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Evaluating the soil physical quality under long-term field experiments in Southern Italy

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Long-term field experiments performed in experimental farms are important research tools to assess the soil physical quality (SPQ) given that relatively stable conditions can be expected in these soils. However, different SPQ indicators may sometimes provide redundant or conflicting results, making difficult an SPQ evaluation (Castellini et al., 2014). As a consequence, it is necessary to apply appropriate statistical procedures to obtain a minimum set of key indicators.

The study was carried out at the Experimental Farm of CREA-SCA (Foggia) in two long-term field experiments performed on durum wheat. The first long-term experiment is aiming at evaluating the effects of two residue management systems (burning, B or soil incorporation of crop residues, I) while the second at comparing the effect of tillage (conventional tillage, CT) and sod-seeding (direct drilling, DD). In order to take into account both optimal and non-optimal soil conditions, five SPQ indicators were monitored at 5-6 sampling dates during the crop season (i.e., between November and June): soil bulk density (BD), macroporosity (P_{MAC}), air capacity (AC), plant available water capacity (PAWC) and relative field capacity (RFC). Two additional data sets, collected on DD plot in different cropping seasons and in Sicilian soils differing for texture, depth and land use (N=140), were also used with the aim to check the correlation among indicators. Impact of soil management was assessed by comparing SPQ evaluated under different management systems with optimal reference values reported in literature. Two techniques of multivariate analysis (principal component analysis, PCA and stepwise discriminant analysis, SDA) were applied to select the most suitable indicator to facilitate the judgment on SPQ.

Regardless of the considered management system, sampling date or auxiliary data set, correlation matrices always showed significant negative relationships between RFC and AC. Decreasing RFC at increasing AC is expected as both indicators depends on soil water contents at saturation and field capacity. Our results reinforce the suggestion that one of the two indicators can be neglected (Cullotta et al., 2016) even if further investigations are necessary to choose the most accurate and/or widely applicable indicator since different optimal ranges were suggested in literature. A positive significant correlation was also generally found between P_{MAC} and AC. PCA analysis identified RFC and AC as the main indicators that explain most of the data variation. When the data collected at the different sampling dates were pooled together, in both experiments the first principal component explained the highest proportion of total variance (67.9% and 81.5%, respectively for residue management and tillage) and RFC showed the highest loadings, followed by AC and P_{MAC}. SDA provided consistent results and RFC was selected as the main variable to assess the effects of tillage. Conversely, the residue management had no effect on SPQ as indicated by negligible differences between indicators. Finally, our results suggest that RFC always reached optimal and steady values between April and June.

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