Soil Water Repellency: Problems for Fibreboard Effluent Irrigation to Pumice Soils

Azam Khan

What is Water Repellency?

As soils dry, hydrophobic compounds polymerize and water repellency increases. Once a critical moisture content is reached soils shift from wettable to non-wettable, impacting infiltration and unsaturated flow in affected soils.

Water repellency occurs in most irrigated soils, but is most pronounced in coarse sands and sandy soils due to accumulation of hydrophobic compounds on soil particles or to physiochemical changes in soil organic matter.

Taupo Soils – Is it Repellent?

Investigations undertaken by O'Connor *et al* (2004) on a dairy farm in Tihoi (north-west of Taupo) showed severe water repellence.

This investigation resulted in a re-think on the land disposal system with application rate reducing to 2.4 mm/hr.

Water Repellency Testing

There are two methods of testing:

Molarity of an Ethanol Droplet (MED) – King, 1981.
Water Drop Penetration Time (WDPT) – Doerr, 1998.

We used WDPT test as a measure of determining soil water repellency.

Repellency Determination – WDPT Test

200-µL drop of distilled water placed on the surface of the soil sample, and the time that elapsed before the drop is absorbed was determined.

In general, a soil is considered to be water repellent if WDPT exceeds 5 sec.

Wallach (2005) has identified five distinguishable hydrophobicity classes.

Hydrophobicity Descriptive Label

Class 1 – Hydrophilic (WDPT < 5 s)
Class 2 – Slightly Hydrophobic (5 < WDPT ≤ 60 s)
Class 3 – Strongly Hydrophobic (60 < WDPT ≤ 600 s)
Class 4 – Severely Hydrophobic (600 < WDPT ≤ 3600 s)
Class 5 – Extremely Hydrophobic (WDPT > 3600 s)

Test time was extended to a maximum of 1 hour, after which time, if the drops still had not penetrated, a reading of 3,600 s was recorded.

Soil Surface Layer Transects

Sampling of the Laminex Taupo wastewater irrigated farm was undertaken in March 2006. Sampling took place in an area where the irrigation had not occurred for that week.

Sharpened stainless steel cylinders (50 mm id) and 70 mm height were used. The vegetal residue was gently removed from the surface by cutting.

WDPT tests were undertaken on 10 mm slices starting at the surface and finishing at 50 mm depth.

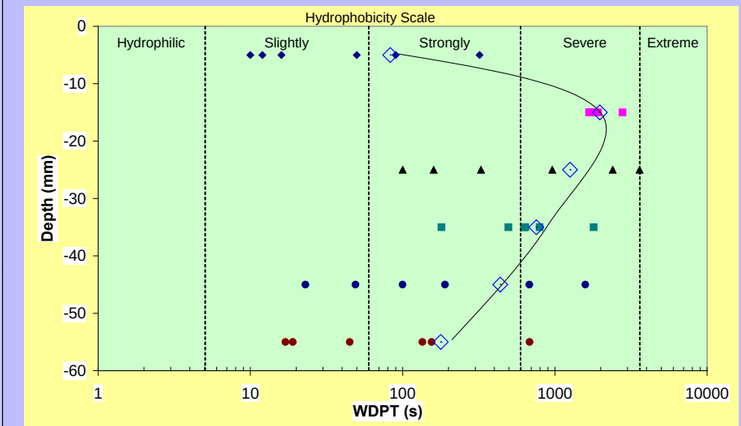
Initial Results and Observations

The WDPT test results are shown for 6 discrete cores.

The abscissa represents WDPT (in log scale), and the ordinate represents the average depth of each 10-mm slice below ground surface.

Individual results are denoted by small markers, while the average WDPT is denoted by large open marker.

The vertical dotted lines indicate the boundaries between different repellency classes.



Impact of Soil Water Repellency

- Reduced infiltration
- Increased overland flow
- Spatially localised infiltration
- Fingered flow development
- Change in soil moisture dynamics
- Flow responses to rainstorms

Because of enhanced overland flow on, and increased erodibility of, water repellent soil, slopewash, and sometimes the formation of rills and gullies, may be promoted.

References

Doerr, SH. 1998. *On standardizing the water drop penetration time and the molarity of an ethanol droplet techniques to classify soil hydrophobicity: a case study using medium textured soils*. Earth Surf. Process. Landforms, 23: 663-668.

King, PM. 1981. *Comparison of methods for measuring severity of water repellence of sandy soils and assessment of some factors that affect its measurement*. Aus. J. Soil Res., 19:275-286.

O'Connor, M *et al*. 2004. *Water repellent soils can cause problems for effluent application to land*. NZLTC, 25:40-43.

Wallach, R *et al*. 2005. *Soil water repellency induced by long-term irrigation with treated sewage effluent*. J. Env. Qual. 34: 1910-1920.

Acknowledgement

The author wishes to thank Laminex Taupo for use of the information collected during the various investigations