After any particular lot is dipped, it is placed in the bed or beds on top of the 4″ layer of coarse sand. The seed is spread out evenly over the sand, not more than two walnuts deep, covered with expanded vermiculite to a depth of 1″ and watered down During the winter months, frequent checks are made to see that adequate moisture is in the stratification beds. If they are too dry, the seed will not sprout uniformly — if too wet, much of the sand is apt to drown out.

Under normal conditions, the seed usually begins to sprout in early March. Unseasonably warm and moist weather encourages sprouting before normal planting time.

The sprouting seed is carefully taken out of the beds by use of a trowl. Each lot is handled separately as to maintain identity by lot number as originally given. All deformed or twisted sprouts are discarded and the good seed placed into field lugs, covered with a moist burlap bag and taken to the field In the field, a shallow furrow approximately 6″ deep is made with a cub cultivating tractor and the seed is hand planted, spaced from 3 to 4 inches apart in the row and covered with dirt.

Later when the seedlings have emerged, they are thinned to a final spacing of 9 to 12 inches apart. The identity of the seed is maintained in the field by placing a stake with its corresponding lot number. A map is made of our growing grounds, showing locations of all lots planted

This general procdure that we now follow has worked out well for the problems confronting us at this time. Other modifications may be needed in the future as conditions change

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CHAIRMAN HERB FOWLER: At what stage of germination do you prefer to move walnut seedlings?

MR STUKE: Seeds germinate over a period of time, so vary in their development. Some of the sprouts will be out 4 or 5 inches, whereas others are just beginning to show the tip. We try to remove the seedlings only at two times. We get approximately half of the seed out the first time. We put the rest of the seed back, take them out one more time and get all the sprouts out.

Chairman Stoutemyer introduced Mr. Hugh Steavenson of Forrest Keeling Nursery, Elsberry, Missouri.

FIELD PRODUCTION OF SEEDLINGS IN A CENTRAL STATES NURSERY

HUGH STEAVENSON

Forrest Keeling Nursery
Elsberry, Missouri

Each nursery, or certainly each region, evolves its own methods and techniques of propagation, according to local conditions of soils, climate, marketing opportunities, available skills and historic precedent.

As a student many years ago, I came under the forest nursery influence Shortly thereafter, in the mid-thirties, I had the opportunity of setting up one of the early soil conservation nurseries in Iowa, and this was followed by a 10-year stretch of developing and managing a similar nursery in Missouri While Uncle Sam steered clear of the ornamental field, the wildlifers called for just about any kind of hardy shrub and vine, as well as many evergreens, while the foresters demanded an assortment of trees for erosion control and other plantings

Thus when I established my own commercial nursery several years ago, it was only logical to pick up seedling production practices where I had left off working for the government.

In other discussions we have referred to our system at Elsberry, Missouri, as the "mulch bed method of seedling production." In our rolling hills rising from the Mississippi River, we are blessed with a mellow loessal soil, recognized wherever found for its horticultural merit. A portion of this loessal mantle has been washed out onto the adjacent river bottom lands during the farming period before conservation. This alluvial outwash, where deep enough, has properties similar to the wind-deposited hill soils.

While these soils are excellent for plant growth, their colloidal properties, humus limitations and the intensive tillage of the past years, make for a crusting problem Soil crusting and germination of tree and shrub seeds do not go together, as you well know. This is where the sand area seedling growers have an advantage. But we think our compensation is in growth performance after germination.

Many of the forest nurseries use a sand covering over seeds to secure good seedling emergence. For many years we have tested a variety of organic substances. Several have proven more satisfactory than sand. The one that has proven most efficacious and economical for our conditions is a stringy sawdust called "header-tow," a by-product of local saw mills making bourbon barrel heads. As long as the white oak trees keep growing and the drinking habit persists, we are assured of a reasonable supply of this material We do use ordinary sawdust as a substitute when tow is not available, but plain sawdust blows, washes and packs where the stringy material resists these hazards.

None of the seeds we sow — and we do grow a wide range of over 100 tree, shrub and vine species — are drilled or otherwise covered with soil All are broadcast on the seed-bed surface, firmed by rolling, and then covered with the tow. The thickness of the tow covering will vary from one-half inch to two inches or more, depending upon the diameter of the seed and time of sowing It will be observed that a tow covering much thicker than a soil covering is permissable and desirable, seedlings will readily emerge through a relatively thick mulch covering

The essential function of this tow mulch is to create a surface to facilitate seed germination and seedling emergence. Germination is abetted by the more uniform moisture and temperature environment of the seed and emergence is facilitated by the loose, porous structure of the material The heavier applications of tow are also helpful in weed control.

After using this material for some two decades, at the rate of a couple of hundred truckloads per year, we have never observed any toxicity to any plant species. (Nor have we observed toxicity with any kind of sawdust.) Nitrogen starvation is another matter. The fertilizing program must be modified to supply the extra nitrogen which is absorbed as the mulch breaks down. There is, of course, no tillage of the bed surface under this method of seedling production. It is a well-known phenomenon that soil structure improves markedly under a mulch culture, and we believe that the very large quantities of organic material that are incorporated into the soil, balanced with high-nitrogen fertilizer, significantly add to the soil humus content over the years.

All seedlings are produced in raised seed-beds formed with a Larchmont bed former. In the early years we have tried seeding "on the flat" and we became convinced that we wanted a seed-bed raised some 6 inches above the path

The primary purpose of a raised bed is to improve soil drainage and aeration. We have almost concluded that there ain't no such animal as too much drainage. Another benefit of the raised bed is that it is possible to finish it off to a near-perfect seeding condition without any hand work whatsoever.

Beds are four feet wide, paths two feet wide. The actual seeding is done on a three-foot strip down the center of the bed, giving us a 6-inch bed shoulder. All of our equipment used in seedling production has a wheel spacing of 6 ft. center-to-center. This applies to all tractors, diggers, manure spreaders used to spread mulch, wagons and any special carts used for moving shade and the like.

One tool we have found that is most useful in rolling and finishing the bed is the Brillion corrugated seeder-roller. This roller has very narrow two-inch corrugations. Seeding is done with this tool, with a Gandy seeder, or by hand. Miscellaneous small lots of seed are more practicably sown by hand, while hand broadcasting usually is best with stratified seed and various types that do not lend themselves to mechanical seeders.

As a guide in processing, pre-treating, sowing and growing the crop, a "Seed Sowing Data Sheet" is maintained for each species or accession of seed. This sheet serves not only as a production plan but also as a record for future reference You will note that the sheet records such data as accession number, common and botanic name, source, amount of seed, seed per pound, cutting test, estimated emergence, estimated plants per pound, production goal, quantity of seed to sow, seedbed density desired, bed feet to sow, preplanting treatments, seeding details, disease and insect control treatments, germination notes and counts as the season progresses.

Fertilizing treatments and soil development are similar to any other good nursery practice. In starting a new seedbed area, we try to bring the land to a finished grade with a land leveler. Then we go through a perennial sod crop, involving a fibrous-rooted grass like brome-grass or perennial fescue, for at least two years. During this period we strive to bring the soil to an optimum level of fertility. Necessary liming and rock phosphate go on, usually prior to seeding the sod crop, and supplementary fertilizing is done as indicated by soil tests and plant growth to achieve a high, balanced level of fertility. Growth of the sod crop is either grazed or mowed and allowed to fall back on the ground, rather than removed as forage.

We attempt to maintain the pH level somewhat on the acid side (about pH 5 5 to 6 0) which is near optimum for most of the seedlings we grow. Rarely are acidifying amendments necessary as in our area do not grow any of the ericacious plants under open field conditions.

Needless to say, on such an intensive crop as tree and shrub seedlings, it is economical to apply whatever fertilizer is indicated to maintain an optimum level of the major elements. (Trace elements under our system have not been a problem) Indicated amounts of fertilizers are applied prior to bed formation. Supplementary feedings, primarily nitrogen, are made as the seedling crops grow, either with a bed spreader or, preferably, in soluble form through the irrigation system

WEED, DISEASE, INSECT CONTROL

In preparing new ground for seed-beds, particularly following a sod-crop, we treat with Dieldrin or a similar insecticide as a protection against grubs and other root-attacking insects.

We used to worry a lot about damping-off control and possibly should be a little more concerned now. In times past we have run the gamut of various chemicals suggested for controlling damping-off diseases, but we now use no specific for this purpose, except where a known or anticipated critical problem exists If we can get our seedlings germinated and growing during their normal early spring germination period, our damping-off difficulties appear much less pronounced. This usually means either fall seeding or early spring sowing of stratified seed. The non-dormant early-summer fruiters, such as certain maples and elms, respond with little damping-off difficulty when sown during their normal dispersal period. In fact, seeding when nature normally disseminates her seeds is an excellent rule of thumb. Stratification is usually an acceptable substitute for over-wintering (or over-summering) seed in the bed but failure will often attend the practice of sowing after-ripened seeds when seed-bed temperature conditions do not correspond with those under which the seed normally germinates

We very much subscribe to the theory of cleaning up the seed-bed area of weed seeds and pathogens prior to seeding, and wish there was a more efficient, economical means of doing this Among the chemical methods, methyl bromide is certainly outstanding. The objection is the cost and the labor of laying tarps. For $400 or $500 per acre we can do a lot of hand weeding.

We have in years past used calcium cyanamide effectively against weed seeds This does entail a several-month time lag from treatment to seeding and involves cumbersome mulching. Furthermore, it will certainly raise hob with soil pH if you want to stay on the acid side.

We have tested the various proprietary soil sterilants without getting too enthusiastic. For some years we have been using allyl alcohol, which can be applied safely and conveniently through the irrigation system. In fact, that is the only way I would want to touch this stuff.

An application of 25 gal. per acre will run about one-sixth the cost of methyl bromide and will clean up 90% or so of the weed seeds. No control of pathogens or insects is ascribed to this treatment, but we suspect there are some benefits in this direction. There is certainly no substitute for a good sanitation program that prevents weeds from going to seed.

For post-emergence chemical weeding we use the standard Stoddard solvent treatment with conifers. There is no chemical we can use on the broad-bladed seedlings. For transplants, which are something else again, we have tested a number of the herbicides and find that Simazine seems to be the best so far.

We still have hand weeding to do. But the fact is that it is much less of a job than it used to be in the early years. Instead of 50 weeders in a 10-acre field of seed-beds in June, we can get along with a dozen, thanks to chemicals.

SEED PRETREATMENT

I have touched on this subject and time does not permit a rundown on treatment by species. Suffice it is to say that any seedling grower would do well to have a file of the Boyce Thompson Institute bulletins on woody plant seed studies. Another "must" is the U.S. Forest Service 'Woody Plant Seed Manual," Misc. Pub 654. The various seed propagation papers in the *Proceedings of the Plant Propagators Society* are among the very best references available.

For 20 years we have vacillated between fall seeding vs. stratification and spring seeding. There are hazards either way. Here on the West Coast where you have little if any cold period, the dormancy problems of your seed subjects would certainly be different to ours where we have honest-to-gosh winters. With few exceptions, such as those species that mature their fruits in the spring or early summer, the woody plant seeds we propagate have dormancy of some kind, and this is a fascinating subject in itself. Often as not there will be a factor of seed-coat impermeability combined with internal dormancy. A large number of the desirable genera, such as Viburnum, Crataegus, Ilex, Tilia, Taxus, etc., are members of the "two-year" class, which require a warm after-ripening period preceding a cold period. Impermeable seed-coats (which most legumes possess) are usually handled by scarification. We have standardized on a bath in sulphuric acid for all our scarification work.

SEED PROCUREMENT

We obtain seed from a number of domestic sources and foreign sources, as well as from our local harvestings. Every seedling grower bats his head against the problem of importing seed and getting it in time to sow or stratify at the proper period. In many cases there simply isn't any answer except to carry the seed over an extra year. We have gone to some effort to establish hedge rows or other stock plantings to produce our own seed of several species. If one will only look ahead far enough, this is an excellent step.

Seed propagation will always have its limitations because of the necessity to produce clones vegetatively. But where a subject can be propagated by seed, this practice has much to commend it. I believe it is a rare instance where a properly-produced seedling will not outperform in growth a cutting-grown plant of the same species. Sometimes this difference is spectacular. Seedlings are needed in quantity as understocks But again, where a seedling type is comparable in characteristics to the selected clone, the seedling may have important advantages. Incompatability problems or graft weakness often appear years after planting, sometimes with disastrous results. Seed propagation is required to select new and better types, and many types will, of course, come reasonably true from seed. So in the art and science of propagation we will always have a place for the sexually-produced plant. It is a fascinating field and may offer rewards comensurate with vegetative techniques

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Chairman Stoutemyer introduced Mr. Gerd Schneider, Saratoga Horticultural Foundation, Saratoga, California, who presented his paper on the production of tree rootstocks

PRODUCTION OF ROOTSTOCKS FOR ORNAMENTAL TREES IN THE CONTAINER NURSERY

GERD SCHNEIDER
Saratoga Horticultural Foundation
Saratoga, California

For the discussion of rootstock production of ornamental trees in the container nursery, I have selected five trees widely planted in Central California Although clonal reproduction is practiced with all of these trees, most of them are planted as seedlings Seeding techniques for container production differ only in few respects, when the young plant is to be used as a rootstock and when it is to be grown as a seedling specimen for planting The purpose of this paper is to focus on the seedling, which is to be used as a rootstock and to point out the practical steps and considerations necessary to produce that plant. I shall emphasize the selection of the seed parents, with a view toward obtaining material which is vigorous and of uniform size in the seed bed. I also want to emphasize some aspects of propagation unique to each tree.

The following trees will be discussed: *Liquidambar styraciflua, Pistacia chinensis, Ginkgo biloba, Magnolia grandiflora* and *Quercus ilex*

Liquidambar styraciflua is monoecious; every tree has the potential to bear fruit and seed. Although reports from the Eastern United States indicate that the tree has to be almost 25 years old before it starts to bear fruit, we find that the trees in Central California usually start to bear fruit when they are seven to eight years old, often yielding heavy crops at the age of fifteen.