Agricultural and food-industry by-products are becoming of increasing interest as soil amendments in agriculture, as their accumulation may lead to soil and water pollution, while their proper use is usually inexpensive, contributes to improve soil properties and is permitted by organic agriculture regulations. Nevertheless, little research has been done on the cumulative effect of their continuous application on soil organic matter dynamics. This work aimed to assess the small-scale variation in soil organic matter properties produced by continuous drip irrigation with wine industry by-products.

Material and methods

A study in field conditions using wine industry by-products was carried out in a vineyard in La Mancha region (Central Spain), developed on Petríc Calcisol. Plots were labelled as A: wine by-product inputs, in the middle line between consecutive vine rows; B: no organic inputs, in the vine row adjacent to the wine by-product application; and C: control; no organic inputs, with four replicates each. After the liquid organic amendment was applied for five years by drip irrigation, the humic acid fraction of soils was isolated (Duchaufour & Jacquin, 1975) and characterized by visible and resolution-enhanced infrared (IR) spectroscopies (Almendros & Sanz, 1992).

Results and discussion

The comparison of the resolution-enhanced IR spectra (Fig. 1) showed that protein (1640, 1540 cm⁻¹), aromatic (1620, 1510 cm⁻¹), and carbohydrate-like units (~1030 cm⁻¹) accumulated in A plots. In these plots the IR profile resembled to that of yeast-containing fermentation residues, in particular by the CH₂ wagging peak at ca. 1370 cm⁻¹, typical of peptidoglycans (Naumann et al., 1982). On the other hand, in B and C plots a series of methoxyl-containing structures (suggesting lignins and/or suberin), in addition to carboxyl groups (1720 cm⁻¹), were prevalent.

The second-derivative visible spectra (Fig. 2) showed intense valleys ca. 530, 570 and 620 nm which coincided with absorption maxima of fungal perylenequinonic chromophors (Valmaseda et al., 1989). The intensity of such peaks decreased in amended soils (C > A), then behaving as semiquantitative descriptors of the extent to which organic matter has not received external inputs.

The quantitative analysis of the humic fractions indicated a large increase in the humic acid concentration in soils receiving wine by-product (~10), which is an outstanding response of soil considering that these organic amendments exclusively consisted of some particulate organic matter (more than 30% by carbon) and soluble organic matter similar to a fulvic acid (~70% by carbon). In this sense, it is worthwhile pointing out that a lignin-lacking organic material is being transformed in soil into biodegradation-resistant matter such as humic acids.

Conclusions

Semi-arid Mediterranean vineyard soil showed rapid local accumulation of humic acid-type substances after the application of wine by-products inputs, as well as soil-like spatial variation in soil organic matter associated with organic inputs applied by drip irrigation, showing sites with acid insoluble Maillard’s products, or sites accumulating biomarker compounds typical for soil-borne fungi associated with lignin-derived, predominantly aromatic, relict humic substances.

References