Controle biológico de doenças de plantas no Brasil: história, pesquisa, comercialização e perspectivas.
Biological control of plant diseases in Brazil: history, research, commercialization and perspectives.
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The use of biocontrol agents (BCA) on the control of plant diseases is still bounded in Brazil, though its accessibility nowadays. However, biocontrol agents are being used more often in plant protection, given the variety of products available and, in particular, users' increasing confidence with those. The main BCAs available in Brazil are mild strains of Tristeza virus of citrus and Papaya Ring Spot Virus of zucchini squash for the control of Tristeza virus and Papaya Ring Spot Virus through premunization, respectively; *Trichoderma* for the control of *Rhizoctonia, Fusarium, Pythium, Phytophthora, Sclerotinia* and *Sclerotium* in soybean, bean, cotton, corn, cotton, strawberry, ornamentals plants, tobacco, and apple, among others; *Trichoderma stromaticum* for the control of the cacao witches' broom disease; *Dycima pulvinata* for the control of South American leaf blight (*Microcyclus ulei*) of rubber tree (*Hevea brasiliensis*) associated with polyclone plantation; *Acremonium alternatum* and *A. persicinum* for the control of tar spot of coconut (*Catacauma torrendiella* and *Coccostroma palmicola*); *Clonostachys rosea* for the control of *Botrytis* in strawberry and flowers; *Trichoderma* in substrates and container media, as well as seedlings production, in vegetable and flowers; Among other products. Despite the commercialization of several BCAs, *Trichoderma* is the most important. In 1987, thirty-seven years since the first publication on biocontrol of plant diseases by *Trichoderma* in Brazil (R.Forster, *Bragantia* 10:139-148, 1950), a pioneer product arrived in the market against *Phytophthora cactorum* in apple trees. At this time, the BCA was supplied in polypropylene bags containing 24g of sorghum seeds colonized by *T. viride*. The first enterprise specialized in production and commercialization of *Trichoderma* started to operate in 1992. Since then, other products came out and nowadays there are more than ten commercial trademarks. Nowadays the main species in the market are: *T. asperellum, T harzianum, T. stromaticum, T. viride*, and the pathogens target includes *Fusarium, Pythium, Rhizoctonia, Macrophomina, Sclerotinia, Sclerotium, Botrytis; Crinipellis perniciosa. Trichoderma* is mostly produced by solid fermentation on rice or millet grains (approximately 550ton/year), and commercialized in formulations WP, WG, SC, EC, grain+spores, dry spores. The average cost of treatment, for example, against bean white-mold with *Trichoderma* is US$54.00/ha, while with fungicides is about US$92.00/ha. The recent organization of a Brazilian Biocontrol Association (ABCbio) and the enhancement of the legislation for registration and commercialization of BCAs are boosting the market, particularly for *Trichoderma* that is in frankly expansion. Many circumstances limit the adoption of these techniques, for instance, few plant pathologists are involved in this matter and agriculturists are generally prone to use only pesticides. Moreover, agronomists usually recommend pesticides to solve plant disease issues, and last but not least, the industries influence in technical support to producers. Despite the considerable number of biocompatible products available, the market still demands wider production. It is noticeable that main users of biocompatible products and BCAs are combining these techniques with physical control (steam, solarization and solar collector for substrate desinfestation) and other cultural techniques to the control of diseases and pests, because the enlargement of these products usage relies on the knowledge of agroecosystem's structure and functioning. These growers aim to take advantage of natural interactions, in order to intensify and support the biological interactions in which agriculture production is based, because just the substitution of pesticides will not guarantee a cleaner agriculture. Therefore, upgrading the systems of production is crucial to achieve its sustainability.

Propuestas ecofisiológicas para mejorar la adaptación de los hongos como agentes de biocontrol.
Ecophysiological approaches to improving fitness of fungal biocontrol agents in the environment.
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A prerequisite for the successful development and commercialisation of fungal biocontrol agents is the production and formulation of a product which has the necessary physiological quality, shelf-life and consistency of performance when used. Thus a major hurdle to success has been the production of quality inocula with the necessary ecological competence. We have examined the potential for physiological manipulation of the growth of fungal biocontrol agents to channel or synthesize useful endogenous reserves which are implicated in improved environmental stress tolerance combined with conserved biocontrol capacity. Increased accumulation of trehalose has implications for desiccation tolerance, while sugar alcohol accumulation (e.g. arabitol in yeasts and glycerol and erythritol in filamentous fungi) can improve tolerance to water and temperature stress. We have recently developed a "hydrotime" modelling approach to help determine and evaluate stress tolerance of antagonists in different formulations for both disease and pest control. Examples will be chosen from studies on biocontrol yeasts (*Candida sake*, *Pichia anomala*) and filamentous fungi (*Epicocuum nigrum*, *Ulocladium atra*, entomogenous fungi). Another hurdle is the development of formulated biocontrol products which have the same efficacy as fresh cells. This is critical for the potential commercial development of such antagonsist. Thus, our recent physiological work has been coupled with examining formulation of characterised inocula using fluidised bed drying to conserve quality and examine shelf-life of produced inocula. Comparison have shown that for species such as *C.sake*, *P.anomola*, *E.nigrum* and *U.atrum* that this is indeed possible. These studies suggest that the production and formulation of ecologically competent biocontrol agents is critical for the realistic application and potential commercialization of such fungal antagonists.