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Biopesticides and Biofertilizers Based on Fungal Secondary Metabolites

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Hundreds of secondary metabolites produced by beneficial fungi have been isolated and characterized, mainly from biocontrol strains of the genus *Trichoderma*. The production of these natural compounds is strain dependent and varies on: i) the compound considered; ii) the species and the strain; iii) the presence of other microbes; iv) the balance between elicited biosynthesis and biotransformation rate; v) the growth conditions. In some cases, the biocontrol agent is able to modulate the production of toxic secondary metabolites according to the presence or the absence of the target pathogen [1].

Several fungal species, as well as numerous chemically different substances, have been found to be able to modify plant development and crop yield [2]. A hormone-like effect has been proposed for some *Trichoderma* secondary metabolites and specific antimicrobial compounds having these characteristics have been detected in plant-fungus cultures [3]. In fact, treatment with *Trichoderma* metabolites produces extensive changes of the plant expressome, proteome and metabolome, by acting on specific pathways involved in the synthesis of major hormones, resistance to biotic/abiotic stresses and nutrient uptake [3]. These recent findings have suggested new strategies for the development of novel bioformulates based on microbial metabolites alone or in combination with live microbes, in order to maximize the beneficial effects and reduce the risks associated with the release of microorganisms into the environment. Secondary metabolites, various cell wall degrading enzymes or even the whole fungal organism could be used in the field as stimulators of induced systemic resistance or as plant growth promoters of crop plants. Application of the fungal substances could not only protect the germinating seeds from pathogen attack, as well as augment seed germinability and survival, and consequently improve development of the root system, plant growth and yield.

The isolation of compounds that affect plant metabolism may help to overcome the problems related with use of living microorganisms, through the introduction of new secondary metabolites - based biopesticides and biofertilizers that may help to overcome the problems related to use of living microorganisms through the introduction of biopesticides or biofertilizers based on the bioactive natural products responsible for the desired beneficial effects on crops.

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