CONCLUSION

Seed has its place in the production of north American natives but the above methods of asexual propagation work well for our nursery operation. In each case blooming-size plants are produced faster than by using seed.

Commercial Propagation of *Trillium*

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INTRODUCTION

Trillium has a bad reputation. There's a prevailing sentiment among propagators that growing them from seed is difficult. I spoke to a number of you at the Eastern Region meeting in Newport, Rhode Island, in the fall of 1997 and you said, "it takes too long to grow to a saleable size and ties up valuable space in the nursery". When I mentioned vegetative propagation you said, "it doesn't produce the numbers necessary to be worth the effort". I also heard "there's very little demand." Finally, I got the feeling that you thought that no one was propagating trillium commercially.

Trillium doesn't deserve a bad reputation. Growing them from seed is not difficult. They can be brought to a saleable size in a relatively small amount of space in less time than you think. Vegetative propagation is a good method for certain species as well as cultivars and the double-flowered trilliums. A growing number of wholesale nurseries have made the commitment to propagate trilliums. They can't keep up with the demand!

GERMINATION

Understanding the germination process is the first step toward propagation. The seed has an appendage called an aril (or elaisome or strophiole depending on whom you talk to). The aril serves to attract ants and other insects who either eat the aril and discard the seed on the spot or take the seed back to their underground nest for a midnight aril snack eventually discarding the seed in their trash heap. It's been suggested that the aril should be removed prior to planting but that's labor intensive and unnecessary. If you are conducting a seed germination experiment under sterile conditions, it's advisable to remove the aril since a fungus in the aril may interfere with the experiment. The first step in the germination process is the splitting of the seed coat as the cells of the micropylar end of the seed enlarge. The root tip emerges through the enlarged collar followed by the immature rhizome. The root elongates and the rhizome enlarges. The petiole appears next followed by the cotyledon. The seed coat remains attached to the tip of the cotyledon until the cotyledon has absorbed the remaining food supply then drops off. Germination is completed during the first growing season for some species while others may exhibit a need for a subsequent cold period before cotyledon emergence.

FACTORS AFFECTING GERMINATION

A number of factors affect the germination process.

Moisture. The level of moisture within the seed is important. The germination percentage of the seed lot drops and the remaining ungerminated seed either go into a secondary dormancy or die if the seed are allowed to dry out. Short of soaking, if the seed is kept in constant contact with water, the germination percentage will be much higher. If you sow 100 seed in a flat and 50 come up, don't throw the flat away. Keep the flat moist and, over time, you may get close to 90% to 100% germination.

Temperature. Another factor affecting germination is temperature. Some species need a cold period for embryo maturation. Barton (1944) did research on *T. grandiflorum* and *T. erectum* and concluded that they had double dormancy and required two cold periods for complete germination. An initial cold period was needed for the emergence of the root and another cold period for the emergence of the cotyledon. In my work with seeds of *T. grandiflorum* and *T. erectum* gathered in Vermont I never saw a cessation of growth after the emergence of the root (under experimental conditions). The juvenile rhizome emerged right after the root followed by the petiole and then the cotyledon. The seed coat remained on the end of the cotyledon, shrinking as the cotyledon enlarged and eventually dropping off. As the cotyledon emerged, chlorophyll became evident. No second cold period was needed for complete germination. I suggest that these species have an embryo dormancy with a second cold period needed for cotyledon growth above the soil line rather than emergence from the seed. Patrick (1973) and Jacobs (1997) came to the same conclusion.

Germination Requirements May Vary Among Species. Many references on trillium propagation perpetuate the belief that all species have the same dormancy and that dormancy is a double dormancy. Don Jacobs, in his book *Trillium in Woodland and Garden*, says that while the northern species exhibit the need for a period of cold for embryo maturation, he has observed that other species do not have this requirement. He states, "that while it can be demonstrated that trilliums have a double dormancy and can take 6 to 10 seasons for flowering to commence, this is unnecessarily discouraging and simplistic". He goes on to state that many species germinate the following March after a July sowing at his site in Decatur, Georgia. Apparently one cannot make the assumption that every species of trillium will exhibit double dormancy.

Finally, date of collection and length of time at warm temperatures can affect dormancy. I have observed that *T. grandiflorum* seeds collected while still green but full size (early July in Vermont) will germinate with no cold period in the same season. Jacobs (1997) makes the same observation. Both Patrick (1973) and Jacobs (1997) observed that seeds will germinate if exposed to a sufficient length of warmth (~70F). This could be up to 10 or more months depending on the species.

TIME TO SALEABLE SIZE

Does it take too long to grow to a saleable size? What is a saleable size and how long does it take to attain that size? In preparation for this talk, I interviewed a number of commercial growers of trillium and their idea of what constituted a saleable size varied. A few sell seed-propagated, 4- to 6-year-old, flowering plants. One wholesale grower sells seed-propagated, immature, bareroot, 3-year-old plants while another sells vegetatively propagated, flowering, bareroot, 3- to 4-year-old plants. The key to attaining a saleable size is to maximize water availability and fertility for

optimum growth (Jacobs, 1997). Richard Fraser (1998), from Frasers Thimble Farm in British Columbia, claims to have 3-year-old plants as large as most 7-year-old plants. He recommends fertilizing 3 or more times a month with a weak solution of water soluble 20N-20P-20K fertilizer starting as soon as the plant is in active growth and stopping in July. Bill Cullina, of the New England Wildflower Society in Massachusetts, says that, while trillium benefit from a good water and fertility regime, they will only tolerate a certain amount of fertilizer before they go dormant and overwatering will result in root rot. British Columbia has a long, cool, wet growing season while the growing season in Massachusetts is shorter, warmer, and dryer in comparison. This suggests the location of your nursery will be a factor in determining water and fertility regimes.

VEGETATIVE PROPAGATION

If you want to sell many species of trillium, you have to do some vegetative propagation. Most growers who do seed propagation also propagate vegetatively. Seed of some species is difficult to find so growers have to acquire plants and propagate vegetatively to build up their stock. Up to 20 plants can be propagated from one plant in 3 to 4 years in this manner. If you are selling any of the cultivars or double trilliums, you can command high prices since they are much sought after by collectors. White Flower Farm, in Litchfield, Connecticut, offers a double-flowered *T. grandiflorum* every few years and it's always sold out immediately!

NURSERIES THAT PROPAGATE TRILLIUM

Is anybody in the business of propagating trillium? You bet! In 1995, Van Berkum Nursery in Deerfield, New Hampshire started growing trillium from seed with the eventual goal of selling 3- to 4-year-old preflowering plants. In August, they sow the seed ¼ inch deep in Fafard #2 medium in plastic seedling trays 12 inches × 24 inches. The trays are put outside in a shaded seedling bed under automatic overhead irrigation. In November the trays are covered with a foam mat which is removed as soon as the snow has melted and the temperature is above 0C (32F) at night (April). An upside-down seed tray separates the mat from the soil surface. In 1999 they will have saleable size plants. Peter Van Berkum tells me he doesn't know what price he will ask for these plants but he expects a 20% to 30% margin of profit. Peter Joppe, of Hillside Nursery in Shelburne, Massachusetts, does both seed and vegetative propagation depending on the species. He sells all species in ½-gal containers for $6.40 wholesale and retail for $12.70. His goal is to produce plants from seed to bloom in 4 years. Canada has quite a few wholesalers. Richard Fraser of Fraser's Thimble Farm on Salt Spring Island in British Columbia, sells seed-propagated, bareroot, immature *T. ovatum*. Landscapers buy them in bundles of 100 for woodland mass plantings. He also does a fair amount of vegetative propagation when he can't get enough seed. Majella Larochelle, of Seeds and Plants International, Canada, has hired local people to make an initial collection from their own property. He then teaches them how to propagate vegetatively. He states that there are several benefits from this method. The impact on the trillium population in their landscape is kept to a minimum while a sustainable crop is produced. Larochelle feels that vegetatively propagated plants have stronger root systems, are much healthier, and flower sooner. He then buys from this network of propagators and sells to local retailers while making a profit of 50%.

Tissue culture of trillium has, so far, eluded propagators. However, a nursery in New Zealand has apparently figured out a method. Barry Sligh of Taunton Gardens in Christchurch, New Zealand, is selling tissue-cultured *T. sessile* [however, they may be *T. chloropetulum* according to Jim McClements (1998)]. Heronswood Nursery, in Kingston, Washington is one source of Slighs' plants.

SUMMARY

In summary, commercial production of trillium is possible and profitable. If you wish to propagate trillium from seed, obtain fresh seed and sow it immediately. Maintain a level of moisture for optimum germination and subsequent growth while maximizing soil fertility. Transplant after the appearance of the cotyledon and grow on to saleable size. If you wish to propagate vegetatively, refer to Leo Blanchettes presentation titled "Asexual Propagation of *Dodecatheon, Trillium*, and *Anemonella*" in the 1998 I.P.P.S. Proceedings. For more details and other methods, read either *Trilliums* by Case or *Trilliums in Woodland or Garden* by Jacobs.

I hope I have convinced you to consider propagating trillium in your nursery. Richard Fraser from Fraser's Thimble Farm commented that there's a mind set against trillium propagation. He says, "propagating them is really no more different than propagating peonies or slow hostas". Based on the interviews I've conducted, I suggest that there is a growing movement among the nurseries specializing in native plant propagation to include trillium in their inventory. All express a commitment to nursery propagation for commercial production rather than wild collection. Examine your own mind set to see if you could have a change of heart. Then there truly would be "trilliums unlimited"!

(A list of nurseries which propagate trillium can be provided upon request.)

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RESOURCES

Internet: Trillium Listserve. Send an email to: listserv@nic.surfnet.nl

Type "subscribe Trillium-L, your name (not email name), location and USDA zone or minimum/maximum temperature" in message window.

Commercial Propagation of Hardy Geraniums: Techniques and Recommendations for Successful Production

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INTRODUCTION

My first introduction to hardy geraniums was as a child. In rich woodlands, meadows, and along roadsides in New England, the wild geranium or *Geranium maculatum* is abundant and a great treat for a small child to come across. It was not until my college years, many bouquets later, did I actually realize what a geranium was. The hardy geraniums, most commonly know as crane's bill geraniums, I will talk about today are members of the Geraniaceae family. I want to stress these are not the common tropical *Pelargonium* species, more commonly called geraniums, and that are frequently referred to in most literature as geraniums.

Hardy geraniums range in size from 4-inch specimens of *G. dalmaticum* to *G. psilostemon* that can reach 48 inches. The name, crane's bill, comes from the look of the enlarged seed pods, before they coil away from each other and disperse their seed. At White Flower Farm, I have seen an increased interest in geraniums, by our customers, in the past 5 years that I have been employed there. Much of this is a result of a fairly new horticultural team that has been stressing the merits of geraniums and initiating the trialing of them at White Flower Farm. This alone is not the sole reason for the increased number and changes in species being added to our mailorder catalog. If it wasn't for the interest of our customers, our nursery would not profit from adding new geranium taxa. The interest of gardeners, both experienced and novice, are contributing to the growth in hardy geranium sales. Most geraniums are easy to grow, and provide extended enjoyment for novices looking to try their hand at gardening. For the more advance gardener, the vast quantity of species and cultivars adds new opportunities to add to their collections.

My discussion will concentrate on the commercial propagation of "hardy" geraniums using examples from species I work with at White flower Farm. The majority of geranium taxa, for the commercial market, are produced by the division of "mother plants" with the few exceptions that are produced by basal and tip cuttings. Seed propagation in most circumstances is unreliable as far as germination rates and many do not come true to type. An alternate method of root cuttings is appropriate for select taxa, although yields tend to be lower, and the length of stay in propagation areas tends to increase.