the rate of 200 ppm N immediately after potting. Two weeks after that we used a second application.

GUSTAV MELQUIST: Was the 63°F temperature scientifically determined or could some other temperature work just as well? For most warm crops the greenhouses are kept at 60°F at night so this would actually require increasing the temperature over the normal.

JOHN HAVIS: We determined the temperature by looking in the literature, not scientifically.

PROPAGATION OF HERBACEOUS PERENNIALS

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Our primary objective at Walters Gardens Inc. is to produce the perennials we need to meet the projected demand. This is not our only concern. With today's market conditions, we must look very closely at the cost of producing perennials with an attempt to keep this cost reasonable. We must be able to produce perennials profitably. Please keep this in mind as we examine the following methods of propagating perennials.

First of all, one must have a plan of action. One must write down what is to be done and how it is to be done. One must also set goals of production levels. Never rely on verbal communication. Never just guess at what you need. Never propagate more just because you happen to have a lot of propagation stock and it would be a shame for it to go to waste. Always analyze your market. Try to propagate what you think you can sell.

Setting down a plan of action gives you something to refer back to at any point in time. It also gives you the opportunity to assess your performance, giving facts in which to allow for corrections for future years.

The first method of propagating perennials that I will discuss is by seed. A large number of perennials can be produced from seed. As a general rule, if a perennial can be produced from seed, this is the most economical way to go. However, an exception to this might be in choosing a hybrid improvement of a seedling strain which would require propagation by another method.

There are two important considerations to look at. First, the germination level of seed is affected by many variables. There is an optimal level of daytime and nighttime temperatures required for the best germination. Some cultivars are best germinated at a constant temperature. Others require alternating temperatures for maximum germination. For example, *Euphorbia epithymoides* (Syn.: *E. polychroma*) seed germinates best if day temperatures are 85°F, and night temperatures are 70°F. A certain temperature is required for the best germination in the shortest period of time. *Campanula medium* 'Calycanthema' seed germinates best if the temperature is maintained around 70°F. *Aubrietia* seed germinates best around 55°F. In both situations, germination time would increase as temperatures are changed, and possibly germination levels would decrease at other than the optimum temperatures.

Germination may occur in flushes over a period of time. Let's look at *Iris kaempferi*. These seeds are sown in trays the first of January and kept in the germination chamber until May 1. This is a long period of time for any seed. During this time, we remove seedlings which have germinated and reached the critical size. Seeds continue to germinate, and seedlings are removed approximately 3 to 4 times. The point I am trying to get at here is do not throw your potential crop away. Two years ago, 70% of our crop came out of the last batch.

Always store seeds in a cool, dry place with low humidity. Typically, if seeds are exposed to warm, humid conditions before they are sown, the germination level will decrease by the week and month. If you need to store seeds for a long time, consider placing the seed in a refrigerator in a sealed container.

Seeds of some species are "frost germinators," require low temperatures for a period of time. This conditioning of the seed is called stratification. If you do not chill such seeds, you will have poor germination or none at all. We normally chill our seed for one to four weeks — sometimes right in the bag it came in, sometimes after sowing in a tray. Seeds of some species germinate best if allowed to soak in water for 24 to 72 hours before planting. *Hibiscus* seed is an example.

The second important consideration in propagating perennials by seed is the *quality* of the seed. Because of environmental and possibly physiological considerations, the quality of the seed may vary from year to year. With certain cultivars, if you have a set goal of production, you may find yourself exceeding or coming short of your goal on a regular basis.

Let's take for example *Aquilegia* 'Spring Song' which costs $289 for ¾ oz. In 1981, 8,000 plants cost us 3.6¢ per seed. In 1982, 6,000 plants cost 4.8¢ per seed. If your goal was 8,000 plants in 1982, you have just missed that goal by 25%, and your cost has increased by 33⅓%. Underproduction can be costly in terms of lost sales. Overproduction can be held to the cost of the seed if you can restrain yourself from planting the extra seed.

Deal with the seed companies you can trust for quality and dependability. Price is not the over-riding consideration, although it is a factor. Non-delivery of ordered seeds and poor quality seeds is very costly. Usually by the time you find out you will not be receiving the seeds, or by the time you discover the germination is poor, it is too late for your planting cycle. Bargain seed prices may be a poor investment if you cannot buy with the confidence of obtaining good germination.

There are 3 methods of sowing seeds. The first is to sow directly in the field. This is an excellent method in our operation for certain kinds of perennials. A tractor is used in the direct sowing process with special "seeder" units attached and spaced to meet our requirements. There are certain requirements for direct sowing. You must have knowledge of the cultivars which would perform well in this situation and must properly prepare the land. Soil temperature must be proper for germination. Adequate soil moisture is necessary. You must know the proper depth of sowing. Finally, you must have cooperation of the environment — no bad wind storms to blow out the seeds and no sudden late frosts after the seeds have germinated.

The second method is sowing seeds directly into trays (or other containers) in the greenhouse. They are sown in rows at the proper density. This method is necessary for some perennials which require a longer period of time to reach the desired size. It allows us to basically germinate seeds all year round, but especially during January and February. Once the seeds are sown, they are placed in a controlled environment — whether a greenhouse or a growing chamber. We prefer a growing chamber because we can control the temperature, humidity, and air circulation better. Also, we can control the amount of light the plants receive once they are germinated (probably more important during short days). Hopefully, this translates into better germination and better plants in a shorter period of time. Once germinated, at the proper time the seedlings can be transplanted into "starter plugs" and later planted into the field and/or into containers.

The third method is sowing seeds into a cold frame in

early August. The purpose of this is to have young seedlings ready to transplant the following May (an example of this would be *Lavendula*). Germination can take place either in the fall or the following spring. This process can be economical if germination does not decrease by too much as a minimal amount of care is needed. There are no heating costs but the seeds still need moisture. On the other hand, this process can have problems since we do not have much control. We may have over-wintering problems and in the spring may have difficulty deciding when to take the protection off (this is a critical period). Additional problems can result from an exposure to a period of harsh weather in late spring.

Other methods of propagating perennials are by cuttings and divisions. There are important considerations to be taken here. It is a common tendency of growers to ship out the finest and best stock they have. They sometimes feel that the poorer plants will improve with additional time. At the end of the shipping season, plants which are left over become the stock plants for next year from which top cuttings or divisions are made. This is a very dangerous practice. Poor or marginal propagation stock will typically result in poor or marginal plants to sell for the next year. It is imperative that the finest and best stock plants be set aside to produce the next year's crop. These are not to be used for anything but propagation.

The timing of taking cuttings or making divisions is also very important. You normally do not want to take cuttings or make divisions just before the blooming period, since most of the energy is directed toward the blooming process and root development, making general growth minimal.

As a general rule, morning is the best time for taking cuttings or making divisions since afternoons are typically warmer and dryer. We must try to minimize stress in the early propagation stages.

Some examples of perennials we are propagating by cuttings are:

Iris (Dwarf) — Blooms early in spring (late April-early May). The best success in propagating is after the blooming period. Begin propagation in June.

Achillea 'Moonshine' — Blooms for a long period of time beginning in early summer. Propagation is best done early in the spring.

Gypsophila 'Pink Fairy' — Late spring bloomer (during June and early July). Our best success with propagation has been during August. In the spring the wood is too soft for a good rooting percentage and transplanting success. But in late summer, the condition of the plants seem just right.

Salvia 'East Friesland' — Blooms during June. After blooming, the cutting stock is too woody and the success rate decreases dramatically. It is best propagated in early spring.

Artemisia 'Silver Mound' — To maximize the amount of planters from one parent plant, we wait until early June. We can propagate earlier but the yield per plant is considerably less.

Astilbe — These are best propagated during January and February and allowed to become established in a cool poly-house. This allows for maximum growth before hot weather arrives which slows this plants growth considerably.

Dicentra 'Luxuriant' PP3324 — We have found that it is best propagated in late October and buried in the ground or in containers — growth to appear next spring.

Coreopsis 'Grandiflora' — A June bloomer. This can be propagated by division or cuttings in the spring. We choose cuttings which gives us a better stand and healthier, larger plants.

Stachys lanata 'Silver Carpet' — This hybrid is propagated by division rather than using seedlings. Since "lamb's ears" is best noted for its unique foliage flowering depreciates its appearance. The hybrid is non-flowering.

Top cuttings is the only way to economically produce some perennial species. One example is *Lamium maculatum* 'Beacon Silver'. The parent plant is in the proper condition during the cooler months of the year. The cuttings will vary in length depending upon the cultivars. Hormones can be applied to facilitate rooting, if necessary. Possibly, these can be rooted directly into the finished containers. They should be placed in a controlled environment where temperature and humidity can be regulated. Once rooted, the cuttings can be planted into the field or placed into containers.

Another method is root cuttings. This is the only practical way to multiply some perennial species. A good example is *Phlox paniculata*. A selection of the healthiest dormant plants is made in late fall. The roots are cut off the main system and divided into 2-in. sections. Keeping the top and bottom of the cuttings distinct is very important. When planting put the tops just below the soil line. These can be placed in a cool, poly-covered house. Callusing and development of new growth will begin in the spring in response to temperature. They are now ready for planting into fields or containers.

Examples of other species propagated by root cuttings are: *Filapendula vulgaris* (Syn.: *F. hexapetala*) 'Pleno', *Papaver* hybrids, *Geranium* (some cultivars), *Bergenia* (hybrids), *Gaillardia* 'Baby Cole', and *Anemone japonica*.

Division is an ideal method for propagating some perennials. Here again, you select your best stock at the proper time of year. Dividing is done by cutting with a knife or pulling apart the mature clumps. *Iris sibirica* 'Caesar's Brother' is an example. Another method is to pull stolons off the mother plant as in asters. They can be transplanted into the field or directly into containers.

Still another method for propagating perennials is by tissue culture. I would like to briefly discuss why we use tissue culture in our operation.

Tissue culture helps in building up stock of new cultivars. We are presently working on *Hemerocallis* and *Hosta* 'Frances Williams'. If we had to propagate the conventional way, which is strictly by division, it would take many years to be able to offer newer cultivars to the trade. Usually not many plants are available in a new cultivar. *Hosta* must grow for 2 years before dividing the parent stock into planters, and then it yields only 3 to 5 divisions. With tissue culture it is possible to have thousands of plants within a year's time.

With tissue culture we are able to eliminate diseases and help in the prevention of diseases. Crown gall problems occur in both *Artemisia* 'Silver King' and *Gypsophila paniculata* 'Bristol Fairy'. Tissue cultured 'Bristol Fairy' does not have crown gall nor does crown gall move into the plant if planted in a field environment (at least not for the first year).

Tissue culture also helps rejuvenate certain plants. Regression takes place in asters over a 4 to 5 year period in which the stolons (next year's plants) slowly decrease in number from 15 to 20, to 1 to 4. First generation tissue culture plants develop as many as 25 to 50 stolons.

DON SHADOW: I notice that you are offering the white form of *Dicentra spectabilis*. How are you propagating this?

JOHN WALTERS: By top cuttings.

RALPH SHUGERT: Are you using any herbicide treatment after the methyl bromide application?

JOHN WALTERS: We are using no weed control chemicals other than the pretreatment with methyl bromide, + 2% chloropicrin. We have stayed away from herbicides because of the wide diversity of herbaceous plants we grow. We are waiting for more university research in this area.

QUESTION BOX

The Question Box session was convened at 3:00 p.m. with Ralph Shugert and Bruce Briggs serving as Moderators.

MODERATOR SHUGERT: Question for Bob Eastman. Please talk about storing bareroot plants ungraded over winter as opposed to graded prior to storage.

BOB EASTMAN: My philosophy has been to grade them shortly after digging because you do not have to rehandle