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Geostatistical analysis of soil properties at field scale using standardized data

H. Millan (1), A.M. Tarquis (2), L.D. Pérez (3), J. Matos (3), and M. González-Posada (1)

(1) Dept of Physics and Chemistry, University of Granma, Apdo. 21, 85100 Bayamo, Granma, Cuba (hmillanv@udg.co.cu, (2) CEIGRAM, ETSI Agrónomos, UPM, Ciudad Universitaria sn, 28040 Madrid, Spain (anamaria.tarquis@upm.es), (3) Dept of Agricultural Engineering, University of Granma, Apdo. 21, 85100 Bayamo, Granma, Cuba (lperezs@udg.co.cu)

Indentifying areas with physical degradation is a crucial step to ameliorate the effects in soil erosion. The quantification and interpretation of spatial variability is a key issue for site-specific soil management. Geostatistics has been the main methodological tool for implementing precision agriculture using field data collected at different spatial resolutions. Even though many works have made significant contributions to the body of knowledge on spatial statistics and its applications, some other key points need to be addressed for conducting precise comparisons between soil properties using geostatistical parameters.

The objectives of the present work were (i) to quantify the spatial structure of different physical properties collected from a Vertisol, (ii) to search for potential correlations between different spatial patterns and (iii) to identify relevant components through multivariate spatial analysis. The study was conducted on a Vertisol (Typic Hapludert) dedicated to sugarcane (Saccharum officinarum L.) production during the last sixty years. We used six soil properties collected from a squared grid (225 points) (penetrometer resistance (PR), total porosity, fragmentation dimension (Df), vertical electrical conductivity (ECv), horizontal electrical conductivity (ECh) and soil water content (WC)). All the original data sets were z-transformed before geostatistical analysis.

Three different types of semivariogram models were necessary for fitting individual experimental semivariograms. This suggests the different natures of spatial variability patterns. Soil water content rendered the largest nugget effect (C0 = 0.933) while soil total porosity showed the largest range of spatial correlation (A = 43.92 m). The bivariate geostatistical analysis also rendered significant cross-semivariance between different paired soil properties. However, four different semivariogram models were required in that case. This indicates an underlying co-regionalization between different soil properties, which is of interest for delineating management zones within sugarcane fields. Cross-semivariograms showed larger correlation ranges than individual, univariate, semivariograms (A 29 m). All the findings were supported by multivariate spatial analysis, which showed the influence of soil tillage operations, harvesting machinery and irrigation water distribution on the status of the investigated area.

Reference

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