Distribution of Soil Water Salinity and Impacts on Maize Yield in Gypsiferous Irrigated Fields with Subsurface Drainage

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Abstract: About 20% of irrigated land worldwide is considered salt-affected, resulting in many billions of dollars of annual loss in global crop yields. A project funded through the US-Pakistan Center for Advanced Studies in Water aims to jointly develop techniques for quantifying severity of soil salinity and impacts on crop production on surface-irrigated fields in Pakistan's Indus River Valley and in the Lower Arkansas River Valley (LARV) in Colorado. As part of this project, the objective of this preliminary study was to characterize the spatial variability of soil salinity and maize yield in a furrow-irrigated, tile-drained (1.2 m depth) field (14 ha) in the LARV during 2016. Electromagnetic induction was used to map apparent soil electrical conductivity (EC_a; 0 – 1.5 m depth). The spatial EC_a values were inputted into the Electromagnetic Sampling Analysis and Prediction (ESAP) program to identify soil sampling points for saturated paste soil extract conductivity (EC_e). A calibration equation was used to convert EC_a to EC_e values that were used to create a spatial map of salinity. Applied irrigation water and salt loading (TDS) on the field was measured. At selected low (0 – 4 dS/m), medium (4 – 6 dS/m), and high (6 – 12 dS/m) EC_e (dS/m) zones, volumetric water content (θ_v) at 10, 50, and 100cm depths, maize growth, and yield were monitored over the growing season. Water table levels were monitored via monitoring wells installed at the perimeter of the field. The θ_v time series indicated that the high EC_e zones had prolonged exposure to saturated root zone conditions. This indicated that high EC_e zones were more severely affected by shallow water table depths (0.34 – 2.85 m). Average grain yields were 16000, 12000, and 8000 kg/ha at the low, medium, and high EC_e zones, respectively. Maize yields varied spatially with severity of soil salinity and water logging, diminishing by as much as 50% in the high salinity zones. Future work will focus on characterization of salt species in the root zone, soil salinity effects on water potential and evapotranspiration, and calibrating remotely-sensed imagery with ground-based EC_e measurements to develop algorithms for regional salinity mapping.