Effects of Cold Stratification, Warm-Cold Stratification, and Acid Scarification on Seed Germination of 3 Crataegus Species.

Greg Morgenson

Nursery manager, Lincoln Oakes Nurseries, Bismarck, North Dakota

Successful germination of seeds of downy hawthorn (Crataegus mollis *Scheele) and Arnold hawthorn 'Homestead'* (C. x anomala *Sarg.) required at least 60 days of warm stratification at 18 to 22 °C* (64 *to 72 °F) followed by 120 days or more cold stratification at 2 to 4 °C (36 to 40 °F). Acid scarification of these two species was not beneficial to germination. Fireberry hawthorn* (C. chrysocarpa *Ashe) required at least 90 to 120 days warm stratification followed by 120 days or more of cold stratification to initiate significant germination. Cold periods of 180 or 240 days following warm stratification resulted in excessively elongated radicles in stratification. Acid scarification may be of benefit in the germination of fireberry hawthorn.* Tree Planters' Notes 49(3): 72-74; 2000.

The genus *Crataegus* occurs across North America, with many species, varieties, and forms having been identified and named. Many of these identities are no longer valid. Despite the taxonomic confusion, the hawthorns as a group are increasingly being used in reclamation, wildlife, and environmental plantings. Planting programs for reestablishing naturally occurring flora use native hawthorns to provide cover and food for wildlife. In addition, a number of ornamental selections have been introduced that exhibit superior form (figure 1), flowering, foliage quality, disease resistance, and showy fruit production (cover photograph). Most of these selections are budded on seedling rootstocks.

Propagation of hawthorn by cuttings is difficult at best, and propagation from seed can be disappointing if the proper sequence of treatments is not known and followed. Consistent year-to-year availability of seedlings is dependent upon proven workable seed treatments.

Procedures for germinating *Crataegus* seeds have been published (Dirr and Heuser 1987, Young and Young 1992), but these have not been found to work at the Lincoln Oakes nursery in Bismarck, ND. Hawthorn seed has embryo dormancy, and many species have a hard, thick endocarp that may inhibit germination (Vanstone and others 1982). A series of temperature stratifications and acid scarification treatments were evaluated for breaking seed dormancy in 3 hardy *Crataegus* species: downy hawthorn *(C. mollis* Scheele), Arnold hawthorn 'Homestead' *(C. xanomala* Sarg.) (USDA 1994), and fireberry hawthorn *(C. chrysocarpa* Ashe). *Crataegus anomala* is widely known in the nursery trade as Arnold hawthorn so this is the common name used here for ease of name recognition to the practitioner. The 3rd species has carried the identifications C. *chrysocarpa,* C. *succulenta, C. rotundifolia,* and C. *inacrantlia; C. chrysocarpa* is used in this paper according to Stephens (1973).

Figure *1—Winter plant form of Arnold hawthorn 'Homestead'* (Crataegus Xanomala *Sarg.) showing uniformity of crown size and shape (© photograph by Greg Morgenson).*

Methods

Downy hawthorn and Arnold hawthorn (USDA 1994) ripen their fruits in late August through early September in Bismarck, ND. Both species bear nonpersistent fruits that abscise and fall to the ground when ripe. Fireberry hawthorn fruits ripen in September and are somewhat persistent into winter. Fruits of the 3 *Crataegus* species were collected when fully ripe (figure 2). Pulp was removed by wet maceration. The very hard stony endocarp made cutting tests impractical for determining the full seed percentage. Instead, all depulped seeds were floated in water several times to remove empty seeds. Seeds were air-dried and stored at 4 °C (40 °F) until treated to break dormancy.

Seeds of each species were counted into sublots of 100 for each treatment, and each treatment was replicat-

Figure *2—Fruit collection from Arnold hawthorn 'Homestead'* (Crataegus xanomala *Sarg.) on fabric mats (©) photograph by Greg Morgenson).*

ed 4 times for 400 seeds per species-treatment combination. Seeds were stratified in damp peat moss in polyethylene bags for the warm and cold stratification periods (table 1). Length of stratification ranged from 0 to 360 days in varying combinations of warm and cold periods. One treatment consisted of 2 cycles of warm-cold to determine whether a significant percentage of seeds that remained ungerminated after the 1st cycle would germinate after a 2nd treatment.

Concentrated sulfuric acid was used for the 2-hour acid soak. Immediately after the acid soak, seeds were thoroughly rinsed with water and treated with baking soda to neutralize the acid.

Seedlots were subjected to 2 to 4 °C (36 to 40 °F) for the cold treatment and 18 to 22 °C (64 to 72 °F) for the warm treatment. At the end of each stratification period, seeds were germinated at room temperature, which ranged from 20 to 25 °C (68 to 77 °F). Four germination counts were made at 7-day intervals.

Results

Seed of the 3 species had little or no response to the 2 cold treatments of 180 and 360 days, but did respond well to warm-cold treatments (table 1). Warm stratification for 60 to 120 days followed by cold stratification for 120 days produced the highest germination with minimal radicle emergence and elongation during stratification for downy hawthorn and Arnold hawthorn. However, the longer cold periods of 180 and 240 days resulted in excessive root elongation, which would make mechanical seeding difficult or impossible. Two cycles of 90 days of warm and 120 days of cold were comparable to a single cycle; only a few additional germinants were produced during the 2nd cycle with these 2 species.

Fireberry hawthorn did not respond to the cold treatments and responded only marginally to the addition of 60 days of warm preceding the cold stratification. Warm stratification of 90 to 120 days was required to initiate germination. The best treatment for this species was 2 cycles of warm-cold. After the 1st cycle, 71 germinants were obtained, and after the 2nd cycle, 78 additional germinants resulted. The longer cold periods of 180 and 240 days caused unacceptable radicle elongation in the stratification bags.

The 2-hour acid soak followed by 180 days of cold produced minimal or no germination for all 3 species. The prior acid treatment did not enhance the 60 days of warm and 180 days of cold on Arnold hawthorn and resulted in the total decay of downy hawthorn seeds in stratification. Acid treatment of fireberry hawthorn prior to warm-cold stratification did increase germination compared to warm-cold stratification without the acid treatment.

The greatest germination occurred in the first *7* days of each treatment. Only minimal germination occurred in the 2nd through the 4th weeks.

Discussion

Successful germination of downy hawthorn and Arnold hawthorn was achieved by the combination of at least 60 days warm stratification followed by 120 days or more of cold stratification. Midsummer (July) nursery planting in mulched moist beds has provided excellent germination results the following spring in North Dakota.

Seed germination of our local source of fireberry hawthorn requires at least 120 days warm stratification preceding the cold stratification. Further trials with longer warm stratification periods could be attempted to determine whether those treatments would overcome the apparent deeper dormancy in many of the seeds and provide more uniform germination. Acid scarification may be used to reduce the warm stratification period required for this species.

Results of these treatments are based on the germination of all seeds planted. Ideally, the seeds of *Crataegus* should be x-rayed to determine total filled seed percentages. A correction for the number of empty seeds would then give a more accurate measure of the success in overcoming the dormancy. These results do provide treatment information for nurseries handling bulk seedlots of these species.

Address correspondence to: Greg Morgenson, Nursery Manager, Lincoln Oakes Nurseries, 3310 University Drive, P.O. Box 1601, Bismarck, ND 58502; e-mail: > lincoln@tic.bisman.com <.

Table 1—*Three species of* Crataegus *(hawthorn): seed treatments and associated germination*[a]

Treatment		Arnold 'Homestead'		Downy		Fireberry	
Days at 18-22 °C	Days at 2-4 °C	No. of seedlings	% of 400 seeds	No. of seedlings	% of 400 seeds	No. of seedlings	% of 400 seeds
0	0	0	0	0	0	0	0
0	180	0	0	1	0	0	0
0	360	0	0	3	0	1	0
60	120	147	37[b]	202	51[b]	19	5[b]
60	180	140	35[c]	183	46[c]	18	5[b]
60	240	158	40[c]	185	46[b]	12	3[c]
120	120	170	43[b]	192	48[b]	71	18[b]
120	180	146	37[c]	200	50[c]	108	27[c]
120	240	179	45[c]	182	46[c]	106	27[c]
90	120 (2 cycles)[d]	149+7[d]	39[b]	168+2[d]	43[c]	71+78[d]	37[c]
0	acid+180[e]	9	2	7	2	0	0
60	acid+180[e]	104	26[c]	sr[f]	sr	84	21

[a]Arnold 'Homestead' (*C.* ×*anomala* Sarg.), downy (*C. mollis* Scheele), fireberry (*C. chrysocarpa* Ashe)
[b]Germination began in stratification with little or no radicle elongation.
[c]Germination began in stratification with excessively elongated radicles.
[d]Cycle repeated after 1 germination period; 2 sets of data represent 1st and 2nd germination results, respectively.
[e]Given a 2-hour acid soak before stratification.
[f]sr = seeds rotted in stratification

Acknowledgment

The author would like to thank Robert P. Karrfalt, Director of the USDA Forest Service's National Tree Seed Laboratory, Dry Branch, GA, for editorial assistance and manuscript revision.

References

Dirr MA, Heuser CW Jr. 1987. The reference manual of woody plant propagation. Athens (GA): Varsity Press. p 114-115.

Stephens HA. 1973. Woody plants of the north central plains. Lawrence(KS): University of Kansas Press. p 234-235.

USDA Soil Conservation Service. 1994. Release brochure for 'Homestead' Arnold hawthorn. Bismarck (ND).

Vanstone DE, Ronald WG, Marshall HH. 1982. Nursery propagation of woody and herbaceous perennials for the prairie provinces. Ottawa: Agriculture Canada. Publication 1733E. 51 p.

Young JA, Young CG. 1992. Seeds of woody plants in North America, revised and enlarged edition. Portland (OR): Dioscorides Press. p 124-126.