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Preliminary Report On Subtratum Temperature Studies On Root Growth

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to natural forest reproduction has occurred. Every severe winter large numbers of deer starve and the situation has now become so critical that the deer are in poor condition even in the summer. In 1936 an attempt was made to trap and transplant some of the deer, but the sentiment of local people prevented its continuation.

The 4 square mile "natural area" chosen by the Minnesota Academy of Science for investigations in the Park was studied intensively in 1942 to determine which species of browse plants in the Park were now being used. A spot-sampling system was used and nearly 18,000 trees and shrubs of 35 species were closely examined for evidence of browsing. Every species had been browsed somewhat, most of them very heavily. Swamp buckthorn and alder were the only shrubs which the deer seemed to avoid. A fenced enclosure of one acre is available to demonstrate reproduction on an area protected from the excessive deer browsing.

PRELIMINARY REPORT ON SUBSTRATUM TEMPERATURE STUDIES ON ROOT GROWTH

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Substratum temperatures in relation to the rooting of cuttings form the subject of numerous and rather diversified investigations. These investigations usually prove interesting to the researcher and have the possibility of leading to important discoveries. Such principles often lead to practical application in plant propagation. Most equipment used in such research, however, is beyond the means of the average worker in either the cost of the apparatus or in its complication for home construction.

The object of the present paper is twofold: firstly, to place before interested workers, in this phase of botanical science, a description of inexpensive apparatus constructed and used by the author; secondly, to show that the use of such equipment is not confined solely to the rooting of cuttings but that it can also be used in various other investigations where it is desirable to work with different soil temperatures. A preliminary report on the growth of radishes, *Raphanus sativus* var. Scarlet Globe, in relation to different soil temperatures follows the description of the apparatus.

APPARATUS: The equipment is made up in sections, each section consisting of three compartments. Each compartment consists of a heating chamber of 9x13x8 inches and is supplied, in the top, with a water pan of 9x13x2½ inches dimension. These heating chambers are placed on a platform over electric lamps. Plate I shows one section of the setup. The water pan in the top of each heating chamber is kept filled with water to within ½ inch of the top. Its object is both to distribute heat evenly to and to give off moisture to the flat above it. The flat contains the medium in which the plants are to grow. Flat dimensions are 9x13x4 inches. The size of the electric lamp used in each heating chamber depends on the temperature at which the soil in the flat above it is to be kept. Ventilation shutters are placed in the ends of the heating chambers as additional aids in temperature regulation. The apparatus works best when placed in a constant temperature case but a greenhouse with fairly constant temperatures is satisfactory.

PROCEDURE: The heating chambers were placed on the platforms over the electric lamps of different sizes to give the approximate soil temperatures desired. Water to a depth of two inches then was added to the water pans. The flats were filled with sphagnum moss to a depth of one inch. This serves as a water reservoir and buffer to keep the soil from drying out rapidly. A good grade of porous garden loam soil mixture was placed on the sphagnum to a depth of two and one-half inches by filling the flats to within ½ inch of the top. The soil was moistened with water and the lamps connected to a light socket. Closer regulation of the soil temperatures was accomplished by means of the shutters in the heating chambers.

After a few days when the temperatures were satisfactorily regulated, about one hundred radish seeds were planted in each flat. The temperature series used was 35, 30, 25, and 20 degrees centigrade. Fifty of the best radish plants in each flat were allowed to grow; the remainder were removed shortly after coming up. Care was taken in an attempt to keep the soil in all flats equally moist at all times. The radishes were pulled twenty-eight days from the time the seeds were planted. They were then carefully washed and fresh weight determinations were made. Average weights were found for the plants as a whole and also for the roots and for the tops separately.

RESULTS: The results of the experiment, as set forth in Table I, were based on a total of four hundred radishes i.e. one hundred in each set. Weights are given as fresh weights. Plate II shows photographs of representative radishes grown under the different soil temperatures in centigrade: A35, B30, C25, and D20.

CONCLUSIONS: 1. There are indications that by proper regulation of temperatures between the soil and the surrounding air the relative growth rate between tops and roots can be controlled, at least, to a certain point.

2. The growth rate for the radish tops is strikingly greater than that for the roots, under the conditions of this experiment, when the soil temperature is considerably below or considerably above the optimum.

3. Of the different soil temperatures used in this experiment, as shown in Table I, a temperature of about 30 degrees centigrade ap-

PLATE I

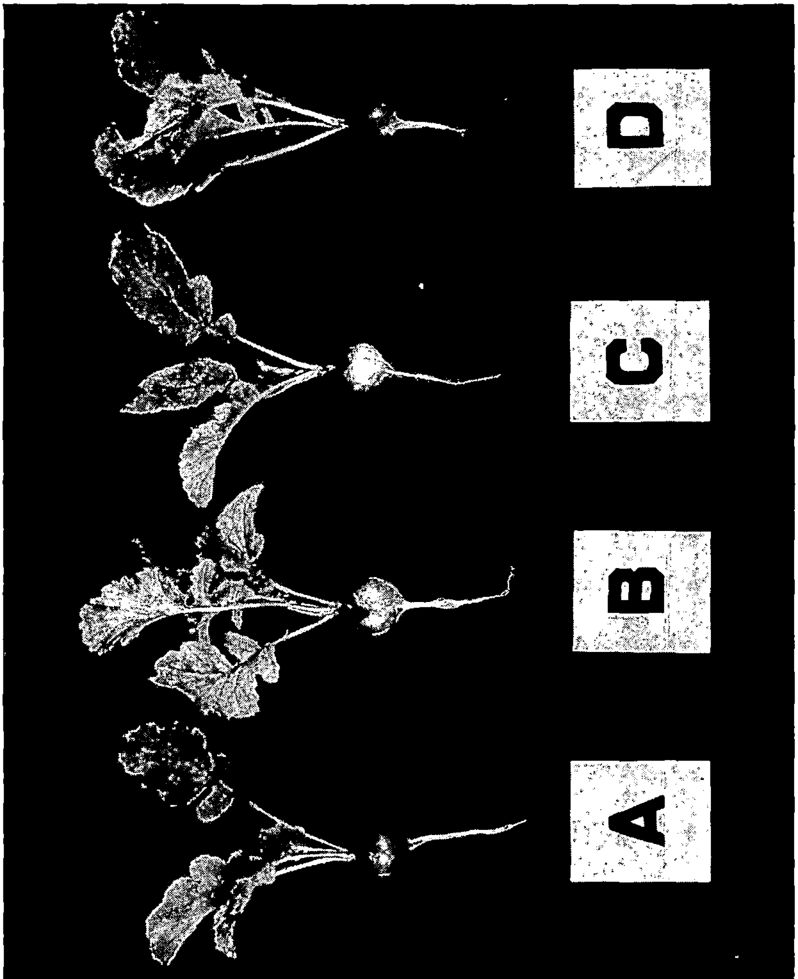

PLATE II

pears to be most nearly optimum for total average weight and also for favoring root growth over the growth of tops.

TABLE I

Radish Weights in Relation to Soil Temperatures

Temperatures in Centigrade....	35	30	25	Control 20
Av. Total Weight per Plant	3.2 g.	4.2 g.	3.5 g.	2.6 g.
Av. Root Weight per Plant	1.3	2.2	1.7	1.0
Av. Top Weight per Plant	1.9	2.0	1.8	1.6

THE USE OF THE C^{13} ISOTOPE AS A TRACER IN TRANSPORT PROBLEMS IN PLANTS

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ABSTRACT

The bean, *Phaseolus vulgaris,* var. Kentucky Wonder, was grown in a Shive solution of nutrient salts. When nearly mature, the primary leaves were enclosed in separate glass chambers and exposed to carbon dioxide enriched with carbon, mass 13. The leaves were illuminated and the movement of the photosynthate to various parts of the plant was followed by burning samples of isolated tissue in a closed system and analyzing the carbon dioxide produced by a mass spectrometer.

Results with root tip and stem tip combustions indicate that the newly photosynthesized food materials are rapidly transported to those actively growing regions. To demonstrate that the movement of these food materials took place primarily in the phloem tissues, three centimeter sections of the stem below the primary leaves and of the stem tip above these leaves were killed with hot wax at 100° Centigrade. The leaves of such plants lived and were able to continue photosynthesis for several days. Although water conduction occurred through such killed tissues, in no case was organic material containing the C^{13} isotope observed to move through these dead areas. This suggested that these materials were conducted exclusively in the living phloem tissues. In some experiments in which heavy carbon dioxide was fed to only one primary leaf, no evidence of cross transport of photosynthate to the opposite primary leaf was observed during a 72 hour period. Exposing the latter leaf to normal carbon dioxide and light, or depriving it of carbon dioxide and keeping it in either light or dark, made no difference in the results. One