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A Quick Look On The Advances In Biological Control In The Last 30 Years

Um breve olhar sobre os avanços no controle biológico nos últimos 30 anos

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Resumo

O controle biológico ainda é bastante discutível e questionado, principalmente por parte dos produtores que ainda não o enxergam como uma alternativa viável e barata ao controle de diversos tipos de doenças. O seu início no mercado brasileiro foi bastante contraditório, principalmente pela falsa premissa de que o controle biológico conseguiria de forma isolada controlar diversas doenças. Sabe-se hoje que o controle biológico, assim como qualquer outra forma de controle de doenças, deve ser associado a mais outro ou outros tipos de controle para que se obtenha sucesso, sobretudo, ao longo do tempo. O controle biológico vem despontando como uma excelente alternativa para controle de alguns tipos de doenças, principalmente associadas ao solo, como no caso de nematoides fitopatogênicos e fungos de solo. É facilmente vendida pela sua menor toxidez e eficácia semelhante em determinados casos ao controle químico. Atualmente diversos produtos de empresas idôneas conseguem entregar excelentes resultados, desde que seguidas as regras de utilização. Desta forma, este breve olhar nos avanços obtidos pelo controle biológico ao longo de 30 anos, objetiva sintetizar alguns conhecimentos e fazer uma reflexão sobre o estado da arte desse tipo de controle e os rumos que provavelmente serão tomados acerca da utilização de organismos vivos e antagônicos para o controle de doenças em organismos vegetais.

Abstract

Biological control is still quite debatable and questioned, especially by producers who still do not see it as a viable and cheap alternative to the control of various types of diseases. Its beginning in the Brazilian market was quite contradictory, mainly due to the false premise that biological control could isolatedly control several diseases. It is known today that biological control, like any other form of disease control, must be associated with another or other types of control to be successful, especially over time. Biological control has emerged as an excellent alternative to control some types of diseases, mainly associated to soil, as in the case of phytopathogenic nematodes and soil fungi. It is easily sold for its lower toxicity and similar effectiveness in certain cases to chemical control. Currently several products from reputable companies can deliver excellent results, provided that the rules of use are followed. Thus, this brief look at the advances achieved by biological control over 30 years, aims to synthesize some knowledge and reflect on the state of the art of this type of control and the directions that will probably be taken about the use of living and antagonistic organisms for the control of diseases in plant organisms.

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INTRODUCTION

Biological control is commonly made with antagonistic species, mostly parasitic at some stage of the phytopathogen's life cycle through several modes of action, such as: antibiosis, competition for colonization sites, parasitism or still trough interactions with the host inducing systemic resistance (Stefanello et al., 2018). Here we have a quick look at 30 years of the evolution of biological control and its impact on the way we perceive products of this kind.

1988-1998

One of the most common forms of disease control is the biological control. This is commonly associated with another type of control (chemical, physical, genetic). Studies of this period assert that the biological control as an isolated way, leads to a partial control of the disease, being necessary an integrated use of this type of control form, since the biological control depends on several biotic and abiotic factors (Ghini, 1991a; Henis & Chet, 1975).

Chemical control is highly effective, however, with some issues. The selection of resistant strains of pathogens due to high pressure and the continuity of the application of the same molecule was a very common problem. There are several reports of increased resistance to benzamidazoles. Since the fungicide besides selecting resistant strains, it also eliminated antagonistic microorganisms (Blakeman, 1985). Studies as the ones of Koenraadt et al., 1992 and Jung et al., 1992, reported this issue in a lot of fungus species: *Venturia inequalis, V. pirina, Sclerotinia homeocarpa* and six species of *Penicillium* that demonstrated resistance to benzamidazoles. There are also several reports of resistance to cupric fungicides (Goto et al., 1994; Culbreath et al., 1992; Cervantes & Gutierrez-Corona, 1994).

This way, the biological control came to stand out as an alternative control, since the efficiency decrease of several fungicides that were used at the time. Several preliminary in vitro studies were conducted aiming to broaden the knowledge about the synergy between chemical control and biological control. The studies of Baker & Cook (1974), presented interesting results, where an underdose of the product was applied to the control of stress to the phytopathogen and became more vulnerable to the antagonistic organism used in biological control. In this relation, it was determined that if the antagonist is alternated with the fungicide, it is possible to reduce the number of applications of the chemical, the risk of problems arising: such as resistance to the pathogen and choosing to apply the fungicide only in critical periods, rationalizing the use of the product (Ghini et al., 1991b).

It was also investigated the integration between physical control and biological control, for example through the solarization technique, where the elevation of temperature led to the better development of some types of antagonists due to reduced competition with other types of microorganisms that could hinder their development (Mandelbaum et al., 1988).

At that time the cotton crop (*Gossypium histutum L.*) was the first crop of agricultural interest in the world to be treated with biological control on a large scale. The so-called "Kodiak®", basically an association between growth promoter and selected strains of *Bacillus subtilis* that brought to the fore the discussion on the integration between industry and the scientific/academic environment to focus more on effective production methods for the multiplication of this type of organism (Brannen & Kenney, 1997).

<u>1998-2008</u>

During this period the intense recommendation of the use of *Trichoderma spp.* is common. Several products are available in the country based on this microorganism and have proven efficiency when used on seedlings substrates, being used mainly for ornamental plants and vegetables (Bettiol et al., 2008a). These products are also used to control soil pathogens such as *Pythium, Selerotinia* and *Rhizoctonia* (Howell et al., 2000; Harman et al., 2004; Ethur et al., 2001). The production of the antagonist is carried out in rice grains, in the so-called "solid" or "semi-solid" fermentation and the products are formulated as powder or liquid (Latifian et al., 2007).

It is interesting to observe the use of non-pathogenic strains for the control of diseases. Such as strains of *Fusarium oxysporum* that do not present pathogenicity to the tomato being used as a form of biological control and presenting interesting results, where these isolates without pathogenicity reduce the severity of the disease caused by pathogenic strains and can be used as another biological control tool (Silva & Bettiol, 2005).

It is also important to emphasize the studies with the use of exudates or plant extracts in the control of phytopathogenic organisms, this being another form of biological control that may be feasible, provided that further studies are done on the interaction between the exudate and the phytopathogen and the viability of large-scale production of this type of product (Schwan-Estrada et al., 2000). There are several studies that prove the effectiveness of this type of control, but the feasibility of producing such products on a large scale, ends up hampering advances in this area, due to the little economic interest on the part of the companies (considering the use as biological, discarding the isolation of the molecule and the production of a chemical). These radicular exudates, for example, besides acting directly, can also promote a resistance by the plant, or even increase the interaction between the microorganisms of the rhizosphere where the occurrence of a greater variety of microorganisms can influence beneficially in the control of diseases (De Oliveira et al., 2003).

The discussion on the lack of legally registered products that are produced with little attention to quality and specific to the area in which they will be used, ie most of the products available for the time, was made in a "rudimentary" way by and not adapted to the regions in which they would be employed. There are reports from several producers that have joined and set up simple laboratories to produce *Trichoderma spp.* with the purpose of supplying their properties, but with several problems regarding the quality of this material produced (Bettiol et al., 2008b).

<u>2008-2018</u>

Biological control can and should be associated with some other types of control. It is usually made with antagonistic species, commonly parasitic at some stage of the phytopathogen's life cycle (Morandi & Bettiol, 2009). For some types of pathogens, biological control has proven to be quite effective since it is conducted correctly and with products of high quality. The integration of this with other types of control has demonstrated success in several cultures. We can quote the example used for the cassava associated with the treatment of solarization along with fungicide exudates released by some plant materials, being successful in the control of soil phytopathogens (Ambrósio et al., 2008). We can also cite the example of *Trichoderma harzianum* in joint action with *Brachiaria ruziziensis* straw for the control of *Sclerotinia sclerotiorum* (white mold) in the soybean crop, representing an effective method of control (Gorgen et al., 2009b).

There is considerable interest in the biological control of post-harvest products, especially in relation to the problem of fruit conservation in underdeveloped countries, due to the cost involved (Sharma et al., 2009; Jamalizadeh et al., 2011). These losses can reach up to 50% in these countries, as well as the problem of confirmed resistance to some types of fungicides and the removal of effective but toxic fungicides from the market (Nunes, 2012).

One of the well-developed niches for the promotion of biological control is the discussion on the toxicity of various chemical products on the market. Although some biologicals also present toxicity, this is greatly reduced in comparison to most chemicals (Radcliffe et al., 2009).

The present farm model, based on a smaller number of annual crops, cultivated in extensive areas and for several consecutive harvests, together with the intense traffic of machines and implements, constituted as important factor of loss of the quality of the soil, with selection, dispersion and increase of the population of root pathogens (Teodoro et al., 2017). Consequently, nematodes have been emerging as important phytopathogenic organisms lately, and one of the most effective ways to control this type of organism is the use of antagonists. Rotation with non-host cultures associated with biological control is an effective form of management and an excellent alternative to other forms of control (Stirling, 2017).

With the advancement of technologies and the possibility of having effective and large-scale products, biological control is a viable and very promising alternative. Mainly used in integrated management with other forms of control, so that we can mitigate the environmental and financial impacts from the constant evolution of resistance and adaptation of phytopathogens to traditional control methods.

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