1. INTRODUCTION

Textile industry is one of the major industry play a significant role in contributing industrial output by providing employment to over 45 million people and economy more than $400 billion in many countries (Ghaly et al., 2014). Textile industry is also a major consumer of dyes, colourants and intermediates worth US$ 24 billion of which dyes and pigments constitute $17 billion (71%) and dye intermediates $7 billion (29%) (Murthy, 2010). Textile dyeing industries are one of the main sources with severe pollution problems worldwide (Mahfuza et al., 2009; Rajamanickam and Nagan, 2010; Carmen and Daniela, 2012; Chequer et al., 2013). There are about 10,000 different textile dyes with an estimated annual production of $7 \times 10^5$ metric tons are commercially available worldwide of which 30% of these dyes are used in excess of 1,000 tons per annum (Robinson et al., 2001; Mohan et al., 2002; Aksu and Donmez, 2005; Daneshvar et al., 2007; Soloman et al., 2009; Baban et al., 2010). Among various synthetic dyes, azo dyes are the most important synthetic dyes (Fang et al., 2004; Puvaneswari et al., 2006; Joshni and Subramaniam, 2011; Ghaly et al., 2014). There are about 10-35% of textile dyes are lost during the textile dyeing process and 2 – 20% is directly discharged as effluents into ponds, streams and rivers. The textile dyeing effluents containing synthetic dyes are undesirable, toxic, carcinogenic or mutagenic to life forms (Suteu et al., 2011; Ratna and Padhi, 2012).

In India 4.25 billion gallons of water are being consumed by textile industries of which 2.6 billion gallons of textile dyeing effluents are being discharged daily. Tiruppur is a major textile city in Tamil Nadu, India having 754 dyeing units of which 502 industries
jointly have 20 common effluent treatment plants and 252 dyeing industries have individual effluent treatment plants. These 754 industries discharge about 87,250 liters of wastewater every day in rivers and streams. Moreover, dyes without appropriate treatment are deleterious to the photosynthetic processes of the aquatic plants and also to many living organisms (Hao et al., 2000; Pinheiro et al., 2004; Lavanya et al., 2014). There are many physico-chemical processes such as membrane filtration, coagulation, flocculation, precipitation, floatation, adsorption, ion exchange, mineralization, advanced oxidation, electrolysis and chemical reduction are being followed to treat the effluents and these processes are expensive and generate large quantities of sludge having toxic by-products (Kumar et al., 2006; Adinew, 2012; Huber and Carre, 2012; Huang et al., 2014). Several microorganisms such as bacteria, fungi and yeasts decolourize textile dyes and textile dyeing effluents (Wesenberg et al., 2003; Saranraj et al., 2010; Arun Prasad and Bhaskara Rao, 2010; Stella et al., 2012; Perumal et al., 2012; Alalewi and Jiang, 2012; Manikandan et al., 2012; Hassan et al., 2013; Sriram et al., 2013; Olukanni et al., 2013; Pratap Singh et al., 2014; Hatice et al., 2014; Dastagir et al., 2014). Azo dye degradation by bacteria has been investigated by many researchers (Tripathi and Srivastava, 2011; Kumar Praveen and Bhat, 2012; Stanley Abraham, 2010). Under aerobic conditions azo dyes are not readily metabolized, although the ability of bacteria having reducing enzymes to aerobically degrade certain azo dyes. In contrast, under anaerobic conditions many bacteria reduce azo dyes by the activity of unspecific, soluble, cytoplasmatic reductase, known as azo reductases. The anaerobic reduction degrades azo dyes that are converted into aromatic amines (Blümel et al., 2002; Ola et al., 2010; Soon-An et al., 2012) and these amines
which are toxic, mutagenic and possibly carcinogenic to mammalians (Pinheiro et al., 2004).

Hence aerobic fungal enzymes represent an attractive option for treatment of textile dyeing effluent. The enzymes such as lignin peroxidase (LiP), manganese peroxidase (MnP) and laccase produced by macro fungi depolymerise and degrade organic pollutants such as phenolic, non-phenolic, soluble and insoluble dyes (Robinson et al., 2001; Tišmal et al., 2010; Gao et al., 2010; Singh et al., 2013; Sahadevan et al., 2013). The white rot fungus *Phanerochaete chrysosporium* and its non-specific extracellular oxidative enzyme system such as LiP, MnP and laccases have been extensively studied for textile dye degradation. Hydrogen peroxide is essential for catalytic process of LiP and MnP, whereas oxygen is needed for laccases so as to degrade azo dyes through a non-specific free radical mechanism which prevents the formation of aromatic amines as degradation products (Joshni and Subramaniam et al., 2011; Vishwakarma et al., 2012; Forootanfar et al., 2012). Recently laccases have received much attention from researchers due to their ability to oxidise both phenolic and non-phenolic, lignin related compounds as well as highly recalcitrant environmental pollutants (Nyanhongo et al., 2002; Forootanfar et al., 2012).

Laccase from *Pleurotus ostreatus*, *Schizophyllum commune*, *Sclerotium rolfsii* and *Neurospora crassa* reported 25% dye decolourization of commercially available triarylmethane and anthraquinonic dyes (Abadulla et al., 2000). Reactive Black 5 (RB 5) pure dye solution (0.04 g/L) and industrial dyeing effluent (1 g/L RB 5, 30 g/L NaCl) were decolourized (85-95 %) by free and immobilized laccase reported by Tzanov et al., (2003b). The azo dye blue HFRL 75 ppm was decolourized (97.67%) by laccase from
Pleurotus florida (Malini Devi et al., 2012). Synthetic dye decolorization by using the crude laccase (1:10) was reported by Krishnaveni and Kowsalya (2011). The production of laccase from Trametes sp. under solid (205 –22550 U/L) and liquid (300 - 25120 U/L) state fermentation by white rot fungi has been reported by several authors (Songulashvilia et al., 2007; Balaraju et al., 2010; Fernandes et al., 2011; Gonzalez et al., 2013; Kalra and Shavez et al., 2014). There are limited investigation carried out by few researchers and reported for an enhanced laccase production (2, 00,000 U/L) under solid state fermentation however, continuous production, availability of these enzymes and its application at pilot and industrial scales are still a major challenge.

Hence, the present study is aimed for isolation, identification of an effective biological system for an enhancement of extracellular laccase production, purification and utilization of extracellular laccase for the decolourization of textile dyeing effluent. Development of laccase based biosensor for the detection of phenols, phenolic compounds in water, wastewaters, textile dyes and dyeing effluents were also investigated. Finally the development of a simple and efficient biotreat system called mycofilter containing Trametes versicolor (UC-3), Ganoderma lucidum (GL 03) and Pleurotus florida (UP-2) were also studied for the treatment of raw textile dyeing effluent containing high TDS, COD, BOD and synthetic dyes.