THE UPTAKE OF CARBON DIOXIDE BY PLANT ROOTS

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INTRODUCTION

The uptake of CO₂ by plant roots was previously investigated in Russia by Kursanov et al.¹ ². They concluded that plants take up CO₂ through their roots to such an extent that fertilization with soluble carbonates should have advantageous effects on plant growth. Stolwijk and Thimann ³ carried out similar investigations but came to the conclusion that plants take up so little CO₂ through their roots that no advantage would be gained by fertilization with carbonates. The CO₂ content of most soils would already be more than sufficient.

Although it is thus generally accepted that plants do take up CO₂ through their roots, little is known about the eventual distribution of the assimilated carbon. In the present investigation the uptake of CO₂ by plant roots, the transport of the assimilated carbon to the foliage and its possible release as CO₂ under different light intensities were studied with the aid of carbon-14.

MATERIAL AND METHODS

Tomato plants (Lycopersicum esculentum L. cultivar Pearson) were grown in soil for 20 to 24 days. A number of plants of uniform size were then removed, the soil carefully washed from their roots, and the roots then immersed for 12 hours in distilled water which had been freed of CO₂. A number of 120 ml screw cap flasks were filled with a Na₂C¹⁴O₃ solution with activity 1µc per ml, and adjusted to a pH of 7.0 with hydrochloric acid. The total concentration of the solution amounted to 3.83 mg Na₂CO₃ per litre, which was equivalent to 1.59 mg CO₂ per litre of solution. The plants were placed
in these flasks containing the Na₂C₁⁴O₃ solution by inserting the roots through holes in the screw caps. The flasks were sealed tightly with parafilm. A cellophane bag was placed over the aerial parts of each plant and sealed tightly to the flask. Air was drawn over the plants in the bags at a constant speed by means of a water jet pump. The carbon dioxide in the air which had been passed over the plants was absorbed in a 5% NaOH solution.

The C¹⁴ contents of the roots and foliage, as well as any C¹⁴ released by the leaves, were determined with different plants after varying time intervals. The experiment was repeated under three different light conditions, viz

(1) Natural light in the laboratory
(2) Natural light supplemented by electric light
(3) Total darkness.

Each plant was removed from the active solution after a given time and the roots were thoroughly rinsed with tap water. The roots and foliage were thereupon separated and dried to constant weight at 105°C. After grinding of the dry material, 100 mg of the leaf powder and 25 mg of the root material were separately ashed in a combustion tube through which a steady current of oxygen was being passed. The hydrocarbon gases formed during combustion were oxidised to CO₂ by passing them over heated cupric oxide. The CO₂ liberated was then absorbed in 2 ml of a 5% NaOH solution. This solution as well as the solution containing the C¹⁴ released by the leaves, were then partially evaporated under reduced pressure. A 10-ml aliquot of a suitable liquid scintillator was then added to each solution and its activity determined in a liquid scintillation counter. From these results the C¹⁴ content of the roots and foliage as well as the amount of C¹⁴ released by the leaves was calculated on a dry weight basis.

**EXPERIMENTAL RESULTS**

a) **Plants under natural light**

Plants were grown at a light intensity of 75 metre candles, the average temperature during the course of the experiment being 24.0°C. The relationship between the amount of C¹⁴ absorbed and the time is illustrated in Fig. 1. Each point represent the average of at least three determinations. These graphs indicate that a saturation point with regard to C¹⁴O₂ uptake was reached after approximately three hours. After three hours only sufficient C¹⁴O₂ was absorbed to maintain a constant level. Furthermore the amount of C¹⁴ absorbed per unit of dry weight was of the same order of magnitude for the roots and foliage. The total amount of C¹⁴ in the roots, however, was slightly more than that in the foliage. A small amount of C¹⁴O₂ was liberated by the leaves, increasing linearly with time.