Pesticide-fungi interaction and their impact on fungal population in agricultural soil

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Abstract

The response of soil fungi to the insecticide malathion was studied under laboratory conditions. The colony forming units (CFU) of fungi were determined by means of serial dilution technique. The plate count data indicated that the insecticide affected the number of fungi in medium containing insecticide. The effect of different concentrations of insecticide on fungal growth was studied. The growth of isolated fungi was evaluated at different insecticide concentrations up to 800µl. Aspergillus fumigatus, Fusarium oxysporum and Aspergillus terreus, Fusarium solani and Trichoderma harzianum were the most tolerance fungi to high insecticide concentration grown up to 400µl, while all fungal species failed to grow at 800µl. On the other hand Rhizopus stonifer was sensitive to insecticide where, it grow up to 200 µl only. T. harzianum showed biodegradable efficacy of insecticide 40 and 45 % after 10 and 20 days at 100 µl of insecticide.

Key words: agricultural soil; fungi; insecticides; pesticide.

Introduction

One of the major environmental problems facing the world today is the contamination of soil, water, and air by toxic chemicals. Eighty billion pounds of hazardous organo-pollutants are produced annually in agricultural farms and only 10% of these are disposed of safely [1]. Organochloride pesticides are cumulative in the organisms and pose chronic health effects, such as cancer and neurological and teratogenic effects [2]. Excess use of pesticides in agricultural fields causes serious pollution of the soil and groundwater. The characteristics of soil pollution by pesticides are that the area of pollution is huge, and the pollution reaches to deep layers [3]. The organochlorine pesticides are known to be highly persistant in the environment. This class of pesticides includes the chlorinated derivatives of diphenyl ethane (dichlorodiphenyltrichloroethane - DDT, its metabolites dichlorodiphenyldichloroethylene - DDE, dichlorodiphenyldi-chloroethane - DDD, and methoxychlor), hexachlorobenzene (HCB), the group of hexachlorocyclohexane (α-HCH, β-HCH, γ-HCH), the group of cyclodiene (aldrin, dieldrin, endrin, chlordane, nonachlor, heptachlor andheptachlor-epoxide), and...
chlorinated hydrocarbons (dodecachlorine, toxaphene, and chlordecone), [4, 5]. Although most organochlorine were banned from some countries, organochlorine pesticides are still widely studied due to their recalcitrant nature, that is, even after years since the use has been banned, organochlorine contaminated sites are not rare. Not to mention, that the DDT use is still allowed to control malaria bearing mosquitoes, even though, narrowly. Some pesticides such as DDT and dieldrin have proven to be recalcitrant. Consequently, they remain in the environment for a long time and accumulate into food chains for decades after their application to the soil [6]. The pesticides dichlorodiphenyltrichloroethane (DDT), 2,4-dichlorophenoxyacetic acid (2,4-D) and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), plasticizers, pentachlorophenol, and polychlorinated biphenyls, among others are examples of halogenated aromatic compounds. Their stability and toxicity are cause for concern for the environment and public health. The halogenated aliphatic compound, position, and number of halogens are important in determining both rate and mechanism of biodegradation [7].

Among biological approaches, the use of microbes with degradative ability is considered the most efficient and cost-effective option to clean pesticide-contaminated sites. One promising treatment method is to exploit the ability of microorganisms to remove pollutants from contaminated sites, an alternative treatment strategy that is effective, minimally hazardous, economical, versatile and environment-friendly, is the process known as bioremediation [8, 9, 10, 11].

Research on biodegradation has demonstrated the potential of white-rot fungi to degrade pesticide [12]. Four main genera of white rot fungi have shown potential for bioremediation: Phanerochaete, Trametes, Bjerkandera, and Pleurotus [13]. Also, some results showed that the fungi Penicillium miczynskii, Aspergillus sydowii and Trichoderma sp. presented good growth in the presence of the pesticide. For further experiments Trichoderma sp. was selected as the standard microorganism, as it showed the best resistance to DDD in both solid and liquid medium [14]. The present investigation was undertaken to isolate fungi from pesticide contaminated soil.

**Materials and Methods**

**Growth medium Used**

Czapek's agar medium supplemented with different concentrations of insecticide malathion.

**Soil Samples and fungal isolates.**

Three soil samples (sample 1 cultivated with Mangifera indica, sample 2 cultivated with Zea mays, sample 3 cultivated with Cucumis sativus) were collected from the 0-15 cm top layer of cultivated soil, from several farms, where different pesticides were applied to control various pests. Fungi were isolated from these soil and identified [15, 16, 17].

**Biodegradation of Insecticide**

The metabolized medium containing insecticide (100 µL) after inoculation with T. harzianum (potent fungus for insecticide resistance), and incubated for 20 days at 28±2 ºC was loaded in TLC scanner to detect the presence of insecticide after 10 and 20 days at Regional Center for Mycology and Biotechnology AL-Azhar University).

**Results and Discussion**

Total number of isolated fungi decreased with increasing insecticide concentration where, CFU was 14 at high concentration of insecticide soil sample 1, all results of other sample was similar (Table 1). The effect of insecticides the total numbers of soil microorganisms has been reported on in many studies [18, 19, 20, 21]. By contrast, few studies have examined the effect of insecticides on the morphological features, metabolic activity, and sporogenesis of fungi [22] found that, by using various doses of Dimethoate, no mycelial growth appeared in cultures at a rate above 5 ppm. There was no appreciable effect of the low dose of the insecticide (2.5 ppm) when incorporated into water cultures on vegetative growth; asexual and sexual sporulations of all tested fungi were comparable to those of the control. The growth of isolated fungi was evaluated at different insecticide concentrations up to 800µl (Table 2).
Table 1: CFU of fungi isolated from different samples of contaminated soil with pesticide

<table>
<thead>
<tr>
<th>Insecticide Concentration (µL/100 ml growth medium)</th>
<th>CFU of fungi at 10^3</th>
<th>Soil sample 1</th>
<th>Soil sample 2</th>
<th>Soil sample 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>35</td>
<td>39</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>25</td>
<td>23</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>14</td>
<td>12</td>
<td>14</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Fungal growth on medium supplemented with different insecticide concentrations

<table>
<thead>
<tr>
<th>Test fungi</th>
<th>Fungal growth at different insecticide Concentration(µL/100 ml growth medium)</th>
<th>Control</th>
<th>100</th>
<th>200</th>
<th>400</th>
<th>800</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspergillus fumigatus</td>
<td></td>
<td>5.4±0.5</td>
<td>3.4±0.6</td>
<td>3.0±0.6</td>
<td>1.4±0.5</td>
<td>0.0</td>
</tr>
<tr>
<td>Aspergillus terreus</td>
<td></td>
<td>4.8±0.6</td>
<td>3.4±0.5</td>
<td>3.2±0.4</td>
<td>1.5±0.6</td>
<td>0.0</td>
</tr>
<tr>
<td>Fusarium oxysporum</td>
<td></td>
<td>5.3±0.2</td>
<td>3.4±0.3</td>
<td>1.9±0.2</td>
<td>1.2±0.5</td>
<td>0.0</td>
</tr>
<tr>
<td>Fusarium solani</td>
<td></td>
<td>5.4±0.4</td>
<td>4.0±0.2</td>
<td>1.8±0.4</td>
<td>0.8±0.4</td>
<td>0.0</td>
</tr>
<tr>
<td>Trichoderma harization</td>
<td></td>
<td>3.7±0.5</td>
<td>3.6±0.1</td>
<td>3.0±0.5</td>
<td>2.2±0.2</td>
<td>0.0</td>
</tr>
<tr>
<td>Rhizopus stonifer</td>
<td></td>
<td>5.2±0.3</td>
<td>2.4±0.4</td>
<td>1.2±0.2</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Aspergillus niger</td>
<td></td>
<td>4.0±0.2</td>
<td>3.6±0.4</td>
<td>2.4±0.3</td>
<td>1.4±0.4</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Aspergillus fumigatus, Fusarium oxysporum and Aspergillus terreus, Fusarium solani and Trichoderma harization were the most tolerance fungi to high insecticide concentration grown up to 400µl while all fungal species failed to grow at 800µl. On the other hand Rhizopus stonifer was sensitive to insecticide where, it grow up to 200 µl only. These studies elucidated the reaction of fungal species in the presence of insecticide and the minimum inhibitory concentration. The results described here show that the effect of insecticide on the total soil fungi varied considerably. This result agrees with the findings [23].

After different incubation periods TLC scanner indicated that malathion is partially degraded by T. harization after several days of incubation periods, where it degraded after 10 and 20 days with 40 and 45 % compared with the control and the quantity decreased with increasing incubation periods (Figure 2). Therefore TLC scanner indicated the decreasing of insecticide after 20 days of incubation periods. The results described here show that the ability of T. harization to degrade the insecticide and decreasing their effects on environmental health. Hussaini et al. [24] stated that Trichosporon sp.,

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has given highest degradation of Chlorpyrifos at 55%, and for Endosulfan and Lindane it was 10% and 7% respectively. For Verticillium dahliae, maximum degradation of 64% was seen for Chlorpyrifos, whereas for Endosulfan it was 8%, for Malathion it was 10% and for Lindane it was 10%.

**Conclusion**

Some fungal isolates from insecticide contaminated soil were highly tolerance to insecticide malathion. Therefore this fungal isolates may be used for degradation of these insecticide.

**Acknowledgement**

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**References**

14. Ortega NO, Nitschke M, Mouad AM., Landgraf MD, Rezende MOO, Seleglim MHR, Sette L D, Porto ALM. 2011. Isolation of Brazilian Marine Fungi Capable of


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