Chairman Ward: One of the looked-for pleasures of our past meetings has been a series of very informative papers on forest pathology as related to nurseries. It would seem that most nurseries have had experience with Fusarium and, to a greater or lesser extent, each nursery has worked with their individual controls. It is always a pleasure to have Doctor Ernest Wright come through with a refresher course and to bring us up to date on recent developments.

TESTS TO CONTROL FUSARIUM ROOT ROT IN FOREST NURSERIES

by

Dr. Ernest Wright

For some reason I have permitted myself to be roped in to present another paper at the nurerymen's meeting. I should think by now that you would be tired of hearing what I have to say. I know some of you are so I will try to make this presentation as painless as possible. The subject of my talk is "Tests to Control Fusarium Root Rot in Forest Nurseries."

I first became acquainted, to my sorrow, with Fusarium root rot in the early thirties at a Forest Service nursery at Susanville, California. Various methods of control were tried. Soil acidification was being widely used to control damping-off, but tests definitely showed that acidification was not effective in controlling root rot of 1-0 ponderosa and Jeffrey pine seedlings. It was quickly determined that Fusarium root rot was generally of little importance on two-year-

seedlings. It was also found that seedlings in fall-sown seed beds had much less root rot than those in spring sowings. There was, however, usually considerable frost damage **in** the fall-sown beds. Root rot losses were most severe during July and August when soil temperatures were highest.

About three years later I was transferred from Region 5 to the Shelterbelt Project, and for a decade Fusarium root rot did not prove to be a personal problem. In the late forties, however, my old headache reappeared at the Bend, Oregon, forest nursery. Beginning in about 1950, numerous tests including soil fumigation have been made at this nursery to control Fusarium root rot of 1-0 ponderosa pine. Usually these tests were made in small experimental plots, but in the last few years entire seed beds have been used. What I learned at Susanville about Fusarium proved equally true at Bend; however, it was soon apparent that a reduction in soil temperatures was not the entire answer to the control of this root rot. This was determined from shaded and unshaded seed beds, there being no significant differences in root rot losses. Laboratory tests, however, have shown that the Fusarium fungus is a high temperature organism making its best growth at about 80°F. Pathogenicity, determined by greenhouse tests, have shown this Fusarium to be most virulent when soil temperatures were held above 90°F.

Like most other biological problems it was becoming increasingly evident that control of Fusarium root rot in the nursery could most likely be expected only by the use of a combination of treatments. For one thing it is important to prepare uncultivated soil for seed beds by first growing a desirable rotation crop. Our tests have shown that wheat is one of the most desirable rotation crops. Incidentally, wheat also proved to be a good preceding crop in shelterbelt nurseries. Wheat is disced in before maturity the year preceding the establishment of the seed beds.

Tests showed that discing in sawdust at the rate of 100 cubic yards per acre was also helpful in reducing root rot losses as well as helping to maintain soil fertility. These treatments, however, either singly or in combination, did not give a satisfactory reduction in root rot losses. In fact, **in** 1954, drastic losses were experienced in sawdust-treated beds. These beds, however, did not have the desired rotation crop. Other beds close by which did have both a rotation crop and sawdust showed less loss; but even in these beds root rot was excessive.

Aluminum sulfate and ammo phos when added to sawdust-treated beds with wheat as a rotation crop further reduced root rot losses but not satisfactorily. It was further determined that time of sowing was also very important in the control of Fusarium root rot. As at Susanville, seedlings in fall-sown beds generally showed less losses; however, it developed that beds sown early in the spring were equally successful. Even with proper timing and combinations of treatments, root rot losses still continued to be too high for scheduled production.

Meanwhile, preliminary tests indicated that heavy watering during July and August might also help reduce losses. Accordingly, since 1955 the seed beds have been watered very heavily at the Bend Forest Service nursery during the heat of the summer. These practices, namely the application of sawdust plus aluminum sulfate and ammo phos plus heavy watering and early sowing of the seed beds, have reduced root rot losses greatly and will probably become common practice at this nursery.

At first it was thought that heavy watering was effective because it lowered soil temperatures sufficiently to reduce the virulence of the Fusarium root rot fungus. Infection of the pine seedlings takes place at or just below the ground line; therefore heavy watering could also be effective by reducing soil aeration as well as soil temperatures. To substantiate this statement completely, additional laboratory tests are required. I hope to make these this winter. Greenhouse tests made during the past year on the effect of watering on the development of Fusarium root rot in uncultivated, (unused) soil have shown the following:

Test 1

Watered Bi-weekly			Watered Daily			
Final Stand	Root Rot	Total	Final Stand	Root Rot	Total	Check
61	33	94	90	40	130	165
Av. 12.2	6.6	18.8	18	8	26	35

Test 2

20	37	57	41	27	68	115
Av. 5	9.2	14	10.2	6.7	17	28.6

It is evident from these greenhouse tests that the amount of water applied to the soil is a decided factor in the control of Fusarium root rot but not the complete answer. Additional tests are required and are essential to a satisfactory root rot control program. It should be emphasized also that it is essential to water normally or even sparingly during and immediately after germination to reduce losses from damping-off. I should mention also that this is not the only instance where Fusarium root rot has been reduced by the excessive use of water; in fact, it has been reported recently that a Fusarium root rot of banana plantations in Central America is greatly reduced by flooding the areas before planting. It appears, therefore, that we have found a partially satisfactory method of controlling Fusarium root rot at least in nurseries east of the Cascades.

Also, I want to acknowledge at this time the assistance given me in doing my studies by Walter Engstrom, Jim Betz, and Chuck Bigelow. I should also add that Charlie Rindt has continually encouraged and assisted me administratively during the years when the going was toughest.

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Chairman Ward: Those of us who were fortunate enough to attend the meeting in 1954 in Sacramento will recall the work being done by Doctor Stone, at the University of California, on root initiation of transplanted seedlings. This work has been continued in collaboration with Mr. G. H. Schubert, and we are very fortunate in having Dr. Stone up from Berkley to give his personal report on some of the work he