phenology have been ruled out as causes. Viral infections or biochemical antagonisms caused through stock-scion interaction might be causes of symptom initiation.

MODERATOR DOUGLASS: The next speaker is Ralph Jack, who is the owner of the Silver Falls Nursery and Christmas Tree Farm, Silverton, Oregon, which is in the Cascade Foothills, east of Salem. Mr. Jack has specialized in growing some 200 varieties of trees and shrubs for the wholesale market; these include Christmas trees, Christmas tree planting stocks, specimen trees, ornamentals and bonzais. Ralph Jack:

FIELD PRODUCTION OF CONIFERS

RALPH A. JACK
Silver Falls Nursery and Christmas Tree Farm
Silverton, Oregon

Our nursery and tree farm has as objectives: (1) raising seedlings and transplants for our use in growing Christmas trees, which we wholesale and (2) producing container stock for wholesale to nurseries, as well as for our own mail-order retail business.

We are located at Silverton Hills near Silverton, Oregon, in the Cascade foothills at an elevation of 1500 feet. We are 15 airline miles east of Salem, Oregon. Our soil is Olympic clay loam and is of a medium texture. Locally it is called "shot" soil.

We gather some conifer seeds for our own use, such as noble fir, western and mountain hemlock, *Abies magnifica* and *Abies concolor*. Noble fir is collected in the Cascades at 3500-4000 feet elevation. *Abies concolor* and *Abies magnifica* are collected in the Sierra Nevada mountains of California at about 7000 and 8000 feet elevation, respectively. We buy most of our seeds.

Seed is stratified in one of two ways; (1) with damp peat in plastic bags—50% seeds and 50% peat with moisture squeezed out—or (2) soaked overnight, drained and placed in plastic bags. For both methods we keep the seed in cold storage at 34° to 41° F. from five to eight weeks. We try to plant them just as soon as sprouts appear.

Seed bed preparation includes plowing with a rotary plow which breaks the soil into particles about ⅛ inch size. Vapam has been used in the past for soil sterilization. Beds are 34 inches wide, and are cultivated and raked. Seeds are broadcast by hand, then covered with ¼ to ⅜ inches of fine soil. This is either done by hand or by a trailer following a tractor. Sifted soil is shoveled onto a 4′ x 4′ plywood piece with a long handle. One man rides the trailer and shakes the board to drop the soil off evenly onto the seeds.

Seed beds are enclosed by wooden frames 3′ x 12′, made of 1 x 4 lumber. Hardware cloth (½″ x ½″ mesh) is nailed

on top. This protects the seeds from birds and field mice. Ground squirrels and sometimes field mice will burrow under the screens. For them we place a small aluminum container of poisoned barley or wheat in every fourth frame. Our nursery is bordered on three sides by timberland so our "varmint" problem is greater than it is in more settled communities. Seed beds are sprinkled by irrigation lines once or twice daily. We try to grow 25 seedlings per square foot. As conifer seeds range from 400 to 240,000 seeds per pound, our plantings are only roughly at the rate we desire. Extremely small seeds are either mixed with sand for planting or are scattered, then spread by a very light raking. Fifty percent shade is required for seedlings of most spruces. For them we use lath nailed over the screens above the hardware cloth. We had been advised that lath alone on the frames would frighten the birds away but we found the lath was merely a good landing field for the birds who hop right down through into the seed beds.

Almost all of our seedlings are transplanted. They are dug, root-pruned and wrapped in crinkly waterproof paper or one-mil plastic with the roots covered with damp peat or shingle tow. Our tree planter is a "Root Spread". It has a double plow which opens a furrow several inches deep and about four inches wide. We can place the roots and keep the trees straight. Rubber tired packing wheels tamp them. If the soil is at just the right dampness nothing further is required. On days when the soil is not good for planting I have a man follow, straighten any seedlings that are leaning and tamp each one by stepping near it. We use this planter for seedlings 7 to 24 inches tall, planted 8 to 16 inches apart. We also use it for planting Christmas trees. For smaller seedlings we use a two-seater berry-type planter. Seedlings are placed between two fiber disks which rotate and release them right side up in the row which the machine has opened. Metal wheels tamp them. We plant from 3 to 12 inches apart. Many seedlings are hand-transplanted. We use either planting boards, trenching tools, or hoe and trowel. We have tried 3-foot planting boards crosswize or 12-foot boards lengthwise of the row. We find the shorter ones are better as two planters can work, one from each side without being on the transplant bed. We had a tool made for trenching. A piece of flat $\frac{1}{8}$" steel, 7" x 20", has a light piece of one-inch angle iron welded across the long edge. This provides a wide edge upon which to step. A 27" handle of $\frac{1}{2}$" pipe has 12 inches of $\frac{1}{2}$-inch pipe welded across the handle for hand grips. One can open prepared soil by inserting this into the soil then wriggling it back and forth. Trees are placed in the opening. Opening the next trench tamps those previously planted. At certain soil moisture levels the soil sticks to the trencher. This is a nuisance and slows work. Our planters prefer to use the hoe and trowel method. Prepared soil is opened with a narrow or pointed hoe. One worker opens the trench across the row. One women at each

side of the row places and covers the trees.

Field plantings of conifers for Christmas trees are made with a tree planter, planting 4 x 4 feet for true firs. We grow red fir, *Abies magnifica;* Shasta fir, *Abies magnifica* var. *shastensis;* white fir, *Abies concolor;* and noble fir, *Abies procera.* True firs command top prices, require no pruning unless injured, have excellent taper, good color and are good for stump culture. In our soil, with one heavy irrigation in late June, the trees grow about the right amount (about 12 inches) per year. True firs have even whorls of four to seven segments. This gives the trees an excellent shape. Fertilizer is used only about very two years. Two ounces of ammonium sulphate per tree is sprinkled near the drip line. It must be kept off the foliage as it will burn the needles. Nitrogen helps needle length and improves color. Trees that were culls one season became premium trees the next after ammonium sulphate was applied. We apply the fertilizer just prior to the June irrigation. Alternate years we spot fertilize only those trees that appear to need it, either because of slow growth or yellowish color.

True firs lend themselves to "stump culture". Our policy is that if a tree is good all the way down we cut it near ground level. If one or more whorls are irregular we cut just above them. This leaves a whorl or more of limbs to keep the roots alive. Limbs will either turn up and form a tree, or central shoots will form which will make an excellent tree. We prefer to use the central shoot. When limbs turn up for a year or two the new tree will tend to be flat. A central shoot will produce a symmetrical tree. *Abies concolor* limbs will produce a nice tree without waiting for a center shoot. I have found that to get good central shoots the stump should be cut within one inch of the whorl that is being left. We allow two or three central shoots to grow until they are about one foot tall. We select the best one and prune off the others. These we prune about two inches long so they will form more central shoots. We have five-foot stump culture trees nearly ready to harvest, with another shoot a foot tall growing to form the third tree from the stump.

Where we live deer are in our fields every night. Of 40,000 trees we lose about six per year where bucks rub the velvet off their horns. Perhaps they ruin a few others but we see little evidence of it. Jack rabbits like to bite off *Abies concolor* transplants which are about twelve inches tall. We dispose of some of the rabbits, but found the best remedy is to plant more trees.

All true firs seem to be subject to frost damage under certain conditions. Perhaps some seasons the buds come out too early. After all, our true firs are displaced 600 miles and 6000 to 7000 feet in elevation from their native habitat.

True firs are tough enough to start new tops after frost or rabbit damage. We select the best top and prune off the

others. Of those we grow, *Abies concolor* trees seems to be most affected by frost damage but they recover readily.

MODERATOR DOUGLASS: We have one more presentation in this session. John Walters is the Director of the University of British Columbia Research Forest, Haney, B. C. John, we understand you have developed an ingenious gun for literally "shooting" planting stock into the ground. It will be our pleasure to have you explain this to us. John Walters:

CONTAINER PLANTING IN FORESTRY

JOHN WALTERS
Research Forest, University of British Columbia
Haney, British Columbia

Forest tree planting began about 400 years ago. Since that time the methods of tree planting have changed only slightly while the principles have changed not at all. Although 1½ billion seedlings are planted each year in North America we rely still on the same techniques which were developed for much smaller quantities of planting stock at a time when labour costs were insignificant. Forestry in the Pacific Northwest currently relies on manual methods to plant two-year-old bare root Douglas fir seedlings. About 500 trees per man-day are planted with this technique, currently in wide use in the Pacific Northwest.

Today, we are faced with the problem of accomplishing a monotonous, tedious job with a labour force which is rapidly diminishing in terms of quantity and quality. In some regions an attempt has been made to mechanize this operation by borrowing techniques from agricultural practice and by modifying agricultural equipment such as the broccoli planter. These tractor-drawn implements do not operate well on sandy and rocky soils, nor do they do a good job of planting on rolling terrain. Moreover, much of the terrain of the Pacific Northwest is inaccessible to this type of furrow-making planter. Besides the steep slopes broken by granitic outcrops, the areas are littered with large volumes of heavy logging debris.

However, regardless of the topographic conditions of the planting site, present day reliance on bare-root seedlings limits the development and introduction of new planting methods. Bare-root seedlings, having dimensions and succulence which vary from seedling to seedling, have obliged all modern tree-planting machines to rely heavily on manual aids both during the insertion of seedlings into the furrows and also, subsequent to planting, follow-up operations to improve the job done by the machine. Moreover, critical requirements of seedling physiology must be protected during the planting operation. The accommodation of these requirements imposes stringent demands upon the planting process and it is safe to say that bare-root planting requires more accommodation than any other method, whether machine or manual.