THE RELATIONSHIP OF THE SIZE AND STRUCTURAL RIGIDITY OF PORES TO THEIR PENETRATION BY ROOTS

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INTRODUCTION

Although under favorable conditions a plant may develop a more or less characteristic root system, unfavourable conditions in the soil can bring about marked alterations in the form of the root system. Shallow rooting can be the consequence of a number of different factors, acting either separately or together. The mechanical resistance of the soil is one of the factors which is not infrequently claimed to be responsible for restriction of root penetration. This is also the case in a recent series of papers—the results of which have been summarized by Goedewaagen—where the suggestion is made that mechanical resistance of the sand subsoil may be a contributory factor in the restriction of root penetration below the loam topsoil. However, a clear definition of this term is usually lacking although it may be obvious what is meant in many cases, e.g. in case of the occurrence of an indurated sub-surface pan.

One of the difficulties in evaluating this factor is the close similarity of the effects of soil density, excess moisture, and poor aeration. Furthermore a dense soil is usually poorly aerated and may often contain an excess of moisture. The object of the present studies has been to obtain data which could lead to a better understanding of mechanical resistance in its strict sense. This seems to be all the more important since Pfeffer had already given data on the very high pressures which can be exerted by the root tip in 1893. However, it was only quite recently that Gill and Miller extended these early investigations by measuring the mechanical
resistance that could be overcome by young roots. In the experiments to be described below, attention was paid primarily to the ability of young roots to penetrate pores of various sizes. The effect of rigidity of the pore structure was also taken into consideration.

A. THE ABILITY OF ROOTS OF VARIOUS DIAMETER TO PENETRATE PORES OF VARIOUS DIAMETERS

Experimental method

Sintered glass-filter discs having different pore-diameter ranges were used in the experiments. The filter discs were 6 cm in diameter and about 4 mm thick. The diameter of the pores varied from 500–200 μ, 205–150 μ and 150–90 μ. The pores in these discs are very irregular in shape and should closely resemble the pore structure in soil.

Six filter discs were laid on top of a shallow layer of moist sawdust in a wide enamelled container. Seeds of the species to be investigated were spread on top of the discs (Fig. 1). The container was covered by a sheet of glass and put into a small glass-walled moist chamber. When the young seedlings started to grow the sheet of glass was removed.

In order to be able to investigate roots of a higher order of branching, root formation by cuttings was induced by placing a shallow plastic ring filled with coarse sand on top of the discs (Fig. 2).

Some 2–3 weeks after the start of an experiment the discs were