Some Apparent Mycorrhizal Relationships on Douglas-Fir

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The controversy over mycorrhizae that continues to some extent today was started in 1885 by Frank, a German botanist [1/]. Most researchers, however, now agree that under at least some conditions, mycorrhizae benefit the host plant. This is especially true where exotic species have been introduced from abroad, or where trees are planted on an area previously barren of arboreal growth, such as grasslands or heaths.

Good examples of the benefit of mycorrhizae to tree growth have been demonstrated for our native species, such as Monterey pine, when the seed has been sown in such faraway places as *New* Zealand, Australia, and Africa. Since the soil in those lands had no suitable local fungi that could form mycorrhizae on roots of Monterey pine seedlings, growth failed until a suitable mycorrhizal symbiont was introduced by inoculation of the seedbed.

I *am* sure that most of you know what a mycorrhiza **is. To clarify** the matter, a mycorrhiza can be described as an intimate union of a fungus with the root tips of a living plant. It sometimes is defined simply as a fungus root. The two main types of mycorchizae are an external form known as ectotrophic mycorrhizae, and an internal form known as endotrophic. Sometimes there are combinations of both types, in which instance the mycorrhizae are termed ectendotrophic. The fungi that form mycorrhizae are mostly the so-called toadstools or mushrooms; frequently, these are boletes.

Ectotrophic mycorrhizae replace the root hairs, and provide greater and more extensive contact with **soil** particles and soil moisture. This can best be illustrated by a few slides of mycorrhizae on Douglas-fir (Slide 1, 13X, shoals root hairs and a root tip covered by mycorrhizae with no root hairs. Slide 2, 30X, shows profuse extension of mycorrhizal strands or hyphae. Slide 3, 60X, is an enlargement of Slide 2).

For Douglas-fir seedlings, I have observed mainly three kinds of mycorrhizae, namely black, white, and gray. They form digit-like or racemose (Slide 4 and 5) types and sometimes combinations (Slide 6). At the beginning of the growing season, the root tip pushes through the mycelial mantle (Slide 7) and eventually is surrounded again by a mycorrhizal envelope. Consequently, sometimes mycorrhizal hyphae are observed on parts of the root besides the root tip.

The question arises, are mycorrhizal fungi naturally widespread in the western part of the United States and the Pacific coastal area in particular? This question can be answered affirmatively by stating that, with the exception of severely burned soil, fungi capable of forming mycorrhizae are present in practically all our forest areas. Why, then, should we be so concerned about mycorrhizae?

The answer to that question is that certain nursery practices, such as soil fumigationt may eliminate, or at least reduce, the number and kinds of fungi that may form mycorrhizae. We know this by microscopic examination of the roots of seedlings as they are lifted. How can we determine the most beneficial mycorrhizae? This has not yet been determined for Douglas-fir, but the number and kinds of mycorrhizae present on roots of seedling can be counted. In this way, lack of mycorrhizae on 2-0 ponderosa pine after fumigation of soil in the U. S. Forest Service Nursery at Bend was determined. Subsequent findings were that stock lacking, or with very *few,* mycorrhizae had field survival significantly poorer than that of stock with abundant mycorrhizae 2/

Besides treatments of soil, other factors, such as cold storage or date of lifting, may have a deleterious effect on mycorrhizae. The effect of refrigerated storage on mycorrhizae is more difficult to detect than effect of date of lifting. For example, stored seedlings may have abundant mycorrhizae, yet the viability or efficiency of the mycorrhizae may be impaired.. To determine this condition requires culturing, and, since to culture mycorrhizae from roots under any condition is extremely difficult, one can see the hazard in trying to assess the effect of cold temperatures on mycorrhizae.

The effect on mycorrhizae of date of lifting can be assessed by count. This appears simpler than it actually is, since hours of painstaking work is necessary for each 2-0 seedling. By making such counts, some interesting data were obtained on number and kind of mycorrhizae on seedlings of the same seed source lifted at different dates. These seedlings were outplanted in two deer-fenced plantations. The relationship of number of mycorrhizae to mid--season survival is shown in the next slide (8 .

The upper curves show a definite correlation between number of mycorrhizae and survival in the field up to the December lifting. The more numerous the mycorrhizae, the better the survival. Seedlings lifted in December, January, and February, however, show a negative, or at least a nonsignificant, difference from late-lifted stock in number of mycorrhizae and survival in the field. Why this is so could be theorized indefinitely. The lowest curve on this graph shows the number of nonmycorrhizal roots, which indicates an inverse relationship to survival. The fewer the nonmycorrhizal roots, the better the survival; again, up until the December lifting. By a stretch of this analysis, the nonmycorrhizal roots can be assumed to be active roots. If we agree to this, then is number of mycorrhizae or number of active roots at lifting time the more important? This possibly can be determined by additional tests.

Significance of color and type of mycorrhizae has not been established; however, black (Cenococcum type) and white mycorrhizae were more common on seedlings lifted before December than the usual blue-gray type, which was especially numerous on stock dug in December and later.

Evidently' no definite conclusion can be drawn from these root examinations and the Mytorrhizal counts , but certainly these data raise some interesting questions oh mycotrophy.

Investigations also have shown that there is a significant difference in the number of mycorrhizae on different Douglas-fir seed sources, for 1-0 seedlings. These differences, however, have not been related to field survival.

Kelley, A. P. Mycotrophy in Plants. 223 p. Waltham, Mass. 1950.

2/ Wright, E. Importance of Mycorrhizae to ponderosa pine. Forest Service 3 No. 3: 275-280. 1957.

MYCORRHIZAE AS RELATED TO SEEDLING SURVIVAL AND DATE OF LIFTING