THE FUNCTION OF ROOT SYSTEMS IN MINERAL NUTRITION OF WATERCRESS (*RORIPPA NASTURTIIUM-AQUATICUM* (L) HAYEK)

by I. P. CUMBUS and L. W. ROBINSON

School of Biological Sciences, University of Bath, Bath, Avon, U.K.

SUMMARY

The ability of 'adventitious' and 'basal' root systems of watercress (*Rorippa nasturtium-aquaticum* (L) Hayek) to absorb mineral nutrients from surrounding media has been demonstrated using radioisotopes $^{32}$P, $^{86}$Rb and $^{59}$Fe. Controlled experiments on single whole plants cultured in a dual-medium-apparatus, indicate that both root systems have a capacity for nutrient absorption. Analysis of axillary shoots formed during a seven day experimental period show that a greater proportion of phosphate and potassium, gained from the ambient media, was absorbed by the adventitious root system, although there was a greater mass of basal root tissue. Extensive translocation of nutrients to actively growing plant organs occurs from absorption sites on both root systems.

INTRODUCTION

Watercress is grown as a commercial semi-aquatic crop plant. Under normal conditions of cultivation the plant comprises an aerial, root-free stem portion and apex projecting above the water level. Submersed in the irrigating water is a portion of stem and foliage having extensive adventitious roots developing exogenously from the stem in the region of the leaf axils. These roots remain free-floating in the stream of water whereas a more finely branched basal root system anchors the plant within prepared bed substrates.

The nutritional role of these two root systems has remained uncertain to date. A limited number of studies$^2$ 6 12 have found that irrigating waters, although containing low concentrations of many essential nutrient ions, are generally supplied to crops in sufficiently large quantities to account theoretically for crop nutrient status. In most water supplies phosphate and some trace elements, including
iron, are present in exceptionally low concentration, thus suggesting that bed substrates may function as a source of these nutrients. Experiments have shown that some aquatic species require the presence of a soil substrate for healthy growth. Recent investigations have shown that phosphate can be absorbed by roots of several aquatic species and is subsequently translocated throughout the plant. Conversely it has been considered that nutrients are absorbed primarily through leaves of submerged plants and the function of roots is predominantly anchorage.

Irrigating water for cress cultivation is supplied either by natural springs, which are common in limestone regions, or by bore holes. These supplies are maintained throughout the year, often by supplementary pumping, to provide crops with an adequate flow rate. Adverse effects on growth rate and yield can result if water flow is reduced below a critical level. Similar reductions in growth occur when plants become uprooted by turbulent water. Both these nutrients sources, water and substrate, appear to be essential for healthy growth.

This study was intended to elucidate relative contributions of the two root systems in absorption of nutrients and to observe the subsequent distribution pattern of minerals within the plant. A dual-medium apparatus allowed radioisotope labelled nutrients to be applied specifically to basal or adventitious roots. Phosphate labelled with $^{32}$P was included in the study as a representative of macro-nutrient anions. Studies with several plants have shown that uptake of rubidium and potassium is so similar that $^{86}$Rb can conveniently be used as a tracer for potassium. A preliminary investigation with watercress confirmed this finding and $^{86}$Rb labelled potassium was subsequently used in the reported experiments. Iron labelled with $^{59}$Fe represented the micronutrients. The source of these three nutrients in a cress bed and their sites of absorption are uncertain. The supplementary fertilizing of watercress crops requires a greater understanding of the ion uptake pathway in this semi-aquatic crop.

METHODS

Uniform 6-week-old watercress plants grown in commercial beds were selected, lifted, washed in running distilled water and transferred to beakers.