Soil biodiversity and sustainable vineyards: hints from the analysis of microarthropod communities

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INTRODUCTION

The aim of this study, was to evaluate the long-term effects of organic management on soil health in a commercial vineyard situated in the district of Verdicchio of Matelica (Marche, Italy). Assessment of soil health was performed by using the Biological Soil Quality index (QBS-ar) based on the analysis of the micro-arthropods communities (Parisi *et al.*, 2005). In the selected 3 vineyards, that were organically managed since 1992 (19 years under organic management, V92), 1998 (13 years, V98) and 2009 (2 years, V09), the QBS-ar index was applied (Fig. 1a). Typically, vineyards have undergone to alternate management of the tractor-rows on either side of the vine row with tillage and non-tillage annual cover crop species (Fig. 1c, 1d, 1e).

MATERIALS AND METHODS

Sampling was performed once a month from March 2011 to September, except for the month of August. Two additional samplings were done in June and September, for a total of 8 sampling events. As shown in Fig. 1a, the study plots were located at the center of each selected vineyard. Further, in each plot were identified two adjacent sampling units, each one represented by the disturbed (tillage) and un-disturbed (no-tillage) grassed inter-rows (Fig. 1b). For the purpose of the QBS-ar analysis, a sampling unit is composed by three soil cores (replica) at about 2 m distance from each other, in both tilled (*ifd*) and no-tilled (*ifu*) grassed inter-rows (Fig. 1b). Samples were collected using a corer of 10 cm diameter per 10 cm depth, transported in the laboratory and placed in a Berlese-Tullgren apparatus for the extraction of microarthropods. Identification of microarthropods was accomplished following the scheme of Parisi *et al.* (2005). Obtained data were used to calculate QBS-ar index, abundances of individuals (*N*) and diversity indices (Shannon-Wiener (H'), Margalef (d) indices and equitability (J)), taking into account the number of biological forms (BF) and the number of euedaphic forms (EF).

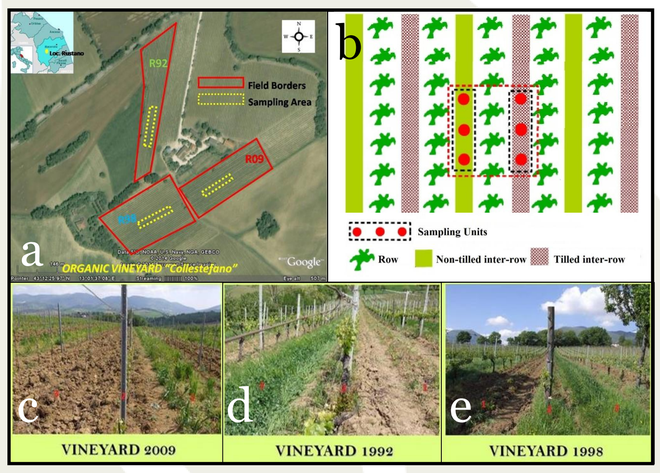

Fig.1: a) Google maps view of the three vineyards V92, V98 and V09 and study plots/areas; b) sampling design; c, d, e) representative images of the three study plots V92 , V98 , V09, showing the tilled (ifd) and no-tilled (ifu) grassed inter-rows.

Statistical analyses were performed using: PAST v.2.17c package (Hammer *et al.*, 2001) and BioEstat v.5.3 (Ayeres *et al.*, 2007).

MAIN RESULTS

As shown in Table 1, the comparison of microarthropod communities in the disturbed (tillage) (*ifd*) and un-disturbed (no-tillage) (*ifu*) inter-rows of the three plots, based on the richness of the biological forms (BF), abundances and diversity indices (H', d, J) highlight some differences between the *ifd* and *ifu* inter-rows. In all the three study plots, and irrespective of the time under organic management, the abundances were higher in the no-tilled (*ifu)* inter-rows than those in the tilled *(ifd*) inter-rows. However, no significant differences among the tilled (*ifd*) and no-tilled (*ifu*) inter-rows for H', d, J values were detected for the three plots. On the other hand, the comparison of microarthropod communities in the tilled (*ifd*) and no-tilled (*ifu*) inter-rows of the three vineyards, based on the values of QBS-*ar* and abundances of FB and EF (Biological and Euedaphic forms), show and solely for the oldest vineyard V92, no significant differences (Table 2). On the contrary, significant differences (with the exception of the EF value in V98) between the tilled (*ifd*) and no-tilled (*ifu*) inter-rows were detected for the V98 and V09 vineyards. Results of this study show the benefits of organic management on soil biodiversity and soil health. The microarthropods communities experience less fluctuations (are more stable) in the oldest vineyard V92. As reported by Elliott and Lynch (1994), this effect may be due to the greater resilience of the soils of the vineyard V92, possibly achieved during the long-term organic management. Only in the oldest vineyard (V92), and irrespective of the type of disturbance applied, the microarthropods communities remain more stable/resilient in both the disturbed and un-disturbed inter-rows than in the other vineyards. Moreover, this study helps in evaluating the long-term effects of common organic vineyard floor management practices as well as in raising awareness among stakeholders and policy makers on the importance of soil biodiversity in preserving soil health and assisting them to select, promote and stimulate adequate sustainable farming practices.

Table 1: Comparison of results obtained from the tilled and not tilled inter-rows from each vineyard.

	V92-ifd	V92-ifu	V98-ifd	V98-ifu	V09-ifd	V09-ifu
BF (S)	21	21	19	21	19	22
Abundance (N)	547	1147	733	1648	589	2291
Shannon (H)	2.349	2.46	2.287	1.448	1.982	1.906
Margalef (d)	3.172	2.839	2.728	2.7	2.822	2.714
Equitability (J)	0.7715	0.8081	0.7768	0.8042	0.6732	0.6165

Table 2: Kruskal-Wallis test: comparison between tilled and covered inter-rows in V92, V98 and V09.

	V92	V98	V09
QBS-ar	0.6737 n.s.	0.0311	0.0269
BF	0.0691 n.s.	0.0067	0.0567
EF	0.4132 n.s.	0.3594 n.s.	0.0170

Similar results have been obtained through the study of ciliated protists communities in the same vineyards and in the same study context, thus confirming further the results obtained with the investigations carried on microarthropods (Oral presentation on Wednesday, 21 April by Antonietta La Terza; Title: Ciliated protists as indicators of soil health: Three case studies from Italy).

QBS-ar siss