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Pervaporative irrigation: a flow rate driven by environmental conditions

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Pervaporative irrigation allows in-situ treatment of low quality water (e.g. saline water) whilst simultaneously distributing water throughout the soil. The system is also low energy, requiring only that a positive head of water is maintained in a supply tank. To irrigate using this method a pervaporative polymer membrane is formed into a pipe, buried in the soil and filled with water. Water is transported across the membrane by the process of pervaporation whilst the transport of contaminants is retarded, thus reducing the risk of soil degradation due to the use of low water quality. Uniquely these systems also inherently provide a feedback mechanism by which crops can affect the irrigation rate. Such a system has significant possibilities to provide an irrigation pipe from which water is only applied when required, hence reducing the volume of water used. However such systems are currently not fully understood and, to be implemented effectively, the behaviour of the membrane in different environmental conditions must be quantified. From experimental results this work has identified the significance of vapour flows in predicting the flux from the irrigation system in dry soils. In a 15cm layer of sand, the presence of a desiccant above the soil doubled the flux from the pipe, but more than 70% of this mass was adsorbed by the desiccant. Experiments also show that the flux into typical top soil was greater than into sand because of the greater capacity of the top soil for water adsorption. This adsorption maintained a lower humidity in the soil, hence providing a larger gradient across the irrigation membrane and inducing a higher flux. Although there is some evidence that seeds can absorb water from vapour flows the possibility that plants also do this has not yet been explored. This technology provides future opportunities to explore the interaction of plants both with vapour flows, and with a system where the irrigation rate is influenced by the crop uptake and the surrounding environmental conditions.