QBS-ar in soil biodiversity monitoring: the experience of Emilia-Romagna Region

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INTRODUCTION

As required by the EU's Common Agricultural Policy (CAP 2014-2020), the Rural Development Program (RDP) of Emilia-Romagna Region promotes soil conservation practices to achieve food production with less input in terms of pesticides, chemicals, water and lower CO_2 emissions, to protect natural resources and the environment.

The awareness of the importance of soil biota on soil functions (Fig. 1), led us to investigate how soil management impacts the soil community.

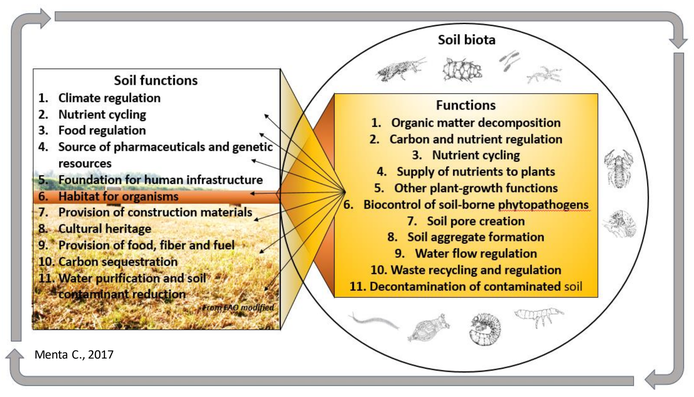

Fig.1: Soil biota and his influence on soil functions

Soil Biological Quality Index based on soil arthropods (QBS-ar index; Parisi, 2001, Parisi et al., 2005) was chosen as a soil biodiversity indicator.

The index values are directly related to the use and state of the soil (Tabaglio et al., 2009), allowing the use of QBS-ar index to draw conclusions on the impact of soil management practices on the soil living community.

The index is based on the concept that the presence of microarthropod groups morphologically well adapted to soil is higher in soils with high quality and health.

The index is required to be tested at the local level to describe the current state of soil quality and to establish local reference values according to the different pedo-climatic conditions, land use and soil management. With this purpose in 2015, Emilia-Romagna Region and University of Parma started a st

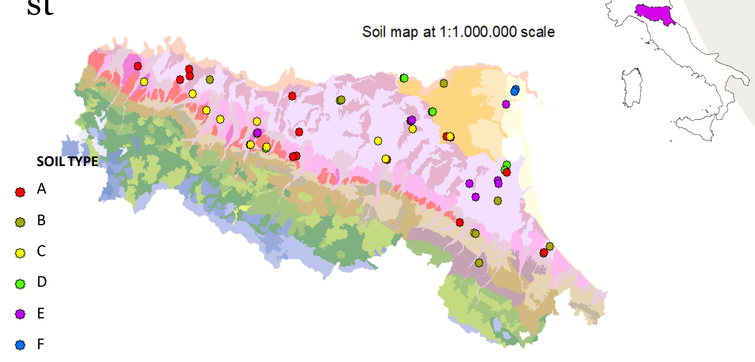

Fig.2: Soil map of Emilia-Romagna region and sampling sites. (A fine texture, B moderately fine texture with > 35% of clay, C moderately fine texture with < 35% of clay, D medium texture, E moderately coarse texture, F coarse texture)

MATERIAL AND METHODS

The sites located in the plain and on the hill of the Emilia-Romagna region (Fig.2) were chosen considering the soil types described by the regional Soil Database. Different types of soil from fine to coarse texture were sampled and analyzed.

Table 1: Mean values of soil parameters of the 58 sites
(A fine texture, B moderately fine texture with > 35% of clay, C moderately fine texture with < 35% of clay, D medium texture, E moderately coarse texture, F coarse texture)

SOIL TIPES	Organic Carbon %	Clay %	Sand %	pH
A (15 sites)	1.46 ± 0.62	45±5.3	12±5.8	7.7±0.5
B (8 sites)	1.66±0.27	37±1.4	14±7.1	7.8±0.4
C (16 sites)	2.06±1.45	31±2.4	20±7.8	7.7±0.5
D (6 sites)	1.24±0.53	18±3.2	21±3.7	7.9±0.3
E (11 sites)	1.23±0.49	16±5.3	48±16.1	7.9±0.19
F (2 sites)	2.49±2.37	8±2.4	83±0.7	7.9±0.19

The sites include 3 different land uses: 22 arable lands (annual crop), 19 permanent crops (8 in the vineyard, 11 in the orchard), and 19 grasslands. Each site was sampled twice, in spring and autumn, with three clods of soil, and arthropod extraction was performed by Berlese-Tüllgren funnel. The specimens were identified in class/order level and an ecological–morphological index (EMI) was assigned to each taxon. QBS-ar index resulted as the sum of the highest EMI values of the three replications relative to each taxon (Fig.3).

Fig.3: QBS-ar determination: soil sampling; extraction; identification of microarthropods; attribution of EMI

MAIN RESULTS

The two-way ANOVA analysis shows that land use is the factor that most affects the QBS-ar values (p value <0.001) and Tukey's test highlights significant differences between annual crops and all other land uses.

Arable land shows the lowest QBS-ar values with an average of 105 and the 75% of the values even lower than total mean of 133 (Fig.4).

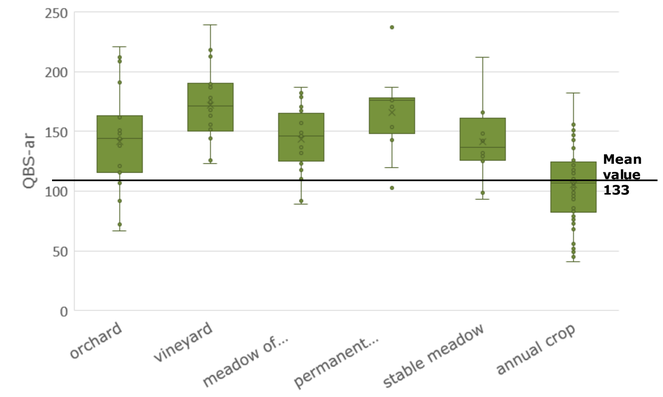

Fig.4: QBS-ar values for different land uses (box plot: X= mean, line=median, box= interquartile range, whisker=minimum, maximum)

Meadows reach higher values of the index thanks the absence of tillage and the major protection of the soil surface. Despite vineyards and orchards being affected by management practices, the presence of grass cover reduces the disturbance of soil and creates an edaphic environment similar to permanent grassland.

The study shows that intensive agricultural systems make the biological community more vulnerable with simpler and poorer communities. The lowest values are often observed next to more intensive agricultural practices, such as tillage, seeding and planting (Fig. 5, 6).

Fig.5: Annual crop before tillage
May 2015 QBS-ar = 88

After tillage
December 2015 QBS-ar = 41

Fig.6: From permanent meadow
June 2015 QBS-ar = 154

To annual crop
November 2015 QBS-ar = 98

CONCLUSIONS

This study led to a first important evaluation of the biological quality of regional agricultural soils and has given reference values. The QBS-ar index was confirmed as an efficient tool to detect soil quality and soil biodiversity and it has been chosen as a quality soil indicator in soil monitoring activity funded by the CAP 2014-2020 through Measure 20 of regional RDP.

The soil monitoring, started in 2018, is still in progress and it will assess whether agricultural systems are sustainable and respectful even towards soil biodiversity.