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Assessment of physical and chemical indicators of sandy soil quality for sustainable crop production

Jerzy Lipiec and Boguslaw Usowicz
Institute of Agrophysics, Polish Academy of Sciences, Lublin, Lublin, Poland (j.lipiec@ipan.lublin.pl)

Sandy soils are used in agriculture in many regions of the world. The share of sandy soils in Poland is about 55%. The aim of this study was to assess spatial variability of soil physical and chemical properties affecting soil quality and crop yields in the scale of field (40 x 600 m) during three years of different weather conditions. The experimental field was located on the post glacial and acidified sandy deposits of low productivity (Szaniawy, Podlasie Region, Poland). Physical soil quality indicators included: content of sand, silt, clay and water, bulk density and those chemical: organic carbon, cation exchange capacity, acidity (pH). Measurements of the most soil properties were done at spring and summer each year in topsoil and subsoil layer in 150 points. Crop yields were evaluated in places close to measuring points of the soil properties. Basic statistics including mean, standard deviation, skewness, kurtosis minimal, maximal and correlations between the soil properties and crop yields were calculated. Analysis of spatial dependence and distribution for each property was performed using geostatistical methods. Mathematical functions were fitted to the experimentally derived semivariograms that were used for mapping the soil properties and crop yield by kriging. The results showed that the largest variations had clay content (CV 67%) and the lowest: sand content (5%). The crop yield was most negatively correlated with sand content and most positively with soil water content and cation exchange capacity. In general the exponential semivariogram models fairly good matched to empirical data. The range of semivariogram models of the measured indicators varied from 14 m to 250 m indicate high and moderate spatial variability. The values of the nugget-to-sill+nugget ratios showed that most of the soil properties and crop yields exhibited strong and moderate spatial dependency. The kriging maps allowed identification of low yielding sub-field areas that correspond with low soil organic carbon and cation exchange capacity and high content of sand. These areas are considered as management zones to improve crop productivity and soil properties responsible for soil quality and functions. We conclude that soil organic carbon, cation exchange capacity and pH should be included as indicators of soil quality in sandy soils.

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