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Influence of Pore-water Electrical Conductivity on Responses of Electromagnetic Induction and Ground-Penetrating Radar

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Soil electrical conductivity (EC) determines the response of electromagnetic induction (EMI) and influences ground-penetrating radar (GPR) measurements as well, depending on the radar configuration. Irrigation water quality alters subsurface EC by changing the pore-water conductivity (ECw), which is difficult to measure. Objectives of this study were to: (i) develop a relationship between soil:water extract conductivity (EC1:2) and saturated paste extract conductivity (ECe) to obtain the conversion factor (f) for boreal podzolic soil; and (ii) evaluate the influence of ECw on GPR direct ground wave amplitude (DGWA) and apparent electrical conductivity (ECa) measured by EMI. During two irrigation events, lowly conductive fresh-water (FW) and highly conductive salt-water (SW) were applied to an experimental field (72 m2) in Pasadena, Newfoundland, Canada. EMI and GPR surveys were carried out to collect ECa and DGWA data, and soil samples (n=108) were collected for background, irrigation-1, and irrigation-2. Factor f was estimated to derive ECe from EC1:2 and ECw was calculated and correlated with ECa and DGWA. A relationship of ECe=4.6xEC1:2 was found where f=4.6. Weakly positive (r=0.117, p=0.644) and strongly positive (r=0.830, p=0.000) correlations between ECw and ECa were found for FW and SW irrigated plots, respectively. Moreover, weakly positive (r=0.394, p=0.146) and strongly negative (r=-0.884, p=0.000) correlations were found between ECw and DGWA for FW and SW irrigated plots, respectively. These findings illustrate the influence of ECw on both EMI and GPR responses and will provide valuable insights to advance the incorporation of GPR and EMI techniques to support precision agriculture.