ART DE WIT: What was your propagation procedure?

BRIAN MAYNARD: We put them in a medium of peat: perlite:sand (1:2:1, v/v/v) under mist and with an extended photoperiod.

MIKE DODGE: I tried the technique after Nina's talk last year but got into trouble when I took the cover off. The shoots just dried up. What did I do wrong?

BRIAN MAYNARD: You have to gradually remove the cover and it is best to start on the north side. You need to get the feel of your own individual plants and environmental conditions.

SEED TREATMENTS TO ENHANCE GERMINATION

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Seedlings are an important source of planting stock for nursery production and, in our case, over 200 species of both coniferous and deciduous plants are seeded. Most kinds of seeds will germinate readily, especially when fall-seeded, and I will not concern myself with them. Instead, I will address the problem seeds, those that have given us poor or no germination in the past, and describe the treatments that we use to produce seedlings of consistent quality and size required for field and understocks production. A number of reasons can be advanced for poor germination, such as, embryoless seed, dried out seed, impermeable seed coats, seeds that have not fully ripened, seeds exhibiting various internal dormancy problems, and last but not least, a reliable seed supplier who supplies fresh seeds in good condition. It is still a good idea to pick as much seed yourself as possible to avoid some of the above problems.

Before any treatment is attempted — as a matter of fact before seeds are collected, a cutting test is conducted to check for the presence of well developed embryos. It has been our experience that during stressful growing conditions, seeds are often devoid of embryos even though the seed coat looks perfectly normal. *Carpinus caroliniana, Liriodendron tulipifera, Rhus typhina* are prime examples of plants that show this problem.

Seed propagation is a fascinating and challenging way of propagation that can often be unpredictable. The treatments

and procedures described below make seed propagation a little more predictable, however, they are in no way complete and we are always trying to improve our germination percentages. Our treatments have evolved over many years and new ways to stimulate the germination of difficult seeds are being tried.

HARVEST TIME

Many seeds lose their ability to germinate unless harvested and sown at a certain seed developmental stage. Below are listed some examples:

Acer saccharinum — Sow as soon as ripe in June.

Aesculus glabra — Sow when ripe in September because the seed deteriorates quickly.

Cotoneaster — Seed from fruit picked green often germinates the first year; sow August-September.

Daphne mezereum — Pick, stratify, or seed beginning of July; often germinates in September.

Quercus alba and related white oak species — Root emergence often starts on the tree; fall sow in October.

Quercus (red oak species) — If they cannot be fall-seeded, store moist and cool.

Tilia americana — Will germinate nearly always if picked before the seed coat and wing turns from grey to brown; sow in early September.

Tilia cordata — Will germinate if picked before seed coat turns brown. Seed kept moist and planted by the middle of October will always germinate the following spring. If seed dries it has to be stratified to restore moisture and break dormancy, and requires one more season to germinate. The resulting seedlings are inferior to seedlings germinating the first spring following ripening.

Viburnum carlesii and *V. lantana* — If seeds are picked on coloring in early August before the fruit coats are soft and black, many seedlings will emerge the following spring. Many viburnums need warm stratification for development of the radicle followed by cold stratification to break dormancy in the epicotyl.

POSTHARVEST TREATMENTS

1) **Water Soak.** Many seeds not protected by a fleshy covering often lose moisture to the extent that soil moisture is not sufficient to restore enough moisture in the seed for germination, especially in well-drained sandy soils.

To restore moisture and bring the seed up to its maximum imbibition capacity, we soak seeds in water for a period of 12

to 36 hr. The procedure is to cover the seed with water in a pail or plastic bag, equal amounts of seed and water, and leave them for the specified period. It is normal to see the seeds swollen and little free water left. Some seeds benefit from water of 80°C to remove waxy coatings. Seeds of the following plants are treated with a water soak:

Acer palmatum — 24 hr before sowing.

Acer rubrum — 24 hr before sowing (fresh seed); northern seed will benefit by 30 days cold stratification at 1°C.

Corylus — 36 hr or until shells are moist inside.

Cornus kousa — 24 hr soak before planting.

Cercis canadensis — Some seeds will swell, the rest can be treated with acid.

Larix — 24 to 36 hr before sowing.

Rhus typhina and *Robinia* — Soak in 80°C water and let cool for 24 hr.

2) **Acid Treatment.** Concentrated sulfuric acid (94%) is used in a non-corrosive (plastic) vessel. Sufficient acid is poured over the seeds to cover them. The mixture is stirred until the time specified has elapsed. It is wise to periodicially check the progress of seed coat digestion by washing and examining small samples of seeds.

When the specified time has elapsed, or seeds are sufficiently scarified, the acid is poured off and the seeds cleaned with running water. This treatment will scarify the seed coat and make it water permeable.

3) **Stratification to Keep Seeds Moist.** One type of stratification treatment is only to keep seeds moist until sowing. *Prunus* species, which fall into this group, will go dormant if they dry out and not germinate for one full year. The stratification medium must be moist.

4) **Warm Stratification.** Seeds of a number of species require a warm stratification before planting. Examples of this are the following:

Euonymus europaeus — We can accelerate or make possible seed germination by after-ripening for 8 to 10 weeks at 18°C. *Euonymus euorpaeus* seed will normally lay dormant for one additional season.

Ginkgo biloba — Seeds of this plant will not germinate at all when harvested locally unless after-ripened for 8 to 10 weeks at 18°C. Following warm stratification seeds are stored at 0°C until the middle of May when soil temperatures are sufficient for germination and danger of frost is past.

Halesia carolina — Seeds of the Carolina silverbell should

be after-ripened for 3 months at 18°C. They can then be seeded or kept stratified for one full year while being subjected to cold, warm and cold treatments. Seedlings will emerge in the summer of the second year after harvest. There are from 2 to 4 seeds in each drupe.

5) **Cold Stratification.** Cold stratification at 1 to 4°C for a minimum of 30 to 60 days is necessary for seeds of certain species. Included in this group are: *Abies concolor, Chaenomeles, Fraxinus americana, F. pennsylvanica, Malus, Pinus strobus, Rosa multiflora, R. rugosa* and *Sorbus.*

6) **Cold, Warm, Cold Stratification.** Plants having seeds falling into this group include the following: *Cornus alternifolia, C. mas, Cotoneaster, Crataegus* except *C. cordata, Fothergilla, Hamamelis, Rosa canina, R. rubrifolia,* and *Taxus cuspidata.* They usually require one year outside.

FUNGICIDE TREATMENTS

This procedure is used for two purposes. First is for the protection of the emerging seedling from damping-off fungi and the second is as a bird repellent.

Our procedure is to use a plastic bag of large enough size to hold at least twice the volume of seeds. We then moisten the seeds with a sticker by shaking the bag until all seeds are moist. Our sticker is Dow "Methocel" used at 4%. Then sufficient fungicide is put into the bag and shaken until all seeds are covered with a good fungicide coat. It is much easier to add both sticker and fungicide as needed than starting with too much sticker. If done properly seeds come out individually coated and nearly dry. The fungicide we use is Captan.

CAMERON SMITH: *Cercis canadensis* seeds this year have a lot of wax on the seed coats. We have had very irregular results with the sulfuric acid treatment. We have tried hexane and acetone to remove the wax before acid treatment. If you leave the seed in long enough to get all the seeds etched, some will be over-etched and acid will get into the embryo. Do you have any suggestions?

JOERG LEISS: Coatings on some of the seed is water soluble and those are the ones damaged by the acid. We soak our seed first, take out the swollen seeds, and treat the others with acid. This problem also happens with *Gleditsia triacanthos.*

RALPH SHUGERT: Forget the acid treatment. Put the seeds in hot water at 140 to 160°F. It is a lot safer and cheaper.

TOM MCCLOUD: Any suggestions for treating bayberry seed with the wax covering?

JOERG LEISS: We rub the seed coat off first. We tried other treatments such as acetone but they did not work. Just

rub the seed between two pieces of wood.

FRANK GOUIN: Have you tried vinegar or tannic acid instead of sulfuric acid?

JOERG LEISS: Vinegar is a weak acid; however, sulfuric acid is not dangerous if handled properly.

RALPH SHUGERT: What is your treatment for *Taxus cuspidata*?

JOERG LEISS: Our seed is imported from Japan. We receive the seed by the end of January, treat with Terrachlor, and combine with an equal amount of moist sand and peat medium. The mixture is packed in shallow boxes, placed outside, and left until the spring two years following. Therefore 1986 seed will come out in the spring of 1988. You give them a cold, warm, then cold cycle before spring planting. You cannot speed it up.

PHOTOPERIODISM IN WOODY PLANTS AND ITS SIGNIFICANCE TO PLANT PROPAGATION AND PRODUCTION[1]

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Woody perennial plants which have developed in temperate regions have evolved intricate mechanisms to allow survival, competition, and reproduction. This has led to complicated, sophisticated mechanisms for starting and stopping growth at the appropriate times for best survival and growth. One of these mechanisms is the ability to sense the gradual seasonal changing of daylength or photoperiod that occurs because of the tilt of the earth's axis and its orbit around the sun. The higher the latitude the greater daylength changes between winter and summer. These photoperiod changes and their effects on flowering of greenhouse crops are reviewed in Post (35).

There are several early reports and reviews of woody plants responding markedly to daylength or photoperiod (12,25,36,43). One of the first of these in our Society was by Waxman (42). Nitsch (31), in his classic review, modified Chouard's (8) criteria and separated plants into response groups to photoperiod (see Table 1). He also listed as many

[1] Contribution from Department of Horticulture and Illinois Agr. Exp. Proj. No. 65-364 and Illinois Christmas Tree Growers Proj. No. 42867.