The 8th National Fungus Day of Egypt Online
اليوم الوطنى الثامن لفطريات مصر

Agricultural Research Center
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المعمل المركزى للزراعة العضوية
Central Lab. of Organic Agriculture

Nematicidal Activity of Soil Fungi Against Plant Parasitic Nematodes

Presented By

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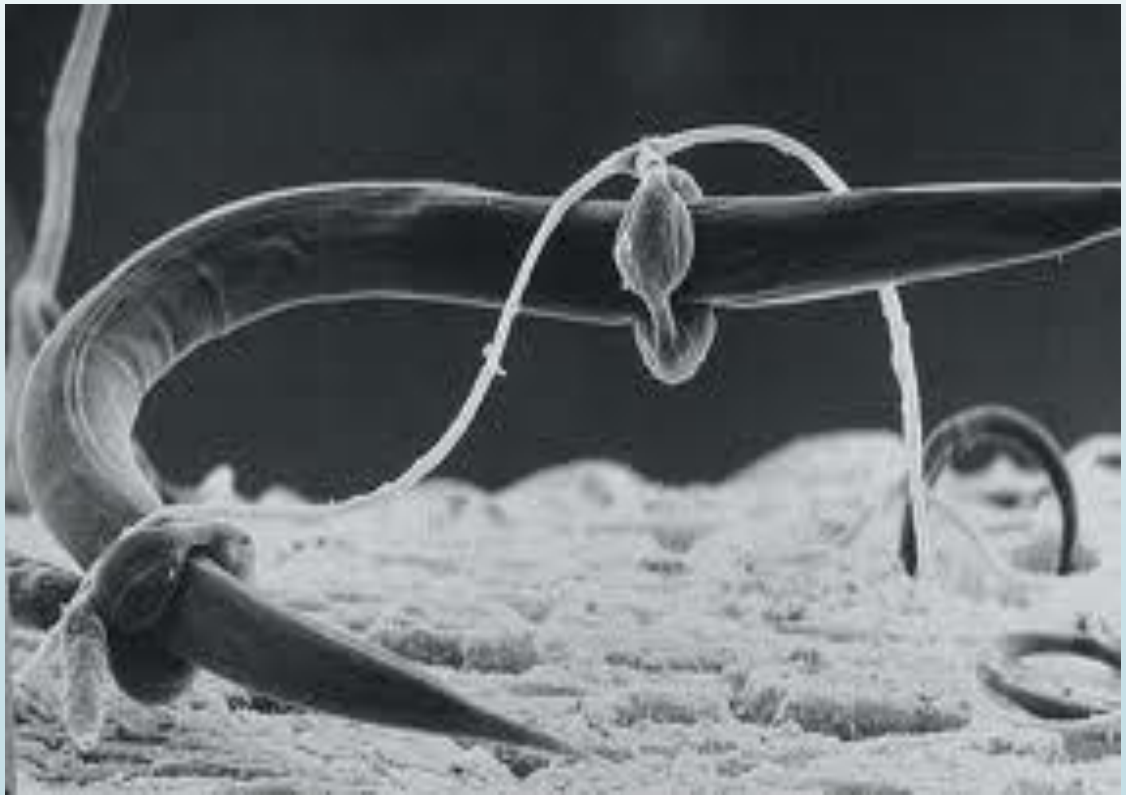
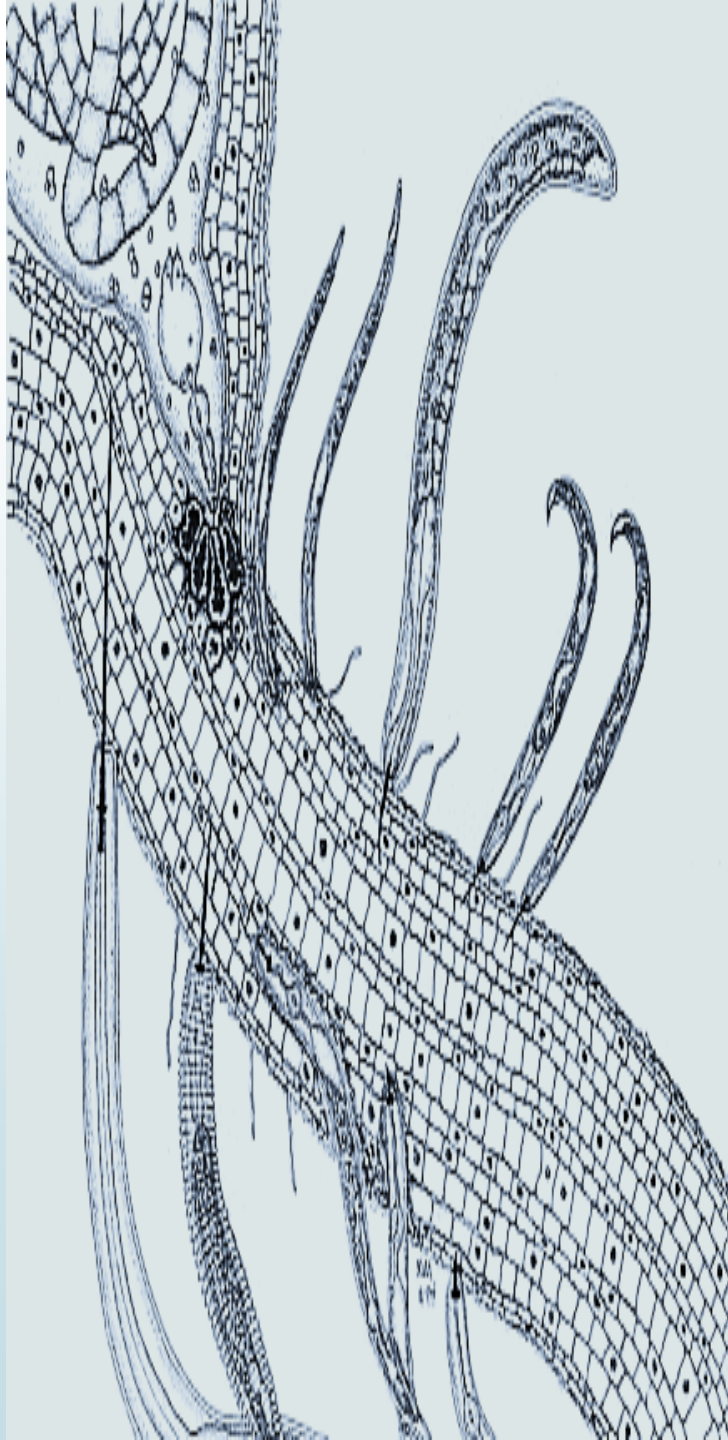
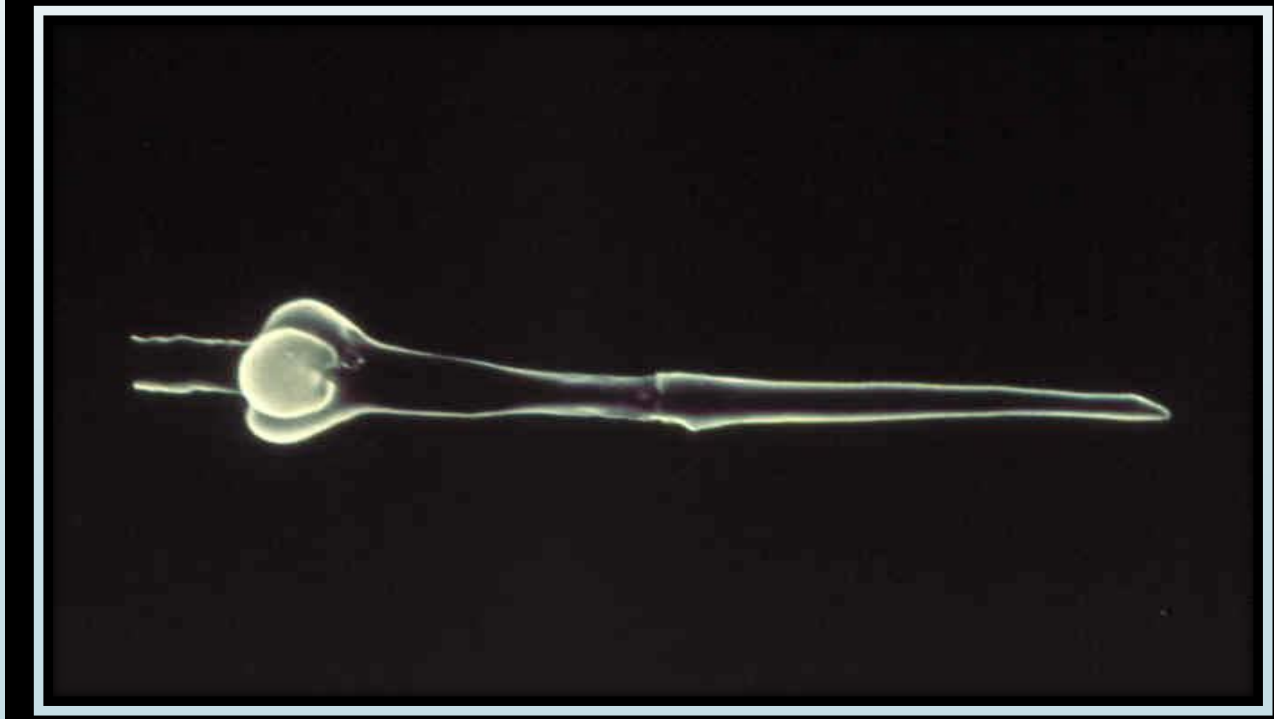


Plant Parasitic Nematodes

- Microscopic worms causing economically high yield losses in plants cultivated worldwide.
- Over 6000 known species of plant parasite nematodes
- Present in all ecological niches
- Attacks almost all plants
- Cause huge losses to most of economic crops



The most important morphological feature of plant parasitic nematodes is the presence of stylets (spears) that enable them to penetrate root cells and withdraw the contents.



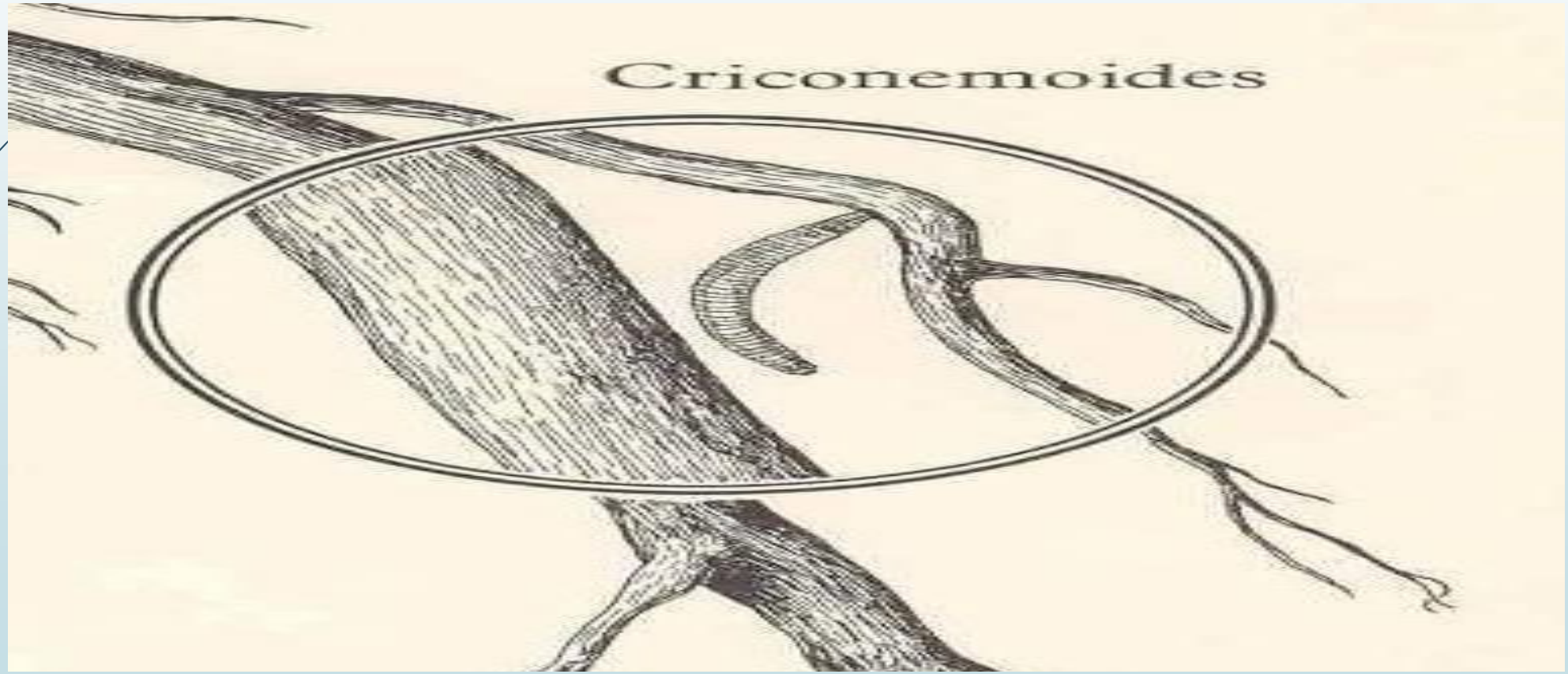
According to the Feeding Habitat, Phyto-Nematodes Classified in to:

Endoparasitic Nematodes

- Entire their bodies are inside the root as they feed inside the plant tissues
- e.g.: Root-knot & Lesion Nematodes
- Root-knot nematodes are sedentary endoparasitic while the lesion nematodes are migratory endoparasitic.

Ectoparasitic Nematodes

- Feed on plant tissues from outside the plant
- e.g.: Ring nematodes

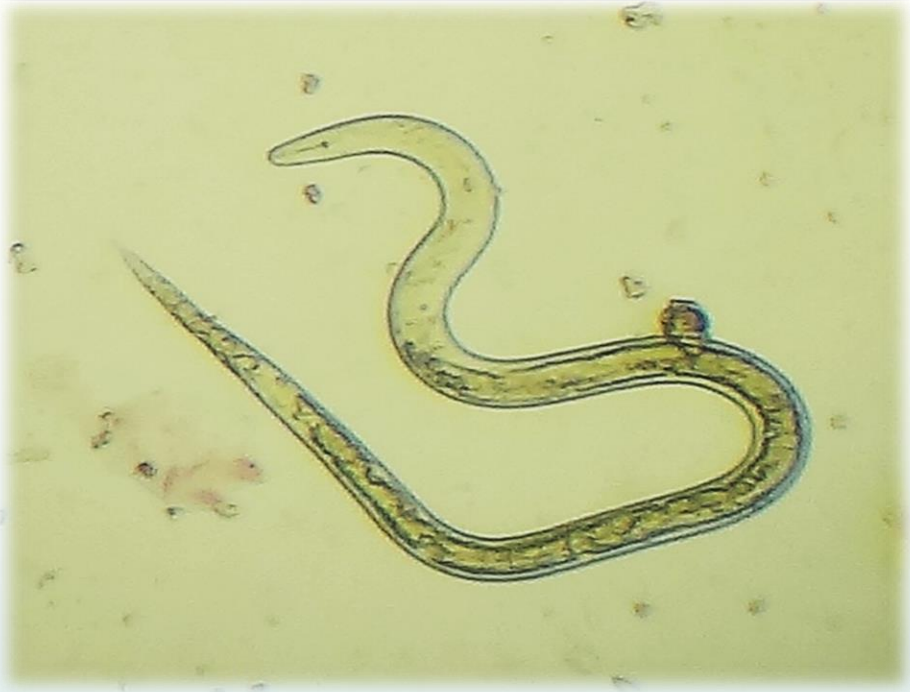


Semi-endoparasitic Nematodes

- Penetrate roots to feed, while its posterior part remaining in the soil.
- e.g.: Cyst nematodes

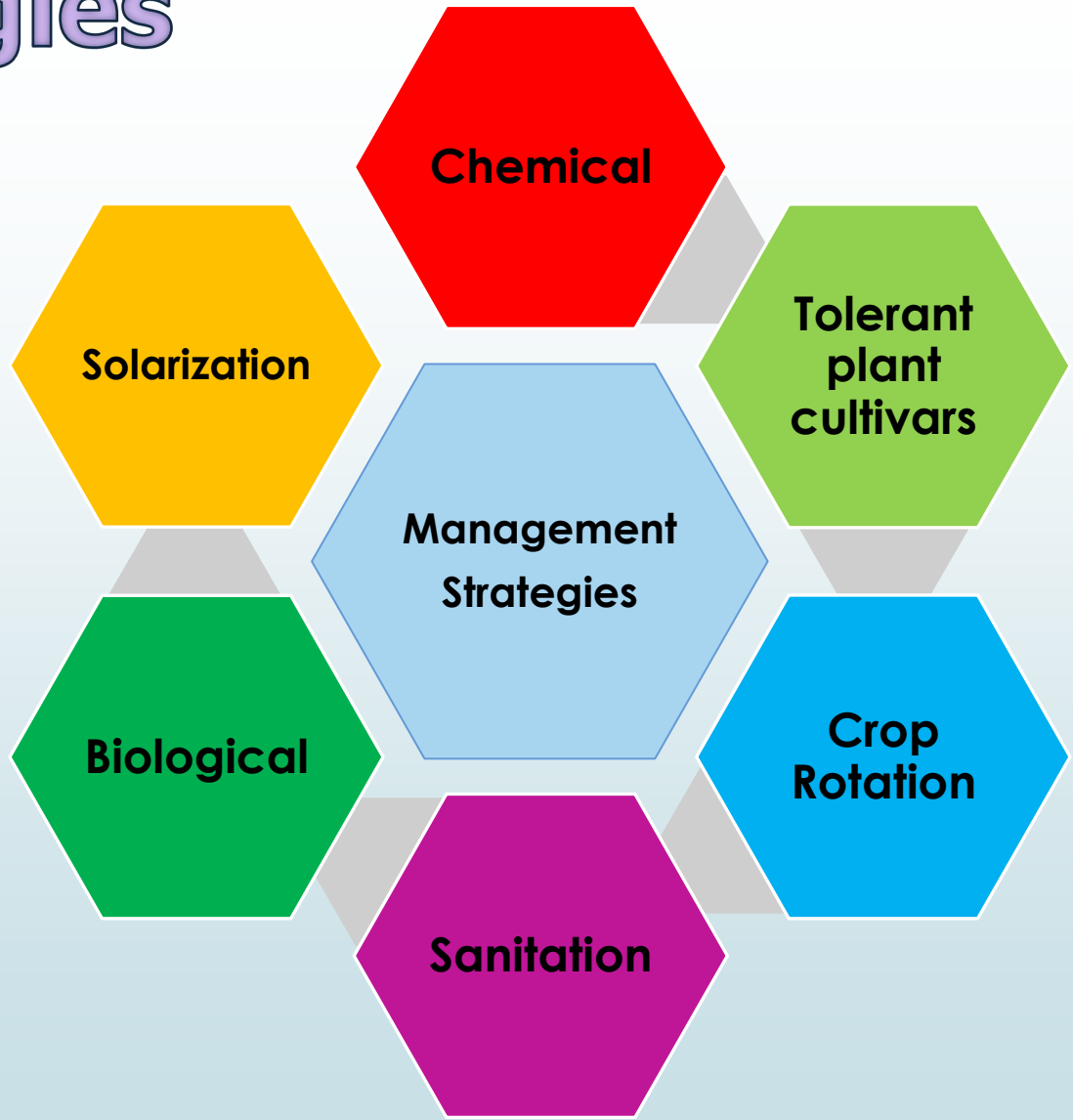
Root-Knot Nematodes *Meloidogyne* Spp.

- Root-knot nematodes are plant-parasitic nematodes from the genus *Meloidogyne*. They exist in soil in areas with hot climates or short winters and cause severe crop damage especially in light soil.
- Root-knot nematodes are non host specific causing sever damage to thousands of plant species
- The main symptom of nematode infection is formation of galls that drain the plant's nutrients and reduce water uptake to shoots



Management Strategies

The effective management of plant parasitic nematodes is usually depends on the combination of two or more controlling methods



Biological Control

Environment and health concerns related to the use of chemical nematicides have increased the need to development of safe alternatives

Biological control is the application of microorganisms or their natural products to eliminate or reduce the damage caused by plant parasitic nematodes

Biological Control Agents may be:

- Fungi
- Actinobacteria
- Bacteria

Nematophagous Fungi

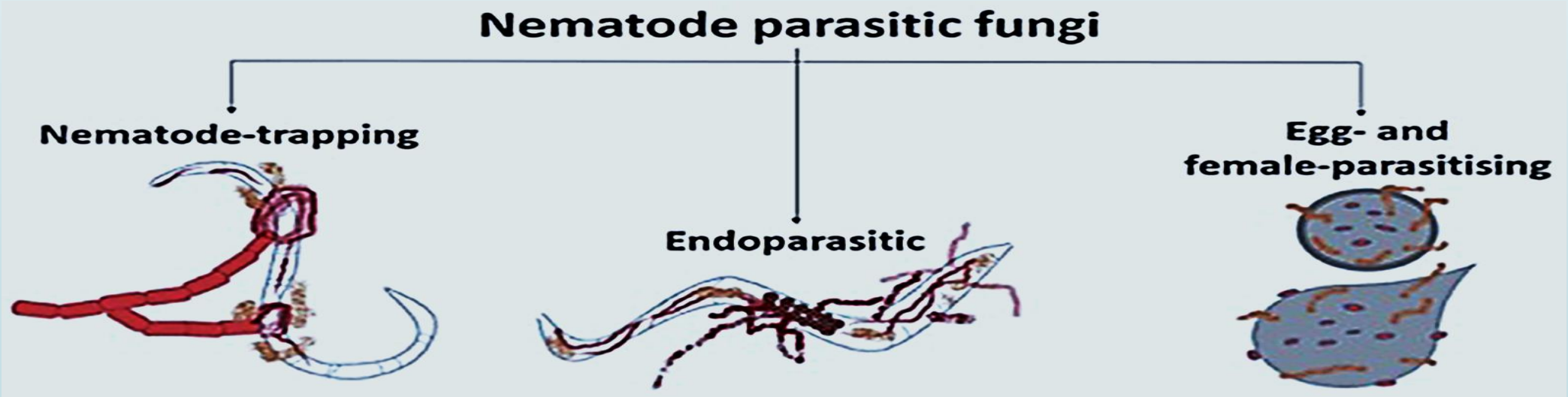
- Nematophagous fungi are those that can capture, kill and digest nematodes.
- Based on the mechanisms by which they attack nematodes, nematophagous fungi are classified into four general groups:

(i) Nematode-trapping fungi that use specialized trapping structures differentiated from hyphae;

(ii) Endoparasitic fungi that use their spores to invade larvae;

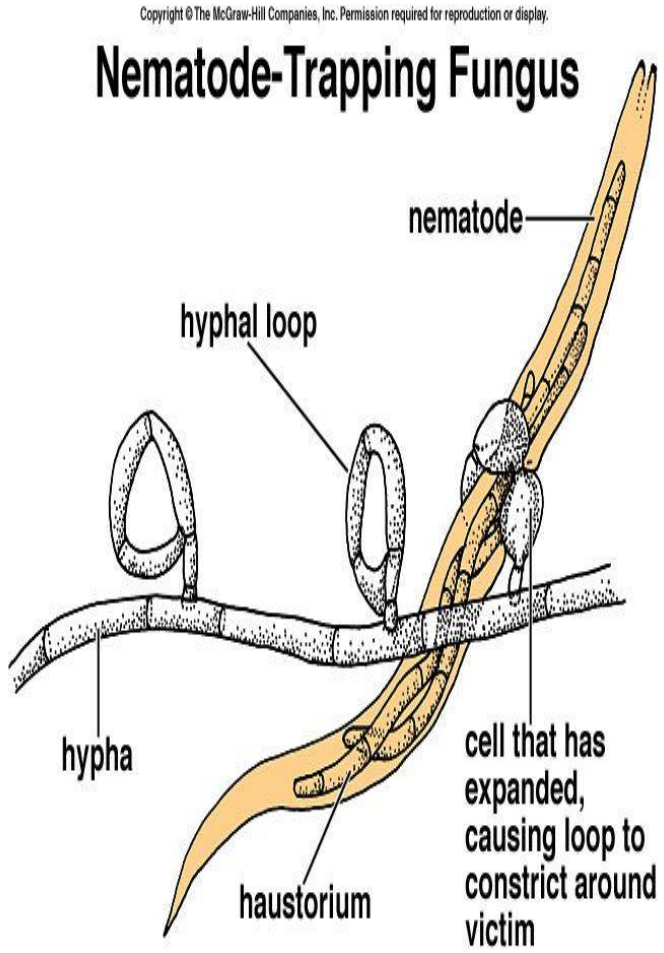
(iii) The opportunistic fungi that invade or colonize nematode eggs, or cysts with their hyphal tips; and

(iv) Toxin-producing fungi that immobilize nematodes before invasion



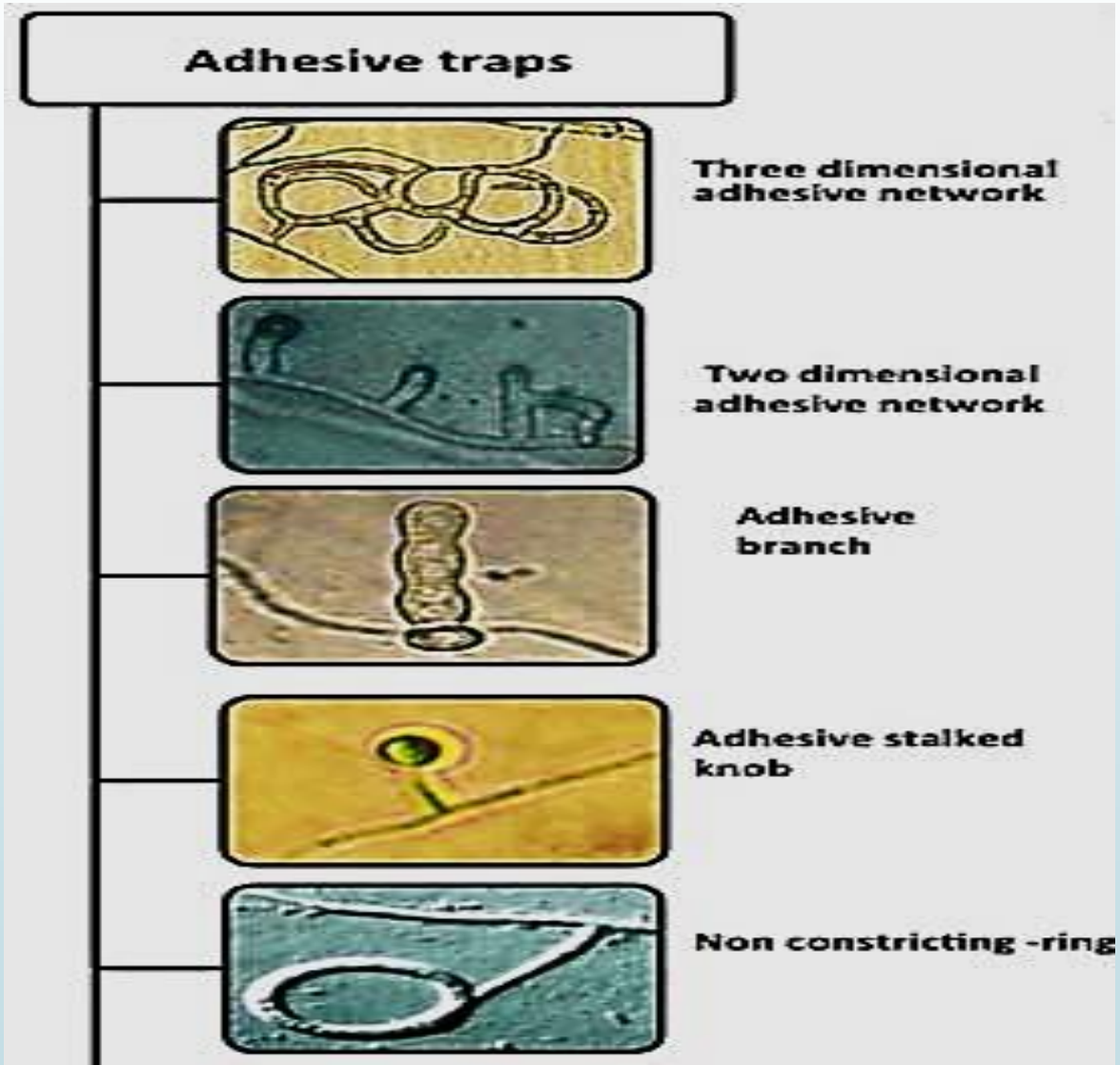
Nematode-Trapping Fungi

- Nematode-trapping fungi are soilborne fungi that can trap and digest nematodes by means of specialized trapping structures.
- Most nematode-trapping fungi can live both saprophytically on organic matter and as predators by capturing tiny animals.
- Nematode-trapping fungi are usually not host specific and can trap all types of soil nematodes.
- About 300 species of nematode-trapping fungi have been reported from different regions of the world, most of them belonging to *Arthrobotrys*, *Cystopage*, *Monacrosporium*, *Nematoctonus*, and *Zoophagus*



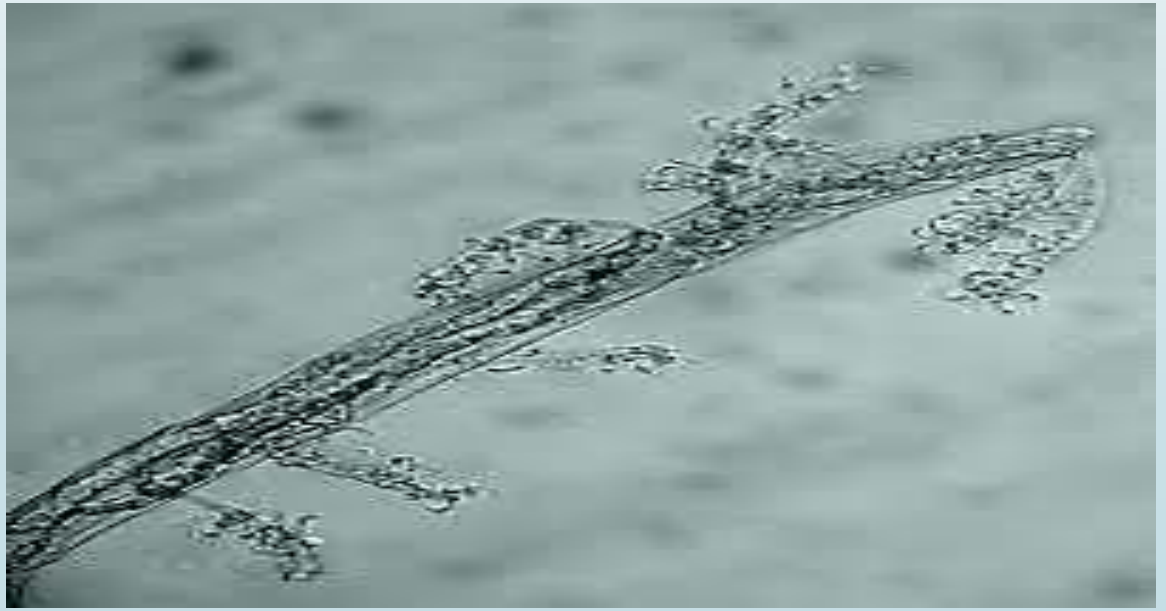
Mechanisms of Trapping

- Adhesive Hyphae
- Adhesive Branches
- Adhesive Net
- Adhesive Knops



Endoparasitic Fungi

- Endoparasitic fungi does not form specialized structures to infect nematodes but rather they use their spores (conidia or zoospores) to this function.
- Most of this group are obligate parasites of nematodes
- The spores of these fungi infect the nematode when ingested,
- *e.g. Harposporium* spp. and *Verticillium* spp.



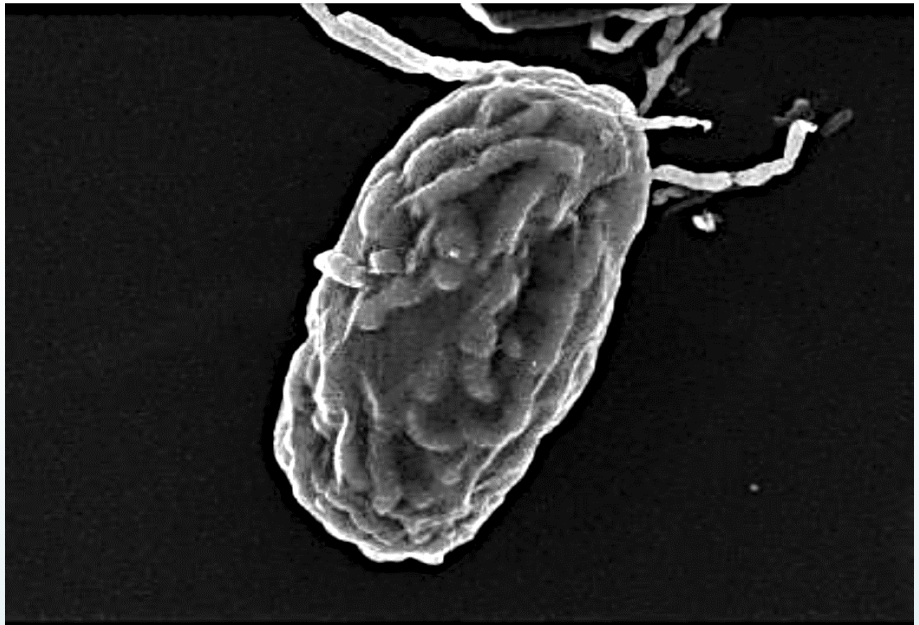
Egg Parasitic Fungi

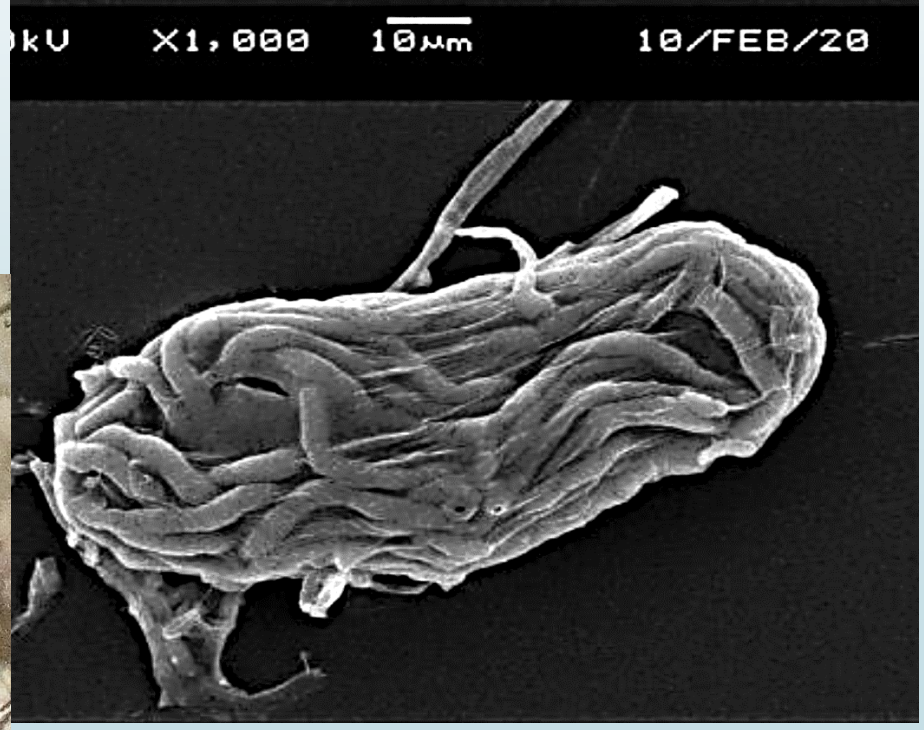
The fungal Hyphae develops a terminal swollen structure

Then Narrow infectious tube is developed

The tube penetrates the egg shell

Then fungal hyphae consume the egg nutrients





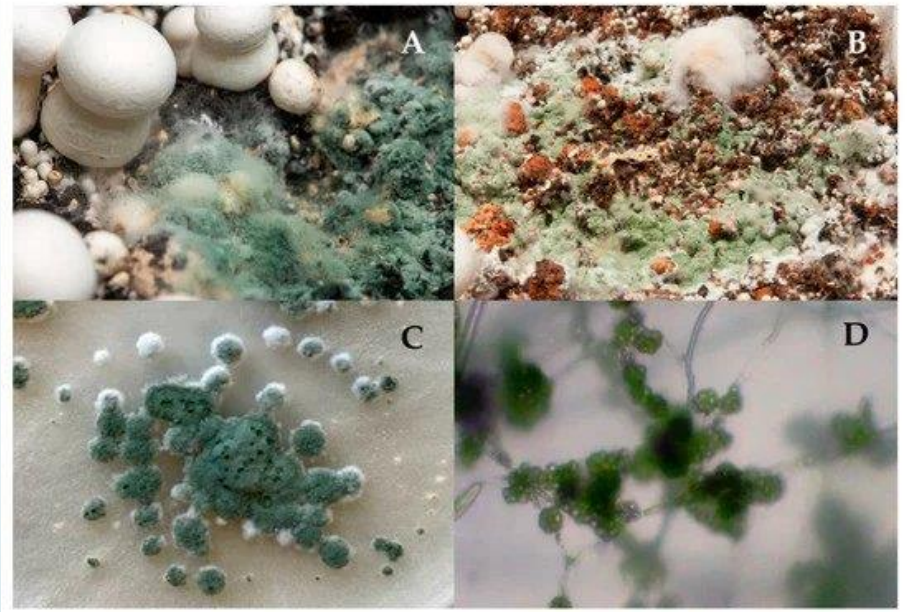
e.g. *Paecilomyces* sp. & *Trichoderma* sp.

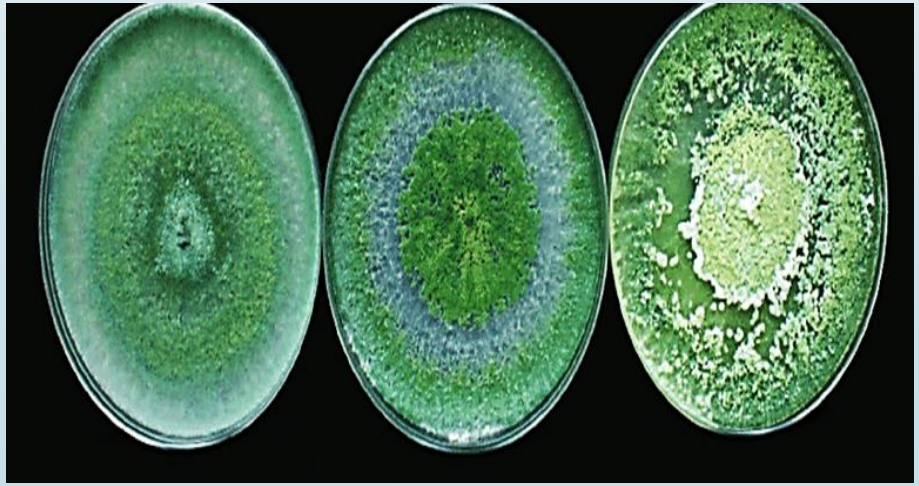
Nematicidal Activity of Chitinase Producing Fungi

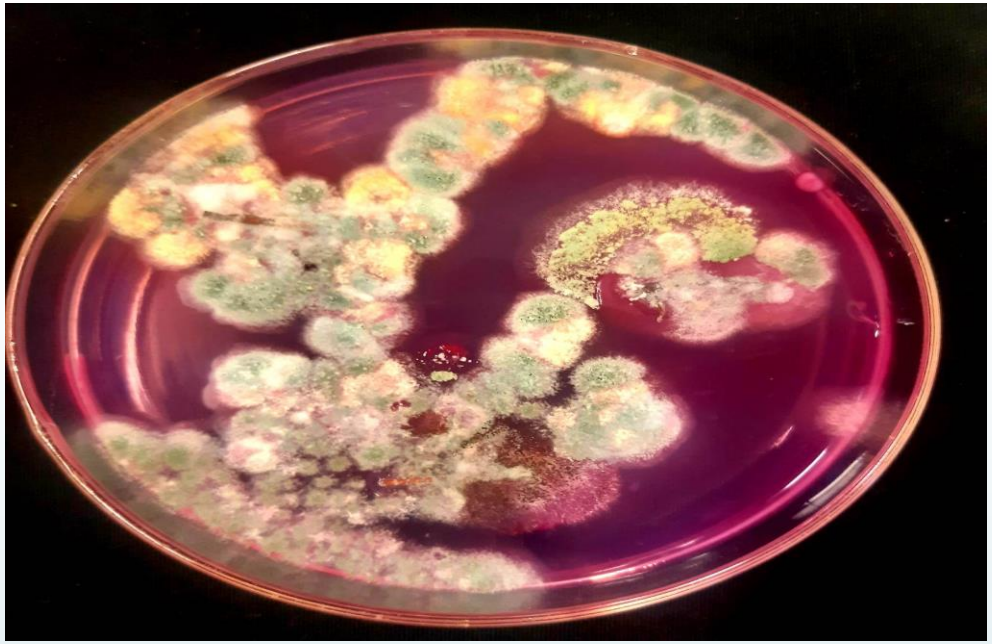
- Chitin, the most abundant aminopolysaccharide in nature, is a rigid and resistant structural component that contributes to the mechanical strength of chitin-containing organisms.
- Chemically, chitin is a linear polymer composed of N-acetylglucosamine (GlcNAc) subunits.
- Chitin is the main component of Nematode egg shell.
- Chitinases are hydrolytic enzymes that catalysing the degradation of chitin.
- These enzymes are secreted effectively by diverse soil fungi
- Microbial chitinolytic enzymes is promising in the antagonistic activity against pathogenic chitin-containing organisms such nematodes these enzymes has the key role in fungal parasitism activity by creating infection sites in nematode egg shell

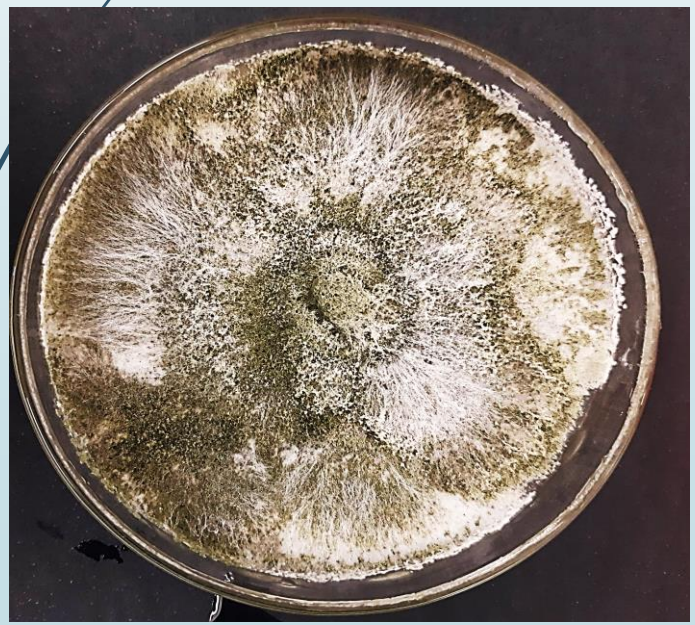
Trichderma spp. as a Promising model of Bionematicide

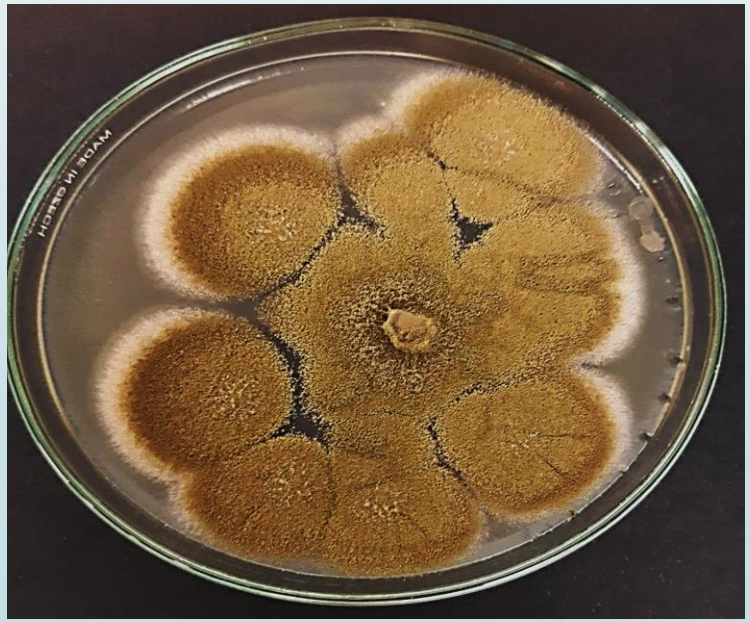
- Trichoderma spp. acts as prominent biological control agents as they can protect the root system against plant parasitic nematodes attack
- This biocontrol agent can colonize the root surface and is strongly parasitic to eggs and egg masses of plant parasitic nematode
- They are a good producer of chitinases and proteases which enable them to degrade the nematode egg shell
- They are strong competitors for place and nutrients

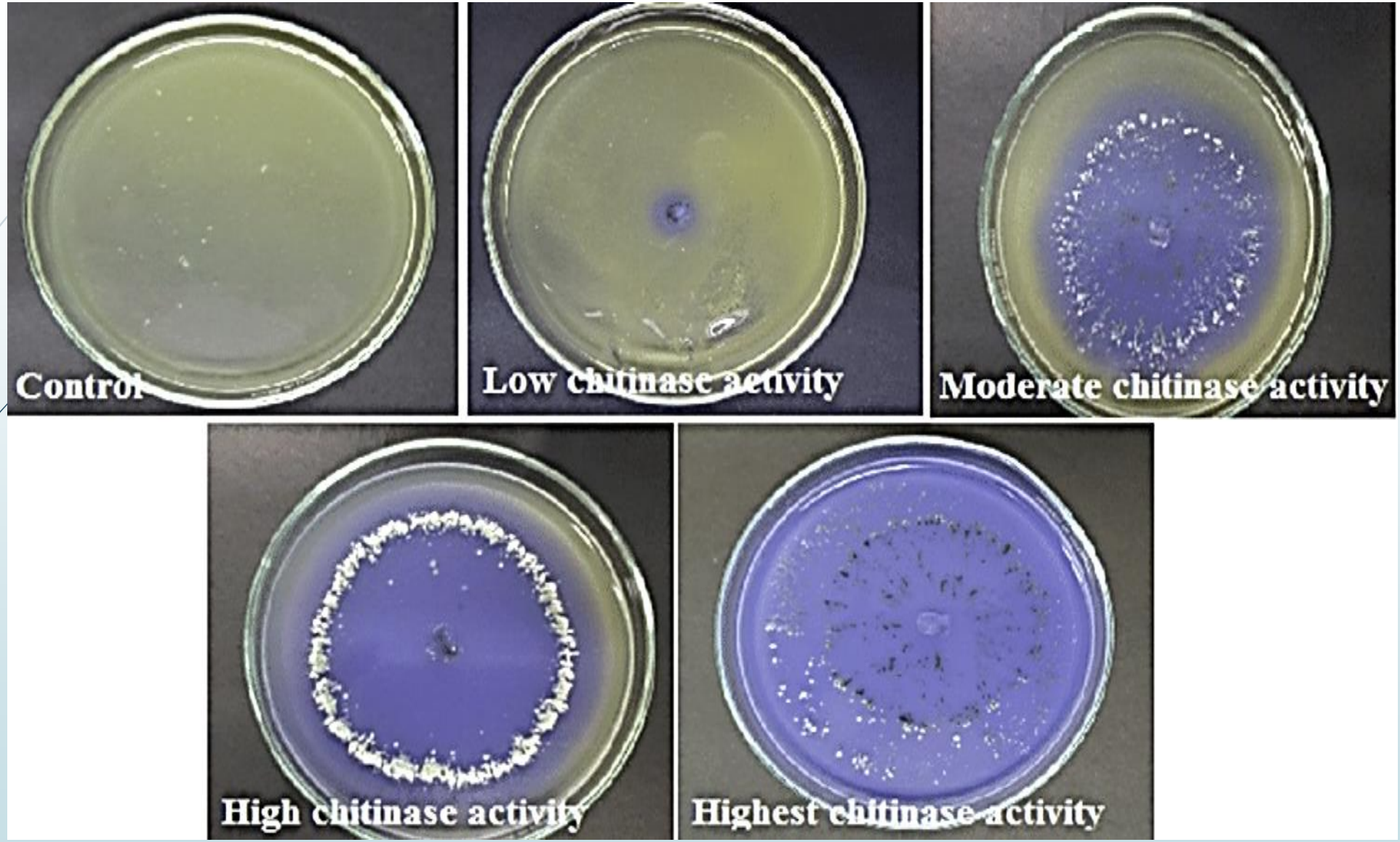











Control
Low chitinase activity
Moderate chitinase activity
High chitinase activity
Highest chitinase activity

Control

Treated

Conclusion

- Climate change is the most significant problem that recognized recently as threat to food system sustainability and food security.
- The over application of synthetic pesticides contribute to climate change through greenhouse gas emissions (GHG) and toxic soil depositions.
- At this crucial time, there is a pressing need to more sustainable crop production practices.
- In this respect, filamentous fungi can be an interesting biocontrol alternative.
- They are able to reduce the damage caused by plant-parasitic nematodes directly by parasitism, antibiosis and by the production of lytic enzymes.
- They also proved to minimize harm by space and resource-competition and by providing higher nutrient and water uptake to the plant.
- Therefore, the use of beneficial soil fungi as nematicidal agents is a promising strategy in agriculture against plant-parasitic nematodes.

Thank you