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Mini Review

An User Friendly Tool to Assess the Effects on Agricultural Soils of Different Practices: The QBS-Ar Index

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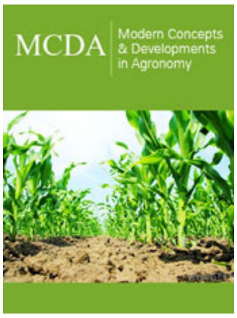
ISSN: 2637-7659



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Submission: June 25, 2020

Published: July 13, 2020

Volume 6 - Issue 5

How to cite this article: Loris Galli. An User Friendly Tool to Assess the Effects on Agricultural Soils of Different Practices: The QBS-Ar Index. Mod Concep Dev Agrono. 6(5). MCDA. 000648. 2020. DOI: 10.31031/MCDA.2020.06.000648

Abstract

The QBS-ar index was proposed in Italy nearly 20 years ago as a biotic index aimed at biological quality assessment of soils based on their microarthropod communities composition and diversity. It is user friendly and quite expeditious. Therefore, since its introduction, it was applied in many natural and anthropogenic terrestrial environments in order to assess the impact of different forms of disturbance. QBS-ar resulted a reliable and sensitive tool for environmental monitoring in most of the contexts in which it was used. In particular, in a wide range of crops (like maize, apple, citrus, vineyards) it proved to be an useful index to distinguish among different management practices (conventional, no tillage, organic, green manure, etc.). In this paper, the principles on which the QBS-ar index is based are summarized and some examples from literature on its application in agroecosystems are reviewed.

Keywords: Soil microarthropods; Agricultural lands; Management; Biological quality; Sustainability

Introduction

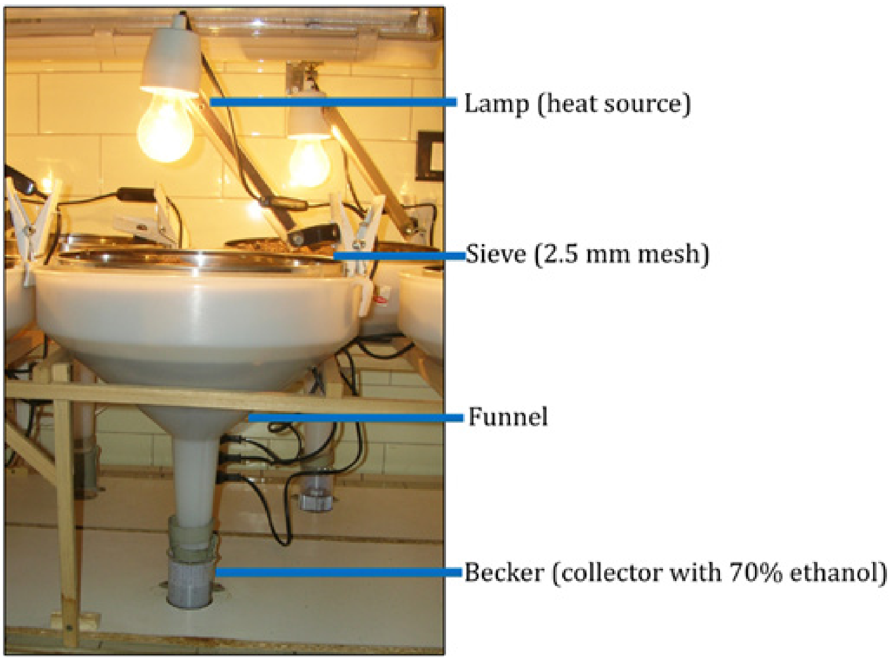

Figure 1: Berlese-Tullgren funnel: the tool used for microarthropods extraction from soil cores. Sample should be evenly distributed on the funnel. The heat generated by lamp causes the soil to dry out from the surface and pushes organisms to move downward. They pass through the mesh of the sieve, fall into the funnel and are collected in the container below.

Soil Arthropods have often been used as soil quality indicators and to implement biotic indices [1]. Among the others, the QBS-ar index (Biological Quality of Soil, based on arthropods)

[2] was introduced nearly 20 years ago for the estimation of the environmental quality in terrestrial habitats. This index is based on the correlation between the number of microarthropod groups adapted to soil habitats and the soil quality. Their extraction takes place by means of Berlese-Tullgren funnels (Figure 1). Each taxon is evaluated based on morphological characteristics that represent an adaptation to soil life (reduction or loss of pigmentation and eyes, tiny size or streamlined body, reduction and transformation of appendages, presence of peculiar sense organs). Based on these features, an eco-morphological index (EMI) ranging from 1 (no adaptation to soil) to 20 (full adaptation), is given to each arthropod order. The sum of EMI scores of all the groups extracted from a soil gives the QBS-ar value. The higher the value obtained, the better the biological quality of the soil examined. This index is low cost and easy to perform: field soil cores collection is expeditious and laboratory analyses require generic taxonomic skills. Therefore, since its introduction and improvement, the QBS-ar index was widely applied mainly in Italy and in other European countries, but also elsewhere. In particular, it was used both in order to evaluate soil quality in agroecosystems and in polluted or degraded sites, and to assess the impact of different disturbances in natural and semi-natural habitats [3].

Discussion

Some studies based on QBS-ar index considered agricultural lands as examples of degraded habitats in comparison to natural environments [4,5]. However, the literature does not lack cases in which agroecosystems are the focus of investigation and different methods of agricultural management are compared. In chronological order, the QBS-ar index was successfully used in South Italy to distinguish citrus groves subjected to plowing and grassing, with values of 65 and 132, respectively [6]. This result reflects the negative effect of mechanical disturbances on soil arthropods communities. On the contrary, in Lombardy (NW-Italy) such index resulted sensitive enough to detect the important seasonal variations in soil conditions but not able to express a clear gradient of biological soil quality among three investigated sites differing for agronomic practices, but also in terms of agronomic history and soil characteristics [7]. Similarly, the QBS-ar index did not show significant differences among barley monoculture fields under different soil management systems (conventional tillage, no-tillage and nitrogen fertilization) [8]. The same results were obtained analyzing maize fields: the index turned out to be unsuitable for detecting the influence of tillage management and N fertilization on the microarthropod community [9].

The suitability of the method, on the other hand, was positively tested in Northern Italian corn crops, where reference values of the QBS-ar index (76.4±23.5) for such environment were recorded [10]. A multidisciplinary approach in conventional and organic stockless arable systems highlighted the responses of biological quality index to different forms of management and disturbance [11]. The same is true for a 15 year study carried out in Central Italy, where mean QBS-ar value (75) resulted higher in no-tillage crops than in conventional tillage (43.3) [12]. A sensitivity to different maize farming systems, with a maximum of 183 in fields converted to organic management for six years, was outlined too [13]. Organic management led to higher quality scores (mean QBS-ar values over 150) than conventional management (mean 120) in sites under different cultivations (apple, kiwi, vineyards, strawberry, asparagus) [14]. Moreover, an extensive research in South Tyrol [15] highlighted that QBS-ar reacts sensitively to land use and can serve as an important indicator for sustainable land use practices. Mean values ranging from 95-98 in anthropogenic habitats like arable fields and mountain pastures, to 175 in undisturbed mixed deciduous forest were obtained. In the Valpolicella area (Veneto), the index made it possible to differentiate, according to an increasing biological quality gradient, conventional vineyards (QBS-ar=92), organic green manure vineyards (QBS-ar=102) and classic organic vineyards (not subject to plowing disturbance characterizing green manure - QBS-ar=141) [16]. The reliability of this tool to discriminate soil management practices in vineyards was highlighted also in Piedmont [17] and Northeast Portugal [18]. In the former case it was recorded an increasing QBS-ar value from conventional (109), through integrated and organic, to biodynamic management practices (143). In the latter, the QBS-ar index was significantly higher in ground cover treatments (80) than in the tillage (48). Finally, it is worth remembering that, based on the same principle and approach of the QBS-ar index, some more specialized indices were suggested too. The QBS-C, is based only on the Collembolan community and it proved to be highly effective in the evaluation of differences in soils characterized by different organic matter content, moisture and mechanical tillage [19]. More recently, the QBS-e, based on earthworms, was designed for farmers and operators with limited expertise on species taxonomy [20].

Conclusion

Although with some exceptions, the QBS-ar index, after almost 20 years from its introduction, turned out to be a reliable and sensitive tool for environmental monitoring in agroecosystems. A 15 years review on this method confirmed that land use significantly affects QBS-ar values and that a value of 93.7 can be considered a threshold separating high quality soils from poor soils [3]. Thanks to its ease of execution, this index can be applied by operators without particularly in-depth taxonomic skills, providing in a short time a numerical output of easy interpretation. Therefore, its application is recommended whenever the responsible of agricultural lands wish to assess the effects of different practices or to face a more sustainable management.

Conflict of Interest

The author declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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