Review

Predacious Strategies of Nematophagous Fungi as Bio-Control Agents

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Abstract: Plant-parasitic nematodes significantly threaten agriculture and forestry, causing various diseases. They cause annual losses of up to 178 billion dollars worldwide due to their parasitism. Nematophagous fungi (NF) are valuable in controlling or reducing parasitic nematode diseases by killing nematodes through predatory behavior. This article summarizes the strategic approaches adopted by NF to capture, poison, or consume nematodes for food. NF are classified based on their attacking strategies, including nematode trapping, endoparasitism, toxin production, and egg and female parasitism. Moreover, extracellular enzymes such as serine proteases and chitinases also play an important role in the fungal infection of nematodes by disrupting nematode cuticles, which act as essential virulence factors to target the chemical constituents comprising the nematode cuticle and eggshell. Based on the mentioned approaches, it is crucial to consider the mechanisms employed by NF to control nematodes focused on the use of NF as biocontrol agents.

Keywords: nematophagous fungi; biological control agents; nematodes; enzymes

1. Introduction

Nematodes are highly ubiquitous animal groups found throughout the planet. Despite being over 28,000 known species, they are challenging to differentiate. Out of all these species, 16,000 are recognized as parasitic towards animals, insects, or plants [1]. Over 4000 species of plant-parasitic nematodes (PPNs) have been identified [2] which severely threaten agricultural and horticultural crops [3]. These harmful pathogens are hideous crop parasites that cause global annual losses between USD 78 and 125 billion [4,5]. PPNs can actively move in the soil region adjacent to the plant roots, known as the rhizosphere, as well as on the aerial parts of the plant, or within the plant itself. They feed and breed on living organisms, with some nematodes feeding on plant parts such as flowers, leaves, stems, and seeds [6]. However, most of these worms feed on underground plant parts like roots, bulbs, and tubers, causing substantial plant damage ranging from mild harm to destruction [5].

Synthetic nematicides are highly effective at controlling PPNs. However, their widespread impact, toxic environmental effects, and significant government restrictions necessitate exploring alternative measures for PPN control [7]. Pathogenic factors against insects, nematodes, and vertebrates have been documented in bacterial or fungal pathogens [8–10]. Biological control agents (BCAs) are promising candidates for managing PPNs due to their environmentally friendly and economically sustainable nature. Many fungi can cause diseases in various nematode groups. About 200 taxonomically diverse species can attack active nematodes [11]. Nematophagous fungi (NF) are natural nematode antagonists and offer promising biocontrol strategies [12]. NF are classified based on the mechanisms by which they invade nematodes: (1) nematode-trapping fungi use...
morphological hyphae traps, (2) endoparasitic fungi employ spores, (3) egg-parasitic fungi attack nematode eggs or females, and (4) toxin-generating fungi restrain nematodes before invasion [13,14]. NF have long been utilized as biological control agents against PPNs [12,15,16] and animal parasitic nematodes [17].

Extracellular enzymes play a crucial role in the fungal infection of nematodes by disrupting nematode cuticles' physical and physiological integrity, thereby promoting fungal penetration and colonization [9,10]. It has been shown that extracellular enzymes, such as serine proteases, chitinases, and collagenases act as essential virulence factors that can target the chemical constituents comprising the nematode cuticle and eggshell [18]. Serine proteases are enzymes that hydrolyze peptide bonds catalytically by utilizing a serine residue in the substrate-binding pocket that is specially activated [19,20]. Chitin serves as the structural component of PPNs and their eggshells. Enzymes known as chitinases are found in fungi that parasitize eggs and are utilized to penetrate the eggshells of nematodes. In fact, the first chitinase, Chi43 enzyme, was isolated from two nematode-consuming fungi, *Planktothrix rubescens* and *Pochonia chlamydospora* [21].

Based on previous studies, we have assessed NF as a valuable biocontrol agent and have shown that it has tremendous potential for controlling pathogenic nematodes as an alternative, sustainable, and practical approach.

2. Taxonomic Classification of Nematophagous Fungi

Nematophagous fungi can be used as highly effective biological control agents. They are classified into various fungal taxa groups, including Ascomycota, Oomycota, Pleurotaceae (Basidomyctota), Chytridiomycetes, and Zygomycota [22–24]. The taxonomic information for nematophagous fungi is summarized in Figure 1, which includes their division, genus, interaction, and infection structures.

![Figure 1. Representative types of nematophagous fungi from different taxonomical groups and their infection structures [25].](image-url)
3. Isolation and Characterization of NF

3.1. NF Isolation Using Selective Media

NF have been found in various habitats, such as deciduous leaf litter, coniferous leaf litter, partly revegetated dung, permanent pasture, temporary agricultural grassland, cultivated land, moss cushions, decaying vegetation, and compost peatland coastal vegetation. Coniferous leaf litter has the highest number of these fungi, while peat and dung have the greatest species diversity [26].

The first step in isolating nematophagous fungi is to collect soil or other environmental samples from regions known to harbor nematodes, which are typically obtained from agricultural fields, forests, or gardens. While various techniques can be used for isolating NF, the soil sprinkling and Baermann funnel techniques were the most efficient methods, which can isolate all the predator and endoparasite species with 95% probability [27]. The Baermann funnel technique is more effective than the soil sprinkling method in isolating endoparasitic NF, but it does not capture all endoparasites [28]. Isolated samples are processed using selective media that encourage the growth of NF. Commonly used media include cornmeal agar, potato dextrose agar, and yeast extract agar [29]. The incubation of NF under controlled conditions (23 °C to 26 °C) for several weeks enables them to develop and reproduce [30].

3.2. Morphological and Molecular Characterization

Morphological characterization is a fundamental step in the identification and classification of NF, allowing researchers to distinguish them from non-nematophagous species and understand their functional structures. Fungal colonies are identified based on their physical characteristics, specifically the shape and structure of their spores. These features are critical for distinguishing between different types of NF. In some cases, microscopic examination may be necessary to identify them accurately. The spores possess a diverse range of shapes, sizes, and structures, which may be round, oval, or elongated, and often bear specialized structures or bumps that successfully adhere to nematodes [31].

Similarly, molecular identification is also essential for the accurate identification of NF. In previous studies, a PCR assay using species-specific primers was developed for the rapid and accurate identification of NF Duddingtonia flagrans, which was capable of detecting the fungus in various environmental samples [32]. Similarly, NF Arthrobotrys sinense was studied as a potential biocontrol agent of domestic animal nematode Haemonchus contortus, and five isolates of Arthrobotrys sinense were identified and characterized using molecular techniques [33]. Moreover, a group of nematophagous fungi isolated from soil and animal feces in Mexico were studied to determine their predatory ability against Panagrellus redivivus. The molecular identification of nine isolates was accomplished by amplifying the 18S, 5.8S, and 28S regions with ITS5 and ITS4 oligonucleotides, followed by BLAST sequencing and alignment [34].

4. Nematophagous Fungi (NF)

NF are capable of capturing, killing, and digesting nematodes [35]. They reside externally or internally within the host organism, exploiting it for sustenance. These fungi use specific traps to ensnare prey, hyphae tips to parasitize females and eggs, and conidia to adhere while generating toxins to attack nematodes. Based on these strategies, NF are traditionally classified into four groups (Figure 2): (1) The group of fungi that prey on nematodes using specialized traps; (2) some fungi are egg-parasitic and invade nematode eggs or females through their hyphal tips, (3) while others are endoparasitic and use their spores. (4) Additionally, toxin-producing fungi immobilize nematodes before invading them [14,36].
Figure 2. Mode of action of nematophagous fungi.

4.1. Predatory Fungi

Predatory fungi employ hyphal structures in nematodes. Studies on nematode-trapping fungi have drawn much attention to their diverse and intricate catching structures [37]. The traps generated by the fungi’s mycelium adversely affect the nematode’s cuticle. The mycelium proliferates within the nematode’s body, resulting in the formation of a penetration peg, whose growth over time causes the hyphae to cover the outer surface of the colonized nematode [38]. The fungus *A. oligospora* has a unique mechanism for penetrating the cuticle of nematodes via penetrating tubes, and its impact on *Meloidogyne javanica* in tomato cultivars has been empirically demonstrated [39]. Predatory structures are vital for the life and activity of trapping fungi. Compared to regular hyphae, adhesive traps have a longer lifespan [40,41]. These specialized traps are utilized by over two hundred fungal species (found within the Zygomycota, Basidiomycota, and Ascomycota phyla) to capture free-living nematodes in soil [42]. NF play a vital role in maintaining the population of nematodes through natural methods, such as parasitism, trapping, and poisoning [43,44]. *Basidiomycota* trapping fungi use spores and adhesive knobs to capture nematodes [45–47]. The Orbiliaceae family comprises over 80% of nematode-trapping fungi within the Ascomycota Phylum, where constricting rings, adhesive networks, adhesive branches, adhesive knobs, and non-constricting rings are all used to ensnare nematodes (Figure 2) [48,49]. The study of nematode-trapping fungi in Zygomyctota has faced obstacles due to inadequate isolation and culture techniques, despite the growing interest in it [50].
4.1. Adhesive Branches

Adhesive branches, also known as adhesive columns, have a simpler morphological structure than other capture organs (Figure 2). These vertical branches consist of one to three cells that merge via anastomosis, forming adhesive hoops or networks with two-dimensional structures resembling crochet or lines. The nematode is easily captured upon contact with the branch due to its complete coverage by a delicate adhesive layer. Due to the proximity of adhesive branches, nematodes frequently become stuck to more sticky hyphae upon contact and struggle to detach themselves. The species commonly found in temperate soils with developed adhesive branches is *Dactylella cionopaga* [51]. These branches serve as typical trapping mechanisms for *Monacrosporium cionopagum* and *M. geophyrophagum* [52]. For example, *M. cionopagum* produces adhesive branches that trap and immobilize the sugar beet cyst nematode *Heterodera schachtii* [53]. Likewise, *Gamalyella gephyropaga* produces adhesive branches to trap nematodes [54,55].

4.1.2. Adhesive Hyphal Network

The adhesive network, widely distributed in fungi, is comprised of an upright lateral branch emerging from a vegetative hypha (Figure 2), extending approximately 20–25 μm from the parent hypha [56], and is characterized by a longer lifespan in comparison to typical hyphae [40]. These adhesive nets are constructed using intricate three-dimensional networks. *A. oligospora*, with a global distribution, is the most frequently observed species in this specific trapping structure [57]. Adhesive nets form from vegetative hyphae by curving a solitary lateral branch and can combine with parental hyphae. Adhesive nets are regarded as an evolutionary progression from adhesive branches. More lateral hyphae are generated from the parental hyphae, or a loop is formed to generate additional loops once a complex of interconnected loops that extend away from the potential hyphae in all logical directions is established. Nematodes are attracted to the network's surface, which is coated with a thin layer of adhesives [58].

4.1.3. Adhesive Knobs

Adhesive knobs are specialized cells with a small layer of adhesive covering them (Figure 2). When a nematode becomes ensnared, the contact area between it and the spherical knob is limited, allowing it to resist and free itself. However, upon coming into contact with a flattened, sticky pad, the fungus takes control and traps the nematode. This significantly increases the adhering surface, resulting in a secure binding of the captured nematode, followed by fungal penetration that involves both enzymatic and physical mechanisms. For example, the fungus synthesis of collagenase aids in penetrating the nematode's cuticle, while the dense sticky pad provides strength and rigidity, allowing the piercing hyphae to move toward the cuticle [51]. Once a spherical infection bulb has formed, assimilative hyphae emerge to consume the internal contents of the nematode [31,59]. *Dactylellina arcuata, D. athenopaga, D. leptosphora, D. copepodii*, and *D. ellipsospora* use adhesive knobs to capture nematodes [60–62].

4.1.4. Constricting Rings

Constricting rings are hyphal branches with a circular arrangement typically composed of three cells (Figure 3). These structures are highly sophisticated and actively capture prey. A nematode entering the cavity triggers the rapid expansion of the three surrounding cells, resulting in a threefold increase in their volume. This process effectively seals the orifice and confines the nematode inside the cavity. Subsequently, the hyphae penetrate and assimilate the nematode [63]. Twelve species of hyphomycetes have been discovered to form constricting rings of varying internal diameters ranging from 20 to 40 μm [51]. Constricting rings are distinct from other mechanisms because they encircle nematodes upon contact with the inner edge of the trap, resulting in closure. The nematode is strangled by the expansion of an internally located cell wall of a con-
stricting ring, causing inward swelling through the outer cell wall of these rings. Rapid water intake causes an increase in the volume of the cells forming the ring [64]. The traps of D. brochopaga mutants are considerably larger, almost eight times more than conventional traps. It has been observed that the cells in these traps release fluid droplets, reducing their volume. The humidity of the surrounding environment can be adjusted to facilitate the entry or exit of atmospheric water into or out of these cells. Additionally, a correlation has been established between the ambient humidity level and the frequency of ring closures [65]. The source of the water supply has been investigated, and evidence suggests that it mainly originates primarily from stalk cells or mycelium [66]. Furthermore, once the stalk cell closed, there was no noticeable movement of internal components, suggesting that water from the surrounding environment may have been retained [67]. This is supported by the observation that rings can continue to spread even after being detached from the original stalk on which they first appeared [65,68]. This idea is plausible as live nematodes are typically surrounded by a thin layer of water, which could serve as a sufficient source of moisture for the process of ring closure. Additionally, the ring closure process in D. brochopaga can be chemically induced, in addition to physical methods like touch, elevated temperature, or electrical stimulation [69]. When exposed to solutions containing methanol, ethanol, propanol, or butanol, or to chlorobutanol vapor, this fungus's traps expanded in 10 to 15 s. In contrast, it is important to note that benzene, ether, and chloroform did not have any detectable effect, suggesting that unidentified variables drive this significant phenomenon [70].

4.1.5. Non-Constricting Rings

Non-constricting rings are a type of three-celled rings that grow on a short supportive stalk originating from prostrate septate hyphae (Figure 3D). The nematodes display passive behavioral responses during the predation process. As noted, the attachment point between the supporting stalk and the ring was weakened. As the nematode attempted to free itself, the ring often detached, indicating that the fungus may have facilitated its escape by allowing it to carry the non-constricting ring tightly wrapped around its body. This seems to be a favored method for achieving widespread dissemination in the soil [71]. For example, fungi, such as Dactylaria candida and D. lysipaga, which produce non-constricting rings, often create adhesive knobs [60,72] and capture nematodes using non-constricting rings [61]. A similar pattern was observed in Dactylellina daliensis via non-constricting rings [73].

Figure 3. Different morphological structures used by predatory fungi for capturing nematodes. (A) Adhesive branches (adhesive column [74]), (B) adhesive hyphae network [75], (C) adhesive knob [76], (D) constricting ring, and (E) non-constricting ring [77].
4.2. Egg- and Female-Parasitic Fungi

Research on egg- and female-parasitic fungi has been in progress since the 1990s. These fungi employ appressoria (*Purpureocillium* spp. and *Pochonia* spp.), zoospores (*Nematophthora gynaphila*), lateral mycelial branches, and penetration pegs to parasitize eggs, females, and other growth stages of the PPNs [78]. An in vitro assessment was conducted to evaluate the parasitism of 10 isolates of *P. chlamydosporia* on *Globodera pallida* eggs; the levels of observed pathogenicity ranged from 34% to 49%. The event of impulsive hatching occurs when *P. chlamydosporia* isolates aggressively parasitize immature eggs as opposed to those containing second-stage juveniles [79]. Additionally, the use of wild-type *Beauveria bassiana* 08F04 and transformant G10 resulted in a substantial decrease in the cereal cyst nematode (female) population in the roots [80]. In a greenhouse study, it was found that the presence of the arbuscular mycorrhizal fungus (AMF) *Glomus etunicatum* reduced the population of *H. glycines* female nematodes by 28.21% in root systems compared to untreated roots. This finding suggests that *G. etunicatum* may play a role in promoting the ability of host plants to tolerate the presence of the soybean cyst nematode (SCN) [81]. Figure 4 displays fungal species that parasitize the egg and female.

**Figure 4.** The nematode egg- and female-parasitic fungi and their infection modes.

4.3. Endoparasitic Fungi

Endoparasitic fungi are a category of nematophagous fungi which infect nematodes by producing spores. These spores can either be internalized by the nematodes through ingestion, leading to infection, or attach to the nematode epidermis, initiating the infection [14,82,83]. Endoparasites utilize spores, such as conidia and zoospores, for infection, which may attach to the nematode cuticle or be ingested [84]. It has been found that endoparasitic fungi can reduce the number of root-knot nematodes that create galls on tomatoes and alfalfa in greenhouse experiments [14]. These fungi exhibit varying degrees of diversity, with studies indicating differences in their production of conidia per infected nematode. *D. coniospora* fungi produce a significant amount of conidia, with up to 10,000 per hyphal material, while *H. rhossoliensis* yields 100–1000 conidia per infected nematode. Conidia germinate immediately, and assimilative hyphae infiltrate and absorb the entire contents of the nematode body, enabling the fungus to penetrate the host's outer layer [85]. *D. coniospora* is an aggressive endoparasitic fungus that targets nematodes. The endoparasitic fungus *Drechmeria coniospora* YMF1.01759 strain exhibited excellent nema-
tode-infecting ability. The study revealed that it hindered nematodes from hatching their eggs, infected them with spores, and produced active metabolites that killed them [86].

4.4. Toxin Production

Some nematophagous fungi produce toxins that kill nematodes and impact plant defense and resistance mechanisms against parasitic nematodes [87–89]. Toxin-producing fungi originate from various orders and families. The fungus assaults nematodes via the secretion of inhibitory metabolites without physically interacting and immobilized them [78,90]. After immobilization, the hyphae penetrate the nematode cuticle. Culture filtrates of these fungi contain strong enzymatic (proteolytic and chitinolytic) activities, low-molecular-weight metabolites, and specific non-volatile oil components that cause larval death or inhibit egg hatching [91]. The metabolites secreted by the fungi alter the composition of nematode eggs and prevent embryonic development, rendering them unable to hatch due to their varying shapes and sizes. Similarly, fungi produce toxic chemicals, other than enzymes, that immobilize nematodes and later consume them [92]. Basidiomycetes are the predominant fungi that produce toxins. Recent research on Basidiomycetous fungi (Coprinus comatus and Stropharia rugosoannulata) has revealed that the action mechanisms of these toxins against nematodes are varied and multifaceted [93]. Among Basidiomycetes, numerous Pleurotus species produce toxins with nematotoxic activity [92,94]. For example, P. ostreatus produces trans-2-decenolic acid, a compound obtained from linoleic acid that is detrimental to nematodes, insects, and other fungi [95]. Basidiomycetes are not the only fungi that generate these kinds of toxins; some fungi also produce toxins that are harmful to nematodes, but these are not nematophagous [38]. These compounds exhibit diverse chemical properties, including simple fatty acids or other organic acids such as lactones, pyrones, anthraquinones, benzoquinones, alkaloids, furans, peptaibiotics, and cyclodepsipeptides.

5. Enzymes of NF

Some NF use enzymes to facilitate the infection and digestion of nematodes [38,84]. Nematodes possess physical barriers, consisting of abundant proteins in their composition, that protect them from natural predators [96]. NF penetrate the nematode cuticle and eggshell via enzymatic (protease and chitinase) and mechanical means [78] (Figure 5). The enzymes responsible for breaking down nematode cuticles include alkaline and neutral serine proteases, which facilitate the hydrolysis of the peptide bonds in the cuticle protein [97]. Serine proteases hydrolyze peptide bonds by utilizing a serine residue specifically triggered in the substrate-binding pocket [19,20]. The alkaline serine protease triggers the destruction of cuticles within hours and restrains the nematode P. redivivus [98]. Neutral serine protease produced by Arthrobotrys oligospora causes pathogenicity against nematodes [99]. Arthrobotrys oligospora can control Haemonchus contortus and Caenorhabditis elegans under laboratory conditions [100,101]. The fungus Monacrosporium thaumasium produces a high-level serine protease that has a destructive effect on M. javanica eggs, as demonstrated by [102]. These studies highlight the importance of serine protease as a crucial enzyme in the progression of fungus-initiated infection. The shells of nematode eggs contain high levels of chitin and proteins, which are hydrolyzed by endochitinases and exochitinases, catalyzing the glycosidic bonds between chitin N-acetylglucosamine groups [21]. The nematode-trapping fungus M. thaumasium produces chitinases and exhibits nematocidal activity against the nematode Panagrellus redivivus [103]. Furthermore, chitinases have demonstrated nematocidal activity when used without the presence of fungi [104]. These enzymes are also crucial in the development of infection and shell digestion of nematodes [105].
6. Biocontrol Using NF

Biocontrol is considered to be an eco-friendly and sustainable alternative to pesticides [106]. It involves using microbial species, particularly fungus, which has shown significant antagonistic effects against PPNs [107]. Several types of fungi can be harmful to nematodes, but simply being aggressive is not enough to qualify as a dependable biocontrol agent [108]. Two main methods for implementing the use of nematode-killing fungi for nematode biocontrol are adding fungi to the soil or supporting the activity of already-existing fungi via various alterations. Early research on controlling PPNs used fungi, such as *Arthrobotrys* and *Monacrosporium* species that trap nematodes. Later, endo-parasitic fungi such as *H. rhossoliensis* and *D. coniospora*, and egg-parasitic fungi *P. chlamydosporia*, were also utilized as biocontrol agents. The efficacy of these agents varies, as reported in [109–111]. Due to an advancement in the formulation and soil application of fungal biocontrol agents, as well as a growing comprehension of the biology of these

**Figure 5.** General representation of nematophagous fungi’s enzymes against cuticle, females, and eggs.
fungi, there is a heightened interest in utilizing nematode-trapping fungi. Additional research is needed to further improve the effectiveness of these biocontrol agents (Table 1).

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<tr>
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7. Limitations and Future Directions

One significant limitation of NF as bio-control agents is their often limited host range. Many species are highly specialized to target specific nematode species. This restricts their applicability in situations where multiple nematode species are present. To address this limitation, future research could focus on isolating and characterizing strains with broader host ranges or exploring ways to enhance their adaptability to different nematode species. Techniques such as genetic manipulation and selective breeding may be explored to achieve this diversified goal. The efficacy of NF can be influenced by various environmental conditions as these fungi are susceptible to temperature, humidity, and soil type. Extreme conditions such as extremely dry or hot environments can limit their ability to establish and reproduce effectively. Researchers should investigate strategies to improve the resilience of NF to adverse environmental conditions, possibly through the development of more robust strains or innovative application techniques. NF generally act more slowly than chemical nematicides, which can be a disadvantage when rapid nematode control is required, especially in high-value agricultural settings. In the future, research could focus on enhancing the speed of action of these fungi, possibly by developing more virulent strains or optimizing application methods. The effectiveness of NF can vary from one application to another, where factors such as soil microbial communities and nematode densities can influence their success. These factors should be investigated in more detail to develop strategies that can improve the consistency of nematode control using fungi, which may involve the development of tools for monitoring and predicting fungal performance under different conditions. The registration and approval of NF for commercial use can be challenging and time-consuming due to regulatory requirements and the need for safety assessments. Hence, collaboration be-
tween researchers, regulatory agencies, and industry stakeholders is essential to stream-line this process and facilitate the adoption of NF as biocontrol agents.

Additionally, developing new and improved formulations should be explored for NF, such as encapsulation or granules, which can ultimately enhance their stability and shelf life, making them more practical for field applications. Research into novel delivery methods, such as sprays or seed coatings, can also help ensure efficient distribution.

Deep investigation should be encouraged to show insights into the impacts of NF on non-target organisms and the environment to ensure their safety and environmental compatibility. Understanding their ecological interactions in greater detail can guide the development of safer and more sustainable bio-control strategies. Exploring biotechnological tools is necessary to enhance the virulence and adaptability of NF to different environmental conditions and nematode species, which can involve identifying and manipulating the genes responsible for crucial predation mechanisms. In addition, integrating NF with other nematode management strategies, such as crop rotation, resistant crop varieties, and chemical nematicides, should be conducted to create more comprehensive and effective nematode control programs where integrated pest management approaches can be developed and tested for specific agricultural systems. Interdisciplinary work and collaboration with regulatory bodies should be prioritized to streamline the approval process for NF-based products, making them more accessible to farmers with industry partners to ultimately scale up production and distribution channels for these bio-control agents. At last, extensive field trials should be conducted to demonstrate the effectiveness of NF in real-world conditions and encourage their adoption by farmers, which requires a proper monitoring system of the long-term effects on soil health and crop productivity to provide practical recommendations for sustainable nematode management.

8. Conclusions

Nematophagous fungi are known for their predatory nature against nematodes. They adopt different approaches for capturing nematodes and gradually consume them. They are divided into groups such as nematode-trapping, eggs- and female-parasitic, endoparasitic, and toxin-producing fungi. Moreover, they also secrete enzymes like serine proteases and chitinases, which immobilize, eventually consume nematodes, and parasitize female eggs. The mentioned knowledge regarding taxonomy, predacious structures, and enzyme involvement of NF is fundamental to be considered while applying them as biocontrol agents against parasitic nematodes in practice.

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