Duncan, B.C. - J. R. Long. One of the three nurseries mentioned by McWilliams. Duncan Forest Nursery situated in the Cowichan Valley on Vancouver Island 40 miles north of Victoria. Twenty-three acres with a maximum capacity of 7 million 2-0 trees. Production is 3 million, 2-0 stock, root pruned, chiefly confined to Douglas fir and experimenting with other species. No transplanting.

Campbell River, B. C. - William Turner. Another of the three nurseries mentioned by McWilliams. Quinsam Forest Nursery is located about 2 miles west of the village of Campbell River on Vancouver Island. Approximately 25 acres with capacity of 6 million annually, root pruned. No transplants.

Neah Bay, Washington - Earle R. Wilcox. U.S. Indian Service. Located 72 miles west of Port Angeles. Normally it would have 900,000 2-0 each year. This nursery was started during CCC days and maintained by CCC funds. Indian Service has received some appropriations, but have not been able to maintain production.

McCloud, California - Karl B. Lanquist. U.S. Forest Service. R-5. Located 9 miles east of McCloud, California. Capacity of 5 million transplants. 1-1 and 1-0 seedlings. Species, Yellow pine, Jeffrey pine and Sugar pine. Small quantity of fir. Most of the stock goes to National Forest land.

Pullman, Washington - J. W. Stubbs. Washington State College. Are hoping for cooperation from the state legislature. Have a total land area of about 35 acres. Clarke-McNary nursery producing for farm planting. Some conifers and some hardwoods. 2-0 Hardwood seedlings and 2-2 transplants.

Bellingham, Washington - W. E. Chapin. Soil Conservation Service. Nursery is at Bellingham. Have 75 acres producing 3/4 million. Capacity practically unlimited on 75 acres. Had 10 million in CCC days. Species dealt with regulated by Soil Conservation. Have produced 300 different species. Producing some cascara.

Chairman Webster: Maintenance of Soil Fertility in the nursery is a vital problem that has been ever present with nurserymen since nurseries were first started. I am hopeful that many of the answers may be forthcoming in the presentation by Mr. R. Spilsbury of the B.C. Forest Service and from the discussion to follow. Mr. Spilsbury.

MAINTENANCE OF SOIL FERTILITY
by
R. Spilsbury

The purpose of a forest nursery is to raise seedlings that have the ability to make vigorous growth when planted in the field. I do not care how little it costs to raise your seedlings, what ingenious mechanical aids you have or how many tons of fertilizer you use; if your seedlings fail to survive transplanting, your nursery is not successful. We cannot report like the doctors, that the operation was successful, but the patient died. To my mind, emphasis must be continuously placed on field survival; in other words, field survival is the criterion of nursery practice.

The experience of nurserymen throughout the world has shown that continuous cropping is inevitably accompanied by declining yields, unless adequate cultural and fertility programs are practiced. It is also true that disease and insect problems become more serious with increasing age of the nursery. If one studies the literature on nursery fertility problems, one conclusion stands out above all else; and that is that the solution to one nursery's problems is ineffective in

the next. In other words, each nursery has its own problems and these problems are constantly changing with age.

I do not wish to monopolize all of the time allotted for this discussion. I would, however, like to tell you something about what we are doing in British Columbia from an experimental angle. We are making an annual inventory of soil conditions by means of chemical analysis, and of seedling growth by weighings and measurements. The purpose of this inventory is to set up standards so that in the future we will have factual records showing changes for better or worse in soil conditions and seedling growth. I do not believe that casual records of observations or impressions are adequate. We all are prone to get distorted ideas when we look back in our old age and say, "When I was a boy, we raised seedlings you young fellows never saw the like of. Why they were so big, etc." An accurate inventory is essential. We record length of top, dry weight of top and root, diameter of stem and number of primary roots from a sufficient number of samples to give a good picture of average conditions.

A second project we have just started is an attempt to determine what type of seedling has the best survival in the field. Last year we set out plots in the field of the best and the poorest seedlings from each nursery. Due to the exceptionally cool wet summer we have just experienced, we found that the survival rate varied from 98 to 99.5%, so I am afraid we didn't learn very much. However, it seems logical to expect that there are minimum specifications of size or root development that will assure a high survival rate. Eventually we may find it possible to classify seedlings according to sites; i.e., one type of seedling for moist, rich sites and another type for dry, poor areas.

Although our nurseries have not been in operation many years, there is already some indication of soil depletion. We have started a few experiments with fertilizers. Two years ago we set out to test the effects of seven different combinations of nitrogen, phosphates and potash. The fertilizers were applied prior to seeding. This fall we measured the growth responses. At Green Timbers Nursery all the fertilizer combinations showed increased growth over the check plot. The length of tops was increased by 27 to 51%; the dry weight per seedlings by 43 to 75%; the number of primary roots increased from 0 to 1% and the average stem diameter by 16 to 27%. These increases were obtained at the cost of a slightly poorer top to root ratio. The seedlings from these plots will be planted out this year in order to determine if fertilization increases the vigor of the seedlings as measured by field survival.

At the Quinsam Nursery we tried applying chemical fertilizers to the 1-0 stock, dusting it over the seedlings early in spring. Again, positive results were obtained. The length of top was increased by 33 to 47%; the dry weight per seedling by 17 to 48% and the number of primary roots by 21 to 37%.

From these limited studies it is difficult to say just what is the best fertilizer combination. Potash and phosphates showed up well at Green Timbers and nitrogen and phosphorus at Quinsam.

As nurserymen, you probably have only a limited opportunity for experimentation. Your main concern is the mass production of seedlings. In spite of these limitations, your comments concerning nursery research problems definitely have a place in this discussion.

There are a great many aspects to fertility maintenance. We will have to choose between discussing 2 or 3 phases thoroughly or lightly touching upon a number. As this is our first meeting, perhaps we would be advised to cover the

whole field briefly and in this way get a general picture of the diverse problems with which you have to deal. Here are some general headings that may serve to direct the discussion:

(1) Field survival from your nursery stock.

(2) Inventory of records of the quality of stock produced.

(3) Evidence of soil depletion.

(4) Fertilizers and methods of application.

(a) Chemical

(b) Organic

(c) Composts

(5) Sprinkling - use of moisture metres.

(6) Seed covering - texture of soil used.

(7) Mulching -- sawdust -- peat -- straw.

(8) Erosion.

(9) Rotations and green manures.

(10) Drainage.

(11) Use of soil and plant tissue tests to diagnose deficiencies.

(12) Problems for research.

(13) Soil borne diseases.

Lanquist: You mentioned that field survival depends on the seedlings shipped from the nursery.

Spilsbury: Fertilized stock has greater survival. It has more vigor and the stock has a better chance for survival.

Hagenstein: Do you apply your fertilizer without first testing the soil?

Spilsbury: We have tested our soil, but we have no way of correlating the test with the need of fertilizer. We try to fertilize to see what effect it has on roots and tops.

Chairman Webster: How do you maintain your humus?

Hagenstein: We have used peat moss in which the nitrogen content is very high.

Chairman Webster: You rotate every other year. Sometimes overlapping. The Nisqually Nursery has operated very successfully that way.

Kindt: I think soil fertility is an important subject. I think most of us are going at it in a hit-or-miss fashion. We find a deficiency of nitrogen and add that, or find some other deficiency and add that, and build the deficiency up. There are certain things that a seedling needs. The chemical quality of a seedling has an important bearing. It starts at the nursery. If we have the seedling properly fertilized and in a sturdy condition, it has a better chance of survival. Growth depends on site and heredity. Another thing of importance is mycorrhiza. We notice better survival from the trees that have mycorrhiza on the roots. Building up the enzymes and hormones is also important. We know there are certain chemicals in the fertilizer to help build up the stock. It is my belief that trees in a dormant condition and perhaps in storage will build up certain enzymes in the roots after the roots have been damaged and give the trees an initial start. It is a big field and I think it is time for us to follow British Columbia and get down to facts of fertilization so that we know what we are doing.

Chairman Webster: What is mycorrhiza?

Wright: Primarily a parasite. It acts like a parasite. It develops on the little rootlets and root tips. We often break a lot of them off in our operations. If we can plant a tree with a lot of the root tips intact, it is better for the tree. It seems that the soil can be innoculated to grow more of the mycorrhiza on the root tips. It can be killed by application of fertilizer and other chemicals. There are two types of mycorrhiza. One is a pseudo mycorrhiza and the other is the true form. The true mycorrhiza is beneficial to seedling growth.

Schroeder: Some experiments show that survival was practically nil when there was no mycorrhiza. How can you control conditions so as not to lose the true mycorrhiza?

Wright: It requires a lot of experiments. You have to do a lot of work in a systematic manner and run tests.

Augenstein: Dr. Waters from Missoula has given us some help in building up mycorrhiza in our nursery. We did this by use of red clover, as a cover crop. It appears to do more than any other type of soil crop. When we started, we used the red clover and mycorrhiza increased and our soil holds moisture better. Clover was sowed everywhere in barren areas to hold the soil and keep the weeds down. We do not plow it under until we need the area. We sow the clover in the spring one year and plow it under a year and a half later.

Chairman Webster: In using soiling crops you need sufficient land to handle the proper crop rotation.

McDermitt: We are firm believers in cover crops. I am going to start on the use of white sweet clover. We plow it under the second growing season.

Lanquist: We have been raising a combination. All year we had Austrian field peas and winter barley. Before plowing, we mow it down with a tandem roller. In the winter time we raise vetch and oats. If you have vacant lands, it is recommended that you plant that area to some good clover that builds your soil.

Chapin: We could not get along without green manure crops. Our land is completely idle for a year and we operate on a five year rotation plan. The best way to get the land back in shape is by using green manure crops.

Engstrom: I am glad we are getting away from commercial fertilizer, and into organic matter. I believe we should be building up our soil with compost. We talk about manure bringing in weed seed. Getting compost by green manure crop, I believe, is a good thing for our soil. I think our commercial fertilizers kill off our earthworms.

Spilsbury: How much compost are you able to make in a year?

Lanquist: We use sawdust for winter mulch. Fir sawdust which is old and partially broken down.

Augenstein: We had some experience with it. Our soil was heavy. The sawdust we tried was Douglas fir and Lodgepole pine. We find that it contains a resin that got into the soil and we had it tested and found that it would become toxic. There was less resin in the lodgepole than in the fir. Resin never leaves the sawdust.

Chairman Webster: I read an article to the effect that we could use sawdust without any toxic danger.

Spilsbury: Fir sawdust is being used as a 3-inch mulch on strawberry beds in our vicinity without any toxic effects.

Schroeder: A commercial nurseryman in Yakima uses pine sawdust. He claims that resin is not soluble in water and therefore is not harmful.

McDaniel: We have been using alder sawdust. We used some of that for covering the seed. There is a warning that after you work the sawdust in the ground you must add amonium sulphate to replace the nitrogen taken out in breaking down the sawdust. Gardens and pear orchards are mulched with sawdust.

Lanquist: A good soil building is humus. We have one nursery in which the soil fertility fell off. We collected some duff in layers under the big trees. We put a 2-inch layer on the ground which improved the soil very much.

Wright: If you have a seed bed and put straw or sawdust in it and sow your seed on this soil you probably get very little damping off. When there is a lack of nitrogen in the soil, you would probably get stunted growth.

Chapin: There has been quite a little work done on the use of grasses as green manure crop and soil building crop. Sheep's fescue and all fescue is good. It makes the soil more friable. A farmer has plowed a pasture that has run out and with the use of grasses has renewed soil with very good success.

Chairman Webster: Mr. Spilsbury, we are obliged to you for presenting the topic and leading such an interesting discussion. Our next subject of seed stratification will be presented by Homer Ward, Nurseryman for the State of Washington Division of Forestry.