

Original Research Article

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## Fourier Transform Infrared (FTIR) Spectroscopy of Soil Humic and Fulvic Acids Extracted from Paddy Land Use System

Sharan Bhoopal Reddy<sup>1\*</sup>, M.S. Nagaraja<sup>2</sup>, G.G. Kadalli<sup>3</sup> and B.V. Champa<sup>2</sup>

<sup>1</sup>Agriculture College, Bheemarayanagudi-585287 (UAS, Raichur), Karnataka, India

<sup>2</sup>College of Horticulture, Bagalkot – 587104 (UHS, Bagalkot), Karnataka, India

<sup>3</sup>College of Agriculture, Hassan-573225 (UAS, Bengaluru), Karnataka, India

\*Corresponding author

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Fourier Transform Infrared (FTIR) Spectroscopy of humic substances shows major components through different peaks. FTIR spectrum of humic acid (HA) showed bands at 3246 cm<sup>-1</sup> (H-bonded OH), 1721 cm<sup>-1</sup> (C=O of COOH, C=O stretch of ketonic C=O), 1634 cm<sup>-1</sup> (COO-, C=O of carbonyl and quinone) and 1102 cm<sup>-1</sup> (C-O stretch or OH deformation of COOH). Whereas, fulvic acid (FA) showed peaks at 3497cm<sup>-1</sup> (H bonded OH), 2925-2855cm<sup>-1</sup> (aliphatic C-H stretch), 2415 cm<sup>-1</sup> (extended aliphatic C-H stretch), 1648cm<sup>-1</sup> (COO-, C=O of carbonyl and quinone), 1158 cm<sup>-1</sup> (aliphatic C-H). Humic acid gives prominent peaks of aromatic components whereas, aliphatic peaks for FA. The distinctiveness of humic substances was influenced by land use management and climatic parameters (temperature and rainfall).

### Introduction

Humic substances are major fractions of soil organic matter and in any ecosystem status and composition of humic substances were governed by most of the factors as importantly management > climate > biota > topography = parent material > time (Garcia-Herrera *et al.*, 2010., Lobell *et al.*, 2011., Reddy, 2012., Reddy, 2014).

Therefore any significant influence of any of these factors will determine the content and composition of the humic substances in any particular soil. Thus, better understanding of characteristics and functional groups of humic

substances induced by land use management may serve as essential guide in the study of soil organic matter en bloc. Paddy is one of the major production systems in Hassan district. Fertiliser use and frequent cultural operations in rice may greatly influence the composition of humic substances.

FTIR spectroscopy of humic substances extracted from these paddy land use systems could serve as an effective technique to know the composition of humic fractions.

Therefore, a study was carried out to know the spectral characteristics of HA and FA of paddy land use system.

## Materials and Methods

Study area (Hassan district) situated eastern side of the Western Ghats, in the southern part of Karnataka state. Fifteen surface composite soil samples (0-0.15 m) were pooled from 3 soil sampling points, within a pre-identified representative site from the LUS. Extraction, fractionation and purification of humic substances (HA and FA) was done following the procedures given by Stevenson (1994) and Wander and Traina (1996). Purified samples of HA and FA were subjected to FTIR spectral analysis to understand the major components and functional groups present in each fraction.

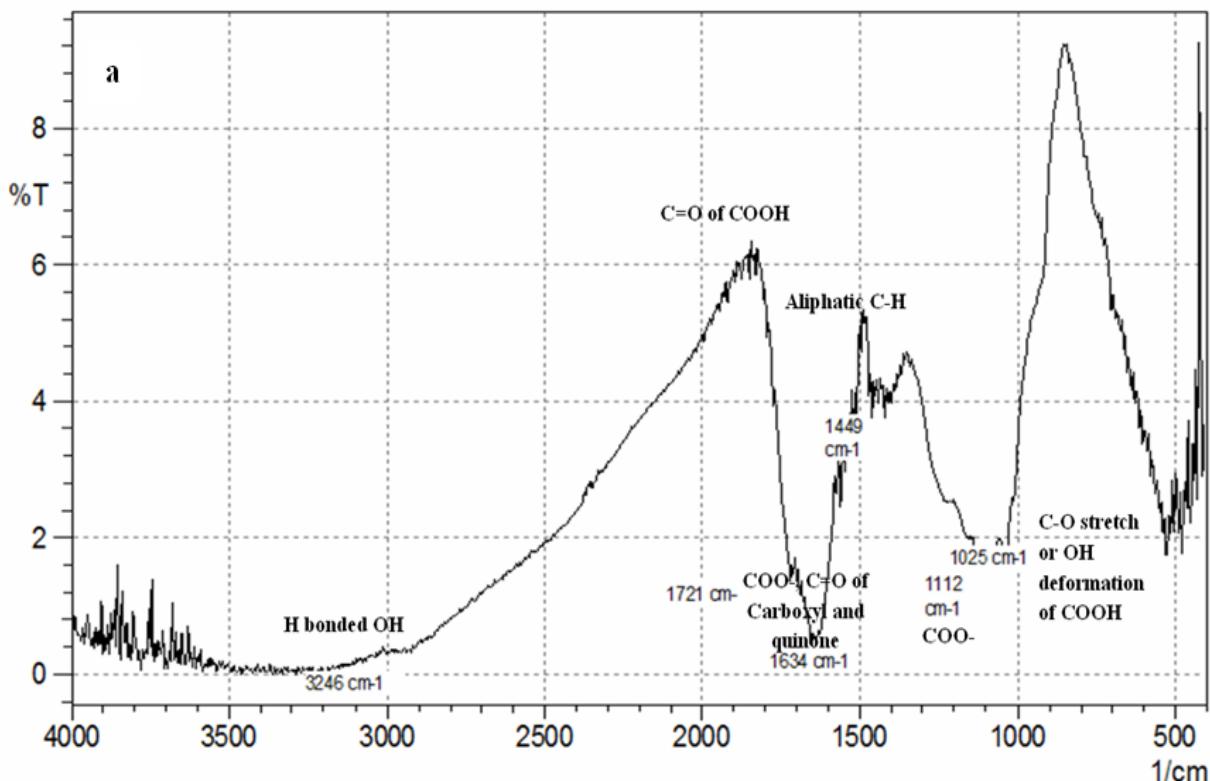
Samples were prepared in the form of pellets by mixing humic materials separately with dry KBr powder and pressed under vacuum at a pressure of 50-100 kg cm<sup>-2</sup> for 20 min (Niemeyer *et al.*, 1992). These pellets were

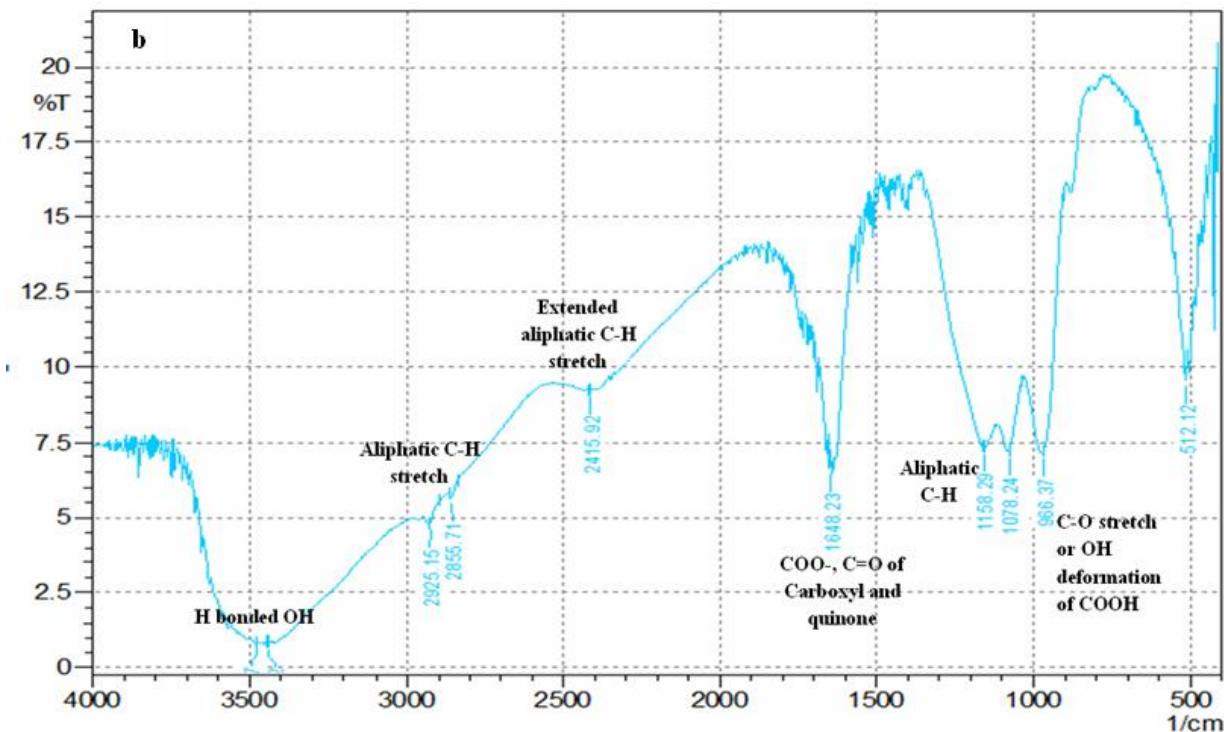
fed to Shimadzu FTIR spectroscopy for spectral analysis and peaks obtained were in the range of 500-4000 cm<sup>-1</sup>.

## Results and Discussion

Spectra of Fourier Transform Infrared (FTIR) spectroscopy endow with valuable information on the functional groups present in the HA and FA fractions. The spectra obtained for HA and FA fractions did not vary much with respect to the peaks obtained for same land use system at different sites, therefore spectra of paddy system of only one location is presented in Figure 1. The main absorption bands irrespective of both HA and FA were assigned as per the reference outlined by Flaig *et al.*, (1975). The absorption spectra of HA and FA samples extracted from different soils indicate similar structure, differing only in their intensities of absorption (Stevenson, 1994).

**Fig.1** FTIR spectra of (a) HA and (b) FA fractions from soils of paddy land use system





FTIR spectrum of HA of paddy soils showed bands at  $3246\text{ cm}^{-1}$  (H-bonded OH),  $2420\text{ cm}^{-1}$  (aliphatic C-H strech),  $1721\text{ cm}^{-1}$  ( $\text{C=O}$  of  $\text{COOH}$ ,  $\text{C=O}$  stretch of ketonic  $\text{C=O}$ ),  $1634\text{ cm}^{-1}$  ( $\text{COO-}$ ,  $\text{C=O}$  of carbonyl and quinone),  $1449\text{ cm}^{-1}$  (aliphatic C-H),  $1112\text{ cm}^{-1}$  ( $\text{COO-}$ ) and  $1102\text{ cm}^{-1}$  ( $\text{C-O}$  stretch or OH deformation of  $\text{COOH}$ ). In case of FA, the FTIR spectrum showed peaks at  $3497\text{ cm}^{-1}$  (H-bonded OH),  $2925 - 2855\text{ cm}^{-1}$  (aliphatic C-H strech),  $2415\text{ cm}^{-1}$  (extended aliphatic C-H stretch),  $1648\text{ cm}^{-1}$  ( $\text{COO-}$ ,  $\text{C=O}$  of carbonyl and quinone),  $1158\text{ cm}^{-1}$  (aliphatic C-H),  $1078\text{ cm}^{-1}$  ( $\text{COO-}$ ),  $966\text{ cm}^{-1}$  ( $\text{C-O}$  stretch or OH deformation of  $\text{COOH}$ ) and  $512\text{ cm}^{-1}$ . All the spectra showed a strong absorption band at  $3450 - 3345\text{ cm}^{-1}$ , indicating extensive overlapping of the OH groups with various degree of H-bonding. A weak band at  $1725\text{ cm}^{-1}$  in HAs and medium in FAs indicate higher number of COOH groups in the latter. The band of medium to strong intensity at  $1300\text{ cm}^{-1}$  indicate that HAs and FAs may be present in the form of

the salts of  $\text{COOH}$ , whereas, the strong and broad band near  $1200\text{ cm}^{-1}$  suggest  $\text{C-O}$  stretching of aromatic ethers in all HAs and FAs (Schnitzer, 2000).

Present study revealed that FTIR characterization resulted in better understanding of humic substances composition, functional groups in respective humic material as influenced by paddy land use practices. This work supports further for the studies involving land use systems influence on characteristics of humic substances.

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