Bioresource Technology 126 (2012) 216–223

Contents lists available at SciVerse ScienceDirect

Bioresource Technology

journal homepage: www.elsevier.com/locate/biortech

Degradation kinetics of chlorpyrifos and 3,5,6-trichloro-2-pyridinol (TCP) by fungal communities

K. Maya [a], S.N. Upadhyay [b,1], R.S. Singh [b], Suresh K. Dubey [a,*]

[a] Department of Botany, Faculty of Science, Banaras Hindu University, Varanasi 221005, India
[b] Department of Chemical Engineering & Technology, Indian Institute of Technology, Banaras Hindu University, Varanasi 221005, India

HIGHLIGHTS

- ▶ Biodegradation of chlorpyrifos (CP) and 3,5,6-trichlorio-2-pyridinol (TCP) by five fungal isolates are reported.
- ▶ It is found that the *Aspergillus* sp. is the most efficient isolate.
- ▶ Degradation of TCP is higher than that of CP.
- ▶ Kinetics of biodegradation of CP and TCP has been investigated and kinetic constants are reported.
- ▶ Results of biomass growth experiments are supported by those of kinetic studies.

ARTICLE INFO

Article history:
Received 30 July 2012
Received in revised form 2 September 2012
Accepted 3 September 2012
Available online 11 September 2012

Keywords:
Bioremediation
Chlorpyrifos
TCP
Fungal community

ABSTRACT

Fungal isolates obtained from soil were used for degrading chlorpyrifos (CP) and TCP. The percentage degradation ranged from 69.4 to 89.8 for CP and 62.2 to 92.6 for TCP after one week. The values of K_s and V_{max} were different for different isolates. The K_s ranged from 66.66 to 169.5 mg/L and V_{max} from 6.56 to 40.4 mg/L/d for CP and from 53.19 to 163.9 mg/L and 3.41 to 40.40 mg/L/d, respectively, for TCP. Fungal community showed high affinity for both CP and TCP. The genetic relatedness of isolate F1 to *Aspergillus* sp., F2 and F3 to *Penicillium* sp., F4 to *Eurotium* sp. and F5 to *Emericella* sp. were confirmed. The degradation potential was in the order: F1 > F2 = F3 > F4 > F5.

1. Introduction

Chlorpyrifos [($C_9H_{11}Cl_3NO_3PS$) or (O,O-diethyl O-(3,5,6-trichloro-2-pyridyl) phosphorothioate), CP], a member of phosphorothioate class of chlorinated organophosphorous compounds, is a moderately toxic broad-spectrum insecticide. It is widely applied in agriculture, animal houses, and for the control of household pests and subterranean termites. It has low solubility in water (2 mg/L) but strong adsorptive affinity to most organic matter and soil particles (Racke, 1993). The half-life of CP in soil is usually between 10 to 120 days but can range up to one year depending on climate, dose and other environmental conditions (Singh et al., 2006a), thus causing threat to environment and public health (Kulshretha and Kumari, 2011).

Physico-chemical methods used for detoxification of CP and the like are often costly and result in accumulation of recalcitrant residues and transfer of pollutants from one system to the other (Chowdhury et al., 2008). Therefore, biodegradation using native microorganisms is considered to be a safe, cost effective, efficient and eco-friendly method. Biodegradation of CP results in the formation of an antimicrobial compound TCP (Armbrust, 2001), classified as mobile, persistent (half-life of 65–360 days), and toxic by US EPA (1997). It is more mobile compared to the parent molecule due to its higher water solubility, thus causing widespread contamination of soil and aquatic environments (Feng et al., 1997). Through chemical and physical interactions with substances, microorganisms have the ability to effect morphological and structural changes as well as complete degradation of the target molecules (Raymond et al., 2001). Therefore, assessment of the potential of microorganisms as bioremediation agents has attracted the attention of several workers (Khan et al., 2011; Maya et al., 2011). Considerable amount of work have been reported on biodegradation of CP and TCP by bacterial strains (Li et al., 2007). *Flavobacterium* (Mallick et al., 1999), *Alkaligenes faecalis* DSP3 (Yang et al., 2005) and *Sphingomonas* sp. (Li et al., 2007) are reported to be CP degraders and *Pseudomonas* ATCC700113, *Ralstonia* sp. T6

* Corresponding author. Tel.: +91 0542 2307147; fax: +91 0542 2368174.
E-mail address: sureshkd1@hotmail.com (S.K. Dubey).
[1] Currently at: Rajiv Gandhi Institute of Petroleum Technology, Rai Bareli- 229, 316, India.

0960-8524/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.biortech.2012.09.003