BRIEF PAPERS

THE EFFECT OF VOLATILE SUBSTANCES RELEASED BY SOIL, HUMUS, AND COMPOSTS ON THE GROWTH OF EXCISED ROOTS

D. J. PERSIDSKY AND S. A. WILDE
SOILS DEPARTMENT, WISCONSIN AGRICULTURAL EXPERIMENT STATION, MADISON, WISCONSIN

Recent investigations of Chodny (1, 2) revealed that volatile organic substances given off by soils and manures caused pronounced differences in the longevity and the rate of growth of excised roots. In his opinion, the effect of volatile substances presents interest from standpoints of plant physiology, plant nutrition, and soil science. The role of volatile substances in the "biogenic structure" of soils was pointed out previously by Vernadsky (6).

The writers thought that the observations of Chodny might prove valuable in regeneration of forest by partial cuttings and in production of nursery stock. Therefore, the experiments of Chodny were repeated, and, in the course of time, his "biotest" was subjected to several modifications. The investigations included different types of holorganic and hemorganic forest humus and composts prepared from sawdust. Roots of blue lupine were used as indicators. A modified technique of analysis and the results obtained are reported in this paper.

About 200 ml of air-dry soil or organic material are placed in a small desiccator. The lid of the desiccator is covered inside with filter paper. An aluminum stand, supporting an inclined glass plate, 5.5 x 9 cm, is installed above the test material. The glass plate is provided with a scale drawn by means of a diamond pencil. The seeds of the test plant are planted in sterilized quartz sand, and seedlings allowed to grow until their roots reach an approximate length of 7 cm. Eight excised roots, exactly 3 cm long and of similar diameters, are placed carefully on the wet glass plate where they are held by the surface tension of the water (fig 1). Depending on its water holding capacity, the material analyzed is moistened with from 25 to 50 ml of distilled water. The inside walls and the lid of the desiccator are sprayed with distilled water by means of an atomizer. The desiccator is closed and placed in an incubator at 20 to 23°C. The maintenance of suitable and uniform temperature proved to be of extreme importance for obtaining dependable results.

The roots are observed at daily intervals and their growth is measured within precision of 0.5 mm. In the initial stages of the test, as a rule, the phenomenon of guttation occurs. Under favorable conditions, the segments produce normal root hairs within 24 hours and remain turgid for several days. After each 48 hours the roots and the inner surface of the desiccator are sprayed with distilled water. The loss of turgor and browning of root tips indicate the cessation of growth of root segments. The results are expressed in terms of average total lengths of root growth and longevity of roots. In spite of careful selection of seed and test plants, individual roots occasionally exhibit abnormally slow or rapid growth. Such exceptions should be rejected in calculation of the average data, following the principle of the extreme mean test (4).

The investigation included the following natural and artificially prepared organic materials (7): hemorganic prairie mull humus, derived largely from the remains of roots of tall prairie grasses; hemorganic crumb mull humus, formed by the action of Lumbricus earthworms; holorganic Douglas fir mull humus of amorphous or fine grained structure, developed by arthropods; holorganic hardwood-hemlock bran-like mor, developed by arthropods; hardwood-coniferous matted mor, consisting in a large part of fungus mycelia; hemlock saprogenous, partly lignified matted mor; fresh hard maple and speckled

1 Received August 26, 1953.
2 In cooperation with the Wisconsin Conservation Department and with the support of the Research Program on the U.S.S.R. Publication approved by the Director.
TABLE I

THE GROWTH OF EXCISED ROOTS OF BLUE LUPINE UNDER THE INFLUENCE OF VOLATILE ORGANIC SUBSTANCES RELEASED BY DIFFERENT GENETIC TYPES OF FOREST HUMUS

<table>
<thead>
<tr>
<th>TYPE OF HUMUS</th>
<th>AVE LONGEVITY IN DAYS</th>
<th>AVE TOTAL ROOT GROWTH IN MM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control: distilled water .............</td>
<td>3</td>
<td>1.8</td>
</tr>
<tr>
<td>Rhizogenous prairie mull .............</td>
<td>3</td>
<td>1.7</td>
</tr>
<tr>
<td>Lumbricus crumb mull .................</td>
<td>4</td>
<td>3.5</td>
</tr>
<tr>
<td>Arthropod amorphous ectorganic mull</td>
<td>5</td>
<td>4.5</td>
</tr>
<tr>
<td>Arthropod bran mor ...................</td>
<td>8</td>
<td>5.3</td>
</tr>
<tr>
<td>Mycelial matted mor ..................</td>
<td>7</td>
<td>2.6</td>
</tr>
<tr>
<td>Saprogenous, partly lignified mor</td>
<td>3</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Top: Average growth of 5.3 mm produced under the influence of arthropod bran-like mor; Bottom: Average growth of 0.8 mm produced under the influence of saprogenous, partly lignified mor.

TABLE II

THE GROWTH OF EXCISED ROOTS OF BLUE LUPINE UNDER THE INFLUENCE OF VOLATILE SUBSTANCES RELEASED BY NATURAL ORGANIC MATERIALS AND SAWDUST COMPOSTS

<table>
<thead>
<tr>
<th>TYPE OF MATERIAL</th>
<th>AVE LONGEVITY IN DAYS</th>
<th>AVE TOTAL ROOT GROWTH IN MM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh hard maple sawdust ...............</td>
<td>5</td>
<td>2.7</td>
</tr>
<tr>
<td>Hard maple sawdust treated with anhydrous ammonia and phosphoric acid .................</td>
<td>1</td>
<td>..</td>
</tr>
<tr>
<td>Chemically treated and fermented hard maple sawdust ...........</td>
<td>11</td>
<td>3.6</td>
</tr>
<tr>
<td>Chemically treated and fermented speckled alder sawdust ......</td>
<td>10</td>
<td>4.8</td>
</tr>
<tr>
<td>Hardwood-hemlock leaf mold ............</td>
<td>9</td>
<td>4.7</td>
</tr>
</tbody>
</table>

alder sawdust; similar sawdust treated with anhydrous ammonia and phosphoric acid, and similar chemically treated sawdust, decomposed by the action of *Coprinus ephemerus*. Detailed information on the properties of these materials was reported by Davey (3) and Mader (5).

The results of investigations are presented in tables I and II. Under the conditions of these studies, volatile substances released by the surface layers of some forest soils exerted a definite influence on the growth of excised roots. This influence was especially pronounced in roots exposed to arthropod mor and lignified mor (fig 2). The former type of humus is known to provide an excellent seed bed; the latter is characterized by a restricted capacity...
for natural forest reproduction. The observed effects, however, may not be directly applicable to natural conditions because the environment in a closed desiccator differs from the environment in an aerated humus layer. Consequently, the knowledge of the effects of humus layers on the course of natural forest regeneration will require additional investigations in situ with an appropriately modified technique of analysis.

The results obtained with unfermented and fermented composts clearly show the danger involved in application of highly concentrated organic fertilizers, as well as the "detoxicating" effect produced by the action of microorganisms.

Modern agronomical and silvicultural practices include the use of a great number of toxic organic compounds for the control of weeds, harmful insects, and parasitic fungi. Therefore, Cholodny's biotest may prove to be of considerable value in the appraisal of different treatments of soils and may lead to better management techniques. It is likely that the study of the gaseous phase of soils will reveal other interesting relationships.

DIFFERENCES IN SURVIVAL OF EXCISED PONDEROSA PINE LEAVES OF VARIOUS AGES

JOHNSON PARKER

DEPARTMENT OF BIOLOGICAL SCIENCES, UNIVERSITY OF IDAHO, MOSCOW, IDAHO

It was the purpose of the present paper to show that there are distinct differences in time of survival of *Pinus ponderosa* Dougl. leaves of different ages when leaves or entire branches were excised. It is often assumed that all leaves of a single tree are exactly the same in general physiological characteristics so that the age factor can be ignored in comparing certain other factors among different species of trees.

Branches of ponderosa pine were cut from trees in their natural habitat on the south slope of Moscow Mountain. These branches were seven feet long and about three inches in diameter at the cut end. Some were allowed to dry as they were on the laboratory table; others had their leaves removed by cutting them off at the base of the fascicles. These excised leaves were arranged in groups of three fascicles per group with four different ages and three replications for each age. The 12 groups of leaves were weighed every 24 hours after their bases were sealed in paraffin-beeswax.

Both attached and detached leaves were observed for color changes. The color change from grass green to light green is quite definite in dehydrating leaves kept in subduced light at room temperature. This light green color most closely resembles the parrot green given in the Ridgway color tables (7). When the leaf shrinks with dehydration and also

1 Received March 8, 1954.

LITERATURE CITED


FIG. 1. Rates of mortality in ponderosa pine leaves of various ages. Three replications of each of four years numbered 1 to 4 are plotted as percentage dead (light green) over the number of days since removal from the twigs. Replications in one age are shown by the same kind of line, dashed, dash-dot, or continuous.

changes color to light green the cells have never been found to recover with subsequent rehydration as indicated by the tetrazolium chloride test (5, 6). There are circumstances, such as with leaves that have been warmed very rapidly from low temperatures, when the leaf color may become lighter and yet the leaves still give a positive tetrazolium test, but this has not proven to be the case with the dehydration phenomenon. The fact that ponderosa pine