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Soil sampling for variable-rate fertilization using spatial clustering

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Clustering is still an active method of soil sampling. The defined clusters not only can direct soil sampling for digital soil mapping, but also can serve as management zones for variable application of inputs based on soil sample analysis. This study compares a nonspatial and spatial fuzzy clustering approach of management zones delineation enabling sampling design for both site specific and zonal fertilization. An actual yield potential and a bare soil composite computed from Sentinel-2 imagery featuring soil texture serve as covariates for clustering analysis ensuring a high interpretability of results. The minimum area of clusters and the number of sampling locations is defined by a user. The optimum number of constrained clusters is selected for every field based on silhouette index calculation ensuring the variable soil sampling density according to the variability of field conditions. Soil sampling locations were selected using shortest weighted distances to centroids of clusters or randomly. The results showed that nonspatial fuzzy clustering worked only for relatively homogenous fields with low number of clusters. For highly heterogeneous fields, the formed clusters were not spatially compact, because no spatial weight matrix was used. However, setting the minimum cluster size equal or greater than 1ha significantly improved the clusters compactness for heterogeneous fields even using nonspatial approach. The application of spatial approach improved the cluster compactness of heterogenous fields regardless to cluster size which makes this approach more universal.

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