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RHIZON SOIL SOLUTION SAMPLERS AS ARTIFICIAL ROOTS

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SUMMARY: A brief description is given of a new cylindrical microporous device for extracting soil solution samples.

INTRODUCTION: Frequent sampling of soil solution is often required to evaluate solute transport in soils, e.g. due to nutrient uptake by root systems. Prequisites for an adequate sampling system are that it does not disturb soil structure, has no ion-exchange properties, that its internal, 'dead', volume is small and that it can function for at least one growing season. BRIGGS and McCALL (1904) proposed the use of ceramic cups as 'artificial roots' to extract soil solution. As reviewed by GROSSMAN and UDLUFT (1991), this technique is now widely used, but ceramic cups have some disadvantages (Table 1). The RHIZON SSS, Soil Solution Sampler, provides a new option for such studies.

MATERIAL AND METHODS: Figure 1 shows the design of the sampler. A hydrophylic polymer with a typical pore diameter of 0.1 μm is used to extract the samples. A stainless steel wire gives support while inserting the sampler into the soil in a pre-drilled hole. The samplers should be installed into wet soil, after preparing a hole with a 2 mm rod. A good tube-soil contact can be obtained when samplers are inserted horizontally into cylinders of soil. Horizontal installation in the field is possible from trenches or cylindrical holes ('inverted lysimeter'). Vertically placed samplers may have less satisfactory tube-soil contact. A simple stainless steel wire positioning system is available for use in very soft soil, e.g. rice fields. The samplers are directly suited to sample water saturated materials.

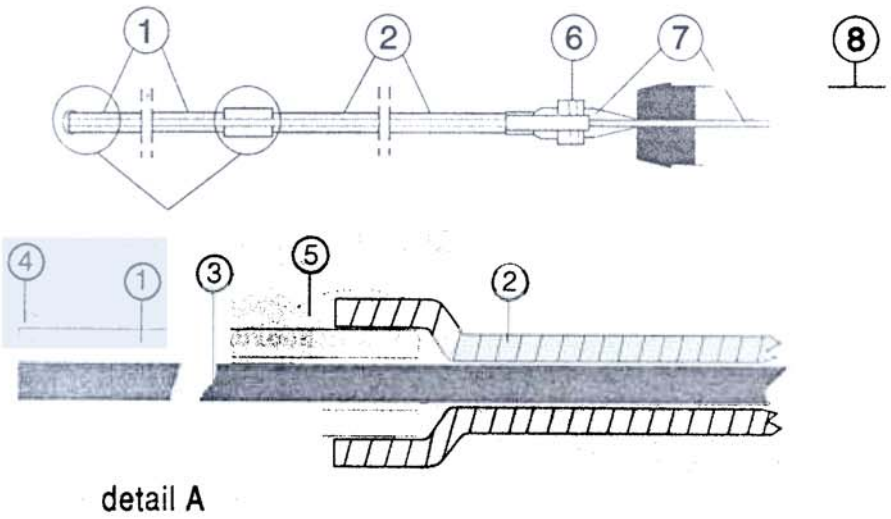

Fig. 1. Construction of RHIZON SSS soil solution sampler. 1. Porous hydrophylic hollow fibre of 2.5 mm outer and 1.4 mm inner diameter, 100 mm long; 2. PVC tubing of 2.7 mm outer and 1.0 mm inner diameter; 3. Stainless steel wire of 0.8 mm diameter; 4. & 5. Adhesives; 6. Luer-lock connector; 7. Injection needle; 8. Vacuum tube.

Samples can be extracted by connecting a syringe to the sampler (using the Luer-Lock connection), or - as shown in Fig. 1 - by the use of a vacuum bottle (as used for collecting blood samples). In water a 10 ml sample can be extracted in less than 5 minutes. In soil 7 ml of sample can be obtained per 10 ml vacuum tube, in 1 - 16 hours (overnight), depending on soil water content. Below a hydrostatic soil water potential of -200 to - 500 cm (depending on soil physical characteristics), no satisfactory sampling is possible.

RESULTS AND DISCUSSION: In Table 1 a tentative comparison of ceramic cups and the new samplers is made, based on experience obtained in a range of field and pot experiments. Quantitative measurements of the water extraction rate as a function of soil water content are currently performed in our Institute. In this work the samplers are used to check model calculations of soil water uptake by roots. In further applications of this kind, effects of partial root-soil contact on uptake rates can be investigated by making half of the tube diameter impermeable to water. The tubes can

Table 1. Tentative evaluation of ceramic cups and Rhizon soil solution samplers.

Criterion	Ceramic cups	Rhizon SSS
Soil disturbance	Minimally 6 mm diameter	2.5 mm diameter
Dead volume	Usually high	0.5 ml
Mechanical strength	High	Low
Ion-exchange	Yes, varies with age	Inert
Longevity	Ageing depends on soil	No ageing; samplers fragile in craking soils
pH-measurements	Unreliable CO_2 loss	Correct, no CO_2 loss

also be used to inject solutes into the soil, e.g. to simulate exudates and subsequently extract soil solution. The tube diameter is within the range normally encountered for roots.

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The Rhizon SSS can be obtained from Eijkelkamp Agrisearch Equipment P.O.Box 4, 6987 ZG Giesbeek, The Netherlands.