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Study of Nematophagous Hyfomycetes Under Various Vegetable Crops Cultivated in Absheron

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Abstract

A study was carried out of the total number of fungi and nematophagous hyfomycetes, as well as nematodes in the soil under different vegetables crops. It was revealed that the total number of fungi ranged from 5.7x103 to 9.6x103 CFU/g in soil from the non-root zone (NRS) and from 5.5x103 to 8.5x103 CFU/g in soil from the root soil (RS). The number of fungi with nematophagous hyfomycetes activity ranged from 1.6 x 10^3 to 5.3 x 10^3 in the NRS and from 1.8 x 10^3 to 6.8 x 10^3 CFU/g in the RS, and the increase in the proportion of nematophagous hyfomycetes (24–31% of the total number of fungi) relates to plant species.

Keywords: nematophagous hyfomycetes, soil, *M. arenararia, M. incognita, Heterodera*

Introduction

Various types of microscopic organisms, such as bacteria, protozoa, fungi, and nematodes, are part of the biocenosis. By interacting with each other and with macroscopic organisms (animals and plants), they perform ecosystem functions. Such interactions play a crucial role in maintaining the balance of the biocenosis (Topalovic O. & Heuer H., 2019).

Fungi and nematodes are among the most widely distributed living organisms in soil biota.

The coexistence and interactions between nematodes and fungi, whether antagonistic or mutualistic, direct or indirect, are fundamental for understanding their impact on the ecosystem and their potential applications in agriculture. It should be noted that the nature of their interactions can vary significantly among different species of fungi and nematodes. Furthermore, environmental factors can influence both the type and scale of these interactions (Ragozzino, A., D'Errico, G., 2011).

In most natural soil ecosystems, fungi coexist with nematodes, and both often interact with plants. It has been found that chemical signals released by bacteria, nematodes, fungi, and plants—volatile organic compounds—initiate interactions between fungi and nematodes. Given the widespread presence of these organisms in natural and artificial ecosystems, their interactions have significant economic and ecological consequences. Therefore, it is essential to assess the interactions of all participants in terrestrial and agricultural ecosystems (Martinez-Medina, A. et al., 2017, Martinuz, A. et al., 2014).

The discovery of antagonistic interactions between nematodes and certain rhizosphere microorganisms, particularly nematophagous hyphomycetes, could form the basis for developing control strategies to enhance plant protection against root-knot nematode parasites, including *Meloidogyne spp*. and others.

The occurrence frequency of nematophagous fungi can be influenced by numerous environmental factors, as well as the nutritional and physiological properties of the soil. Jaffee's research demonstrated that using grape leaves as a source of organic matter increased the population and activity of the predatory fungi *Arthrobotrys oligospora* and *A.eudermata* (Jaffee, B.A, 2002).

It has been found that sources of organic matter influence the effect of the fungus *Arthrobotrys oligospora* on the nematode *Meloidogyne mayaguensis* in tomato roots (Duponnois, R, et al., 2001). Additionally, environmental conditions are noted to affect the frequency and diversity of nematophagous fungi. For instance, fungi of the genera *Arthrobotrys* and *Monacrosporium* were discovered in the banana rhizosphere, as this plant provides optimal conditions of soil moisture, temperature, and nutrient supply for fungal development (Cardoso E.R. & Nahas. E., 2015). Factors such as pH, temperature, light intensity, and sources of carbon and nitrogen significantly influence the growth of nematophagous fungi (Barroti, G, Nahas E., 2000, Cardoso E.R. & Nahas. E., 2015). Plant roots excrete a variety of compounds that affect microorganisms and nutrient cycling (Walker, T.S, et al., 2003). The synthesis and amount of exudate depend on the plant species, developmental stage, photosynthesis intensity, and nitrogen fertilization (Houlden, A, 2008). Therefore, different plant species can exert different rhizospheric effects, influencing the composition and diversity of fungal populations (Broeckling, C.D, et al., 2008). Comparing the population density and number of fungal genera in rhizospheric and non-rhizospheric soil shows a predominance in the former (Barroti, G & Nahas E., 2000, Lauber, CL. et al., 2008).

Considering the above, this study focused on examining the total number of fungi and nematophagous hyphomycetes, as well as nematodes, in the soil under different types of vegetable crops.

Materials and methods

Soil samples were collected under different plants species grown in the Absheron region. The studied plants included lettuce, tomato, cucumber, and eggplant. Soil samples were taken at a depth of 5-15 cm. Soil samples from the rhizosphere and non-rhizosphere zones were plated onto agarized Czapek medium using the soil dilution method: (g/L) - sucrose (20), $NaNO_3$ (2), KH_2PO_4 or K_2HPO_4(1), $MgSO_4 \cdot 7H_2O$ (0.5), KCl (0.5), $FeSO_4$ (0.01), agar (15-20); distilled water (1 L). Cultivation was conducted at a temperature of 24-26°C for 10 days. To prevent the development of bacterial cultures, nutrient media were acidified to pH 4-3.8 by adding acids (15-20 ml per 1 liter of medium). Nematophagous hyphomycetes were isolated using the method of Soprunov F.F. Nematode isolation was performed according to the Baermann funnel method (Mehtieva, N.A., 1979).

Result and Discussion

The first phase of the study was devoted to the assessment of the number of nematodes (*M. incognita, M. arenaria, Heterodera*) was recorded in RS and the roots of the examined plants. Their numbers ranged from 47 to 586 per 10 grams of soil or roots depending on the plant species (Table 1).

Table1. Amount of nematodes in soil and roots of different plants

Nematodes	Cucumber		Tomato		Eggplant		Lettuce	
	I	II	I	II	I	II	I	II
	The number of nematods /10 g soil							
M.incognita	352	586	297	520	126	179	63	113
M.arenaria	305	562	236	489	121	163	58	97
Heterodera	278	428	109	231	97	102	47	71

I – soil, II - root

These results are consistent with findings from other researchers, demonstrating the influence of different plants and organic substances on nematode populations (Asmus, G.L. et al., 2008, Bongers, T., Bongers, M., 1998, Hu, C., Qi, Y.C., 2010). A lower number of nematodes (in soil and roots) was found in lettuce and eggplant plants. However, the number of nematodes in the roots of the examined plants was higher compared to RS. Thus, our findings correlate with data from other researchers, who also noted a reduced density of nematodes in relation to lettuce plants (Cardoso, E.R. & Nahas, E**.**, 2015).

The results of the conducted research showed that the total number of fungi ranged from 5.7 × 10^3 to 9.6 × 10^3 CFU/g (colony-forming units) in the soil of the non-root zone (NRS) and from 5.5 × 10^3 to 8.5 × 10^3 CFU/g in the soil of the root (RS) zone (Fig. 1 below).

The number of fungi in the soil under lettuce was 1.2–1.7 times higher in NRS and 1.2–1.5 times higher in RS than the CFU found in the other soils. The number of fungi with nematophagous activity ranged from 1.6 × 10^3 to 5.3 × 10^3 in NRS and from 1.8 × 10^3 to 6.8 × 10^3 CFU/g in RS (Fig. 2).

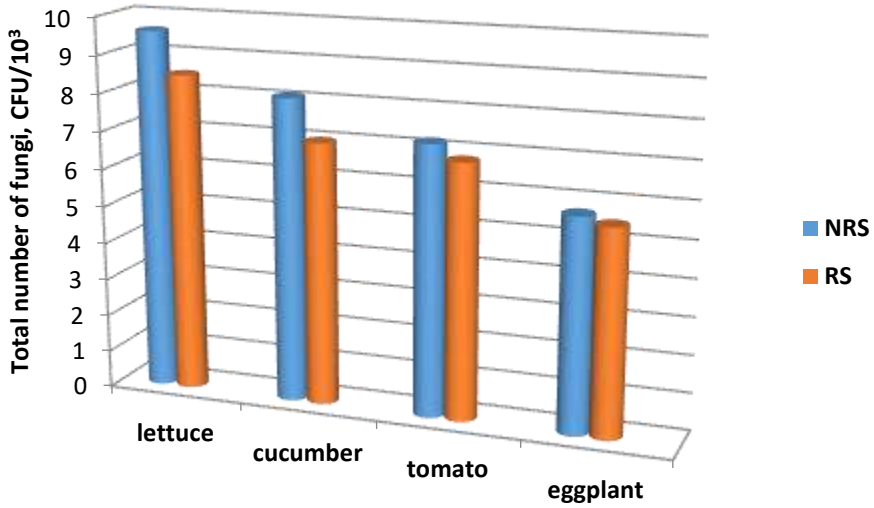

Figure 1, The total number of fungi in the soil of the root and non-root zones

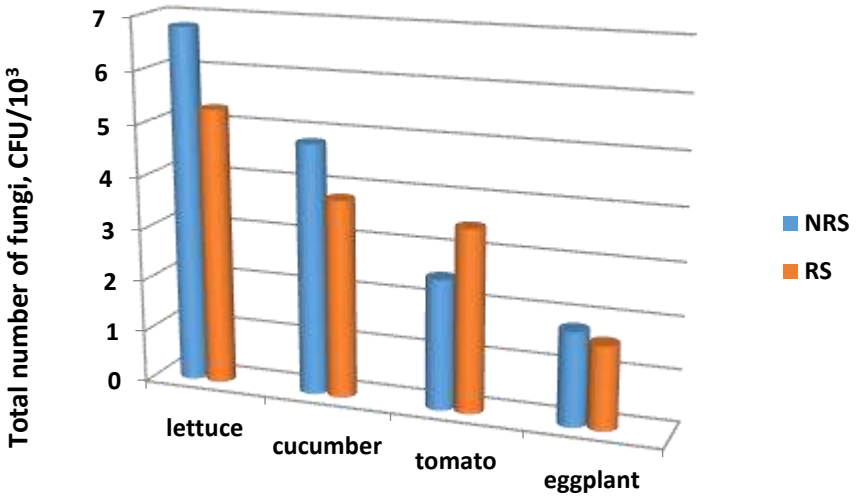

Figure 2. The number of nematophagous hyphomycetes in the soil of the root and non-root zones

Similarly to the total number of fungi, the number of nematophagous hyphomycetes under lettuce plants exceeded these indicators by 1.4–3.3 times in NRS and by 1.4–3.7 times in RS compared to the soils under other plants. The

detected nematophagous fungi in RS and NRS comprised 33–68% and 28–55%, respectively, of the total number of fungal isolates. The greater growth of fungi in RS is likely associated with the presence of exudates, plant secretions containing organic matter that serve as substrates. Exudates released by each plant species may be highly specific, thereby exerting different effects on fungal growth (Canbolat, M.Y. et al., 2006., Jones, D.L., Hodg, A, Kuzyakov, Y., 2004).

Conclusion

The predominance of the number of nematophagous fungi in RS, as revealed in the study, may have significant implications in combating parasitic phytonematodes.

However, it should be noted that fungi have different relationships with nematodes—either saprophytic or parasitic. The increased number of nematophagous hyphomycetes and the low number of nematodes in the soil under lettuce are apparently associated with a predominance of saprophytic rather than predatory forms.

Thus, the conducted research has shown that the increase in the proportion of nematophagous hyphomycetes (24–31% of the total number of fungi) is significantly influenced by the plant species.

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