A TECHNIQUE FOR THE PERIODIC OBSERVATION OF ROOT SYSTEMS IN SITU

IN GENERAL, research on higher plants has concerned itself more with the foliage than with the root systems. This is partially due to the greater difficulty in making periodic examinations of roots growing in soil. As a consequence, much more is known about top growth than about roots.

For some years, the senior author has been developing the use of glass-faced boxes for the study of growth of underground root systems. They have been used for studies on the rhizomes, tubers, and root systems of numerous species such as nutgrass, bindweed, beans, corn, wheat, and tomatoes. Several workers have expressed interest in these boxes as research tools and, therefore, a brief description of their design and use is given here.

The original type of box, although still very useful, was rather cumbersome. The boxes presently used are smaller and considerably more versatile. They can be transferred to varying growth conditions almost as easily as potted plants. They are made of 3/4-inch marine plywood and are 2 inches thick, 8 inches wide, and 36 inches deep in the inside dimensions. One side of the box is left open and grooved so that a glass plate can fit into it. This plate can be covered with a close-fitting removable shutter which clips into place and keeps the roots in the dark (Figure 1).

The empty boxes are laid flat on a greenhouse bench and filled with vermiculite, sand, or soil, which is then moistened. Vermiculite is preferred as the medium because of its light weight and cleanliness. Seedlings or rooted cuttings are then laid on the surface of the medium, with the top of the plant placed to extend out the open end. The roots are spread out to permit ready observation, and the glass plate is placed over them. The wooden shutter is then slipped over the glass and the box placed at a 45° angle with the glass face down. Geotropic response of the roots induces them to grow against the glass plate. An essential feature of the design is to place the glass plate an angle such that the roots will grow along it. Angles of 30 to 45° have proved satisfactory.

The examination of intact root systems with minimum disturbance of the plant is therefore a simple matter, since the roots can be observed simply by removing the shutter (Figure 1). In practice, it has been found convenient to determine the rate of elongation by marking the growth occurring during a desired period directly on the glass plate with a wax pencil, making the final measurements and recordings later to suit the worker's convenience. Once the roots are growing well, usually within a week or two after planting, chemicals can be applied to the foliage or to the soil and their effects on growth rate measured, not only in comparison to the controls but in comparison to their own previous growth rate. If desired, the glass plate can be removed temporarily and treatments applied directly to individual roots, without effect on the rate of elongation of the untreated roots. It is advisable to wait several hours after watering before removing the glass because of adherence of the vermiculite to wet glass.

By the use of this technique, it has been possible to show that roots of many species are affected by foliar applications of 2,4-D within 4 to 6 days. In some cases elongation of the roots ceased and various abnormalities occurred within this time. A time sequence of these changes was easily obtained by visual examination of the roots. For example, 2,4-D applied directly to the root tip of wheat temporarily inhibited elongation and lateral roots did not emerge on the new root growth. Lateral roots developed extensively immediately behind the inhibited root tips. Individual roots were excised for the study of progressive histological changes.

Other sizes of boxes can be used. For example, 2 boxes similar in design but 96 inches tall were constructed for a study on translocation of 2,4-D in the extensive root systems of bindweed. Roots of bindweed grew along the glass until they came out the bottom of the boxes some three months after planting.

This simple technique permits the detailed study of root growth and development under a variety of experimental conditions. The authors have used it mostly for the study of growth regulation effects. The technique may be useful in studying the other aspects of root growth, such as varietal differences in root development in different soil types, under moisture stress, low and high rates of fertilization, and the influence of foliar-applied nutrients on root growth.

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