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A COMPARISON OF PENETROMETER PRESSURES AND THE PRESSURES EXERTED BY ROOTS

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KEY WORDS

Confined cores Penetrometer Remoulded soil Root growth pressure Tensile strength Unconfined cores Weathering Wetting and drying

SUMMARY

Previous work is reviewed in which the ratio of the pressures required for soil penetration by roots and penetrometers are compared. It appears that this ratio can vary from about 2 to 8 depending on conditions. However, there is very little experimental evidence and most of the work has been inferential.

Direct measurements are reported for the stresses exerted by a 1 mm diameter penetrometer probe and by the roots of pea seedlings when penetrating Urrbrae fine sandy loam. Six soil conditions were used: (non-weathered remoulded soil cores + artificially weathered remoulded soil cores + undisturbed field clods) × (confined + unconfined cores or clods). The confinement treatment was to test for any effects of additional restraint to cylindrical root expansion. The weathering and field clod treatments were to test the hypothesis that root elongation is facilitated by tensile failure ahead of the root tip.

The principal conclusions are as follows. The laboratory weathering treatment reduced the soil tensile strength by 25%. This resulted in a small but significant reduction in the pressure for root penetration into confined cores. Compared with remoulded non-weathered cores, field clods had a 2 to 3 fold greater penetrometer resistance and a 50% lower tensile strength. The force required for root penetration into unconfined field clods was only 10% greater than for unconfined non-weathered cores. For the former (which is closest to field conditions) the penetrometer had to exert a pressure 5.1 times greater than a root tip in order to penetrate the soil. Penetrometer penetration pressure was independent of probe diameter in the 1–2 mm range in the soil used. Core confinement restricts root radial expansion and modifies the penetration force of metal probes and plant roots.

On the basis of the new results it is tentatively concluded that soil tensile failure can facilitate penetration by roots.

INTRODUCTION

Although penetrometers have been widely used to relate soil strength factors to the rate of elongation or penetration behaviour of plant roots, few detailed comparisons have been made between penetrometer resistance and the resistance encountered by growing roots. There is however a considerable body of

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