THESIS

MODELLING EFFLUENT WATER QUALITY OF PIPE DRAINS

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(2002-PG-WRM-07)

For the Degree of

MASTER OF PHILOSOPHY

IN

WATER RESOURCES MANAGEMENT

CENTRE OF EXCELLENCE IN WATER RESOURCES ENGINEERING
University of Engineering and Technology, Lahore, Pakistan.

2004

ABSTRACT

Installation of subsurface drains is an effective measure to combat water logging and salinity by lowering the water table and maintaining a clear root zone for plant growth. Pipe drains usually pick salts from soil profile. Thus effluents of deep drains installed in high profile salinity soils become very saline and pose considerable challenges in disposal of the saline effluent. The present study was carried to determine the effect of varying drain depth on the quality of the drainage effluent using a computer based model MODFLOW - MT3D. Further analyses were carried out to determine effect of different soil EC profiles, on subsurface drain effluent quality.

A model was developed to represent a single lateral for the field data reported by Christen and Skehan (2001). The subsurface drains were installed at a depth of 1.8 m with spacing of 20 m maintaining a clear root zone (water table is below root zone) of 1.6 m below ground surface. The profile was modeled by 15 layers with varied solute concentration. Model was simulated for known stresses for one crop season of 150 days.

The model was calibrated against field observations and a good match was obtained for both effluent water quality and water table height midway between the drains. Effluent water quality of subsurface drains was computed by the model as 10.67 dS/m which differed by 3.0 % with observed values of 11 dS/m, which is acceptable deviation. The water quality improves with time due to leaching of the profile.

Clear root zone for the drains at 1.8 m adopted by Christen and Skehan (2001) was due to the nature of specific crop (vineyard). Simulation of model was then carried for a clear root zone depth of 1.2 m, which is acceptable for most other crops. Simulation included varied drain depths of 1.3 m, 1.4 m, 1.5 m, 1.6 m and 1.8 m to investigate the effect of drain depth on the effluent water quality. The corresponding spacing for varied drain depth was obtained by Hooghoudt formula. Simulation resulted in effluent quality of 9.80, 10.44, 11.06,12.08 and 17.77 dS/m for drain depths of 1.3, 1.4, 1.5,1.6 and 1.8 m, respectively. Thus the results show that effluent water quality of subsurface drains deteriorate with increase in drain depth. The effluent water quality is 45 % smaller for 1.3 m deep drains when compared with the effluent water quality of drains at 1.8 m depth. This is due to the fact that soil salinity increases with depth and the flow lines for deep drains (with wide spacing) pass through deeper but more saline layers with the resultant of more saline effluent than for shallow drains.

Existing soil EC profile shows an increase of salinity of 2 dS/m per meter depth of profile below drain invert level representing a profile salinity factor S = dEC/dZ = 2 for the present field soil. The salinity profile in the soil was synthesized for different profile salinity factor S. The drain effluent water quality was determined for different synthesized salinity profiles for salinity factor of 0.5, 1.0, 1.5, 2.0, 2.5, 3.0 for the drains installed at a depth of 1.8 m with 20 m spacing between the drains. The resultant effluent quality was determined as 9.08, 9.61, 10.13, 10.67, 11.18 and 11.71 dS/m, respectively. The results show a linear increase of effluent salinity, with the increased profile salinity factor S. However all profiles get leached out with time with more saline profiles taking more time to leach than less saline profiles.

This study shows that subsurface drains should be installed at as shallow depth as possible in soils with increasing soil profile salinity in order to obtain lesser saline effluent and thus reduce the problem associated with the disposal of more saline drainage effluent.