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LIGHT AND MYCORRHIZA DEVELOPMENT

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Reprinted from *Ecology*, Vol. 36, No. 3, July, 1955

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Björkman (1942) has proposed a theory that seems to account for the varying degrees of ectotrophic mycorrhiza development occurring under different environmental conditions. He believes, and has obtained strong supporting evidence, that ectotrophic mycorrhiza form when there is a surplus of carbohydrates in the host plant. This theory is in good accord with other aspects of the mycorrhizal problem. Hatch (1935) and others have observed extensive mycorrhizal development under conditions of moderate soil deficiencies of nitrogen, phosphorous, potassium, and calcium. Moderate deficiencies of these elements sometimes retard vegetative growth and result in the accumulation of surplus carbohydrates.

By the same reasoning, mycorrhizal development should be directly correlated with the light intensity under which the host plant is growing, providing other environmental conditions permit the accumulation of surplus carbohydrates. Björkman (1949) grew pine and spruce seedlings in the greenhouse under different light intensities, using six forest soils of "extremely varied chemical composition." He found that the frequency of occurrence of mycorrhiza generally followed the curve of carbohydrate production in relation to light intensity found by Stålfelt (1924). Under natural conditions on similar soils, the occurrence of mycorrhiza accordingly should be closely related to the light intensity under which the host plants are growing. A study, therefore, was made in the Duke Forest (North Carolina) to determine if such a relation existed among loblolly pine (*Pinus taeda* L.) seedlings growing under natural conditions.

PROCEDURE

Seedlings were collected in October from within a loblolly pine stand, from a bulldozed area in the open, and from an open area that had not been bulldozed. Bulldozing had stripped off the A horizon and the seedlings were growing on the B horizon of Georgeville silt loam. The soil was the same type and series at the other two locations. Light intensity was measured at noon on a clear day within the pine stand where the seedlings had been taken up, and in the open. The average of several readings within the stand was 31 per cent of full sunlight.

The roots were carefully washed out of the soil after soaking overnight. The number of mycorrhizal tips per centimeter of root length was determined by either (1) measuring total root length and counting all mycorrhizal tips, or (2) counting mycorrhizal tips on randomly selected segments of the whole root. The whole root was used when the root system was small and sampling was resorted to with larger root systems.

The numbers of mycorrhizal tips per centimeter of root length found under the three environmental conditions were as follows:

3.6 in full light, A horizon present (17 seedlings)

2.6 in full light, A horizon absent (10 seedlings)

1.1 in partial light, A horizon present (29 seedlings)

Although all differences among these three values were highly significant, the extent of mycorrhizal development is not accurately reflected because the degree of proliferation of the infected tips cannot be shown.

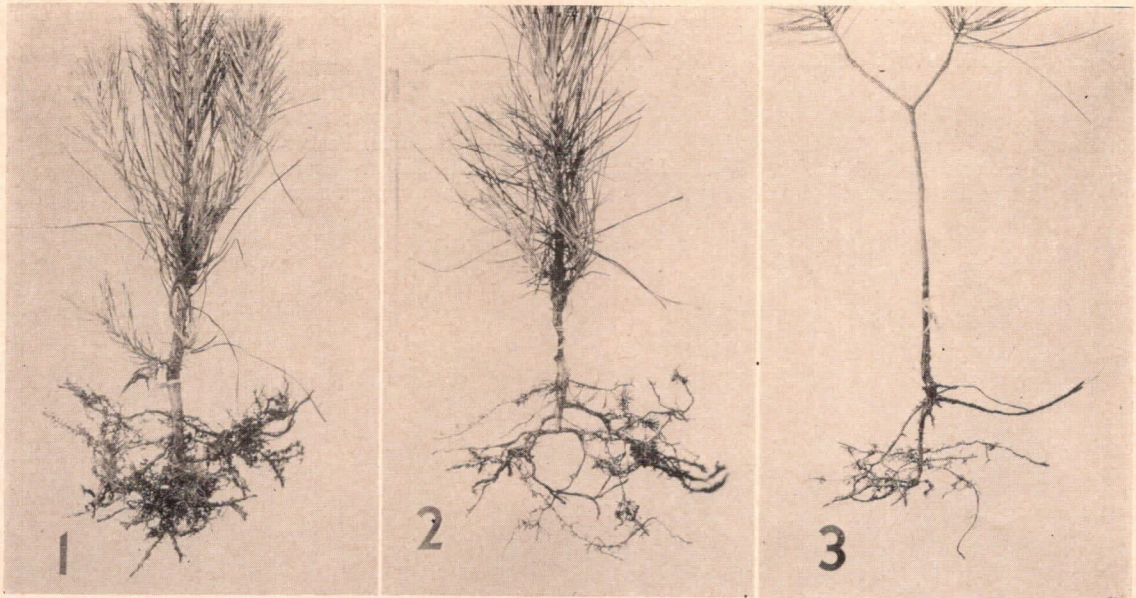


FIG. 1. Best mycorrhizal development with (A) A horizon present, (B) A horizon absent, and (C) within a pine stand.

Another group of seedlings was collected from the same locations the following June. However, instead of counting infected tips as before, three seedlings showing best, moderate, and poorest development of mycorrhiza were chosen from the sample of each location and photographed. The best development for each location is shown in Figure 1.

In addition, several blocks of soil were lifted within the pine stand at spots well away from any seedlings. The root fragments found in them therefore presumably were from the large overstory pines that were receiving ample light. Again, fragments showing best, moderate, and poor development of mycorrhiza were chosen and photographed. The best development of mycorrhiza is shown in Figure 2.

DISCUSSION

It is evident from the counts of infected roots and the pictures that there was a strong relation between the light intensity under which the seedlings were growing and the amount of mycorrhizal development. Since it has been amply demonstrated that carbohydrates are produced in accordance with the amount of light received by plants, Björkman's theory concerning the relation between surplus carbohydrates and mycorrhiza formation may be regarded as corroborated for the conditions of this study.

Of some interest also is the more extensive development of mycorrhiza that is associated with the presence of the A horizon. With the A horizon undisturbed, sources of infection might be more numerous so that root tips are more frequently attacked. A somewhat less likely reason is that mycorrhiza are able to utilize carbohydrates from the substrate as well as from the host plant (MacDougal and Dufrenoy 1944). The A horizon, containing a much greater quantity of carbohydrates than the B horizon, thus might support a greater development of mycorrhiza.



FIG. 2. Root fragments of overstory pine trees. Best mycorrhizal development. (Compare with Fig. 1.)

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