Problems in the Control of Damping-Off

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Damping-off of seedlings is a disease problem which confronts every grower of plants: ornamentals, field crops, vegetable crops, and forest and shade trees. Damping-off is of especial importance when seedlings are grown closely together and in great numbers as is done whenever transplanting of the seedlings is practiced. This applies to the growing of forest and shade trees.

In the case of herbaceous plants such as flowers and vegetables, the disinfection of the soil in flats by steaming or by application of fungicides to the soil surface has proved quite satisfactory in reducing losses by this disease. For the forest tree nurseryman who has large areas of outdoor seed beds with a dense population of seedlings, losses often run very high and suitable control measures are difficult to manipulate.

CAUSE OF DAMPING-OFF AND SYMPTOMS

This disease is caused by several fungi which live and grow in the soil. For the most part they belong to the genera Pythium, Phytophthora, Fusarium and Rhizoctonia. Some or all of them are usually present in the nursery. These fungi are capable of feeding on the humus materials in the soil without the presence of living plant roots or stems. However if seedling plants are present, they will attack and rot the succulent living tissues of the stem and roots. The typical condition from which the name "damping-off" is derived, is the invasion and killing of the seedling stem tissues, near or at the soil surface. The infected tissues are rotted and the seedling drops over and lies on the soil surface. Since this disease occurs most abundantly during periods of wet weather, the descriptive name "damping-off" is very appropriate.

In a few weeks after the seedlings emerge, the stem tissues become more strong and rigid and plants are less susceptible to rotting of the above ground parts. However, the roots may be killed and rotted by these fungi. This phase of the disease is recognized as root rot.

These described forms of injury by parasitic soil inhabiting fungi are called post-emergence damping-off. These same organisms very often attack the young seedling as soon as it starts to germinate and before it emerges above the soil surface. Pre-emergence damping-off is usually not recognized and the reduced numbers of emerging seedlings is attributed to poor viability and germinibility of the seed.

In some cases such as with the Rhizoctonia fungi, the roots may be attacked after the stems become rigid and not subject to invasion. This is true of conifer seedlings whose roots may be rotted with resultant death of the plants even into the second year of growth.

CONDITIONS FAVORING THE DISEASE

The more humus material present in the soil, the more favorable it is for the fungi as more food is available. Hence muck soils are not suitable for seed beds. On the other hand sand usually supports few fungi and is often useful as cover for the seed bed. The water holding capacity of a soil high in humus is also favorable for the development of damping-off while sand affords good drainage. Probably the best medium for the seed bed is a mixture of sand and loam.

The acidity of the seed bed bears some relation to the fungi which will be present in it. An acid soil favors the development of Rhizoctonia, while a neutral or alkaline soil favors Pythium. In general it is considered that a soil which is quite acid favors growth of conifer seedlings while inhibiting most of the damping-off fungi.

A heavy clay soil can be improved by mixing into it a finely ground peat. The amount depends on the acidity of the original clay soil, and of the peat used. The peat will improve the friability of the clay and will change it from a tight, easily water-logged soil, to one affording good water drainage between the soil particles.

The various species of fungi causing damping-off have different requirements for their growth. For example Rhizoctonia grows best in drier soils and at high soil temperatures, while Pythium grows best in wet soils and at low temperatures. The variability of growth habits of these fungi makes the problem of control difficult. One species of fungus may be predominant in the soil one year while another species may predominate in another year. These features account for the good control one year with a given fungicide and poor or no control in other years with the same fungicide.

CONTROL OF DAMPING-OFF

Now that we have seen some of the factors favoring this disease it is obvious that the first control is to provide a well drained seed bed, and avoid over crowding and over watering.

Then comes the problem of combatting the damping-off fungi themselves.

Sterilization with Steam

Various methods of sterilizing the soil are available. One of the best soil sterilization methods is steaming. It is not possible from an economic standpoint to treat large areas. The use of an inverted pan and a mobile steam generator will kill not only all fungi but also nematodes and some of the insects. It will not kill white grubs unless a long steaming for deep sterilization is practiced. Such deep steaming of the soil is not easily done with the inverted pan.

Steaming of the soil should be done about two weeks prior to sowing to permit the nitrifying bacteria to reestablish themselves. Recontamination of steamed soil by tools and other implements should be guarded against since damping-off fungi, if carelessly brought into sterile soil will increase with great rapidity in the absence of other soil flora, and loss of seedlings will be greater than if the soil had not been steamed.

A poor or incomplete job of soil sterilization by steam is for the same reason worse than no sterilization.

Use of Chemical Fungicides

The use of fungicidal chemicals has been practiced for many years. These chemicals are sprinkled or dusted on the surface of the soil, either at the time of sowing or at intervals until the seedlings are a month to six weeks old. Some chemicals are mixed into the soil before sowing of the seed. The practice of seed dusting has been tried but with indifferent success, although this method is very successful for the prevention of damping-off in vegetable and flower seedlings.

Sulphuric Acid

This chemical has been used for years in the treatment of conifer tree seed beds. It cannot be used for broad-leafed trees. In sandy soils

low in humus content, it has been effective in preventing damping-off.

It is applied immediately after the sowing of the seed. Usually a 2% solution is made up and applied at the rate of ½ pint of the dilution per square foot.

Sulphuric acid is very corrosive to metals, burns severely when in contact with the skin, and eats holes wherever drops splash on clothing and other cloth.

Formaldehyde

Formaldehyde has been used with success on small areas of seed beds. The chemical is applied at the rate of ¼ to 1¼ fluid ounces per square foot. Dilution with water, varying with the dryness of the soil, will permit of even distribution. The treated soil is immediately covered with tight woven or waterproof canvas. After 24 hours the canvas is removed and the soil allowed to aerate for at least five days. If the soil is wet and cold it must be allowed to aerate for at least 10 days before the seed are sowed. The chief drawbacks to this type of treatment are: the need for lots of canvas; the delay between treatment and sowing; and the poor penetration of the formalin gas into wet cold soils.

Other Chemicals

Other chemicals have been used and found to be effective in some nurseries in some years and deserve consideration.

Aluminum sulphate, iron sulphate, acetic acid and similar chemicals applied primarily to increase the acidity of the soil have reduced the incidence of damping-off markedly in many instances.

In the past few years some of the more recently developed chemical fungicides have been tested. Metallic compounds of copper, mercury, zinc and others, also organic compounds containing these metals, as well as dinitro phenols, quarternary ammonium and other organic compounds have been tried. These materials include calomel, zinc oxide, copper carbonate, and proprietary materials such as Cuprocide, Semesan, Ceresan, Tersan, Crag 658, and many others.

One of the most promising of these materials is Thiram, tetromethyl thiuramdisulphide, earlier known as Tersan or Tuads. This material applied and worked into the soil a few days before sowing has been consistent in reducing damping-off as compared with untreated beds. It is quite effective when used at the rate of 150 pounds per acre. This amounts to .05 ounce or 1.5 grams per square foot. This fungicide is mixed into the top 4 inches of the soil. About 3 days should elapse before sowing the seed. Pre-emergence damping-off is reduced and the percentage of emerging seedlings often runs higher than the average germination per cent of the seed used.

Others which appear to give good control of damping-off in many cases are Crag 658, and a mixture of New Improved Ceresan with Potassium Iodide. Some fungicides still under the experimental numbers given by the companies making them, show promise, but need further testing.

Seed Dusting

Many of these same chemicals have been used to dust the seed prior to sowing. At the present time consistently good control has not been obtained where the seed was sowed in soil highly contaminated with the damping-off fungi. It is hoped that some of the difficulties such as obtaining good adhesion of the chemical to the surface of the seed coat, avoiding injury to the germinating seedlings by the chemical, and obtaining longer duration of protection by the chemical can be overcome.

Surface Application After Sowing

Sprinkling the seed bed with fungicidal chemicals after sowing and at intervals until a few weeks after emergence has shown considerable promise. Some reports indicate very good control of damping-off. However where careful observations and counts in comparison with untreated plots have been made, some chemicals reported to be very good, have not given appreciable reduction of damping-off.

From such work as has been done, it appears that there may be chemicals which if applied at the right time and in suitable amounts will prove effective. Of all the methods of applying the fungicide this seems to be the best from several standpoints, such as avoiding the lapse of time between application of the chemical and the sowing of the seed, the mechanical difficulties of sowing dusted seed, and the possibility of modifying the times of application and the amounts of chemical dependent upon the weather conditions of the particular season.

OTHER CAUSES OF FAILURE OR DEATH OF SEEDLINGS

Beside the damping-off of seedlings by fungi there are several other causes of the failure of tree seedlings. Drought injury may occur at any time during the growing season. It is especially common during periods of hot weather or windy days. It can happen within a matter of hours. The central parts of seed beds are vulnerable because of the root competition for the soil water.

In light soils during sunny days and high temperature, heat injury may take place on the young stems because of the soil surface reflected heat added to the heat of the direct rays of the sun.

Nutrient deficiencies leading to chlorosis, the yellowing of the seedling, stunted growth and even death by starvation also may occur to confuse the picture of the actual losses by damping-off.

Water-logged soils may in themselves cause suffocation of the roots with resultant death of the seedlings.

Birds scratching up the seed and various kinds of insect injuries, grubs for example, take a great toll in the seed beds.

CONCLUSION

In conclusion it is apparent that prevention of damping-off of tree seedlings is most dependent on a suitable nursery site, soils free of, or unfavorable for the development of damping-off fungi, and on good nursery practices of handling the seed beds during the critical periods when the seedlings are susceptible.

The use of suitable fungicides mixed into the soil prior to sowing has been most effective in the control of damping-off of seedlings. If sprinkling of the seed beds is to be practiced, applications of the fungicide must be made immediately after sowing and continued at intervals until the seedlings are from 4 to 6 weeks old.

At this time, dusting of tree seeds with a fungicide has not proved consistently good enough to warrant recommendation.

It is possible that a combination of soil treatment prior to sowing, followed by surface applications, may be developed that will prevent damping-off to a satisfactory degree even in the most stubborn cases.

A FEW IMPORTANT REFERENCES ON DAMPING-OFF OF TREE SEEDLINGS

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Nursery Practice for Trees and Shrubs
U. S. Dept. of Agric. Pub. 434 1941

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U. S. Dept of Agric. Bul. 934 1921

Riker, A. J., R. H. Gruenhagen, L. F. Roth, and W. R. Brener
Some Chemical Treatments and Their Influence on Damping-off, Weed Control and Winter Injury of Red Pine Seedlings.
Jour. of Agric Res. 74(3): 87-95 1947

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Mich. Agric. Exp. Sta. Quart Bul. 34 (3): 285-296 1952

Ernest Wright
Damping-off in Broad Leaf Nurseries of the Great Plains Region
Jour Agric Res. 69(2): 77-94 1944

The discussion following Professor Strong's paper had to be cut off by the chairman after an hour.

Chairman Scanlon: I have some slides of Shade Tree Selections that I should like to show—we will then adjourn for lunch.