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Use of electromagnetic induction surveys to delimit zones of contrasting tree development in an irrigated olive orchard in Southern Spain.

Aura Pedrera (1), Karl Vanderlinden (1), Antonio Jesús Espejo-Pérez (2), José Alfonso Gómez (3), Juan Vicente Giráldez (2,3)

(1) IFAPA, Centro Las Torres-Tomejil, Alcalá del Río (Seville), Spain (aura.pedrera@juntadeandalucia.es), (2) Departamento de Agronomía, Universidad de Córdoba, Campus de Rabanales, Edificio da Vinci. Ctra. Madrid km 396, 14071 Córdoba, Spain., (3) Instituto de Agricultura Sostenible, CSIC, Avda. Menéndez Pidal s/n, 14080 Córdoba, Spain.

Olives are historically closely linked to Mediterranean culture and have nowadays important societal and economical implications. Improving yield and preventing infestation by soil-borne pathogens are crucial issues in maintaining olive cropping competitive. In order to assess both issues properly at the farm or field scale, accurate knowledge of the spatial distribution of soil physical properties and associated water dynamics is required. Conventional soil surveying is generally prohibitive at commercial farms, but electromagnetic induction (EMI) sensors, measuring soil apparent electrical conductivity (ECa) provide a suitable alternative. ECa depends strongly on soil texture and water content and has been used exhaustively in precision agriculture to delimit management zones.

The aim of this study was to delimit areas with unsatisfactory tree development in an olive orchard using EMI, and to identify the underlying relationships between ECa and the soil properties driving the spatial tree development pattern.

An experimental catchment in S. Spain dedicated to irrigated olive cropping was surveyed for ECa under dry and wet soil conditions (0.06 vs. 0.22 g/g, respectively), using a Dualem 21-S EMI sensor. In addition, ECa and gravimetric soil water content (SWC) was measured at 45 locations throughout the catchment during each survey. At each of these locations, soil profile samples were collected to determine textural class including coarse particles content, organic matter (OM), and bulk density.

Measurements for dry soil conditions with the perpendicular coil configuration with a separation of 2.1 m (P2.1) were chosen to make a first assessment of the orchard-growth variability. According to the shape of the histogram, the P2.1 ECa values were classified to delimit three areas in the field for which canopy coverage was estimated. Combining the 4 ECa signals for the wet and dry surveys, a principal component (PC) analysis showed that 91% of the total variance could be explained by the first PC, representing a common pattern in the ECa data and showing a correlation of 0.98 with the P2.1 signal. The spatial pattern of canopy coverage corresponded well with the pattern of the ECa P2.1 signal. The area with the lowest ECa (Zone A) showed optimal tree growth and presented significantly lower average clay content than the area with intermediate and highest ECa (Zones B and C, respectively). Zone B, located in the lowest area of the field, with the highest profile-averaged soil-water, stone and OM contents, showed deficient tree development and tree die-off as a result of soil-borne pathogens.

EMI surveys reflecting subtle differences in soil properties provided a useful information to delimit areas with tree development problems. This information can be used in conjunction with topographic surveys to identify before planting areas with potential tree development problems, including soil-borne pathogens.