As soon as germination begins the erosion cloth and salt hay are removed. Evergreen seedlings need shade to prevent damage from the sun and we immediately punch 2×2 pointed stakes on the outside of the bed on top of which we stretch wire held on the stake by a staple, and the wire is drawn tight on each end and the lath shading rolled out on top.

Our soil being a light sandy loam requires plenty of water and fertilizer for good growth. Irrigation mains are put in place soon after germination and remain for the entire season. We apply, if there is no rain, 1½ inches of water per week and 200 lbs of 20-10-10 fertilizer per acre every two weeks. The fertilizer is applied by plane since a tractor can not go over the lath shading. Fertilizing is shut down by mid August so that the plants can harden for winter. In mid-September we remove the shading from the seedlings except for a few cultivars which need the shade for winter proteciton. These would include *Cedrus* and fir species.

The growth response is quite good. *Taxus* and hemlocks are 2-4 inches in height, most pines 3-6 inches, *Platycladus orientalis* (Syn.: *Thuja orientalis*), 6-8 inches and, *Cedrus deodara*, 8-12 inches. We sell the *Cedrus deodara* as one year plants. Many of them are of sufficient caliper to be used as grafting understock A few pines are also sold as one year plants for potting to prepare for spring field planting.

The majority of the evergreen cultivars are not ready for sale until the end of their second year. During the second year we use a combination of 20-10-10 and Osmocote 14-14-14, a slow release fertilizer. This combination is applied every 3 weeks during the growing season. The first application is applied in March and the last in mid-August. Water is applied at the same rate of 1½ inches per week during the growing season. Our two year seedlings are of good caliper and height. *Abies concolor* 6-10 in, Douglas fir 10-15 in, *Pinus strobus* 6-8 in, Japanese black pine 10-15 in, *Taxus cuspidata* (Syn.: *T capitata*), 6-8 in and, *Tsuga canadensis* 8-12 in.

WOODY TREE AND SHRUB SEEDLING PRODUCTION

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Production of tree and shrub seedlings in open field beds presents many management factors not present in more controlled seedling production programs such as greenhouses, coldframes, and other protected structures. It represents one of

the more intense types of field production often exceeding 200,000 plants per acre. An investment with this potential requires as much pre-planning and technical management as possible in order to produce the desired size and quality seedling at the least possible cost Many factors affect this production, presenting opportunities for profit when properly implemented

SITE SELECTION AND LONG RANGE PLANNING

We are located on the first hills adjacent to the Mississippi River. These rolling hills are capped with a deep layer of windblown, well drained loess soil, which is particularly suited for seedling production. They are also higher than the surrounding countryside giving good air drainage, thus good protection against late spring frosts Inherently these are timber soils suggesting a most suitable soil for our production of 100 selections of deciduous tree and shrub seedlings.

Future production areas are established to a heavy sod pasture grass, predominately improved strains of Kentucky fescue, to begin a long range soil buildup. During this period, ideally 4 to 5 years, these areas are grazed intensively by a cow-calf herd, the objective being to convert the forage produced to organic matter (manure) An optimum fertility level is maintained during this phase of soil building, making certain we are adding more to the fertility level than we are removing.

Following 4 to 5 years of sod culture the pasture is chisel plowed keeping a high percentage of organic matter produced from the sod in the upper 6 to 8 inches of the soil. The soil is then fallowed for 1 to 2 months to break-up life cycles of weeds. An application of approximately 1,000 lbs of inorganic fertilizer (28-14-14 analysis) is applied followed by 30 tons of chicken manure per acre. A seedbed is prepared and hybrid Sudan grass is planted for green manure production After reaching about 6 feet tall it is cut with a rotary mower and chopped as much as possible. Regrowth occurs very rapidly and the mowing process is repeated again. We are able to mow as many as 3 to 5 times before fall. The combination of chicken manure and Sudan grass promotes a maximum of biological, physical, and organic properties that aid greatly to the seedling crop to be produced. Since we embarked on the use of chicken maure we observe a profusion of mycorrhiza present on roots of most species we grow Other beneficial results derived from the use of chicken manure have been observed in connection with improved seed germination. These will be discussed later.

SEED SOURCE AND PROCUREMENT

The value and source of good viable seed cannot be stressed enough in seedling propagation. A history as to origin, adaptability, hardiness, and any other pertinent information is important when a species is added to our production program. Where possible we have established seed rows in the nursery to insure our own supply of many items we grow. We prefer to produce our own seed whenever possible Many species do not seed well locally so alterate sources must be established to insure a supply. A good dependable source of seed is invaluable to the seedling grower. Close contact should be maintained with those sources as to crop outlook and availability. Records should be maintained as to true-to-name, stands secured, growth rates, and other pertinent information so you know what to expect from this same source in future crops. Many species do not bear fruit annually. They might bear crops of seed biennially or, in some cases, as long as 10 years lapse between good seed crops. Here good seed storage facilities become necessary. A future supply can be stored in a good crop year to insure an annual supply of seed until another crop occurs Under ideal storage conditions, usually about 0 to −10°F and sealed in air tight containers, seeds of many species can be stored for a period of years with very little loss of viability. The length of storage and temperatures vary from species to species so one should research each specific species before attemtping extended storage.

We collect approximately ½ of our seed. Collection is essentially a hand operation. Fruits can be hand picked from the parent plants, or nearing natural dispersal time, they can be flailed onto a plastic tarp or net. Larger seed such as acorns, walnuts, or pecans or simply picked from the ground after they fall and before the rodents store them for winter

Species bearing seed enclosed within a fleshy fruit must be separated and cleaned, then dried prior to seeding. Most of these fruits contain inhibitors that impair to some extent seed germination. Fruit can be removed in a number of ways. Our quantities are large enough to justify use of mechnical macerators that are commercially available They are designed to remove the pulp as water is applied acting as a cushion preventing injury to the seed and to float the pulp away. On more stubborn species a conventional hammermill will suffice, using water again and a slow speed. A hammermill will also clean seeds of many species such as redbud as well as other species normally born in dry pods. There are many other methods of cleaning small lots of seed mostly by hand rubbing and screening on up to very sophisticated machinery; however the above methods are predominately used.

Upon completing the cleaning and drying (if required) many species need further treatments. Those having impermeable seed coats require some form of scarification. We use essentially four approaches to this problem. They are:

1 Mechanical. Using this method seed are blasted under pressure on an abrasive surface physically scratching the seed coat.

2. Acid soak Soaking the seed in concentrated sulfuric acid until the seed coat is burned about ½ way through

3. Hot water. Soaking in hot water bringing the temperature to the boiling point, then adding the seed and letting soak until the water cools.

4. Biological. Early planting to allow more time for natural seedcoat breakdown in the seedbed.

PREPARATION OF THE SEEDBED

Following the soil building program outlined earlier, and the necessary seed pretreatments, preparation for planting begins. We use 1000 lbs per acre of 28-14-14 analysis commercial fertilizer, applied to the production areas to be seeded. Seedbeds are then formed with a commercial bedformer. They are raised 4 to 6 inches high, 48 inches wide, with a 2 foot pathway on either side making them 6 foot center to center. This spacing will accommodate any standard row-crop machinery thus getting away from specialized equipment. By concentrating the top soil in a raised bed much improved drainage and aeration occurs, essential to good seed germination and subsequent growth. Also organic matter produced in the soil building program is concentrated in the seedbed further improving the physical and biological makeup.

SEEDING

Determining the number of seedlings to produce per square foot becomes most important We find under our conditions and for our market we produce our best quality seedling at a density of 5 to 10 per square foot, depending on the specific species and its ultimate use. The number of seed to plant per square foot in order to get the desired density becomes extremely important A sample of each seed lot is weighed to determine the actual number of seed per pound. Then a cutting test is made to determine as close as possible the percentage of sound viable seed in the lot. At this point past records are studied and good judgment and experience is called upon. The above information combined with the projected production quotas indicate the number of bed feet to be planted. A majority of our planting is done by hand. A skilled,

experienced, seeder can evenly distribute the desired number of seed over the bed area. We do some mechanical seeding, but find the diversity of size and shape of various species to be an almost unmanageable problem in our situation. We do both broadcast seeding and row seeding Usually species having larger seed such as oaks, walnuts, chestnuts, filberts are planted in rows and also certain species that have a tendency to dry out such as some of the maples. After sowing, the bed area is rolled with a cultipacker pressing the seed into the bed surface. Then a mixture of sawdust and hardwood bark is applied for a mulch. The bark tends to stabilize the sawdust and hold it on the surface of the seedbed. Also we feel we are deriving additional pathological benefits from the use of hardwood bark.

Timing of our seeding depends upon the length of after-ripening required for the species we are growing. Some species such as certain viburnums are seeded as early as mid-June, remaining in the ground for 9 to 10 months before emergence. This method of production was made possible mostly with the advent of the knock-down herbicides, Paraquat and Roundup, so weeds can be controlled by repeated sprayings. Since we depend on most of our after-ripening to occur in the field beds, we find ourselves seeding virtually every month of the year that our soil can be tilled.

SEEDLING GERMINATION AND GROWTH

Since embarking on our soil building program, we observe much improved seed germination. Improved aeration with the added accumulation of organic matter has been a prime factor. Beyond this we feel the increased biological activity is helping in the breakdown of seed coats on most species, thus markedly improving our germination percentages Over the last few years under this program we have reduced our average sow rates up to 50%. We are convinced this saving is tied to our soil program

After emergence occurs we shift our emphasis to cultural practices aimed at producing maximum growth in one season As soon as true leaves appear on the young seedlings, Dacthal herbicide is applied at 6 pounds per acre to aid in weed control. Also fertilizing begins with an initial application of 300 pounds of 28-14-14 applied per acre. An additional 1,000 to 1,500 pounds per acre will be applied periodically throughout the remainder of the growing season. Coupled with sufficient water supplied through our solid set irrigation system our goal becomes getting maximum growth in one year Size for size a one-year seedling is far superior to a two-year or older seedling as to survival and growth after transplanting. For this

reason we take every step to push our seedlings to maximum size in a single growing season

Good seedling production practices must continue until the crop is harvested, graded, stored and shipped making certain a minimum amount of stress is placed on the plant material. Great care is exercised to apply a protective spray in the field as soon as the seedlings are dug and placed in pallets. The pallets are tarped for additional protection while transported to the storage buildings. They are held in high humidity storage (98 to 100% relative humidity) during the storage period, which begins in November and extends through the following May for a portion of the crop. When grown properly and handled carefully, one can approach a near perfect stand when the seedlings are transplanted to the nursery for future production.

SIGNIFICANT ENVIRONMENTAL AND BIOCHEMICAL FACTORS IN SEED GERMINATION OF *LIRIOPE MUSCARI* AND TWO RELATED TAXA

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Liriope muscari (Decne.) Bailey, big blue liriope, is one of the most commercially important groundcovers in the southeastern landscape, and is also widely used in the southwest and California. Hardy to Zone 6, it could be used in additional geographic areas. The 1 to 2 foot grass-like evergreen foliage; lilac-purple flowers borne on a spike above the foliage; sun and shade tolerance; and adaptability to a wide range of soil types are traits contributing to its popularity. *Liriope* displays a high degree of salt tolerance which makes it particularly useful in coastal landscapes (5,20).

Abundant blue-black, single-seeded berries are produced on upright spikes in the fall. Seeds are globose and the embryo is surrounded by copious, hard endosperm A deep blue-black skin envelopes a purple, pulpy inner matrix (collectively called pulp). Seed appears to be a logical method of propagation, although division, which is not only time consuming but expensive, is the only method referred to in the literature (1,5,20).

Dormancy mechanisms in other members of the Liliaceae, specifically *Trillium grandiflorum* (Michx.) Salisb. (3), *Polygonatum biflorum* (Walt) Ell. (3) and *Lilium* (2) species posed ques-