

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

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Pyrolysis technology producing biochar and bio-oils can be used as a potential alternative to make biopesticides which are urgently needed in integrated pest management (IPM). The insecticidal activity of the three components bio-oils, aqueous, organic and in the mixture was evaluated individually and with three different entomopathogens of the baculovirus *Agrotis ipsilon* nucleopolyhedrovirus (*AgipMNPV*), bacterium *Bacillus thuringiensis* var. *kurstaki* (*Btk*) and fungus *Beauveria bassiana* (*Bb*). Effect of the alkaline conditions of spray-dried biochar was as well as studied with the previous microbial pathogens. Our bioassay results indicated, that the organic bio-oil phase was the most active causing 100% mortality after 24 h, when was estimated median lethal toxicity values LC_{50s} (mg/mL) However, the bio-oil fractions applied alone tended to cause higher mortality of the exposed larvae than did either mix with the microbial agents. Also, results revealed that the highest mortalities were found in spray-dried formulation made with biochar at level pH 7.1. It was concluded that pyrolysis oils are effective insecticides and biochar could be an useful additive in production and formulation of biopesticides. This interesting finding further promote the use of pyrolysis bio-oils and biochar compounds as an eco-friendly alternative to replace conventional pesticides.

Keywords. Pyrolysis - Microbial agents - Insecticidal properties - *Agrotis ipsilon*.