HYDRAULIC FACTORS LIMITING THE USE OF SUBIRRIGATION IN FINE TEXTURED SOILS

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ABSTRACT

Subirrigation is a method of supplying water directly to the plant root zone under the ground surface by means of subsurfce drains which are also used to remove excess water from the root zone. Subsurface drainage systems are used to maintain appropriate levels of soil moisture in the root zone of a crop by managing the water table. Subirrigation is seen as being an economic alternative to conventional sprinkler irrigation systems on dairy farms where mole drainage systems are already installed. However, information on subirrigation of these fine textured soils is very limited. The primary focus of this study was to evaluate the hydraulic parameters limiting the use of subirrigation in fine textured soils.

A field experiment was carried out on the Massey University No. 4 Dairy Farm in Palmerston North. During the study, a subsurface tile drainage system, with mole channels, was used to subirrigate 1248 m^2 of Tokomaru silt loam soil. The depth of irrigation applied was 185.71mm (232 m^3 of water added to the system). Time Domain Reflectometry (TDR) was used to measure the soil moisture content to a depth of 400mm at three positions, 5 m away from the drainage lateral and at three control points in an adjacent unirrigated plot. A theoretical daily water balance was developed for the irrigated plot and unirrigated control, based on the available weather data.

The results from field experiment showed that sufficient water did not move from the drainage lateral to the moles. Reasons for this may include: (a) Not enough water applied, (b) Not enough pressure head was available to force water from the drainage lateral to the moles or (c) hydraulic conductivity of the backfill was too low.

Having identified, from the field experiment, that the hydraulic connection between the lateral and mole was a potential problem, a bin model experiment was carried out in the hydraulic laboratory of the Agricultural Engineering Department. Two different backfill materials (gravel and tokomaru silt loam soil) were used with two mole positions in the bin relative to the drainage lateral. The flow rate and head losses through the system were measured for different applied pressure heads. The saturated hydraulic conductivity *(K_{sat})* of the backfill materials were measured in the laboratory and were measured other relevant physical properties (bulk density, particle density and porosity).

The bin model experiment showed that flow rate through the system increases as the pressure head increases for both gravel and Tokomaru silt loam soil backfills. The flow rate with gravel backfill was eight times more than the flow rate with Tokomaru silt loam soil.

For a gravel backfill the efficiency of hydraulic connection between the lateral and moles must only be in the order of 2 to 3% for successful subirrigation. With a backfill of Tokomaru silt loam the efficiency of connection must be 10 to 20%. This may not be achieved in the field as the hydraulic conductivity of the backfill will be of a similar magnitude to the surrounding soil leading to significant water losses vertically downward as well as horizontally.

It is recommended that further field studies be conducted using gravel backfill. Further laboratory studies using other alternative backfill materials are also suggested.

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