Crimson Publishers
Wings to the Research

Mini Review

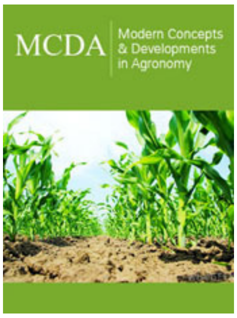
Arbuscular Mycorrhizal Fungi in the Management of Nematodes in Protected Culture Conditions

Daniel Rafael Vuelta Lorenzo[1]*, Siannah María Mas Diego[2], Gerardo Montero Limonta[1], Miriela Rizo Mustelier[1], Luis Ángel Paneque Pérez[1] and Belyani Vargas Batis[1]

[1]Faculty of Chemical Engineering and Agronomy, Cuba

[2]National Center for Applied Electromagnetism, Cuba

ISSN: 2637-7659



***Corresponding author:** Daniel Rafael Vuelta Lorenzo, Faculty of Chemical Engineering and Agronomy, Universidad de Oriente, Cuba

Submission: April 04, 2022

Published: July 20, 2022

Volume 11 - Issue 1

How to cite this article: Daniel Rafael Vuelta Lorenzo*, Siannah María Mas Diego, Gerardo Montero Limonta, Miriela Rizo Mustelier, Luis Ángel Paneque Pérez, Belyani Vargas Batis. Arbuscular Mycorrhizal Fungi in the Management of Nematodes in Protected Culture Conditions. Mod Concep Dev Agrono. 11(1). MCDA. 000755. 2022. DOI: 10.31031/MCDA.2022.11.000755

Abstract

Arbuscular mycorrhizal fungi are soil organisms that live symbiotically with most plants. Providing them with benefits, giving them advantages over non-mycorrhizal plants, making it easier for the plant to take up nutrients that are not readily available or have little mobility in the soil, avoiding the action of pathogenic microorganisms in the root, increasing the tolerance of plants to conditions of abiotic stresses in the soil. They can be used as biological control agents to reduce the populations of other organisms that cause damage and diseases in agricultural crops, these rhizosphere organisms are capable of colonizing the roots of at least 80% of terrestrial plant species by establishing an interaction with them mutualistic type.

Keywords: Biological control; Mycorrhizae; Nematodes

Introduction

Nematodes are called hidden or invisible enemies due to their small size and because, when their effect becomes evident, the population level of the pest is high. They not only weaken plants and decrease yields due to their direct action on the roots, but they also act in etiological complexes that involve fungi, bacteria and viruses [1]. Within the gall-forming nematodes, *Meloidogyne incognita* (Kofoidy White) Chitwood is the species most commonly found affecting plants, mainly in the tropics [2].

Different control alternatives aimed at reducing and/or eliminating nematode populations have traditionally been used. For many years, a wide range of chemical nematicides have been used to control them, many of which are biocides with a negative impact on beneficial organisms present in the soil. Likewise, the harmful impact that these cause to human health and the environment in general, limit their use worldwide [3]. It is necessary to work on the search for new management alternatives that are effective and environmentally safe. In this sense, the use of biological control agents is of great importance, which show, with increasing force, their potentialities [4].

Advantages of Arbuscular Mycorrhizal Fungi

In recent decades, special importance has been given to mycorrhizal fungi, particularly the Arbuscular Mycorrhiza (AMF), based on the beneficial effects that these myco-symbionts provide to their hosts; Therefore, the management of these endophytes has potential use in the different plant propagation processes. Although it can be applied in the field, with various restrictions, the main application of these fungi is in those systems that require a nursery phase before they are released into the field. The management or establishment of the biotechnology represented by the arbuscular mycorrhizal fungi must be carried out in the first phases of the growth and/or establishment of the plants, so that they receive the greatest benefit prior to their commercial exploitation in orchards [5].

Arbuscular Mycorrhizal Fungi (AMF) colonize the cortical tissue of terrestrial plants and among the benefits they provide to the host, reducing susceptibility or improving host vigor against root pathogens is one of the most important. Most of the studies that cover these interactions evaluate the growth of the host, the pathogen, mycorrhizal colonization, incidence, and severity of the disease, among others. However, this interaction depends on the type of root pathogen. It seems that AMF have a negative effect on the growth of the pathogen. Most fungal pathogens have a higher infection rate than AMF, which is why, as the pathogen establishes itself in the plant before the symbiont, it does not allow the latter to develop the beneficial functions that it grants to the host. However, sometimes root pathogens and AMF occupy adjacent sites in the roots, with no apparent effect on each other [6]. There are several studies on the effects of AMF on plants attacked by nematodes, however, in most of them a decrease in the severity of the infestation is observed. Possibly due to the fact that plant parasitic nematodes are antagonistic, obligate biotrophs, like AMF.

A wide range of plants with agronomic interest in our region (bananas, papaya, tomato, grapevine, avocado, pineapple, etc.) depend on mycorrhizae for optimal growth in soils at certain fertility levels. The effects of these microorganisms not only have consequences on development and nutrition but can also increase the natural resistance of plants in situations of biotic (pathogens) or abiotic imbalances (water or saline stress, etc.). In recent years, the incorporation of micropropagation techniques to plant production systems has increased the possibilities of using mycorrhizae, since it has been shown that the inoculation of micro seedlings with these fungi increases tolerance to stress derived from transplantation, also improving the development and nutritional level [7].

Mycorrhizae allow plants four fundamental advantages: capture more phosphorus, nitrogen and water, main plant nutrients; improve its resistance to extreme environmental conditions; build barriers against root diseases and protect the environment by completely avoiding the use of agrochemicals [8]. The high incidence of nematodes, causes considerable effects on the amount and quality of production in protected crops, constituting the main limiting factor for obtaining high yields for the conditions of Santiago de Cuba, Cuba, without being able to manage successfully using conventional methods.

Mechanisms of Action of AMF in the Biocontrol of Nematodes

It has been proven that there is an antagonistic relationship caused by the arbuscular mycorrhizal fungi towards the pathogens and that the reduction of damage due to their attacks is not based solely on a greater number of roots [9].

The potential of AMF to affect host-pathogen relationships by mechanisms unrelated to phosphorus acquisition appears to be greater with obligate biotrophs than with facultative saprotrophs. The mechanisms are related to the contribution of resistance to the plant, and generally depend on changes in the physiology of the host. Changes in root exudates would modify the attraction of nematodes to the roots. Good phosphorus nutrition would improve plant vigor and thus decrease nematode losses, especially in low phosphorus soils if mycorrhizae are established early in the host life cycle before nematode infection. HMAs seem not to affect penetration or the infection process. In general, the reductions in infection and reproduction produced by AMF are evidenced in the density of nematodes or eggs per gram of soil [6].

Numerous mechanisms are manifested when AMFs promote biocontrol. They can be grouped into two: those that include a direct effect of the fungus on the pathogen, such as competition for nutrients, space, and infection/colonization sites, and those that include indirect effects on the pathogen, such as improved nutrient uptake from the host, changes in root architecture, changes in the interaction of microorganisms in the rhizosphere and activation of plant defense mechanisms [10].

The different mechanisms cannot be considered completely independent of each other; that is, the resulting biocontrol comes from a combination of several of them. Mechanisms include increased plant tolerance, direct competition for nutrients and space, induced systemic resistance, and rhizosphere interactions.

Poveda et al. [11] state that mycorrhizal fungi used against nematodes as resistance inducers are capable of reducing the damage caused by plant parasitic nematodes, minimize damage, establish competition for space and resources, provide more nutrients and greater absorption of water by the plant, modify the morphology of the root and/or the rhizosphere, which constitutes an advantage for the growth of the plant. In addition, fungi can induce resistance against nematodes by activating hormones (salicylic and jasmonic acid, strigolactones, among others) as a defense mechanism in plants. AMFs cause an increase in the growth and development of plants, developing resistance against nematode infestation, acting as an effective and alternative biocontrol agent against nematodes [12].

Conclusion

Although AMFs do not prevent the attack of nematodes, they are capable of reducing gall formation and the reproductive capacity of the nematode. When performing the inoculation of AMF in the plants, it produces an increase in the indicators of growth and development of the crop, increasing its yield, which shows that its use can be a beneficial alternative for the management of this pest in crops.

References

1. Arenas P (2016) Fitopatología (3rd revised and updated edition), ISBN: 978-84-9077-282-9, p.82.

2. Fernández G, Casanueva M, Gandarilla B, Márquez G, María E, et al. (2015) Nemátodos en cultivos protegidos de hortalizas y su manejo en tres localidades de La Habana. Fitosanidad 19(1):13-22.

3. Cristóbal-Alejo, Cetz-Chi, J, Tún-Suárez, Felicia A, Fernando A, et al. (2018) Filtrados fúngicos de Trichoderma con actividad nematicida contra Meloidogyne incognita (Kofoid & White) Chitwood. Revista de Protección Vegetal 33(3): e01.

4. Hernández-O, Rodríguez H, Holgado R (2018) Parasitic nematodes that affect Phaseolus vulgaris L.- in Latin America and Cuba: species, damages and tactics evaluated for their management. Plant Protection Magazine 33(3): E-ISSN: 2224-4697.

5. Gianinazzi S (1990) Vesicular arbuscular mycorrhizas: celular, biochemicals, and genetics aspects. Agric Ecosystems Environ 35(2-3): 105-119.

6. Batistella R (2008) Interactions between mycorrhizae and root pathogens. Seminar series. Master in Plant Production INTA, pp.1-3.

7. Jaizme-Vega M, Pérez DF, Rodríguez R, López M Pozo (1997) Mycorrhization in the production of banana plants: biological control of soil pathogens and nutritional aspects. Canarian Institute of Agricultural Research. (ICIA). Canarias, Africa.

8. Escalón A (2005) At UV, natural vitamins are being created for the Mexican countryside. Gazette of the Veracruzana University, pp. 91-93.

9. Contreras JR, Mercado D (2019) Arbuscular mycorrhizae: natural antagonists of soil pathogens. Agroexcellence Magazine Capaciagro Mexico 24(1): 22-24.

10. Dar MH, Reshi ZA (2017) Vesicular Arbuscular Mycorrhizal (VAM) fungi- as a major biocontrol agent in modern sustainable agriculture system. Russian Agricultural Sciences 43(2): 138-143.

11. Poveda J, Abril P, Escobar C (2020) Biological control of plant-parasitic nematodes by filamentous fungi inducers of resistance: Trichoderma, mycorrhizal and endophytic fungi. Microbiol Frontal 11: 992.

12. Sharma M, Saini I, Kaushik P, Aldawsari MM, Balawi TA, et al. (2021) Mycorrhizal fungi and *Pseudomonas fluorescens* application reduces root-knot nematode (*Meloidogyne javanica*) infestation in eggplant. Saudi Journal of Biological Sciences 28(7): 3685-3691.