ENHANCED GERMINATION TECHNIQUES

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You don't need a biotechnology lab to improve the germination of your aril and arilbred seeds. Here's a step-by-step guide.

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Seed handling begins the same way, whether you ultimately use direct planting, enhanced germination, forced germination, or embryo culture—so I'll start at the beginning.

Pod Patrol and Seed Harvest

After a couple of weeks, you'll be able to tell whether your cross "took." You'll probably want to go ahead and cut the bloomstalks that aren't supporting pods, both to make the garden look neater and to make "pod patrol" itself easier. After about five to six weeks, a pod will reach its full size. Pods from halfbred lines will usually be full and feel firm. Pods from wide crosses may be empty "balloons" that deflate when you squeeze them gently. Warning: don't test your pods by pinching them hard—you might dislodge the one or two precious seeds that may be forming.

As the pod ripens, its color will change from leaf green through pale greenish-yellow to tan. The pod wall will thin and, if it's full, you'll be able to see the outline of the seeds within it. After a couple of months the pod will be fully ripe, and a narrow slit will open up along one of its seams, exposing a few caramel-colored seeds. Wait for full pods to open spontaneously. If you have some scant pods from wide crosses, watch them carefully because they may need a bit of

help. If a scant pod turns from tan to brown and hardens but does not split, go ahead and pick it. At this point, it's wise to conduct a daily pod patrol to find and pick the ripened pods. The alternative is to pick the scattered seeds up off of the ground later, when you may not be sure which seeds came from which pod. (Yes, that's the voice of experience speaking! I've learned to make a master list of the ripening pods and follow a definite pattern for pod patrol, to make sure that I don't miss any beds as I cover the garden from one end to the other. Because I'm a fanatic about keeping records straight, I pick one cross at a time and carry the pod (or pods) into the house with the appropriate tag.)

Shell the seeds out of their pod, keeping their label with them. The next step will depend on whether you're planning to start processing the seeds immediately or store them. In most cases, it's strictly a matter of personal preference. Seeds from halfbred lines remain viable for years if stored under the right conditions, but it's best to process seeds from wide crosses immediately because they deteriorate more quickly in storage.

If you choose to dry the seeds, the next step is simple. Just spread them out in something saucer-shaped and leave them exposed to the air for a week or two—keeping the proper label with each cross. When the seeds are hard and shriveled up, they're ready to package. I use small coin envelopes to store my seeds, typing the pedigree, date, and number of seeds directly onto the envelope. If your handwriting is better than mine, you probably won't want to go to this much trouble—to me, legible labels are worth it. This way, the seeds can easily be taken out of storage and planted or processed at the appropriate time.

Preparing Seeds for Stratification

Preparing the seeds for immediate processing is just as easy. The goal is keeping them moist—neither so dry that they can't germinate, nor so wet that they will rot. Some people prefer flat dishes, some rely on jars, while others use sandwich bags.

Some have reported success with moistened pads made from blotting paper or paper towels. Others use vermiculite. There's clearly no one "right" way to do this, but many that work. The following is just what works for me.

My preference is perlite and pint-sized refrigerator dishes. My recipe starts with about a cup of perlite and $^1/_3$ cup water, placed in the bottom of the dish. I spread a layer of seeds on top of the moistened perlite, preferably no more than 50 to a dish, then cover them with another ½ cup of perlite and sprinkle it with a bit more water. Over the years, I've discovered that the moisture content of perlite varies so much that it's really more a matter of developing a "feel" for the mixture than making precise measurements. It's a lot like our grandmothers' approach to cooking.

I label the dish with a strip of masking tape, writing the pedigree and number of seeds on it with a permanent pen (like a Sharpie®). Then I cover the dish with plastic wrap, held in place by a rubber band. This holds in the moisture, but lets the dish breathe—it's very important not to seal it airtight. If the moisture content is right, a thin mist will form on the plastic wrap. If there's no mist the next day, I just add a bit more water. If the mist forms droplets of "rain," I carefully remove the cover, wipe off the excess water, and replace the cover.

Then I subject the flats to a series of alternating warm and cold treatments. This is termed an enhanced germination process because it is a noninvasive procedure that merely encourages viable seeds to germinate—unlike the forced germination techniques that involve peeling and chipping the seeds or embryo culture that is essentially a surgical technique. The advantages are threefold: 1) it's easier, because it doesn't require superior eyesight and steady hands; 2) it's safer, with much greater tolerance for error; and 3) it's more flexible, with opportunities to interrupt the process and dry the seeds to save for another season.

Warm and Cold Stratification

I hold the seed flats at room temperature for about a month. I haven't determined the optimal period; I have found that some warm, moist stratification is clearly better than none, and one month is better than three. There seems to be fairly wide latitude for this factor, but my rule of thumb has become to refrigerate the seeds before the worst of the summer heat hits.

Before moving the flats to the refrigerator, I check them for germination. It's unusual to find fully sprouted seeds at this stage, but if I do find any, I go ahead and pot them before transferring the flats themselves to the refrigerator. I keep the flats in the refrigerator until fall, checking them every month for signs of germination. Again, I haven't found the optimum period for the initial cold stratification. There seems to be even greater latitude for this factor. I have found that less than a month seems to provide little benefit, but it's possible to hold seeds in the refrigerator for many months with no adverse effect. I do check the flats at least once a month, and move any with signs of sprouting out to the lights. When the first green leaf shows above the perlite or fall arrives (whichever comes first), I move the flats into a series of alternating warm and cold treatments.

The next stop is under the growlights, where the combination of temperature change and light triggers germination. The first seedlings are usually ready to transplant after about seven days, when the root is an inch or more in length and the first leaf has broken free but is less than an inch high. Those planted too soon may not finish germinating. Those planted too late may have already exhausted so much of the food supply in their seeds that they can't survive.

Under the lights, however, a seed may pass through that optimal stage in less than 48 hours. That would be plenty of time if all of the seeds in a flat sprouted at once. They don't. If we're lucky, we manage to catch a flat when most of the sprouted seeds are at the proper stage—but almost inevitably

some are too young and others are too old.

In an experiment with treatment times, I found that flats that were cycled in and out of the refrigerator every day not only produced huskier seedlings, but individual seedlings took up to a week to pass through this optimal stage for planting. Because this seems to have improved the survival rate markedly, I consider it my most significant innovation since I started using perlite as my medium. Of course, doing this for a large number of flats isn't very practical—but it's actually quite easy to use this discovery to add a new step to the traditional enhanced germinating procedures:

1. When I go through a flat of perlite to remove and plant the sprouted seeds, I set aside any that have started to germinate but aren't far enough along to plant.
2. I fold two paper towels several times to form a pad* that will fit into a sandwich bag. I then label the pad, moisten it, unfold it once, and place the seeds on it so that when it is folded up again and placed in the sandwich bag the seeds will be held in an upright position as long as the bag itself is upright. (The sandwich bag must be the foldover type, which isn't airtight, not the type that completely seals.) Several of these bags will fit nicely into a small cake or bread pan and be held upright.
3. I put the pan in the refrigerator each night and remove it each morning. I check the pads daily, potting the seedlings that are ready. After several days, most of the seeds will be ready to plant, but any that are still too small can be cycled longer.

I inspect any flats that do not have sprouts showing after 14 days. If I find any small seedlings, I plant them. If there are sprouted seeds not large enough to pot, I put them through this towel-pad and baggie treatment. If no seeds are sprouting, I remove any soft seeds and return the flat to the refrigerator with the remaining, firm seeds.

* See *Seed Germination Theory and Practice* by Norman C. Deno.

Because trial and error has shown that at least 10 days are needed for each cold cycle, but a longer period is more effective, and also that no more than 14 days should be allowed for a growlight cycle, I usually divide the flats into two or three groups for processing. While one group is held at room temperature, one or two are kept in the refrigerator. If there are two groups in the refrigerator, with each rotation the flats that have been in the refrigerator the longest are moved out to the shelves so that each group stays in the refrigerator for about three to four weeks.

Of course, all good things must come to an end, and this treatment cycle is no exception. I've tried planting newly sprouted seeds directly in the ground, but this produced an unacceptably high mortality rate. Although most of the viable seeds will have sprouted by the first of January, there may be a few firm seeds left. I return those flats to the refrigerator for an extended cold treatment or, if refrigerator space is at a premium, I dry out the seeds from lower priority crosses.

Life Under Lights

I plant the seedlings in a mixture of equal parts garden sand and potting soil. Singletons get their own, separate pots. If several siblings are ready to pot at the same time, I plant up to seven of them in a 6-inch pot. I label the pots, not only with the pedigree, but also with the date it was planted and the number of seedlings planted.

The most recently planted pots usually seem to have 100% survival—mostly because their seedlings haven't yet made the transition to living on their own. Sprouted seedlings are drawing on the food reserves stored in their seeds for roughly their first three weeks. As a rule of thumb, the appearance of the third leaf signals that event. After about a month, the surviving seedlings have three or four leaves and are living on their own. Some crosses have a higher survival rate than others. In general, the wider crosses have both lower germination rates and lower survival rates.

Graduation to the Garden

The seedlings will remain under lights until late winter, when I move the pots to a sheltered spot outdoors to harden the seedlings for transplant. (When a hard freeze is predicted, of course, I bring them back into the house for the night.) By mid-to-late February, they'll be ready to be lined out in seedling beds. I don't do this strictly by the calendar, but watch for the established arilbreds to break their winter dormancy and start rapid spring growth.

"The Bottom Line"

Now that you have some idea of the amount of work involved in processing seeds through enhanced germination procedures, the obvious question is: Is it worth it? For me, the answer is: definitely! It has given far better results here than in-ground planting for even the easiest-to-germinate arilbreds.

But is it the answer for you? Practically speaking, this technique falls in the middle of the spectrum that ranges from natural planting, through enhanced-germination and forced-germination techniques, to embryo culture, and one of the methods from either of the extremes may well be more appropriate for your program. Specifically:

Natural Planting—If you're working with halfbreds and are satisfied with the germination rate you're getting from in-ground planting, enhanced-germination is probably not worth the extra effort.

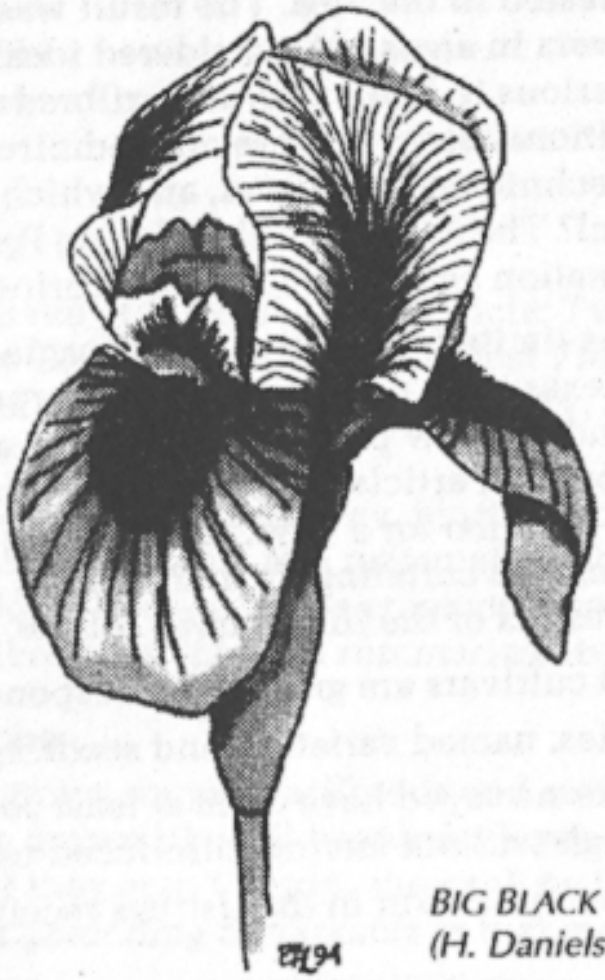
Natural Planting/Enhanced Germination—If you're working with quarterbreds or ¾-breds, but would like to get better results than in-ground planting can produce, you may well find it worthwhile.

Enhanced Germination—If you're working with arilbreds, but not satisfied with the results you're getting from in-ground planting, you should definitely try this technique—this is where enhanced germination techniques are most effective.

Enhanced Germination/Forced Germination—If you've been using forced-germination techniques with viable seeds (such as those of the arils), but find it difficult to cut the seeds precisely enough, you may want to experiment with this. I've found that it's often an effective substitute for the more invasive procedures.

Forced Germination—If you have been using forced-germination techniques with seeds from wide crosses, you may still find it useful to put the seeds through at least one warm/cold/lights cycle before you peel and chip them. I've found the seeds that sprout in response tend to become the strongest seedlings.

Embryo Culture—If you've been using embryo culture for seeds from wide crosses, especially to obtain plants from seeds that have defective endosperm, enhanced germination will probably not be effective.



BIG BLACK BUMBLEBEE
(H. Danielson '66)