by
Dr. Ernest Wright

we think of disease we generally consider it to be the result of infection by pathogenic fungi. In its broader sense, however, disease is considered as any disturbance of the normal or healthy development of the plant, which nay cause premature death. Hence malformations such as walls, nutritional deficiencies such as chlorosis or heat lesions, frost damage, physiological disturbances, all fall within the field of plant pathology. With such a broad definition, it is apparent that a complete discussion en disease control in the nursery would involve much more time than we now have available. There already have been frequent references in previous discussions here on the effect of various nursery practices on the development of disease. Some of these will be briefly mentioned again and a few additional points which are considered of importance in the disease control program will also be stressed.

As already has been pointed out, seedlings are grown in nurseries primarily to develop stock of good vigor that can withstand the adverse conditions encountered in field planting. While mortality to nursery grown stock transplanted in the field nay be high at times, survival is generally more satisfactory than from artificial reseeding.

Principal Aim of Nursery Soil Management

The principal aim of nursery soil management is to provide adequate moisture and aeration in the soil by careful watering, cultivation, and the addition of organic matter to develop vigorous crops of seedlings. A good index to satisfactory soil fertility is the characteristics of the seedlings produced. The seedlings should have a good root-top ratio and a healthy foliage color.

Soil management will necessarily vary from nursery to nursery and sometimes within the same nursery, depending on the character of the soil, climatic variations and the kind of seedlings crop grown.

Soil Fertility in the Disease Control Program

All soils are biological units. Soils are dynamic and thus continually changing. The nurseryman must so adjust his soil management program to obtain the best possible biological balance.

Careful soil cultivation and seed bed preparation are highly important. Good soil pulverizing and levelling are essential. Depressions, even slight ones, nay result in frost pockets. Crusting of the surface soil should be prevented if possible.

In general it can be stated that cover crop rotations aid in holding disease losses to a minimum. Year to year seed bed rotations are also desirable when possible. such practices help to keep soil pathogens from increasing to epidemic proportions.

Green manure crops should be turned under well in advance of sowing the seed. The time required will vary according to climatic conditions. In cool regions, turning under the rotation crop will probably be safest then done in the fall. In warmer areas perhaps 6 weeks previous to sowing is sufficient time to allow before sowing the seed. In transplant beds, less care is necessary. Such

precautions are necessary in order to properly control the carbohydrate-nitrogen ratio in the soil.

Watering in the Disease Control Program

In most instances excessive watering should be avoided. However, there is much less danger in watering than is popularly supposed. Excess watering does leach the soil and when the soil becomes saturated, damping-off is generally increased. This is due both to the reduction of soil aeration and to the increase in succulence of the seedling crop.

On the other hand, increased watering can be used to decrease the damage from sunscald, frost, and chemical injuries. Cutting off watering will sometimes aid in controlling damping-off, once it is in progress.

The rate of watering will, of course, vary with the type of nursery soil and the local climatic conditions.

The time of watering is debatable and again will vary according to local conditions. In nurseries where foliage diseases are damaging the crop, it is probably best to avoid late afternoon or early evening watering. Late watering tends to raise humidity and permits the over-night accumulation of water droplets on the leaves. These conditions are particularly favorable to the germination of airborne fungus spores such as those which cause leaf spot diseases.

Application of Fertilizers in the Disease Control Program

We have already given this topic considerable attention, but it should be re-emphasized here. The proper addition of fertilizers to the nursery soil, be they mineral or organic, is one of the most important and most necessary of nursery practices. Soil analyses are generally desirable in carrying out the soil fertility program. An excess of nitrate-nitrogen at the time the seedlings are emerging and shortly, thereafter, increases the danger of damping-off. With good balanced soil fertility, the seedlings will usually develop true mycorrhizae, are generally more vigorous and consequently more resistant to disease.

Disease Control by Chemical Applications

The application of chemicals in the disease control program should be determined by a rather complete series of test plots. These trials should extend over at least two seasons.

The application of such chemicals as sulphuric acid, aluminum sulfate, sulfur, Bordeaux, and other chemicals while controlling diseases over a period of years may have an accumulative detrimental effect on the soil. This also applies to arsenicals, D.D.T., and other treatments used in insect control. Likewise, weed eradicators such as 2-4-D, Elegetol and similar chemicals should be used with caution until the after-effects are carefully tested.

Damping-off

Damping-off is caused by soil-inhabiting fungi generally Pythium and Rhizoctonia. It is one of the most common and most serious problems facing nurserymen, particularly those growing coniferous seedlings. It is always advisable to attempt to prevent rather than to control damping-off. Besides the suggestions that have already been made, there are other measures that aid in the control of damping-off.

The time the seed arc sown is important. Usually early spring sowing is better than late spring seeding. Over-dense sowing tends to increase damping-off losses, The correct density varies according to soil type and can best be determined by local tests. Over-deep sowing likewise increases damping-off losses. The longer it takes the seedling to emerge, the greater the chances for damping-off. This applies particularly to pre-emergence losses. Seed source is also important. Seed of high viability produce seedlings of greater vigor and hence they are susceptible to damping-off for a minimum of time. Also there is considerable evidence that seedlings originating from local seed sources are more vigorous than when the seed is secured from less comparable geographic situations.

For coniferous seedlings, an acid soil is essential if damping-off losses are to be held to a minimum; usually a soil with a pH of 5.3 has a minimum of damping-off. For broadleaf seedlings, soil pH appears to be less important. In coniferous nurseries where sand is used to cover the seed bed, be certain this covering is not alkaline.

In spite of all the precautions nurserymen can take, damping-off will usually take a considerable annual toll unless soil treatments are made. Since these vary so greatly for localities, no attempt will be made here to give specific directions for application. The most common treatments used arc :

1. Sulfuric acid	(Applied immediately following seeding.
2. Aluminum sulfate	(Strength depends on soil pH and soil
3. Ferrous sulfate	(type .
4. Sulfur	(For deep acidification and root rot.
5. Formaldehyde	(Applied before seeding. For sandy soils, (delay seeding 5 to 7 days after treatment; (for heavy and loamy soils, delay seeding (10 days following troatmont.

Use care in all these treatments not to get the chemical into the worker's eyes. It is safest to provide goggles to protect the eyes. For diluting sulfuric acid, always pour acid into the water, never the water into the acid.

Foliage Diseases

Use sprays.. Bordeaux is one of the best. Use tanks of high pressure and fine spray nozzles. Adjust the spray nozzles so as to get as complete coverage of the foliage as possible. Watch sulfur sprays carefully as they sometimes cause burning. Spray frequently and regularly. Spreaders and stickers arc sometimes necessary if most satisfactory results arc to be obtained.

Deficiency Diseases

Deficiency diseases manifest themselves most commonly in the form of chlorosis or yellowing of the foliage. They are caused by the unavailability or the tying up of certain elements in the soil, sometimes also from actual lack of the elements such as iron, for example. Chemical soil treatments or spraying of the foliage is frequently necessary to correct the deficiency. Chlorosis also may result from lack of proper aeration, especially *on* heavy soils. Here deep cultivation may correct the trouble.

Storage Problems

Storage problems in the immediate future arc likely to attract considerably more attention than in the oast, since heel-in beds are giving way to cold storage. Only general advice can be given on cold storage. Keep the temperature down to as near 34 degrees F. as possible and keep the roots hoist. Examine frequently to determine the condition of the seedlings, particularly the roots. Save a bundle of 25 or more seedlings of each species when the stock is shipped and plant then out in an unused part of your nursery to determine survival. Thus you will be in a better position to know from actual observation how the plants can be expected to survive in the field. If during storage you find anything which appears wrong with the plants, either to the roots or tops, call it to the attention of a pathologist.

Heel-in beds arc generally best ,hen located in well-drained soils of good aeration. A sandy soil is usually preferred. Keep the tops well covered with straw to protect than from freezing and also from unseasonable high temperatures. Always save a few seedlings for planting as suggested above.

In closing, may I repeat again that no ono knows the condition of your seedlings butter than you do. It is the nurseryman's duty to call any abnormalities to the attention o a specialist as soon as they are detected. The pathologist, entomologist, soils specialist, biologist, or other specialist will the opportunity to demonstrate that he is not only an ologist but a practical helper.

Augenstein: Regarding mycorrhiza, we were told that the. mold forming on roots was

Wright: Mycorrhiza has been effective In some cases in getting biological balance of the soil where it is easily upset. There are certain root rots that develop in the soil. Just what takes place in the soil has never been found out. The plant" is the best indicator of that.

Wright: Is there any way of detecting root rot?

Some pathologists take a sample from the nursery. When you introduce soil from the forest, it is well to be careful not to bring in something which might be infected with root rot.

Question: Is there any way to knot : whether there are parasites or disease in the soil?

So far as I know there no root rot in Chit Part of the country, which infects nursery stock.

Rindt: Do you third: that we should sot up the studdoter ration of stock in storage? When we put the stock in storage, the roots have been cut or injured. I have trusted many trees in storage that rot progresses and takes off the fine root tips. We have found some trees that died and I attribute it to this.

Wright: I have planted out a *few* seedlings myself and got good survival. It is *a* problem that should be investigated thoroughly. It might be most important to make the study on an adverse year. If you strike an adverse *year*, you might get very heavy losses. We do not know too much about the semi-parasitic mold that comes in storage roots. Cold storage is the coming practice in place of heeling-in. If you have heel-in bads, you get more damage than in cold storage.

Augenstein: vie have had some snow mold.

'Wright: That is quite common. It does a lot of damage to pine and conifer seedlings.

Augenstein: It has a smothering effect. With a loose snow we don't notice it, but under a crusted snow it does do some damage.

Wright: Out in the woods the trees have enough foliage to counteract the effect.

Chairman Webster: Asked for discussion on growing hemlock.

Sells: We have not had trouble growing them, but cannot keep them in the ground because of frost heave. he mix the hemlock with Douglas fir seed and that helps as the fir becomes better established and help to protect the hemlock.

McDermitt: We have total failure with hemlock.

Deffenbacher: Our trouble *is* with frost heave. Germination and density in beds is good, but we lose the stock the first winter.

Chairman Webster: There is some demand for hemlock and it might be well to try to solve this problem.

McWilliams: In 1921 we planted some hemlock. Survival was about 60%. Put out 100,000 trees. Some hemlock and some white fir and cedar. Our stand is now 75% Douglas fir from natural restocking. Our survey does not give us any cedar.

Long: What species of hemlock are you talking about?

Chairman Webster: Tsuga heterophylla.

Wilcox : we have never grown any hemlock. We have grown some spruce.

Chapin: Vie have come through with fairly good success by planting an exceedingly heavy stand. We get 50% survival of the seed beds.

McDaniel: We have raised 60 to the square foot broadcast, covering with sawdust 1/4 inch deep. It did very well. We used to transplant, but lost 30 to 40% by transplanting, even if *web* shaded.

Wells: We have even covered them completely, but still no success.

Chairman Webster What about cultivation to hold soil moisture? e you sow in drills, is cultivation advantageous?

McDaniel: I believe' that as lone an there is a film of dirt over the beds, it is not necessary. We try to stay away from cultivating if possible. The theory of the sawdust mulching is to affect weed control and not cultivate too much. Every time you work the soil, you get some damage.

Chairman Webster: Every time you water you get some crust on the soil and it was my thought that breaking this crust and creating a mulch would be advantageous.

Augenstein: Depends on the soil. I do not believe in deep cultivation. You tend to tear the hair roots. If you cultivate z inch deep, O.K. Our type of soil does not require a lot of cultivation for weed control, but we may have to do it some to break up the soil.

The following recommendations were made:

1. Scientific information cn storage of planting stock should be assembled.

2. Continue the investigation of oil *spray* to determine the best type of oil to use for weed control and the best time and method of application.

3. Encourage the continuation of research to determine superior strains of seed.

4. Ascertain needs of the men and agencies who use the planting stock, as to type of stock desired and necessity of standard specifications for planting stock.

5. organizations, private, state and federal, having wide experience in nursery practices, should be given an opportunity to offer an opinion on any proposed new nursery sites, thus foregoing the possibility of establishing a nursery in an unfavorable location.

Discussion was held on future meetings cf this type and by a slight majority the group favored having a biennial rather than an annual nursery meeting. It bus also sug gested that, the men who use the trees be called in to the next meeting to find out how we can best give them what they want.

Chairman Webster : In closing the meeting, I want to express my sincere appreciation to all of you gentlemen who have presented papers and entered into the interesting discussion of various topics. It is through your efforts and cooperation that this meeting has been a real success. The meeting stands adjourned.

The following men were present:

Name	Address	Representing
Wm. Turner	Campbell River, B.C.	B.C. Forest Service
J. R. Long	Duncan, B.C., Box 204	B.C. Forest Service
T. Wells	(New Westminster, B.C. (Green Timbers Forestry station	B.C. Forest Service

	Address	Representing
Frank Pitkin	Moscow, Idaho	University of Idaho
Honer S. Ward	Olympia, Washington	State Division of Forestry
Earle R. Wilcox	Noah Bay, Washington	U.S. Indian Service
Karl B. Lanquist	McCloud, California	U.S. Forest Service
H. G. McWilliams	Victoria, B.C.	B.C. Forest Service
Earl McDermitt	Nisqually, Washington	West Coast Lumbermen's Assn.
Herman C. Dill	Portland, Oregon	U.S. Forest Service 5 & P
N. E. Bjorklund	Portland, Oregon	West Coast Lumbermen's Assn.
James W. Augenstein	Haugan, Montana	U.S. For st Service, R-1
Lynn F. Cronemiller	Salem ,	Oregon State Board of Forestry
Vern E. McDaniel	Corvallis, Oregon	State Board of Forestry
L. O. Barrett	601 East 5th St. Vancouver, Wash.	Columbia National Forest
F. W Deffenbacher	Carson, Washington	U.S. Forest Service
L. Mason	Haugan, MMontana	U.S. Forest Service
Charles A. Findt	Portland, Oregon	U.S. Forest Service
Hagenstein	Portland, Oregon	West Coast Lumbermen's Assn.
Ernest Wright	Portland, Ore ==	Division Forest Pathology
Robert L. Furniss	Portland, Oregon	Bureau of Entomology & Plant Quarantine
Ronald S. Adams	10th & L St., Forest Mgr.'s Office, Sacramento, Calif.	California State Division of Forestry
Stanley P. Gessel	Seattle, Washington	University of Washington
A. Engstrom	Bend, Oregon	U.S. Forest Service
George H. Schroeder	Portland, Oregon	Crown Zellerbach Corp.
L. T. Webster	Olympia, Washington	State Division of Forestry
Al Henderson	Centralia, Washington	Weyerhaeuser Timber Co.
J. W. Stubbs	Pullman, Washington	Washington State College
C. Montgomery Johnson	Anderson Hall, University of Washington , Seattle, Wash.	Keep Washington Green Assn.