient seeds as a result of self-incompatibility.

In summary, stratification of seeds of *Abelia* ×*grandiflora* with pericarps was the best treatment. Seeds with intact pericarps had a higher final germination percentage than seeds with pericarps removed; seeds that received stratification germinated more uniformly and in significantly fewer days than the other treatments. Though the final germination percentage was not higher for stratified seeds compared to control seeds, the uniform germination and reduction in time of germination is advantageous because less time on the germination bench tends to reduce seedling losses, is more efficient, and yields a more uniform seedling population for evaluation in the breeding program.

Literature Cited

1. Bean, W.J. 1970. Trees and Shrubs Hardy in the British Isles. 8th ed. Vol. I. John Murray Ltd., London.

2. Bousewinkel, F.D. and F. Bouman. 1995. The seed: Structure and function. p. 1–24. *In*: J. Kigel and G. Galili (Editors). Seed Development and Germination. Marcel Dekker, Inc. New York.

3. Dirr, M.A. 1998a. Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses. 5th ed. Stipes Publishing Co. Champaign, IL.

4. Dirr, M.A. 1998b. Promise of seeds is beyond our imagination. Nursery Management and Production 14(10):14–15, 91–93.

5. Dirr, M.A. and C.W. Heuser, Jr. 1987. The Reference Manual of Woody Plant Propagation: From Seed to Tissue Culture. Varsity Press, Inc., Athens, GA.

6. Gealy, D.R., F.L. Young, and L.A. Morrow. 1985. Germination of mayweed (*Anthemis cotula*) achenes and seed. Weed Sci. 33:69–73.

7. Krussmann, G. 1985. Manual of Cultivated Broadleaved Trees and Shrubs. Vol. I. Timber Press, Portland, OR.

8. Leck, M.A., C.C. Baskin, and J.M. Baskin. 1994. Germination ecology of *Bidens laevis* (Asteraceae) from a tidal freshwater wetland. Bul. Torrey Bot. Club 121:230–239.

9. Metzger, J.D. 1992. Physiological basis of achene dormancy in *Polygonum convolvulus* (Polygonaceae). Amer. J. Bot. 79:882–886.

10. Ono, E.O., S. Leonel, and J.D. Rodrigues. 1995. Effect of growth regulators on seed germination in 'Swingle' citrumelo. Semina 16:47–50.

11. Salisbury, F.B. and C.W. Ross. 1992. Plant Physiology. 4th ed. Wadsworth Publishing Co., Belmont, CA.

12. SAS Institute, Inc. 1990. SAS User's Guide: Statistics. 6th ed.. SAS Inst., Inc., Cary, NC.

13. Seiler, G.J. 1998. Seed maturity, storage time and temperature, and media treatment effects on germination of two wild sunflowers. Agron. J. 90:221–226.

14. Shahi, A.K. and D.N. Sen. 1991. Effect of GA on seed germination of aromatic and some fodder grasses of Indian desert. Res. Dev. Rptr. 8:80–81.

15. Upfold, S.J. and J. Van Staden. 1990. The germination characteristics of *Tithonia rotundifolia*. Ann. Bot. 66:57–62.

16. Walck, J.L. J.M. Baskin, and C.C. Baskin. 1997. A comparative study of the seed germination biology of a narrow endemic and two geographically-widespread species of *Solidago* (Asteraceae). 1. Germination phenology and effect of cold stratification on germination. Seed Sci. Res. 7:47–58.

17. Yambe, Y. and K. Takeno. 1992. Improvement of rose achene germination by treatment with macerating enzymes. HortScience 27:1018–1020.