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STUDY ON MAIN IR BANDS OF SUNFLOWER TREATED ROOTS

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ABSTRACT

A study had been made on four different varieties of sunflower, namely CO-4, CO-5, HYCO-2 and TCSH-1 which were grown in trial fields with three different manure treatments viz. control (T1), chemical fertilizer (T2) and organic manure (T3). From the root rot disease roots, the compound identified and quantified for the four sunflower varieties by FT-IR analysis and the spectra were recorded for all the samples in the range of 4000 – 400 cm–1. Also an attempt has been made to correlate the extinction coefficient (K) values with changes in with respect to sunflower root rot disease treated roots. In this study the calculated extinction co-efficient values were higher in treatment T1 and T2 compared to treatment T3.

Keywords: Sunflower, Spectrometry, Fertilizer, Fourier Transform

1. INTRODUCTION

Fourier Transform Infrared Spectroscopy (FT-IR) is a powerful tool for identifying types of chemical bonds in a molecule by producing an infrared absorption spectrum that is like a molecular „finger print". It is a well-recognized analytical tool for the identification of reactive chemical groups in chemical and biological samples.

FT-IR spectroscopy differs fundamentally from diffraction technology. Since it is based on interferometery, which makes use of the entire source of spectrum, so that all wavelengths are recorded simultaneously. The advantage of this technique over other methods include a dramatic improvement in the signal to noise ratio, a significant reduction in the scan time, higher energy throughout, superior spectral resolution, wavelength accuracy, ease of sample handling and non-destructive aspects [Sivakesava and Irudyaraj, 2020]. Oil seeds play an important role as tool in Indian agriculture and industrial commodity. India is the largest producer of oilseeds in the world in terms of output and second in terms of area. Among the oil seed crops, sunflower is an all season crop [Sivamurugan*et al.*, 2003]. It is well recognized that the disease constitutes a major constrain in increasing the yield level of sunflower crop. *Macrophominaphaseolina*causal agent of charcoal rot is a serious threat for sunflower crop especially in the arid regions of the world. Fourier Transform Infrared Spectroscopy (FT-IR) is a

powerful tool for identifying types of chemical bonds in a molecule by producing an infrared absorption spectrum that is like a molecular „finger print". It is a well-recognized analytical tool for the identification of reactive chemical groups in chemical and biological samples.

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2. MATERIALS AND METHODS

2.1 Sample collection

In the present study four varieties of sunflower, namely CO-4, CO-5, HYCO-2 and TCSH-1 are obtained from G.B. Pant University of Agriculture &Technology ,Pantnagar, Uttarakhand, India.. All the varieties are grown in kharif and rabi seasons, the soil locations are red and sandy. In the fields three manure treatments such as control T1 (without any manure treatment), chemical fertilizer T2 (NPK) and organic manure treatment T3(farm yard manure and neem cake) were used. All the roots samples are powdered well, oven dried to remove the moisture content. The oven dried roots are ground well into a fine power by using agate mortar. The Infra spectra were recorded in BRUKER IFS 66V model FT-IR spectrometer in the region 4000 – 400 cm-1.

2.2 Sample preparation

The root samples were collected from four different varieties of sunflower in two different seasons. The collected samples were identified by the names of sunflower varieties grown in the respectively fields (CO-4, CO-5, HYCO-2 and TCSH-1). The samples were oven dried at 110°C individually, grind to a fine powder, FT-IR spectra of the samples were recorded using KBr pellet technique. All samples for irradiation were prepared by mixing the powdered sample with spectral grade KBr in the ratio of 1:20. Pellets with 13 mm diameter and 1 mm thickness were prepared under vacuum condition by applying a pressure of 10 tons per inch in the stainless steel dies. The spectra of all powdered and pelletized samples were recorded under identical condition in the 4000 – 400 cm-1region.The FT-IR measurements were performed using a Perkin Elmer Spectrum RX1 Model FT-IR spectrometer which is available at Centralized Instrumentation Laboratory, Department of Physics, Sunrise University AlwarRajsthan.

3. Results and Discussion

Sample characterization using FT-IR spectroscopy concerns the correct assignment of the observed spectral characteristics to the most likely origin of the absorption bands. The characteristic bands that

are observed in sunflower root rot disease in red and sandy soils (kharif and rabi seasons) and their tentative assignments are presented in Table 3.1.

Table 3.1: Assignments of the main IR bands in IR spectra of sunflower treated roots

Absorption Frequency (cm-1)	Visual intensity estimates	Tentative assignments	References
3392	S.Bd	Bonded O-H / NH stretching	Hirano et al., (2008)
2921	W	CH (Sym/Asym) aliphatic	Cocozzza et al., (2003), Bellamy (1975)
1749	W	Ketons, Ester carbonyl group	Guillen and Cabo, (2020)
1636	M	C = O stretching phynyl ring amino acid-1	Zaccheo et al., (2012)
1508	W	N-H deformation	Ibarra et al., (2020), Zaccheo et al., (2012)
1424	W	C-N stretching in plane OH bending	Parker, (1971)
1376	W	CH3 (asym./ deformation)	Parker, (1971)
1249	M	C-O (stret.) Ester	Ibarra et al., (2020)
1054	S	CO (stret.)	Grube, (2006)
609	W	CC (bending)	Buchi, (1971)

S – Strong; M – Medium; W – Weak; Bd – Broad

In FT-IR spectrum corresponding to all the sunflower root rot disease roots of absorption bands are found at around 3429-3409 cm-1, 3393 cm-1, 2922 cm-1, 2853 cm-1, 1736 cm-1, 1638 cm-1, 1506 cm-1, 1424 cm-1, 1376 cm-1, 1248 cm-1, 1054 cm-1, 1035 cm-1 and 609 cm-1 in all the samples of red & sandy soil from kharif and rabi seasons. The absorption bands at around 3429 cm-1 are due to banded OH / NH stretching. A strong broad absorption band around 3393 cm–1 is found in all samples may be due to the presence of hydrogen bond N–H stretching, characteristic of amino acids IR bands mainly associated with lipids are located between 3000 cm-1 - 2800 cm-1) and correspond to asymmetric and symmetric stretching of CH3 and CH2 groups. The absorption band around 2922 cm–1, corresponding to C–H stretching of the CH2 groups, indicates the presence of various amino acids. This band may also be characterized for the presence of aliphatic C-H groups in these compounds.

The absorption band at 1736 cm–1, characteristic of C=O stretching, indicates the carbonyl groups [Guillen and Cabo, 2020]. Carbonyl stretches of carboxyl and phenolic esters at 1740 cm-1 and 1735 cm-1 respectively, also signify the presence of lipids. Proteins are represented by IR bands near 1628 cm-1 (amide I) due to the amide linkage [Sutherland, 1952]. The aromatic rings of lignin give rise to IR bands from C=C stretching at 1634 cm-1 [Sene*et al.,* 1994] and 1506 cm-1 is due to presence of N-H deformation of amino acids [Sene*et al.,* 1994; Williams and Fleming, 1980]. IR bands from polysaccharides, cellulose, and carbohydrates overlap in the carbohydrate fingerprint region of 1200–900 cm-1 [Williams and Fleming, 1980]. There are also some regions of overlap with components of polysaccharides, cellulose, and lipids in the region of 1447 – 1459 cm-1 and 1395–1364 cm-1 representing C-H bend of symmetric and asymmetric CH3 group [Sene*et al.,* 1994]. The absorption bands 1248 cm–1 are due to the stretching vibration of C–O group of esters and phenols [Valchos*et al.,* 2006]. The band 609 cm–1 belongs to C–C ring bending coumarine structure [Buchi*et al.,* 1971]. When IR spectra of Kharif&rabi season samples (red and sandy soils) are compared, almost same peak is present in both season (2854 cm-1, 668 cm-1, 909 cm-1, 898 cm-1 and 836 cm-1). This quantitative infrared analysis of different treated field sunflower root rot disease roots in red and sandy soils (kharif and rabi seasons) reveal that the presence of different amino acids, esters, ethers and phenols probably in different amounts. The following infrared absorption bands at 3393 cm-1, 2920 cm-1, 2853 cm-1, 1736 cm-1, 1506 cm-1, 1424 cm-1, 1376 cm-1, 1248 cm-1, 1035 cm-1, 1054 cm-1, 607 cm-1 are attributed to root rot pathogen and especially the band at 3400 cm-1, 2922 cm-1, 1735 cm-1, 1638 cm-1, 1252 cm-1, 1054 cm-1, and 606 cm-1 are also observed.

4. CONCLUSION

FT-IR spectra of the sunflower roots exhibited the absorption bands of chromophoricgroup characteristics of phenols, amino acids and proteins. From the quantitative analysis of these organic constituents, it was found that the levels of total phenols and amino acids were higher in control (T1) and also in chemical fertilizer (T2) than in the organic manure (T3) treated roots. This indicates the higher level of diketopiperazine (macrophominal) in T1 and T2 samples and the lower level of it in T3 samples. Here, organic treated field samples indicated the less disease proliferation of root rot disease when compared to the other two treatments, chemical fertilizer T2 and control T1. It was found that the proper management of the soil with T3 treatment might lead to a reduction in root rot disease incidence.

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