

- Rashid, M., Baghdadi, A., Sheikhi, A., Pourian, H. R., Gazavi, M. (2010). Compatibility of *Metarhizium anisopliae* (Ascomycota: Hypocreales) with several insecticides. *Journal of plant protection research*, 50(1). doi: <https://doi.org/10.2478/v10045-010-0004-6>
- Ravensberg, W. J. (2015.). Commercialisation of microbes: present situation and future prospects. Ed: Lugtenberg, E. *Principles of plant-microbe interactions*. Cham, Germany. Springer, 309-317. doi: https://doi.org/10.1007/978-3-319-08575-3_32
- Ravindran, K., Chitra, S., Wilson, A., Sivaramakrishnan, S. (2014). Evaluation of antifungal activity of *Metarhizium anisopliae* against plant phytopathogenic fungi. Eds: Kharwar, R. N., Upadhyay, R. S., Dubey, N. K., Raghuvanshi, R. *Microbial diversity and biotechnology in food security*. New Delhi, India. Springer, 251-255. doi: https://doi.org/10.1007/978-81-322-1801-2_22
- Roberts, D.W., J. ST. Leger, R. (2004). *Metarhizium* spp., cosmopolitan insect-pathogenic fungi: mycological aspects. Eds: Laskin, A., Bennett, J., Gadd, G. *Advances in applied microbiology*. English. Academic Press, V54: 1-51.
- Shah, F. A., Gaffney, M., Ansari, M. A., Prasad, M., Butt, T. M. (2008.). Neem seed cake enhances the efficacy of the insect pathogenic fungus *Metarhizium anisopliae* for the control of black vine weevil, *Otiorynchus sulcatus* (Coleoptera: Curculionidae). *Biological control*, 44(1), 111-115. doi: <https://doi.org/10.1016/j.biocontrol.2007.09.009>
- Strasser, H., Vey, A., Butt, T. M. (2000). Are there any risks in using entomopathogenic fungi for pest control, with particular reference to the bioactive metabolites of *Metarhizium*, *Tolypocladium* and *Beauveria* species? *Biocontrol science and technology*. 10(6):717-735. doi: <https://doi.org/10.1080/09583150020011690>
- Sun, M. H., Gao, L., Shi, Y. X., Li, B. J., Liu, X. Z. (2006). Fungi and actinomycetes associated with *Meloidogyne* spp. eggs and females in China and their biocontrol potential. *Journal of invertebrate pathology*, 93(1): 22-28. doi: <https://doi.org/10.1016/j.jip.2006.03.006>
- Tarasco, E., Alvarez, C. S., Triggiani, O., Moraga, E. Q. (2011). Laboratory studies on the competition for insect haemocoel between *Beauveria bassiana* and *Steinernema ichnusae* recovered in the same ecological niche. *Biocontrol science and technology*, 21(6): 693-704. doi: <https://doi.org/10.1080/09583157.2011.570428>
- van Lenteren, J. C., Bolckmans, K., Köhl, J., Ravensberg, W. J., Urbaneja, A. (2018). Biological control using invertebrates and microorganisms: plenty of new opportunities. *BioControl*, 63(1): 39-59.
- Vestergaard S., Cherry A., Keller S., Goettel, M. (2003). Safety of hyphomycete fungi as microbial control agents. *environmental*. Eds: Hokkanen, H. M. T., Hajek, A. E. *Environmental impacts of microbial insecticides*. Dordrecht, Netherlands. Springer, 35-62. doi: https://doi.org/10.1007/978-94-017-1441-9_3
- Xavier-Santos, S., Lopes, R. B., Faria, M. (2011). Emulsifiable oils protect *Metarhizium robertsii* and *Metarhizium pingshaense* conidia from imbibitional damage. *Biological control*, 59(2): 261-267. doi: <https://doi.org/10.1016/j.biocontrol.2011.08.00340>
- Yousef, M., Garrido-Jurado, I., Ruiz-Torres, M., Quesada-Moraga, E. (2016). Reduction of adult olive fruit fly populations by targeting preimaginals in the soil with the entomopathogenic fungus *Metarhizium brunneum*. *Journal of pest science*, 90(1): 345-354. doi: <https://doi.org/10.1007/s10340-016-0779-y>

Prispjelo/Received: 22.4.2018

Prihvaćeno/Accepted: 2.7.2018.

Review paper

Potential of entomopathogenic fungi *Metarhizium* spp. in control of insects pest

Abstract

Biological control of insect pests has increasing importance due to a insect resistance to certain chemical pesticides, and for the purpose of producing toxicologically safe food. Biological control methods are based on the application of natural agents such as pathogens, parasites and predators of insects pests. The aim of this paper is to reveal the advantages and disadvantages of *Metarhizium* based mycoinsecticides. We discussed the biology of these entomopathogenic fungi, their interaction with the plant, the environment, other organisms and agrochemicals, and their availability on the market. Successful examples of *Metarhizium* spp. in the control of wireworms (Elateridae), olive fruit fly (*Bactrocera oleae*), two-spotted spider mite (*Tetranychus urticae*) and pear psylla (*Cacopsylla pyri*) are described. The efficiency of *Metarhizium* spp. in control of important pests provided results that are comparable to the chemical pesticides. Besides their properties as biopesticides, *Metarhizium* spp. are also considered as biostimulators or biofertilizers. Availability, high price of mycoinsecticides, and a small number of researches done in the fields are major causes of poor utilization of this bioagent.

Keywords: biocontrol, biopesticide, interaction, efficiency, compatibility