Insecticidia Activity of bio-oils and biochar as pyrolysis products and their combination with microbial agents against *Agrotis ipsilon* (Lepidoptera: Noctuidae)

Atef M.M. Sayed\(^1\)*, Robert W. Behle\(^2\), Kari Tiilikkala\(^3\) and Steven F.

1. Agricultural Research Center, Plant Protection Research Institute, Biological Control Research Department, Giza, Egypt
2. United States Department of Agriculture, Agricultural Research Service, National Center for Agricultural Utilization Research, Crop Bioprotection Research Unit, Peoria, Illinois, USA
3. MTT Agrifood Research Finland, Natural Resources Institute (Luke), 31600 Jokioinen, Finland
There is now more than ever an urgent need to develop pest control methods which are environmentally safe and economically sustainable. We suggest that use of pyrolysis products, bio-oil and biochar for use as environmentally friendly biocontrol agents.

The objective of the present study was to determine the efficacy of pyrolysis bio-oil fractions as a new alternative pesticide against black cutworm *A. ipsilon* (Hufnagel). Another aim was to evaluate the toxicity of mixtures of biomass pyrolysis bio-oils with three different entomopathogens: the baculovirus *Agrotis ipsilon* nucleopolyhedrovirus (*AgipMNPV*), bacterium *Bacillus thuringiensis* var. *kurstaki* (*Bt*) and fungus *Beauveria bassiana* (*Bb*). The third objective was to study the impact of alkaline conditions of spray-dried biochar when combined with the microbial pathogens.

Three experiments were conducted, two experiments with bio-oils and one with biochar to assess of bio-oil fractions (aqueous, organic and mixture) against 1<sup>st</sup> larval instar of black cut worm, *A. ipsilon* (experiment I). Based on results of the experiment 1 for bio–oil phases, experiment II examined the effects of bio-oil fractions at each of the concentration 2% and 4% mixed with median lethal concentration LC<sub>50</sub> of the three different microbial agents, $1.2 \times 10^5$ OB mL<sup>-1</sup> for baculovirus *AgipMNPV*, $3.85 \times 10^7$ spores mL<sup>-1</sup> for *Bacillus thuringiensis kurstaki* and $3.58 \times 10^7$ spores mL<sup>-1</sup> for *Beauveria bassiana*. The experiment III was performed to compared pHs of spray-dryer formulation ingredients including biochar mixed with the previously microbial agents on the insecticidal activity.
Main Results

Among the six fractions tested as illustrated in Figure 1, the organic fraction C revealed the greatest activity over all other fractions.

The comparison of bio-oil fractions only and in combination with the three microbial agents indicated no significant differences in insecticidal efficacy for baculovirus AgipMNPV seven days \((t= 0.410, \text{df}=10, P=0.690)\), Bt three days \((t= 0.992, \text{df}=9, P=0.334)\), and Bb five days \((t=1.784, \text{df}=10, P=0.105)\) after initial exposure as shown in Figure 2. Overall, the bio-oil fractions applied alone tended to cause greater mortality of the exposed larvae than did any mix with the microbial agents. The bio-oils were not observed to cause damage to the treated leaves.

It is obvious that the spray-dried formulation ingredient of biochar formulation mixed with baculovirus AgipMNPV, Bt and Bb at pH 7.1 had significantly higher insecticidal effects of 64.93, 65.84 and 62.87 %, respectively, compared with the biochar formulation made in combination with the same agents at pH 4.0 (36.04, 39.53 and 42.22 %, respectively), and pH 9.6 (3.76, 21.17 and 54.56 %, respectively), whereas biochar without the microbial agents had the lowest effect of 4.37% at pH 7.1.

Table 4. Insecticidal activity against Agrotis ipsilon larvae treated by bio-oil phases of aqueous, organic and mixture at two concentrations 4% and 2% exposed individually and mixing with the median lethal concentrations (LC50) of microbial agents of AgipMNPV, Bacillus thuringiensis var. kurstaki and Beauveria bassiana.
Impact and Prospectum

The results of this research support earlier findings about good potentials for using pyrolysis products as source material for making insecticides, and for finding alternative compounds to synthetic chemical pesticides.

Biochar may play a vital role in supporting alternatives and could be an appropriate additive or even useful substitute for pesticides, and it has high structural stability and likely some other favorable properties, such as air capacity and water-holding capacity.

There is an increasing interest in developing pyrolysis technology as a “greener” solution to produce energy and chemicals using local natural biomass as feedstock. It is obvious that pyrolysis liquids can be used as raw material for making repellents, insecticides, molluscicides, herbicides and fungicides.
Thank You

Get in Touch
Atef Sayed

Address: 7 Nady El-Sayed Street, Dokki, Giza, Egypt
E-mail: atef.mahmoud1@gmail.com
Phone number: +201000757006